A

MANUAL OF DISSECTION

AND

PRACTICAL ANATOMY.

FOUNDED ON

GRAY AND GERRISH.

BY

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ILLUSTRATED WITH 220 ENGRAVINGS, 116 OF WHICH ARE COLORED.

PROSUNT QUAE OMNIBUS

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TO

ELMER F. CLAPP, M.D.,

FORMERLY PROFESSOR OF ANATOMY IN THE UNIVERSITY OF IOWA,

IN RECOGNITION OF HIS SCHOLARLY ATTAINMENTS AND

ABILITY AS A TEACHER OF HUMAN ANATOMY,

THIS BOOK IS DEDICATED BY THE

AUTHORS,

HIS FORMER PUPILS.

PREFACE.

THE present work has a twofold purpose, namely, to provide the student with a detailed guide for dissection, and to answer the requirements of the physician and surgeon wishing to review the anatomy of any region. The directions for dissecting and identifying the various structures of the human body have been given in full detail, with particular care as to sequence, so that each item of instruction should appear in its natural and most useful relationship. The general arrangement adopted is, first, to give the landmarks, then the integumentary incisions, and, finally, the description and relations of succeeding anatomical entities. Special effort has been devoted toward achieving precision in directions for locating every structure—a matter of the utmost importance, particularly for the surgeon.

Inasmuch as most students prefer *Gray* and *Gerrish*, this Dissector has been prepared for practical use with either. The publishers have placed at our disposal the incomparable series of illustrations found in these two standard works. The student can, therefore, enjoy the advantage of having in the dissecting-room a full and detailed guide for his work, presenting to his eye the same pictures with which he is familiar in his study and class-room.

It scarcely needs to be said that no dissector can take the place of a standard descriptive anatomy. The arrangement of these two classes of books is opposite and correlative, the text-books following the systemic order, and the dissectors being necessarily regional. To increase the usefulness of the present volume it has been developed along this line to such an extent that it might with propriety be entitled a Regional Anatomy as well as a Dissector. It is hoped that the careful and complete treatment of the various areas will enable it to serve the needs of the surgeon and post-mortem pathologist.

Much effort has been bestowed upon the tables, owing to the advantage this method offers for the presentation of anatomical knowledge systematically and clearly.

Acknowledgments are due to the following anatomists: Dr. De Lee Shaw has tabulated with absolute fidelity to *Gray* and *Gerrish* the blood vascular system; Dr. C. M. Jackson prepared the articles on metamerism and conduction paths of the spinal cord and brain; Dr. H. E. Santee read the proof on dissection of the nervous system; Drs. Burkholder and Conboy read proof of the sections on the

thorax and abdomen, and rendered valuable service in advising the judicious parenthetic use of the new nomenclature; Dr. P. Gad Kitterman tabulated the meningeal vessels, and cranial and spinal nerves; Dr. J. S. Brown assisted in reading the proof, and, moreover, made valuable suggestions regarding the legitimate scope of the book; Dr. Mortimer Frank kindly furnished some of the illustrations. We are deeply indebted to Dr. Lewellys F. Barker for suggestions of a conservative nature looking to exactitude in dissecting-room study.

Finally, acknowledgment is due to the works of *Gray* and *Gerrish,* on whose texts the present volume is founded, and from which most of the illustrations are drawn.

CHICAGO, November, 1902.

CONTENTS.

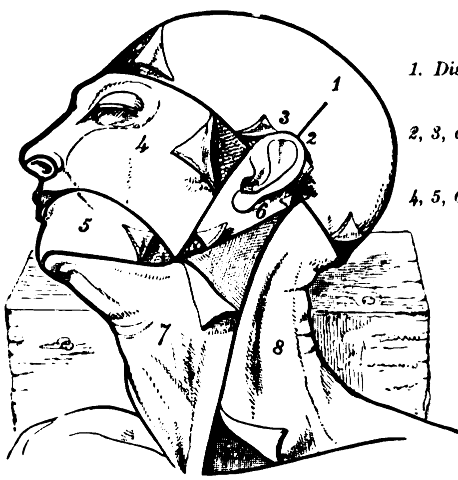
A MANUAL OF DISSECTION.

CHAPTER I.

THE FACE.

Dissection and Identification. Fill the mouth with cotton and sew the lips together. Remove the integument as indicated in Fig. 1. Consult the illustrations and identify the structures found on the cadaver by comparison. Follow order given in text, viz.: mental, infra-orbital, pterygoid, supra-orbital structures, and parotid gland. After these have been studied then turn attention to the muscles, vessels, and nerves.

FIG. 1.



Dissection of the head, face, and neck. (GRAY.)

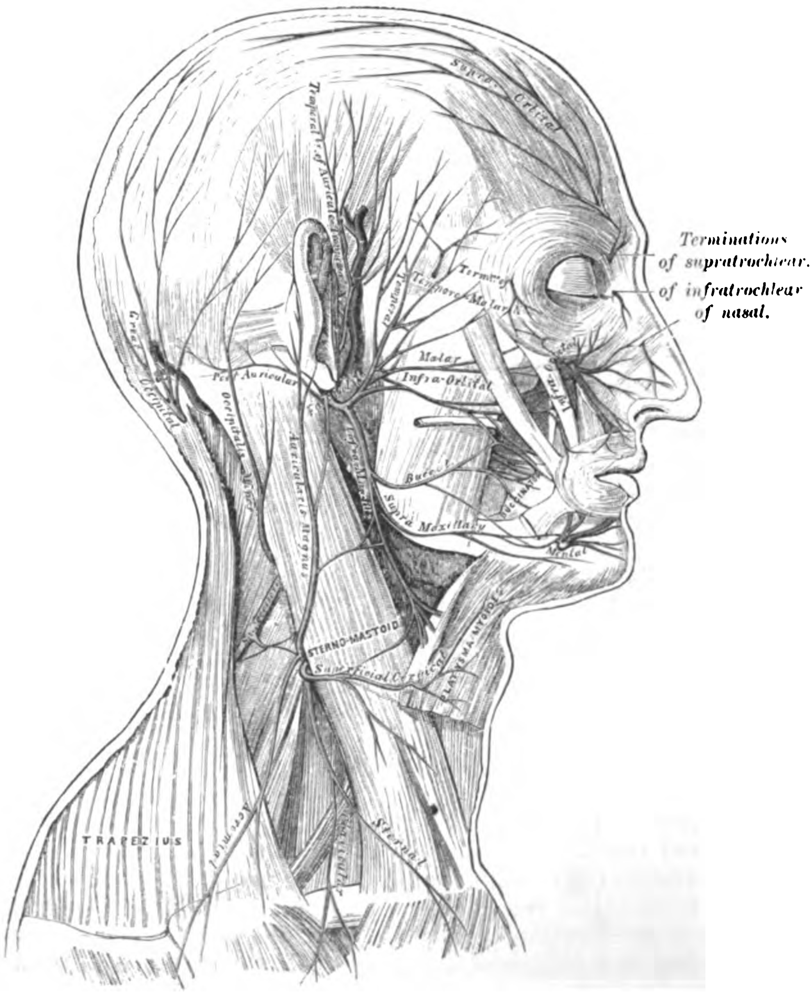
The Mental Nerve. The mental nerve is the cutaneous part of the inferior dental, a branch of the third division of the trifacial. The inferior dental, a sensory nerve, traverses the mandibular canal in the lower jaw, giving in its course branches to the teeth, called the dental; to the gums, called the gingival. The cutaneous branches communicate with branches of the facial, a motor nerve.

The Mental Artery is a branch of the inferior dental; it emerges through the mental foramen. The inferior dental artery, a branch of the internal maxillary, in its course through the canal in the mandible, gives dental branches to the teeth, gingival to the gums. The mental artery, on emerging through the mental foramen, anastomoses with the inferior labial branch of the facial.

The Infra-orbital Nerve emerges through the infra-orbital foramen with vessels of like name (foramen is under cover of the levator labii superioris muscle) and breaks up into a leash of branches. Communications between it and the facial form the infra-orbital plexus, which lies between the levator labii superioris and the levator anguli oris. The infra-orbital nerve is a continuation of the superior maxillary division of the fifth nerve. It traverses the sphenomaxillary fossa and infra-orbital canal, giving dental branches to the upper teeth; gingival branches to the gums; infra-orbital branches to the skin of the nose, eyelid, and upper lip, and is accompanied by the artery and vein of same name.

The Infra-orbital Artery emerges from the infra-orbital foramen, anastomoses with the facial, and is a branch of the internal maxillary, which in turn is a terminal of the external carotid artery. The artery traverses the infra-orbital canal in the floor of the orbit, giving dental branches to the teeth, gingival branches to the gums, cutaneous branches to the nose, eyelid, and upper lip. The veins accompany the artery, take the same name, traverse the same territory, convey the blood in an opposite direction, to the pterygoid plexus.

FIG. 2.



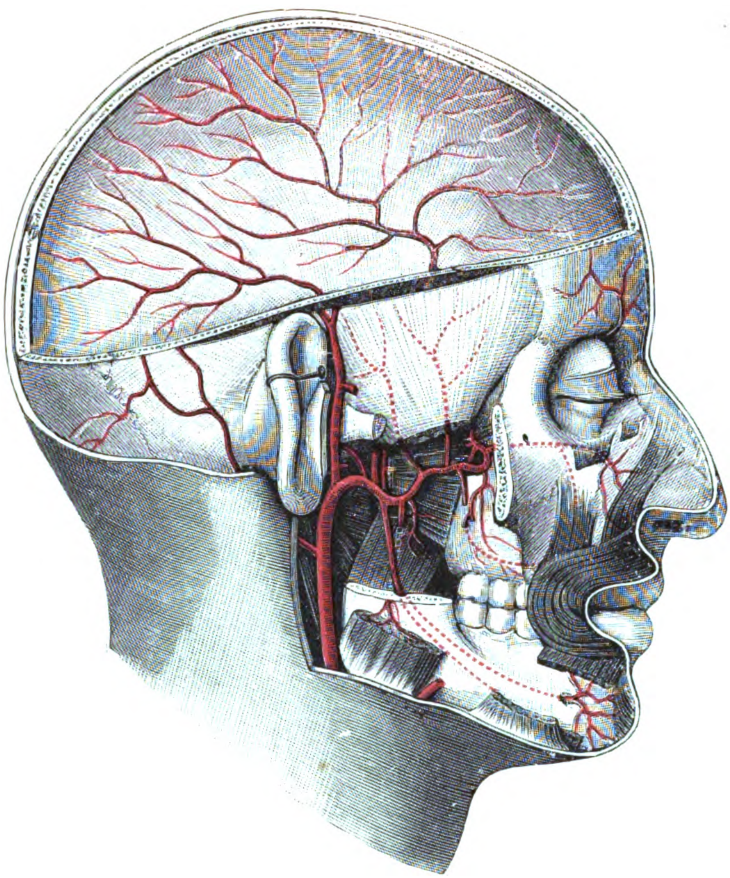
The nerves of the scalp, face, and side of the neck. (GRAY.)

The Pterygoid Plexus is formed by a confluence of veins from the deep parts of the face. It derives its name from its location on the external pterygoid muscle. The veins returning the blood are the inferior dental, the infra-orbital, and certain muscular branches. These veins form a plexus between the external pterygoid and the temporal muscles, preparatory to uniting to form the internal maxillary vein. The veins forming the plexus correspond to the branches of the internal maxillary artery, while the internal maxillary vein corresponds to the internal maxillary artery itself. The internal maxillary joins the temporal vein in the parotid gland to form the external jugular. The veins of the pterygoid plexus have no valves. They communicate in front with the facial vein by the deep facial; at the base of the skull and with the cavernous sinus in the dura mater by the emissary veins.

The Supra-orbital Nerve. The supra-orbital nerve is a branch of the ophthalmic division of the trifacial; it passes through the supra-orbital foramen in the frontal bone, and supplies the skin of the eyelid and forehead with sensation; it communicates with the facial nerve, and is accompanied by the vessels of like name.

The Supra-orbital Artery is a branch of the ophthalmic; it traverses the supra-orbital foramen, and anastomoses with the superficial temporal artery.

FIG. 3.



Internal maxillary artery. (GERRISH after TESTUT.)

The Parotid is the largest salivary gland; it weighs about one ounce, and is covered by a very dense fascia, which is continuous above with the temporal, in front with the masseteric, and below with the cervical fascia.

LIMITATIONS. *Superiorly*, the zygomatic arch; *inferiorly*, the mastomandibular line; *anteriorly*, the mid-line of the masseter; *posteriorly*, the ear and sternomastoid muscle; *internally*, the styloid process.

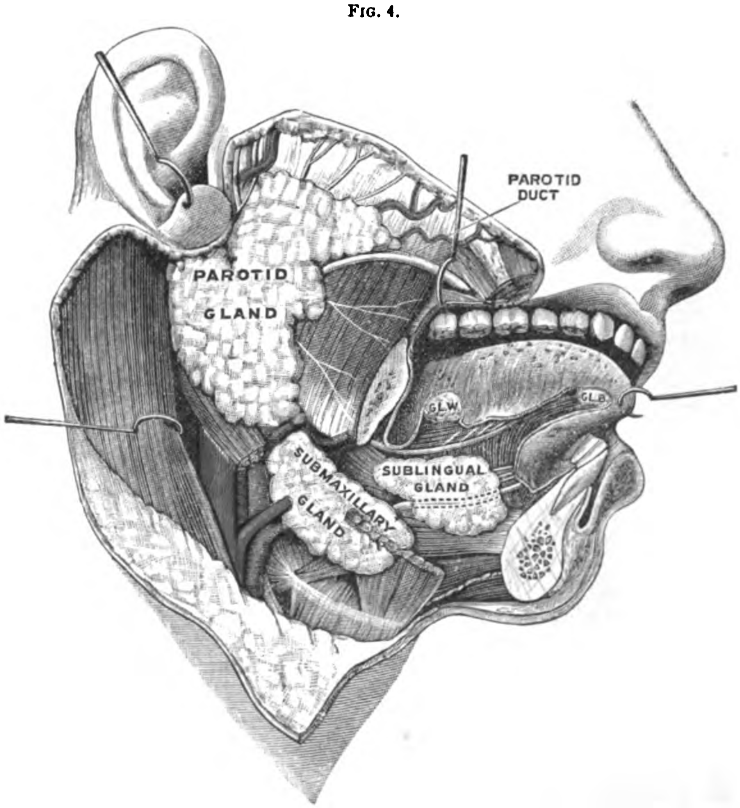
SURFACES. The anterior surface of the gland embraces the mandible; the outer surface is lobulated and covered by the parotid fascia, superficial fascia, and the skin; the inner surface embraces the styloid process of the temporal bone; while the internal carotid artery and the internal jugular vein are in close relation with its deep surface.

CONTENTS. 1. The facial nerve, whose temporofacial and cervicofacial divisions give off the pes anserinus. 2. The auriculotemporal nerve, a branch of the superior maxillary. 3. The external jugular vein, formed by a confluence of the posterior division of the temporomaxillary and posterior auricular veins. 4. The external carotid artery, which breaks up into the temporal, internal maxillary, transverse facial, and posterior auricular arteries.

THE BLOOD-SUPPLY is derived from the external carotid, temporal, internal maxillary, posterior auricular, and transverse facial arteries. The veins which accompany the arteries from the parotid gland empty into the external jugular and take the name of the arteries.

NERVE-SUPPLY. 1. Sympathetic, from the carotid plexus. 2. Motor, from the facial. 3. Sensory, from the great auricular and auriculotemporal. 4. Vaso-

FIG. 4.



The salivary glands. The right half of the body of the mandible has been removed. GL. W., gland of Weber. GL. B., gland of Blandin. (GERRISH after TESTUT.)

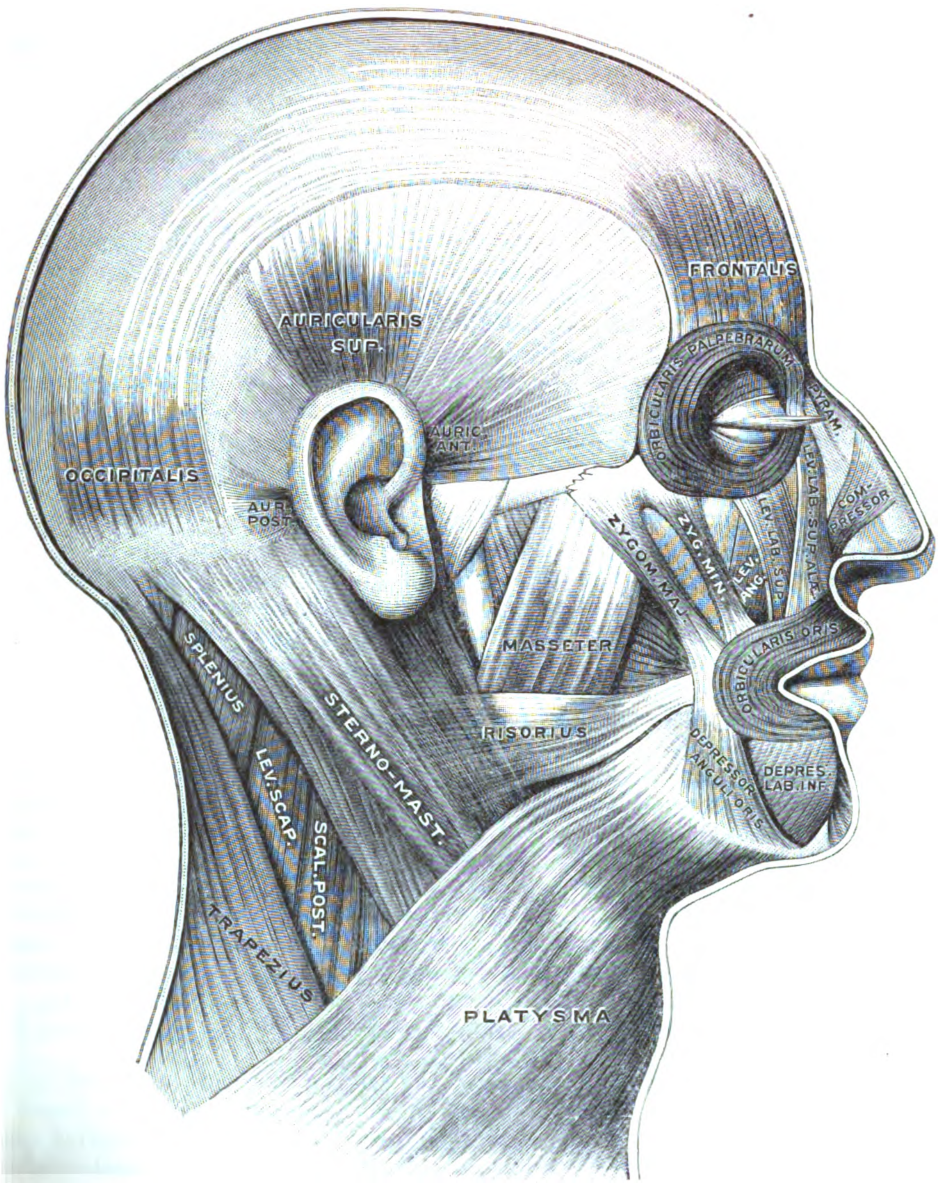
dilator, from the ninth nerve, *via* tympanic, small superficial petrosal, otic ganglion, third division of fifth, and auriculotemporal.

STENSON'S DUCT is the excretory conduit of the parotid gland. It lies in a line extending from the lower part of the lobule of the ear to the middle of the upper lip. It is about a quarter of an inch in diameter, and in its course crosses the masseter muscle, perforates the buccinator, and opens into the vestibule of the mouth opposite the second upper molar tooth. The duct is about one and one-half inches long, and the distal one-half inch lies between the mucous membrane and the buccinator muscle, the mucous membrane forming the valve. The duct may receive a tributary from the glandula socia parotidis—a small, detached portion of the parotid gland on the masseter muscle. The parotid gland is separated from the submaxillary by the stylomaxillary ligament.

THE MUSCLES OF FACIAL EXPRESSION.

The Orbicularis Oris surrounds the mouth. It has two series of fibres: 1. An inner, which surrounds the mouth by continuity. 2. An outer, which decussates at the angles and intermingles with fibres of all muscles, above and below, that antagonize it. The continuous fibres constitute the labial, the decussating fibres

FIG. 5.



Superficial muscles of head and neck. (GERRISH after TESTUT.)

the facial portion of the muscle. The labial fibres are pale, thin, and not attached to the bone. The decussating fibres are thinner, broader, attached to the alveolar processes, and have muscles inserted into them. The muscle is closely connected, both to the skin and to the mucous membrane. The labial glands and coronary vessels are between the mucous membrane and the muscle. Attachments, cartilage of the nasal septum, incisive fossa of the maxilla, incisive fossa of the mandible.

The Zygomaticus Major. *Origin:* The malar bone. *Insertion:* The angle of mouth. The facial artery and vein are beneath, while Stenson's duct passes under this muscle.

The Zygomaticus Minor. *Origin:* The malar bone. *Insertion:* The upper lip. It may be incorporated with the zygomaticus major, and it requires care to distinguish the two muscles.

The Levator Labii Superioris. *Origin:* The superior maxillary bone above the infra-orbital foramen. *Insertion:* The facial part of the orbicularis oris. Beneath the muscle is the infra-orbital plexus, formed by the fifth and seventh nerves, and also the anastomoses of the infra-orbital and facial arteries. Action, elevates and protrudes the lip.

The Levator Anguli Oris. *Origin:* The canine fossa. *Insertion:* The facial part of the orbicularis oris. Between it and the preceding muscle is the infra-orbital plexus.

The Levator Labii Superioris Alæ que Nasi. *Origin:* The nasal process of the superior maxillary bone. *Insertions:* 1. The nasal cartilage of the ala of the nose. 2. Facial part of the orbicularis oris.

The Levator Menti, or Levator Labii Inferioris. *Origin:* The incisive fossa. *Insertion:* The facial part of the orbicularis oris and skin of the chin.

The Depressor Labii Inferioris. *Origin:* The oblique line of the mandible, below and internal to the mental foramen. *Insertion:* The facial part of the orbicularis oris. The muscle is quadrate, hence called quadratus menti. The outer and lower part of the muscle is covered by the depressor anguli oris. Action, draws the lip downward and outward.

The Depressor Anguli Oris. *Origin:* The external oblique line below the cuspid, bicuspid, and first molar teeth. *Insertion:* The corner of the mouth.

The Risorius. *Origin:* The masseter fascia. *Insertion:* The angle of the mouth. The muscle is horizontal, varies in size and shape, and draws the angle back. Morphologically, it is a divorced part of the platysma.

The Platysma Myoides has (1) a facial part; (2) a cervical part. The facial part covers the facial vessels and supramandibular branch of the facial nerve. The muscle arises from the pectoral and deltoid fasciæ, and is inserted into a part of the orbicularis oris. This muscle depresses the mandible.

The Orbicularis Palpebrarum surrounds the base of the orbit and covers the eyelids. The interval between the lids is the palpebral fissure. The extremes of the fissure are the outer and inner canthi. The muscle consists of two parts: 1. An inner, that covers the lids, called the palpebral portion. The fibres of this are pale and thin, and not completely under control of the will. 2. An outer part, spread over the margins of the orbit. The fibres of this part are thicker, voluntary, and mingle with the occipitofrontalis, corrugator supercilii, levator labii superioris alæ que nasi, levator labii superioris, and zygomaticus minor. The muscle has the following attachments: 1. The nasal process of the maxillary bone. 2. The internal angular process of the frontal bone. 3. The lower margin of the orbit. 4. The tendo oculi.

The Tendo Oculi. At the inner angle of the eye is a thin cord, one-sixth of an inch long. It arises from the nasal process of the superior maxilla, in front of the lacrymal groove. The tendon divides into two parts. One is inserted into the upper lid; the other into the lower lid. A part of the tendon is attached to the lacrymal sac and margins of the lacrymal groove, in which the sac rests. The tendo oculi aids indirectly the flow of tears into the lacrymal sac.

The Tensor Tarsi is a deep part of the orbicularis palpebrarum, specialized for drawing the eyelids and lacrymal canals into a position most favorable for receiving the tears. The muscle arises from the crest of the lacrymal bone, passes across the lacrymal sac, and divides into two portions, which are inserted into the upper and lower tarsal cartilages.

The Corrugator Supercilii. *Origin*: The inner end of the superciliary ridge. *Insertion:* The under surface of orbicularis palpebrarum. This muscle produces vertical wrinkles of the forehead by drawing the eyebrows downward and inward.

The Levator Palpebræ arises from the lesser wing of the sphenoid, above and in front of the optic foramen, and is inserted into the tarsal plate of the upper lid.

The Pyramidalis Nasi arises from the occipitofrontalis, and is inserted, with the compressor nasi, into the fibrocartilage of the ala of the nose. It produces transverse wrinkles on the bridge of the nose by drawing the eyebrows down.

The Occipitofrontalis consists of (1) an anterior belly, (2) an intermediary aponeurosis, (3) a posterior belly. The posterior belly arises from the outer two-thirds of the superior curved line of the occipital and mastoid process of the temporal bones. The frontal part is very thin. The internal fibres are continuous with the pyramidalis nasi; the middle and outer fibres are blended with the corrugator supercilii and orbicularis palpebrarum. The two bellies are united by an aponeurosis. The muscle raises the eyebrows.

The Attrahens Aurem. *Origin:* The aponeurosis of the occipitofrontalis. *Insertion:* The helix. The retrahens aurem arises from the mastoid and is inserted into the concha. The attollens aurem arises from the aponeurosis of the occipitofrontalis, and is inserted into the pinna. In man these muscles are rudimentary.[1] (See Chapter VII., External Ear.)

The Compressor Naris arises from the canine fossa. It is inserted into the dorsum of the nose, joining here its fellow of the opposite side. The muscle is triangular. Its origin is concealed by the levator labii superioris alæ que nasi.

The Compressor Narium Minor arises from the fibrocartilage of the nose, and is inserted into the skin of the end of the nose.

The Dilator Naris Posterior arises from the margin of the nasal notch and sesamoid cartilages, and is inserted into the skin near the margin of the nostril. The muscle is partly under cover of the levator labii superioris alæ que nasi.

The Dilator Naris Anterior is in front of the preceding muscle. It arises from the alar cartilage, and is inserted into the skin near the margin of the nose.

The Depressor Alæ Nasi arises from the incisive fossa, and is inserted into the septum and alar cartilage of the nose.

The Buccinator arises from (1) the pterygomaxillary ligament; (2) the alveolar process of the upper jaw; (3) the alveolar process of the lower jaw. *Insertion*: The orbicularis oris in this manner: The upper and lower fibres converge toward the angles of the mouth, where they decussate to become continuous with the fibres of the orbicularis oris. The highest and lowest fibres do not decussate. The buccinator and superior constrictor of the pharynx are united by the pterygomaxillary ligament, and form a continuous muscular wall for the mouth and pharynx. The pterygomaxillary ligament may be readily felt in a patient. This is one of the structures so painfully put on the stretch in prolonged operations on the mouth and teeth. This ligament extends from the hamular process to the posterior extremity of the mylohyoid ridge near the wisdom tooth. The principal use of the ligament, then, is to form a common attachment for the superior constrictor of the pharynx and buccinator. The buccinator muscle expels air and widens the mouth, but its principal use is to assist the tongue in keeping food between the molar teeth during mastication. (See Muscles of Mastication.)

The Buccinator Fascia takes its name from the muscle which it invests and strengthens. This fascia adheres closely to the outer surface of the muscle, and must be removed to appreciate the direction of the muscular fibres. The fascia is thin in front and dense behind, where it is continuous with the aponeurosis of the pharynx; it strengthens the junction between the mouth and pharynx, and for this reason it is called the buccopharyngeal fascia. Owing to the strength of this fascia, and to the great vitality of the buccinator and superior constrictor muscles of the pharynx, abscesses do not readily break into the mouth and pharynx.

[1] Also called attrahens, attollens, and retrahens auriculam.

Summary. The facial muscles are called muscles of expression. The three muscles about the ear are no longer muscles of expression in man, but they still retain this function in the horse and some other lower animals. The muscles about the inlet of the nose are all but obsolete in man, and should be studied on lower animals; their names are perpetuated in human anatomy for comparative and morphological purposes only. The buccinator is intermediate between the muscles of expression and those of mastication. The platysma is given somewhat to expression, being, from an artistic stand-point, the chief agent in derision; but the main function of this muscle is to depress the mandible.

The Nerve-supply of the facial muscles may be summed up: The motor oculi supplies the levator palpebræ. The fifth and seventh nerves supply the buccinator. All the others are supplied by the facial nerve. The fifth nerve supplies the skin of the face with sensation.

The involuntary muscular fibre of the eyelids and the muscle of Müller (a name given to some fibres crossing the sphenomaxillary fissure) are supplied by the sympathetic nerves, called white rami communicantes. These white rami originate in the motor roots of the thoracic spinal nerves, pass to corresponding vertebral ganglia of the gangliated cord, in which they ascend to the superior cervical ganglion, where they arborize about the cells, whose axons continue the journey upward with ascending branches of the superior cervical ganglion to the Gasserian ganglion. Here a second arborization occurs, whence axonic processes accompany the first division of the fifth nerve to the orbit. (See Gerrish.)

TABLE OF MUSCLES OF EXPRESSION.

Name.	*Origin.*	*Insertion.*	*Function.*
Orbicularis oris.	Alveolus.	Reciprocal.	Closes lips.
Levator labii superioris.	Superior maxilla.	Upper lip.	Draws lip upward; expresses sadness.
Levator anguli oris.	Canine fossa.	Angle of lip.	Elevates angle.
Depressor labii inferioris.	Oblique line.	Lower lip.	Depresses lip.
Depressor anguli oris.	Oblique line.	Angle of lip.	Depresses angle.
Levator menti.	Incisive fossa.	Skin of chin.	Protrudes lip.
Zygomaticus major.	Malar bone.	Angle.	Laughing.
Zygomaticus minor.	Malar bone.	Upper lip.	Sadness.
Buccinator.	Alveolus, pterygomaxillary ligament.	Orbicularis oris.	Assists tongue.
Levator labii superioris alæ que nasi.	Nasal process, superior maxillary.	Lip and nose.	Elevates lip and nose.
Pyramidalis nasi.	Occipitofrontalis.	Nasal cartilage.	Elevates ala.
Dilator naris posterior.	Nasal notch.	Skin of nostril.	Enlarges aperture.
Dilator naris anterior.	Ala of nose.	Skin of ala.	Enlarges aperture.
Compressor naris.	Superior maxillary.	Nasal cartilage.	Compresses alæ.
Compressor narium minor.	Alar cartilage.	Skin.	Compresses alæ.
Depressor alæ nasi.	Incisive fossa.	Septum.	Depresses.
Corrugator supercilii.	Superciliary ridge.	Orbicularis palpebrarum.	Frowning.
Orbicularis palpebrarum.	Superior maxilla and frontal.	Surrounds orbit.	Closes lids.
Tensor tarsi.	Lacrymal bone.	Tarsal plate.	Compresses lacrymal sac.
Levator palpebrarum.	Ala of sphenoid.	Tarsal plate.	Lifts upward lid.
Attrahens aurem.	Aponeurosis occipitofrontalis.	Helix.	Forward.
Retrahens aurem.	Mastoid.	Concha.	Backward.
Attollens aurem.	Aponeurosis occipitofrontalis.	Pinna.	Upward.
Platysma myoides.	Deltoid and pectoral fasciæ.	Lower lip.	Melancholy.
Risorius.	Masseteric fascia.	Corner of mouth.	Laughing.

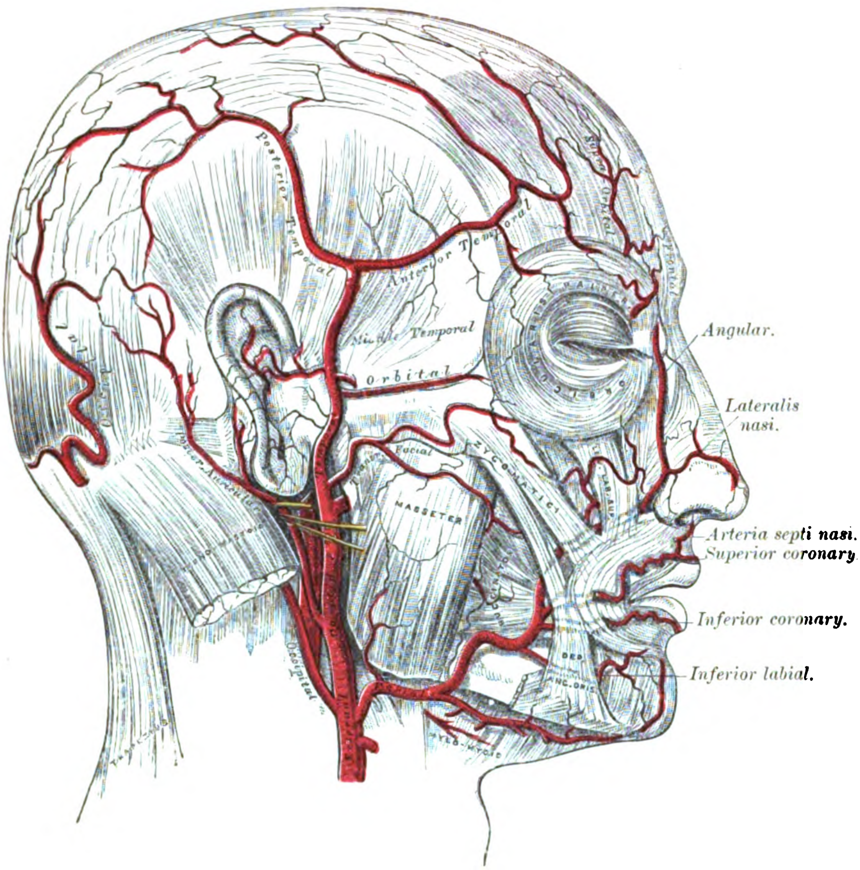
FACIAL ARTERY AND VEIN.

The Facial Artery has two stages: cervical and facial. The cervical stage extends from the external carotid artery, in the superior carotid triangle, to the anterior part of the masseter muscle, on the lower border and outer surface of the mandible. This artery and the lingual may arise by a common trunk. In its course upward and forward the cervical part of the facial artery passes beneath the hypoglossal nerve, the posterior belly of the digastric, stylohyoid muscle, and submaxillary salivary gland. The vein passes superficial to the four preceding structures.

Branches of Cervical Stage. (1) Ascending or inferior palatine; (2) tonsillar; (3) glandular; (4) muscular; (5) submental. The general course of the artery is from a point on the lower border of the mandible, in front of the masseter muscle, to the root of the nose.

The facial stage of the artery rests on the mandible, buccinator, and levator anguli oris, and passes beneath the zygomatics, risorius, and levator labii superioris

Fig. 6.



The arteries of the face and scalp.[1] (Gray.)

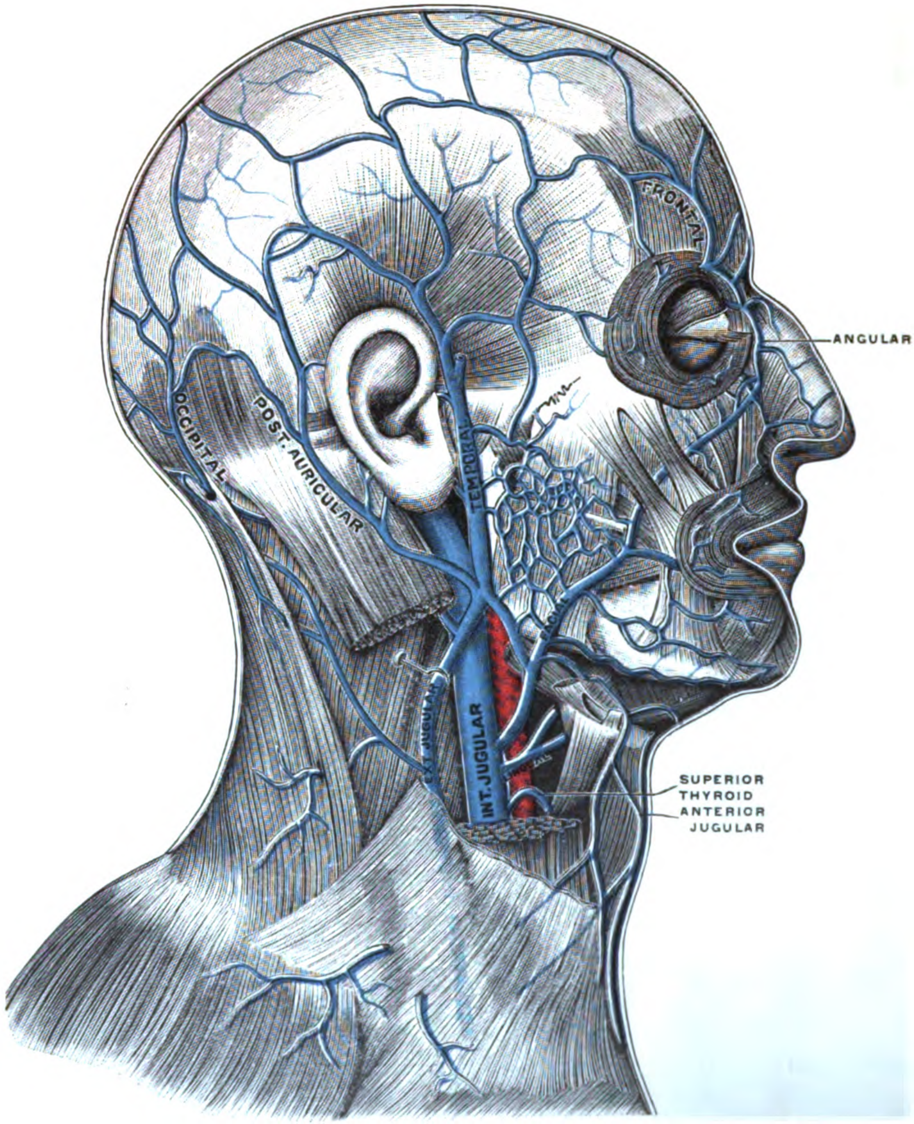
muscles, and the supramandibular and buccal branches of the facial nerve. (See Shaw's Table, Chapter XXXI.)

Branches of Facial Stage. (1) Masseteric; (2) buccal; (3) inferior labial; (4) inferior coronary; (5) superior coronary; (6) lateralis nasi; (7) angular. The masseteric branches pass to the masseter and anastomose with the transverse facial branch of the temporal and the masseteric branches of the internal maxillary artery. The buccal branches pass to the buccinator and anastomose with the internal maxillary, infra-orbital, and transverse facial arteries. The inferior labial passes beneath the depressor anguli oris and over the depressor labii infe-

[1] The muscular tissue of the lips must be supposed to have been cut away, in order to show the course of the coronary arteries.

rioris, supplying the skin and muscles. The inferior coronary passes beneath the depressor anguli oris to the angle of the mouth, thence between the mucous membrane and the orbicularis oris to the lower lip, and anastomoses with the fellow of the opposite side. The superior coronary passes beneath the zygomaticus major, between the mucous membrane and orbicularis oris of the upper lip, and anastomoses with its fellow of the opposite side. The lateralis nasi is given off opposite

FIG. 7.



Superficial veins of the cranium and face, right lateral view. (GERRISH after TESTUT.)

the wing of the nose and passes along the side of the nose to anastomose (*a*) with its fellow of the opposite side; (*b*) with the nasal branches of the ophthalmic. The angular is the termination of the facial artery, and anastomoses at the inner canthus with the nasal branch of the ophthalmic artery.

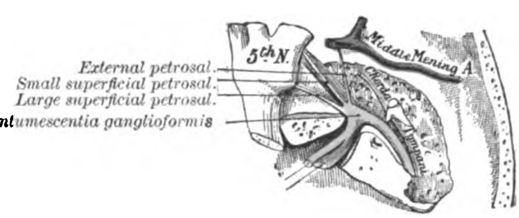
The Facial Vein has cervical and facial stages, and extends obliquely across the face from the inner angle of the orbit to a point on the lower border of the mandible, in front of the masseter muscle. From this point the vein traverses the digastric triangle and enters the internal jugular in the superior carotid triangle. In the cervical stage the facial vein passes superficially to: 1. The submaxillary gland. 2. The digastric muscle. 3. The stylohyoid. 4. The hypoglossal nerve. On the mandible the vein is posterior to the artery. In the facial part of the course the vein is superficial to: 1. The levator labii superioris. 2. The levator anguli oris. 3. The levator labii superioris alæ que nasi. It passes beneath the platysma and zygomatic muscles. *Tributaries:* The frontal, lateralis nasi, supra-orbital, transverse facial, superior and inferior coronary veins. Near the angle of the jaw the facial vein communicates with the external jugular.

The superficial veins of the face and scalp communicate with the deep veins of the face in the region of the muscles of mastication and with the sinuses of the dura mater as follows: The angular communicates with the ophthalmic. The ophthalmic communicates with the cavernous sinus. The deep facial connects the facial vein and pterygoid plexus. The deep temporal connects the deep and superficial temporal veins. The vein of Vesalius connects the cavernous sinus and pterygoid plexus. The pterygoid plexus is between the temporal and external pterygoid muscles. It is formed by the confluence of veins from the region supplied by the internal maxillary artery. It communicates with the cavernous sinus in the dura mater through small veins, among which is the vein of Vesalius, as previously stated.

FACIAL NERVE.

Course in the Temporal Bone. The facial nerve enters the internal auditory meatus on the posterior surface of the petrosa with the auditory nerve and artery, and at the bottom of the meatus enters the facial canal—aquæductus Fallopii. In its course it passes (1) between the roof and inner wall of the tympanum above the fenestra ovalis; (2) between the inner and posterior walls of the tympanum to the stylomastoid foramen. The geniculate ganglion is situated on the nerve, where the latter turns backward and outward to enter the tympanic part of its course; it gives off the large superficial, small superficial, and external petrosal nerves.

FIG. 8.



The course and connections of the facial nerve in the temporal bone. (GRAY.)

Branches in the Facial Canal. 1. The great superficial petrosal, a branch of the geniculate ganglion, is joined by filaments from the carotid plexus, as it leaves the cranium, under the name of Vidian, through the foramen lacerum medium; it passes along the Vidian canal and joins Meckel's ganglion in the sphenomaxillary fossa.

2. The small superficial petrosal nerve, a branch of the geniculate ganglion, leaves the cranium through the canalis innominatus, between the foramen ovale and spinosum in the greater wing of the sphenoid bone, and joins the otic ganglion. The nerve receives the tympanic branch of the glossopharyngeal (Jacobson's nerve), which supplies the parotid gland, reaching the same through the otic ganglion, inferior maxillary division of the trigeminus, and the auriculotemporal nerve.

3. The external petrosal nerve joins the sympathetic plexus on the middle meningeal artery, near the foramen spinosum, and is distributed with this artery.

4. The tympanic branch to the stapedius, the smallest muscle of the body, pierces the pyramid on the inner surface of the tympanum.

5. The chorda tympani is a sensory nerve, and, while given in anatomies as a branch of the seventh nerve, is in reality functionally not so. It accompanies the seventh nerve in the same manner as the descendens hypoglossi—a deep cervical nerve—accompanies, in a part of its course, the hypoglossal nerve, and appears to be a branch thereof.

The chorda tympani is an aberrant branch of the glossopharyngeal nerve. It originates in the nucleus of the glossopharyngeal nerve, and, as the pars intermedia, passes with the seventh nerve in the facial canal to the iter chordæ posterior, whence it traverses the middle ear and reaches the tongue through the lingual branch of the inferior maxillary division of the trifacial under the name of the chorda tympani. It supplies the submaxillary and sublingual glands, and confers the sense of taste on the anterior two-thirds of the tongue. (See Gerrish.)

6. A branch is given off two lines above the stylomastoid foramen to the auricular branch of the vagus nerve.

Branches at the Stylomastoid Foramen. 1. To the stylohyoid and posterior belly of the digastric (digastric branch). 2. To the attollens aurem, retrahens aurem, and posterior belly of the occipitofrontalis muscle (posterior auricular nerve).

Branches on the Face and Neck. Subdivisions, two: cervicofacial (or lower) and temporofacial (or upper).

The cervicofacial division is distributed, as its name implies, to the neck and lower parts of the face. *Branches:* Inframandibular, supramandibular, buccal.

(*a*) The inframandibular branch skirts the angle of the mandible, is distributed to the platysma, and communicates with the superficial cervical nerve, a branch of the cervical plexus.

(*b*) The supramandibular branch crosses the masseter muscle, lies on the body of the mandible, communicates with the mental branch of the mandibular nerve at the mental foramen, and supplies the inferior segment of the orbicularis oris and muscles inserted into the same.

(*c*) The buccal branch crosses the masseter muscle below Stenson's duct, enters a quantity of fat in front of the masseter muscle, and supplies the buccinator muscle. This nerve communicates with the long buccal branch of the inferior maxillary division of the fifth nerve. The buccal branches from the fifth and seventh nerves unite to form a plexus, from which the buccinator muscle is supplied with motion, and the skin, glands, and mucous membrane of the cheek with sensation.

The temporofacial or upper division of the facial nerve is larger than the cervicofacial. It crosses the neck of the mandible and external carotid artery. It receives communicating branches from the auriculotemporal, and divides into the temporal, malar, and infra-orbital branches.

(*a*) The temporal branches cross the zygomatic and supply the anterior part of the occipitofrontalis, corrugator supercilii, tensor tarsi, and upper segment of the orbicularis palpebrarum. They communicate with the supra-orbital, temporal, lacrymal, and auriculotemporal nerves.

(*b*) The malar branches cross the malar bone and supply the orbicularis palpebrarum. They pass beneath the zygomatic muscles and communicate with the infra-orbital, lacrymal, and malar branches of the superior maxillary.

(*c*) The infra-orbital branches cross the masseter, pass beneath, and supply the zygomatic muscles, and are distributed to the muscles of the nose, upper lip, and orbicularis palpebrarum. They communicate with the nasal and infratrochlear branches of the ophthalmic, the buccal branches of the facial, and the infra-orbital branches of the superior maxillary.

MUSCLES OF MASTICATION.

Dissection and Identification.

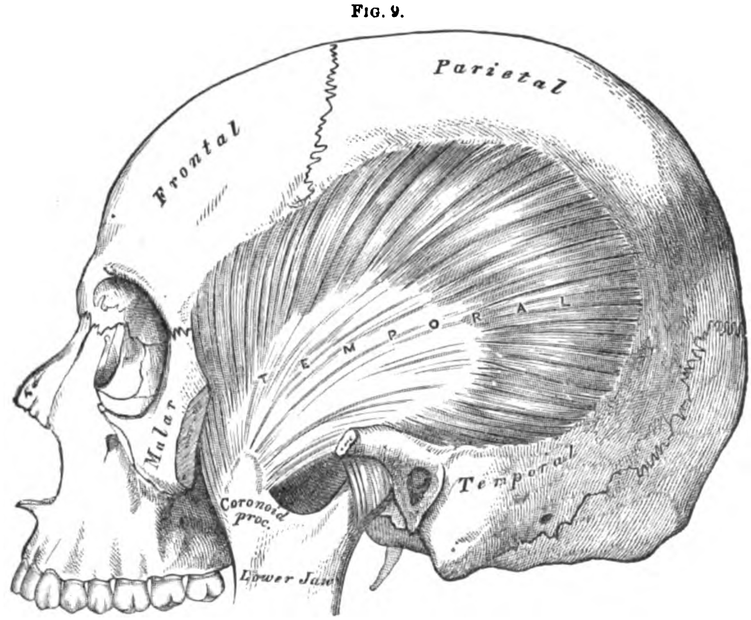
Temporal Fascia. Identify (1) by its origin from the temporal ridge, its insertion into the upper border of the zygomatic arch, and its location on the temporal muscle; (2) by the dense fibrous structure. *Dissection:* Cut at several attachments; remove and expose the subjacent temporal muscle.

Temporal Muscle. Identify (1) by its origin from the temporal ridge and deep part of the temporal fascia; (2) by its insertion into the coronoid process. *Dissection:* Saw through the ends of the zygomatic arch and turn same down with the attached masseter muscle.

Masseteric Fascia. Identify (1) by its location on the outer surface of the masseter muscle; (2) by its continuity with the parotid and temporal fasciæ.

Masseter Muscle. Identify (1) by its origin from the zygomatic arch and its insertion into the outer surface of the ramus; (2) by its superficial relation to the pes anserinus. *Dissection:* Turn down with the zygomatic arch previously sawn through and find its nerve passing through the sigmoid notch.

FIG. 9.



The temporal muscle, the zygoma and masseter having been removed. (GRAY.)

External Pterygoid Muscle. Identify (1) by its origin from the greater wing of the sphenoid and pterygoid plate; (2) by its insertion into the condylar process and interarticular fibrocartilage.

Internal Pterygoid Muscle. Identify (1) by its origin from the external pterygoid plate; (2) by its insertion into the inner surface of the ramus. *Dissection:* These muscles cannot be dissected until the mandible has been sawn through at the symphysis menti and the tongue split. Then work from the inner surface.

Buccinator. Depress the jaw and put the muscle on the stretch; then identify by its location opposite the molar teeth and its attachment to the alveolar processes.

The muscles of mastication derive their nerve-supply from the fifth; their blood-supply from the internal maxillary artery. They are inserted into and move the mandible on the upper jaw for triturative purposes. The buccinator is also a muscle of facial expression, and is further innervated by the seventh nerve. Their collective use is the mastication of solid food; hence the collective name, muscles of mastication.

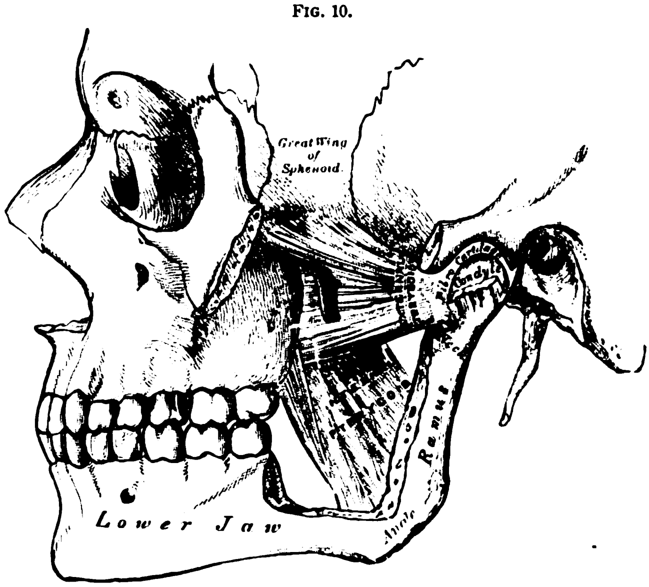
The Temporal Fascia. The temporal fascia covers the greater part of the temporal muscle. It arises from the temporal ridge. It is inserted into both the outer and inner borders of the superior part of the zygomatic arch, and is continuous below with the masseteric fascia. It is in relation superficially with the temporal vessels, the auriculotemporal nerve, and the temporal branches of the facial nerve.

The Temporal Muscle. *Origin:* (1) The temporal ridge; (2) the temporal fascia; (3) the greater part of the temporal fossa. *Insertion:* Coronoid process of the mandible. *Action:* To close and retract the jaw. *Synergists:* The masseter and internal pterygoid. *Antagonists:* Digastric, platysma, hyoid depressors, and gravity. *Nerve-supply:* The temporal branches of the inferior maxillary division of the trigeminus. *Blood-supply:* The muscular branches from the second stage of the internal maxillary artery.

The Masseteric Fascia covers the masseter muscle. It is attached above to the zygomatic arch; below to the posterior and inferior borders of the ramus. It is continuous above with the temporal, posteriorly with the parotid fascia, and is in relation superficially with the pes anserinus, part of the parotid salivary gland, and Stenson's duct.

The Masseter Muscle. *Divisions:* Superficial and deep layers. *Origin:* (1) The lower border of the malar bone and anterior two-thirds of the lower border of the

FIG. 10.



The pterygoid muscles, the zygomatic arch, and a portion of the ramus of the jaw having been removed. (GRAY.)

zygomatic arch; (2) the inner surface of the zygomatic arch and the posterior third of the lower border of the zygomatic arch. *Insertion:* The outer surface of the ramus. *Action:* To close the mouth and draw the jaw forward. *Synergists:* Temporals and pterygoids. *Antagonists:* The same that antagonize the temporal muscle. *Nerve-supply:* The masseteric branch of the inferior maxillary division of the trigeminus. Its nerve passes through the sigmoid notch of the ramus with the masseteric vessels. *Blood-supply:* The muscular branches of the second stage of the internal maxillary artery.

The External Pterygoid Muscle. *Heads:* (1) Upper; (2) lower. *Origin of upper head:* The greater wing of the sphenoid, internal to the pterygoid ridge, and external to the foramen ovale and foramen spinosum. *Origin of lower head:* The outer surface of the external pterygoid plate. *Insertion of upper head:* The interarticular fibrocartilage, the capsule of the joint, and neck of the condyle. *Insertion of lower head:* The neck of the condyle. *Action:* To draw the condyle and interarticular fibrocartilage forward and inward. *Synergists:* Superficial layer of masseter and internal pterygoid. *Antagonists:* The temporal and deep layers of the masseter. *Nerve-supply:* The pterygoid branch of the inferior maxillary division of the trigeminus. *Blood-supply:* The second stage of the internal maxillary artery.

The Internal Pterygoid Muscle. *Origin*: (1) The inner surface of the external pterygoid plate; (2) the tuberosity of the palate and adjacent part of the maxilla. *Insertion:* The internal surface of the ramus, as high as the mandibular foramen

FIG. 11.

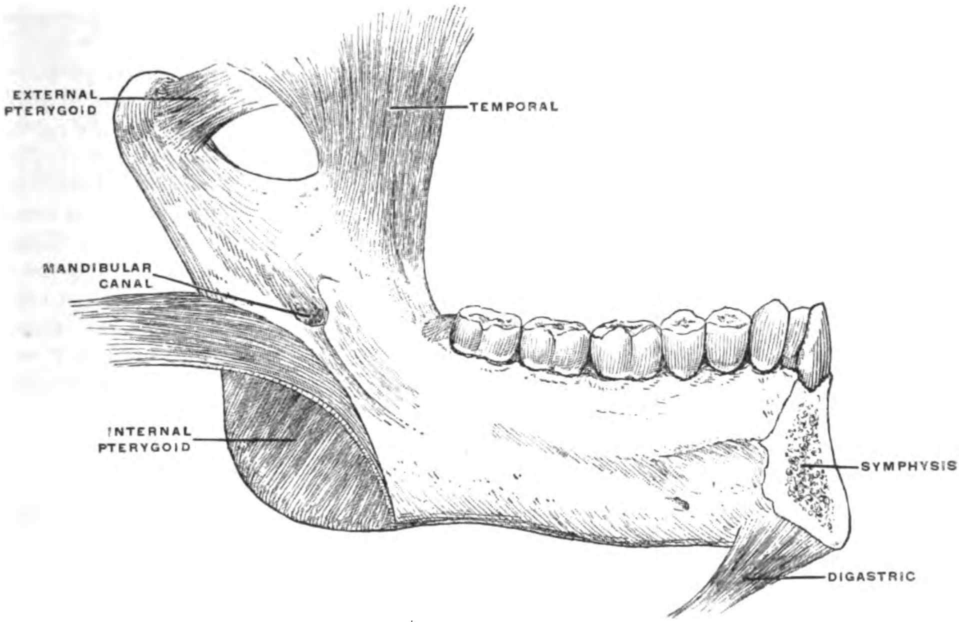
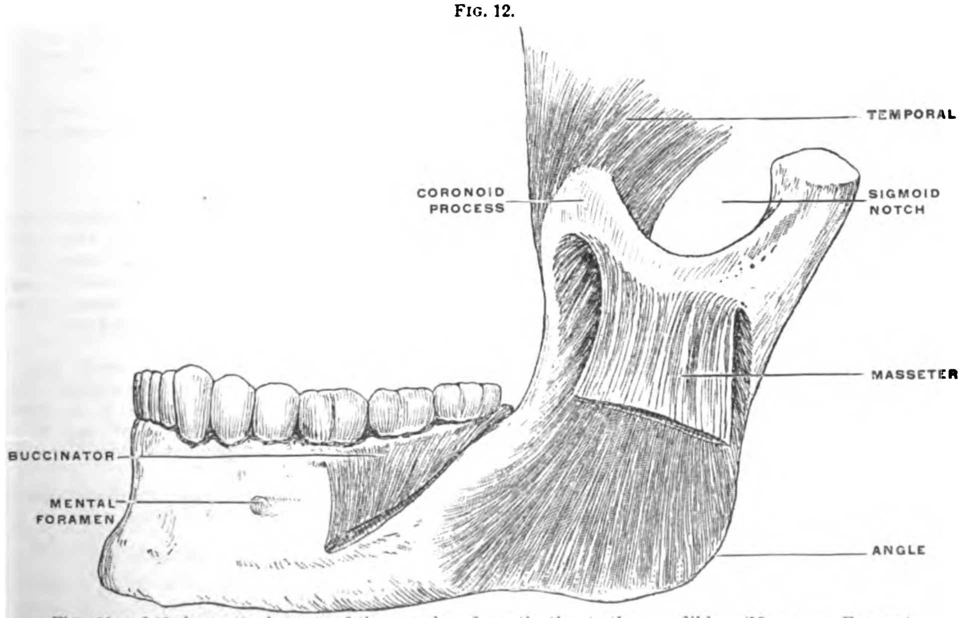


FIG. 12.



Figs. 11 and 12 show attachments of the muscles of mastication to the mandible. (MORTIMER FRANK.)

and mylohyoid groove. *Action:* To close the mouth and draw jaw forward and to the opposite side. *Synergists:* The temporal and masseter muscles. *Antagonists:* The digastric and platysma. *Nerve-supply:* The inferior maxillary division of the trigeminus. *Blood-supply:* The second stage of the internal maxillary artery.

The Buccinator arises from: (1) The pterygomaxillary ligament; (2) the alveolar process of the upper jaw; (3) the alveolar process of the lower jaw. It is inserted into the orbicularis oris in this manner: The upper and lower fibres converge toward the angle of the mouth, where they decussate to become continuous with the fibres of the orbicularis oris. The highest and lowest fibres do not decussate. The buccinator and superior constrictor of the pharynx are united by the pterygomaxillary ligament forming a continuous muscular wall for the mouth and pharynx. The ligament extends from the hamular process to the posterior extremity of the mylohyoid ridge near the wisdom tooth. The principal use of the ligament, then, is to form a common attachment for the superior constrictors of the pharynx and buccinator. The buccinator muscle expels air from the mouth, widens the mouth, and assists the tongue in keeping the food between the molar teeth during mastication. *Nerve-supply:* The fifth and seventh cranial nerves.

The Buccinator Fascia takes its name, according to a general rule, from the muscle which it invests and strengthens. This fascia adheres closely to the outer wall of the muscle, and must be removed to appreciate the direction of its fibres. It is thin in front and dense behind, where it is then continuous with the aponeurosis of the pharynx, and consequently strengthens the junctional area between the mouth and pharynx; for this reason it is called the buccopharyngeal fascia. Owing to the strength of this fascia, and to the great vitality of the buccinator and superior constrictor muscles of the pharynx, abscesses do not readily break into the mouth and pharynx.

TABLE OF MUSCLES OF MASTICATION.

Name.	*Origin.*	*Insertion.*	*Action.*	*Paralytic symptoms.*
Masseter.	Malar process of superior max.; anterior two-thirds lower border zygomatic arch.	Angle and lower one-half of outer surface of ramus.	To draw jaw forward and upward.	Lessened ability to protrude chin.
	Inner surface zygomatic arch; post. one-third of lower border.	Outer surface of upper half of ramus and coronoid process.	To draw jaw up and back.	Lessened ability to retract and elevate jaw.
Temporal.	Temporal ridge and fossa.	Coronoid process.	Ant. half elevates the jaw; post. half retracts and elevates jaw.	Partial loss of power to elevate and retract jaw.
External pterygoid.	Ala of sphenoid.	Interarticular cartilage.	To draw cartilage inward and forward onto the eminentia articularis.	A peculiar creaking noise produced by the condyle riding over the stationary fibrocartilage; noise both subjective and objective symptom.
	Outer surface of external pterygoid plate.	Neck of condyle.	To draw jaw forward and inward.	Inability to move jaw toward the affected side; when chin is depressed deviation of jaw to paralyzed side (Gowers).
Internal pterygoid.	Inner surface of external pterygoid plate; tuberosities of palate and superior maxilla.	Inner surface of lower half of ramus.	To draw jaw forward, upward, and to the opposite side.	Inability to draw closed jaw forward.
Buccinator.	Outer surfaces of both upper and lower alveolar processes; pterygomaxillary ligament.	Orbicularis oris.	To abduct corners of mouth; to force food into vestibule.	Inability to widen the mouth; pendulous cheeks during mastication.

Summary of Nerve-supply.

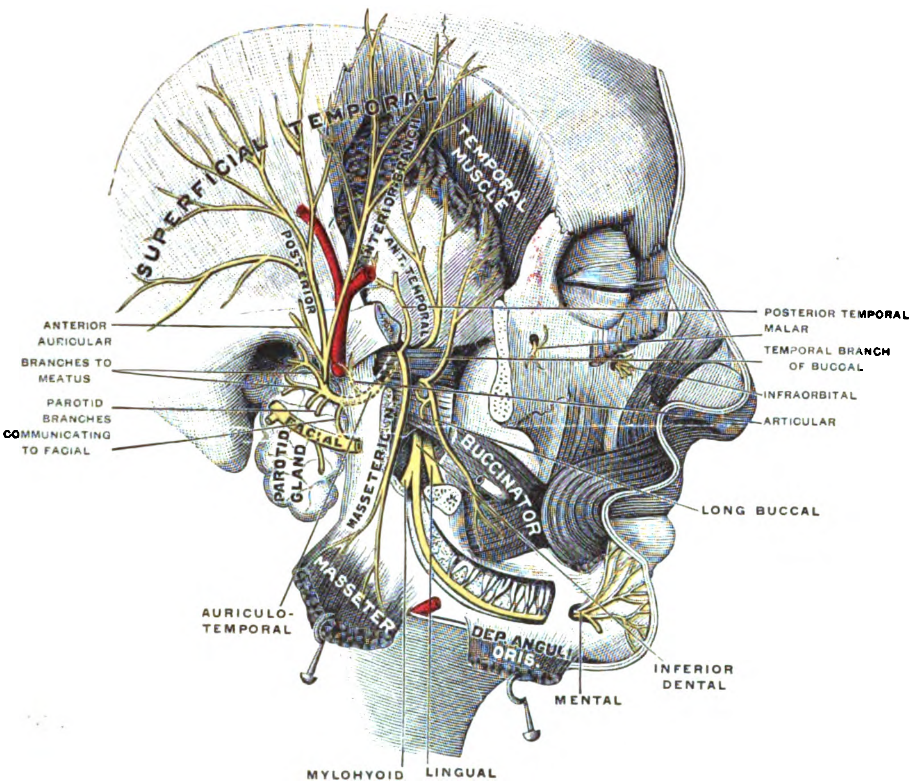
The buccinator receives a motor branch from the seventh and a sensory from the fifth nerve. The remaining muscles are innervated by the inferior maxillary division of the fifth nerve.

Masseter. The nerve to the masseter passes outward above the external pterygoid muscle with the masseteric vessels, through the sigmoid notch of the ramus, and enters the inner surface of the muscle.

Temporal. There are interior and posterior deep temporal nerves, probably corresponding to like physiological portions of the muscle which they supply. They pass over the upper border of the external pterygoid muscle, to the temporal muscle, and bone.

External Pterygoid. The branch to this muscle is from the long buccal nerve.

FIG. 13.



Mandibular division of the trifacial nerve. (GERRISH after TESTUT.)

Internal Pterygoid. The nerve to this muscle is distributed to the inner surface of the muscle.

The Buccinator. The long buccal nerve passes between the upper and lower heads of the external pterygoid, with the buccal artery, and subsequently under cover of the temporal and masseter muscles to the buccinator muscle, and divides into the sensory branches for the skin and cheek. This muscle derives its motor branches from the seventh nerve. The muscles of mastication derive their blood-supply from the second or pterygoid stage of the internal maxillary artery. Collectively, branches of both the artery and nerves are called muscular; individually, each takes the name of the muscle it supplies.

TEMPOROMANDIBULAR ARTICULATION.

Osteological Elements of the Temporomandibular Region. The tympanic plate is a thin lamina which forms the posterior part of the glenoid fossa and the anterior wall of the middle ear and external auditory meatus. It terminates externally in the auditory process, below in the vaginal process, above in the Glaserian fissure.

The Eminentia Articularis is the broad, strong, anterior root of the zygomatic process of the temporal bone. It forms the anterior boundary of the glenoid fossa, and is covered with cartilage. The preglenoid tubercle, at the outer end of the anterior root, is for the attachment of a portion of the external lateral ligament.

The Postglenoid Tubercle, or middle root of the zygoma, forms the posterior boundary of the articular part of the glenoid fossa, and separates the auditory process from the articular part of the glenoid fossa.

The Glaserian or petrotympanic fissure is between the squamous and tympanic elements of the temporal bone It separates the articular from the non-articular part of the glenoid cavity. It leads into the tympanum, lodges the processus gracilis of the malleus, and transmits the tympanic branch of the internal maxillary artery to the middle ear.

The Canal of Huguier or iter chordæ anterius is a subdivision of the Glaserian fissure. It transmits the chorda tympani nerve from the tympanum to the zygomatic fossa, where, after communicating with the otic ganglion, it passes beneath the external pterygoid muscle to the outer side of the lingual nerve.

The Glenoid Fossa is situated in a recess between the squamous and tympanic parts of the temporal bone. It is bounded anteriorly by the eminentia articularis, posteriorly by the tympanic plate. The anterior and posterior limiting structures of the glenoid fossa meet at the Glaserian fissure. The glenoid fossa consists of two parts: (1) One anterior to the Glaserian fissure, covered with cartilage and called the mandibular because it articulates with the condyle of the mandible; (2) another, posterior to the Glaserian fissure, and occupied by a part of the parotid gland. The dome of the glenoid fossa is very thin and easily fractured.

The Condylar Process of the mandible consists of (1) a condyle; (2) a neck. The condyle articulates with the articular part of the glenoid cavity. Its convex surface is covered with cartilage. Its transverse axis is greater than its anteroposterior. Its articular surface is surrounded by the origin of the mandibular part of the capsular ligament. The neck is the constricted part of the process below the condyle. It is flattened in front and gives insertion to the external pterygoid muscle.

The Styloid Process is, morphologically, not a part of the temporal bone. It was evolved from the dorsal extremity of the second visceral arch and became united to the inferior surface of the petrosa. It gives origin to three muscles and two ligaments, as follows: stylohyoid muscle, from the back and outer surface; styloglossus muscle, front and lower part of the tip; stylopharyngeus muscle, from internal part of the base; stylomandibular ligament, from tip of the styloid; stylohyoid ligament, from tip of styloid.

The temporomandibular articulation is held in position or its range of movements limited by certain periosteal and fascial ligaments. One of these, the posterior, is always ruptured in dislocation of the jaw.

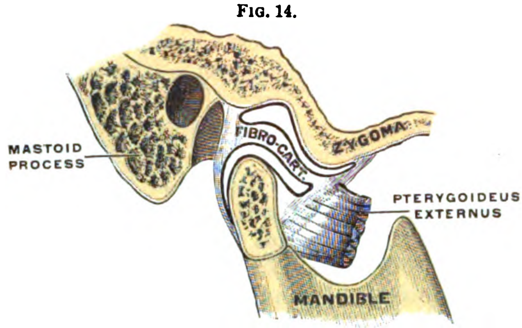
LIGAMENTS OF LOWER JAW.

The ligaments are the following: the capsular ligament; the anterior part of the capsule; the posterior part of the capsule; the internal lateral ligament; the external lateral ligament; the sphenomandibular ligament; the stylomandibular ligament; the interarticular fibrocartilage.

The Capsular Ligament is loose and flabby, and is attached externally to the articular surfaces, above and below. It is in relation internally with the circumference of the interarticular fibrocartilage, and lined by synovial membrane. The anterior, posterior, and lateral parts of the capsule are continuous in such a manner as to encapsulate the joint. (See Gray's *Anatomy.*)

The External Lateral ligament is the strongest part of the capsule. It is attached to the outer surface of the zygoma and to the outer surface of the neck of the condylar process. The synovial membrane lines the compartments of the capsule.

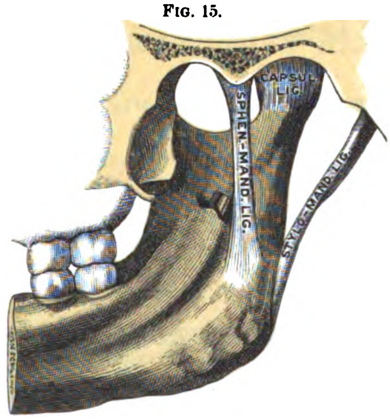
FIG. 14.



Temporomandibular articulation in sagittal section. (GERRISH after TESTUT.)

The upper is larger and looser than the lower. The nerve-supply of this articulation is derived from the masseteric and auriculotemporal branches of the inferior maxillary division of the trifacial nerve. The muscles of mastication move the temporomandibular articulation ; they are supplied by the trifacial nerve ; hence the nerve-supply of the temporomandibular joint is from the trifacial and in harmony with a general law. The interarticular fibrocartilage divides the cavity of the temporomandibular articulation into an upper and a lower portion. It has an upper part accommodated to the surface, over which it glides—concavo-convex antero-posteriorly ; a lower part, corresponding to the articular surface of the

FIG. 15.



Temporomandibular articulation, mesial view. (GERRISH after TESTUT.)

condyle. The circumference of the cartilage, thicker than the central part, is attached to the inner surface of the delicate, loose, flabby, capsular ligament. A few fibres of the external pterygoid muscle are inserted into the anterior part of the cartilage, and by these the same is drawn forward onto the eminentia articularis when the mouth is opened.

The Sphenomandibular (long internal lateral) ligament of the jaw extends from the spine of the sphenoid to the lingula of the mandible. Near the mandibular foramen this ligament is perforated by the mylohyoid nerve. Morphologically, it is a degenerated part of the first visceral arch. Its inner surface is in relation with the internal pterygoid muscle; outer, with the external pterygoid muscle, middle meningeal artery, mandibular nerve, and internal maxillary vessels.

The Stylomandibular ligament is between the masseter and internal pterygoid muscles. It arises from the styloid process near the apex, and is inserted into the posterior border and angle of the mandible. It is of fascial derivation.

Embryology. The temporal bone consists of three genetically distinct parts—petrous, tympanic, and squamous—which at birth are separate from one another.

The Tympanic is the smallest of the three embryonal parts of the bone, and is wedged in between the petrous and squamous parts at the base of the skull in such a way as to form (1) the auditory process around the external auditory canal; (2) the vaginal process and tympanic plate, which latter forms a partition between the middle ear and the glenoid fossa. Union between the tympanic and squamous parts of the bone occurs before birth. Union also occurs between the tympanic and petrous parts, except in the region of the dorsal end of the first visceral arch. Failure to unite here is known as the Glaserian or petrotympanic fissure, located between the articular and non-articular parts of the glenoid fossa. In near relation with the three parts of the temporal bone in the embryo were developing, from an entirely different source, mandible, tympanum, Eustachian tube, bones of hearing, and styloid process. We must see now how these opposite factions became so firmly amalgamated as to make a comprehensive understanding of the adult temporal bone, in its relation to the organs of hearing and mastication, without embryological study an absolute impossibility. We refer to the adjacency of the dorsal extremity of the visceral arches and clefts to the genetic parts of the temporal bone.

The first and second visceral arches and their intervening cleft evolved the bones of hearing, the middle ear, the Eustachian tube, the stylomandibular and sphenomandibular ligaments, the styloid process, and jaw bones before the development of the cranium: the petrosa was subsequently built up *completely* around the middle-ear parts, and *incompletely* about the condyle of the mandible, hence the tympanum and glenoid cavity; perfect union between the tympanic part and petrosa did not occur, hence the Glaserian fissure wedging in the processus gracilis of the malleus.

Table showing the parts in the temporomandibular region, evolved from (1) temporal bone; (2) visceral arches.

Temporal elements.	*Visceral arch structures.*
Auditory process.	Condyle of mandible.
Vaginal process.	Styloid process.
Tympanic plate.	Stylomandibular ligament.
Posterior glenoid tubercle.	Sphenomandibular ligament.
Anterior glenoid tubercle and eminentia articularis.	Tympanic cavity.
Glenoid fossa.	Eustachian tube.
Glaserian fissure and canal of Huguier.	Ossicles of hearing.

DEPRESSIONS AND CANALS.

The locations of depressions and canals in the temporomandibular region, according to the lines of least resistance and junctional areas, are the following:

1. **The Glenoid Fossa** is located between the tympanic and the squamous parts of the temporal bone. It lodges (*a*) condyle of the mandible; (*b*) portion of the parotid gland.

2. **The Glaserian Fissure** is located between the tympanic and petrous portions of the temporal bone. It represents the ununited region between these two parts. It has a subdivision, the canal of Huguier or iter chordæ anterius, through which the chorda tympani passes from the middle ear to the zygomatic fossa.

3. **The Auricular Fissure** is between the auricular process of the tympanic part and the mastoid process of the petrosa. The fissure transmits the auricular

branch of the vagus. This branch supplies the auricular process and communicates with the auriculotemporal branch of the trifacial nerve.

4. **The Tympanum** or middle ear, like the facial canal, is in a junctional area, determined by ossification proceeding from the four ossific nuclei of the petrosa. It was evaginated from the inner part of the first visceral cleft and completely surrounded by the petrosa.

5. **The Facial Canal** extends from the bottom of the internal auditory meatus to the stylomastoid foramen in the petrosa. It lodges the seventh nerve. Its junctional area is determined by the ossification from the opisthotic, pterotic, pro-otic, and epiotic nuclei of the petrosa.

DEPRESSOR AGENTS OF MANDIBLE.

The depressors of the mandible are the following: 1. Gravity—that is, the weight of the jaw. 2. The platysma myoides muscle. 3. The digastric muscle. 4. The mylohyoid muscle. 5. The geniohyoid muscle. These agents are antagonized by the following muscles:

(*a*) The anterior segment of the temporal muscle. (*b*) The masseter muscle. (*c*) The internal pterygoid muscle.

Nerve-supply. The nerve-supply is in harmony with the general rule: nerves that supply the muscles moving a joint supply the joint moved by the muscles. The fifth nerve supplies the muscles of mastication; it also supplies the temporomandibular articulation through (1) the articular branch of the auriculotemporal; (2) the articular branches of the masseteric.

Blood-supply. The blood-supply is from the ascending pharyngeal branch of the external carotid, middle meningeal, and temporal branches of the internal maxillary artery.

Ligamentous Muscles. The ligamentous muscles of the temporomandibular articulation are the temporal, masseter, internal, and external pterygoids. Muscles that cross any joint are said to be ligamentous thereto; they are the elastic ligaments, in contradistinction to the periosteal ligaments.

INTERNAL MAXILLARY ARTERY.

The internal maxillary artery arises from the external carotid in the substance of the parotid gland, behind the neck of the jaw. It traverses the zygomatic fossa, passes between the upper and lower heads of the external pterygoid muscle, and gives off its terminal branches in the sphenomaxillary fossa. It has three portions: maxillary, pterygoid, and sphenomaxillary, and an accompanying internal maxillary vein.

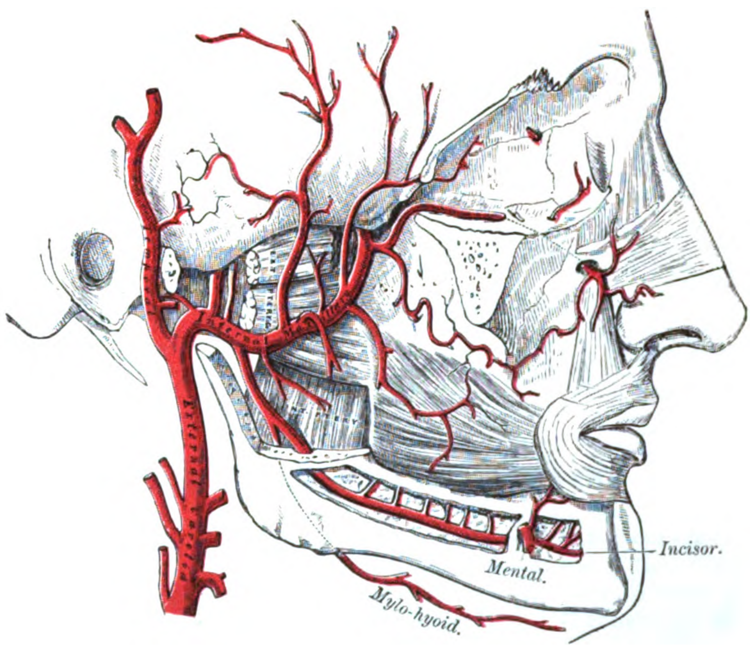
Branches of Internal Maxillary, Tabulated.

Maxillary portion.	*Pterygoid portion.*	*Sphenomaxillary portion.*
Deep auricular.	Masseteric.	Posterior dental (alveolar).
Tympanic.	Deep temporal.	Infra-orbital.
Middle meningeal.	Pterygoid.	The Vidian.
Small meningeal.	Buccal.	The pterygopalatine.
Inferior dental.		The sphenopalatine (nasal).
		The ascending palatine.
		The descending palatine.

The Maxillary Portion is between the neck of the jaw and the internal lateral ligament. From this are given off the following branches: (1) The deep auricular, to the external auditory meatus and drum; (2) the tympanic, which passes through the Glaserian fissure to the middle ear; (3) the middle meningeal, given off between the neck of the jaw and the internal lateral ligament, passes between the two roots of the auriculotemporal nerve, through the foramen spinosum, into the middle fossa of the skull, and is distributed to the dura mater; (4) the small meningeal enters the skull through the foramen ovale and supplies the Gasserian ganglion and dura; (5) the inferior dental accompanies the nerve of the same name, enters the mandibular canal, and is distributed to the teeth and gums of the mandible and to the skin of the chin.

The Pterygoid Portion is between the external pterygoid muscle and the insertion of the temporal. Its branches are: (1) The masseteric, which supplies the masseter muscle and anastomoses with the facial and transverse facial branch of the temporal; it gains the under surface of the muscle through the sigmoid notch, between the coronoid and condylar processes of the ramus, and is accompanied by the nerve and veins of like name; (2) the deep temporal, anterior and posterior, attended by the nerves and veins of like name, and distributed to the deep surface of the temporal muscle; (3) the pterygoid to the pterygoid muscles, attended by the nerves and veins of like name; (4) the buccal, attended by the long buccal branch of the fifth nerve, to the buccinator muscle.

FIG. 16.



The internal maxillary artery and its branches. (GRAY.)

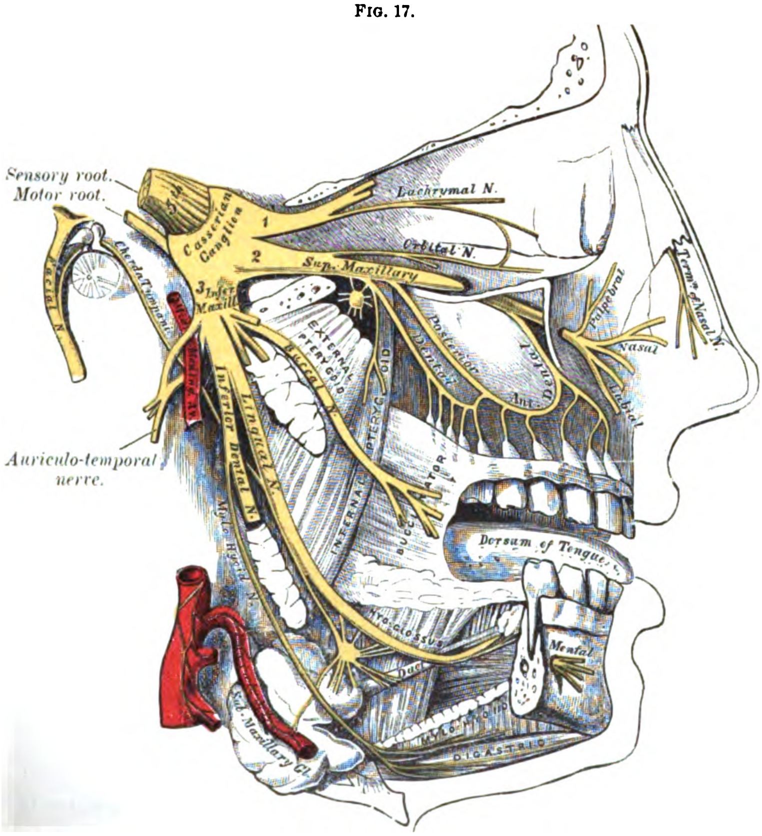
The Sphenomaxillary Portion is in the sphenomaxillary fossa. *Branches:* (1) The posterior dental, given off with the infra-orbital as the artery enters the spheno-maxillary fissure and gives branches to the molar and bicuspid teeth; (*a*) gingival branches to the gums; (*b*) antral branches to the antrum of Highmore. (2) The infra-orbital arises with the inferior dental, passes along the infra-orbital canal, and appears on the face at the infra orbital foramen, between the levator labii superioris and levator anguli oris. *Branches:* (*a*) To the lacrymal gland; (*b*) to the inferior rectus and inferior oblique muscles; (*c*) to the mucous membrane of the *antrum* of Highmore; (*d*) to the incisor and cuspid teeth; (*e*) to the nose, lip, and eyelid. (3) The Vidian, small, passes through the Vidian canal at the junction of the lingula, pterygoid process, and greater wing of the sphenoid bone to the Eustachian tube, middle ear, and pharynx, and is attended by the Vidian nerve and veins. (4) The pterygopalatine passes through the canal of like name, with the pharyngeal branch of Meckel's ganglion, to the pharynx and Eustachian tube. (5) The sphenopalatine or nasal branch enters the nose through the foramen of like name, in company with the sphenopalatine branches of Meckel's ganglion, and supplies the ethmoid cells and mucous membrane of the antrum of Highmore. (6) The ascending palatine passes through the posterior palatine canal, with the palatine nerves from Meckel's ganglion, thence along the roof of the mouth, to the anterior palatine canals, in which they inosculate on the septum with branches of the nasopalatine artery. (7) The descending palatine branches to the gums, glands, mucous membrane, and soft palate.

The Internal Maxillary Vein accompanies and corresponds to the maxillary artery. *Tributaries:* Middle meningeal, deep temporal, pterygoid, masseteric, buccal, superior and inferior dental, palatine, and other veins. These tributary veins form a plexus corresponding to the pterygoid and sphenomaxillary portions of the internal maxillary artery—the pterygoid plexus. The internal maxillary vein passes behind the neck of the mandible and joins the temporal vein, forming the temporomaxillary. This divides into (1) a tributary of the facial vein; (2) the external jugular, which receives the posterior auricular vein.

THE TRIFACIAL NERVE ROOTS AND GANGLION.

Roots. The trifacial has a motor and a sensory portion. The motor root arises from groups of cells in the floor of the fourth ventricle and in the aqueduct of Sylvius, and passes outward to supply the muscles of mastication. The fibres

FIG. 17.



Distribution of the second and third divisions of the fifth nerve and submaxillary ganglion. (GRAY.)

of the sensory portion arise in cells of the Gasserian ganglion, and, passing inward, end around the cells of the gelatinous substance and funiculi gracilis and cuneatus.

The larger or sensory root passes through the trigeminal notch near the apex of the petrosa and enters Meckel's space, where it spreads out, becomes plexiform, and enters the Gasserian ganglion.

The smaller or motor root crosses beneath the Gasserian ganglion, and, joining the sensory portion of the third division, is distributed to the muscles of mastication.

Gasserian Ganglion. The Gasserian ganglion gives origin to the sensory fibres. It lies in a depression on the anterior surface of the petrosa, near the apex of the bone in relation with the internal carotid artery and cavernous sinus. It is joined by sympathetic nerves from the carotid plexus, and gives branches to the dura. From the anterior convex border of the ganglion the ophthalmic, superior, and inferior maxillary divisions of the trifacial nerve arise. The first leaves the cranium through the sphenoidal fissure, the second through the foramen rotundum, the third through the foramen ovale.

Ophthalmic Division of Trifacial.

The ophthalmic division is sensory, and supplies the eyeball, ciliary muscle, iris, lacrymal gland, nasal and ocular mucous membrane, skin of eyebrow, forehead and nose, and ciliary ganglion. Its branches are the lacrymal, frontal, and nasal. (See Fig. 18.)

The Lacrymal Nerve passes through the outer angle of the sphenoidal fissure to the orbit. It reaches the lacrymal gland, having traversed the cavity of the orbit along the upper border of the external rectus muscle. Its branches are to the lacrymal gland, conjunctiva, skin of the upper lid, and communicating to the orbital branch of the superior maxillary nerve.

The Frontal Nerve, the largest branch of the ophthalmic, enters the orbit through the sphenoidal fissure. It lies on the levator palpebræ, and, midway between the apex and base of the orbit, divides into supratrochlear and supra-orbital branches. The supratrochlear crosses the tendon of the superior oblique, passes over the inner angle of the orbital arch, and is distributed to the eyelid, conjunctiva, and forehead. Near the pulley of the superior oblique muscle it gives a branch to the infratrochlear branch of the nasal nerve. The supra-orbital branch leaves the orbit through the supra-orbital foramen, with an artery of like name, and supplies the skin of the forehead.

The Nasal Nerve, on entering the orbit through the sphenoidal fissure, passes between the two divisions of the third nerve, and also between the two heads of the external rectus muscle. It passes between the optic nerve and the superior rectus muscle to the anterior ethmoidal foramen, through which it passes into the cranial cavity, attended by the anterior ethmoidal vessels, and, running forward on the cribriform plate of the ethmoid, passes through a slit into the nasal fossa. It gives off the following branches:

(*a*) Long ciliary nerves to the eyeball.
(*b*) A septal branch to the mucous membrane of the septum.
(*c*) An external branch to the outer wall of the nasal fossa.
(*d*) A superficial branch to the lower part of the nose.
(*e*) An infratrochlear branch to the conjunctiva, caruncle, inner canthus, lacrymal sac, eyelids, and nose.

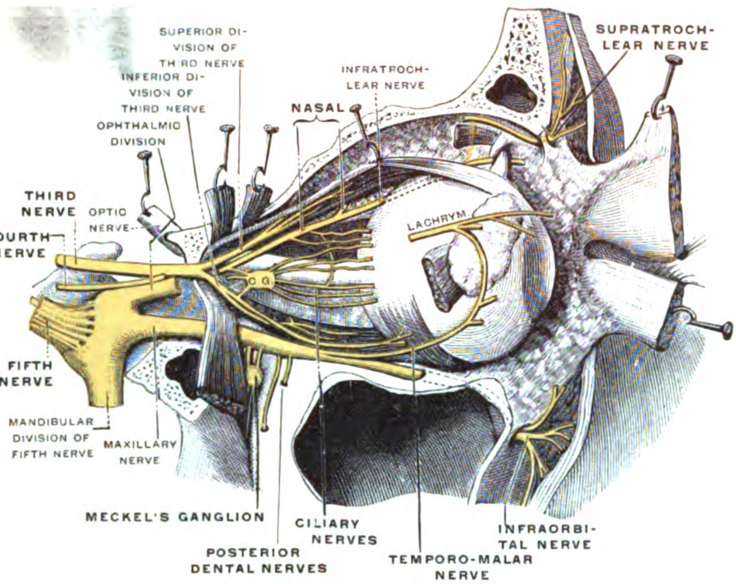
The Ciliary Ganglion.

The ciliary or lenticular ganglion is about the size of a pinhead; it lies near the apex of the orbit, between the optic nerve and the external rectus muscle. Its roots are:

(*a*) Motor, from the third nerve.
(*b*) Sensory, from the nasal nerve.
(*c*) Sympathetic, from the cavernous plexus.

The ciliary ganglion is a composite structure, and each branch of distribution has a definite physiological function. Its ciliary branches are called the short, in contradistinction to the long ciliary branches of the nasal nerve.

FIG. 18.



Oculomotor nerve and ciliary ganglion (C. G.). (GERRISH after TESTUT.)

Function. The ciliary branches, derived from the nasal nerve element of the ganglion, confer trophicity and ordinary sensation on the eyeball. Branches of the ganglion derived from the third nerve element are motor to the ciliary muscle and sphincter of the iris. Branches of sympathetic derivation produce dilatation of the iris. (See Gerrish.)

Superior Maxillary Division of Trifacial.

The superior maxillary, a sensory nerve, begins in the Gasserian ganglion and ends on the face around the infra-orbital foramen. The nerve leaves the cranium through the foramen rotundum, in the greater wing of the sphenoid bone, and enters the upper part of the sphenomaxillary fossa. It then passes through the sphenomaxillary fissure (as infra-orbital nerve) in company with the vessels of like name, and enters the infra-orbital canal in the floor of the orbit. This nerve reaches the face through the infra-orbital foramen, and gives off the following branches: (*a*) A recurrent branch to the dura mater; (*b*) two sphenopalatine branches to Meckel's ganglion; (*c*) the orbital or temporomalar; (*d*) the middle superior dental; (*e*) the posterior dental; (*f*) the anterior dental; (*g*) the infra-orbital to the nose, lip, and eyelid; (*h*) a recurrent branch to the dura mater accompanying the middle meningeal artery.

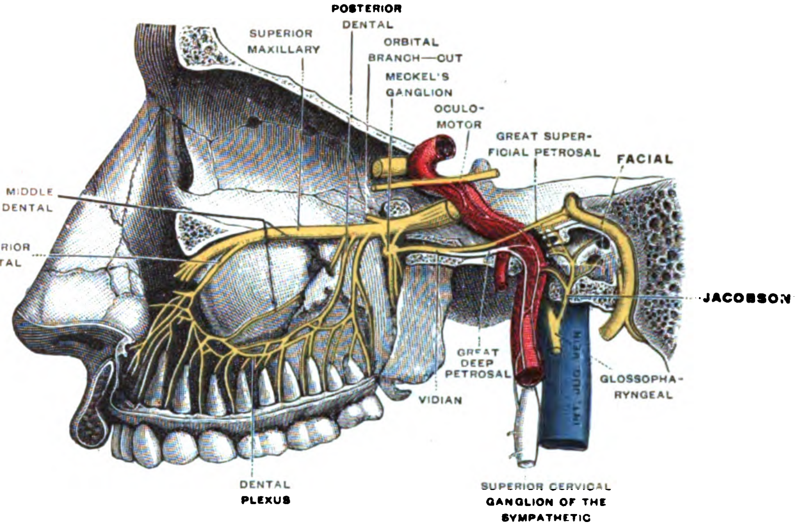
The Orbital or temporomalar branch enters the orbit through the sphenomaxillary fissure, and divides into the temporal and malar branches. It communicates with the lacrymal nerve and passes through a canal in the malar bone to the temporal region. The malar branch passes forward between the floor and outer wall of the orbit, and escapes on the face through a small foramen in the malar bone.

The Posterior Dental Nerves, accompanied by vessels of like name, contribute branches to the mucous membrane of the cheek and gums, and enter the posterior dental canals in the zygomatic surface of the maxilla for the supply of the molar teeth and antrum of Highmore.

The Anterior Superior Dental nerves arise near the front of the infra-orbital canal, pass through the canals in the anterior wall of the antrum, and supply the nasal fossæ, incisors, cuspid, and gums.

The Middle Dental Nerves are given off in the infra-orbital canal. They pass through small canals in the outer wall of the antrum and supply the bicuspids. On emergence from the infra-orbital foramen the infra-orbital nerve breaks up

FIG. 19.



Dental branches of superior maxillary nerve and sphenopalatine ganglion. (GERRISH after TESTUT.)

into eight or ten sensory branches, of which two—the inferior palpebral—supply the skin and conjunctiva of the lower lid; two—the lateral nasal—supply the skin of the nose; the remaining branches—the superior labial—supply the skin and mucous membrane of the upper lip. These several branches communicate with the seventh nerve to form the infra-orbital plexus, a structure which lies between the levator labii superioris and levator anguli oris muscles.

Meckel's Ganglion (Sphenopalatine).

Meckel's ganglion is in the sphenomaxillary fossa, below the superior maxillary nerve, in a fatty mass surrounded by the terminal branches of the internal maxillary artery.

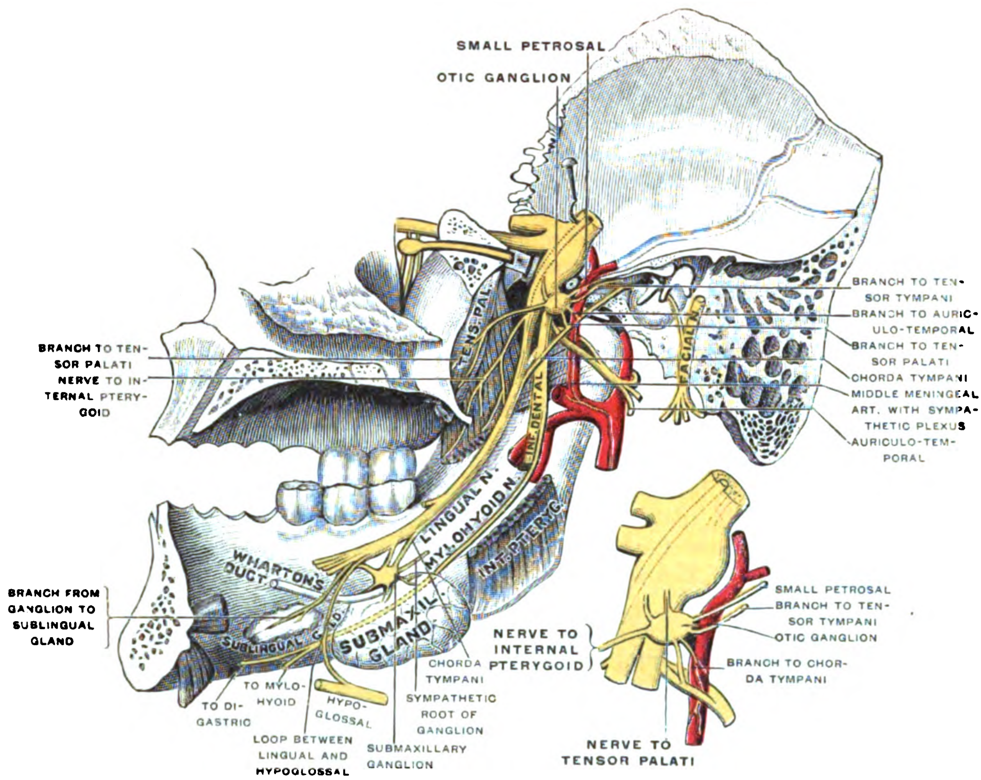
Roots: (1) Sensory, from the superior maxillary divisions of the fifth nerve, through two sphenopalatine nerves; (2) motor, from the seventh nerve, through the great superficial petrosal; (3) sympathetic, from the carotid plexus, through the great deep petrosal. The sympathetic and motor roots combine to form the Vidian nerve and pass through the Vidian canal.

Branches. (1) The ascending, leave the sphenomaxillary fossa through the sphenomaxillary fissure to the periosteum of the orbit; (2) the descending or palatine, leave the fossa at the apex, through the posterior palatine canal, and supply the gums, mucous membrane, glands of roof of mouth, and soft palate; (3) the posterior: (*a*) the Vidian, formed by union of the great superficial petrosal (a branch of the facial) and the great deep petrosal (a branch of the carotid plexus), passes through the Vidian canal and forms the motor and sympathetic roots of Meckel's ganglion; (*b*) the pharyngeal, passes through the pterygopalatine canal and supplies the mucous membrane of the upper part of the pharynx; (4) the internal: (*a*) the nasal, pass through the sphenopalatine foramen, in the inner wall of the sphenomaxillary fossa, and are distributed to the upper and back part of the septum ; (*b*) the nasopalatine, enters the nasal fossa through the spheno-palatine foramen, passes along the groove on the vomer, thence through the foramina of Scarpa, where it communicates with the nerve of the opposite side to form a plexus, from which the mucous membrane of the anterior half of the hard palate is supplied.

Inferior Maxillary Division of Trifacial.

The inferior maxillary division arises from the Gasserian ganglion, leaves the cranium through the foramen ovale in the greater wing of the sphenoid, and enters the zygomatic fossa. It is composed of sensory and motor fibres. The motor root accompanies the sensory, and the two unite after they pass through the foramen ovale and form a mixed trunk, which divides into the anterior and posterior parts.

FIG. 20.



Mandibular division of trifacial nerve, seen from the middle line. The small figure is an enlarged view of the otic ganglion. (GERRISH after TESTUT.)

The Branches from Mixed Trunk. (1) The sensory recurrent ; (2) the motor, to the internal pterygoid. *Branches of the anterior division :* (1) The deep temporal ; (2) the masseteric ; (3) to the external pterygoid ; (4) the long buccal. *Branches of posterior division :* (1) The auriculotemporal ; (2) the inferior dental ; (3) the lingual or gustatory.

The Branches of the Anterior Division. (*a*) The long buccal nerve, passes between the upper and lower heads of the external pterygoid muscle ; then downward and forward, internal to the temporal and masseter muscles, to the outer surface of the temporal and buccinator muscles, where it forms the buccal plexus with the buccal branch of the facial nerve. From this plexus the buccinator muscle, skin, and mucous membrane of the cheek are supplied.

(*b*) The masseteric nerve passes through the sigmoid notch to the masseter muscle in company with the masseteric vessels.

(*c*) The deep temporal nerves, two in number, pass above the external pterygoid muscle, hugging the bone closely, and soon enter the temporal muscle as very small twigs.

(*d*) The external pterygoid nerve arises with the long buccal, and supplies the external pterygoid muscle.

Branches of the Posterior Division. (*a*) The auriculotemporal nerve, sensory, arises by two roots, between which passes the middle meningeal artery. The roots soon unite, and the nerve passes beneath the neck on the condyle, gains the space between the ear and jaw, whence it passes through the parotid gland and lies beneath and accompanies the superficial temporal artery across the zygoma. Branches of auriculotemporal nerve: communicating, to the seventh nerve; articular, to the temporomandibular joint; sensory, to the parotid gland; auricular, to the external auditory meatus and skin of the upper and anterior part of the pinna. (*b*) The inferior dental nerve passes beneath the external pterygoid muscle, across the internal lateral ligament of the jaw, and enters the mandibular canal with the inferior dental vessels. The inferior dental nerve gives dental branches to the teeth; gingival branches to the gums; mental branches to the skin of the chin; muscular to the mylohyoid muscle and anterior belly of the digastric. (*c*) The lingual or gustatory, a sensory nerve, is joined on its outer side by the chorda tympani. *Course:* Under cover of the external pterygoid muscle; between the internal pterygoid and ramus, in front of the inferior dental nerve; on the mylohyoid muscle, beneath the mucous membrane; between the mylohyoid and hyoglossus muscles, below Wharton's duct; it is connected to the submaxillary ganglion as it crosses the hyoglossus muscle. The nerve may be reached by cutting longitudinally through the mucous membrane opposite the second lower molar tooth. *Branches:* Sensory, to the anterior two-thirds of the tongue; to the sublingual gland, secretomotor fibres from the chorda tympani; to the mucous membrane; communicating, to the hypoglossal nerve, submaxillary ganglion, and inferior dental nerve.

The chorda tympani is a branch of the seventh cranial nerve, passes through the tympanum, and leaves this cavity through the canal of Huguier, in the petrous portion of the temporal bone. It meets the lingual nerve near its origin, accompanies the same as far as the submaxillary gland, and gives branches to the tongue, submaxillary, and sublingual glands.

The Submaxillary Ganglion.

Location. The submaxillary ganglion is on the outer surface of the hyoglossus muscle, attached to the gustatory nerve, and about the size of a pinhead.

Roots. (1) Sensory, from the gustatory; (2) motor, from the chorda tympani; (3) sympathetic, from the nervi molles, surrounding the facial artery. *Distribution:* To the mucous membrane of the floor of the mouth and to the submaxillary gland.

The Otic Ganglion.

Location. The otic ganglion is on the inferior maxillary division of the fifth nerve. Its roots are: (1) Motor, from the inferior maxillary; (2) sensory, from the auriculotemporal; (3) sympathetic, from the plexus on the middle meningeal artery. *Relations:* (1) External, to the inferior maxillary nerve; (2) internal, to the tensor palati; (3) posterior, to the middle meningeal artery. *Distribution:* To the tensor palati, tensor tympani, and a communication to the tympanic branch of the ninth nerve.

NASAL FOSSÆ AND ACCESSORY SINUSES.

Dissection and Identification.

Make median incision with sharp saw through the entire head, a little to one side of the mid-line, including the lower jaw. Usually this incision will expose the frontal, ethmoid, and sphenoidal sinuses sufficiently for study of these regions. Thoroughly cleanse the parts with warm water. (See Figs. 23, 24.)

Nasal Fossæ Identify (1) by the location vertically extending from the roof of the mouth to the base of the skull; (2) by the presence of the antrum and orbit externally; (3) by the anterior nasal openings (anterior nares) in front, and the posterior openings (posterior nares) discharging into the pharynx behind.

Turbinate Bones (superior, middle, inferior). Identify (1) by their location on the outer wall of the nose; (2) by their characteristic scroll shape.

Meatuses (superior, middle, inferior). Identify (1) by the location of the superior meatus between the upper and middle turbinate bones; (2) of the middle meatus between the inferior and middle turbinate bones; (3) of the inferior meatus, between the floor of the mouth and the inferior turbinate bone.

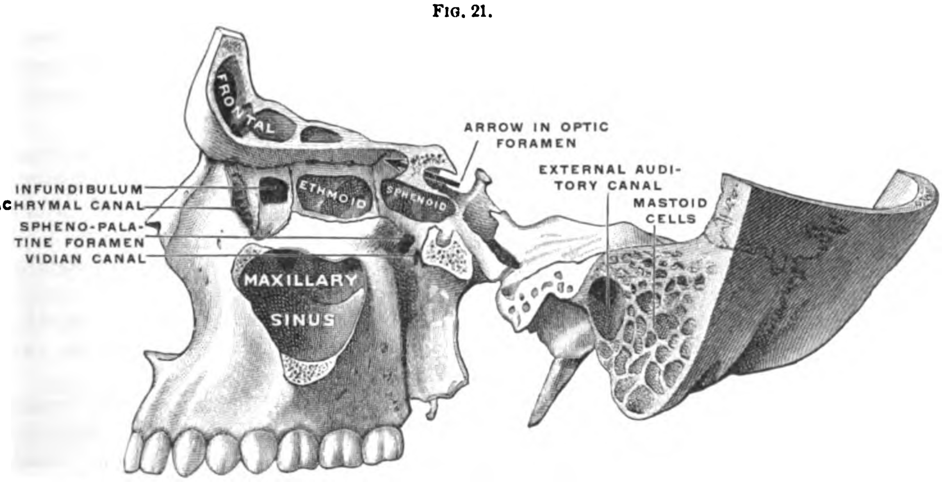
Posterior Narial Openings. Identify (1) by the location on each side of the posterior border of the nasal septum; (2) by opening into the pharynx.

Septum Nasi. Identify (1) by the location so as to divide the internal nose into a right and a left part; (2) by the composition of these parts (easily demonstrable when the mucous membrane is removed), the vertical plate of the ethmoid, triangular cartilages, and vomer; (3) by the location so as to form the inner wall of each nasal fossa.

Nasal Duct and Valve of Hassner. Identify (1) by opening well forward into the inferior meatus, beneath the inferior turbinate bone; (2) by communication with the conjunctival sac through the lacrymal sac and canaliculi. An imperfect valve of mucous membrane guards the opening.

Ostium Maxillaire. Identify (1) by the location in the middle meatus, beneath the middle turbinate bone; (2) by communication with the antrum of Highmore.

FIG. 21.



The bony sinuses of the head. (GERRISH after TESTUT.)

Infundibulum. Identify (1) by the termination in the middle meatus, well forward, beneath the middle turbinate bone; (2) by communication above with the frontal sinus and anterior ethmoidal cells.

Frontal Sinuses. Identify (1) by the location in the frontal bone, corresponding to the superciliary ridges; (2) by the presence of an opening (infundibulum) leading into the middle meatus, on the outer wall of the nose; (3) by a delicate, loosely attached mucous membrane. *Dissection:* The incision commonly employed in the removal of the calvarium usually makes a good exposure from above. Access may also be gained by trephining through the superciliary ridge. In this latter method note the mucous membrane when the button is removed. If the sinus contains pus, examine other intramural sinuses for pus.

Ethmoidal Cells. Identify (1) by their location in the lateral mass of the ethmoid bone; (2) by the communication in front with the frontal, behind with the sphenoid sinus; (3) by the delicate mucous membrane; (4) by the spongy texture of the bone and cellular nature of the interior; (5) by their location between the os planum and ethmo-turbinals. *Dissection:*

Gain access through the very thin os planum of the ethmoid, behind the lacrymal bone, on the inner wall of the orbit.

Sphenoidal Sinuses. Identify (1) by their location in the body of the sphenoid, beneath the sella turcica; (2) by their communication with the posterior ethmoid cells, and with these open into the superior meatus on the outer wall of the nose; (3) by the delicate mucous membrane lining the same. *Dissection:* Gain access through the floor of the sella turcica.

Antrum of Highmore. Identify (1) by its location in the body of the superior maxillary bone; (2) by its communication with the middle meatus on the outer wall of the nose; (3) by subjacency to the floor of the orbit; (4) by the second bicuspid, first and second molars, whose roots occupy the floor of the antrum. (Note the delicate mucous membrane and its continuation into the nose through the opening—ostium maxillaire. *Dissection:* Saw away one inch of the most prominent part of the cheek bone, the apex of the antrum. (See Fig. 21.)

Mastoid Cells. Identify (1) by their location in the mastoid process of the temporal bone; (2) by their delicate mucous membrane. The higher cells are strictly pneumatic, and contain no fat; the lower ones usually contain fatty connective tissue. *Dissection:* Saw away one inch of the mastoid and squamosa, as in Fig. 21. (Mastoid antrum—see tympanum.)

NASAL FOSSÆ.

The Nasal Fossæ are limited above by the base of the skull, below by the hard palate. The former limiting wall separates the nose from the cranial cavity, the latter from the oral cavity. In the mid-line the two fossæ are separated by the septum nasi. The nasal fossæ are limited in front by the anterior, behind by the posterior nares; the former open on the face, the latter into the pharynx.

The Shape. The cribriform plate of the ethmoid bone, about one inch long, is the highest part of the nasal fossæ, and from this the fossæ slope laterally toward the teeth, forward toward the tip of the nose, and backward toward the pharynx.

The Roof. The forward slope of the roof corresponds to the bridge of the nose, and is composed of the nasal bones and the nasal spine of the frontal bone. The horizontal part of the roof is formed by the cribriform plate of the ethmoid. The backward slope of the roof is formed by the body of the sphenoid, alæ of vomer, and sphenoidal processes of the palate bone. The foramina in the cribriform plate transmit the olfactory nerves. Posteriorly, the roof has an occasional opening for the sphenoidal sinus.

The Floor of the nasal fossæ is about one inch wide. It is somewhat canoe-shaped, ending in front in the anterior, and behind in the posterior nasal spine, to which latter the uvula is attached. The floor is formed by the palatine process of the superior maxillary bone, articulating with the horizontal process of the palate bone. On the floor, just behind the anterior nasal spine, are the openings of the anterior palatine canal, four compartments: (1) Two lateral, the foramina of Stenson, through which pass the posterior palatine arteries from the mouth to the nose; (2) two median, the foramina of Scarpa, through which pass the naso-palatine nerves from the nose to the roof of the mouth.

The Inner Wall is called the septum nasi, and is formed by the vomer, vertical plate of the ethmoid, triangular cartilage, crests of maxillæ, palate, sphenoid, nasal bones, and nasal spine of frontal. The posterior border of the vomer is free, and separates the posterior nares. The anterior border articulates with the incisor crest of the superior maxilla; the inferior, with the floor of the nasal fossæ; the superior, with the sphenoid, triangular cartilage, and vertical plate of the ethmoid.

The Outer Wall is formed by the inner surface and nasal process of the superior maxillary, three turbinates, vertical part of the palate, pterygoid process of the sphenoid, and lacrymal bone.

The Anterior Narial Openings are bounded by the nasal bones above, the maxillary bones below, and the nasal processes of the superior maxillary bones laterally.

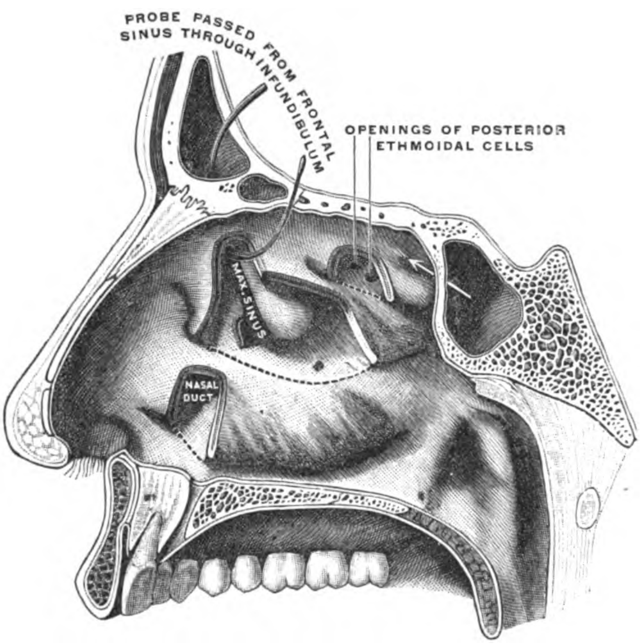
The Posterior Narial Openings are bounded above by the sphenoid, palate, and alæ of vomer; below by the horizontal plate of the palate bone; externally by the internal pterygoid plate; internally by the vomer and posterior nasal spine. The posterior narial opening of each side is about one-half inch wide and one inch from above downward.

The Turbinate Bones are the superior, middle, and inferior, and are modified parts of the outer wall of the nasal fossæ. The superior and middle are convoluted parts of the lateral mass of the ethmoid bone, hence called ethmo-turbinals; the inferior turbinate is described as an independent bone, articulating with the maxilla, ethmoid, palate, and lacrymal; still, morphologically, it is a dismembered part of the lateral mass of the ethmoid.

Meatuses. There are three recesses or meatuses on the outer walls of the nasal fossæ, superior, middle, and inferior. The superior meatus is between the superior and middle turbinate bones; the middle meatus, between the middle and inferior turbinate bones; the inferior meatus between the inferior turbinate bone and floor of the nasal fossæ.

Orifices of Meatuses. The superior meatus has (1) an orifice for the posterior ethmoidal cells, through which the sphenoidal sinus occasionally opens; (2) the sphenopalatine foramen, covered by mucous membrane in the recent state, which transmits the nasopalatine nerve and vessels from the sphenomaxillary fossa to

FIG. 22.



External wall of right nasal fossa, parts of the turbinates having been cut away to show the orifices of the sinuses which open into the meatuses. (GERRISH after TESTUT.)

the nose. The middle meatus has (1) a curved groove, the sulcus semilunaris (continuous above with the infundibulum), into which the frontal sinus and anterior ethmoidal cells open; (2) an opening for the antrum of Highmore. The inferior meatus has an opening for the nasal duct in front, guarded by a circular fold of mucous membrane, called the valve of Hassner.

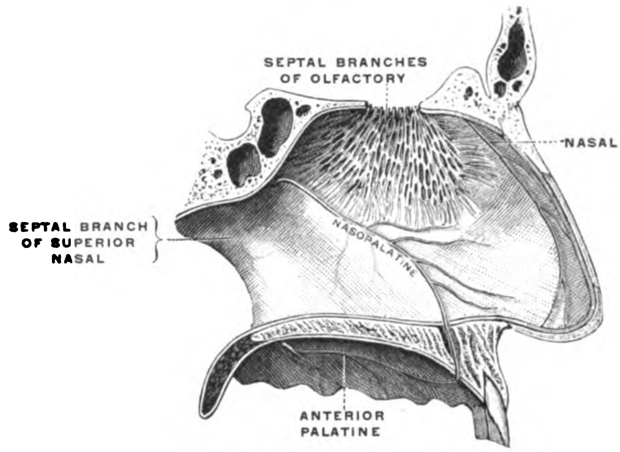
The Mucous Membrane (called pituitary and Schneiderian) is thick over the lower turbinate bone and septum, thin in the meatuses and intramural sinuses, and intimately adherent to the periosteum and perichondrium.

Communications. The nasal fossæ communicate: (1) With the orbit, by the lacrymal groove; (2) with the cranial cavity, by the nasal split and olfactory foramina; (3) with the mouth, by the anterior palatine canal; (4) with the sphenomaxillary fossa, by the sphenopalatine foramen; (5) with the middle ear, mastoid antrum, and mastoid cells, through the Eustachian tube and pharynx; (6) with the frontal, sphenoidal, maxillary sinuses, and ethmoid cells.

Areas. The nasal fossæ are divided (1) into an upper or olfactory area ; (2) a lower or respiratory area. The former is supplied by the olfactory nerves and branches from the trigeminus, through the Vidian nerve and Meckel's ganglion.

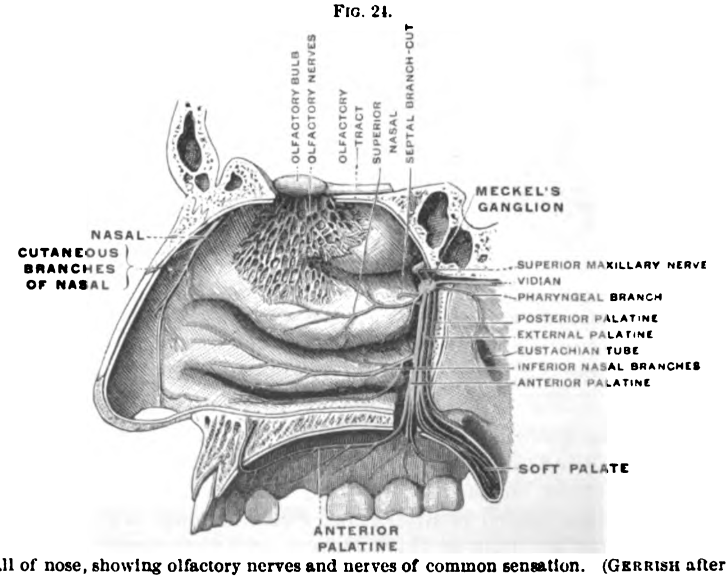
Nerve-supply of Nasal Fossæ. The nasal nerve supplies : 1. The anterior half of the outer wall. 2. The anterior half of the septum. 3. The anterior half of the roof. Meckel's ganglion supplies : 1. The posterior half of the outer wall. 2. The posterior half of the septum. 3. The posterior half of the roof. The olfactory nerve supplies : 1. The upper third of the septum nasi. 2. The superior turbinated bone. 3. The middle turbinated bone. The anterior dental supplies : 1. The inferior turbinated bone. 2. The inferior meatus.

FIG. 23.



Nasal septum, showing olfactory nerves and nerves of common sensation. (GERRISH after TESTUT.)

FIG. 24.



Outer wall of nose, showing olfactory nerves and nerves of common sensation. (GERRISH after TESTUT.)

Nerve-supply of the Intramural Sinuses. The ethmoidal cells, by the orbital branch of Meckel's ganglion. The sphenoidal sinus, by the orbital branches of Meckel's ganglion ; the antrum of Highmore, by the posterior superior dental ; the mastoid antrum, by the recurrent branch of the trifacial ; the mastoid cells, by the recurrent branch of the trifacial ; the frontal sinus, by the supratrochlear branch of the frontal nerve.

Vessels of the Intramural Sinuses and Nasal Fossæ. The sphenopalatine artery supplies the vomer, the antrum of Highmore, the frontal sinus, the ethmoidal cells, the turbinated bones, and meatuses.

The anterior and posterior ethmoidal arteries supply the septum, the roof and outer wall of the nose, the anterior and posterior ethmoidal cells. The descending palatine supplies the inferior meatus and the inferior turbinated bone.

The Vidian and pterygopalatine supply the roof of the nose ; the stylomastoid, the mastoid cells ; the pterygopalatine, the ethmoidal cells.

The source of the arteries to the preceding regions are the stylomastoid from the posterior articular, the ethmoidals from the ophthalmic, the remaining ones from the internal maxillary.

INTRAMURAL OR ACCESSORY SINUSES.

Intramural or accessory sinuses of respiration are in the bones of the head ; they contain air and are evolved by evagination from the nose, another and more highly specialized pneumatic cavity. They are absent in the very young, and attain full development and become pneumatically competent in early adolescence.

Mucous Membrane. The mucous membrane of the intramural sinuses is weak, pale, thin, flabby, detachable, poorly nourished, and liable to infection, just the opposite of the predominating physical traits of the mucous membrane of the parent cavity, the nasal fossæ.

Frontal Sinuses. The frontal sinuses are between the outer and inner tables of the vertical portion of the frontal bone, corresponding to the location on the surface of the superciliary ridges, but are not governed in size by these. There may be a large bump in this locality, due to the heaping up of bone, and not necessarily to a large sinus. The frontal sinus may occupy the greater part of the vertical portion of the frontal bone ; on the other hand, it may be very small or entirely absent. Its absence is noted in some Indian hill tribes. Posteriorly, the sinus communicates with the anterior ethmoidal cells ; it opens into the middle meatus about on a level with the palpebral fissure. The frontal sinuses are lined by a delicate mucous membrane, are asymmetrical on the two sides, and separated from each other by an incomplete partition of bone. This sinus is formed by an evagination of the original nasal pit. The frontal sinuses obtain as imperfect cells before the tenth year, but are well developed by the twentieth. (See Gray.)

Ethmoidal Cells. The ethmoidal cells occupy the lateral masses of the ethmoid bone, being limited externally by the os planum, and internally by the superior and middle turbinated bones. At the points where the frontal, lacrymal, sphenoid, palate, and maxillary bones articulate with the ethmoid there are cells designated fronto-ethmoidal, lacrymo-ethmoidal, spheno-ethmoidal, palato-ethmoidal, and maxillo-ethmoidal. The ethmoidal cells are lined by delicate mucous membrane, and are divided into (1) anterior, which open into the frontal sinuses ; (2) posterior, which open into the sphenoidal sinuses.

Sphenoidal Sinuses. The sphenoidal sinuses are in the body of the sphenoid bone. They are irregular in size, and separated from each other by an imperfect bony partition. They may extend into the basilar process of the occipital bone or even invade the pterygoid processes. They are lined by delicate mucous membrane, communicate with the posterior ethmoidal cells, and open into the superior meatus on the outer wall of the nasal fossæ.

Maxillary Sinus. The maxillary sinus or antrum of Highmore is the largest of the intramural sinuses. It is in the body of the upper jaw. Above it is the orbit, below it the mouth, internal to it the nasal fossa. Its capacity varies from three to eight drachms, and it is larger in the male than in the female. The antrum is formed by an evagination of the primitive nasal pit about the sixth month of fœtal life, and is lined by a mucous membrane, continuous with that of the nose, through the nasal orifice or ostium maxillaire. As a rule the cavity of the antrum is single; still, it may be divided into pockets or recesses by imperfect bony partitions. For purposes of systematic study the antrum should be considered as having the following parts:

The Apex, which corresponds to the malar prominence. The antral cavity may even invade the substance of the malar bone.

The Base is the part directed toward the nose, and is also called the internal or nasal surface. This surface is very thin, deficient behind, and presents one or more openings close up under the roof, by which the antrum communicates with the middle meatus of the nose. The inferior turbinated bone and the vertical portion of the palate bone close in the opening of the antrum.

The Roof is formed by the orbital plate of the superior maxillary bone, and separates the antrum from the orbit. The roof of the antrum and floor of the orbit are the same, and contain the infra-orbital canal, in which are lodged the infra-orbital nerve and vessels.

The Floor is formed by more or less of the alveolar process, and presents irregularities corresponding to the roots of the first and second molar and second bicuspid teeth. It must be remembered, however, that, while the first and second molars are in the closest relation with the antrum, under some circumstances any of the sockets of the upper teeth may communicate with this cavity.

The Anterior Wall is formed by the facial surface of the upper jawbone. It contains the anterior-superior dental canals, in which are lodged the vessels and nerves for the supply of the incisor and cuspid teeth.

The Posterior Wall is formed by the zygomatic surface of the jaw. This wall contains the posterior-superior dental canals, in which are located the vessels and nerves for the supply of the molar teeth.

The walls of the antrum may be displaced by a large tumor in any direction (except in the line of the alveolar process and malar bone) on account of their frail structure. The antrum may be tapped (1) in the inner wall *via* the anterior nares; (2) above the second bicuspid tooth; (3) a molar tooth may be extracted; still, this latter procedure is at variance with conservative dentistry. Large tumors of the antrum become painful on account of the pressure they exert on the nerves in the roof, anterior and posterior walls. Discharges from the frontal sinus may fill the antrum when, as occasionally happens, the opening for the antrum lies in the course of the infundibulum, in the hiatus semilunaris.

The Mastoid Antrum is present at birth. It attains its largest size (about that of a pea) in the third or fourth year, becoming somewhat smaller in the adult. It lies behind and communicates with the tympanum. Its floor communicates with the mastoid cells. Its roof is continuous with the roof of the tympanum, and is called the tegmen antri. The outer wall is continuous with the squamosa, and is the place through which the operator reaches the antrum.

CHAPTER II.

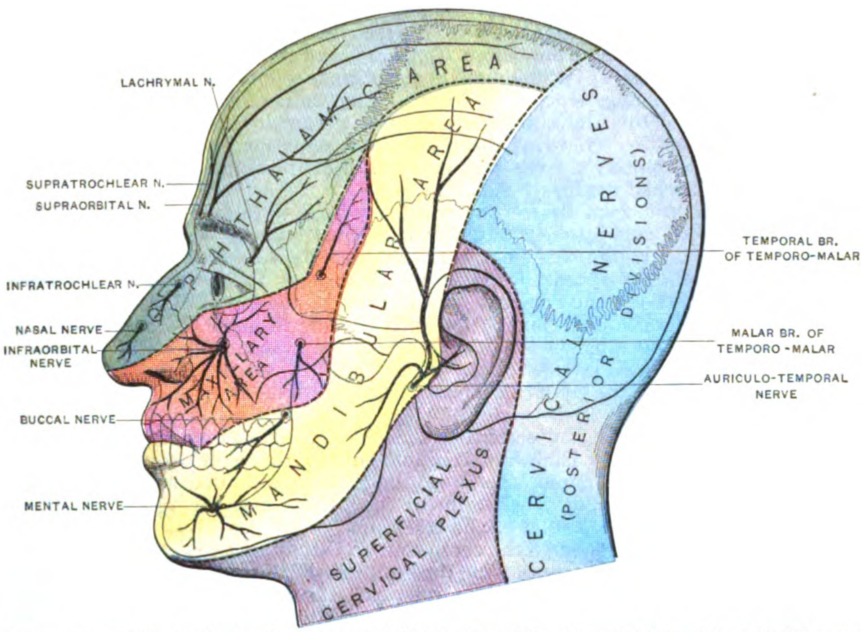
THE SCALP, MENINGES AND BASE OF THE SKULL.

THE SCALP.

Definition. Soft structures covering the bones of the cranium. It may be moved both actively and passively on the living.

Composition. (*a*) Very thick skin, covered with hair (except the forehead), and intimately attached to the subjacent superficial fascia; (*b*) superficial fascia, a very dense, fibro-fatty structure intimately attached to the skin and occipitofrontalis, and containing the vessels and nerves of the scalp; (*c*) occipitofrontalis (see muscles of expression); (*d*) vessels and nerves. The pericranium lies next to the bone, but does not form a part of the scalp.

FIG. 25.



Sensory areas of the head, showing the general distribution of the three divisions of the trifacial nerve. (Modified from TESTUT.)

Nerves (*sensory*). (*a*) Supraorbital, passing onto the forehead through the supra-orbital foramen (with supra-orbital artery), a branch of the frontal division of the ophthalmic; (*b*) temporal branch of the temporomalar or orbital (from second division of the fifth nerve); (*c*) auriculotemporal; from the third division of the fifth nerve; it pierces the temporal muscle and its aponeurosis one inch above the zygoma, and accompanies the temporal artery between the ear and the condyle of the jaw, giving off the anterior auricular, parotid, articular, temporal, and branches to the external auditory meatus; (*d*) supratrochlear, from the frontal branch of the ophthalmic (internal to the supra-orbital); (*e*) auricularis magnus and occipitalis minor, from the cervical plexus; (*f*) great occipital, from the posterior division of the second cervical nerve; (*g*) auricular branch of the vagus to the posterior part of the meatus, back of the pinna and adjacent part of the scalp;

(*h*) posterior auricular of the facial (motor) to the posterior belly of the occipitofrontalis, retrahens aurem, and small muscles on the cranial surface of the pinna; (*i*) temporal branches of the facial (motor) to the frontal portion of the occipitofrontalis, orbicularis palpebrarum, corrugator supercilii, attollens, and attrahens aurem muscles (auriculam is also used for aurem).

Arteries. (*a*) Frontal from the ophthalmic, leaves the orbit at its inner angle, anastomosing with the supra-orbital on the forehead; (*b*) supra-orbital, a branch of the ophthalmic, leaves the orbit through the supra-orbital foramen (with the supra-orbital nerve) to the forehead; (*c*) temporal, anterior and posterior terminals of the external carotid, supplies the side of the scalp as far as the vertex; (*d*) posterior auricular, from the external carotid, distributed to the ear and the adjacent scalp; (*e*) occipital, from the external carotid, to the posterior part of the scalp. (See Chapter I. for illustrations of arteries and veins.)

Technique of Removing the Brain.

1. After the scalp has been dissected and the temporal muscle with its investing aponeurosis turned down over the zygomatic arch, saw through the calvaria, in a line extending from the glabella (the smooth place between the superciliary ridges) to the external occipital protuberance. Care must be taken not to cut through the dura with the saw when the bony skull-cap is removed. Note adhesions of dura to same.

2. Study (*a*) the attachment of the dura to the bone; (*b*) the meningeal arteries between the dura and bone (seen, however, on the outer surface of the dura); (*c*) an elevation (slight) in the mid-dural line, extending from before backward, and produced by clotted blood in the superior longitudinal sinus; (*d*) Pacchionian bodies near the sinus and their villi perforating the dura mater and producing depressions in the inner table of the skull; (*e*) frontal sinus between the two tables of the frontal bone, about one inch above the root of the nose.

3. Cut through the entire length of the base of the superior longitudinal sinus in midline, remove the clotted blood; cleanse and study most of the veins opening into the sinus. This sinus is in the attached border of the falx cerebri.

4. Cut through the dura, from before backward, one inch to the right and left of the preceding incision; at right angles to this latter (from a point midway between the anterior and posterior poles) cut to the region of the ear, turn the dural flaps back and expose the subdural space. Note (*a*) the shining appearance given to the surface of the brain by the arachnoid membrane; (*b*) sulci between the adjacent convolutions of the brain, and the vessels of the pia mater showing through the arachnoid; (*c*) veins passing through the arachnoid, crossing the subdural space, and entering the superior longitudinal sinus, from behind forward, as a rule; (*d*) the falx cerebri, a process of the dura mater, in the great longitudinal fissure, between the hemispheres of the cerebrum; (*e*) attachment of the front end of the falx cerebri to the crista galli.

5. Cut the attachment of the falx cerebri to the crista galli; gently remove the falx from the great longitudinal fissure by backward traction, cutting the veins opening into the superior and inferior longitudinal sinuses. Study (*a*) the great longitudinal fissure; (*b*) the upper surface of the corpus callosum, at the bottom of the fissure, seen by separating the hemispheres; (*c*) the convolutions and sulci of the cerebrum.

6. Gently retract the frontal lobe of the cerebrum, and study in succession (*a*) the olfactory bulb, with its twenty nerves (the latter passing through the cribriform plate of the ethmoid bone); (*b*) the optic nerve and the optic chiasm (the former entering the apex of the orbit through the optic foramen); (*c*) the internal carotid artery to the outer side of the optic nerve (often called the ophthalmic by the inexperienced); (*d*) the pituitary body (in the pituitary fossa) connected to the tuber cinerium by a constriction—the infundibulum; (*e*) the motor oculi nerve; (*f*) the tentorium cerebelli, attached to the superior border of the petrous part of the temporal bone.

7. Cut the tentorium cerebelli along the upper border of the petrosa; make slight gentle backward traction on the brain-mass, and study (*a*) the patheticus (fourth nerve) in the free border of the tentorium; (*b*) the trigeminus (fifth nerve) beneath the tentorium, entering the middle fossa through the trigeminal notch; (*c*) abducens (sixth nerve) seen perforating the dura on the dorsum sellæ; (*d*) the facial (seventh nerve), auditory (eighth nerve), and auditory artery are seen entering the internal auditory meatus on the posterior surface of the petrosa; (*e*) the glossopharyngeal (ninth nerve), vagus (tenth nerve), spinal accessory (eleventh nerve), pass through the jugular foramen; (*f*) the hypoglossal (twelfth nerve) pierces the dura as two small strands and emerges through the anterior condyloid foramen; (*g*) the foramen magnum transmits the spinal cord and its coverings, the vertebral arteries and the spinal portion of the eleventh nerve.

8. Thrust a long, sharp scalpel as far as possible downward through the foramen magnum, and with side motion sever the cord and vertebral arteries. Now pass the middle finger through the foramen magnum and deliver the entire brain.

9. Locate the cranial nerves from the first to the twelfth, inclusive, by reference to Fig. 28 and the subjoined table. Note the first, second, fifth, seventh, eighth, ninth, tenth, eleventh, and twelfth nerves passing through the dura and the bone in corresponding foramina. The third, fourth, sixth, and the three divisions of the fifth nerve pass through the dura and then run between the dura and the bone until the bony foramina are reached; in other words, these nerves do not leave the base of the skull through corresponding foramina in the dura and bone. (See primary and secondary foramina).

10. Tear the dura from the anterior fossa and study (*a*) the Gasserian ganglion (on the sensory root of the fifth nerve) on the anterior surface of the petrosa near its apex; (*b*) the great and small superficial petrosal nerve branches of the seventh on the anterior surface of the petrosa; (*c*) the first division of the fifth nerve (ophthalmic), dividing into three branches, which pass through the sphenoidal fissure into the orbit; (*d*) the second division of the fifth nerve (superior maxillary), passing through the foramen rotundum; (*e*) the third division of the fifth nerve (inferior maxillary), passing through the foramen ovale.

Cranial Nerve.

By P. Gad Kitterman, M.D.

Name.	*Superficial origins.*	*Deep origin.*	*Foramen of exit.*	*Distribution.*	*Function.*
1. Olfactory.	Olfactory bulbs.	Gyrus fornicatus, trigonum olfactorium, uncus hippocampi.	Foramina in the cribriform plate of ethmoid.	Upper one-third nasal mucous membrane.	Special sense, smell.
2. Optic.	Optic chiasma.	External geniculate, pulvinar of optic thalamus and ant. quadrigeminal body.	Foramen opticum.	Retina.	Special sense, sight.
3. Oculomotor.	Inner side crus cerebri.	Floor of aquæductus Sylvii.	Sphenoidal fissure.	To all the muscles of the eyeball except external rectus and the superior oblique.	Motor.
4. Trochlearis.	Valve of Vieussens.	Floor of aquæductus Sylvii.	Sphenoidal fissure.	Superior oblique muscle.	Motor.
5. Trifacial.	Middle of the lateral surface of the pons.	Motor root: floor of 4th vent. and beneath aquæductus Sylvii. Sensory: cells in Gasserian ganglion; a sensory nucleus in 4th vent. and in nucleus of Rolando.	1. Sphenoidal fissure. 2. Foramen rotundum. 3. Foramen ovale.	Sensory: to face, forepart of scalp, ear, eye, cheek, tongue, gum, and teeth. Motor: to muscles of mastication.	Ordinary sensation Motor.
6. Abducent.	Groove between pons and medulla.	Floor of 4th ventricle.	Sphenoidal fissure.	External rectus and a few fibres to internal rectus of the opposite eye.	Motor.
7. Facial.	Groove between pons and medulla.	Floor of 4th ventricle.	Internal auditory meatus.	Facial muscles, frontalis, platysma, stylohyoid, and posterior belly of digastric.	Motor.
8. Auditory.	Groove between pons and medulla.	Chief nucleus in floor of 4th ventricle. Dieters' nucleus to inner side of restiform body. Accessory nucleus, postquadrigeminal body and internal geniculate by lateral commissure.	Internal auditory meatus.	Membranous labyrinth.	Special sense, hearing, equilibrium.
9. Glosso-pharyngeal.	Groove between olivary and restiform bodies.	Floor of the 4th ventricle.	Jugular foramen.	Pharynx, post part of tongue, fauces; soft palate and stylopharyngeus muscle.	Ordinary sense, special sense (taste), motor.

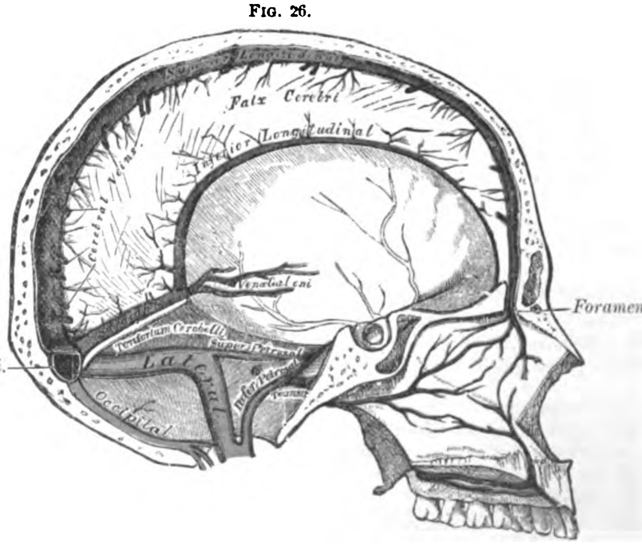
Name.	Superficial origins.	Deep origin.	Foramen of exit.	Distribution.	Function.
10. Pneumogastric.	Groove between olivary and restiform bodies.	Floor of the 4th ventricle.	Jugular foramen.	Sensory to ear; motor and sensory to pharynx, trachea, larynx, lungs, heart, œsophagus, stomach, and liver.	Ordinary sense, motor.
11. Spinal accessory.	Groove between olivary and restiform bodies and from cord.	Floor of 4th ventricle and intermediary column of cells and spinal cord.	Jugular foramen.	Motor to trapezius and sternomastoid and accessory to pneumogastric.	Motor and ordinary sense.
12. Hypoglossal.	Between the pyramidal and olivary bodies.	Trigonum hypoglossi in floor of 4th ventricle.	Anterior condyloid foramen.	Intrinsic and extrinsic muscles of tongue and by a common branch (ansa hypoglossal loop) to depressors of hyoid.	Motor.

THE DURAL SINUSES.

Definition. The dural sinuses are venous channels in the dura mater, which collect the blood from the brain and the orbit entire, and in some degree from the meninges. They are lined by endothelium, as are veins. The blood in the sinuses reaches the internal jugular veins. The sinuses communicate with the veins of the face, neck, and scalp, and are liable to infection in diseased conditions of these regions.

FIG. 26.

Torcular herophili.



Foramen cæcum.

Vertical section of the skull, showing the sinuses of the dura mater. (GRAY.)

Names. Superior longitudinal sinus (one); inferior longitudinal sinus (one); straight sinus (one); lateral sinuses (two); occipital sinus (one); cavernous sinuses (two); superior petrosal sinuses (two); inferior petrosal sinuses (two); transverse sinus (one); circular sinus (one).

The Superior Longitudinal Sinus is in the attached margin of the falx cerebri. It communicates in front, through a vein in the foramen cæcum, with the lining mucous membrane of the nose, and ends in an enlargement, torcular Herophili, near the internal occipital protuberance. This sinus receives the superior cerebral veins, and communicates through the parietal foramen with the temporal veins of the scalp. In surgical operations involving the removal of the bone in the midline of the cranium, care must be taken not to injure this sinus.

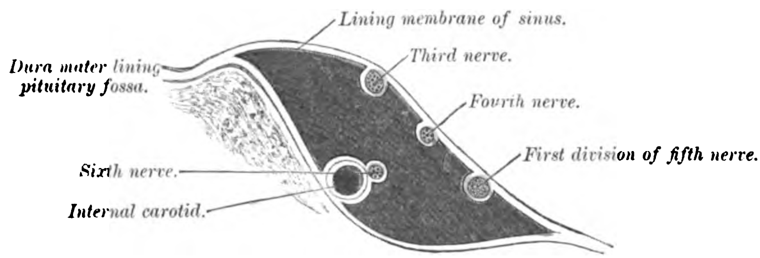
The Inferior Longitudinal Sinus is in the free margin of the falx cerebri. It collects blood from the falx itself and from the mesial surface of the brain, and ends posteriorly in the straight sinus.

The Straight Sinus is at the junction of the falx cerebri and tentorium cerebelli. It receives the vein of Galen and the inferior longitudinal sinus in front, and ends in the torcular behind. The lateral sinuses extend from the torcular to the commencement of the internal jugular vein. The distal curved part, in relation with the temporal bone, is called the sigmoid sinus. The greater part of the sinus is in the attached part of the tentorium cerebelli. The lateral sinus receives venous blood from the cerebellum, temporosphenoidal lobe, pons, medulla, diploë, and communicates through the mastoid emissary with the occipital vein.

The Occipital Sinus is in the attached margin of the falx cerebelli, and extends from the foramen magnum to the torcular. Its tributaries are the inferior cerebellar and spinal veins.

The Cavernous Sinuses are two in number. As they are similar, a description will be given in the singular. Although of limited extent, its relation to the orbit, base of the skull, and deep parts of the face, together with its important contents, makes its pathological importance great. The sinus extends in relation with the body of the sphenoid bone, from the sphenoidal fissure to the apex of the petrosa, where it ends in the superior and inferior petrosal sinuses. The two sinuses communicate on the superior surface of the body of the sphenoid, by two

FIG. 27.



Plan showing the relative position of the structures in the right cavernous sinus, viewed from behind. (GRAY.)

channels in the diaphragma sellæ (one in front of and the other behind the pituitary body), forming the circular sinus. The tributaries of the cavernous sinus are the ophthalmic and the inferior cerebral veins. Its communications are with: 1. The pterygoid plexus, through the foramen of Vesalius. 2. The pterygoid plexus, through the ophthalmic vein. 3. The pterygoid plexus, through the foramen ovale. 4. The pharyngeal plexus, through the foramen lacerum medium. 5. The internal jugular vein, through the carotid canal.

The cavernous sinus contains on its inner wall the sixth nerve and the cavernous stage of the internal carotid artery, with its plexus of sympathetic nerves; on its outer wall (from above down) the third and fourth nerves and the ophthalmic division of the trifacial nerve.

Sympathetic Nerves on the Internal Carotid Artery. The ascending branch of the superior cervical ganglion accompanies the internal carotid artery through the carotid canal in the petrosa. Here it divides into two branches: one forms a plexus on the carotid artery in the carotid canal (called carotid plexus); the other forms a plexus on the same artery a little higher in the cavernous sinus (called cavernous plexus).

The Carotid Plexus is situated on the internal carotid artery, in the carotid canal, in the petrous part of the temporal bone, receiving filaments from the tympanic branch of the glossopharyngeal nerve. The branches of this plexus are to (1) sixth nerve; (2) Gasserian ganglion; (3) tympanic plexus (small, deep petrosal nerve); (4) Vidian nerve (large, deep petrosal).

The Cavernous Plexus is situated on the internal carotid artery, in the cavernous sinus. Its branches are to the third nerve, fourth nerve, pituitary body, and ciliary ganglion.

The Superior Petrosal Sinus occupies the superior border of the petrosa in the attached margin of the tentorium cerebelli. It extends from the cavernous to the lateral sinus. Its tributaries are from the middle ear, cerebellum, and temporo-sphenoidal lobe of the cerebrum.

The Inferior Petrosal Sinus extends from the cavernous sinus along the posterior margin of the petrosa to the jugular foramen, where it becomes confluent with the lateral sinus to form the internal jugular vein. The two inferior petrosal sinuses communicate on the basilar process of the occipital bone, by the transverse sinus. Veins from the pons, medulla, internal ear, and cerebellum are tributary to the inferior petrosal sinuses.

DURA MATER OF BRAIN.

The dura mater is a dense inelastic membrane composed of two layers: (*a*) An outer endosteal, attached to the cranial bones; (*b*) an inner (covered by epithelial cells), which forms sheaths for the cranial nerves, a lining for the dural sinuses, and certain incomplete partitions called dural processes. The processes of the dura and their location are: (*a*) Falx cerebri, in the great longitudinal fissure, between the hemispheres; (*b*) falx cerebri, in the posterior notch of the cerebellum; (*c*) tentorium cerebelli, in the great transverse fissure, between the occipital lobe of the cerebrum and the cerebellum; (*d*) diaphragma sellæ, covering the pituitary body.

The dura of the brain differs from that of the spinal cord in the possession of sinuses, processes, bony attachments, Pacchionian bodies, endothelial cells on the inner side only, and no space between it and the bony walls. The dura of the brain derives its nerves from the sympathetic, Gasserian ganglion, fourth, fifth, tenth, and twelfth cranial nerves; that of the cord from the spinal nerves, through sympathetic filaments.

CLASSIFICATION OF MENINGEAL ARTERIES.

The three fossæ at the base of the skull form the basis of their classification, hence we speak of anterior, middle, and posterior meningeal arteries. There are numerous meningeal arteries, but each, with a single exception, is located in one of the three fossæ, and falls into the category of anterior, middle, or posterior meningeal.

The Anterior Meningeal arteries supply the dura and bone in the anterior fossa. They are very small, and often stripped off with the dura unrecognized.

The Middle Meningeal artery is a branch of the first stage of the internal maxillary. External to the cranium, it lies behind the internal pterygoid muscle. It passes between the two roots of the auriculotemporal nerve, enters the cranium through the foramen spinosum in the greater wing of the sphenoid bone, and ramifies between the dura mater and the bone, both of which it supplies.

The middle meningeal artery divides into anterior and posterior branches, which supply the greater part of the bones of the cranium and give off the following minor branches: (1) Small branches to the Gasserian ganglion; (2) a branch through the hiatus Fallopii to the seventh nerve and tympanum; (3) temporal branches, perforating the bone to the temporal fossa; (4) orbital branches, passing through the sphenoidal fissure to the orbit.

The Posterior Meningeal arteries supply the dura and bone in the posterior fossa. They are intermediate in size between the anterior and middle. The small meningeal artery supplies the Gasserian ganglion and adjacent dura mater.

TABLE SHOWING NAMES, SOURCE, AND POSITION OF MENINGEAL ARTERIES.

Name.	*Source.*	*Foramen.*	*Fossa.*
Anterior meningeal	Anterior ethmoidal.	Anterior ethmoidal.	
" "	Posterior "	Posterior "	Anterior.
" "	Ophthalmic.	Internal artery.	
" "	Internal carotid.	" "	
Great meningeal	Internal maxillary.	Spinosum.	
Small "	" "	Ovale.	Middle.
Middle "	Ascending pharyngeal.	Sphenotic.	
" "	Internal carotid.	Internal artery.	
Posterior meningeal	Occipital.	Mastoid.	
" "	"	Jugular.	
" "	Ascending pharyngeal.	Anterior condylar.	Posterior.
" "	" "	Magnum.	
" "	Vertebral.		

The *ramus parietalis*, a branch of the occipital artery, according to Cruveilhier, is occasionally found passing through the parietal foramen with the parietal emissary vein.

ARACHNOID.

The arachnoid membrane, the second meningeal covering, is a very delicate fibrous structure, covered on its outer surface by epithelial cells. It is in relation with the dura externally, and attached to the pia mater internally (by subarachnoid tissue), except at the base of the brain, where the anterior and posterior subarachnoid spaces (filled by subarachnoid fluid) intervene.

The anterior space is between the temporal lobes, anterior to the pons; the posterior, between the medulla and cerebellum, communicates with the fourth ventricle through the foramina of Key, Retzius, and Majendie, located in the posterior choroid tela of the pia mater.

PIA MATER.

The pia mater, the innermost meningeal covering of the brain, is composed of arteries, veins, and connective tissue. Its outer surface is covered by epithelial cells, continuous with those of the subarachnoid tissue and spaces.

The pia mater invests the surface of the brain, transmits bloodvessels into its interior, and forms sheaths for the cranial nerves. It forms (*a*) velum interpositum, located in the great transverse fissure, between the fornix and interbrain; (*b*) a second process, covering the fourth ventricle (between the medulla and the cerebellum), is perforated by the foramina of Key, Retzius, and Majendie, by which the fluid in the ventricles of the brain communicates with that in the posterior subarachnoid space. Nerves: sympathetic, third, fifth, sixth, seventh, ninth, tenth, and eleventh cranial. (See circle of Willis for vessels.)

FORAMINA AT THE BASE OF THE SKULL.

The foramina at the base of the skull should be thoroughly studied on both dry and moist specimens. A student may become familiar with the base of a dry skull and be still at sea on a recent one, because the nerves do not always pass out through the dura and bone in corresponding openings. For example, the seventh and eighth nerves are readily recognized, entering the internal auditory meatus, having perforated the dura at a corresponding spot. Likewise there is a correspondence of the foramina in dura and bone, where the ninth, tenth, and eleventh nerves escape. On the other hand, the third, fourth, sixth, and the three divisions of the trigeminus, after perforating the dura, pass long distances between this and the bone before they reach the bony foramina for final emergence.

Primary Foramina at the base of the skull are those in which there is correspondence between the foramen in the dura and that in the bone. They are: (1) Optic; (2) trigeminal; (3) auditory; (4) jugular; (5) anterior condyloid; (6) petrosphenoidal; (7) foramen magnum.

Secondary Foramina are those in which the cranial nerves perforate the dura, and, before passing through foramina in the bone, traverse a considerable distance between the dura and bone. They are: (1) The sphenoidal fissure; (2) foramen rotundum; (3) foramen ovale; (4) ethmoid canals; (5) infra-orbital canal; (6) sphenopalatine foramen; (7) sphenomalar foramen; (8) malar canals; (9) pterygopalatine foramen; (10) Vidian canal; (11) posterior palatine canal; (12) inferior dental canal; (13) facial canal; (14) iter chordæ posterius; (15) iter chordæ anterius; (16) sphenomaxillary fissure.

TABLE OF CRANIAL FORAMINA.

Ant. fossa.	Foramen cæcum	Transmits an emissary vein to the nose.
	Nasal slit	Transmits the nasal branch of ophthalmic nerve.
	Olfactory foramina	Twenty in number, transmit the olfactory nerves.
	Optic foramina	Transmit the optic nerves and the ophthalmic artery.
Mid. fossa.	Sphenoidal fissure	Transmits 3d, 4th, 6th, and 1st divisions of the 5th nerve, the ophthalmic vein and sympathetic nerve.
	Foramen rotundum	Transmits the second division of the 5th nerve.
	Foramen ovale	Transmits the third division of the 5th nerve and the small meningeal artery.
	Foramen spinosum	Transmits the great meningeal artery.
	Foramen sphenotic	Transmits internal carotid artery and carotid petrosal for Vidian nerve.
	Hiatus Fallopii	Transmits petrosal branch of the Vidian nerve.
	Petrosal foramen	Transmits the smaller petrosal nerve.
	Carotid canal	Transmits internal carotid artery and its sympathetic nerves.
Post. fossa.	Internal auditory meatus	Transmits 7th and 8th nerves and auditory artery.
	Jugular foramen	Transmits jugular vein, 9th, 10th, and 11th nerves.
	Anterior condyloid foramen	Transmits the hypoglossal nerve.
	Foramen magnum	Transmits (1) spinal cord and its meninges; (2) the vertebral arteries and their sympathetic nerves; (3) the spinal accessory nerve.

Constant Foramina transmits nerves; conversely, the presence of a nerve assures the constancy of a foramen. All primary and secondary foramina are constant.

Inconstant Foramina do not transmit nerves. They usually transmit veins which extend from the sinuses of the dura mater to the vessels in the soft parts, outside the bones of the cranium; they are also called emissary foramina.

CHAPTER III.

THE BRAIN AND THE SPINAL CORD.

DISSECTION AND IDENTIFICATION.

1. CONSULT illustration of circle of Willis and superficial origins of the cranial nerves, then carefully read the text on these two. This identification will call for no cutting, except now and then the arachnoid or pia, to more fully expose the brain surface.
2. To expose the fissure of Sylvius and branches of the middle cerebral artery given off on the island of Reil, cut through the arachnoid and pia mater and gently separate the frontal, temporal, and parietal lobes.
3. After having identified the vessels and cranial nerves according to the text, remove the pia mater and arachnoid (in one mass) from the entire surface of the brain. Note that the vessels dip down into the fissure and sulci, and that the pia and arachnoid, except at the base of the brain, are intimately fused.
4. The pia and arachnoid having been removed, as previously stated, study the lobes and fissures in the order of sequence of the text and illustrations.
5. To study the interior, follow the illustrations, whose sequence and appearance will be a better guide than many pages of written directions.

CIRCLE OF WILLIS.

Arteries from Circle of Willis (anterior, middle, and posterior cerebrals) give off numerous branches, which supply, in the main, the hemispheres of the cerebrum, and constitute the cortical system. Branches from the circle supplying the ganglia and interbrain constitute the ganglionic system.

Circle of Willis. Identify (1) by extent from the anterior part of the pons, one inch and a half forward, and one inch from side to side; (2) by formation from branches of the internal carotid and basilar arteries.

Internal Carotid Artery. Identify (1) by location, lateral to optic chiasm; (2) by anterior cerebral, middle cerebral, and posterior communicating branches.

Anterior Cerebral Artery. Identify (1) by origin from the front of the internal carotid and its passage inward and forward into the great longitudinal fissure; (2) by climbing over the genu of the corpus callosum and the distribution to the mesial surface of the hemisphere as far backward as the parieto-occipital fissure; (3) by union with its fellow of the opposite side, through the very short anterior communicating artery; (4) by the antero-median ganglionic, inferior internal frontal, anterior internal frontal, middle internal frontal, and posterior internal frontal branches.

Middle Cerebral. Identify (1) as the largest cerebral artery, and a branch of the internal carotid; (2) by its course outward along the fissure of Sylvius; (3) by dividing opposite the island of Reil into the antero-lateral ganglionic, inferior external frontal, ascending frontal, ascending parietal, and parieto-temporal branches.

Posterior Cerebral Artery. Identify (1) by its origin from the basilar and its location in front of the third nerve; (2) by a course outward across the crus cerebri to the under surface of the occipital lobe of the brain and the distribution to the temporal and occipital lobes; (3) by the postero-median ganglionic, posterior choroid, postero-lateral ganglionic, anterior temporal, posterior temporal, and occipital branches.

Anterior Communicating Artery. Identify (1) by location in front of the circle of Willis connecting the anterior cerebral arteries; (2) by its length, less than one-quarter inch.

Posterior Communicating Artery. Identify (1) by the origin from the internal carotid and anastomosis with the posterior cerebral; (2) by forming the lateral boundary of the circle of Willis.

The following arteries, given off from the circle of Willis or near thereto, are called terminal end arteries. They constitute the ganglionic system, and are arranged in six groups. The antero-median and postero-median groups are single and central; the others are bilateral. These vessels anastomose neither with the arteries of their own nor with those of the cortical system.

Antero-median Group. Identify these small vessels (1) by the origin from the anterior cerebral and anterior communicating arteries; (2) by piercing the lamina cinerea and anterior perforated lamina, and supplying the anterior wall of the third ventricle and bulb of the nucleus caudatus.

Postero-median Group. Identify (1) by the origin from the posterior cerebral and posterior communicating arteries; (2) by the distribution to the interpeduncular space and crustæ; (3) by piercing the posterior perforated lamina, and the distribution to the third ventricle and the adjacent part of the optic thalamus.

Antero-lateral Group. Identify (1) by the origin from the middle cerebral; (2) by passing through the anterior perforated lamina to the corpus striatum, optic thalamus, and the internal capsule. This group gives off the lenticulo-striate, called the artery of cerebral hemorrhage, on account of its frequent rupture.

Postero-lateral Group. Identify (1) by the origin from the posterior cerebral after crossing the crus; (2) by the distribution to the corpora geniculata and quadrigemina and optic thalamus.

Superior Cerebellar Artery. Identify (1) by the origin near the end of the basilar; (2) by the course parallel with the posterior cerebral, behind the third nerve, around the crus cerebri to the upper surface of the cerebellum; (3) by the distribution to the velum interpositum, pineal gland, valve of Vieussens, and the upper surface of the cerebellum.

Anterior Inferior Cerebellar Artery. Identify (1) by the origin from the basilar; (2) by the course backward across the middle cerebellar crus and the distribution to the anterior border of the cerebellum.

Posterior Inferior Cerebellar Artery. Identify (1) by the origin from the vertebral; (2) by the course around the upper part of the medulla, between the origins of the tenth and eleventh nerves, to the under surface of the cerebellum.

Transverse Branches to Pons Varolii. Identify (1) by the origin from the basilar; (2) by the distribution to the pons and internal ear (cochlear and vestibular branches), which accompany the two divisions of the auditory nerve.

Anterior Choroid Artery. Identify (1) by the origin from the internal carotid; (2) by the course through the cortex to the descending horn of the lateral ventricle; (3) by the distribution to the choroid plexus, corpus fimbriatum, and hippocampus major.

Postero-lateral Choroid Artery. Identify (1) by the origin from the posterior cerebral; (2) by the distribution to the choroid plexus and velum interpositum.

Posterior-mesial Choroid Artery. Identify (1) by the origin from the posterior cerebral; (2) by the distribution to the choroid plexus of the third ventricle.

Superior Cerebral Veins. Identify (1) by the location on the superior surface of the hemisphere; (2) by receiving tributary, the median cerebral veins, and the opening from behind forward into the superior longitudinal sinus.

Median Cerebral Veins. Identify (1) by the location on the median surface of the hemisphere; (2) by the opening into the superior cerebral veins and inferior longitudinal sinus.

Inferior Cerebral Veins. Identify (1) by the location on the under surface of the hemisphere; (2) by the following manner of reaching the sinuses: one large vein (middle cerebral) from the under surface of the temporal lobe runs along the fissure of Sylvius and reaches the cavernous sinus; the great anastomotic vein of Trolard begins on the parietal lobe, passes along the fissure of Sylvius to the cavernous sinus; others open into the superior petrosal and lateral sinuses.

Ventricular Veins (Veins of Galen). Identify (1) by the location between the layers of the velum interpositum; (2) by the emergence from the brain at the great transverse fissure, between the splenium of the corpus callosum and the tubercula quadrigemina; (3) by opening into the straight sinus; (4) by the following tributaries: basilar, choroid, and vein of the corpus striatum.

Basilar Vein. Identify (1) by the origin at the anterior perforated space by union of the small anterior cerebral veins and the deep Sylvian vein, seen in the lower part of the Sylvian fissure; (2) by the course around the crus cerebri to the vein of Galen; (3) by the receiving inferior striate, interpeduncular, ventricular, and uncinate veins.

Cerebellar Veins. Identify (1) the superior, by the course across the superior vermiform process to the vein of Galen and the straight sinus; (2) the inferior, by the termination in the lateral, superior petrosal, and occipital sinuses.

STRUCTURES ON THE BASE OF THE BRAIN.

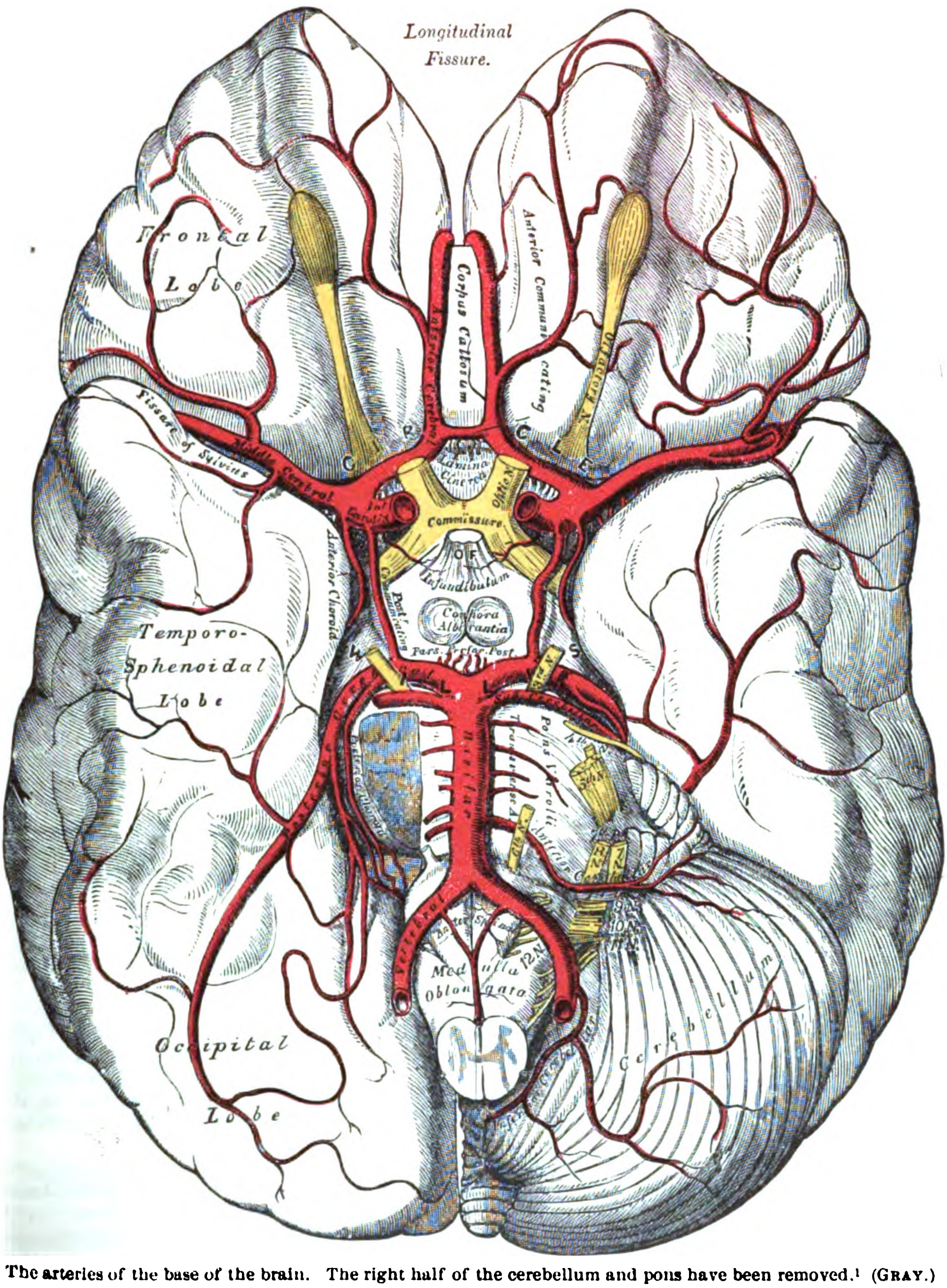
Longitudinal Fissure. Identify (1) by the location between the hemispheres, separating completely the occipital lobes, and, partially, the frontal lobes. Intermediately, it is filled by corpus callosum; (2) by the presence of the anterior cerebral arteries, connected by the anterior communicating artery between the frontal lobes.

Termination of the Corpus Callosum. Identify (1) by the location in the longitudinal fissure (seen by gently separating the frontal lobes); (2) by the connection to the tuber cinereum through the lamina cinerea and to the hippocampal gyrus through the peduncles of the corpus callosum.

Lamina Cinerea. Identify (1) by the location as gray matter extending from the corpus callosum to the tuber cinereum; (2) by the continuity on each side with the gray matter of the anterior perforated space. To expose the lamina cinerea, gently draw the optic commissure back.

Peduncles of the Corpus Callosum. Identify (1) by the location as white bands, one on each side, extending from the under surface of the corpus callosum across the posterior margin of the anterior perforated space to the hippocampal gyrus; (2) by the continuity with the striæ longitudinales, on either side of the raphe of the corpus callosum.

FIG. 28.



The arteries of the base of the brain. The right half of the cerebellum and pons have been removed.[1] (GRAY.)

Anterior Perforated Space (posterior **olfactory lobe**). Identify (1) by the location at the beginning of the fissure of Sylvius, with **numerous perforations for the ganglionic arteries**; (2) by the boundaries: peduncle of the **corpus callosum, optic tract, fissura prima, and fissure of Sylvius**. This is the surface area of the **lenticular and caudate nuclei and claustrum.**

[1] It will be noticed that in the illustration the two anterior cerebral arteries have been drawn at a considerable distance from each other; this makes the anterior communicating artery appear very much longer than it really is.

Optic Commissure. Identify (1) by the location in the mid line, beneath the lamina cinerea, in front of the tuber cinereum; (2) by the junction of the optic tracts and the continuation forward and outward, as the optic nerves.

Tuber Cinereum. Identify (1) as the eminence of gray matter, situated between the optic tracts, limited in front by the optic commissure, behind by the corpora albicantia; (2) by the tubular neck of gray matter, the infundibulum, leading to the posterior lobe of the pituitary body.

Pituitary Body (hypophysis cerebri). Identify (1) by the round form and the location in the sella turcica of the sphenoid bone; (2) by the connection with the floor of the third ventricle through the infundibulum; (3) by being held in the sella turcica by a process of the dura—diaphragma sellæ.

Corpora Albicantia. Identify (1) by the location in the interpeduncular space in front of the posterior perforated space; (2) by the small size (pea), round form, and white color.

Posterior Perforated Space. Identify (1) by the location between the pons varolii and corpora albicantia; (2) by transmitting numerous small, ganglionic arteries (postero-median) to the interior of the brain.

Pons Varolii. Identify (1) by the location as a broad band of white fibres, extending from one hemisphere of the cerebellum to the other; (2) by the location between the crura cerebri and medulla; (3) by the presence of the longitudinal groove (sulcus basilaris) for the basilar artery.

Medulla Oblongata. Identify (1) by the location as a pyramidal body between the pons and the spinal cord; (2) by the anterior median fissure continuous with that of the spinal cord; (3) by the origin of certain cranial nerves therefrom.

Pyramids of the Medulla. Identify (1) by the location as two pyramidal bundles of white matter on either side of the anterior median fissure; (2) by the presence of the roots of the hypoglossal nerve, between the pyramid and the olivary body. The pyramids are represented in the spinal cord by the direct and crossed tracts.

Olivary Body. Identify by the location external to the pyramid, and separated therefrom by fibres of the hypoglossal nerve. Restiform body: Identify (1) by the location in the upper and posterior parts of the medulla; (2) by the presence, between this and the olivary body, of the band of fibres from the lateral tract, and the origins of the ninth, tenth, and eleventh nerves.

Crusta Cerebri. Identify (1) by the location as two thick, cylindrical bundles of white matter emerging from the front of the pons Varolii; (2) by diverging and entering the cerebral hemispheres; (3) by the presence of the longitudinal striæ on the surface; (4) by the presence of the optic tract adhered to the surface

Optic Tracts. Identify (1) by the location on the crustæ cerebri; (2) by the continuity with the optic commissure.

Interpeduncular Space. Identify (1) by boundaries: In front, the optic commissure; behind, the pons Varolii; laterally, the crura cerebri and optic tract; (2) by contents: tuber cinereum, infundibulum, pituitary body, corpora albicantia, posterior perforated space.

Fissure of Sylvius. Identify (1) by the location between the frontal and temporal lobes; (2) by the middle cerebral artery and the island of Reil continued therein.

Middle Peduncles of the Cerebellum. Identify (1) as a broad band comprising most of the transverse fibres of the pons, entering the cerebellum at the anterior notch, between the margins of the great horizontal fissure.

The Frontal and Temporal Lobes, separated by the fissure of Sylvius, need no further identification here. The cerebellum cannot be mistaken.

Olfactory Lobe. This is rudimentary in man, and consists of posterior and anterior olfactory lobules. Posterior olfactory lobule: Identify (1) by its synonym, the anterior perforated lamina; (2) by the foramina, transmitting the vessels to the interior of the brain; (3) by the location and boundaries. (See "anterior perforated space.") Anterior olfactory lobule: Identify (1) by the olfactory bulb, olfactory tract, trigone, and olfactory area of Broca.

Olfactory Bulb. Identify (1) as the anterior, expanded end of the olfactory tract; (2) by the location on the cribriform plate of the ethmoid; (3) by the olfactory nerves, about twenty in number, received from the olfactory region of the nose, through the olfactory foramina.

Olfactory Tract. Identify (1) as a white, triangular band in the olfactory sulcus, on the under surface of the frontal lobe; (2) by the division into an outer and an inner root uniting the two ends of the limbic lobe.

Outer Root of Olfactory Tract Identify by the course across the anterior perforated space to the gyrus hippocampi and the nucleus situated at the tip of the temporal lobe. Inner root of the olfactory tract: Identify (1) by the termination in **Broca's area and gyrus fornicatus**; (2) by the location between the trigone and the area of Broca.

Trigonum Olfactorium. Identify (1) by the location between the diverging outer and inner roots of the olfactory tract; (2) by forming the base of the anterior olfactory lobule; (3) by the continuity with Broca's area; (4) by the boundaries: fissura prima, outer and inner roots of the olfactory tract.

Fissura Prima. Identify (1) by the location (horizontal part) between the anterior and posterior olfactory lobules; (2) by the location (oblique part) between the area of Broca and the peduncle of the corpus callosum.

Area of Broca. Identify (1) by the continuity with the trigonum olfactorium (inner root of the olfactory tract separating the two); (2) by the continuity with the gyrus fornicatus.

The Area of Smell is in the uncus hippocampi, which is reached by roots of the olfactory nerve in two ways: direct and indirect. The outer root, having crossed the anterior, perforated space, ends directly in the nucleus amygdalæ and gyrus hippocampi. The inner root, having ended in Broca's area and the gyrus fornicatus, communicates with the uncus hippocampi through two sets of long association fibres—cingulum and uncinate fasciculus. The uncinate fasciculus, crossing the bottom of the Sylvian fissure, connects the anterior end of the temporal lobe. The cingulum connects the anterior perforated lamina with the gyrus hippocampi. In its course it passes forward and upward, parallel with the rostrum, winds around the genu, runs immediately above the corpus callosum, passes to the anterior end of the hippocampus major, where it ends in association with the gray matter of the uncus.

Optic Tracts. Identify (1) by the continuity with the optic commissure; (2) by the location on and attachment to the under surface of the crustæ cerebri; (3) by the division (at the connection with the brain) into the external and internal bands.

External Band of the Optic Tract. Identify (1) by the origin from the external geniculate body, pulvinar of the optic thalamus, brachium of the anterior quadrigeminal body.

Internal Band of the Optic Tract. Identify (1) by the course around the crusta and beneath the internal geniculate body; (2) by the origin from the optic thalamus and the internal geniculate body.

Motor Oculi (third cranial nerve). Identify (1) by the superficial origin from the inner surface of the crusta in front of the pons; (2) by investments from the arachnoid and pia mater; (3) by the course between the posterior cerebral and the superior cerebellar arteries; (4) by piercing the dura in front of and external to the posterior clinoid process.

Trochlear Nerve (fourth cranial). Identify (1) by the superficial origin from the base of the brain seen on the outer side of the crusta cerebri, in front of the pons Varolii, but originating from the valve of Vieussens; (2) by piercing the dura in the free border of the tentorium behind and external to the posterior clinoid process.

Trifacial Nerve (fifth cranial). Identify (1) by the very large superficial origin from the side of the pons near the upper border; (2) by the course beneath the tentorium cerebelli and through the trigeminal notch.

Abducent Nerve (sixth cranial). Identify (1) by the superficial origin in the groove between the pyramid of the medulla and pons; (2) by piercing the dura on the basilar surface of the sphenoid and passing through the notch below the posterior clinoid process of the sphenoid bone.

Facial Nerve (seventh cranial). Identify (1) by the superficial origin from the upper end of the medulla in the groove between the olivary and restiform bodies; (2) by the course forward and outward on the middle cerebellar peduncle with the eighth nerve to the internal auditory meatus; (3) by the presence of the auditory artery, accompanying the seventh and eighth nerves.

Auditory Nerve (eighth cranial). Identify by the superficial origin in the groove between the pons and medulla, with the facial nerve in front and the restiform body behind.

Glossopharyngeal Nerve (ninth cranial). Identify (1) by three or four filaments of origin from the upper part of the medulla, between the olivary and the restiform bodies; (2) by the outward course across the flocculus, and the emergence through the centre of the jugular foramen, external to and in front of the tenth and eleventh cranial nerves.

Pneumogastric Nerve (vagus, parvagum—tenth cranial). Identify (1) by eight or ten filaments of the origin between the olivary and restiform bodies below the ninth nerve; (2) by the emergence through the jugular foramen with the ninth and eleventh nerves and the internal jugular vein.

Spinal Accessory Nerve (eleventh cranial). Identify (1) by two portions—spinal and bulbar; (2) by the superficial origin of the bulbar portion from the side of the medulla below the vagus; (3) by the superficial origin of the spinal portion, by several filaments from the lateral tract of the cord, as low as the sixth cervical, and passage through the foramen magnum; (4) by emergence of both portions through the jugular foramen, with the jugular vein, ninth and tenth nerves.

Hypoglossal Nerve (twelfth cranial). Identify (1) by the superficial origin between the pyramidal and olivary bodies, by several filaments; (2) by perforating the dura in two bundles and emerging through the anterior condyloid foramen.

LOBES, CONVOLUTIONS, FISSURES, SULCI (OUTER SURFACE).

Longitudinal Fissure. Identify (1) by the location between the cerebral hemispheres; (2) by the presence of the falx cerebri; (3) by the corpus callosum forming the floor of the middle part.

Sylvian Fissure. Identify (1) by the location on the base and side of the hemisphere, between the frontal and temporal lobes; (2) by the origin in the vallecula Sylvii (in which is situated the anterior perforated space), and the termination in the parietal lobe; (3) by the division into three limbs—anterior, vertical, and horizontal.

Fissure of Rolando. Identify (1) by the location in the middle of the outer surface of the hemisphere; (2) by the downward and forward direction, dividing the hemisphere into about equal parts; (3) by the location between the frontal and parietal lobes.

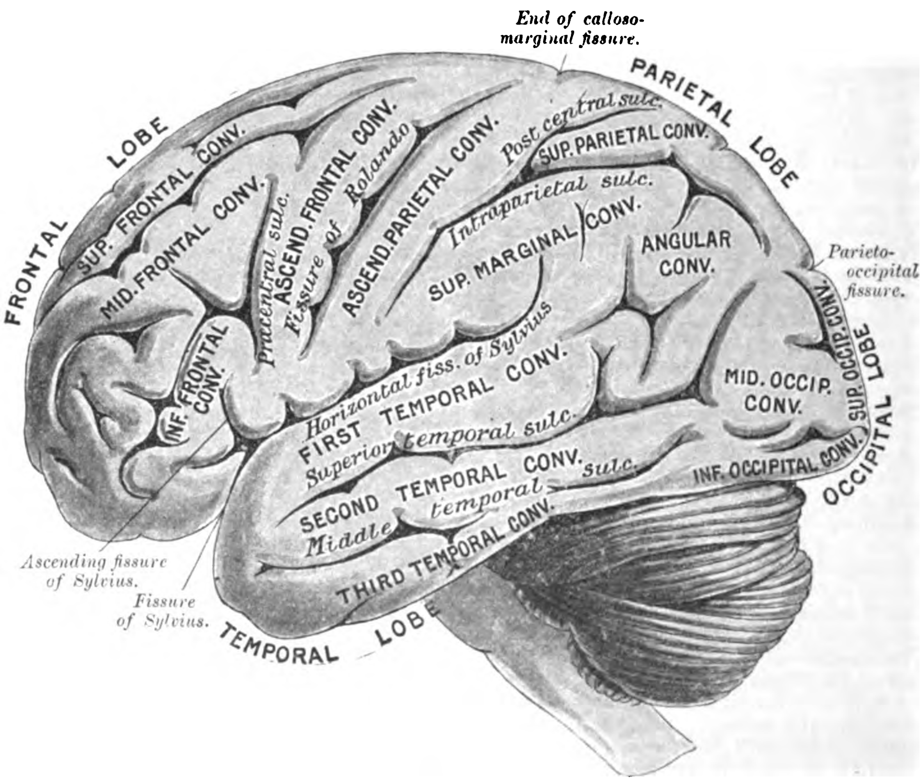
Parieto-occipital Fissure. Identify (1) by the situation partly on the outer surface (external parieto-occipital fissure) and partly on the mesial surface of the hemisphere (internal parieto-occipital fissure).

Calloso-marginal Fissure. Identify (1) by the location between the gyrus fornicatus and the marginal convolution; (2) by the posterior end, separating the paracentral lobule and the quadrate lobe, and terminating just behind the superior end of the Rolandic fissure.

Great Transverse Fissure. Identify (1) by the location between the cerebrum and cerebellum; (2) by the presence of the tentorium in the posterior and velum interpositum in the anterior part; (3) by opening posteriorly between the splenium of the corpus callosum above and the corpora quadrigemina and pineal gland below; (4) by the transmission of veins of Galen.

Frontal Lobe. Identify (1) by the location at the anterior pole of the hemisphere in front of Rolando's fissure, external to the longitudinal fissure on the orbital plate of the frontal bone; (2) by its external, inferior, and mesial surfaces; (3) by its four sulci and eight convolutions.

FIG. 29.



Convolutions and sulci on the external surface of the cerebral hemisphere. (GRAY.)

Precentral Sulcus. Identify by the location, anterior to the ascending frontal convolution and parallel to the lower half of the fissure of Rolando.

Superior Frontal Sulcus. Identify (1) by the location, running forward between the superior and middle frontal convolutions; (2) by the origin in the precentral sulcus.

Inferior Frontal Sulcus. Identify (1) by the location, running forward between the middle and inferior frontal convolutions; (2) by the origin in the precentral sulcus.

Superior Frontal Convolutions. Identify (1) by the location on the external surface of the frontal lobe, between the longitudinal fissure and the superior frontal sulcus; (2) by forming the greater part of the marginal convolution on the inner surface of the hemisphere; (3) by the continuity with the internal orbital convolution on the inferior surface of the frontal lobe.

Middle Frontal Convolution. Identify (1) by the location between the superior and inferior frontal sulci; (2) by the continuation from the precentral sulcus to the orbital surface of the frontal lobe, where it forms the anterior frontal convolution.

Inferior Frontal Convolution. Identify (1) by the location below the inferior frontal sulcus; (2) by the continuation from the precentral sulcus to the under surface of the frontal lobe, where it forms the posterior orbital convolution.

Parietal Lobe. Identify (1) by the location behind the fissure of Rolando and above the horizontal limb of the fissure of Sylvius; (2) by an intraparietal and a post-central sulcus; (3) by the ascending, superior, and inferior parietal convolutions.

Intraparietal Sulcus Identify (1) by the origin midway between the lower end of the fissure of Rolando and the fissure of Sylvius; (2) by the course parallel with the fissure of Rolando as far as the superior parietal convolution, thence backward near the parieto-occipital fissure, separating the superior and inferior parietal convolutions; (3) by the location posterior to the ascending parietal convolution.

Postcentral Sulcus. Identify (1) by the location between the superior and ascending parietal convolutions; (2) as a very slight groove and a possible branch of the intraparietal sulcus.

Ascending Parietal Convolution. Identify (1) by the location immediately behind the fissure of Rolando, in front of the intraparietal and postcentral sulci; (2) by the great longitudinal fissure above and the fissure of Sylvius below, where it becomes continuous with the ascending frontal convolution.

Superior Parietal Convolution. Identify (1) by the postcentral sulcus in front, intraparietal sulcus below, parieto-occipital fissure behind; (2) by the continuity with the quadrate lobe on the inner surface of the hemisphere.

Inferior Parietal Convolution. Identify (1) by the boundaries—the fissure of Sylvius below, the intraparietal sulcus above, the occipital lobe behind, and the ascending parietal convolution in front; (2) by dividing into the angular and supramarginal convolutions.

The Internal Surface of the parietal lobe is continuous with the external. It is quite small, and is represented by a part of the paracentral convolution and quadrate lobe. The quadrate lobe is sometimes called precuneus, from its location in front of the cuneus.

Occipital Lobe. Identify (1) by the location forming the posterior pole of the hemisphere; (2) by the location on the upper surface of the tentorium cerebelli; (3) by an external convex surface presenting two sulci and three convolutions; (4) by a mesial surface presenting a calcarine and a parieto-occipital fissure and a cuneate lobe.

Occipital Convolutions. Identify the superior by the location above the superior sulcus and connected to the superior parietal convolution by the first annectant gyrus. Identify the middle by the location between the superior and middle sulci, connected to the angular convolution by the second annectant gyrus and to the middle temporal by the third. Identify the inferior by the location below the middle occipital sulcus, connected to the inferior temporal convolution by the fourth annectant gyrus.

Temporal Lobe. Identify (1) by the location posterior to the main branch below the horizontal limb of the fissure of Sylvius and in the middle fossa of the skull; (2) by the outer and inferior surfaces; (3) by four sulci; (4) by five convolutions.

First Temporal Sulcus (outer surface). Identify by the location between the first and second temporal convolutions, parallel with the horizontal limb of the fissure of Sylvius.

Second Temporal Sulcus (outer surface). Identify by the location between the second and third temporal convolutions.

Third Temporal Sulcus (inferior surface). Identify by the location on the inferior surface, extending from near the occipital pole to near the anterior end of the temporal lobe.

Superior Temporal Convolution (outer surface). Identify (1) by the location between the horizontal limb of the fissure of Sylvius and the superior temporal sulcus; (2) by the continuity behind with the inferior parietal convolution.

Middle Temporal Convolution (outer surface). Identify (1) by the location between the superior and middle temporal sulci; (2) by the continuity behind with the angular and middle occipital convolutions.

Inferior Temporal Convolution (outer surface). Identify by the location between the middle and the third temporal sulci.

Central Lobe (island of Reil). Identify (1) by the location in the Sylvian fissure, whose lips must be parted to expose the lobe; (2) by the opercula—orbital, frontal, fronto-parietal, temporal—convolutions which overlap the central lobe and form boundaries of the Sylvian fissure: (3) by the triangular form, with the apex directed toward the anterior perforated space; (4) by being almost completely surrounded at the base by the limiting sulcus; (5) by the composition of from four to eight convolutions—gyric operti; (6) by the presence of the middle cerebral artery, dividing into numerous terminals.

MESIAL SURFACE OF THE HEMISPHERE.

Gyrus Fornicatus. Identify (1) by the location on the mesial surface of the hemisphere, separated from the corpus callosum by the callosal fissure; (2) by commencing below the rostrum of the corpus callosum and ending behind the splenium, where it is connected to the gyrus hippocampi by a narrow isthmus; (3) by forming part of the limbic lobe of Broca.

Hippocampal Gyrus. Identify (1) by the location on the mesial surface, between the dentate and the collateral fissure; (2) by the continuity, behind and above, with the gyrus fornicatus (gyrus cinguli, callosal convolution), behind and below with the lingual convolution. The uncus is formed by the anterior end of the hippocampal gyrus.

Marginal Convolution. Identify (1) by the location on the mesial surface of the hemisphere—on the frontal lobe; (2) by commencing in front of the anterior perforated space and ending in the paracentral convolution; (3) by the intervention of the calloso-marginal fissure between it and the gyrus fornicatus.

Paracentral Convolution. Identify (1) by the continuity with the marginal convolution; (2) by the continuity with the upper ends of the ascending frontal and ascending parietal convolutions about the upper end of the fissure of Rolando.

Quadrate Lobe. Identify (1) by the location on the mesial surface of the hemisphere and continuous with the external surface of the parietal lobe; (2) by the small size and quadrate form; (3) by the intervention of the parieto-occipital fissure, between it and the cuneate lobe.

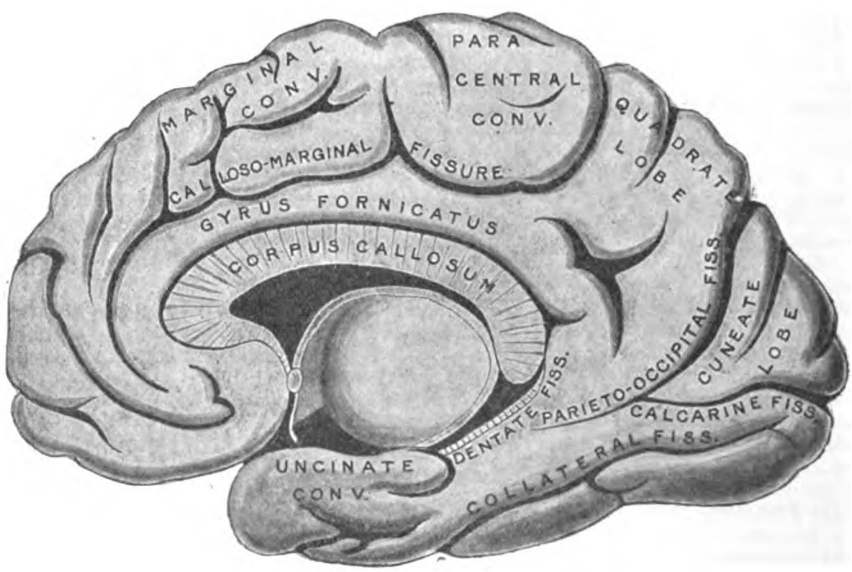
Cuneate Lobe. Identify (1) by the location on the mesial surface of the hemisphere, and a part of the occipital lobe; (2) by the location between the parieto-occipital and the calcarine fissures.

Limbic Lobe of Broca. Identify (1) by the composition: gyrus fornicatus, hippocampal convolution, nerves of Lancisi, peduncles of the corpus callosum, fascia dentata, and one-half each of the septum lucidum and the body of the fornix.

The Corpus Callosum shows on the mesial surface in sagittal section, but its identification is reserved until the interior of the brain is studied.

Calloso-marginal Fissure. Identify (1) by the location between the marginal gyrus and the anterior and upper parts of the limbic lobe; (2) by following the course: (*a*) commences below the anterior end of the corpus callosum; (*b*) runs parallel with the rostrum and in front of the genu of the corpus callosum; (*c*) passes between the marginal convolution and the gyrus fornicatus; (*d*) midway between the anterior and posterior poles of the cerebrum, ascends, and reaches the upper margin of the hemisphere, posterior to the fissure of Rolando.

FIG. 30.



Convolutions and sulci on the internal surface of cerebral hemispheres. (GRAY.)

Parieto-occipital Fissure (internal). Identify (1) by the location between the quadrate and cuneate lobes; (2) by the extent, in backward and upward direction, from beneath the splenium of the corpus callosum to the border of the mesial surface; (3) by the continuity with the external parieto-occipital fissure at the margin of the longitudinal fissure.

Calcarine Fissure. Identify (1) by the location on the mesial surface of the hemisphere, between the occipital and temporal lobes; (2) by the termination a little below the level of the corpus callosum; (3) by the production of the hippocampus minor in the posterior horn of the lateral ventricle.

Collateral Fissure. Identify (1) by the location on the tentorial surface below and external to the calcarine fissure; (2) the middle part of the fissure corresponds to the eminentia collateralis in the descending horn of the lateral ventricle.

Hippocampal Fissure (dentate). Identify (1) by the extent from the splenium of the corpus callosum, beneath the optic thalamus to near the end of the temporal lobe. This fissure is represented by the hippocampus major in the descending horn of the lateral ventricle.

UNDER SURFACE—TEMPORAL LOBE.

Fourth Temporal Convolution (inferior surface). Identify by the location between the third temporal sulcus and the collateral fissure.

Subcalcarine Convolution (lingulal lobe—inferior surface). Identify (1) by the location between the calcarine and collateral fissures; (2) by the continuity with the hippocampal convolution in front.

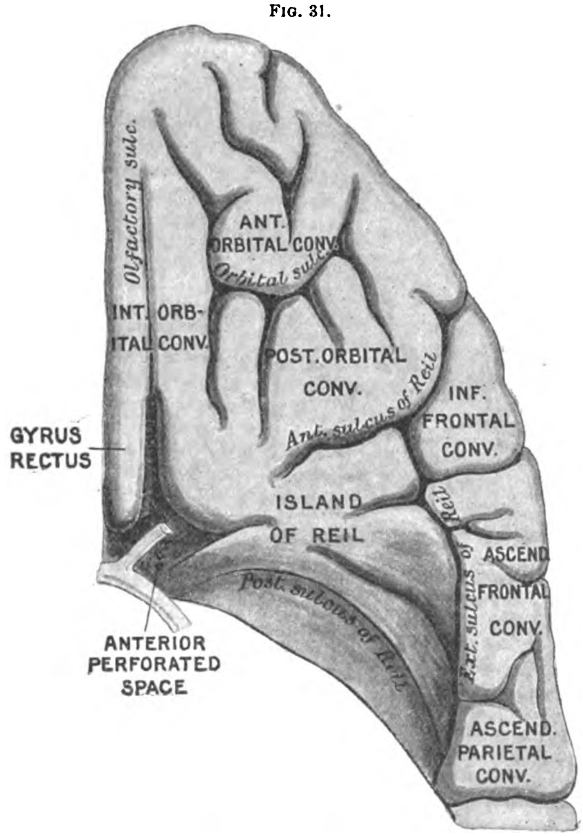
The Cortical Centres of smell, hearing, and taste are probably located in the temporal lobe.

Collateral Fissure (inferior surface). Identify (1) by the location on the inferior surface below and external to the calcarine fissure; (2) by the course forward to near the tip of the temporal lobe.

FRONTAL LOBE.

Internal Orbital Convolution. Identify (1) by the location on under surface of the frontal lobe near the longitudinal fissure; (2) by the continuity with superior frontal convolution of the external surface of the frontal lobe; (3) by the presence of the olfactory sulcus for the olfactory tract; (4) that portion of the convolution internal to the olfactory sulcus is the gyrus rectus.

FIG. 31.



Convolutions and sulci on the under surface of the anterior lobe. (GRAY.)

The Anterior and Posterior Orbital Convolutions are continuations, respectively, of the middle and inferior frontal convolutions on the external surface of the frontal lobe.

Triradiate Sulcus (orbital). Identify (1) by the location near the centre of the inferior surface; (2) by giving origin to the internal, anterior, and posterior orbital convolutions.

The Inferior and Ascending Frontal and ascending parietal show in part on under surface of frontal lobe.

INTERIOR STRUCTURES OF THE BRAIN.

Corpus Callosum. Identify (1) as a thick, white, flattened arch (of transversely directed nerve fibres), about four inches long, connecting the two hemispheres of the brain, and seen at the bottom of the middle part of the longitudinal fissure; (2) by the fibres passing into the hemispheres, radiating in various directions and ending in the gray matter of the periphery; (3) by specialized anterior and posterior extremities—rostrum and splenium; (4) composed of axons of cells in one hemisphere, which arborize about cells in the opposite hemisphere; (5) by forming the roof of the lateral ventricles.

Rostrum. Identify (1) by the continuity with the corpus callosum turning sharply at the genu, passing backward to the base of the brain and becoming connected with the lamina cinerea; (2) by the peduncles of the corpus callosum, which, crossing the posterior part of the anterior perforated space, join the outer roots of the olfactory tracts in the hippocampal gyri.

Splenium. Identify (1) by the location at the posterior end of the corpus callosum as a thick, rounded pad, continuous by the under surface with the fornix; (2) by overlapping mesencephalon or mid-brain—crustæ, substantia nigra, iter, tegmentum, corpora quadrigemina, and internal geniculate bodies.

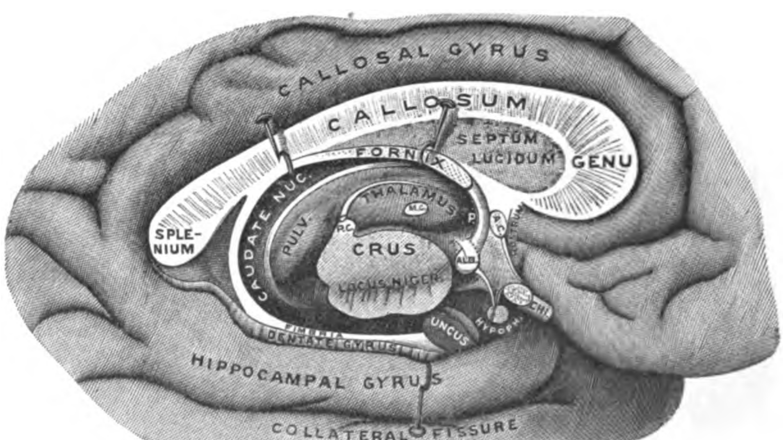
Nerves of Lancisi (striæ longitudinales). Indentify (1) by the location on the upper surface of the corpus callosum, lateral to the raphe; (2) by continuity with the peduncles of the corpus callosum.

Forceps Anterior (minor). Identify as the fibres of the corpus callosum curving forward into the frontal lobe and covering the anterior horn of the lateral ventricle.

Forceps Posterior (major). Identify as fibres of the corpus callosum, passing from the splenium into the occipital lobe and lying in the roof of the posterior horn of the lateral ventricle.

Tapetum. Identify as fibres of the corpus callosum (given off between the forceps minor and major), which extend into the temporal lobe and cover the body of the lateral ventricle.

FIG. 32.



Parts of the mesial and tentorial surfaces of the left hemisphere, showing callosum in the sagittal section with many of its relations. A.C., anterior commissure; ALB., corpus albicans; CHI., chiasma; HYPOPH., hypophysis; P., porta. (GERRISH modified from TESTUT.)

Lateral Ventricles. Identify (1) by the location in the lower and inner parts of the cerebral hemispheres, separated from each other by the septum lucidum and covered in by the corpus callosum; (2) by the central cavity and the anterior, middle, and posterior horns or cornua; (3) by a lining ependyma covered by ciliated epithelium.

Central Cavity of the Ventricle. Identify (1) by the location in the lower part of the parietal lobe; (2) by a roof formed by the tapetum of the corpus callosum; (3) by an inner wall formed by the septum lucidum connecting the corpus callosum with the fornix; (4) by a floor formed by the caudate nucleus, tænia semicircularis, optic thalamus, choroid plexus, one-half of the fornix and its posterior pillar; (5) by an outer wall formed by the internal capsule.

Anterior Cornu of the Lateral Ventricle. Identify (1) by the continuity with the central cavity, extending from the foramen of Monro into the frontal lobe, curving outward around the anterior end of the caudate nucleus; (2) by the boundaries—above, the corpus callosum; below, the rostrum of the corpus callosum; internally, the anterior part of the septum lucidum; externally, the head of the caudate nucleus; the apex reaches the genu of the corpus callosum.

Posterior Cornu of the Lateral Ventricle. Identify (1) by the location in the substance of the occipital lobe, extending backward, outward, and inward from the central cavity of the ventricle; (2) by the derivation of the roof from the fibres of the corpus callosum; (3) by the presence of the hippocampus minor produced by the calcarine fissure.

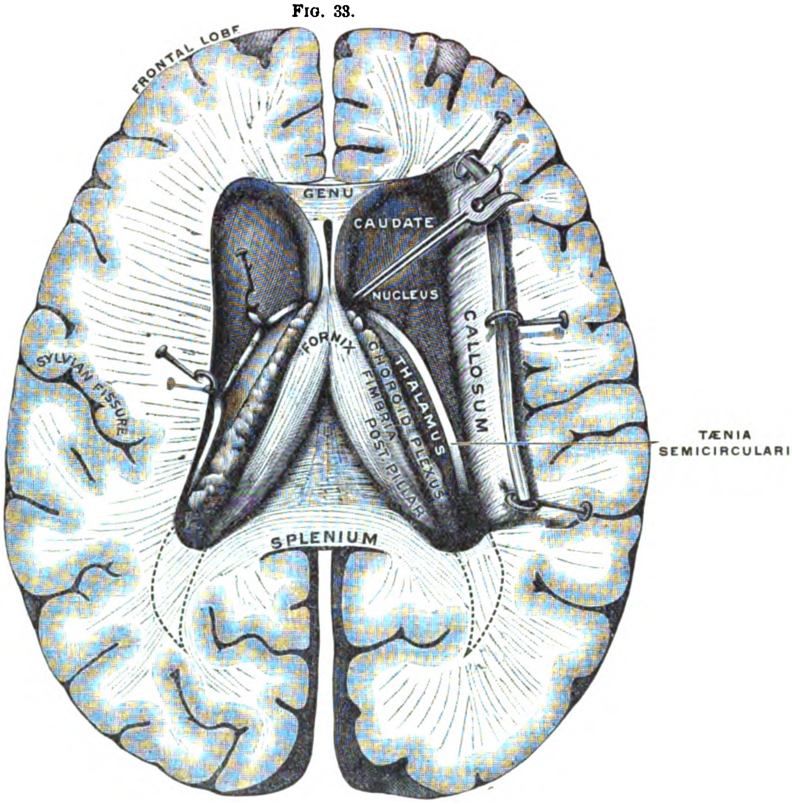
Descending Cornu of the Lateral Ventricle. Identify (1) by the location in the temporal lobe forming a curve around the back of the optic thalamus, backward, downward, forward, and inward to within one inch of the temporal lobe; (2) by the roof formed by the tapetum, in which are located the tail of the nucleus caudatus and tænia semicircularis, ending in the amygdaloid nucleus; (3) by the floor presenting the hippocampus major (produced by the dentate or hippocampal fissure); the pes hippocampi; eminentia collateralis (produced by the middle part of the collateral fissure); the corpus fimbriatum, prolonged from the posterior pillar of the fornix and choroid plexus.

Septum Lucidum. Identify (1) as a thin, double, semitransparent septum between the two lateral ventricles (forming their inner wall), attached above to the corpus callosum, below to the anterior part of the fornix and reflected part of the corpus callosum; (3) by the presence of the fifth ventricle between its two laminæ; (4) by the triangular form, its broad end being in front.

Fornix. Identify (1) by the location on the floor of the lateral ventricle, continuous behind with the corpus callosum and separated in front by the septum lucidum; (2) by the two symmetrical halves; (3) by the anterior pillars, body, and posterior pillars.

Body of the Fornix. Identify (1) by the triangular form—narrow in front and broad behind; (2) by the upper surface on the septum lucidum and corpus callosum, under surface on the velum interpositum and optic thalami; (3) the outer edges free and connected with the choroid plexuses; (4) by the continuity with the anterior and posterior pillars of the fornix.

FIG. 33.



Floor of the lateral ventricles. On the left side the vein of the corpus striatum is lifted up. The director is in the right porta. Dotted outlines indicate the position of the posterior cornua. (GERRISH after TESTUT.)

Anterior Pillar of the Fornix. Identify as two white bands continuous with the body of the fornix in front, descending behind the anterior commissure into the lateral wall of the third ventricle to the base of the brain, and ending in the corpora albicantia (in the interpeduncular space).

Posterior Pillars of the Fornix. Identify (1) as the posterior continuations of the body of the fornix; (2) by the connection with the under surface of the corpus callosum; (3) by winding divergently around the posterior end of the optic thalami, passing into the descending horn of the lateral ventricle and lying along the concavity of the hippocampus major, some of its fibres extending into the uncus and corpus fimbriatum.

Velum Interpositum. Identify (1) by the location in the lateral ventricle beneath the body of the fornix, forming part of the roof of the third ventricle; (2) by composition—a vascular membrane derived from the pia mater gaining the interior of the brain through the middle part of the transverse fissure; (3) by separating the fornix from roof epithelium of the third ventricle.

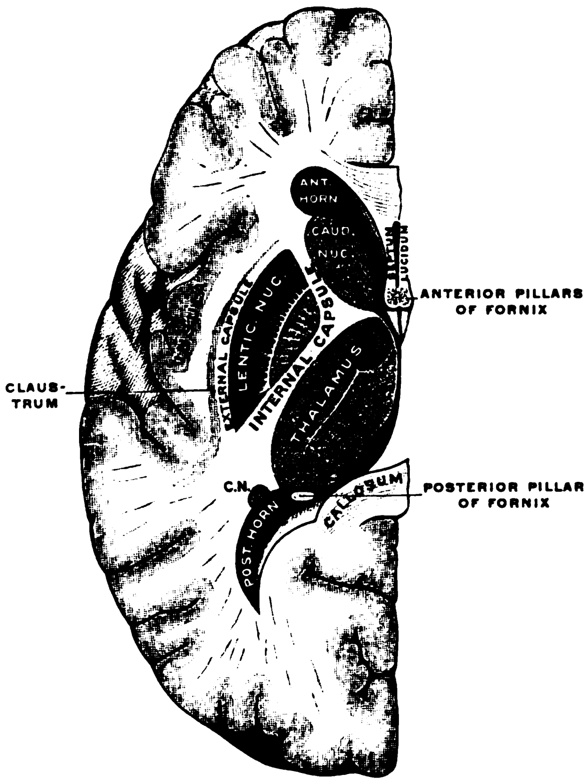
Choroid Plexus of the Body of the Ventricles. Identify (1) as the fringed, vascular border of the velum interpositum; (2) by the plexuses of the two sides communicating through the foramen of Monro.

Choroid Plexus of the Descending Horn. Identify (1) by the continuity with the choroid plexus of the body of the ventricle; (2) like that of the body, it gains the interior of the brain through the transverse fissure, and is covered by epithelium.

Ganglia of the Hemisphere (caudate nucleus, lenticular nucleus, claustrum, and amygdala). Identify as gray matter in the substance of the hemisphere somewhat divergently arranged, but uniting at a common surface area—the anterior perforated space previously identified.

Caudate Nucleus (seen in the lateral ventricle). Identify (1) by the location in the lateral ventricle, anterior and external to the optic thalamus; (2) by the tail-like process, extending along the roof of the descending horn of the lateral ventricle, and ending in the amygdala at the front end of the temporal lobe; (3) by the separation (partial) from the lenticular nucleus by the internal capsule.

FIG. 34.



Horizontal section of the left hemisphere through the basal ganglia, viewed from above. C.N., caudate nucleus. (GERRISH after TESTUT.)

Lenticular Nucleus (seen in the horizontal section). Identify (1) by the lens-shape and the location to the outer side of the caudate nucleus; (2) by the contact with the internal and external capsules; (3) by the continuity with the other basal ganglia at the common surface area—the anterior perforated space.

Claustrum (seen in the horizontal section). Identify (1) by the location between the lenticular nucleus and the island of Reil; (2) by the presence of the external capsule along its inner part; (3) by the continuity with the lenticular, caudate, and amygdalar nuclei at the common surface area—the anterior perforated space.

Internal Capsule (seen in the horizontal section). Identify (1) by an anterior limb between the caudate and the lenticular nuclei; (2) by a genu connecting the two limbs and presenting at the tænia semicircularis between the caudate nucleus and the optic thalamus; (3) by a posterior limb separating the optic thalamus from the lenticular nucleus; (4) by the fibres from the following sources: crusta, tegmentum, caudate and lenticular nuclei, corpus callosum, and optic thalamus.

External Capsule (seen in the horizontal section). Identify (1) by the location between the lenticular nucleus and claustrum; (2) by the continuity with the internal capsule below and behind the lenticular nucleus.

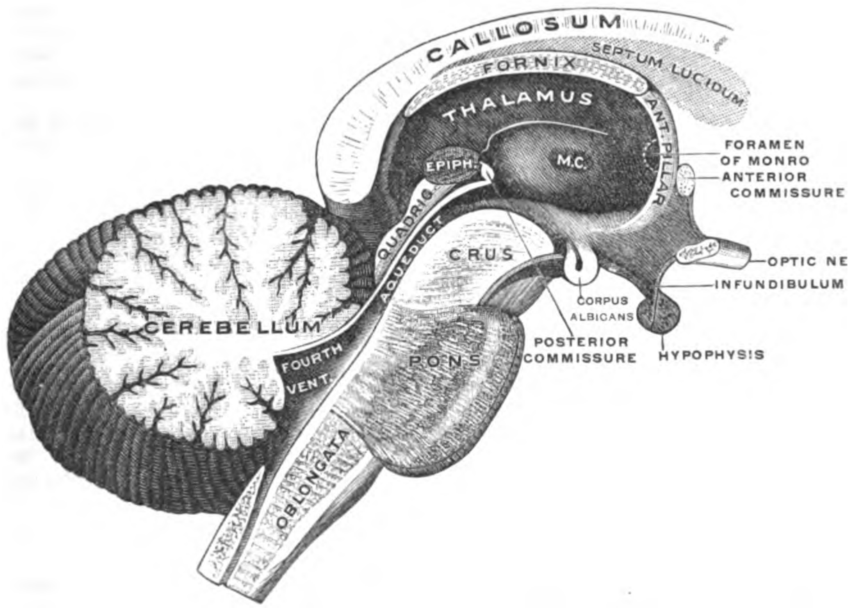
Tænia Semicircularis. Identify (1) as a narrow, white band between the caudate nucleus and the optic thalamus; (2) by passing into the roof of the descending horn posteriorly and into the anterior pillar of the fornix and anterior commissure in front.

Optic Thalamus. Identify (1) as two oblong masses on either side of the third ventricle behind and internal to the tænia semicircularis in the lateral ventricle; (2) by a narrow, anterior extremity forming the posterior boundary of the foramen of Monro; (3) by the pulvinar or posterior extremity; (4) by a superior free surface, part of which is covered by ependyma; another part located beneath the velum interpositum and wanting in the ependyma; (5) by the inferior surface resting on and continuous with the tegmentum; (6) by the outer surface in contact with the posterior limb of the internal capsule; (7) by the internal surface forming the lateral wall of the third ventricle.

Pineal Gland (conarium epiphysis cerebri). Identify (1) by the location between the anterior corpora quadrigemina resting on the posterior commissure; (2) by the location beneath the velum interpositum; (3) by two peduncles extending to the anterior pillars of the fornix along the superior and mesial surfaces of the optic thalamus.

Third Ventricle. Identify (1) by the location between the optic thalami; (2) by the roof—the velum interpositum and fornix; (3) by the floor—the tuber cinereum, infundibulum, pituitary body, corpora albicantia, posterior perforated space, and tegmenta of the crura cerebri; (4) by the lateral walls—the internal surfaces of the optic thalami; (5) by the

FIG. 35.



Median section through the third and fourth ventricles. Left half. M.C., middle commissure. (GERRISH after TESTUT.)

anterior boundary—the anterior pillars of the fornix and lamina cinerea; (6) by the posterior boundary—pineal gland, posterior commissure, and iter a tertio ad quartum ventriculum; (7) by the foramen of Monro in front of the optic thalamus and behind the anterior pillars of the fornix, by which the third and lateral ventricles communicate; (8) by the aqueduct of Sylvius or iter a tertio ad quartum ventriculum, situated between the corpora quadrigemina and tegmentum and leading from the posterior extremity of the third ventricle to the fourth ventricle; (9) by the choroid plexus derived from the under surface of the velum interpositum.

Anterior Commissure. Identify by the location as a bundle of white fibres in front of the anterior pillars of the fornix, connecting the two temporal lobes and containing fibres from the olfactory tract of the opposite side. Middle commissure: Identify by the location in the third ventricle, connecting its walls, and composed mostly of gray matter. Posterior commissure: Identify by the location; it connects the optic thalami and lies just above the iter.

Corpora Quadrigemina. Identify (1) as four rounded eminences, two in front and two behind (on either side), called nates and testes, respectively; (2) by the location on the tegmentum, behind the third ventricle and posterior commissure, on the floor of the great transverse fissure, covered by the pia mater and in relation with the pineal body; (3) by the connection with the corpora geniculata through the brachia, as follows: anterior connects the nates with the external geniculate bodies; the posterior brachia connect the testes with the internal geniculate bodies; (4) by the close relation to the superior cerebellar peduncles, which pass beneath them through the tegmenta to the optic thalami.

Corpora Geniculata (external and internal). External geniculate body: Identify (1) by the location on the optic thalamus beneath the pulvinar; (2) by the continuity with the outer root of the optic tract; (3) by the connection with the anterior quadrigeminal body through the anterior brachium. It belongs to the optic thalamus.

Internal Geniculate Body. Identify (1) by the location external to the corpora quadrigemina; (2) by the connection with the posterior quadrigeminal body through the posterior brachium; (3) by the continuity with the inner root of the optic tract. It belongs to the mid-brain.

Aqueduct of Sylvius (iter a tertio ad quartum ventriculum). Identify (1) by the location between the tegmentum and the corpora quadrigemina, connecting the third and fourth ventricles; (2) as a very narrow canal, about one-half inch in length, through which a broom-straw may be passed.

Trochlear Nerve. Identify (1) emerging from the upper end of the valve of Vieussens; (2) by the course outward across the superior peduncle of the cerebellum and crus cerebri.

Optic Tract consists of two bands or roots—external and internal. Identify the external root, the larger of the two, by the origin from the external geniculate body and pulvinar of the optic thalamus and its continuity with the anterior brachium. Identify the internal root by its course around the crusta and connection with the internal geniculate body and the posterior brachium.

Superior Cerebellar Peduncle. Identify (1) by the extent, from hilum of corpus dentatum to a point beneath the corpora quadrigemina; (2) by its attachment to the valve of Vieussens.

Valve of Vieussens (superior medullary velum). Identify (1) by the location stretching across from one superior peduncle to the other; (2) by aiding the superior peduncle in forming the roof of the upper part of the fourth ventricle; (3) by its continuity with the white matter of the superior worm of the cerebellum below, and passing beneath the corpora quadrigemina above.

Middle Peduncle of the Cerebellum. Identify (1) by the large size, comprising most of the transverse fibres of the pons; (2) by the direct continuity with the superficial transverse fibres of the pons; (3) by the location external to the superior peduncles.

Inferior Peduncle. Identify (1) by connecting the cerebellum with the medulla (restiform bodies of the medulla oblongata); (2) by forming part of the lateral wall of the fourth ventricle and entering the cerebellum beneath the middle peduncle.

THE CEREBELLUM.

Dissection. Make incisions corresponding to the illustration in the text as nearly as possible. Study the marginal names of the parts in the illustrations and compare with the dissection. Identify (1) by the location in the posterior part of the cranium beneath the tentorium; (2) by its two lateral hemispheres and a central part—the vermiform process; (3) by the three bands on each side connecting the cerebellum to the other parts of the encephalon (a superior peduncle connecting with the corpora quadrigemina; a middle, connecting with the pons varolii; an inferior, connecting with the medulla); (4) by a flat upper surface marked by transverse fissures.

SUPERIOR SURFACE OF THE CEREBELLUM.

Name.	*Location.*	*Importance.*
Superior vermis.	Median portion between the hemispheres.	Central and most prominent part of the superior vermis is called the monticulus. Partially separated from the hemispheres by shallow grooves.
Lingula.	In front of the central lobe and connected by the same, partially or completely.	Rests on and connected to the dorsal surface of the valve of Vieussens, the white matter of the two being continuous. It is represented in the hemisphere by the frænulum.
Lobulus centralis.	Located in the anterior notch, overlapping the lingula.	Extends laterally along the upper and anterior parts of the hemisphere, forming the ala lobuli centralis.
Culmen monticuli.	Forms bulk of the superior worm with the clivus.	Overlaps the central lobe, and is separated from the clivus by the preclival fissure. Forms the most prominent part of the superior vermis, and is divided into lobules. It corresponds to the anterior crescentic lobe of the hemisphere.
Clivus monticuli.	Median area—a part of the superior worm or vermis.	Separated from the culmen by the preclival fissure and almost continuous behind with the folium cacuminis, still separated therefrom by the postclival fissure. Represented in the hemisphere by the posterior crescentic lobe.

Name.	*Location.*	*Importance.*
Folium cacuminis	In the median area at the posterior part of the superior vermis.	A short, narrow band concealed by the extremity of the vermis. Represented in the hemisphere by the posterior superior lobe.
Frænulum.	Upper surface of the cerebellar hemisphere.	It lies on the superior peduncle of the cerebellum, continuous with the lingula of the superior vermis.
Ala lobuli centralis.	Upper surface of the cerebellar hemisphere.	A prolongation of the lobulus centralis of the central region.
Anterior crescentic lobe.	Upper surface of the cerebellar hemisphere.	Continuous with the culmen monticuli of the superior vermis of the central region.
Posterior crescentic lobe.	Superior surface of the cerebellar hemisphere.	Continuous with the clivus monticuli of the central region.
Posterior superior lobe.	Superior surface of the cerebellar hemisphere.	Continuous with the folium cacuminis of the central region.

SCHEME SHOWING THE CONTINUITY OF THE LOBES OF THE CENTRAL AND LATERAL REGIONS OF THE UPPER SURFACE OF THE CEREBELLUM, AND THE LOCATION OF THE FISSURES BY WHICH THE LOBES ARE DELIMITED. ENUMERATED FROM BEFORE BACKWARD.

Cerebellar Worm.	*Cerebellar Hemisphere.*
1. Lingula, continuous with	1. Frænulum.
(Location of precentral fissure.)	
2. Lobulus centralis, continuous with	2. Ala lobuli.
(Location of postcentral fissure.)	
3. Culmen, continuous with	3. Anterior crescentic lobe.
(Location of preclival fissure.)	
4. Clivus, continuous with	4. Posterior crescentic lobe.
(Location of the great horizontal fissure.)	

INFERIOR SURFACE OF THE CEREBELLUM.

Cerebellar Worm.	*Cerebellar Hemisphere.*
1. Nodule	Flocculus.
(Location of the postnodular fissure.)	
2. Uvula	Amygdala.
(Location of the prepyramidal fissure.)	
3. Pyramid	Biventral lobe.
(Location of the postpyramidal fissure.)	
4. Tuber valvulæ	Slender lobe, postgracile fissure, inferior semilunar lobe.

THE MEDULLA OBLONGATA.

Medulla Oblongata. Identify (1) by the location extending from the margin of the pons Varolii to the lower margin of the foramen magnum; (2) by the location of the ventral surface on the basilar groove of the occipital bone, and the dorsal surface in the fossa between the cerebellar hemispheres; (3) by the continuity with the pons above and the cord below; (4) by the anterior and posterior median fissures continuous with similar fissures of the spinal cord; (5) by a ventrolateral groove in line with the anterior roots of the spinal nerves and a dorsolateral groove (continuous with the posterolateral fissure of the spinal cord), from which arise the seventh, eighth (mesial root), ninth, tenth, and eleventh cranial nerves.

Ventral Surface. Identify by the presence of an eminence, the pyramid (on each side of the anterior median fissure) represented in the cord by the direct and crossed pyramidal tracts.

Lateral Surface. Identify (1) by the location between the ventrolateral and the dorsolateral grooves; (2) by the olivary body, lateral tract, and external archiform fibres.

Olivary Body. Identify (1) by the location in the lateral area of the medulla, just behind the pons; (2) by the elongated, oval shape, and situation external to the pyramid, separated therefrom by the emergence of the hypoglossal nerve; (3) by the separation externally from the restiform body by a band of fibres and a groove, from which latter arise the ninth, tenth, and eleventh cranial nerves.

Dorsal Surface. Identify by the location between the dorsolateral grooves.

Restiform Body. Identify (1) by the location between the lateral tracts in front and the funiculus cuneatus behind, from which eminences they are separated by grooves; (2) by forming the inferior peduncles of the cerebellum and the lower part of the lateral boundary of the fourth ventricle.

Posterior Surface. Identify (1) by forming part of the floor of the fourth ventricle, seen when the pia mater with the roof epithelium is removed; (2) by the triangular shape bounded by the restiform bodies, funiculi graciles and cuneati; (3) by a longitudinal furrow dividing the floor of the medulla into right and left lateral halves.

Fourth Ventricle. Identify (1) by the location in front of the cerebellum and in the pons and medulla; (2) by its four angles—an upper, reaching the superior border of the pons at the aqueduct of Sylvius; a lower, on a level with the lower part of the olivary body and continuous with the central canal of the spinal cord; lateral angles, extending between the medulla and the cerebellum and forming a pointed lateral recess.

Floor of the Fourth Ventricle. Identify (1) by the boundary of the anterior triangle—the superior peduncles of the cerebellum; (2) by the boundary of the posterior triangle—the inferior cerebellar peduncles, funiculi graciles, and funiculi cuneati; (3) by the striæ acusticæ, which divide the floor into anterior and posterior triangles.

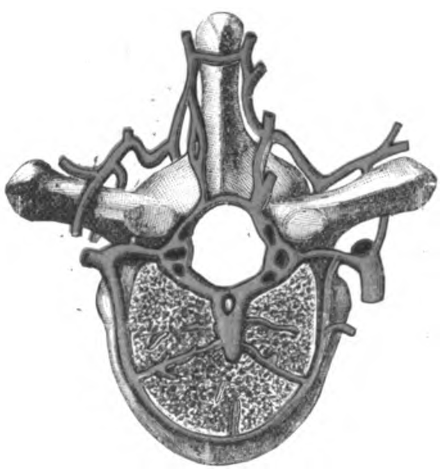
SPINAL CORD.

Dissection. Remove all soft structures; cut through the laminæ, removing these with the spinous processes, and study the structures according to the following steps.

Spinal Veins. Identify by the location, formation, function, and arrangement in four sets, as follows: dorsi spinal, meningorachidian, venæ basis vertebrarum, and medulli spinal veins.

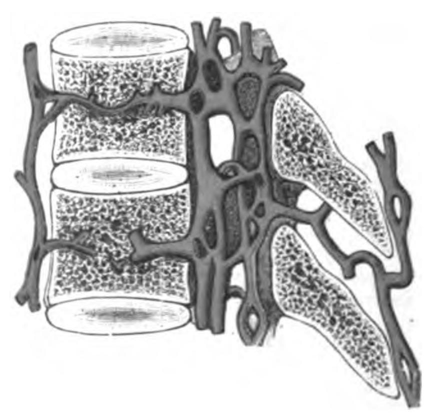
Dorsi Spinal Veins. Identify (1) by the location around the laminæ, articular, transverse, and spinous processes of all the vertebræ; (2) by the tributaries from the muscles in the vertebral grooves and dorsal integument; (3) by communicating with the intraspinal veins passing through the ligamenta subflava; (4) by terminating in the vertebral, intercostal, lumbar, and sacral veins.

FIG. 36.



Veins of the spine, seen in a transverse horizontal section of a thoracic vertebra. (GERRISH after TESTUT.)

FIG. 37.



Veins of the spine, seen in a sagittal section of two thoracic vertebræ. (GERRISH after TESTUT.)

Meningorachidian Veins. Identify (1) by the location between the walls of the neural canal and the dura mater in a quantity of fat and connective tissue; (2) by receiving the venæ basis vertebrarum; (3) by the termination in the vertebral, intercostal, lumbar, and sacral veins.

Venæ Basis Vertebrarum. Identify (1) by the emergence from the bodies of the vertebræ through the foramina on the posterior surfaces; (2) by the termination in the meningorachidian veins.

Medulli Spinal Veins. Identify (1) by the location as a minute venous plexus covering the entire surface of the cord between the pia mater and the arachnoid; (2) by forming two or three small trunks near the base of the skull, communicating with the vertebral veins and terminating in the inferior cerebellar veins or inferior petrosal sinuses.

Dura Mater. Identify (1) by the location in the spinal canal, extending from the foramen magnum to the third sacral vertebra, where it dwindles to a small fibrous cord, passes down, and is attached to the periosteum of the coccyx; (2) by the attachment to the margin of the foramen magnum and the bodies of the three upper cervical vertebræ and having no other bony attachments; (3) by containing the spinal cord, cauda equina, arachnoid, and pia mater; (4) by the brilliant inner serous surface in contact with the cerebro-spinal fluid; (5) by the prolongations on each side which transmit arteries and roots of the spinal nerves; (6) by the absence of sinuses, processes, Pacchionian bodies, and periosteal function.

Subdural Space. Identify (1) by the location between the dura and arachnoid, containing a small amount of cerebro-spinal fluid; (2) by the extreme narrowness, since the dura and arachnoid are in contact.

Arachnoid. Identify (1) by the location in and correspondence in length to the dura, with whose inner surface it is in contact; (2) by the presence of two secreting, serous surfaces; (3) by the tubular prolongations about the spinal nerves; (4) by the continuity with the cerebral arachnoid; (5) by the attachment to the pia mater by the connective tissue; (6) by the subarachnoid space situated between this and the pia mater.

Subarachnoid Space. Identify (1) by the location between the arachnoid and pia mater; (2) by the presence of the cerebro-spinal fluid and the cauda equina; (3) by communicating with the general ventricular cavity of the brain through foramina in the pia mater in the roof of the fourth ventricle; (4) by the continuity with the cerebral and subarachnoid space above.

Pia Mater. Identify (1) by the location about and intimate adherence to the spinal cord; (2) by forming a sheath for each filament of the spinal nerves and an investment for the spinal nerves themselves; (3) by sending a process into the anterior fissure of the cord; (4) by the contraction at the end of the cord to form the filum terminale; (5) by the formation of the linea splendens on the anterior surface.

Filum Terminale. Identify by the continuation with the pia mater of the cord, extending down the centre of the cauda equina, perforating the arachnoid and dura at the level of the third lumbar vertebra and fusing with the periosteum of the coccyx.

Ligamentum Denticulatum. Identify (1) by the location on each side of the spinal cord, separating the anterior and posterior nerve roots; (2) by the possession of an inner border continuous with the pia, and an outer composed of twenty-one tooth-like processes, which, pushing the arachnoid outward, are attached to the dura. The first attachment is between the vertebral artery and the hypoglossal nerve. The ligamentum denticulatum and the filum terminale support the cord.

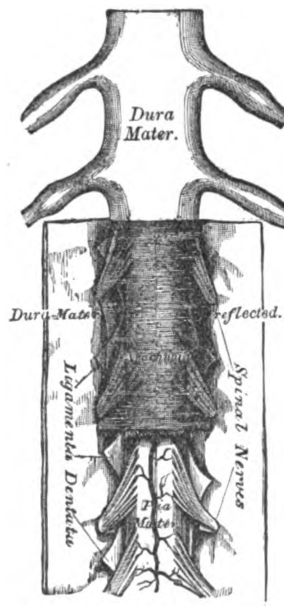
Cauda Equina. Identify (1) by the location in the sheath of the arachnoid and dura; (2) by the composition (filum terminale and roots of the sacral and coccygeal nerves).

Cervical Enlargement of the Cord. Identify (1) by the extent from the medulla to the second dorsal vertebra; (2) by giving origin to the cervical nerves.

Lumbar Enlargement of the Cord. Identify (1) by the location extending from the tenth to the twelfth thoracic vertebræ; (2) by continuing, cone-like, into the filum terminale of the pia mater (conus terminalis.)

Spinal Arteries. Identify (1) by the origin from the vertebral, inferior thyroid, intercostal, lateral sacral, lumbar, and iliolumbar arteries.

FIG. 38.



The spinal cord and its membranes. (GRAY.)

Anterior Spinal Artery. Identify (1) by the double origin from the vertebral on each side; (2) by union of its two roots to form a single artery at the level of the foramen magnum; (3) by descending on the front of the spinal cord and uniting with the lateral branches from other sources.

Median Spinal Artery. Identify (1) by the location in the pia mater along the anterior median fissure; (2) formed by the union of the anterior spinal with the lateral branches from the vertebral, inferior thyroid, intercostal, lumbar, iliolumbar, and lateral sacral arteries; (3) by the distribution to the spinal cord, pia mater, and cauda equina.

Posterior Spinal Artery. Identify (1) by the origin from the vertebral on each side by the side of the medulla; (2) by the downward course behind the posterior roots of the spinal nerves; (3) by the frequent accessions from the lateral spinal arteries from the successive regions, entering the spinal canal through the intervertebral foramina.

Posterior Roots. Identify (1) by the origin, by from six to eight fasciculi, from the posterolateral fissure of the cord arranged in a single linear series all down the spinal cord; (2) by piercing the dura separately, developing the posterior root ganglion and uniting with the anterior root in the intervertebral foramen; (3) by the presence of the posterior spinal artery behind the posterior roots; (4) the posterior root is sensory.

Anterior Roots. Identify (1) by the origin from the anterolateral columns of the cord, corresponding to the anterior horn of the gray matter; (2) by the composition of from four to eight filaments; (3) by union in the intervertebral foramen with the posterior root to form mixed nerve trunk; (4) the anterior or motor root is smaller than the posterior root in all except the first nerve.

Ganglia. Identify (1) by the location on the posterior root (2) by the location as follows: the first and second cervical lie on the corresponding vertebræ; the sacral and coccygeal in the sacral canal; all the others in the intervertebral foramina. Ganglion of the first cervical nerve may be absent.

CHAPTER IV.

THE MOUTH.

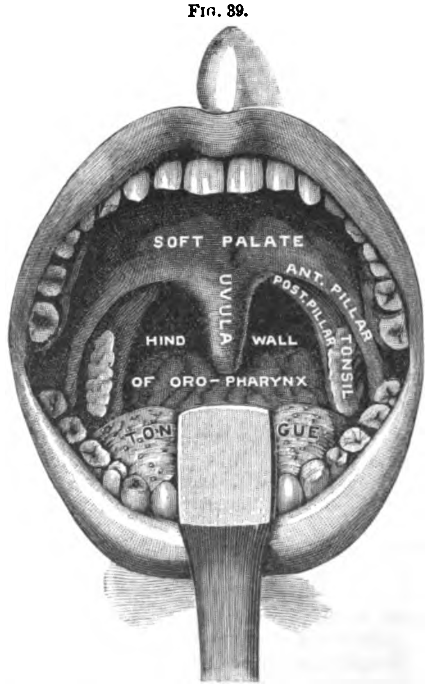
IDENTIFICATION.

Lips (upper and lower). Identify (1) by location so as to form a complete boundary for the buccal orifice; (2) by a dry, red, sensitive mucous membrance (in the living) and a pronounced muco-cutaneous margin.

Cheek. Identify (1) by its composition: all the soft structures, external to the angle of the mouth and anterior to the masseter muscle, corresponding to and forming the outer wall of the vestibule; (2) by the continuity with the lips anteriorly.

Dental Arches. Identify (1) by their composition—teeth in the alveoli of the alveolar processes; (2) by their gum tissue covered by the mucous membrane and closely investing the teeth so as to form the gingival margin; (3) by the vestibule external and the cavum oris internal to the dental arches.

FIG. 39.



The soft palate, mouth, and tonsillar regions. (GERRISH after TESTUT.)

Hard Palate. Identify (1) as the roof of the mouth; (2) by the continuity with the alveolar processes covered by the soft structures, continuous posteriorly with the soft palate.

Isthmus of the Fauces. Identify as the space bounded by the arch of the soft palate and tongue, and leading from the mouth to the pharynx.

Soft Palate. Identify (1) by its location between the mouth and pharynx, forming an incomplete partition between the two; (2) by its attachment to the posterior border of the hard palate, and composed of soft, freely-movable structures.

Uvula. Identify (1) by its location as a small pyramidal, contractile, pendulous mass (apex down) in the mid-line of the soft palate; (2) by the marked tendency to chronic elongation; (3) by the marked shortening in the living when irritated.

Anterior Pillar. Identify (1) by its location, extending from the base of the uvula, downward and forward to the side of the tongue; (2) by its coming into easy view when the tongue is drawn forward.

Posterior Pillar. Identify (1) by its location, extending from the base of the uvula downward, backward, and outward to the outer wall of the pharynx; (2) by its adjacency to the pharynx.

Tonsillar Recess. Identify (1) as the triangular space between the pillars of the palate; (2) by its containing the tonsil and corresponding in location to the angle of the jaw.

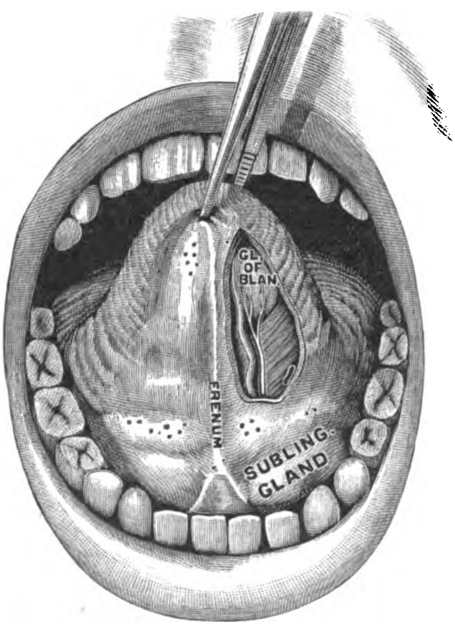
Tongue. Identify (1) by its location in the mouth and its attachment to the mandible, hyoid, hard palate, and styloid processes; (2) by the pointed, freely-movable apex; (3) by the expanded dorsum, with the oral and pharyngeal surfaces supporting the papillæ; (4) by its reflection of the mucous membrane onto the pillars of the palate, tonsil, epiglottis, alveolar process of the mandible, and symphysis.

Circumvallate Papillæ (papillæ maximæ). Identify (1) by their location between the oral and pharyngeal surfaces of the tongue (eight to twelve in number); (2) by their arrangement in two rows like the letter V inverted; (3) by the foramen cæcum behind the apex of the V.

Fungiform Papillæ (papillæ mediæ). Identify (1) by their location principally at the tip and the sides of the tongue; (2) by their great number and deep red color.

Filiform Papillæ (papillæ minimæ). Identify (1) by their location on the anterior two-thirds of the tongue, arranged in lines corresponding with the rows of the circumvallate papillæ; (2) by their small size and conical shape. (Study with the glass.)

FIG. 40.



Under surface of tongue and the sublingual space, showing openings of salivary ducts. The lingual mucosa of the left side is partly removed, and shows the ranine artery, the lingual nerve, and the gland of Blandin. (GERRISH after TESTUT.)

Frænum Linguæ. Identify by its location on the under surface of the tongue as a fold of the lingual mucous membrane extending in the mid-line from the tongue to the symphysis menti.

Sublingual Elevation. Identify (1) by its location (one on either side) beneath the anterior part of the tongue, and corresponding to the sublingual salivary gland; (2) by the presence of orifices and of small ducts of the gland. (Study with the glass.)

Submaxillary Orifices (two in number). Identify (1) by their location near the frænum, marked by the papillæ; (2) by the exudation of saliva (in the living) following the application of gustatory stimulation to the tongue.

Ranine Veins. Identify by their blue color, large size, and location on either side of the frænum linguæ on the under surface of the tongue.

Plica Fimbriata. Identify (1) by its fimbriated margin (best seen in young people) just external to the ranine veins and about one-half inch external to the frænum linguæ; (2) by its derivation from the lingual mucous membrane.

Lingual Nerve (gustatory). Identify by its location just external to the ranine artery (identify artery by pulsation), and it may be identified by pressure between the thumb and finger, as it is the sensory nerve of the anterior two-thirds of the tongue.

DISSECTION.

Coronary Arteries. Turn the lower lip down and cut through the mucous membrane as far as the angle of the mouth. This incision will expose the inferior coronary artery. Turn the upper lip upward and incise similarly its mucous membrane to expose the superior coronary artery. The coronary arteries are branches of the facial, given off near the angle of the mouth.

The Lips. Cut through the entire thickness of each lip with scissors one-half inch to the outer side of the median line. Study (*a*) the frænum of each lip (a fold of the mucous membrane in the mid-line connecting the lip and gum); (*b*) the orbicularis oris fibres; (*c*) the cut ends of the coronary vessels; (*d*) the median tubercle of the upper lip.

The Cheeks. Cut with scissors through the cheek from the angle of the mouth to the masseter muscle and study (*a*) the orifice of Stenson's duct (opposite the second molar), guarded by a fold of mucous membrane; (*b*) the fibres of the buccinator muscle; (*c*) the cushion of fat called the sucking cushion.

Vessels of Tongue. Pass a thread through the tip of the tongue so as to hold and move the same. Cut through the mucous membrane (Fig. 40) and expose the ranine vessels (immediately beneath the mucous membrane) and the lingual nerve. At the root of the tongue these vessels are between the hyoglossus and geniohyoglossus muscles.

Sublingual Gland. Remove the mucous membrane covering the sublingual elevation and expose the sublingual salivary gland. This lies on the mylohyoid muscle.

Soft Palate. Saw through the lower jaw between the central incisor teeth. With a sharp scalpel cut through all the soft structures, including tongue, from the hyoid bone to the epiglottis (seen now behind the base of the tongue). Draw the parts of the several structures aside so as to gain space, and the soft palate may be dissected fairly well.

The Uvula. Grasp with the long dressing forceps near the tip and draw the same forward; incise the mucous membrane and study its muscle, the azygos uvulæ. (Fig. 39.)

The Tonsil and Tonsillar Recess. Make traction on the tongue and bring into view the tonsil between the pillars (Fig. 39), corresponding deeply in location to the angle of the jaw. Study (*a*) the openings on the inner surface; (*b*) the continuity of the mucous membrane of the tonsil with the pillars.

Palatoglossus Muscle. Put the tongue on the stretch, incise the mucous membrane from the base of the uvula to the side of the tongue along the anterior pillar of the palate, and expose the palatoglossus muscle.

Palatopharyngeal Muscle. Incise the mucous membrane along the posterior pillar of the palate and expose the palatopharyngeus muscle.

Lingual Nerve and Mylohyoid Muscle. Draw the halves of the tongue toward the mid-line and cut through the mucous membrane in the bottom of the groove between the molar teeth and the tongue, when will be exposed the lingual nerve lying on the mylohyoid muscle. Find the lingual nerve communicating with the hypoglossal on the geniohyoglossus muscle.

Hypoglossal Nerve. Draw the tongue well to the median line and cut through the mucous membrane along the gutter lateral to the tongue, and find this nerve, the mylohyoid and geniohyoglossus muscles. Further back it lies to the outer side of the hyoglossus muscle with the lingual vein.

Geniohyoid Muscle. Examine the cut surface of the tongue (in mid-line) and find the cellular space between this and the geniohyoglossus muscles. The geniohyoid passes from the mandible to the body of the hyoid bone.

Geniohyoglossus Muscle. This muscle extends from the mandible to the hyoid bone and tongue. It is above the geniohyoid. Between its outer surface and the hyoglossus muscle are the lingual vessels (known as ranine vessels, in front of the hyoglossus muscle).

Stylohyoid Muscle. Remove the mucous membrane of the posterior lateral part of the tongue and find the muscle inserted into the side and under part of the tongue.

Glossopharyngeal Nerve. Find beneath the styloglossus muscle. The tongue must be drawn well out and to the opposite side to make the proper exposure.

THE CAVUM ORIS.

Location. The mouth or cavum oris is the space, limited roughly, above by the superior maxillary bone, below by the mandible, laterally by the cheeks, posteriorly by the pendulous soft palate and isthmus of the fauces, in front by the buccal orifice and lips.

Communications. The mouth communicates directly with the pharynx through the isthmus of the fauces, with the external world through the buccal orifice, with the nose through the anterior palatine canal, with the sphenomaxillary fossa through the posterior palatine canal. It communicates indirectly with the nose through the posterior nares; with the frontal sinuses through the infundibulum; with the antrum of Highmore through the ostium maxillaire; with the sphenoidal sinus and ethmoidal cells through an unnamed opening; with the tympanum through the Eustachian tube, with the larynx through the chink of the glottis, with the œsophagus through the pharynx.

Contents. The mouth contains the teeth, in their alveoli; the termini of the ducts of Stenson, Wharton, and Ravini; the buccal, labial, and palatine mucous glands; the tongue, endowed with motor, sensory, sympathetic, and special sense taste nerves. The mouth is an organ of prehension, mastication, taste, respiration, speech, and pantomime.

The Lips. The lips vary in thickness in different races and in different people of the same race. The upper lip has a median tubercle (especially prominent in young children), a remnant of the distal part of the embryonal nasofrontal process. The lips are composed of skin, orbicularis oris, connective tissue, coronary arteries, veins, lymphatics, mental and infra-orbital nerves, and mucous membrane. The frænum labii superioris and inferioris are two pronounced folds of mucous membrane connecting the gums and lip in the mid-line. On examining a patient's mouth care should be exercised on the part of the operator not to exert undue traction on the frænum, and thereby produce unnecessary pain.

The Mucous Membrane of the lips (in the living) is dry, red, and sensitive. The lips are in a sense prehensile organs, hence they are provided with nerve endings resembling touch corpuscles. Racemose labial glands occupy the connective tissue lamina beneath the mucous membrane. The junction of the mucous membrane and skin is called the muco-cutaneous margin. The lips, by virtue of their rich blood-supply and nerve-supply, undergo rapid repair after surgical operations. The labial mucous membrane is reflected onto the gums.

THE CHEEK.

Shape. The cheek is quadrilateral, bounded below by the inferior border of the lower jaw, above by the lower margin of the orbit, behind by the ramus of the mandible, in front by the side of the nose and geniolabial sulcus. (See Gerrish.)

Composition. 1. Integument, similar to and continuous with that of the lips, and in the male is covered with hair. 2. Areolar tissue, containing the long buccal nerve and vessels, molar glands, and sucking cushion of fat, which latter gives rotundity to the cheek. In nursing children this pad of fat is encapsulated, resembling very much in shape and appearance the yolk of an egg. 3. The buccinator and masseteric fasciæ covering their respective muscles. 4. The buccinator and masseter muscles. The masseter muscle is crossed by Stenson's duct; the buccinator is pierced by the same. The mucous membrane is continuous with the labial mucous membrane, and contains the openings of the buccal and molar mucous glands and Stenson's duct.

THE SOFT PALATE.

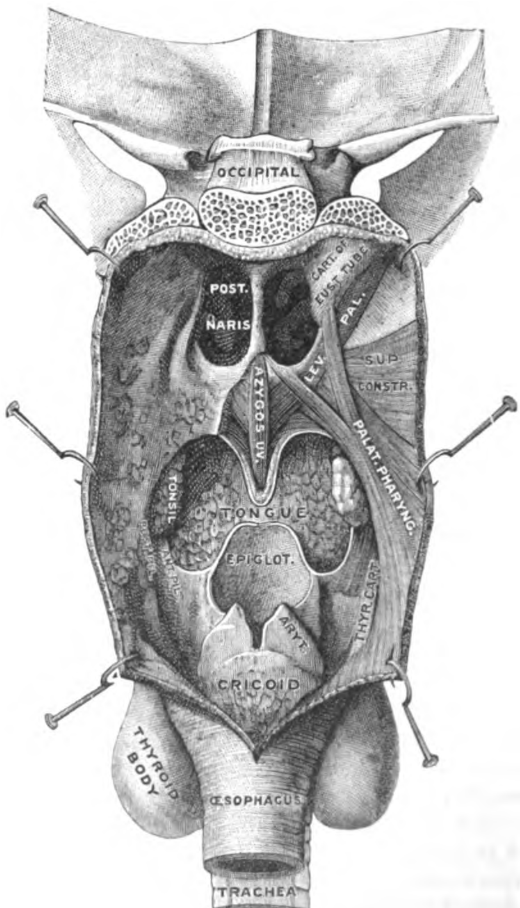
Location. The soft palate is easily seen by firmly depressing the tongue. At times other than deglutition it forms an imperfect partition between the oral cavity and pharynx, and its movements should be, as far as possible, studied on the living.

Attachments. The soft palate is attached (1) to the posterior border of the hard palate (2) to the side of the tongue through the palatoglossus muscle; (3) to the lateral wall of the pharynx and thyroid cartilage through the palatopharyngeus muscle. The free border of the soft palate has a wide range of motion forward, backward, and upward.

Composition. 1. The velum, uvula, and mucous membrane. 2. The anterior pillar and palatoglossus muscle. 3. The posterior pillar and palatopharyngeus muscle. 4. The tonsillar recess and tonsil. 5. Nerves from the pharyngeal plexus and otic ganglion. 6. The palatine arteries and veins.

The Uvula is a small, pendulous process, composed of muscle and mucous membrane, situated in the median line of the velum palati. Its great tendency to move depends on its richness of muscular fibre, by which it is influenced. The uvula has one intrinsic muscle, azygos uvulæ, taking origin in the posterior nasal spine. The extrinsic muscles are the tensor and levator palati, palatoglossus, and palatopharyngeus.

FIG. 41.



Muscles of the soft palate, viewed from behind. The dorsal wall of the pharynx has been laid open. (GERRISH after TESTUT.)

Pillars of Palate. Near the base of the uvula the soft palate splits into the anterior and posterior pillars, leaving a triangular region (tonsillar recess) between them.

The Anterior Pillar passes downward, forward, and outward to the side of the tongue, and consists of (1) a fold of mucous membrane; (2) the hidden palatoglossus muscle beneath the mucous membrane. Action, to lift the tongue, depress the velum, and narrow the isthmus.

The Posterior Pillar of the palate passes downward, backward, and outward to the lateral wall of the pharynx and thyroid cartilage. It consists of (1) a fold of mucous membrane; (2) a hidden palatopharyngeus muscle beneath the mucous membrane. Action, to pull down the velum, lift the tongue and larynx, and shut off the mouth from the pharynx by narrowing the isthmus.

The Levator Palati, as its name implies, lifts the palate. Its origin is from the petrosa, in front of the carotid canal. It is inserted into the base of the uvula with its fellow of the opposite side.

The Tensor Palati tightens the velum by lateral traction, just as the lips may be rendered tense by lateral traction at the corners of the mouth. The muscle arises from (1) the root of the internal pterygoid plate ; (2) the spine of the sphenoid ; (3) the cartilaginous end of the Eustachian tube. Its tendon turns inward at a right angle around the hamular process, and is inserted into the soft palate and palate bone.

The Isthmus of the Fauces is bounded by the anterior pillars of the palate, the uvula, and dorsum of the tongue. It is the aperture by which the mouth and pharynx communicate. The isthmus may become obliterated by its own boundary structures—that is, relations of the surrounding parts are so changed during the act of swallowing that for the moment a perfect partition exists between the mouth and pharynx. The digastric and stylohyoid muscles, aided by the palatopharyngeus, elevate the tongue ; the levator and tensor palati muscles render the velum tense ; the palatoglossus and palatopharyngeus draw the velum downward and inward in close apposition with the tongue.

The Tonsils are in the tonsillar recess, between the pillars of the palate. They are evolved from the lateral wall of the pharynx, between the second and third visceral arches. In the adult the tonsils resemble glands of intestine, and belong physiologically to the lymphatic system. The location of the tonsil corresponds to the angle of the jaw. Its dimensions are one-half inch wide, one-half inch thick, and one inch in length. The tonsils have recesses fed by numerous follicles. The openings are on the inner surface of the tonsil, and through these the mucous membrane extends into and lines the follicles. The outer surface of the tonsil is in relation with the superior constrictor of the pharynx ; the latter intervenes between the tonsil and the ascending pharyngeal artery. The internal carotid artery is about one inch behind and external to the tonsil. *Nerve-supply:* (*a*) The glossopharyngeal; (*b*) Meckel's ganglion. *Arteries:* Dorsalis linguæ, ascending pharyngeal, internal carotid, ascending palatine, and descending palatine.

THE TONGUE.

Definition. The tongue is an organ of taste, speech, touch, deglutition, prehension, and mastication. It is composed of muscles and mucous membrane, and has an abundant supply of vessels and nerves.

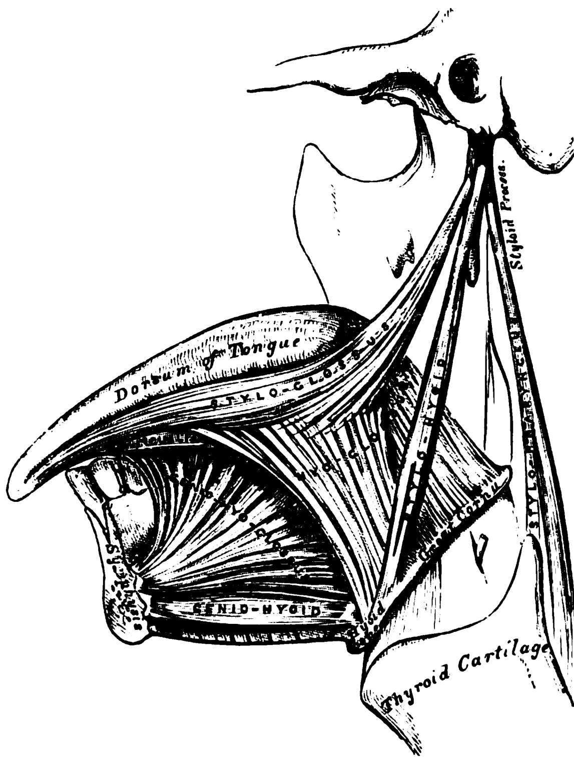
The base of the tongue is attached to the hyoid bone and mandible ; the sides to the hard palate and styloid process. The dorsum has an oral and a pharyngeal surface. The oral surface is anterior to the circumvallate papillæ, and bears the lingual taste-organs ; the pharyngeal surface is posterior to these, and rich in mucous glands and lymphoid tissue. The tongue was evolved from (1) the tuberculum impar, from the middle of the anterior wall of the pharynx below the first visceral arch ; (2) the ventral extremities of the second and third visceral arches. The line of union is at the thyroglossal duct, and the foramen cæcum on the back of the tongue is its vestige.

The Mucous Membrane is reflected from the tongue, (1) laterally and anteriorly, onto the gums ; (2) anteriorly, beneath the tip, onto the symphysis menti, to form the frænum linguæ ; (3) onto the palatoglossus muscle, to form the anterior pillar of the palate ; (4) onto the superior surface of the epiglottis, to form the glosso-epiglottidean folds—central and lateral.

The peculiarities of the lingual mucous membrane are : 1. Immovable, on the base and upper surface of the tongue. 2. Absence of the mucous glands. 3. Presence of papillæ and lymph follices. (See Gray's *Anatomy.*)

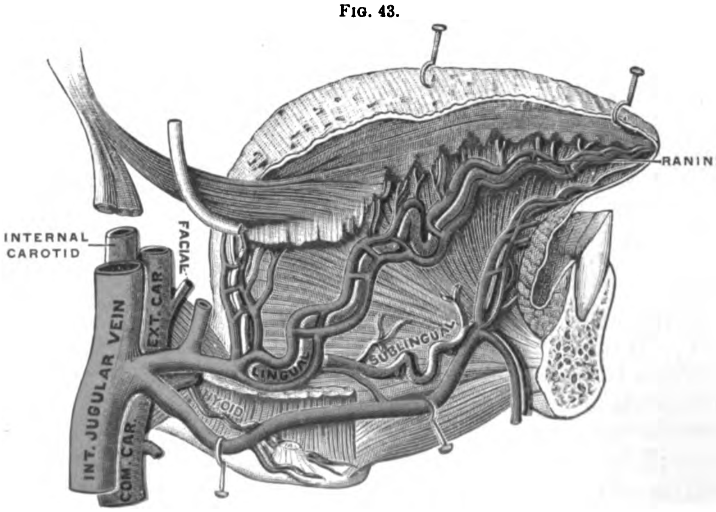
Muscles of the Tongue. The muscles of the tongue, both intrinsic and extrinsic, are supplied by the hypoglossal or twelfth cranial nerve. The intrinsic muscles collectively form the musculus lingualis, and have origin and insertion in

FIG. 42.



Muscles of the tongue. Left side. (GRAY.)

FIG. 43.



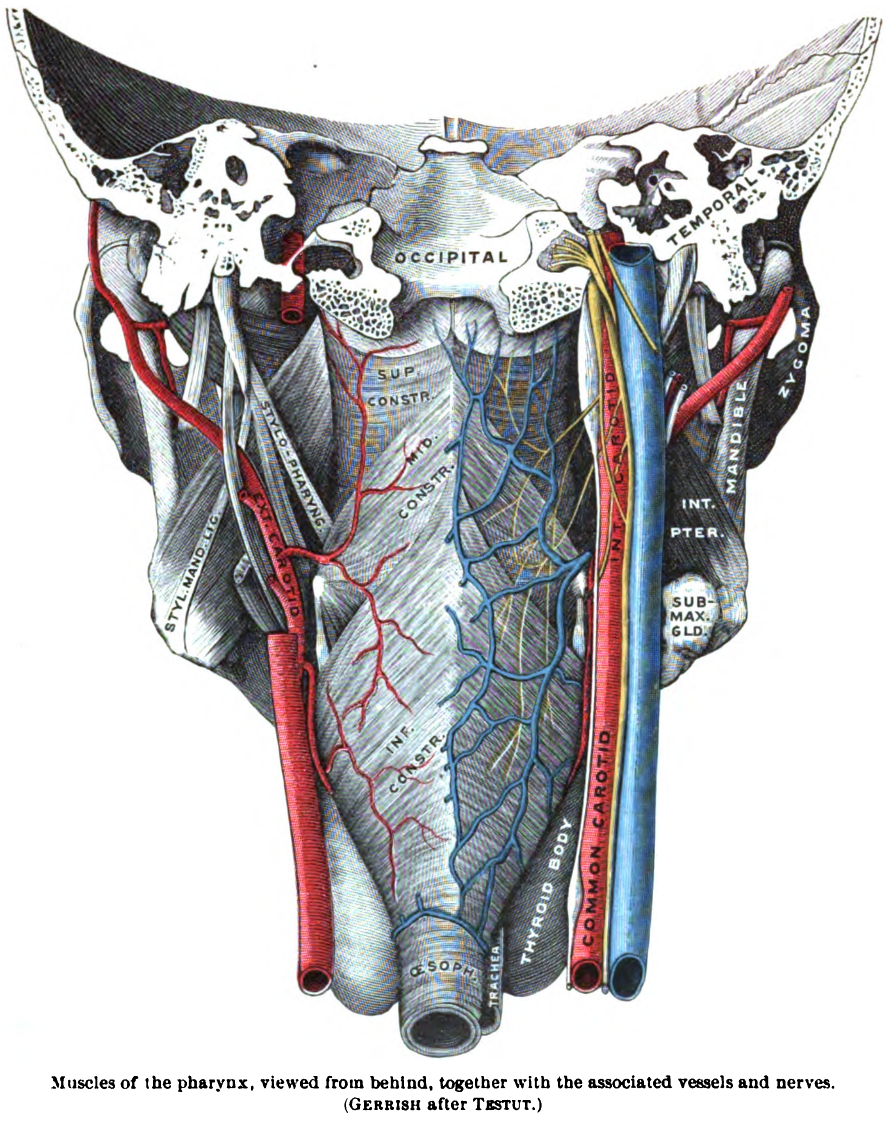
Arteries and veins of the tongue, viewed from the right side. (GERRISH after TESTUT.)

the tongue-mass proper. The extrinsic muscles have origin outside the muscle-mass proper of the tongue, and insertion in the musculus lingualis. The specific origin and insertion of each group is given in the table of the muscles (page 84).

Intrinsic Muscles. 1. The superior lingualis produces shortening and longitudinal grooving of the dorsum. 2. The inferior lingualis shortens the tongue and rounds up its dorsum. 3. The transverse lingualis diminishes the width and increases the length. 4. The vertical lingualis broadens and flattens the organ.

Extrinsic Muscles. 1. The styloglossus lifts the base and retracts. 2. The hyoglossus retracts and depresses. 3. The geniohyoglossus has three actions: (*a*) The back fibres protrude the tongue; (*b*) the front fibres retract the tip; (*c*) the median fibres produce a dorsal gutter. 4. The chondroglossus retracts and depresses the tongue.

FIG. 44.



Muscles of the pharynx, viewed from behind, together with the associated vessels and nerves. (GERRISH after TESTUT.)

Nerves. 1. From the gustatory of the trifacial, to the anterior two-thirds. 2. From the glossopharyngeal (taste) to the posterior one-third. 3. From the hypoglossal, to the intrinsic and extrinsic muscles. 4. From the superior laryngeal, to the base of the tongue. 5. From the chorda tympani, to the anterior two-thirds (taste). 6. From the superior cervical ganglion—vasodilators.

Artery. The tongue has a rich blood-supply through the lingual artery, a branch of the external carotid; the facial and ascending pharyngeal, from the external carotid.

THE PHARYNX.

Location. The pharynx is limited above by the base of the skull, below by the beginning of the œsophagus opposite the cricoid. It is situated behind the nose (nasopharynx), behind the mouth (oropharynx), and behind the larynx (laryngopharynx).

Openings. 1. The Eustachian tube. 2. The posterior nares. 3. The isthmus of fauces. 4. The œsophagus. 5. The larynx.

PHARYNGEAL PLEXUS.

Location. The pharyngeal plexus is on the posterior and lateral aspect of the pharynx, on the outer surface of the middle constrictor. (Fig. 44.)

Formation. 1. The internal branch of the spinal accessory nerve. 2. The pharyngeal branch of the glossopharyngeal. 3. The pharyngeal branch of the pneumogastric. 4. The pharyngeal branch of the superior laryngeal. 5. The pharyngeal branch of the superior cervical ganglion.

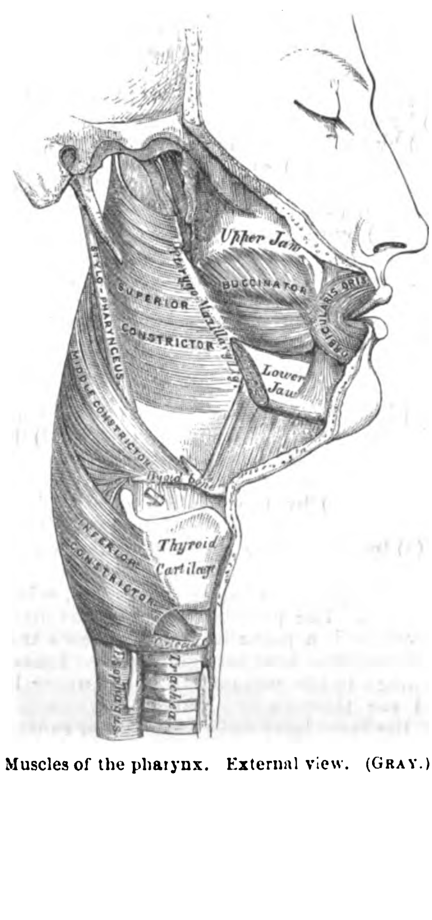
Distribution. To the levator palati, palatoglossus, palatopharyngeus, superior, middle, and inferior constrictors of the pharynx.

TABLE GIVING ORIGIN, INSERTION, ACTION, AND NERVE-SUPPLY OF THE MUSCLES OF THE TONGUE, PALATE, AND PHARYNX.

Name.	*Origin.*	*Insertion.*	*Action.*	*Nerve-supply.*
Palatopharyngeus.	By two heads near median line of soft palate.	Into upper and posterior borders of the thyroid cartilage.	Constricts the fauces, elevates the larynx and tongue, closing off the nasopharynx.	Pharyngeal plexus.
Palatoglossus.	Near median line of soft palate and from its fellow of the opposite side.	Into the side and base of the tongue.	Constricts the fauces, elevates the tongue, and pulls down the velum.	Pharyngeal plexus.
Levator palati.	Inferior surface of petrous portion of temporal bone and of the cartilage of Eustachian tube.	Into the median line with its fellow of the opposite side.	Elevates the soft palate.	Pharyngeal plexus through the eleventh.
Tensor palati.	*a.* Scaphoid fossa of pterygoid plate. *b.* Spine of the sphenoid. *c.* Eustachian tube.	Into the median line of soft palate continuous with its fellow of the opposite side and under surface of the palate bone.	Tightening of soft palate and opening of Eustachian tube during deglutition.	From the otic ganglion on the mandibular division of the trifacial.
Azygos uvulæ.	Posterior nasal spine.	Into uvula.	Shortens the uvula.	Pharyngeal plexus.
Hyoglossus.	From great horn and body of the hyoid bone.	Into side and dorsum of tongue between styloglossus and superior lingualis.	Depression and retraction of the tongue.	Hypoglossal.
Genioglossus.	Upper genial tubercle.	Into the hyoid bone and median line of tongue and just external to it from base to apex.	Its anterior fibres retract the lip; its posterior fibres protrude the tongue.	Hypoglossal.
Styloglossus.	Styloid process of temporal bone and stylomandibular ligament.	Into side and under part of the tongue from base to apex.	To draw the tongue backward and to lift the base and sides.	Hypoglossal.

Name.	*Origin.*	*Insertion.*	*Action.*	*Nerve-supply.*
Chondroglossus.	Lesser horn and body of hyoid.	Into dorsum of tongue.	Retracts and depresses the tongue.	Hypoglossal.
Superior lingualis.	From upper and posterior part of tongue and hyoid bone.	Into submucous tissue of upper surface of tongue throughout its entire length.	Shortens the tongue.	Hypoglossal.
Inferior "	From external and posterior part of tongue.	Under the edge of the tongue throughout its entire length.	Shortens the tongue.	Hypoglossal.
Transverse "	From medium septum.	Into dorsum and margin of tongue.	Narrows and lengthens the tongue.	Hypoglossal.
Vertical "	Under surface of tongue.	Upper surface of tongue.	Flattens and broadens the tongue.	Hypoglossal.
Stylopharyngeus.	Styloid process of temporal bone.	Upper and posterior border of the thyroid cartilage.	Elevates pharynx and larynx.	Glosso-pharyngeal.
Constrictor superior.	Internal pterygoid plate; side of tongue, mylo-hyoid ridges, and pterygomaxillary ligament.	Into mid-line of pharynx.	Narrows upper half of pharynx.	Pharyngeal plexus.
Constrictor medius.	Greater horn of hyoid and stylo-hyoid ligament.	Into mid-line throughout entire length of pharynx.	Narrows the pharynx antero-posteriorly.	Pharyngeal plexus.
Constrictor inferior.	Coracoid and thyroid cartilage.	Into mid-line of pharynx.	Compresses the pharynx and lifts it upward and backward.	Pharyngeal plexus and inferior laryngeal.

FIG. 45.



Muscles of the pharynx. External view. (GRAY.)

CHAPTER V.

THE EYE.

IDENTIFICATION OF STRUCTURES IN SITU BY INSPECTION OF THE EYE ON THE LIVING.

Supercilia. Identify (1) by the location above the circumference of the base of the orbit and arched shape; (2) by the numerous, short, thick, oblique hairs. Composition: thick skin connected with orbicularis palpebrarum, corrugator supercilii, and occipitofrontalis muscles.

Palpebræ (lids). Identify (1) by the location in front of the eyeball, which they protect; (2) by the attachment of the eyelashes to their free edges; (3) by their mobility and the presence of an elliptical space between the occlusal margins.

Fissura Palpebrarum. Identify (1) by the location between the free margins of the lids; (2) by the extent from the inner to the outer canthus palpebrarum.

Canthi. Identify the canthi (inner and outer canthus) (1) by the location at the angles of junction of the upper and lower lids; (2) by the location at the extremities of the palpebral fissure. The inner canthus contains the lacus lacrymalis, caruncula lacrymalis, papilla lacrymalis, and puncta lacrymalia.

Lacus Lacrymalis. Identify (1) as a triangular space separating the lids at the inner canthus; (2) by the prominent lacrymal caruncle in its centre.

Papilla Lacrymalis. Identify (1) as two small elevations on the margins of the lids at the commencement of the lacus lacrymalis; (2) by the presence of a small opening in the apex of each papilla.

Puncta Lacrymales. Identify (1) by the location at the apices of the lacrymal papillæ; (2) by the adjacency of the caruncula lacrymalis.

Cilia. Identify (1) as thick, short, curved hairs at the margins of the lids; (2) by the arrangement of the hairs in two or three rows; (3) by the upward curve of the superior and the downward curve of the inferior cilia.

Glandulæ Molli. These modified sweat glands are identified (1) by the location near the free margin of the lids; (2) by the arrangement in several rows.

Conjunctiva. Identify (1) by the location on the inner surfaces of the lids and its reflection onto the sclerotica and cornea; (2) as a very transparent mucous membrane through which may be seen the bead-like rows of the Meibomian follicles, corresponding in length (the rows) to the width of the tarsal plates.

Palpebral Folds. Identify (1) by the location above and below the fornix; (2) as the conjunctiva reflected from the lids to the eyeball. Folds are called the superior and inferior palpebral. The point of reflection of the conjunctiva from the lid to the eyeball is the fornix conjunctivæ.

Plica Semilunaris. Identify (1) by the location at the inner angle of the eye; (2) as a half-moon-shaped fold of mucous membrane; (3) by the adjacency of the lacrymal caruncle. This and the lacrymal caruncle represent the nictitating membrane of the lower animals.

Caruncula Lacrymalis. Identify (1) by the location at the inner canthus in the lacus lacrymalis; (2) by the adjacency of the plica semilunaris; (3) by the presence of a few attached slender hairs. The caruncle is composed of skin, contains sweat glands, sebaceous glands, and is the source of a whitish secretion.

Meibomian Glands. Identify (1) by the location on the inner surface of the eyelids beneath the palpebral conjunctiva in the grooves of the tarsal plates; (2) by the appearance of strings of small beads; (3) by the minute openings of these glands on the free margins of the lids.

Conjunctival Sac. This is the space limited by the cornea, sclerotica, fornix and conjunctiva of the upper and lower lids. The palpebral fissure leads into the sac. When the eyelids are closed the conjunctival sac is a potential cavity. Tears traverse the sac, moistening, purifying, and keeping the cornea free from foreign bodies. Tears originate in the lacrymal gland, pass through the openings in the conjunctiva of the upper lid near the outer canthus, and leave the conjunctival sac through two puncta lacrymalia in the lacrymal papillæ, situated at the beginning of the lacus lacrymalis at the inner canthus.

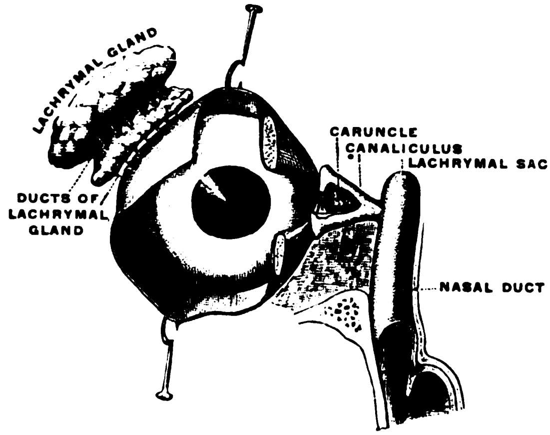
Cornea. Identify (1) by the location so as to form the anterior sixth of the eyeball; (2) by the circular shape, transparency, and continuity with the sclerotic coat at the corneal margin.

Sclerotica. Identify (1) by the location about the cornea and white color; (2) by the extreme density, hardness, and unyielding character; (3) by the insertion of the recti and obliqui muscles; (4) by the investment of the anterior part by the conjunctiva, and the posterior part by the capsule of Tenon; (5) by the continuity with the cornea in front.

Anterior Ciliary Arteries. Identify (1) by the location beneath the conjunctiva of the sclerotic coat; (2) by the sudden disappearance near the margin of the cornea, where they pierce the sclerotic coat and end in the circulus major of the iris. They are derived from the muscular branches of the ophthalmic. In iritis the vascular zone around the cornea is due to inflammation of the anterior ciliary arteries.

Iris. Identify (1) as the colored membrane of the eye (gray, brown, black, blue); (2) by the location in the anterior chamber in the aqueous humor behind the cornea; (3) by the presence a little to the nasal side of the centre of the pupil, limited on all sides by the pupillary margin of the iris.

FIG. 46.



The lacrymal apparatus of the right eye. (GERRISH after TESTUT.)

LACRYMAL APPARATUS.

Dissection of the Lacrymal Sac and Canaliculi. (1) Locate the punctum lacrymale on the summit of the papilla at the outer end of the lacus lacrymalis on the margin of the lid; (2) enter the lacrymal sac through the superior canaliculus with Bowman's grooved lacrymal catheter in upward, inward, and downward directions in succession; (3) move the catheter in various directions to demonstrate the strength, elasticity, and limited distensibility of the sac. (Pass catheter into the sac through the inferior canal downward and inward); (4) cut down on the director with delicate scissors and expose the interior of the canals and sac; (5) make a vertical incision three quarters of an inch long and lay open the nasal duct.

The Lacrymal Gland (Fig. 46) is an oval, compound, racemose structure, lodged in a depression beneath the external angular process of the frontal bone. It rests on the globe of the eye, conjunctiva, superior and external recti muscles, and is in contact with the orbital periosteum externally. It opens by six or seven ducts on the upper and outer half of the palpebral conjunctiva into the conjunctival sac.

The Canaliculi are two canals commencing at the puncta lacrymalia, the superior passing upward and inward to the lacrymal sac, the inferior passing downward, inward, and upward.

The Lacrymal Sac is a dilatation of the upper part of the nasal duct, lodged in the groove formed by the lacrymal bone and nasal process of the superior maxillary; its walls are of fibrous tissue covered in by the tensor tarsi muscle and an expansion from the tendo-oculi attached to the lacrymal bone.

The Nasal Duct is a membranous canal, three-fourths of an inch long, extending from the end of the lacrymal sac through a bony nasal canal to the inferior meatus. Its direction is downward, backward, and outward, its lumen being narrowest about the mid-point. The valve of Hasner is an imperfect fold of mucous membrane guarding the opening of the duct into the inferior meatus of the nose.

THE EYELIDS.

Dissection of the Eyelids. Pass two stitches through the palpebral border of each lid, one-quarter of an inch apart near the mid-line, an assistant making traction on the threads; cut through the lids vertically and secure the same by the four threads, so as to make full exposure of the conjunctival sac. Study carefully their composition.

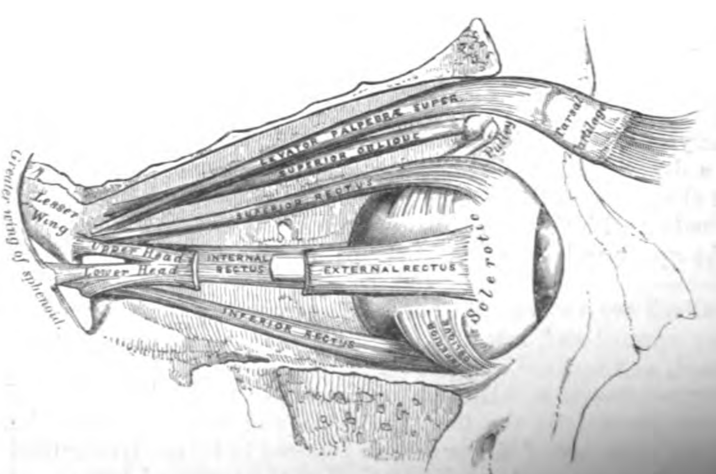
Composition of eyelids seen in the transverse section from without in: integument, loose areolar tissue, orbicularis palpebrarum, tarsal plates, tarsal ligaments, involuntary muscular fibre of Müller, Meibomian sebaceous glands, conjunctiva, palpebral arteries from the facial and ophthalmic, nerves from the third, seventh, fifth, and sympathetic.

The Tarsal Plates, one in each lid, consist of dense connective tissue. The upper is semilunar, the lower elliptical in form. They are attached to the margin of the orbit by fibrous membranes, the tarsal ligaments. The outer angle of each tarsal plate is attached by the external tarsal ligament to the malar bone. The inner angles of the tarsal plates are attached to the nasal process of the superior maxillary bone by the tendo-oculi—the internal tarsal ligament—formed by fusion of the superior and inferior palpebral ligaments. Into the anterior surface of the superior plate is inserted the levator palpebræ muscle, in which are some smooth muscular fibres—the superior palpebral muscle of Müller. The inferior palpebral muscle of Müller is in the lower tarsal plate. Müller's muscles are supplied by sympathetic nerves on which depend the involuntary action of the eyelids. (See nerve-supply of the muscles of expression, p. 24.)

MUSCLES OF THE EYE.

Dissection. Recti and oblique—tendons of insertion. Be guided by the illustration in the book as to the general insertion of the recti and oblique tendons. The recti tendons are inserted into the sclerotic coat of the eye, three or four lines external to the margin of the cornea. Each muscle perforates the capsule of Tenon, and its tendon receives a tubular sheath therefrom. Locate the insertion of the tendon as above indicated, and pinch up and

FIG. 47.



Muscles of the right orbit. (GRAY.)

cut the conjunctiva over the insertion. Now pinch up and cut the tubular sheath of the tendon derived from Tenon's capsule, when the white sclerotic coat [illegible] muscle will appear. Elevate the tendon on a blunt hook. [illegible] the muscles in the subjoined table, and note the extent of [illegible] capsule of Tenon.

MUSCLES OF THE EYEBALL, TABULATED.

Name.	*Origin.*	*Insertion.*	*Function and nerve-supply.*
Levator palpebræ superioris.	Under surface of the lesser wing of the sphenoid above and in front of the optic foramen.	Aponeurotic into the upper margin of the superior tarsal plate; skin of lid; conjunctiva.	Elevates the lid and antagonizes the orbicularis palpebrarum. Supplied by the third nerve.
Superior rectus.	Upper margin of the optic foramen; fibrous sheath of the optic nerve.	Sclerotica, by tendinous expansion, three or four lines from the sclerocorneal junction. Tendon covered by tubular process of Tenon's capsule.	Elevates, adducts, and rotates the cornea inward. Supplied by the third nerve.
Inferior rectus.	Ligament of Zinn with the internal rectus.	Sclerotica, three or four lines from the sclerocorneal junction. Has sheath from Tenon's capsule.	Adducts the cornea. Supplied by the third nerve.
External rectus.	(1) Outer margin of the optic foramen; (2) ligament of Zinn and lower margin of the sphenoidal fissure.	Sclerotica, three or four lines from the corneal margin.	Turns the cornea downward. Supplied by the sixth nerve.
Internal rectus.	Ligament of Zinn by common tendon with the inferior rectus.	Sclerotica, three or four lines from the corneal margin.	Turns the cornea inward. Supplied by the third nerve.
Inferior oblique.	Depression near the anterior margin of the maxillary bone, external to the lacrymal groove	Outer part of the sclerotica, between the superior and external recti, behind the tendon of the superior oblique.	Rotates the cornea outward on the antero-posterior axis. Supplied by the third nerve.
Superior oblique.	One line above the inner margin of the optic foramen.	Passing around the trochlea beneath the internal angular process of the frontal bone, the tendon passes backward, outward, and downward beneath the superior rectus, and is inserted into the sclerotica behind the equator and between the superior and external recti muscles. Sheath derived from Tenon's capsule reaches the floor of the orbit.	Abducts and rotates the cornea inward on the antero-posterior axis. Supplied by the fourth nerve.
Müller's superior palpebral.	Aponeurotic insertion of the levator palpebral.	Upper lid fibres.	Involuntary action of the upper lid. Supplied by the sympathetic nerve.
Müller's inferior palpebral.	Inferior tarsal cartilage plate.	Lower lid fibres.	Involuntary action of the lower lid. Supplied by the sympathetic nerve.

INTRA-ORBITAL STRUCTURES.

Dissection. Remove the orbital plate as far back as the optic foramen. To do this saw through the internal and external angular processes of the frontal bone and give the intervening bony arch a gentle tap, when it will fracture transversely. Remove the remaining bone so as to expose the orbital contents and the sphenoidal fissure. (Fig. 48.) The orbital periosteum is now exposed. Study step by step the directions for identifying the structures. (For a short, systematic description of the muscles, branches of the ophthalmic artery, and orbital cranial nerves, see respective tables. For contents of the cavernous sinus, see dural sinuses, p. 55. For sphenoidal fissure and its contents, see osteology of the orbit.)

Periosteum of the Orbit. Identify (1) by the location in the orbit and the attachment to the orbital walls; (2) by the continuity with the dura through the sphenoidal fissure.

Orbital Fascia. Identify (1) as a thin transparent layer of connective tissue immediately beneath the periosteum; (2) by forming a loose, delicate sheath for the lacrymal gland and muscles; (3) by the formation of the capsule of Tenon. Elevate the orbital fascia and incise the same from the base to the apex of the orbit. Turn the fascia aside.

Frontal Nerve. Identify (1) by the location immediately beneath the orbital fascia (with the supra-orbital artery) on the levator palpebræ muscle in the mid-line; (2) by the division midway in the orbit, into the supratrochlear and supra-orbital branches; (3) by the derivation fro[illegible] ophthalmic division of the trifacial nerve in the cavernous sinus.

[illegible]chlear Nerve. Identify (1) by derivation from the frontal nerve; (2) by the [illegible] inward above the trochlea of the superior oblique muscle to the inner angle of [illegible] the communicating branch to the infratrochlear branch of the nasal nerve.

Supra-orbital Nerve. Identify (1) by the derivation from the frontal nerve; (2) by the location on the levator palpebræ and the emergence from the orbit onto the face through the supra-orbital notch.

Supra-orbital Artery. Identify (1) by the derivation from the ophthalmic; (2) by the location on the levator palpebræ with the supra-orbital branch of the frontal nerve; (3) by the emergence through the supra-orbital foramen.

Frontal Artery. Identify (1) by the location on the inner wall of the orbit with the supratrochlear nerve; (2) by the derivation from the ophthalmic artery; (3) by the emergence from the orbit at the inner angle and anastomosis with the supra-orbital artery.

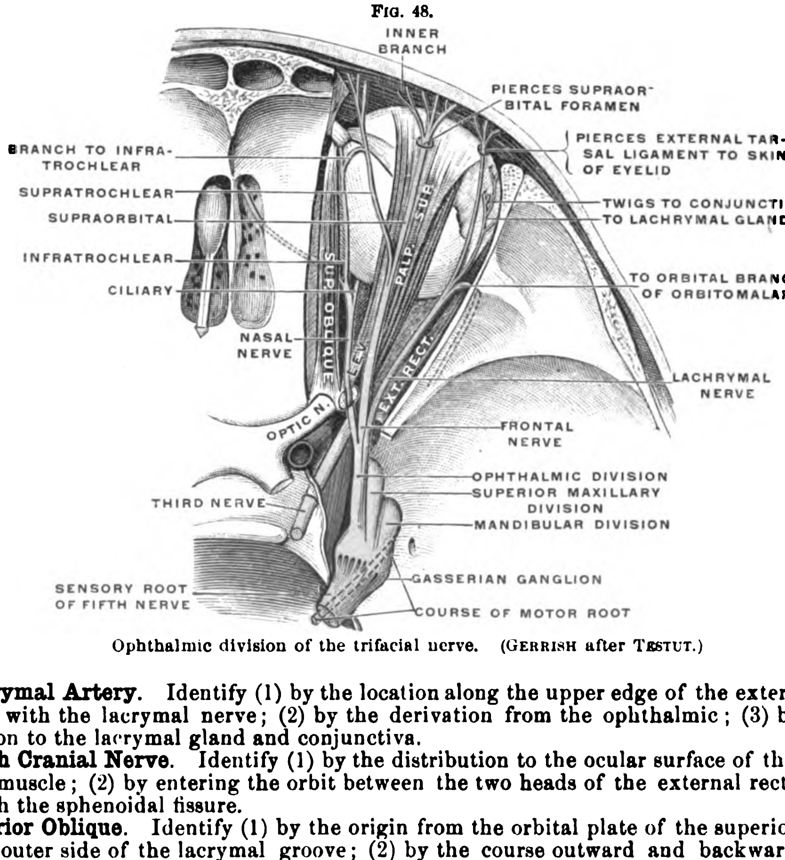
Levator Palpebræ. Identify (1) by the location beneath the frontal nerve and supra-orbital artery; (2) by the insertion into the tarsal plate of the upper eyelid; (3) by the location on the superior rectus muscle. Cut this muscle in the middle and expose the superior rectus beneath.

Superior Rectus. Identify (1) by the location in the upper part of the orbit beneath the levator palpebræ; (2) by the insertion into the upper part of the sclerotic coat.

External Rectus. Identify (1) by the location on the outer side of the orbit with the lacrymal nerve and artery; (2) by the insertion into the outer side of the sclerotic coat of the eyeball; (3) by the distribution of the sixth nerve to its ocular or inner surface.

Lacrymal Nerve. Identify (1) by the location on the upper border of the external rectus muscle, with the lacrymal artery; (2) by the derivation from the ophthalmic division of the trifacial nerve; (3) by the passage through the lacrymal gland with the lacrymal artery.

FIG. 48.



Ophthalmic division of the trifacial nerve. (GERRISH after TESTUT.)

Lacrymal Artery. Identify (1) by the location along the upper edge of the external rectus muscle with the lacrymal nerve; (2) by the derivation from the ophthalmic; (3) by the distribution to the lacrymal gland and conjunctiva.

Sixth Cranial Nerve. Identify (1) by the distribution to the ocular surface of the external rectus muscle; (2) by entering the orbit between the two heads of the external rectus muscle through the sphenoidal fissure.

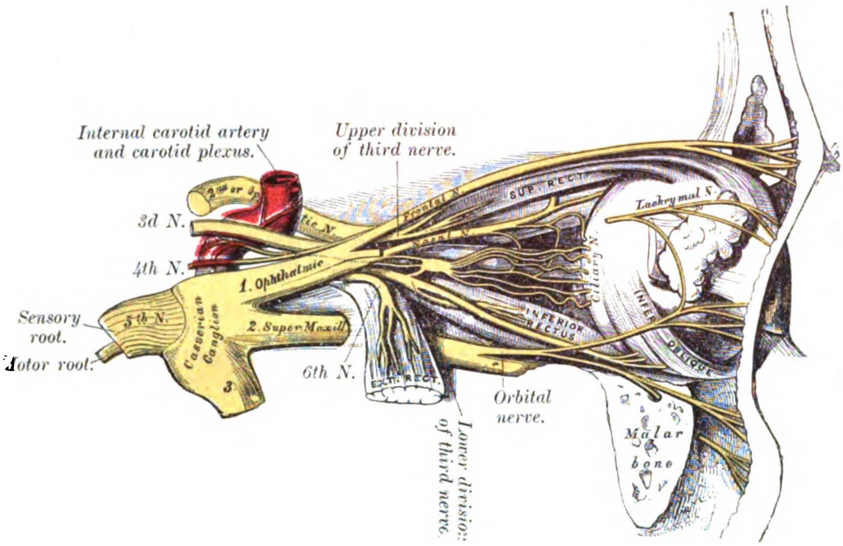
Inferior Oblique. Identify (1) by the origin from the orbital plate of the superior maxilla on the outer side of the lacrymal groove; (2) by the course outward and backward between the orbit and inferior rectus, then between the globe and the external rectus; (3) by the insertion into the outer and back part of the sclerotic coat. Gain this muscle from in front for dissection.

Superior Oblique Muscle. Identify (1) by the location on the inner and upper sides of the orbit with the fourth nerve; (2) by the passage through the pulley of cartilage attached to the trochlear fossa in the frontal bone; (3) by the insertion into the outer part of the sclerotic coat (near the insertion of the inferior oblique), having passed beneath the superior rectus muscle.

Fourth Cranial Nerve. Identify the patheticus (1) by the location on the inner side of the orbit and the distribution to the superior oblique muscle; (2) by the passage through the sphenoidal fissure above the other nerves. (Fig. 49.)

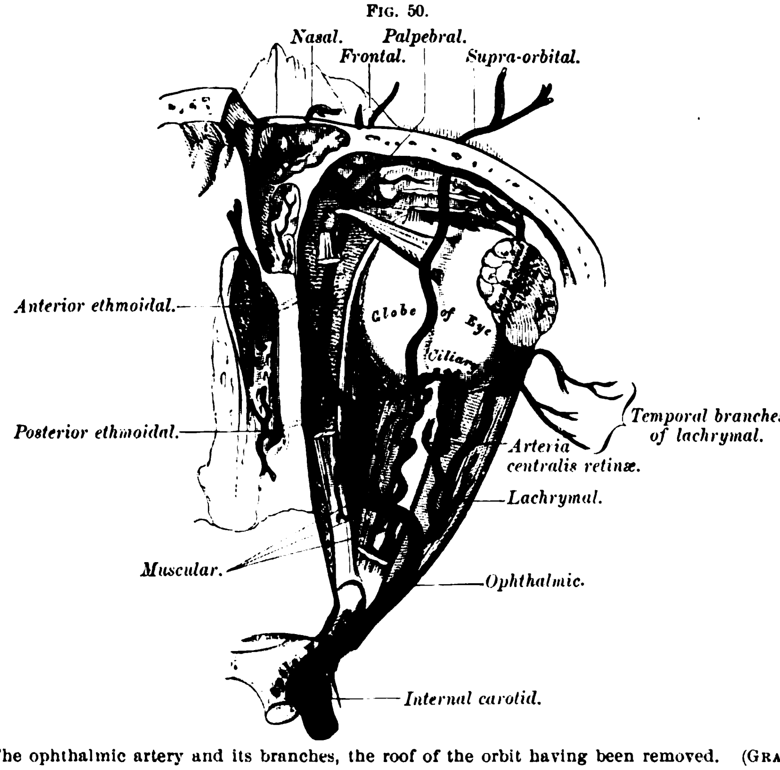
Internal Rectus. Identify (1) by the location on the inner side of the orbit; (2) by the insertion into the inner side of the sclerotic coat; (3) by the origin from the ligament of Zinn with the inferior rectus.

FIG. 49.



Nerves of the orbit and ophthalmic ganglion. Side view. (GRAY.)

FIG. 50.



The ophthalmic artery and its branches, the roof of the orbit having been removed. (GRAY.)

Inferior Rectus. Identify (1) by the location in the inferior part of the orbit; (2) by the origin with the internal rectus from the ligament of Zinn; (3) by the insertion into the sclerotic coat on the inferior part of the globe.

Third Cranial Nerve. Identify the motor oculi (1) by the large size, firm texture, and rounded form; (2) by the distribution to all the orbital muscles, except the superior oblique and the external rectus.

Nasal Nerve. Identify (1) by the derivation from the ophthalmic; (2) by the course through the sphenoidal fissure between the superior and inferior divisions of the third nerve; (3) by the course above the optic nerve, beneath the superior rectus and levator palpebræ; (4) by the emergence from the orbit between the internal rectus and the superior oblique, through the anterior ethmoidal foramen into the cranium; (5) by the passage from the cranium to the nose through the nasal slit.

Optic Nerve. Identify (1) by the large size and the central location in the orbit; (2) by the passage through the optic foramen with the ophthalmic artery; (3) by the fact of being the largest structure piercing the posterior part of the eyeball.

Ciliary Ganglion. Identify (1) by the location in the orbit between the optic nerve and the external rectus muscle; (2) by its pinhead size; (3) by the source of the roots—motor—from the branch of the third nerve to the inferior rectus muscle; sensory, from the nasal nerve; sympathetic, from the cavernous plexus; (4) by the distribution to the eyeball—short ciliary nerves. The nasal nerve element in the ciliary ganglion confers trophicity and common sensation on the eyeball. Branches of the ganglion derived from the third nerve are motor to the ciliary muscle and sphincter of the iris. Branches of the ganglion derived from the sympathetic produce dilatation of the iris.

Short Ciliary Nerves. Identify (1) by the origin from the ciliary ganglion and their course to the posterior part of the eyeball, which they pierce; (2) by uniting with the long ciliary branches of the nasal nerve on piercing the sclerotic coat. (Study with the dissecting microscope.)

Long Ciliary Nerves. Identify (1) by the derivation from the nasal nerve; (2) by the course along the inner side of the optic nerve to the back of the globe; (3) by union with the filaments from the ciliary ganglion—the short ciliary nerves. (Study with the dissecting microscope.)

Short Ciliary Arteries. Identify (1) by their large number (twelve to fifteen) and their location about the optic nerve; (2) by piercing the sclerotic coat to supply the choroid and iris; (3) by attending the ciliary nerves—long and short. (Study with the dissecting microscope.)

THE OPHTHALMIC ARTERY.

The Ophthalmic Artery arises from the internal carotid, near the anterior clinoid process. It passes through the optic foramen with the optic nerve, and, at times, through the sphenoidal fissure. Its branches are to be studied from the following table:

BRANCHES OF THE OPHTHALMIC ARTERY.

Branch.	*Course.*	*Distribution.*
Lacrymal.	Above the external rectus on the outer wall of the orbit with the lacrymal nerve.	Lacrymal gland, lids, conjunctiva, malar branch to the temporal fossæ; anastomotic branch, through the sphenoidal fissure to the middle meningeal artery.
Supra-orbital.	Forward beneath the roof of the orbit on the levator palpebræ, and onto the face through the supra-orbital foramen with the supra-orbital nerve.	Communicates with the frontal, angular, and superficial temporal arteries, and shares their distribution.
Arteria centralis retinæ.	Enters the optic nerve on the outer side near the optic foramen.	To the retina, in which no anastomosis between this and other arteries occurs. (See Gray and Gerrish.)
Short ciliary, twenty in number.	Travel forward with the optic nerve, piercing the sclerotic coat.	To the choroid and iris.
Long ciliary.	One on each side of the optic nerve, pierces the sclerotic coat, and passes between the sclerotic and the choroid coats.	They pass nearly to the iris, anastomose with the short ciliary, and form the circulus major at the circumference of the iris, and the circulus minor at the free margin of the iris.
Anterior ciliary.	They are derived from the muscular branches and follow the tendons to near the corneal margin.	They supply the conjunctiva covering the sclerotic coat, pierce the sclerotica, and join the circulus major.
Anterior ethmoidal.	Through the anterior ethmoidal foramen in company with the nasal nerve.	Branches: to the frontal and the anterior ethmoidal cells; an anterior meningeal branch and a nasal branch.
Posterior ethmoidal.	Through the posterior ethmoidal foramen.	To the posterior ethmoidal cells, upper part of the nose, and a branch to the meninges.
Muscular.	Pass to the upper and lower muscles of the eyeball.	Supply the muscles of the eyeball.
Superior palpebral.	Forms an arch near the margin of the lid, between the tarsal cartilage and the orbicularis palpebrarum.	To the superior lid.

Branch.	*Course.*	*Distribution.*
Inferior palpebral.	Arches between the tarsal cartilage and the orbicularis palpebrarum.	To the inferior lid.
Nasal.	Leaves the orbit above the tendon of the orbicularis and inosculates with the nasal and angular arteries.	Supplies the side of the nose and the lacrymal sac.
Frontal.	Passes upward at the inner angle of the eye and inosculates with the supra-orbital.	Inosculates with the supra-orbital artery and distributed to the skin of the inner canthus and vicinity.

NERVES OF THE EYE.

The following nerves enter the orbit through the optic foramen and sphenoidal fissure, and supply the contents of the same with motion, special and common sensation, and trophic influence :

1. The optic passes through the optic foramen with the ophthalmic artery and is distributed to the retina. 2. The oculomotor (third cranial) is distributed to the levator palpebræ, superior, inferior, internal recti, and inferior oblique. 3. The trochlearis (fourth cranial) is distributed to the superior oblique. 4. The abducens (sixth cranial) is distributed to the internal rectus. 5. The ophthalmic division of the trifacial (fifth cranial) is distributed (*a*) to the skin of the scalp as far as the lambdoid suture; (*b*) to the conjunctiva, lacrymal sac, and caruncle; (*c*) to the skin of the eyelids and nose; (*d*) to the mucous membrane of the upper part of the nasal fossæ. (For ciliary ganglion and nerves, see "dissection.")

EYEBALL.

Ox eyes in large numbers should be used in identification of the following structures. Use variety of lines of incision with very small saw, the eyes being frozen. Study with a dissecting microscope.

Vitreous Humor. Identify (1) by the transparency and gelatinous appearance; (2) by the occupancy of the posterior four-fifths of the interior of the globe; (3) by a depression in front containing the lens; (4) by a structureless hyaloid membrane, which invests the vitreous (except in front), and passes from this to the margin of the lens, forming its suspensory ligament; (5) by the easy detachment from the retina, except at the optic disk.

Retina. Identify (1) by the location immediately in contact with the vitreous humor; (2) by the transparency when fresh, and the pink, milky color when not fresh; (3) by ending as a transparent structure (in the region of the posterior part of the ciliary processes) in a wavy, saw-like margin—ora serrata; (4) by the continuation forward on the ciliary processes and iris as black pigment cells, called respectively pars ciliaris retinæ and pars iridica retinæ.

Choroid. Identify (1) by the dark-brown color and the great vascularity; (2) by the location between the retina and slerotica; (3) by the continuation forward as ciliary processes and iris; (4) by investing the posterior five-sixths of the eyeball and ending near the ora serrata of the retina in the ciliary processes (plicæ ciliares).

Ciliary Processes (about seventy in number). Identify (1) as a rich, brown, circular, plaited frill around and resting on the circumference of the lens; (2) by the continuity with the iris in front, with the choroid behind, as indistinct folds (plicæ ciliares) in the region of the ora serrata of the retina; (3) by interdigitation of its folds with those of the suspensory ligament of the lens. (Note.—When the vitreous is turned out a pigment impress around the lens-cup in the vitreous humor will show this interdigitation.)

Iris. Identify on the living (1) as a thin, circular, multicolored, contractile curtain surrounding the pupil and suspended in the aqueous humor between the cornea and the lens; (2) by the continuity of the circumference with the ciliary body and the connection with the posterior elastic lamina of the cornea by the pectinate ligament (ligamentum pectinatum); (3) by the presence on the anterior surface of lines converging toward the pupil; (4) by the deep purplish tint of the posterior surface, due to the pigmented epithelium of the pars iridica retinæ.

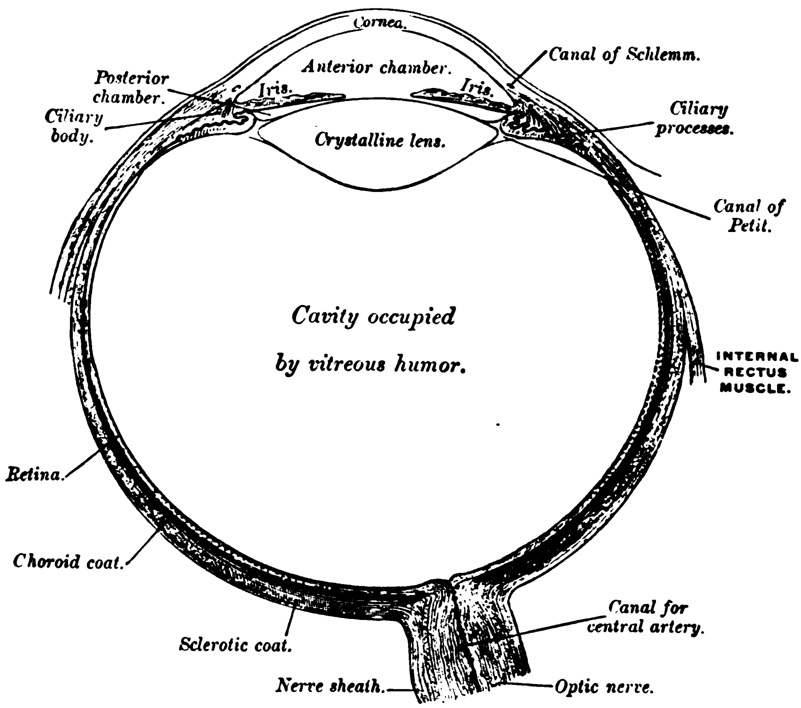
Ciliary Muscle. Identify (1) by the location on the outer surface of the forepart of the choroid near the junction of the cornea and sclerotica; (2) by the grayish, semitransparent appearance, and being one-eighth inch broad; (3) by the origin from the sclerocorneal junction and ligamentum pectinatum iridis; (4) by the backward direction and insertion into the choroid opposite the ciliary processes.

Crystalline Lens. Identify (1) by the location behind the pupil (in contact with the free margin of the iris) and in the fossa patellaris of the vitreous body; (2) by the circumference being surrounded and partly overlapped by the ciliary processes; (3) by the convex anterior and posterior surfaces; (4) by being retained in position chiefly by a suspensory ligament derived from the hyaloid investment of the vitreous body.

Aqueous Humor. Identify by the location in the anterior and posterior chambers, communicating through the pupil.

Ciliary Nerves. Identify (1) by the location in the delicate connective tissue (lamina fusca) between the sclerotic and choroid coats, or in the small grooves on the inner surface of the sclerotica; (2) by the derivation from the ciliary ganglion and nasal nerve; (3) by the distribution to the ciliary muscle, iris, and cornea; (4) by being accompanied by long and short ciliary arteries.

FIG. 51.



A horizontal section of the eyeball. (GRAY.)

Sclerotic Coat. Identify (1) as a white, tough, fibrous structure covering the posterior five-sixths of the globe; (2) by the insertions of the tendons of the four recti and two oblique muscles; (3) by the perforations for the optic and ciliary nerves, and ciliary vessels; (4) by the relation internally with the lamina fusca, a delicate connective tissue containing long and short ciliary vessels and nerves, and binding the sclerotic coat to the choroid; (5) by the relation with the cornea in front.

Cornea. Identify (1) as a brilliant, translucent coat forming the anterior sixth of the globe; (2) by the relation marginally with the sclerotic coat; (3) by contact of the posterior surface with the aqueous humor of the eye in the anterior chamber.

CHAPTER VI.

THE ORGANS OF HEARING.

THESE consist of (*a*) the auricle, or external ear; (*b*) the external auditory canal; (*c*) the middle ear, or tympanum; (*d*) the Eustachian tube; (*e*) the internal ear, or labyrinth.

Dissection and Identification. After the parts of the external ear have been learned, remove integument and study the cartilages. Cut through the lobule one-half inch from the end, and lastly, trace out the arteries and nerves.

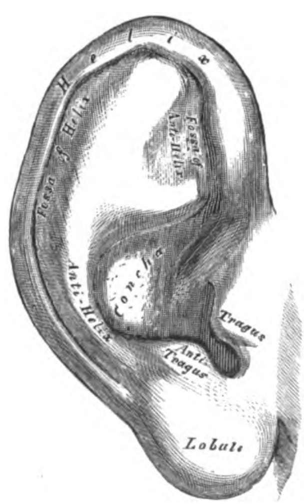
The External Ear, for purposes of dissecting-room study, presents the following points for identification. Here, as in many other regions, but little cutting is necessary:

Pinna (auricle). Identify (1) by its location on the side of the head leading into the middle ear through the external auditory canal; (2) by the irregularly concave interior and uneven oval form; (3) by the composition: skin, connective tissue, and yellow fibrocartilage.

Helix. Identify (1) as a folded, circumferential border; (2) by its great prominence and graceful curve.

Antihelix. Identify (1) by its location in front of and parallel with helix; (2) by the presence of a depression between this and the helix; (3) by its bifurcation above to enclose a triangular fossa.

FIG. 52.



The pinna, or auricle. Outer surfaces. (GRAY.)

Fossa of Helix. Identify (1) by its location between the helix and the antihelix; (2) as a narrow, curved depression.

Fossa of Antihelix. Identify by its location near the upper and inner part of the auricle, in the bifurcation of the antihelix.

Concha. Identify by its location as the capacious cavity in the concavity of the antihelix. Commencement of the helix divides the concha into an upper part (cymba conchæ) and a lower part (cavum conchæ).

Tragus. Identify (1) by its location in front of the concha and backward projection over the external auditory meatus; (2) by the tuft of hair on its under surface, resembling a goat's beard; hence the name.

Antitragus. Identify (1) by its location opposite the tragus; (2) by the presence between this and the tragus of a deep notch—incisura intertragica.

Incisura Intertragica. Identify (1) as a deep notch between the tragus and antitragus; (2) by its course leading into the concha and the external auditory canal.

Lobule. Identify (1) by its location at the lowest part of the auricle; (2) by the absence of firmness and elasticity; (3) by its composition of areolar and adipose tissue and a great tendency to enlarge with age.

External Auditory Meatus. Identify (1) by its location, extending from the bottom of the concha to the membrana tympani; (2) by the length (one and a quarter inch) measured from the tragus; (3) by its oval cylindrical form and S-shaped canal which it forms; (4) by its composition: bone cartilage and skin.

Muscles. The muscles of the external ear are nine in number. They are quite small and unimportant in man. For details the student is referred to Gray's *Anatomy*.

Arteries. The arteries of the external ear are (*a*) posterior auricular, from the external carotid; (*b*) anterior auricular, a branch of the temporal; (*c*) the auricular branch of the occipital. These are small, but may be seen in well-injected material. Each artery is surrounded by sympathetic nerves and accompanied by corresponding veins.

Nerves. 1. The facial supplies the muscles of the external ear through its temporal and auricular branches. 2. The auricularis magnus (second and third of cervical plexus) supplies the skin of back of pinna and communicates with auricular branches of seventh and tenth. 3. The auricularis minor (second of cervical plexus) supplies skin of upper and back part of external ear. 4. The occipitalis major (internal branch of posterior primary division of second cervical nerve) supplies skin of back part of external ear. 5. Arnold's nerve (auricular branch of vagus) supplies (*a*) posterior part of auditory canal; (*b*) skin of back part of pinna. 6. The auriculotemporal (from third division of trifacial) supplies front of the upper part of the pinna.

THE TYMPANUM, OR MIDDLE EAR.

The following five structures should be identified before any attempt is made to dissect this region:

The Petrosa. Identify (1) by its great size and its location between the middle and posterior fossæ at base of the skull; (2) by meeting of its anterior and posterior surfaces at the superior border of the petrosa.

Internal Auditory Meatus. Identify (1) by its location near the middle of the posterior surface of the petrosa; (2) by the size of the opening (one-fourth inch in diameter) and very smooth edges; (3) by the contained structures—seventh nerve, eighth nerve, and auditory artery.

Carotid Canal. Identify (1) by its location near apex of the petrosa and appearing on its anterior surface; (2) by the presence of the internal carotid artery (as large as a lead-pencil) in its canal.

Hiatus Fallopii. Identify (1) by its location near the middle of the anterior surface of the petrosa, about one-half an inch external to the carotid canal; (2) by its very small size and oblique direction; (3) by the emergence of a nerve (great superficial petrosal).

Tegmen Tympani. Identify (1) by its location on the anterior surface of the petrosa near the anterior border; (2) by its very frail, thin structure, and being the only part of this surface that yields to gentle tapping.

Dissection. Remove the tegmen, or roof, of the middle ear by gentle use of a chisel, taking care not to injure the petrosal nerves on the anterior surface of the petrosa. Now study *in situ* the following structures, preferably with a reading-glass: (*a*) the bones of the tympanum; (*b*) the chorda tympani nerve crossing the upper segment of the membrana tympani; (*c*) the membrana tympani forming the greater part of the outer wall of the middle ear; (*d*) the seventh nerve in the aquæductus Fallopii; (*e*) the opening in the posterior wall leading into the mastoid antrum, and the opening for the Eustachian tube in the anterior wall.

The tympanum is about one-half inch in height and one-sixth in width. It is prolonged forward as Eustachian tube, backward as mastoid antrum, and its length is, for practical purposes, one-half inch. The subdivisions are attic and tympanic cavity proper. The latter is quite narrow, and has the membrana tympani, or drum, as its outer wall. The former is broader, contains most of the bones of hearing, and has a part of the temporal bone as its outer wall. The tympanum is not horizontal, but its anterior end, as previously stated, slopes downward, forward, and inward to the Eustachian tube; its posterior end upward, backward, and outward to the mastoid antrum.

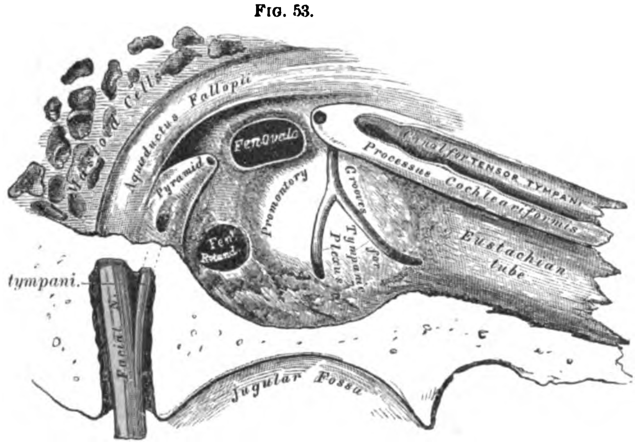
The Roof is a thin plate of bone (tegmen tympani) separating the tympanum from the middle fossa at the base of the skull. It contains the foramina that transmit the petrosal branches of the seventh nerve.

The Floor separates the tympanum from the jugular fossa, in which are the internal jugular vein, and the ninth, tenth, and eleventh cranial nerves. In this floor is an aperture through which Jacobson's nerve (tympanic branch of the glossopharyngeal) passes to form the tympanic plexus.

The Outer Wall is formed by the drum below and squamosa above, these two structures corresponding to the tympanum proper and attic, respectively. Openings: the iter chordæ posterius, by which the chorda tympani nerve, a branch of the seventh cranial, enters the tympanum; the iter chordæ anterius, by which the chorda tympani leaves the tympanum; Glaserian fissure, through which passes the tympanic branch of the internal maxillary artery; the processus gracilis of the malleus and the laxator tympani muscle.

The Inner Wall contains (1) a ridge of bone covering the seventh nerve in its passage through the tympanum; (2) the fenestra ovalis leading into the vestibule, and to which is attached the base of the stapes by a periosteal membrane; (3) the

FIG. 53.



View of inner wall of tympanum, enlarged. (GRAY.)

promontory formed by a turn of the cochlea, covered by the tympanic plexus and located below and in front of the fenestra ovalis; (4) the fenestra rotunda (covered by the membrana secundaria) communicating with the scala tympani of the cochlea; (5) the pyramid, from whose summit emerges the tendon of the stapedius. A branch of the seventh nerve pierces the pyramid for supply of the stapedius muscle.

The Posterior Wall communicates with the mastoid antrum through one large and several small openings. As indicated in a previous paragraph, the mastoid antrum is the backward continuation of the attic or upper part of the tympanic cavity.

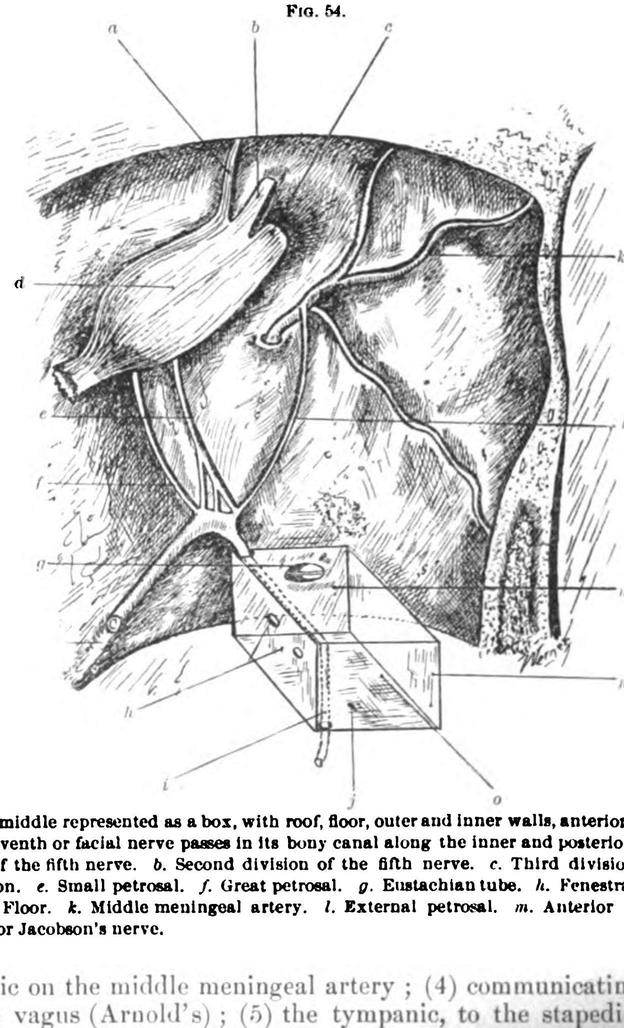
The Anterior Wall presents for examination the canalis musculo-tubarius. This canal is divided into an upper and a lower compartment by a horizontal lamina of bone—the processus cochleariformis. The upper compartment lodges the tensor tympani muscle; the lower is the osseous part of the Eustachian tube.

Contents: the tympanum contains (1) a chain of small bones extending from the drum to the fenestra ovalis; (2) the chorda tympani nerve, a branch of the facial; (3) mucous membrane, continuous in front with that of the Eustachian tube and behind with that of the mastoid antrum; (4) nerves and vessels; (5) the facial nerve in a bony canal, the aquæductus Fallopii.

Course of Facial Nerve. 1. Nerve enters the internal auditory canal with the auditory nerve and auditory artery—a branch of the basilar. 2. Nerve passes into aquæductus Fallopii, or facial canal, through an opening in anterior superior cribriform area of lamina cribrosa, or fundus of auditory canal. 3. Nerve develops ganglion (intumescentia gangliformis) and makes a bend outward and backward along inner wall of tympanum. 4. Nerve makes bend downward between inner and posterior walls of tympanum and passes vertically downward through the petrosa and emerges through the stylomastoid foramen.

Branches of Facial Nerve in the course through the petrosa. From the geniculate ganglion (1) the large superficial petrosal, to Meckel's ganglion ; (2) the small, superficial petrosal, to the otic ganglion ; (3) the external, superficial petrosal, to

FIG. 54.



The tympanum or middle represented as a box, with roof, floor, outer and inner walls, anterior and posterior ends. The seventh or facial nerve passes in its bony canal along the inner and posterior walls.

a. First division of the fifth nerve. *b.* Second division of the fifth nerve. *c.* Third division of the fifth nerve. *d.* Gasserian ganglion. *e.* Small petrosal. *f.* Great petrosal. *g.* Eustachian tube. *h.* Fenestræ ovale and rotunda. *i.* Facial nerve. *j.* Floor. *k.* Middle meningeal artery. *l.* External petrosal. *m.* Anterior wall. *n.* Outer wall (drum). *o.* Canal for Jacobson's nerve.

the sympathetic on the middle meningeal artery ; (4) communicating, to auricular branch of the vagus (Arnold's) ; (5) the tympanic, to the stapedius muscle ; (6) the chorda tympani, to the submaxillary and sublingual glands, and anterior two-thirds of tongue.

The accompanying illustration will aid the memory in fixing the location of roof, floor, and walls of the tympanum and their most important points of interest. The right tympanum is represented by a box, viewed from above and behind. The front of the box, with an aperture divided into two parts, terior wall of the tympanum, with the canal occupied above and Eustachian tube below. The rear end of th terior wall of the tympanum, with an opening into the mastoid antrum. The outer wall of the box represents the external wall of the tympanum, formed by the membrana tympani. The inner wall represents the internal wall of the tympanum, in which are the fenestræ ovalis and rotunda. The floor of the box represents the floor of the tympanum, in which is Jacobson's canal, giving passage to the tympanic branch of the glossopharyngeal nerve (Jacobson's). The facial nerve passes backward between inner wall and roof, then downward, between inner and posterior walls.

Relations. (1) The temporosphenoidal lobe of the brain lies on its roof; (2) the floor of the tympanum lies on the jugular fossa; (3) the drum of ear and chorda tympani are on external wall; (4) the mastoid antrum and cells are behind; (5) the internal carotid artery is in front; (6) the facial nerve skirts two sides; (7) the internal ear is in close relation.

Clinical Importance. (1) The drum of the ear may become ruptured; (2) the interossicular joints may become ankylosed; (3) pus may form in tympanum; (4) in suppuration of the middle ear, the nerve of Jacobson and the chorda tympani are liable to damage. They are, according to Gowers, the two chief paths of taste-fibres.

Ossicles of Tympanum. There are three bones forming a movable chain between membrana tympani and fenestra ovalis (malleus, incus, and stapes). The malleus consists of (1) an oval head articulating with the incus; (2) a neck; (3) a manubrium, giving attachment to the tensor tympani muscle; (4) a short process in contact with the membrana tympani; (5) a processus gracilis, lodged in Glaserian fissure and giving attachment to laxator tympani. The incus or anvil has (1) a body articulating with the malleus; (2) a long process terminating in the os orbiculare, which articulates with the head of the stapes; (3) a short process attached to the margin of the opening into the mastoid cells. The stapes or stirrup has (1) a head, articulating with the os orbiculare; (2) a neck, receiving insertion of the stapedius; (3) two branches or crura joining the base, which is connected with the margins of the fenestra ovalis.

Muscles of the Tympanum. 1. Tensor tympani, arising from (*a*) under surface of petrosa; (*b*) cartilage and bone of Eustachian tube and inserted into handle of malleus near root. Its nerve is from the otic ganglion, and by drawing down inward it increases tension thereof and makes hearing more acute. 2. Laxator tympani (anterior ligament of malleus) arises from (*a*) spine of sphenoid; (*b*) cartilage of Eustachian tube, and is inserted into neck of malleus above processus gracilis. Its nerve is from the facial (tympanic branch), and its action is to relax the drum. 3. Stapedius. *Origin:* Interior of pyramid on inner wall of tympanum. *Insertion:* Neck of stapes. *Nerve:* Facial. *Action:* To compress fluid contents of vestibule.

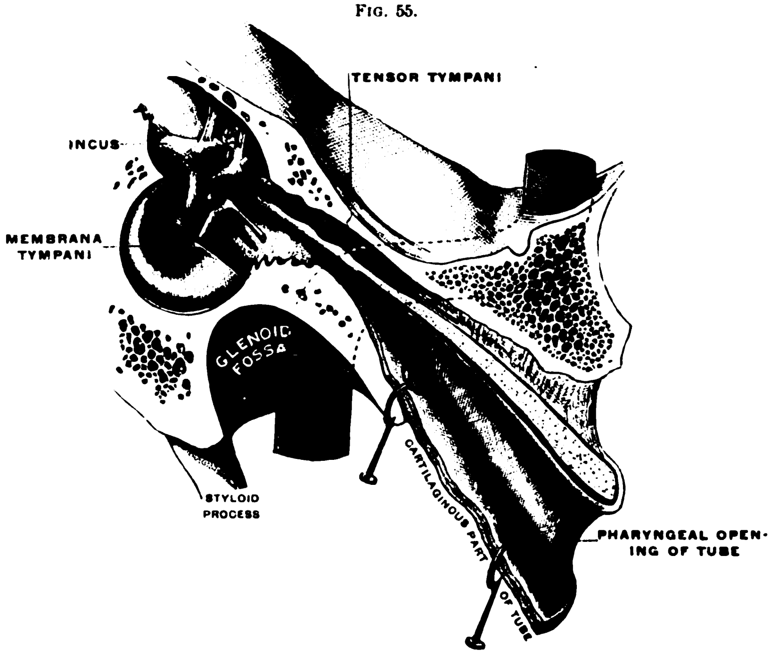
Nerves of Tympanum. 1. Jacobson's (tympanic branch of glossopharyngeal) passes through floor of tympanum and forms tympanic plexus on promontory of inner wall. 2. Small, deep petrosal, a branch of tympanic plexus, passes to carotid plexus of the sympathetic. 3. Small superficial petrosal, a branch of the geniculate ganglion, is joined by twig of tympanic plexus for supply of parotid gland. 4. Tympanic plexus. (See Jacobson's nerve.) 5. Facial nerve, passes through tympanum beneath a ridge of bone along inner and posterior walls. 6. Chorda tympani, a branch of the facial, crosses drum of ear between handle of malleus and long process of incus. 7. The nerve (a branch of the facial) to the stapedius muscle passes through a small canal connecting the aquæductus Fallopii and the interior of the pyramid.

Arteries of the Tympanum. 1. Tympanic branch of internal maxillary, passes thro[illegible]erian fissure and supplies the mucous membrane. 2. Stylomastoid br[illegible]rior auricular enters through stylomastoid foramen and facial [illegible]es (*a*) mastoid cells; (*b*) back part of tympanum. 3. Petrosal [illegible] meningeal artery, enters through hiatus Fallopii, and supplies [illegible]e ganglion, seventh and petrosal nerves. 4. Tympanic branch of internal carotid artery, pierces anterior wall and supplies mucous membrane. 5. Tympanic branch of ascending pharyngeal artery enters through Eustachian tube. 6. Tympanic branch of Vidian passes through Eustachian tube.

EUSTACHIAN TUBE.

Dimensions. The Eustachian tube is an inch and a half long and extends downward, forward, and inward from the anterior wall of the tympanum to the pharynx. The narrowest part is in the middle, and here its walls are in contact. The anterior part is fibrocartilaginous, the posterior part osseous.

FIG. 55.



Eustachian tube, laid open by a cut in its long axis. (GERRISH after TESTUT.)

The cartilaginous end is about one inch long and passes between the origins of the levator and tensor palati, giving attachment to some fibres of these muscles. It is situated in a groove between the petrosa and greater wing of the sphenoid. The pharyngeal opening is a vertical slit one-half inch long and on a line posteriorly with the inferior turbinated bone.

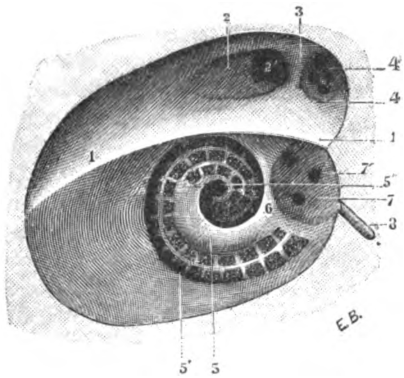
The bony part of the Eustachian tube is about one-half inch long and continuous with the anterior part of the tympanum. It is lined by mucous membrane continuous with that of the pharynx and middle ear.

INTERNAL EAR; LABYRINTH.

The study of the labyrinth includes (1) the fundus of the internal auditory canal; (2) the vestibule; (3) the semicircular canals; (4) the cochlea; (5) the membranous labyrinth; (6) the vestibular and spiral ganglia of the auditory nerve; (7) the primitive otic vesical, its secretory and neuro-epithelia. No one should attempt a dissection of this region until he has made himself thoroughly familiar with the brief outline here given and the embryology of the labyrinth.

Dissection. Study carefully the internal ear in the following table and in Gray's *Anatomy*. Then immerse temporal bone (recent) in dilute muriatic acid for forty-eight hours, after which time the soft structures may be very satisfactorily studied with a dissecting microscope.

FIG. 56.



Diagrammatic view of the fundus of the internal auditory meatus (Testut): 1. Falciform crest. 2. Anterior superior cribriform area. 2'. Internal opening of the aquæductus Fallopii. 3. Vertical crest which separates the anterior and posterior superior cribriform areas. 4. Posterior superior cribriform area, with (4') openings for nerve-filaments. 5. Anterior inferior cribriform area. 5'. Spirally arranged, sieve-like openings for the nerves to the cochlea. 5''. Opening of the central canal of the cochlea. 6. Crest which separates the anterior and posterior inferior cribriform areas. 7. Posterior inferior cribriform area. 7'. Orifices for the branches of the nerve to the saccule. 8. Foramen singulare of Morgagni, with the anterior portion of the canal which gives passage to the nerve to the posterior semicircular canal. (GRAY.)

LAMINA CRIBROSA.

Fundus of the Internal Auditory Canal; Lamina Cribrosa. The lamina cribrosa has three crests which divide its surface into four perforated areas. The crests are called falciform, superior vertical and inferior vertical. The perforated areas are called anterior superior, posterior superior, anterior inferior, posterior inferior. These cribriform or perforated areas transmit the facial and auditory nerves to their respective canals in the petrous part of the temporal bone.

Falciform Crest; Crista Falciformis. Located horizontally across lamina cribrosa, dividing this into a superior and an inferior cribriform area.

Superior Vertical Crest; Crista Verticalis Superior. Located vertically on lamina cribrosa, dividing superior cribriform area into anterior and posterior cribriform areas.

Inferior Vertical Crest; Crista Verticalis Inferior. Located vertically on lamina cribrosa, dividing inferior cribriform area into anterior and posterior cribriform areas.

The Aquæductus Fallopii, Commencement of, in Anterior Superior Cribriform Area, is located in the anterior and upper part of the lamina cribrosa, for the transmission of the facial nerve. The aquæductus Fallopii ends at the stylomastoid foramen, having made a tortuous course through the petrosa.

The Area Cribrosa Superior (in posterior superior cribriform area) is located in the upper and back parts of lamina cribrosa behind beginning of aquæductus Fallopii. This perforated space transmits filaments of auditory nerve to macula acustica of utricle and to cristæ acusticæ of superior and inferior semicircular canals.

The Area Cribrosa Media (in posterior inferior cribriform area) is located below posterior part of falciform crest. It transmits filaments of auditory nerve to macula acustica of saccule.

The Foramen Singulare (in the posterior inferior cribriform area) is located below and posterior to area cribrosa media. It transmits filaments of auditory nerve to crista acustica of posterior semicircular canal.

The Tractus Spiralis Foraminosus (in the anterior inferior cribriform area) is located in anterior and lower part of lamina cribrosa, and consists of spirally arranged openings which end in central canal of cochlea and transmit the auditory nerve.

THE VESTIBULE.

The Vestibule is located on the inner side of tympanum, behind cochlea and in front of semicircular canals. It is about one-fifth inch in diameter and has the following points of importance:

The Fenestra Ovalis. Covered by base of stapes and its annular ligament. It separates tympanum from scala vestibuli of cochlea.

Fovea Hemispherica; Recessus Sphericus. Inner wall of vestibule (a depression). It is perforated in front and below by numerous foramina for branches of auditory nerve to saccule.

The Macula Cribrosa. Anterior and inferior parts of fovea hemispherica. It consists of foramina transmitting branches of auditory nerve to saccule.

The Crista Vestibuli is a vertical ridge located behind macula cribrosa and fovea hemispherica. It bifurcates to form the fossa cochlearis.

The Fossa Cochlearis is embraced by bifurcation of crista vestibuli. It is perforated by foramina for passage of filaments of auditory nerve to posterior end of cochlear duct.

The Aquæductus Vestibuli. Hind part of inner wall of vestibule. It extends to posterior surface of petrous part of temporal bone, and transmits a small vein and ductus endolymphaticus. Ductus endolymphaticus ends in cul-de sac between layers of dura mater.

The Semicircular Canals, Openings of, is posterior wall of vestibule. They are five in number. Each canal has a dilated end, the ampulla.

Fovea Semi-elliptica. Upper wall of vestibule separated from fovea hemispherica by crista vestibuli. It lodges the utricle of the membranous labyrinth.

The Apertura Scalæ Vestibuli Cochleæ. Front wall of vestibule, an elliptical opening. It communicates with scala vestibuli of cochlea.

The Semicircular Canals are three bony tables—superior, external, and posterior—each describing more than a half-circle and lying at right angles to the other two canals. Each presents at one end a dilatation called an ampulla, twice the diameter of the canal. The superior semicircular canal is vertical and forms a prominence on anterior surface of petrosa, and has an outer and an inner end. The outer end opens separately, the inner conjointly with that of posterior semicircular canal into vestibule. The posterior canal is parallel to posterior surface of petrosa, and its dilated extremity opens into back part of vestibule. The external canal is the shortest and opens into vestibule above fenestra ovalis and by a separate orifice into back part of vestibule. The semicircular canals are occupied by the membranous semicircular canals containing endolymph, and between them and bony canals in which they are contained is the perilymphatic space containing perilymph.

The Cochlea is conical and located in front of vestibule. Apex looks forward, outward, and downward in front of inner wall of tympanum. Base corresponds with anterior depression at bottom of internal auditory canal, and has foramina for cochlear branch of auditory nerve.

The Modiolus, or Columella, is the conical central axis or pillar of cochlea extending from base to apex of same, perforated by cochlear nerves, which form the ganglion spirale in attached margin of lamina spiralis ossea.

The Tractus Spinalis Foraminosus is located in the cochlear area (anterior inferior cribriform area) at bottom of internal auditory canal, corresponding to base of modiolus. Nerves traversing tractus pass through canals in modiolus, and, bending outward, reach attached margin of lamina spiralis ossea, where ganglion spirale is developed.

The Canalis Spiralis Modioli is a spiral canal in attached margin of lamina spiralis area, lodging ganglion spirale, the true origin of the cochlear nerve.

The Central Canal of Modiolus extends from base to apex of modiolus, transmitting branches of cochlear division of auditory nerve to apical coil of scala media.

The Cupola, Cul-de-sac, is termination of bony canal of cochlea after two turns and three quarters around modiolus. It forms apex of bony cochlea.

The Bony Canal of Cochlea is a little over one inch long, one-tenth inch in diameter at commencement, and becomes progressively smaller from base to apex of cochlea.

The Fenestra Rotunda is covered by the membrana tympani secundaria; it separates tympanum and scala tympani of bone cochlea.

The Apertura Scalæ Vestibuli Cochleæ is front wall of vestibule, and communicates with scala vestibuli of cochlea.

The Membrana Tympani Secundaria is a membrane covering fenestra rotunda and separating scala tympani of cochlea and tympanum.

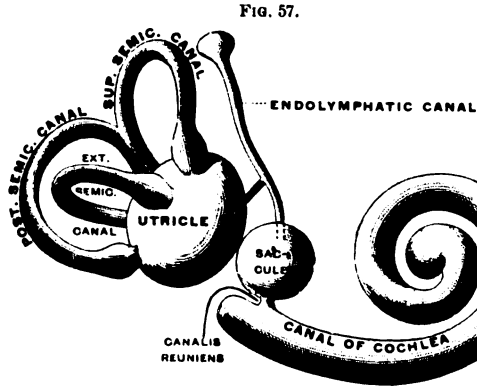
The Aquæductus Cochlea is an aperture leading from cochlea to inferior surface of petrosa, transmitting a small vein and forming a communication between subarachnoid space of skull and perilymph in scala tympani of cochlea.

The Lamina Spiralis Ossea is a bony shelf projecting outward from modiolus into interior of spiral canal, making two and three-quarter turns about modiolus.

The Scala Vestibuli is the upper and smaller of two perilymph spaces of cochlea. It communicates above with scala tympani through helicotrema, below with vestibule.

The Scala Tympani is the lower and larger of the two perilymph spaces in the cochlea. It communicates above with scala vestibuli through helicotrema and below with tympanum, but for membrane covering fenestra rotunda.

FIG. 57.



Membranous labyrinth of the right ear, viewed from the right side. (GERRISH after TESTUT.)

The Helicotrema is a small opening near summit of cochlea, through which scalæ vestibuli and tympani communicate.

The Lamina Spiralis Secundaria is a bony lamina projecting inward from outer wall in lower part of first turn of bony canal of cochlea.

Fissura Vestibuli is a narrow fissure between primary lamina spiralis ossea and lamina spiralis secundaria.

The Membranous Labyrinth is the oldest part of the organs of hearing, originating from ectoderm on dorsolateral surface of head region of embryo, near dorsal end of first outer visceral cleft. The thickened patch of ectoderm becomes an auditory pit; edges of auditory pit meet and form otic vesicle. The vesicle recedes from ectodermic surface and takes position near after-brain in relation with and behind acustico-facial ganglion. From primitive vesicle is evolved the entire complex membranous labyrinth, the endolymph and organ of Corti. These are represented in the adult by endothelium of membranous labyrinth, neuro-epithelial cells, and endolymph.

The Utricle (Utriculus) is the upper and larger of the two parts formed by constriction of otic vesicle. It communicates with semicircular canals directly and with the saccule indirectly through ductus endolymphaticus. The macula acustica has same significance here as in the saccule.

The Semicircular Canals (membranous) are three in number and correspond to the osseous canals in which located, except in size. They open by five orifices into the utricle. Each membranous canal is about one-third the diameter of the osseous canal, and has at one end an enlargement—the ampulla. The walls of ampullæ are thickened in middle, forming the septum transversum. The lining of ampullæ is specialized neuro-epithelial cells (cristæ acusticæ), and receives a partial distribution of auditory nerve.

The Sacculus is the lower and smaller of the two parts into which the otic vesicle divides. It communicates with cochlear duct through canalis reuniens and with utricle through ductus endolymphaticus. The macula acustica is composed of highly specialized neuro-epithelial cells (of ectodermic origin), and is located where branches of eighth nerve enter saccule to arborize around its hair cells.

The Cochlear Duct, Scala Media. That part of membranous labyrinth contained in bony cochlea is scala media. It communicates with saccule through canalis reuniens. Its interior is an endolymph space like that of utricle, saccule, and semicircular canals. The scala media is between two perilymph spaces—the scala vestibuli and the scala tympani.

The Endolymph Spaces and Endolymph. They are the following, and are all derived from an original otic vesicle of ectodermic origin: (1) Scala media, or cochlear duct in the bony cochlea; (2) saccule and utricle in bony vestibule; (3) membranous semicircular canals in the osseous semicircular canals. They all contain a fluid called endolymph.

The Perilymph Spaces and Perilymph. These are between the membranous and osseous labyrinths, and are named as follows: (1) The scala vestibuli and scala tympani are in the bony cochlea with the scala media; (2) all spaces in vestibule and bony semicircular canals external to membranous labyrinth.

GANGLIA OF AUDITORY NERVE.

The Ganglion Spirale (on the cochlear division of the eighth nerve). This occupies spiral canal of modiolus, and is made up of bipolar cells, which constitute the true origin of the cochlear division of the auditory nerve. These cells, by their dendrites, are in relation peripherally with specialized neuro-epithelial cells of the organ of Corti; centrally, axonic processes reach auditory nucleus in medulla.

Ganglion of Scarpa; Vestibular Ganglion; Intumescentia Gangliformis. This is composed of cells forming the true origin of the vestibular division of the eighth nerve. It lies on vestibular nerve in internal auditory canal. Its cells are in relation with neuro-epithelial cells of utricle, saccule, and ampullæ of semicircular canals. Axonic processes reach vestibular origin of auditory nerve in medulla.

OTIC VESICLE AND NEURO-EPITHELIA.

Cells of Otic Vesicle. The majority are arranged as flattened, polyhedral, serous cells in a single layer, forming secretory and protective structures. Some, however, are specialized neuro-epithelial cells, as follows, and form the cristæ acusticæ in the semicircular canals, the maculæ acusticæ in the utricle and saccule and the organ of Corti in the scala media.

The Neuro-epithelia. These cells are found on floor of scala media (membrana basilaris), forming organ of Corti; in utricle, forming macula acustica; in [illegible] cule, forming macula acustica; in ampullated ends of semicircul[illegible] ing cristæ acusticæ. These cells form peripheral end organs [illegible] hearing. Impulses originate in rods and hair cells of C[illegible] dendrites to spiral and vestibular ganglia, thence by axo[illegible] eighth nerve in medulla.

The Macula Acustica of Utricle. A specialization of neuro-epithelial cells marking place where branches of eighth nerve enter utricle to arborize around its cells.

The Macula Acustica of Saccule. An area of neuro-epithelial cells where branches of auditory nerve enter saccule to arborize around its cells.

The Cristæ Acusticæ. An area of neuro-epithelial cells where branches of auditory nerve enter ampullæ of semicircular canals to arborize around its cells.

The Organ of Corti, the most highly specialized neuro-epithelial area, is located on floor of scala media, and is the most important part concerned in hearing. (See Gray and Gerrish.)

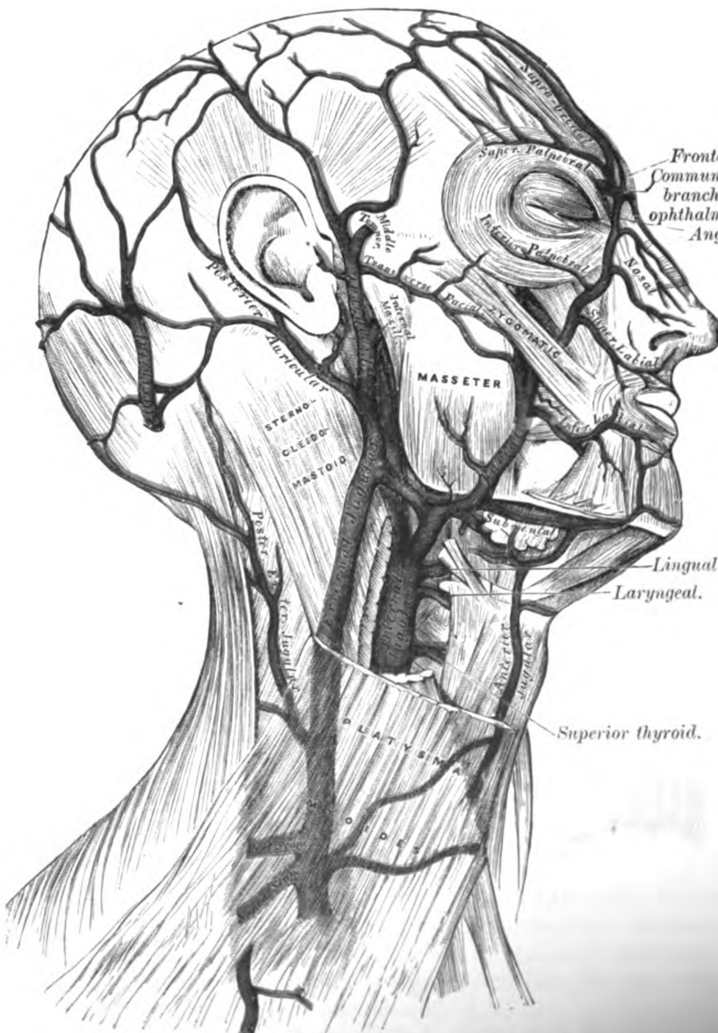
The internal ear (labyrinth) is where the end organs of hearing are located. The sensitive agents concerned, as previously stated, are neuro-epithelial cells of ectodermic origin, derived from the lining of the primitive otic vesicle. Dendritic processes from these several sensitive areas in utricle, saccule, semicircular canals and scala media reach the spiral and vestibular ganglia, whence axons of cells located in these ganglia proceed to the nuclei of the auditory nerve in the medulla.

CHAPTER VII.

THE NECK.

Dissection and Identification. Remove the integument according to the incisions indicated in Fig. 1. Then consult the illustrations and find the structures on the cadaver corresponding thereto in the order in which they are here given. The scalpel should be sparingly used after the skin has been removed. Blunt dissecting with forceps attains far better results.

FIG. 58.



Veins of the head and neck. (GRAY.)

Superficial Fascia. Identify (1) as a thin, fatty layer, especially pronounced in the upper part of the neck, where it forms the double chin; (2) by the location between the platysma myoides muscle and the integument; (3) by containing the platysma myoides, superficial jugular veins, and the superficial branches of the cervical plexus.

Platysma Myoides Muscle. Identify (1) by the location beneath th of the superficial fascia; (2) by composition of muscular fibres e of the clavicle to the lower jaw. Detach the muscle along the mandible and turn it aside to expose the jugular veins.

Anterior Jugular Vein. Identify (1) by the location in the superficial fascia in front of the sternocleidomastoid muscle beneath the platysma; (2) by the origin from small veins in the submaxillary region.

Posterior Jugular Vein. Identify (1) by the location behind the sternocleidomastoid muscle; (2) by the origin in the occipital region; (3) by ending in the external jugular beneath the platysma.

External Jugular Vein. Identify (1) by the vertical course from the parotid region to the clavicle, crossing some of the superficial branches of the cervical plexus; (2) by the course across the sternocleidomastoid muscle from before backward; (3) by ending in the subclavian vein anterior or posterior to the scalenus anticus muscle.

Superficialis Colli Nerve. Identify (1) by the course across the centre of the sternocleidomastoid muscle and the distribution to the skin of the front and sides of the neck; (2) by the location beneath the external jugular vein; (3) by consulting the illustration of the superficial branches of the cervical plexus; (4) by the derivation from the cervical plexus and the emergence behind the sternomastoid.

Auricularis Magnus Nerve. Identify (1) by the course upward and forward across the sternocleidomastoid muscle and the distribution to the skin in the parotid region; (2) by the derivation from the cervical plexus and the emergence at the posterior margin of the sternomastoid muscle.

Lesser Occipital Identify (1) by the location behind the sternomastoid and the distribution to the ear and the side of the head; (2) by the derivation from the cervical plexus.

Small Occipital Nerve. Identify (1) by the location along the posterior margin of the sternomastoid muscle and the distribution to the skin covering the mastoid process.

Supraclavicular Nerve. Identify (1) by the location along the posterior margin of the sternomastoid muscle; (2) by the course across the clavicle and the distribution to the skin covering the pectoralis major muscle; (3) by the derivation from the cervical plexus with the suprasternal nerve.

Suprasternal Nerve. Identify (1) by the location along the posterior border of the sternomastoid and the derivation from the cervical plexus with the supraclavicular; (2) by the course across the sternomastoid and the distribution to the skin covering the manubrium of the sternum.

Supra-acromial Nerve. Identify (1) by the location behind the sternomastoid and the derivation from the cervical plexus; (2) by the course across the acromion process to the integument in this region.

Deep Cervical Fascia. Identify (1) by the location immediately beneath the superficial fascia, forming an investment for the entire neck; (2) by forming the sheaths for all vessels, glands, and muscles of the neck. Study the description of the deep cervical fascia with its superior and inferior attachments on page 123.

Sternum. Identify (1) by the location in the mid-line of the anterior thoracic wall; (2) by the articulation of the clavicles with its upper piece.

Clavicle. Identify (1) by the location along the lower border of the neck (forming part thereof); (2) by the articulation with the sternum and acromion, forming the sternoclavicular and acromioclavicular joints, respectively.

Mastoid Process. Identify (1) by the location behind and below the ear; (2) by the insertion of the sternomastoid muscle in part.

Hyoid Bone. Identify (1) by the location about one inch above Adam's apple (thyroid cartilage) and two or three inches below and behind the symphysis menti.

Sternocleidomastoid Muscle. Identify (1) by the location on the front and side of the neck, extending from the sternum and clavicle diagonally across the neck to the mastoid process and occipital bone; (2) by the location on its surface of the external jugular vein and the branches of the cervical nerves.

Sternohyoid Muscle. Identify (1) by the extent from the sternum to the body of the hyoid; (2) by the location near the mid-line of the neck and the insertion with the omohyoid muscle into the hyoid bone.

Omohyoid Muscle. Identify (1) by the oblique course from the shoulder region to the body of the hyoid bone, where it is inserted with the sternohyoid; (2) by the deep relation with the carotid sheath and the location beneath the sternomastoid muscle.

Sternothyroid Muscle Identify (1) by the extent from the sternum to the thyroid cartilage; (2) by the location beneath the sternohyoid on the thyroid body. The sternothyroid must be cut and turned aside to expose this muscle.

Thyrohyoid Muscle. Identify (1) by the upward continuation of the sternothyroid to the body of the hyoid bone; (2) by the location beneath the sternohyoid and omohyoid muscles on the superior laryngeal nerve and the thyrohyoid membrane.

Ansa Hypoglossi. Identify (1) by the location on the carotid sheath and the distribution to the depressor muscles of the hyoid bone; (2) by the derivation from the hypoglossal nerve and cervical plexus through the descendens and communicantes hypoglossi, respectively.

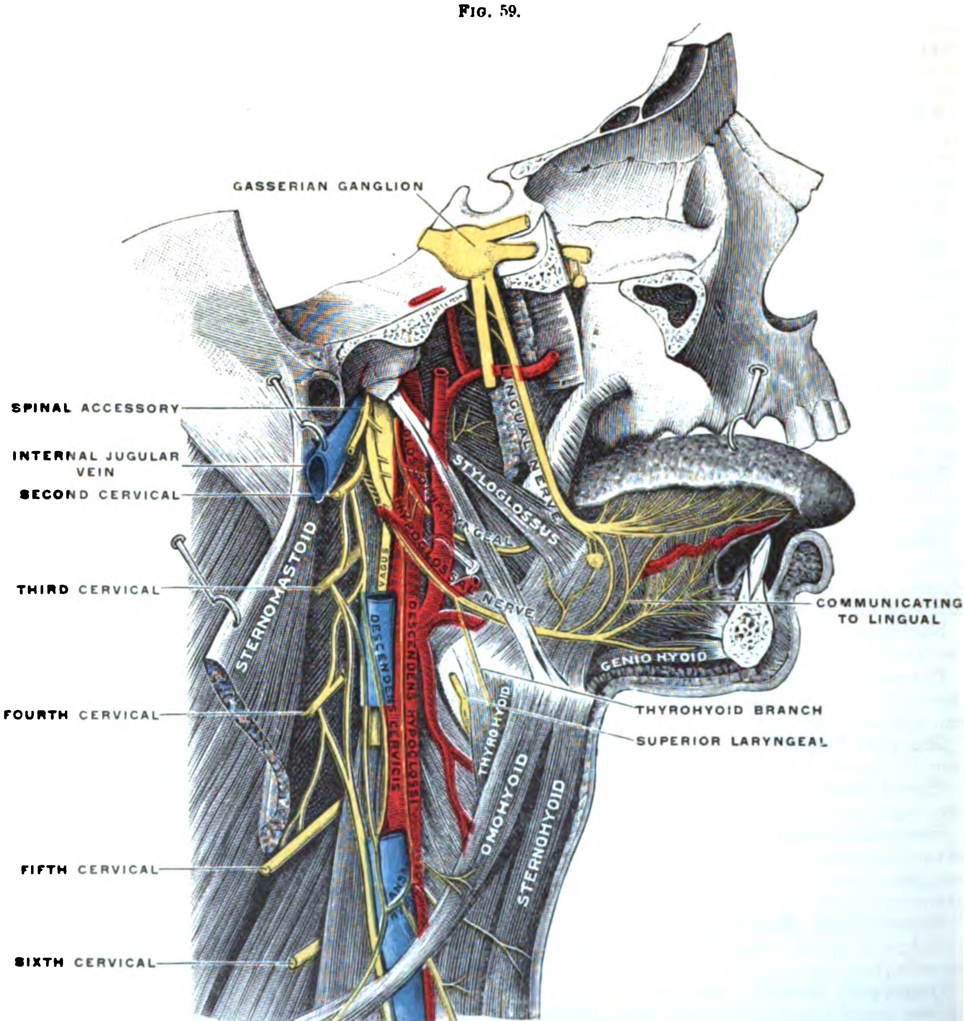
St[illegible]uscle. Identify (1) by the extent below and behind the jaw from the styloid [illegible]id bone; (2) by being perforated by the intermediary tendon of the digastric muscle; (3) by the location above (and in intimate relation with) the posterior belly of the digastric.

Mylohyoid Nerve. Identify (1) by the distribution to the mylohyoid muscle and the anterior belly of the digastric; (2) by the location in the mylohyoid groove of the mandible with the mylohyoid artery.

Hypoglossal Nerve. Identify (1) by the location below the posterior belly of the digastric muscle in front of the carotid vessels; (2) by the course across the hyoglossus and beneath the mylohyoid muscle to the tongue.

Spinal Accessory Nerve. Identify (1) by the location beneath the digastric and stylohyoid muscles; (2) by piercing the upper part of the sternomastoid muscle and appearing in the occipital triangle; (3) by crossing the occipital triangle and entering the trapezius muscle.

FIG. 59.



Nerves of the tongue. (GERRISH after TESTUT.)

Facial Artery and Vein. Identify (1) by the location on the mandible in front of the masseter muscle, the artery in front of the vein; (2) by the location in the digastric and superior carotid triangles, the vein superficial to the submaxillary gland, stylohyoid, and digastric muscles, and hypoglossal nerve; and the artery beneath these; (3) the artery, a branch of the external carotid; the vein, tributary to the internal jugular in the superior carotid triangle.

Superior Thyroid Artery and Vein. Identify (1) by the location beneath the depressor muscles of the hyoid bone and the distribution to the thyroid gland; (2) artery, the first branch of the external carotid; the vein crosses the common carotid artery to reach the internal jugular vein; (3) by the location of the artery and vein one-half inch below the greater horn of the hyoid bone.

Lingual Artery and Vein. Identify (1) by the location in the superior carotid and digastric triangles; (2) by the course beneath the digastric, stylohyoid, and hyoglossus muscles to the tongue; (3) by the origin of the artery from the external carotid; (4) by the termination of the vein in the internal jugular; (5) by the location one-half inch above the greater horn of the hyoid bone where they pass beneath the hyoglossus muscle.

Thyroid Body. Identify (1) by the location on the side and front of the larynx and adjacent part of the trachea beneath the sternohyoid and sternothyroid muscles; (2) by the large size and bluish color.

Submaxillary Gland. Identify (1) by the location in the submaxillary triangle; (2) by the presence of the facial artery on lower surface; (3) by contact of the internal surface with the hyoglossus, mylohyoid, and styloglossus muscles.

Sublingual Gland. Identify (1) by the location immediately beneath the tongue on the mylohyoid muscle; (2) by the sublingual ridge, extending outward and backward from the frænum linguæ when the tongue is elevated (on the living.)

Trachea Identify (1) by the continuity with the larynx above and the bronchi below; (2) by the relation to the spinal column (from the fifth cervical to the fifth thoracic); (3) by its imperfect cartilaginous ring-structure.

Larynx. Identify (1) by the location below the hyoid bone and above the trachea; (2) by the characteristic prominence produced by the thyroid cartilage—Adam's apple.

Thyrohyoid Membrane. Identify (1) by the location between the thyroid cartilage and the hyoid bone; (2) by the location beneath the sternohyoid and thyrohyoid muscles; (3) by being pierced by the superior laryngeal nerve and vessels.

Line of Carotid Vessels. This line extends from the sternoclavicular joint to a point midway between the angle of the jaw and the mastoid process. In this line are the carotid arteries (common, external, and internal), internal jugular vein, vagus nerve, and the cervical sympathetic cord.

Carotid Sheath. Identify (1) by the location beneath the sternomastoid and omohyoid muscles along the neck in the line of the carotid vessels; (2) by the presence of the ansahypoglossal loop on the anterior surface; (3) by the transparent fibrous nature of the structure.

Internal Jugular Vein. Identify (1) by the location in the carotid sheath external to the carotid arteries and vagus nerve; (2) by the union with the subclavian to form the innominate vein; (3) by its tributaries—facial, lingual, pharyngeal, occipital, superior and middle thyroid veins. (See Dr. Shaw's table of veins.)

Common Carotid Artery. Identify (1) by the location in the carotid sheath near the trachea, internal to the vagus and jugular vein; (2) by the division into the internal and external carotids, opposite the upper margin of the thyroid cartilage; (3) by the origin, on the right side from the innominate, on the left from the aortic arch. (See Dr. Shaw's table of arteries.)

External Carotid Artery. Identify (1) by the extent in the carotid sheath from the bifurcation of the common carotid to a point behind the neck of the mandible; (2) by its branches: superior thyroid, lingual, facial, occipital, posterior auricular, internal maxillary, temporal and ascending pharyngeal. (See Dr. Shaw's table of arteries.)

Internal Carotid Artery. Identify (1) by the origin from the common carotid opposite the upper border of the thyroid cartilage with the external carotid artery; (2) by the deep location behind the external carotid and absence of branches in the cervical stage. (See Dr. Shaw's table of arteries.)

Pneumogastric or Vagus Nerve. Identify (1) by the location in the carotid sheath between the internal jugular vein and carotid artery; (2) by entering the thorax (on the right side) between the subclavian artery (which it crosses) and the right innominate vein; on the left side between the common carotid and the subclavian arteries beneath the innominate vein.

Superior Laryngeal Nerve. Identify (1) by the location beneath the thyrohyoid and sternohyoid muscles on the thyrohyoid membrane with the superior laryngeal artery, a branch of the superior thyroid; (2) by perforating the thyrohyoid membrane; (3) by the origin from the ganglion of the trunk of the vagus, and the course behind the common carotid artery and along the pharynx.

Right Recurrent Laryngeal Nerve. Identify (1) by the origin from the vagus in front of the right subclavian artery; (2) by the course behind the subclavian and common carotid arteries to the side of the trachea; (3) by the location in the groove between the trachea and œsophagus, and the further course behind the articulation of the inferior horn of the thyroid cartilage and the cricoid cartilage to the larynx.

Left Recurrent Laryngeal Nerve. Identify (1) by the origin from the vagus in front of the arch of the aorta; (2) by the course around the aortic arch internal to the ductus arteriosus, and to the groove between the trachea and œophagus; (3) the further course, the same as the right recurrent.

Phrenic Nerve. Identify (1) by the location on the scalenus anticus muscle; (2) by entering the thorax between the subclavian artery and vein internal to the scalenus anticus.

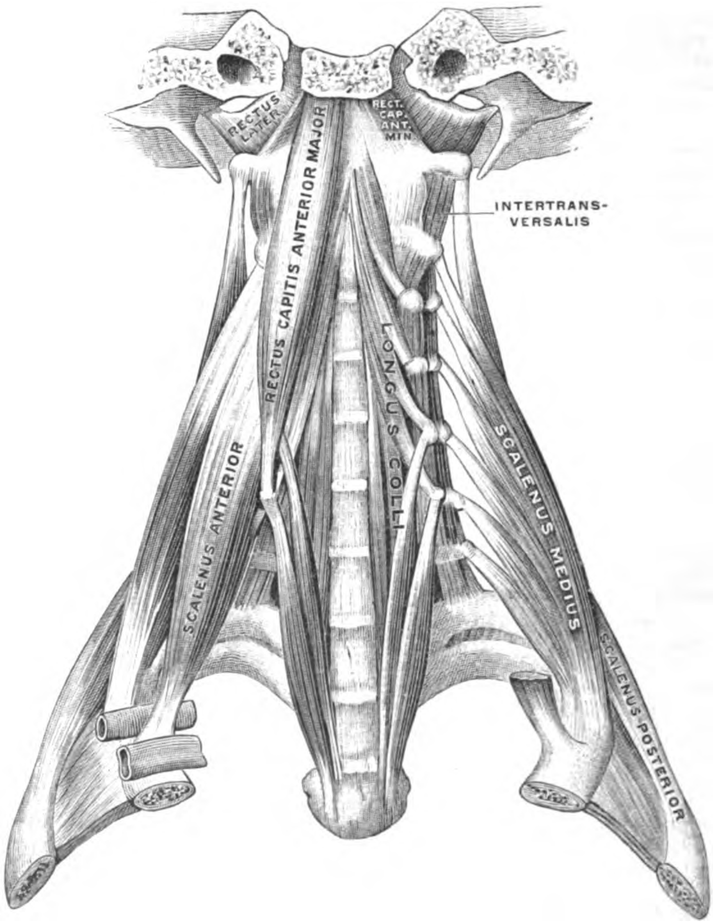
Glandulæ Concatenatæ. Identify (1) as the deep cervical lymphatic glands in company with the carotid arteries and internal jugular vein; (2) by the extent from the base of the [illegible] to the root of the neck, where they enter the mediastinum.

[illegible]vical Plexus. Identify (1) by the superficial branches in the superficial fascia as pre-[illegible]ntified. They emerge through the deep fascia along the posterior border of the sterno-[illegible] (2) by the location opposite the four upper vertebræ resting on the levator anguli scapulæ and scalenus medius muscles; (3) by the location beneath the sternomastoid muscle; (4) deep branches are to be identified by making a study of the text and illustrations.

Scalenus Anticus. Identify (1) by the insertion into the scalene tubercle of the first rib; (2) by the presence of the phrenic nerve and subclavian vein on its anterior surface.

Scalenus Medius Identify (1) by the insertion into the first rib behind the groove for the subclavian artery; (2) by the presence of nerves forming the cervical and brachial plexuses on its anterior surface.

FIG. 60.



Deep lateral and prevertebral muscles of the neck. (GERRISH after TESTUT.)

Scalenus Posticus. Identify (1) by the attachment to the second rib; (2) by attachment to the posterior tubercles of the lower three or four cervical vertebræ.

Brachial Plexus. Identify (1) by the location between the scalenus anticus and medius muscles in the subclavian triangle beneath the clavicle and pectoral muscles; (2) turn to the "Brachial Plexus" in the text and read carefully.

MUSCLES OF THE NECK.

The Platysma Myoides. The platysma myoides is a broad, thin layer of muscular fibre in the superficial fascia. It arises a variable distance below the clavicle from the deep fascia, covering the deltoid and pectoralis major muscles. The fibres extend upward and inward to the corner of the mouth. On the upper boundary line of the neck the muscle extends backward to near the angle of the jaw, covering the facial vessels. The platysma, acting with the hyoid group of muscles, depresses the mandible. *Nerve:* The facial.

The Sternocleidomastoid. *Location:* The neck, extending from the sternum and clavicle to the mastoid and occipital. *Fascial sheath:* First layer of the deep cervical fascia. *Origin:* (1) Manubrium of the sternum, anterior surface; (2) inner third of the clavicle, anterior surface. *Insertion:* (1) Mastoid process of the temporal bone, anterior border and outer surface; (2) superior nuchal line of the occipital bone, outer third. *Nerve-supply:* (1) Spinal accessory; (2) muscular branches of the cervical plexus. *Blood-supply:* (1) Upper mastoid, a branch of the occipital artery; (2) middle mastoid, a branch of the superior thyroid artery; (3) lower mastoid artery, a branch of the suprascapular. The occipital and superior thyroid are branches of the external carotid artery; the suprascapular is a branch of the subclavian. *Deep relations*: (1) Omohyoid muscle; (2) anterior jugular vein passes behind the external head of the muscle; (3) lower part of the sternohyoid and sternothyroid muscles; (4) ansa hypoglossi; (5) carotid sheath, containing the common artery, vagus nerve, and internal jugular vein; (6) posterior belly of the digastric; (7) splenius capitis, levator anguli scapulæ, scaleni, posticus, medius, and anticus; (8) bifurcation of the common carotid into the internal and external carotid arteries; (9) occipital, subclavian, suprascapular, and transversalis colli arteries; (10) a part of the parotid gland; (11) cervical plexus.

Depressors of the Hyoid Bone. The sternohyoid, omohyoid, sternothyroid, and thyrohyoid. *Nerve-supply:* The ansa hypoglossi. This nerve loop usually lies on the carotid sheath. It is formed by the descendens hypoglossi, communicating with the two branches from the second and third nerves of the cervical plexus—the communicantes hypoglossi.

Sternohyoid. *Origin:* (1) Posterior surface of the manubrium; (2) posterior sternoclavicular ligament; (3) clavicle. *Insertion:* Lower border of the body of the hyoid bone, with the omohyoid. *Fascial sheath:* Second layer of the deep cervical fascia. *Blood-supply:* Lingual, inferior, and superior thyroid arteries. *Superficial relations:* Skin, fascia, platysma, sternomastoid, sternum, clavicle. *Deep relations:* Sternothyroid, thyrohyoid, cricothyroid muscles, cricothyroid and thyrohyoid membranes, superior thyroid vessels, thyroid gland, and cartilages of the larynx.

Omohyoid Muscle. *Origin:* Superior border of the scapula, internal to the suprascapular foramen. *Insertion:* Lower border of the body of the hyoid bone with the sternohyoid. *Fascial sheath:* Second layer of the deep cervical fascia. *Blood-supply:* Lingual, inferior and superior thyroids. *Superficial relations:* Anterior belly has the same relations as the contiguous part of the sternohyoid. The sudden deflection of the muscle toward the shoulder makes the deep relations of the intermediary tendon and posterior belly complicated: sternomastoid, platysma, clavicle, and trapezius. *Deep relations:* Sternothyroid and thyrohyoid muscles; common carotid artery, vagus nerve, internal jugular vein, and descendens hypoglossi; scalenus medius and anticus and phrenic nerve.

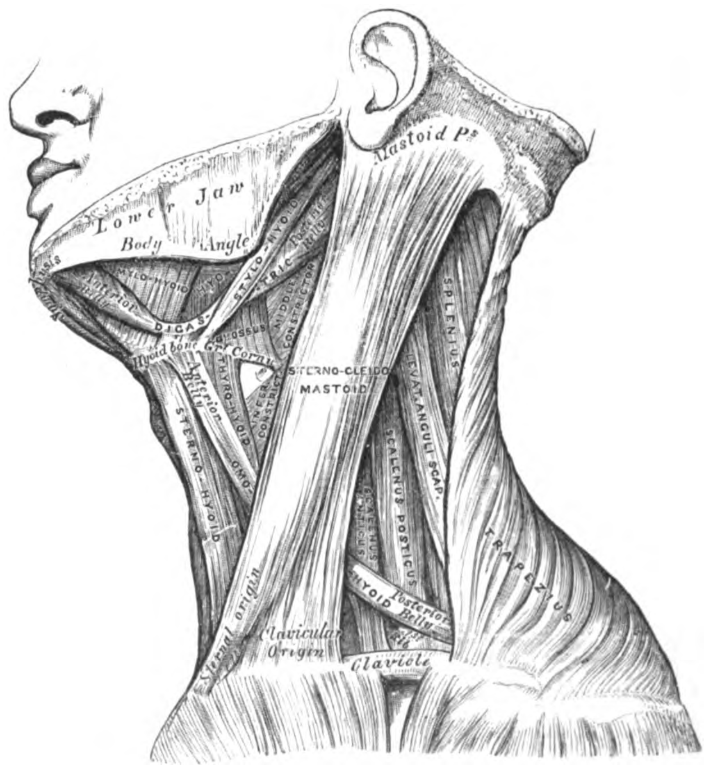
Sternothyroid Muscle. *Synonym:* Sternocleidothyroid. *Origin:* (1) Back and side of the lower part of the manubrium; (2) cartilage of the first rib; (3) back of the clavicle. *Insertion:* Oblique line of the thyroid cartilage. *Nerve-supply:* Ansa hypoglossi. *General action:* To depress the hyoid bone. *Specific action:* To depress the thyroid cartilage. *Fascial sheath:* Second layer of the deep cervical fascia. *Blood-supply:* Lingual, superior and inferior thyroids. *Superficial relations:* Sternomastoid, sternohyoid, omohyoid, and anterior jugular veins. *Deep relations:* (1) Trachea and larynx; (2) common carotid and innominate arteries, thyroid gland and vessels, middle thyroid vein.

The Thyrohyoid. *Origin:* Oblique line of the thyroid cartilage. *Insertion:* Body of the hyoid and greater cornu. *Nerve-supply:* Special branch of the hypoglossal. *Blood-supply:* Lingual and superior thyroid arteries. *Superficial relations:* Sternohyoid and omohyoid muscles. *Deep relations:* Superior laryngeal nerve and vessels, thyroid cartilage, and thyrohyoid membrane. This muscle seems to be an upward continuation of the sternothyroid.

The Digastric Muscle. *Origin of the anterior belly:* Digastric fossa of the mandible. *Origin of the posterior belly:* Digastric groove of the mastoid process.

Attachment of the digastric tendon : Body and greater cornu of the hyoid. *Grand divisions:* Anterior belly, posterior belly, digastric tendon. *Insertions of bellies:* Tendon. *Nerve-supply of the anterior belly:* Mylohyoid; *of the posterior belly:* Facial. *Action of the anterior belly:* To depress the mandible; *of the digastric muscle:* To elevate the hyoid and tongue. *Blood-supply of the posterior belly:* Occipital. *Blood-supply of the anterior belly:* Submental branch of the facial artery. *Mesial connection:* With its fellow of the opposite side. *Superficial relations:* Parotid gland, stylohyoid, splenius, and trachelomastoid muscles, skin fasciæ, platysma and sternomastoid muscles and facial vein. *Deep relations:* Mylohyoid, styloglossus, stylopharyngeus, hypoglossus muscles, external carotid, internal carotid, lingual and facial arteries, internal jugular vein, and hypoglossal nerve.

FIG. 61.



Muscles of the neck and boundaries of the triangles. (GRAY.)

The Stylohyoid Muscle. *Origin:* Back and outer surface of the styloid process near the base. *Insertion:* Junction of the body and the greater cornu of the hyoid bone perforated near the insertion by the tendon of the digastric. *Nerve-supply:* Special branch of the facial. *Blood-supply:* Occipital artery. *Action:* To elevate the hyoid bone. *Synergist:* Posterior belly of the digastric muscle. *Antagonists:* Depressors of the hyoid bone.

The Mylohyoid Muscle. *Origin:* Mylohyoid ridge. *Extent of origin:* Symphysis menti to the last molar tooth. *Insertion:* Posterior fibres into the body of the hyoid bone, anterior and middle, into the fibrous raphe, extending from the symphysis menti to the body of the hyoid. Fibrous raphe may be wanting. *Nerve-supply:* Mylohyoid branch of the inferior dental nerve. *Blood-supply:* Submental and mylohyoid arteries. *Action:* To carry the hyoid bone and tongue forward and form the floor of the mouth.

The Geniohyoid Muscle. *Origin:* Inferior genial tubercle of the mandible. *Insertion:* Anterior surface of the body of the hyoid bone. *Situation:* Above the inner border of the mylohyoid muscle. *Nerve-supply:* Hypoglossal. *Action:* To carry the hyoid bone forward; and depress the jaw. *Blood-supply:* Sublingual branch of the lingual artery.

The Mylohyoid Nerve. The mylohyoid nerve is a branch of the inferior dental. It is given off just before this nerve enters the inferior dental foramen in the mandible. It perforates the sphenomandibular ligament and runs in the mylohyoid groove with the vessels of like name.

The Scalenus Anticus. *Origin:* Scalene tubercle of the first rib. *Insertion:* Anterior tubercles of the third, fourth, fifth, and sixth cervical vertebræ. *Action:* Flexion of the neck and elevation of first rib. *Synergists:* Scalenus medius, scalenus posticus, and longus colli. *Antagonists:* Semispinalis colli. *Relations:* Anterior, sternomastoid, omohyoid, subclavius muscles, phrenic nerve, internal jugular, and subclavian veins. *Internal:* Vertebral vessels and sympathetic cord, longus colli and rectus capitis anticus major. *External:* Pleura, subclavian artery, and cervical nerves.

The Scalenus Medius. *Origin:* First rib, behind the groove for the subclavian artery. *Insertion:* Posterior tubercles of the six lower cervical vertebræ. *Action:* Flexion of the neck and elevation of first rib. *Synergists:* Scalenus anticus, posticus, and longus colli. *Antagonists:* Same as scalenus anticus. *Anterior relations:* Subclavian artery, cervical and brachial plexuses, trapezius, sternomastoid and omohyoid muscles. *Posterior relations:* Levator anguli, scapulæ, and scalenus posticus.

The Scalenus Posticus. *Origin:* Second rib. *Insertion:* Posterior tubercle of the lower cervical vertebræ. *Action:* Flexion of the neck and elevation of second rib.

The Rectus Capitis Lateralis. *Origin:* Front of the upper surface of the lateral mass of the atlas. *Insertion:* Under surface of the jugular process of the occipital bone. *Nerve-supply:* Anterior branch of the first cervical nerve. *Action:* To flex the head laterally.

The Rectus Capitis Anticus Minor. *Origin:* Lateral mass of the atlas. *Insertion:* Under surface of the basilar process of the occipital bone in front of the foramen magnum. *Action:* Flexion of the head. *Synergists:* Rectus capitis anticus major. *Antagonists:* Rectus capitis posticus, major and minor, superior oblique, trachelomastoid, splenius capitis, complexus, biventer cervicis and trapezius. *Nerve-supply:* First cervical.

The Rectus Capitis Anticus Major. *Origin:* From the front of the anterior tubercles of the third, fourth, fifth, and sixth cervical vertebræ. *Insertion:* Under surface of the basilar process of the occipital bone. *Action:* Flexion of the head. *Synergists:* Rectus capitis anticus minor. *Antagonists:* Same as those that antagonize the preceding muscle. *Nerve-supply:* First and second cervical.

The Longus Colli Muscle. The longus colli muscle is in front of the cervical and upper thoracic vertebræ, and has: 1. A vertical division. 2. A lower oblique division. 3. An upper oblique division. *Origin of the vertical division:* 1. Bodies of the sixth and seventh cervical vertebræ. 2. Bodies of the first, second, and third thoracic vertebræ. 3. Transverse processes of the fourth, fifth, sixth, and seventh cervical vertebræ. *Insertion:* Bodies of the second, third, and fourth cervical vertebræ. *Origin of the lower oblique portion:* Bodies of the first, second, and third thoracic vertebræ. *Insertion:* Anterior tubercles of the transverse processes of the fifth and sixth cervical vertebræ. *Origin of the upper oblique portion:* Anterior tubercles of the transverse processes of the third, fourth, and fifth cervical vertebræ. *Insertion:* Anterior tubercle of the atlas. *Nerve:* Cervical.

BOUNDARIES AND TRIANGLES OF THE NECK.

Anterior Boundary. The mentosternal line extending from the mid-line of the chin to the middle of the suprasternal notch. In this line are (1) the hyoid bone; (2) the hyothyroid membrane; (3) the progressive angle of the thyroid cartilage;

(4) the thyrocricoid membrane; (5) the cricoid cartilage; (6) the isthmus of the thyroid gland; (7) the inferior thyroid veins, resting on the trachea; (8) the trachea.

Posterior Boundary. The anterior border of the trapezius muscle. It requires some practice on the part of the student to locate this border. This muscle extends almost to the junction of the middle and outer thirds of the clavicle.

Inferior Boundary. The clavicle and manubrium. The clavicle articulates internally with the manubrium of the sternum; externally, with the acromion process of the scapula. The inner third of the bone is occupied by the clavicular attachment of the sternocleidomastoid muscle.

Superior Boundary. The lower border of the mandible and mastomandibular line. The latter extends from the mastoid process to the angle of the mandible. This boundary is crossed by the facial artery and vein, external jugular vein, and great auricular nerve.

The Triangles of the Neck. The general shape of the neck on each side of the mid-line is that of a parallelogram. The sternocleidomastoid, extending diagonally from the posterior superior angle to the anterior inferior angle, divides this space into two large triangles—one in front of and the other behind the sternocleidomastoid muscle.

The Anterior Triangle has its base up, its apex down, and is bounded in front by the mentosternal line; behind, by the sternomastoid muscle; above, by the mandible and mastomandibular line. This triangle encloses three smaller triangles: 1. The submaxillary. 2. The superior carotid. 3. The inferior carotid.

The Posterior Triangle has its base down, its apex up, and is bounded in front by the sternocleidomastoid; behind, by the trapezius muscle; below, by the middle third of the clavicle. This triangle encloses two smaller triangles: 1. The occipital. 2. The supraclavicular or subclavian. *Names:* The names of the five smaller triangles of the neck are: the submaxillary, superior carotid, inferior carotid, occipital, and subclavian or supraclavicular.

The Submaxillary Triangle is bounded above by the mandible and mastomandibular line; below, by the digastric and stylohyoid muscles; in front, by the anterior belly of the digastric. The floor is formed by the anterior belly of the digastric, the mylohyoid, and hyoglossus muscles. *Contents:* The hypoglossal nerve, mylohyoid nerve and vessels, submaxillary gland, facial artery and vein, ascending palatine artery, tonsillar artery, submaxillary artery, submental artery, parotid gland in part, external carotid artery, the posterior auricular artery, and cervical lymphatic glands.

The Superior Carotid Triangle is bounded posteriorly by the sternocleidomastoid muscle; inferiorly, by the anterior belly of the omohyoid; superiorly, by the posterior belly of the digastric muscle. The floor is formed by the thyrohyoid, hyoglossus, and inferior and middle constrictors of the pharynx.

The contents of the superior carotid triangle are: 1. The bifurcation of the common carotid, internal carotid artery, external carotid artery, and internal jugular vein. 2. Branches of the external carotid: Superior thyroid artery, lingual artery, facial artery, occipital artery, and ascending pharyngeal artery. 3. Branches of the superior thyroid: Hyoid artery, sternomastoid artery, superior laryngeal artery, sternomastoid branch of the occipital artery, and the internal jugular vein. 4. Tributaries of the internal jugular: Facial, temporomaxillary, lingual, superior thyroid and middle thyroid veins. 5. Hypoglossal nerve: Descendens hypoglossi nerve, to the thyrohyoid muscle; internal laryngeal nerve, external laryngeal nerve, spinal accessory nerve, pneumogastric nerve, sympathetic nerve, larynx and pharynx in part, greater cornu of the hyoid bone, intercarotid body, lymphatic vessels and nerves.

The Inferior Carotid Triangle is bounded in front by the mid-line of the neck; behind, by the sternomastoid muscle; above, by the omohyoid muscle. The floor is formed by the longus colli, scalenus anticus, and rectus capitis anticus muscles. The *contents* of the inferior carotid triangle are the sternohyoid and sternothyroid muscles, branches of the ansa hypoglossi, superior thyroid artery and external laryngeal nerve, thyroid body, larynx and trachea, recurrent laryngeal nerve and vessels, œsophagus (on the left side), and common carotid sheath and its contents.

The Occipital Triangle is bounded in front by the sternomastoid; behind, by the trapezius; below, by the omohyoid. The floor is formed by the splenius capitis, levator anguli scapulæ, scalenus medius, and scalenus posticus muscles. *Contents* of the occipital triangle are the spinal accessory nerve, upper part of the brachial plexus, branches of the third and fourth cervical nerves to the trapezius, superficial branches of the cervical plexus, transversalis colli artery and vein, and branches of the third and fourth cervical nerves, to the levator anguli scapulæ.

The Subclavian Triangle is bounded above by the omohyoid muscle; below, by the clavicle; in front, by the sternomastoid. The floor is formed by the scalenus medius, the scalenus posticus, a portion of the first rib, and the serratus magnus. *Contents* of the subclavian triangle are the subclavian artery and vein, transversalis colli artery and vein, suprascapular artery and vein, external jugular vein, trunks of the brachial plexus, and certain cervical lymphatic glands.

Common Roof Structures. The skin, superficial fascia, and the first layer of the deep fascia of the neck form a common roof for all the cervical triangles.

Transitory Nature of Contents. Very few structures of the neck may be located exclusively in a given triangle. The submaxillary gland is wholly in a triangle of the same name, but the facial artery begins in the superior carotid triangle, passes through the submaxillary triangle, and ends on the face. Rather, then, look upon the triangles as areas traversed by nerves and conduits. The nature of the contents of the triangles, then, is rather transitory than resident.

Structures in the Mid-line of the Neck. On either side of the symphysis menti are the two anterior bellies of the digastric muscle. Between the bellies is the fibrous raphe, into which the mylohyoids are inserted. The hyoid bone is easily found at the base of the tongue, while below this is the prominence of the thyroid cartilage known as the "pomum Adami," the cricothyroid membrane and cricoid cartilage, on which latter the cricoid artery rests. Below the cricoid cartilage, in the mid-line of the neck, is the trachea. Superficial to the trachea, in the lower part of the neck, are: 1. The isthmus of the thyroid. 2. The inferior thyroid veins. 3. The innominate artery. 4. The left innominate vein. 5. Remains of the thymus. 6. The thyroid artery.

CAROTID ARTERIES—RIGHT AND LEFT.

These arteries, above the sternoclavicular articulations, are practically alike in course and relations. The left arises in the thorax from the arch of the aorta; the right from the innominate. We must speak, therefore, of the left artery as having a certain length in the thorax not possessed by the right; the left artery exceeds the right in length about two inches.

By the thoracic part of the left common carotid artery is meant that part between the arch of the aorta and the left sternoclavicular articulation. Each artery has a cervical part, which extends from behind the sternoclavicular articulation to the upper border of the thyroid cartilage, where each divides into an internal and an external carotid.[1]

Relation of the thoracic part of the left common carotid artery: 1. Anterior: manubrium, sternohyoid, sternothyroid, the thymus or its remains, and the left innominate vein. 2. Posterior: trachea, œsophagus, thoracic duct, and left recurrent laryngeal nerve. 3. Inner: innominate artery, trachea, inferior thyroid vein. 4. Outer and posterior: left subclavian artery, left vagus nerve, left pleura, left lung.

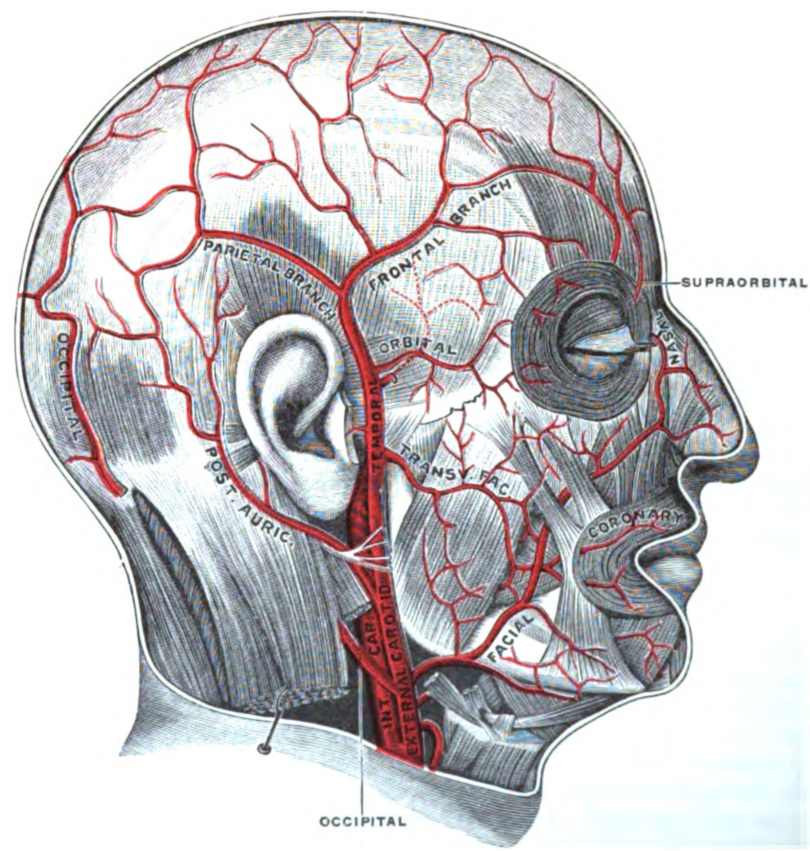
Common Carotid Arteries. *Origin of right:* innominate, behind the sternoclavicular articulation. *Termination of each:* opposite upper border of the thyroid

[1] Experience shows this bifurcation occurring on a level with the hyoid bone in the majority of cases.

cartilage. *Mode of termination of each :* in the internal and external carotids. *Origin of left :* aortic arch, to the left and behind the innominate. *Relation to each other as they ascend :* they diverge. Carotids are separated three-quarters of an inch at the top of the manubrium by the trachea. *Distance between the carotids at bifurcation :* 2.25 inches. *Fascial sheath :* third layer of the deep cervical fascia. *Contents of sheath :* internal jugular, vagus, common carotid. Contents of sheath are separated by fibrous septa. *Relation :* vein external, artery internal, nerve in middle. *Length of arteries :* right, 3.75 inches; left, 4.75 inches. *Lying on the carotid sheath :* ansa hypoglossi. The sympathetic cord of the neck lies behind the sheath.

Internal Carotid Artery. The internal carotid artery begins at the bifurcation of the common carotid, at the level of the upper border of the thyroid cartilage,

FIG. 62.



Superficial arteries of the head. (GERRISH after TESTUT.)

and ends near the optic chiasm, where it breaks up into branches for the supply of the orbit, nose, and brain. The artery has the following stages: cervical, petrosal, cavernous, and terminal.

The cervical stage extends from the bifurcation of the common carotid to the carotid foramen in the petrosa. The artery in this stage rests on (1) the vagus; (2) the superior cervical ganglion; (3) the rectus capitis anticus major; (4) the three upper cervical vertebræ. Near the base of the skull the artery is separated from the internal jugular vein by the ninth, tenth, eleventh, and tw… The vagus and internal jugular vein are external, the pharynx … to the artery. No branches are given off in this stage.

The petrosal stage is in the carotid canal. In this stage the artery gives off (1) a tympanic branch to the middle ear; (2) a Vidian branch, which anastomoses with the Vidian branch of the internal maxillary.

The cavernous stage is in the cavernous sinus of the dura mater. *Branches:* (*a*) To the walls of the cavernous sinus; (*b*) to the Gasserian ganglion; (*c*) to the pituitary body; (*d*) the anterior meningeal.

The terminal stage begins where the artery, emerging from the cavernous sinus, pierces the dura internal to the anterior clinoid process in close relation with the optic nerve and ends in the following branches: (*a*) The ophthalmic enters the orbit through the optic foramen; (*b*) anterior cerebral; (*c*) middle cerebral; (*d*) posterior communicating.

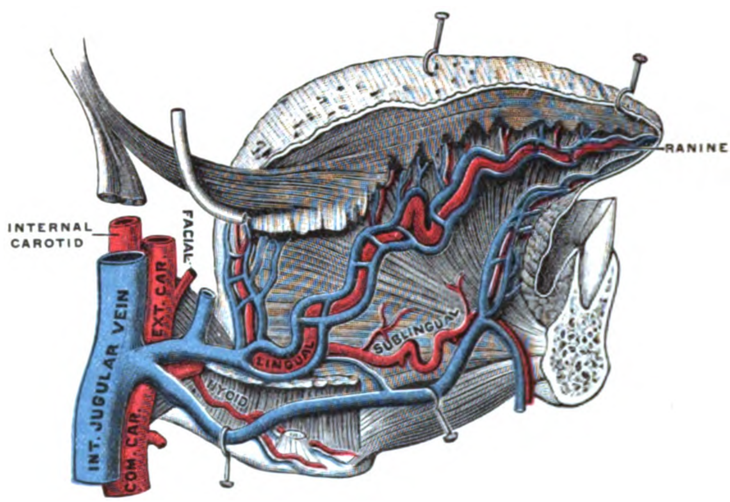
External Carotid Artery. *Origin:* Bifurcation of the common carotid opposite the thyroid. *Termination:* Behind the neck of the condylar process of the mandible. *Relation of the external to the internal carotid artery behind the neck of the mandible:* Superficial to; the external is separated from the internal behind the neck of the jaw by the parotid; covered at the origin by the skin, fascia, and platysma myoides. *Relation to the stylohyoid, digastric, and hypoglossal nerve:* Behind; divides into the temporal and internal maxillary in the parotid gland. *Structures between the external and the internal carotids:* (1) Stylopharyngeus, styloglossus muscle; (2) glossopharyngeal nerve and pharyngeal branch of the vagus; (3) a part of the parotid gland; (4) styloid process; (5) stylohyoid ligament. *Comparative size of carotids:* External smaller. Beneath the ninth nerve and the temporomaxillary vein is in the parotid. *Branches:* Superior thyroid, lingual, facial, occipital, posterior auricular, internal maxillary, temporal, ascending pharyngeal.

Superior Thyroid Artery. *Origin:* In the superior carotid triangle from the external carotid. *Location:* Below and external to the greater horn of the hyoid bone. *Course:* Downward to the thyroid gland and the hyoid depressors. *Termination:* In the upper and front surface of the thyroid gland. Passes beneath the omohyoid, sternohyoid, and the thyrohyoid muscles. *Important anastomoses are:* (1) With the opposite superior thyroid on the upper border of the isthmus; (2) with the inferior thyroid on the lateral lobe of the thyroid. *Secondary function of the superior thyroid artery:* To supply the sternomastoid and depressors of the hyoid bone. *Branches:* Hyoid, sternomastoid, cricothyroid, superior laryngeal. The hyoid branch is below the greater horn of the hyoid bone; the middle sternomastoid supplies the sternomastoid muscle; the cricothyroid lies on the cricothyroid membrane; the superior laryngeal perforates the thyrohyoid membrane and is attended by the superior laryngeal branch of the vagus. It supplies the cricothyroid muscle and mucous membrane of the larynx. *Surgical importance of the cricothyroid branch, in laryngotomy:* The artery may be very large and extended upward. The main branch of the superior thyroid artery may cross the cricothyroid membrane. The membrane should be fully exposed in laryngotomy before a cut into the larynx is made. Make the incision transversely and close to the cricoid cartilage to avoid unnecessary bleeding.

The Lingual Artery. *Origin:* Superior carotid triangle from the external carotid. *Termination:* Apex of the tongue as the ranine artery. *Location:* One-half inch above the greater horn of the hyoid bone. *Course:* Beneath the digastric, stylohyoid, and hyoglossus; crossed by the twelfth nerve at the posterior margin of the hyoglossus muscle; beneath the hyoglossus on the middle constrictor of the pharynx; in the tongue between the inferior lingualis and geniohyoglossus; curved to permit elongation of the tongue. The lingual triangle is a space in which the lingual artery may be ligated preparatory to amputation of the tongue as a palliative measure in malignant diseases of this organ. The triangle is bounded (1) internally, by the mylohyoid muscle; (2) below and externally, by the digastric tendon; [illegible]ove, by the hypoglossal nerve. The floor of this space is formed by the [illegible] beneath which the artery may be found. Hyoid bone as a [illegible]f inch above the greater horn of the hyoid bone demonstrate the lingual artery passing beneath and the hypoglossal nerve lying on the hyoglossus muscle; one-half inch below the greater horn the superior laryngeal nerve and artery penetrate the thyrohyoid membrane to gain the interior of the larynx.

The Facial Artery. *Origin:* Superior carotid triangle, branch of the external carotid. *Termination:* Inner canthus of the eye, as angular artery. *Synonym:* External maxillary artery. *Location:* Superior carotid and digastric triangles, and face. *Grand divisions:* Cervical and facial parts. *Cervical part:* From its origin to front of the masseter on the mandible. *Facial part:* From front of the masseter to the inner canthus. *Attended by:* Sympathetic nerves called nervi molles. (*Function of nervi molles:* To produce blushing and pallor.) *Course of cervical part:* Beneath the digastric, stylohyoid, twelfth, or hypoglossal nerve and submaxillary gland; rests on the mylohyoid muscle; passes behind or through the submaxillary gland; crosses the mandible in front of the masseter muscle; anterior to the facial vein on the mandible; general character of the facial artery: is very tortuous; may be compressed in front of the masseter muscle. *Branches of the cervical stage:* 1. Ascending palatine. *Course:* (*a*) Passes between the styloglossus and stylopharyngeus; (*b*) between the superior constrictor of the

FIG. 63.



Arteries and veins of the tongue, viewed from the right side. (GERRISH after TESTUT.)

pharynx and the internal pterygoid muscle; (*c*) at the level of the levator palati divides into the palatine and tonsillar branches. In the tonsil the artery anastomoses with the descending palatine branch of the internal maxillary, tonsillar branches of the ascending pharyngeal, and the tonsillar branch of the dorsalis linguæ artery. 2. The tonsillar branch ascends between the internal pterygoid and styloglossus. It passes through the superior constrictor of the pharynx and supplies the tonsil and root of the tongue. 3. Submaxillary, glandular branches, numerous and small, supply the submaxillary gland. 4. Submental, given off behind the submaxillary gland. It lies on the mylohyoid muscle, and gives branches to the submaxillary gland and muscles under the jaw; it supplied the lower lip through a superficial branch. The facial stage passes beneath the platysma, risorius, zygomatics, levator labii superioris alæque nasi, and the infra-orbital branches of the seventh nerve; it lies on the levator anguli oris and infra-orbital plexus of the fifth cranial nerve. *Branches:* (1) Inferior labial; (2) inferior coronary; (3) superior coronary; (4) lateralis nasi; (5) angular; (6) masseter and buccinator on the face.

The Occipital Artery. The occipital artery begins in the superior carotid triangle as a branch of the external carotid, and ends in the skin of the posterior part of the scalp. The sternomastoid muscle crosses the artery and determines its stages—the first is anterior, the second beneath, and the third posterior to the muscle. In its first stage the occipital crosses the internal carotid artery, internal jugular vein, vagus nerve, and is itself crossed by the twelfth nerve. The second stage of the artery is deep. It lies between the transverse process of the atlas and the mastoid process, where it changes its course—backward in the occipital groove, beneath the sternomastoid, splenius capitis, trachelomastoid, and digastric muscles, and later becoming superficial and resting on the complexus muscle. *Branches:* (1) Auricular, to the cranial part of the concha; (2) muscular, to the digastric, stylomastoid, splenius, trachelomastoid; (3) the posterior meningeal enters the cranium through the jugular foramen and supplies the dura mater of the posterior fossa; (4) arteria princeps cervicis is a short branch and its course is downward. It divides into (*a*) a superficial branch, which lies beneath the splenius capitis, which, together with the trapezius, it supplies; (*b*) a deep branch, which lies beneath the complexus and anastomoses with the deep cervical branch of the superior intercostal artery, a branch of the subclavian. This anastomotic arch lies on the semispinalis colli muscle, and is an important collateral route after ligation of the common carotid artery.

The Posterior Auricular Artery. The posterior auricular artery arises from the external carotid above the digastric muscle, and lies on the styloid process beneath the parotid gland. It lies in a groove between the cartilage of the ear and the mastoid process. The artery lies just above the spinal accessory nerve and gives off the following branches: (*a*) To the digastric and stylohyoid muscles, and parotid gland; (*b*) stylomastoid artery, which, passing through the stylomastoid foramen, supplies the mastoid cells, vestibule, and membrana tympani; (*c*) auricular branches, to the external ear; (*d*) mastoid branches, to the mastoid region.

The Ascending Pharyngeal. The ascending pharyngeal artery arises either from the bifurcation of the common carotid or half an inch above the same from the external carotid. *Branches:* (1) Muscular, to the rectus capitis anticus major and minor; (2) prevertebral, to the vagus and hypoglossal nerves and superior cervical ganglion; (3) pharyngeal to Eustachian tube, soft palate, stylopharyngeus, superior and middle constrictor muscles of the pharynx; (4) meningeal, to the dura mater; (5) tympanic, to the middle ear.

The Superficial Temporal Artery. The superficial temporal artery is one of the terminals of the external carotid. It arises in the parotid gland behind the neck of the condylar process and crosses the root of the zygoma near the external auditory meatus. About two inches above the zygoma it divides into an anterior and a posterior branch. The artery is attended (1) by sympathetic nerves from the superior cervical ganglion; (2) by the temporal branches of the facial nerve; (3) by the auriculotemporal branch of the inferior maxillary division of the trigeminus; (4) by the temporal veins which lie superficial to the artery. *Branches:* (1) Transverse facial, which crosses and gives branches to the masseter muscle and glandula socia parotidis; (2) anterior auricular, to the front of the external ear; (3) middle temporal, which, piercing the temporal fascia, communicates with the deep temporal branches of the internal maxillary artery, another terminal of the external carotid.

The Internal Maxillary Artery. This artery arises from the external carotid in the substance of the parotid gland behind the neck of the jaw. It transverses the zygomatic fossa, passes between the upper and lower heads of the external pterygoid muscle, and enters and gives off its terminal branches in the sphenomaxillary fossa. The portions of the artery and their branches are as follows: 1. The maxillary portion is between the neck of the jaw and the internal lateral ligament. *Branches:* (*a*) deep auricular, to the external auditory meatus and drum; (*b*) tympanic, passes through the Gasserian fissure to the middle ear; (*c*) middle meningeal, given off between the neck of the jaw and the internal lateral ligament, passes between the two roots of the auriculotemporal nerve through the foramen spinosum into the middle fossa, and is distributed to the dura mater; (*d*) small meningeal, enters the skull through the foramen ovale and supplies the Gasserian ganglion and dura; (*e*) inferior dental, with a nerve of the same name, enters the mandibular canal, and is distributed to the teeth and gums of the mandible and to the skin of the chin. 2. The pterygoid portion is between the external pterygoid muscle and the insertion of the temporal. *Branches:* (*a*) Masseteric, which supplies the masseter muscle and anastomoses with the facial artery and transverse facial branch of the superficial temporal. It gains the under surface of the muscle through the sigmoid notch, and is accompanied by a nerve and veins of like name; (*b*) deep temporal, attended by a nerve and veins of like name to the deep surface of the temporal muscle; (*c*) pterygoid, to the pterygoid muscles. These branches are all attended by nerves (branches of the trigeminus) and veins of like name; (*d*) buccal, attended by the long buccal branch of the inferior maxillary division of the fifth cranial nerve, passes forward to the buccinator muscle, and anastomoses with the facial artery. 3. The sphenomaxillary portion is in the sphenomaxillary fossa.

Branches: (1) Alveolar or posterior superior dental, given off with the infraorbital as this artery enters the sphenomaxillary fossa; (*a*) gingival branches, to the gums; (*b*) antral branches to the antrum of Highmore. (2) The infra-orbital arises with the inferior dental, passes along the infra-orbital canal with the superior maxillary nerve, and appears on the face through the infra-orbital foramen between the levator labii superioris and levator anguli oris. *Branches:* (*a*) To the lacrymal gland; (*b*) to the inferior rectus and inferior oblique muscles; (*c*) to the mucous membrane of the antrum of Highmore; (*d*) to the incisor and cuspid teeth; (*e*) on the face, to the nose, lip, and eyelid. (3) The Vidian, a small branch, passes through the Vidian canal to the Eustachian tube, middle ear, pharynx, and is attended by the Vidian nerve and veins. (4) The pterygopalatine branch passes through a canal of like name with the pharyngeal branch of Meckel's ganglion to the pharynx and Eustachian tube. (5) The nasopalatine or sphenopalatine branch enters the nose through a foramen of like name, with the sphenopalatine branches of Meckel's ganglion. This artery supplies the ethmoid cells and mucous membrane of the antrum of Highmore. (6) The descending or posterior palatine passes through the posterior palatine canal with the palatine nerves from Meckel's ganglion, thence along the roof of the mouth to the anterior palatine canals, in which they inosculate on the septum with branches of the nasopalatine artery. They supply the gums, glands, mucous membrane, and soft palate.

VEINS OF THE NECK.

Superficial Jugular Veins. The jugular veins are four in number on each side of the mid-line of the neck. Of these, one, the internal, is a deep structure in the carotid sheath, and made up at the base of the cranium at the jugular foramen, conveying blood from the sinuses of the dura mater. The veins for our study now are the jugulars found in the superficial fascia and properly called superficial jugulars when spoken of collectively. From their position with reference to the sternocleidomastoid muscle they are called anterior, external, and posterior, and located as follows: (1) The anterior, in front of the sternomastoid muscle; (2) the external, crosses the sternomastoid muscle; (3) the posterior lies behind the sternomastoid muscle.

The anterior jugular vein begins in the submaxillary region by the confluence of small veins; it ends either in the external jugular or subclavian in the region of the clavicle. It descends vertically to within about one inch of the suprasternal notch, and then turns behind the sternomastoid muscle. There may be two anterior jugular veins on each side. This vein communicates with its fellow of the opposite side, and receives tributaries from the inferior thyroid veins. The anterior jugular vein communicates with the internal and has no valves.

The posterior jugular vein begins in the occipital region, is tributary to the external jugular vein, and has no valves.

The external jugular vein is made up in the parotid gland, behind the angle of the jaw by the confluence of the temporal and internal maxillary veins. It descends vertically, crosses the sternomastoid muscle and superficial cervical nerves, opens into the subclavian vein in front of or to the outer side of the scalenus anticus muscle and may be double. It has two pairs of valves—one at its termination, another about two inches above the clavicle.

Internal Jugular Vein. *Inception:* Jugular foramen, between the occipital and petrosa. *Formation:* Confluence of lateral and inferior petrosal sinuses. *Termination:* Root of the neck in the innominate vein. *Special dilatation:* At origin, called gulf or sinus. *General direction:* Vertically down the neck. *Relation to the carotids:* External to both common and internal. It unites with the subclavian to form the innominate vein. The right is larger than the left internal jugular. *Valves:* One pair at or near the termination of the vein. The fascial sheath is derived from the third layer of the cervical fascia. *Function:* To collect blood from the face, neck, and brain. The vein is crossed by the omohyoid muscle and communicantes hypoglossi. *Surgical importance:* Ligated for septic thrombosis of the lateral sinus. Vein lies on the rectus capitis lateralis; and is behind the ninth, tenth, and eleventh cranial nerves. *Tributaries:* Facial, lingual, pharyngeal, occipital, superior and middle thyroid, and may receive a communicating branch from the external jugular vein.

Facial Vein. *Location:* Face, submaxillary, and carotid triangles. *Inception:* Angular vein at the side of the root of the nose. *Termination:* Internal jugular in the superior carotid triangle. Vein descends along the anterior border of the masseter muscle; vein lies beneath the platysma myoides on the face; vein lies posterior to the facial artery on the mandible; vein is superficial to the twelfth nerve, digastric, stylohyoid muscles, and submaxillary glands; vein crosses the carotid artery in the superior carotid triangle. *Course in the neck:* Straight, but does not accompany the facial artery. Vein receives the anterior pterygoid at the angle of the mouth; vein less flaccid than other superficial veins and has no valves. This vein remains open when divided by a knife.

Lingual Vein. *Location:* Dorsum, sides, and under surface of the tongue. Vein is located in the submaxillary and superior carotid triangles; vein follows the course of the lingual artery and ends in the internal jugular.

Pharyngeal Vein. *Origin:* Plexiform in the back and sides of the pharynx. *Common termination:* Internal jugular vein. *Occasional termination:* Facial, lingual, superior thyroid. *Tributaries:* Meningeal, Vidian, and sphenopalatine. Union of tributaries forms the pharyngeal plexus of the veins.

Occipital Veins. *Origin:* Plexiform on the back part of the skull. *Common termination:* Internal jugular vein. *Occasional termination:* External jugular vein. *General course:* Same as that of the artery. Vein communicates with the lateral sinus by an emissary vein; vein lies on complexus and superior oblique muscles of the neck; vein is beneath the sternomastoid, digastric, splenius, trachelomastoid; vein pierces the attachment of the trapezius muscle; vein is crossed by the hypoglossal nerve, and itself crosses the tenth and eleventh cranial nerves.

Superior Thyroid Vein. *Origin:* In substance of the thyroid gland. Vein terminates in the internal jugular; vein crosses the common carotid artery; vein ends occasionally in the facial vein; vein is below the greater cornu of the hyoid bone; vein is located in the superior carotid triangle; vein lies below the depressors of the hyoid bone; vein anastomoses with the inferior thyroid and fellow of the opposite side; vein returns blood from the depressors of the hyoid bone and thyroid gland; vein has general upward and outward direction and receives tributary the superior laryngeal, hyoid, and mastoid.

Middle Thyroid Vein. *Origin:* Lower and lateral part of the thyroid gland. Vein terminates in the internal jugular; vein crosses the common carotid and [illegible]; vein is located in the superior carotid triangle.

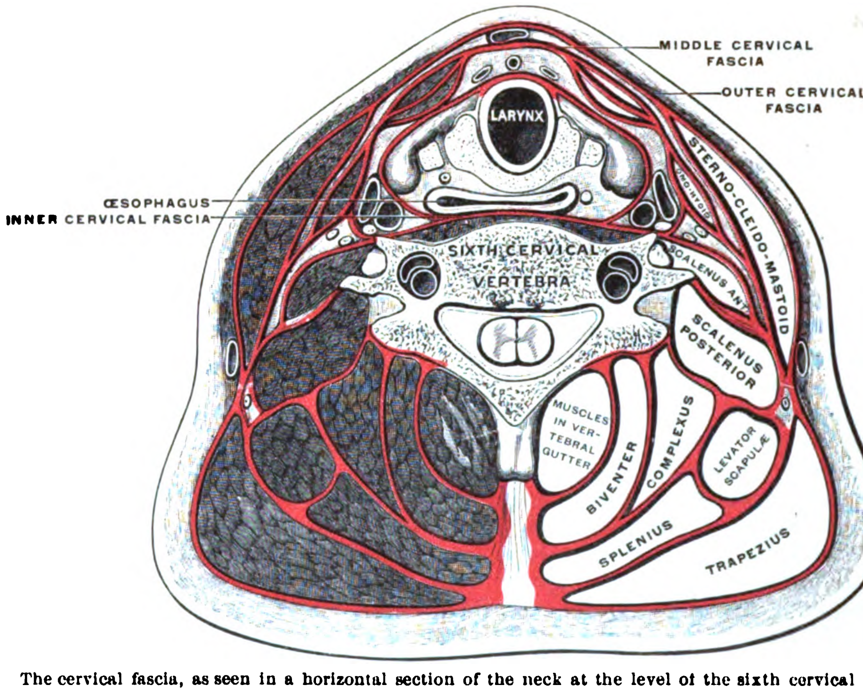
DEEP CERVICAL FASCIA.

The Deep Cervical Fascia forms a strong investment for the entire neck. It divides in various places to form sheaths for muscles, vessels, and glands. It is attached above to the bones of the head; below, to the apex of the thorax; behind, to the ligamentum nuchæ and vertebræ; in front, to the hyoid bone. By means of these several attachments the deep fascia holds the structures of the neck in position.

Dissection. Transverse sections of this as of all other regions of the body should be studied from specimens prepared especially and kept on hand in the dissecting-room for this purpose.

Divisions of the Deep Cervical Fascia. 1. Anterior. 2. Posterior. The anterior division includes the fascia in front of the bodies and transverse processes of the cervical vertebræ. The posterior division includes the fascia behind the cervical

FIG. 64.



The cervical fascia, as seen in a horizontal section of the neck at the level of the sixth cervical vertebra. (GERRISH after TESTUT.)

vertebræ and their transverse processes. Each division consists of four layers and four interfascial spaces. The first layer of the deep cervical fascia is in both the anterior and posterior divisions—that is, it is continuous around the neck.

Anterior Division. The first layer is a continuation of the first layer of the back of the neck. At the posterior border of the sternomastoid it divides to enclose this muscle.

The second layer encloses the depressor muscles of the hyoid bone: omohyoid, sternohyoid, sternothyroid, and thyrohyoid. It is derived from the first layer in the region of the internal part of the sternomastoid muscle.

The third layer forms a common sheath for the carotid artery, vagus nerve, internal jugular vein, trachea, thyroid gland, and œsophagus. This layer is derived from the first layer in the region of the posterior margin of the sternomastoid muscle.

The fourth layer continues behind the pharynx as the prevertebral fascia, and forms a covering for the longus colli muscle.

Attachments. The first or outer layer is attached above to the superior curved line of the occipital bone, mastoid and styloid processes of the temporal bone, and hyoid bone. At the hyoid bone it divides, one layer covering the under surface of the mylohyoid muscle, the other becoming attached to the lower border of the mandible. In the interfascial space between these two layers is the submaxillary gland. Below, the first layer splits, one part being inserted into the anterior, the other into the posterior part of the superior border of the manubrium, forming in this region Burns' space between the two insertions.

The second layer is attached above to the hyoid bone; below, to the sternum, clavicle, scapula, and first rib.

The third layer is attached above to the hyoid bone and styloid process; below, it encloses the subclavius and the minor pectoral muscles, and subclavian vessels, forms the clavipectoral fascia and costo-coracoid ligament, and sends off two prolongations: (1) into the thorax, where it is continuous with the pericardium; (2) into the axilla, about the vessels and nerves.

The fourth layer is attached above to the basi-occipital; below, to the bodies of the cervical vertebræ.

Pus in the region of the internal jugular vein may point (1) into the axilla; (2) into the middle mediastinum.

Posterior Division. The muscles of the back of the neck are ensheathed by the deep fascia, extending in an archiform manner from the cervical spines and ligamentum nuchæ to the articular and transverse processes laterally. There are four layers of the fascia and four spaces containing the muscles, as follows:

Interfascial Spaces. The first space, located between the first and second layers of fascia, contains (1) the trapezius; (2) the levator anguli scapulæ, scalenus posticus, medius, and anticus.

The second space, located between the second and third layers of fascia, contains the splenius capitis et colli.

The third space, located between the third and fourth layers of fascia, contains the complexus muscle.

The fourth space, located between the fourth layer of fascia and the spines and laminæ of the cervical vertebræ, contains the semispinalis colli muscle.

Attachments of the Posterior Division of the Cervical Fascia. This fascia is attached above to the occipital bone; below, to the ribs and vertebral column corresponding to the origin of the several muscles. In the posterior mid-line of the neck the fascia is attached to the ligamentum nuchæ and cervical spines.

THYROID BODY.

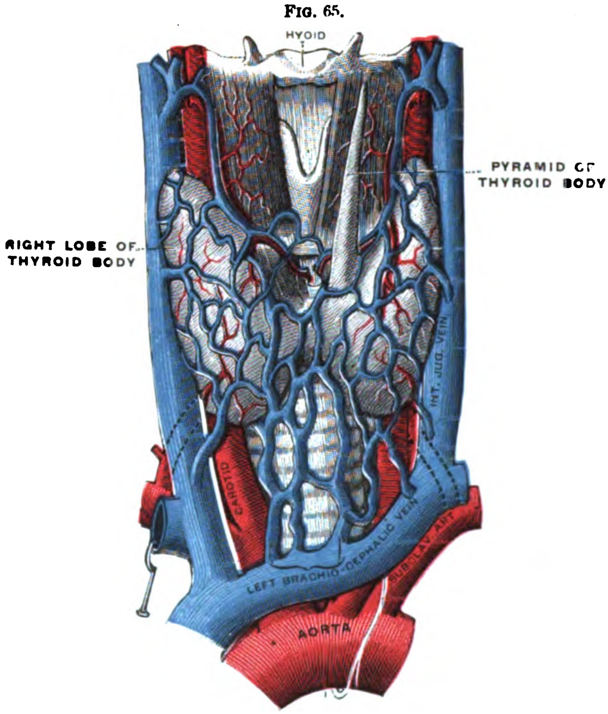
The Thyroid Body, common to all vertebrates, consists genetically of two lobes connected by an isthmus or median lobe. The isthmus varies in size in different persons, is located just below the cricoid cartilage, and may even be absent. Just above the isthmus is the locality for high tracheotomy. A prolongation of the isthmus—the pyramid—may be attached to the body of the hyoid bone. Muscular fibres occasionally develop in this prolongation, and constitute the levator glandulæ thyroideæ. The capsule of the thyroid is derived from the third layer of the deep cervical fascia.

The thyroid body has an apex near the side of the thyroid cartilage; a base, on a level with the fifth ring of the trachea; a convex anterior surface, covered by the depressor muscles of the hyoid bone; a deep or posterior concave surface, which embraces the side of the trachea and larynx, and an external border, which may completely overlap the common carotid artery.

The Blood-supply of the thyroid is from the superior and inferior thyroid arteries and an occasional middle thyroid. The superior thyroid artery is the first branch of the external carotid. It descends beneath the depressor muscles of the hyoid bone to the upper part of the front surface of the thyroid body. The superior thyroid artery anastomoses across the upper border of the isthmus with the artery of the opposite side, and also with the inferior thyroid artery. The inferior thyroid is a branch of the thyroid axis of the subclavian artery. It passes beneath the carotid sheath and sympathetic nerve to the posterior surface of the thyroid body. This artery anastomoses freely with the artery of the opposite side and also with the superior thyroid artery. The middle thyroid artery (arteria thyroidea ima) when present is a branch either of the aortic arch or the innominate artery.

The Thyroid Veins form a considerable plexus on the thyroid body. They are quite large, and occasion troublesome bleeding in operations on the thyroid body. The thyroid veins are (1) superior and middle, which cross the common carotid artery and discharge into the internal jugular vein; (2) an inferior thyroid, which emerges from the base of the lobes, descends on the front of the trachea, and ends in the left innominate vein. These latter veins are in a quantity of fat and connective tissue, and their chief surgical interest is in cases of low tracheotomy.

FIG. 65.



The thyroid body and the related bloodvessels. (GERRISH after TESTUT.)

Embryology. The median lobe of the thyroid originates by evagination from the ventral wall of the pharynx. The tube formed by evagination is the thyroglossal duct or canal of His. As a rule, the duct becomes obliterated by the eighth week of fœtal life. The foramen cæcum at the base of the tongue is a remnant of this duct. The duct may persist in the adult. As previously remarked, the middle lobe of the thyroid body may be absent in man. Its absence is the rule in vertebrates below man, in which the lateral lobes do not unite. The thyroid body is relatively larger in women and children than in adult males.

SUBMAXILLARY GLAND.

The Submaxillary Gland is in the digastric or submaxillary triangle of the neck. The gland, except the part next to the jaw, has (1) capsule of the deep cervical fascia; (2) two extremities, an anterior and posterior; (3) and three surfaces—external, lower, and internal.

The anterior extremity touches the anterior belly of the digastric muscle; the posterior touches the posterior belly of the digastric and stylomaxillary ligament, and is grooved for the facial artery.

The external surface rests in the submaxillary fossa on the inner surface of the body of the mandible and on the internal pterygoid muscle. The lower surface is crossed by the facial vein and the inframandibular branch of the facial nerve. The internal surface rests on the hyoglossus, mylohyoid, and styloglossus muscles.

The deep portion of the gland is anterior to the posterior margin of the mylohyoid muscle; the remainder is superficial. Wharton's duct is a forward continuation of the deep portion of the gland, and opens on the summit of a papilla near the frænum linguæ. The duct passes above the gustatory nerve.

The Blood-supply of the submaxillary gland is from the lingual artery and submental branches of the facial. All branches of the external carotid artery are accompanied by sympathetic nerves, derived from the superior cervical ganglion of the gangliated cord; hence any territory receiving its blood from the external carotid artery receives sympathetic nerve impulse from the superior cervical ganglion. (See page 19 for parotid gland.)

SUBLINGUAL GLAND.

The Sublingual Gland rests in the sublingual fossa of the mandible on the mylohyoid muscle. It is immediately beneath the mucous membrane of the mouth, and produces the sublingual ridge, which may be seen extending outward and backward from the frænum linguæ when the patient's tongue is elevated. It is in relation internally with the geniohyoglossus and styloglossus, and its fellow of the opposite side, and Wharton's duct. Posteriorly it is near the deep portion of the submaxillary gland. Its duct (Rivinus or Bartholin), which is the excretory for the main portion of the gland, opens with Wharton's duct on a papilla near the frænum linguæ; the ducts of Walther are excretories for a minor part of the gland, situated well in front. The sublingual gland derives its blood from the sublingual branch of the lingual artery, and the submental branch of the facial artery. Its nerves are from the submaxillary ganglion and sympathetic.

Nerves. The submaxillary and sublingual glands receive nerves from two sources: (1) From the facial through the chorda tympani; (2) from the superior cervical ganglion. The chorda tympani leaves the tympanum through the canal of Huguier and joins the lingual. There is a small ganglion (submaxillary) where the chorda tympani fibres leave the lingual nerve.

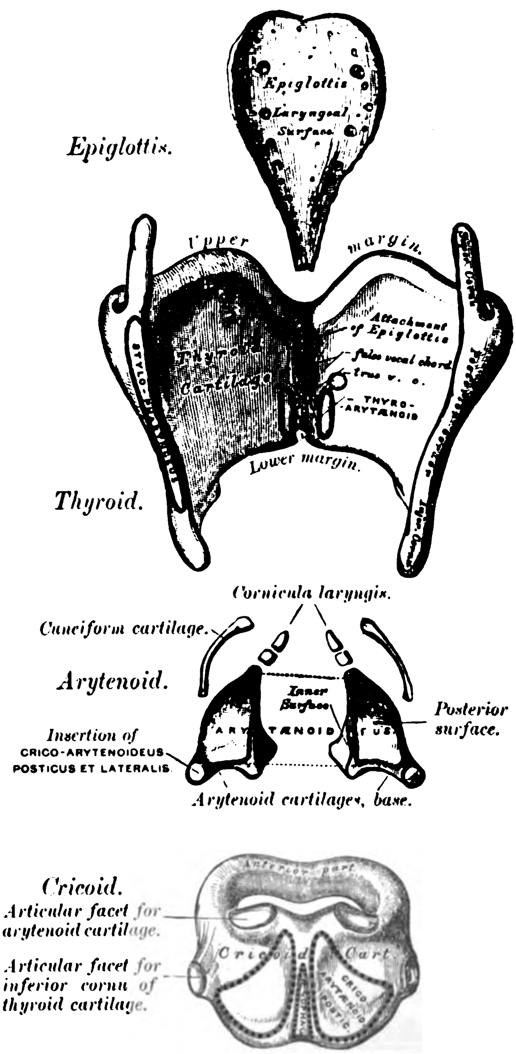
Embryology. The salivary glands, which in mammals consist of three pairs—parotid, submaxillary, and sublingual—develop as outgrowths of the epithelium from the mucous membrane of the mouth. The epithelial elements of the glands are therefore of ectodermic origin. (See Gerrish.)

THE LARYNX.

Dissection. The student should dissect thoroughly the larynx of the ox before the human is undertaken. This possesses all the features of the human larynx, and its great size leads to a clearer conception. Directions: (1) Fasten the larynx to a board (by small nails), putting same on the stretch to its fullest extent. (2) Remove all soft structures, leaving only the cartilages and the crico-thyroid membrane. (3) Cut away the right ala of the thyroid as in Fig. 67, and expose the intrinsic muscles. (4) Remove the thyro-arytenoid muscle and expose the vocal cords. (5) Separate the arytenoid cartilage from the cricoid and study its articulation, borders (three), surfaces (three), muscles, and vocal cords attached. (6) Remove all soft coverings and develop the cartilages until they look like Fig. 66.

The larynx is situated between the hyoid bone and the trachea. It is a highly specialized part of the air passages for the discharge of the following functions: 1. It permits easy passage of air to the lungs. 2. It is the organ of voice, its construction being such that expired air may produce vibration of the vocal cords. 3. By means of the epiglottis it prevents during deglutition entrance of food into the trachea. 4. It may close the chink of the glottis when the lungs are full of air, and thereby favor fixation of the diaphragm. When the diaphragm is fixed the abdominal muscles stimulate the intestines, urinary bladder, gall-bladder, and the gravid uterus to contraction. In a secondary way, therefore, the larynx aids urination, defecation, parturition, and the discharge of bile.

FIG. 66.



The cartilages of the larynx. Posterior view. (GRAY.)

Cartilages of the Larynx. Thyroid (one) shield-like; hyaline cartilage. Cricoid (one) finger-ring-like; hyaline cartilage. Arytenoid (two) pitcher-like; hyaline cartilage. Epiglottis (one) over the glottis; yellow elastic tissue. Cornicula laryngis (two) little horns; yellow elastic tissue. Cuneiform (two) wedge-like; yellow elastic tissue. The tip of the arytenoid is yellow elastic tissue.

The Thyroid Cartilage. The thyroid cartilage is the largest. It consists of two lateral, four-sided plates called wings. These wings meet
neck below the hyoid bone, and form a prominence—A

of the thyroid cartilage has two surfaces—an outer and an inner, and four borders—anterior, posterior, superior, and inferior.

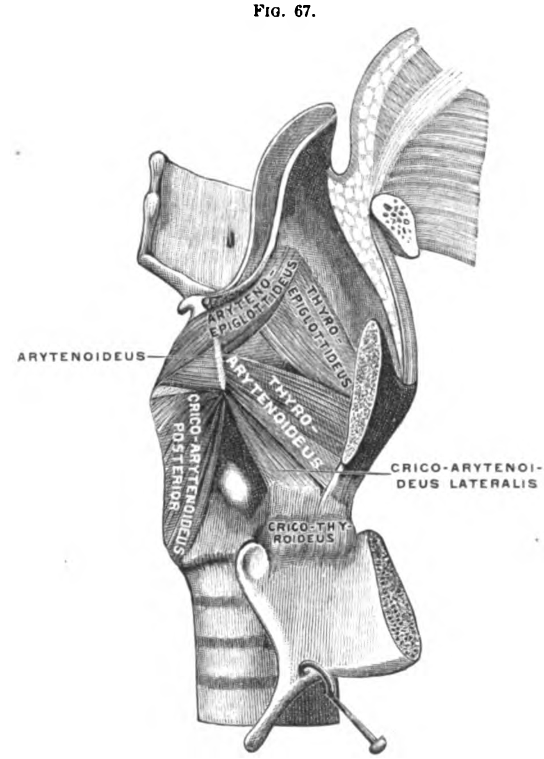
The outer surface has an oblique line, limited above and below by two tubercles. To this surface the sternothyroid and thyrohyoid muscles and inferior constrictor of the pharynx are attached.

The inner surface is smooth and in contact with the vessels and nerves of the larynx, the mucous membrane, and two muscles, thyro-arytenoid and crico-arytenoid lateralis.

The anterior borders form by their union the pomum Adami, in front; behind, they give attachment to (1) the epiglottis; (2) the true and false vocal cords; (3) the thyro-arytenoid and thyro-epiglottidean muscles. (See Fig. 66.)

The posterior border gives partial attachment to the stylopharyngeus and palatopharyngeus muscles. This border is continued downward as the inferior cornu,

FIG. 67.



Muscles of larynx, right side. The right ala of the thyroid cartilage has been cut through and turned down. (GERRISH after TESTUT.)

which articulates with the cricoid cartilage; it is continued upward as the superior cornu, to which the posterior thyrohoid ligaments are attached.

The inferior border gives attachment to the crico-thyroid muscle and crico-thyroid membrane. The superior border gives attachment to the thyrohyoid membrane, and forms in the centre the median notch in front.

The Cricoid Cartilage. The cricoid cartilage resembles a ring with a very large setting behind. The front part is one-quarter inch, the back part one inch wide. The front part gives attachment to the crico-thyroid muscles and the inferior constrictor of the pharynx. The posterior part gives attachment to the posterior crico-arytenoid muscles and œsophagus, and articulates with the arytenoid cartilage. The inferior border is attached to the trachea by the crico-tracheal membrane, an[illegible] (1) an articular surface for the inferior horn of the thyroid cartilage; [illegible] the crico-thyroid membrane and the lateral crico-arytenoid muscle.

The Arytenoid Cartilage. The arytenoid cartilages are two in number, and give attachment to the true and false vocal cords and insertion to all the intrinsic muscles of the larynx except the crico-thyroid. *Analysis.* The apex terminates in the corniculum laryngis, and points inward and backward. The base is irregularly saucer-shaped, and articulates with the cricoid, forming the crico-arytenoid joint. The anterior angle, called the vocal process, gives attachment to the true vocal cord. The external angle, called the muscular process, gives attachment to (1) the lateral crico-arytenoid muscle in front; (2) the posterior crico-arytenoid muscle behind. The internal angle gives attachment to a ligament which binds this angle to the corresponding one of the opposite side and to the cricoid cartilage. The internal surface is covered by mucous membrane. The posterior surface gives attachment to the arytenoid muscle. The cornicula laryngis form the summits of the arytenoid cartilages. The cuneiform cartilages are in front of these in the aryteno-epiglottidean fold of mucous membrane.

The Epiglottis. The epiglottis is attached by its stalk to the retiring angle of the thyroid cartilage. (Fig. 66.) It has lingual and laryngeal surfaces covered by mucous membrane. On the laryngeal surface is an elevation called the cushion. The lateral margins are free above, below they give attachment to the aryteno-epiglottidean folds by which the superior opening of the larynx is bounded. The mucous membrane of the lingual surface is reflected onto the tongue in three folds, one median and two lateral, called the glosso-epiglottidean.

The Thyrohyoid Membrane. The thyrohyoid membrane occupies the space between the thyroid cartilage and the hyoid bone. The central part, quite strong, corresponds to the body of the hyoid bone above and the thyroid notch below. The lateral part is pierced by the superior laryngeal nerve and vessels. The posterior part, cord-like and strong, extends from the tip of the superior cornu of the thyroid cartilage to the tip of the greater horn of the hyoid bone.

The Crico-thyroid Membrane fills the space between the cricoid and thyroid cartilages. The membrane is quite elastic and supports the crico-thyroid artery, a small vessel to be avoided in laryngotomy.

INTRINSIC MUSCLES OF THE LARYNX.

Name.	*Origin.*	*Insertion.*	*Function.*
1. Cricothyroideus.	Front and lateral part of the cricoid cartilage.	Lower border of the thyroid cartilage.	Tension and elongation of the vocal cords.
2. Crico-arytenoideus posticus.	Posterior surface of the cricoid cartilage.	Muscular process of the base of the arytenoid.	Dilates the rima glottidis by rotating the arytenoid outward.
3. Crico-arytenoideus lateralis.	Upper border of the cricoid cartilage.	Forepart of the base of the muscular process of the arytenoid.	Narrows the rima glottidis by rotating the arytenoid inward
4. Thyro-arytenoideus.	Near retiring angle of the thyroid cartilage.	Anterior surface and base of the arytenoid.	Draws the arytenoid forward and relaxes the vocal cords.
5. Arytenoideus.	Posterior surface of the arytenoid.	Posterior surface of the arytenoid.	Approximates the vocal cords and depresses the arytenoid.
6. Aryteno-epiglottideus.	Apex of the arytenoid cartilage.	Into the epiglottis.	Contracts superior aperture of the larynx.
7. Thyro-epiglottideus.	Thyroid cartilage.	Epiglottis.	Depresses the epiglottis and compresses the sacculus laryngis.

Interior of the Larynx. The cavity of the larynx is limited above, by the superior opening, below by the lower border of the cricoid cartilage. It is lin[illegible] by mucous membrane and divided by the space between the true vocal [illegible] the rima glottidis—into a superior and an inferior part, and has [illegible] appearance of an hour-glass.

The True Vocal Cords are remotely derived from the crico-thyroi[illegible] extend from the retiring angle of the thyroid cartilage to th[illegible] anterior angles of the arytenoid cartilages. They are concern[illegible] of the voice. The two cords face each other, and have free, sharp, chisel-like edges above, which vibrates during phonation. They are about one inch long.

The False Vocal Cords are not concerned in phonation. They are about one-quarter of an inch above the true cord. They are composed of fibrous tissue covered by mucous membrane, and cannot be made tense. They extend from the retiring angle of the thyroid cartilage to the anterior surface of the arytenoid cartilage.

The Ventricle of the larynx is a depression limited above by the false, below by the true vocal cords, and externally by the thyro-arytenoid muscle.

The Laryngeal Pouch is a small, blind sac, about one-half inch long, leading upward from the front of the ventricle to the upper border of the thyroid cartilage. The pouch is guarded by two folds of mucous membrane. The fossa innominata is between the false vocal cord and the aryteno-epiglottidean fold, and should not be mistaken for the laryngeal pouch.

The Rima Glottidis is limited laterally (1) by the true vocal cords; (2) by the vocal processes and arytenoid cartilages. The part of the chink between the cords is the glottis vocalis; that between the arytenoids is the respiratory portion.

The Sinus Pyriformis is limited internally by the aryteno-epiglottidean fold and externally by the ala of the thyroid cartilage.

The Superior Laryngeal Nerve, a branch of the vagus, supplies the crico-thyroid muscle and mucous membrane of the larynx as far as the true vocal cords. It perforates the thyrohyoid membrane. (See Vagus Nerve.)

The Recurrent Laryngeal Nerve, a branch of the vagus, supplies all the intrinsic muscles of the larynx except the crico-thyroid. On the right side this nerve is given off from the vagus at the lower part of the subclavian artery, whence it ascends behind the right common carotid artery to the side of the trachea. On the left side the nerve arises in front of the aortic arch, winds inward around and below the ductus arteriosus, and ascends to the side of the trachea.

The Blood-supply is from the superior and inferior laryngeal arteries, derived from the superior and inferior thyroids, respectively. Veins corresponding in name and location accompany the arteries.

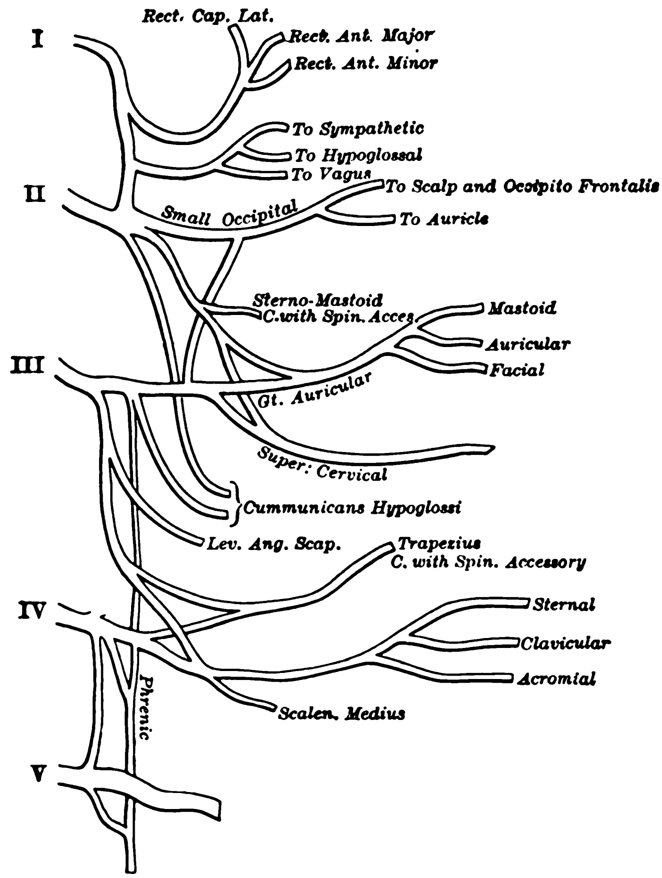
THE TRACHEA.

The trachea is a conduit conveying air to and from the lungs. *Location:* Mid-line of the neck, and extending from the cricoid cartilage of the larynx to the bifurcation at the fifth thoracic vertebra. *Fascial sheath:* Third layer of the deep cervical fascia. Continuous above with the larynx, below with the bronchi. *Relation to the vertebræ:* In front, from the fifth cervical to the fifth thoracic. *Size:* Nearly an inch wide and nearly five inches long. *Characteristic feature:* Imperfect cartilaginous rings, from sixteen to twenty. *Trachea divides into:* Right and left bronchi. *Function of the rings of cartilage:* To keep the trachea open. *Function of deficiency of the rings:* To permit expansion of trachea. *Lining:* Mucous membrane. *Grand divisions:* Cervical and thoracic parts. *Relations of the trachea in the neck:* Posteriorly, œsophagus passing to the left; laterally, common carotid artery, thyroid lobes, inferior thyroid arteries, and recurrent laryngeal nerves, which latter lie in a fatty groove between the trachea and œsophagus; anteriorly, isthmus of the thyroid, inferior thyroid veins, middle thyroid artery, sternohyoid, and sternothyroid muscles, and two layers of the deep cervical fascia. *Rel[illegible] of the trachea in the thorax:* On the right side, pleura and pneu-[illegible]tri[illegible] the left side, pleura, left common carotid artery, pneumo-[illegible]nd recurrent laryngeal nerves; anteriorly, manubrium of [illegible] the sternohyoid and sternothyroid muscles, left innominate [illegible]d artery, transverse part of the aortic arch, and the deep [illegible]ood-supply is from the tracheal branches of the inferior [illegible]ins join the thyroid plexus. *Nerves:* Vagus, sympa-[illegible]al.

CERVICAL PLEXUS.

Location. Opposite the four upper cervical vertebræ. It is covered by the sternomastoid muscle. It rests on the levator anguli scapulæ and scalenus medius muscles. Its superficial branches emerge behind the posterior border of the sternomastoid. This plexus is called cervical on account of its derivation from cervical nerves and its major distribution to the neck.

FIG. 68.



Plan of the cervical plexus. (GRAY.)

Formation. The plexus is formed by the union of the anterior primary divisions of the first, second, third, and fourth cervical nerves. The fourth cervical nerve is connected by a descending twig to the brachial plexus.

TABLE OF BRANCHES OF CERVICAL PLEXUS. (GRAY.)

Superficial	Ascending	Superficialis colli. Auricularis magnus. Occipitalis minor.
	Descending	Supraclavicular. Suprasternal. Supra-acromial.
Deep	Internal	Communicating. Communicantes hypoglossi. Muscular branches. Phrenic nerve.
	External	Communicating branches. Muscular.

Communicating Branches extend to the auriculotemporal, facial, hypoglossal, pneumogastric, spinal accessory, cervical sympathetic, and brachial plexus.

Superficial Branches. The superficialis colli crosses the sternomastoid muscle, and passes beneath the external jugular vein. The nerve perforates the deep fascia near the anterior border of the sternomastoid muscle, and has ascending and descending branches from which the antero-lateral part of the neck is supplied with sensation.

The auricularis magnus crosses the sternomastoid muscle to the ear and face. The nerve is derived from the second and third cervical. *Branches:* Facial, distributed to the skin covering the parotid gland; auricular, to the skin of the back of the ear; mastoid, to the skin over the mastoid process.

The occipitalis minor is behind the sternomastoid muscle, and perforates the deep fascia near the cranium. The nerve arises from the second and third cervical and supplies the side of the head and a part of the ear.

The supraclavicular branches cross the clavicle and supply the skin over a part of the pectoralis major and deltoid muscles.

The suprasternal branches cross the sternomastoid muscle at its origin, and supply the skin covering the manubrium. This nerve crosses the external jugular vein.

The supra-acromial branches supply the skin of the back of the shoulder.

Deep Branches. Communicating branches extend to the cervical sympathetic, pneumogastric, and hypoglossal nerves.

Muscular Branches. They extend to the rectus capitis anticus major (first cervical nerve); to the rectus capitis lateralis (first cervical nerve); to the sternomastoid (second cervical nerve); to the scalenus medius (third and fourth cervical nerves); to the levator anguli scapulæ (third and fourth cervical nerves); to the trapezius (third and fourth cervical nerves); to the longus colli (second, third, fourth, fifth, and sixth cervical nerves); to the diaphragm (third, fourth, and fifth cervical nerves).

The Phrenic Nerve arises from the third, fourth, and fifth cervical. The nerve is beneath the sternomastoid and crosses obliquely inward the scalenus anticus muscle. It is crossed by the suprascapular and transverse cervical arteries and omohyoid muscle. On each side of the neck the nerve passes behind the subclavian vein. In the thorax the right phrenic is to the outer side of the innominate vein and superior vena cava; on the left it passes between the arch of the aorta and lung. On either side the phrenic nerve is closely bound to the pericardium by connective tissue and attended by a small artery (arteria comes nervi phrenici), a branch of the internal mammary.

The phrenic nerve pierces and is distributed to the under surface of the diaphragm, and sends small twigs to the pleura, pericardium, and diaphragmatic peritoneum.

BRACHIAL PLEXUS.

Location of Stages. The first stage is on the scalenus medius muscle, in the posterior triangle of the neck; the second stage is in the subclavian triangle; the third stage is beneath the clavicle and subclavius muscle; the fourth stage is beneath the pectoral muscles.

Names of Stages. STAGE OF EMERGENCE. The five component nerves forming the plexus emerge through the intervertebral foramina, lie on the scalenus medius muscle, and are separate from each other.

STAGE OF TRUNKS. The five component nerves now unite to form the three trunks—upper, middle, and lower; the lower trunk is behind the subclavian artery, the other two above and posterior to it.

STAGE OF DIVISIONS. Each trunk divides into anterior and posterior divisions; the plexus lies beneath the clavicle and subclavius muscle, and is above, external, and posterior to the axillary artery.

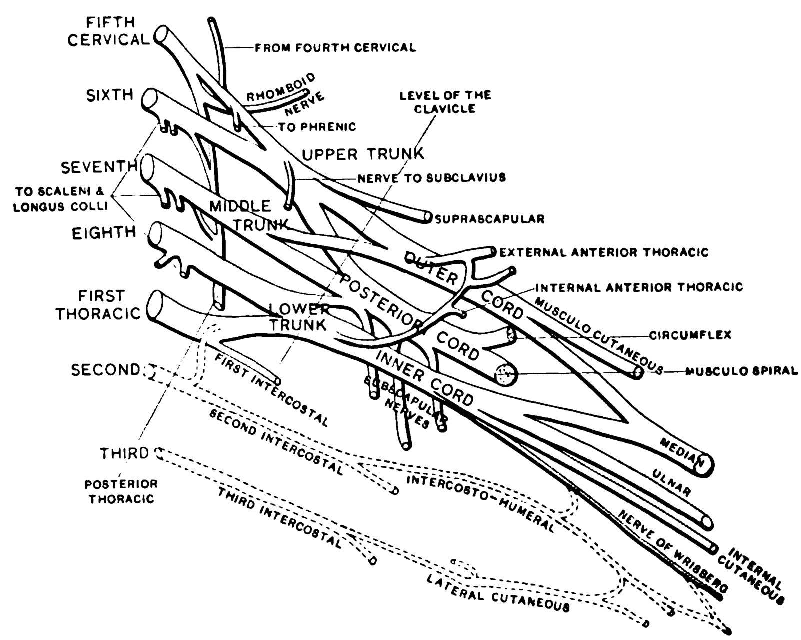
Stage of Cords. The six divisions of the trunk are collected into three cords—posterior, inner, and outer. The plexus lies under the pectoral muscles in the axilla, and its three cords surround the axillary artery.

Formation of Plexus. The brachial plexus is formed by the union of the anterior primary divisions of the fifth, sixth, seventh, and eighth cervical nerves, and the greater part of the first thoracic nerve. The lesser part of the first thoracic forms the first intercostal nerve. The brachial plexus communicates above with the fourth cervical, and below with the second thoracic nerve. The nerves forming the plexus emerge through the intervertebral foramina.

Formation of Trunks. The fifth and sixth fuse to form the upper trunk, the seventh forms the middle trunk, and the eighth cervical and first thoracic (greater part of) fuse to form the lower trunk.

Division of Trunks. Each trunk (upper, middle, and lower) divides into anterior and posterior parts, making six strands in all, three of which are anterior and three posterior.

Fig. 69.



Plan of the brachial plexus. (Gerrish.)

Formation of Cords. The posterior cord is formed by the union of the three posterior divisions of the three trunks; the outer cord by the union of the anterior divisions of the upper and middle trunks; the inner cord by the anterior division of the lower trunk.

Classification of Branches of Distribution. 1. Branches above the clavicle. 2. Branches below the clavicle.

Branches above the Clavicle. 1. The posterior thoracic arises from the fifth, sixth, and seventh cervical nerves, passes behind the brachial plexus, and is distributed to the serratus magnus muscle. 2. The suprascapular nerve arises from the fifth and sixth cervical nerves. It passes beneath the trapezius, and, crossing the suprascapular artery, enters the suprascapular foramen beneath the superior transverse scapular ligament. It gives (*a*) an articular branch to the shoulder-joint; (*b*) a branch to the supraspinatus muscle; (*c*) a branch to the infraspinatus muscle. These branches are accompanied by vessels of like name. The muscular branches enter their respective muscles on the deep surface, near the apex. Gray rami communicantes attend these branches for the supply of bone, cartilage, fasciæ, and vessels. 3. The nerve to rhomboidei, major and minor, arises from the fifth cervical, near the intervertebral foramen. This nerve is in the space between the minor rhomboid and levator anguli scapulæ. It also contains gray rami for bone, fasciæ, ligament, and vessels. 4. The nerve to the subclavius muscle arises from the fifth cervical, near the intervertebral foramen, or a little lower from the upper trunk of the plexus. It crosses the third stage of the subclavian artery, and gives (*a*) a muscular branch to the subclavius muscle; (*b*) a communicating branch to the phrenic nerve; (*c*) gray rami for the supply of bone fasciæ and vessels. 5. The nerves to the longus colli, scalenus anticus, medius and posticus, arise from the sixth, seventh, and eighth cervical, near the exit of these nerves from the intervertebral foramina. They convey gray rami for bone, fascia, and vessels. 6. The communicating branch to the phrenic nerve arises from the fifth cervical. It conveys gray rami for fasciæ, vessels, and bone. (See Sympathetic for Gray Rami.)

BRANCHES BELOW THE CLAVICLE. *From the outer cord:* 1. The outer head of the median. 2. The external anterior thoracic. 3. The musculocutaneous. *From the inner cord:* 1. The inner head of the median. 2. The internal anterior thoracic. 3. The internal cutaneous. 4. The lesser internal cutaneous. 5. The ulnar. *From the posterior cord:* 1. The subscapular nerves (short, long, lower). 2. The circumflex. 3. The musculospiral.

The Median Nerve arises by two heads—an outer and an inner—from the outer and inner cords of the brachial plexus, respectively. It accompanies the axillary artery and its prolongation, the brachial, to the elbow. It gains the forearm between the condylar and the coronoid heads of the pronator radii teres. It is, in rare cases, fused with the musculocutaneous nerve. It is said to give off two articular branches to the elbow-joint. It supplies all the muscles on the anterior surface of the forearm except the flexor carpi ulnaris and one-half of the flexor profundus digitorum. It supplies the outer (radial) three and one-half fingers (palmar surface) with sensation. In the hand it supplies the two radial lumbricales and all the muscles of the thenar eminence except the adductor pollicis and the inner head of the flexor brevis pollicis. It is accompanied by a small artery below the elbow, which occasionally is as large as the radial artery, and passes beneath the anterior annular ligament. In the forearm the median nerve lies beneath the flexor sublimis digitorum. The digital branches of this nerve supply the joints of the thumb, index, and middle fingers and radial half of the ring finger. This nerve conveys gray rami communicantes for bone, fasciæ, ligament, and bloodvessels in its course.

The External Anterior Thoracic Nerve arises from the outer cord. It communicates with the internal anterior thoracic, a branch of the inner cord, pierces the clavi pectoral fascia, and supplies the pectoralis major muscle.

The Musculocutaneous Nerve is a branch of the outer cord of the brachial plexus. It perforates, as a rule, the coracobrachialis muscle, and gains the intermuscular space between the biceps and brachialis anticus. It supplies the coracobrachialis, biceps, and brachialis anticus, that is, the muscles that flex the forearm on the arm; the cutaneous part is distributed (1) to the skin over the outer and posterior part of the forearm as low as the wrist; (2) to the integument of the outer and anterior parts of the forearm and thenar eminence. The musculocutaneous nerve contains gray rami for bone, fasciæ, and vessels.

The Internal Anterior Thoracic Nerve arises from the inner cord of the brachial plexus, and passes between the (first stage of) axillary artery and vein. It communicates with the external anterior thoracic nerve and supplies the pectoralis minor and major muscles. It conveys gray rami for bone, fasciæ, and vessels.

The Ulnar Nerve is a branch of the inner cord of the brachial plexus. It is attended by the inferior profunda artery above the elbow, by the ulnar below. It gains the forearm between the two heads (olecranon and condylar) of the flexor carpi ulnaris. It supplies the flexor carpi ulnaris and the ulnar half of the flexor [illegible] digitorum. It supplies the little finger and the ulnar half of the ring finger dorsally and palmarly. It supplies in the hand all the muscles not innervated by the median nerve: the palmaris brevis, abductor minimi digiti, flexor brevis minimi digiti, opponens minimi digiti, adductor transversus pollicis, adductor obliquus pollicis, inner head of flexor brevis pollicis, the two ulnar lumbricales, and all the interossei of the hand. It gives articular branches to elbow and wrist, and all other joints moved by the muscles which it supplies. This nerve conveys gray rami for bone, fasciæ, and vessels.

The Internal Cutaneous Nerve is a branch of the inner cord of the brachial plexus. It lies on the inner side of the axillary artery at its origin; a little lower it lies between the artery and vein. In the upper two-thirds of the arm it is in front and internal to the brachial vessels. It accompanies the basilic vein. It supplies (1) the integument of the upper and inner part of the arm; (2) the integument of the anterior and postero-internal parts of the forearm. The nerve conveys gray rami for fasciæ and vessels.

The Lesser Internal Cutaneous Nerve (Wrisberg) is a branch of the inner cord of the brachial plexus. It supplies the integument on inner part of arm and olecranon process. In the axilla the nerve communicates with the intercostohumeral.

The Subscapular Nerves arise from the posterior cord of the brachial plexus. They are named short, long, and lower. The short supplies the subscapularis muscle; the long accompanies the subscapular artery and supplies the latissimus dorsi; the lower supplies the teres major and gives filaments to the subscapularis muscle. The nerves convey gray rami communicantes.

The Circumflex Nerve is a branch of the posterior cord of the brachial plexus. It accompanies the posterior circumflex vessels through the quadrilateral space. *Branches:* (1) Articular, to the shoulder; (2) muscular, to the teres minor; (3) muscular, to the deltoid; (4) cutaneous, to the skin over the middle and lower thirds of the deltoid muscle. This also contains gray rami communicantes.

The Quadrilateral Space, through which the circumflex nerve and posterior circumflex vessels pass from the axilla to the back of the shoulder, is bounded above by the teres minor; below, by the teres major and latissimus dorsi; internally, by the scapular or long head of the triceps; externally, by the surgical neck of the humerus.

The Musculospiral Nerve is a branch of the posterior cord of the brachial plexus. It is between the two humeral heads of the triceps muscle, in the musculospiral groove, with the superior profunda artery. In the lower third of the arm it lies between the brachialis anticus and supinator longus. In this space it gives branches to the radial group of muscles (supinator longus and extensors carpi radialis longior and brevior). It divides, here, into the radial and posterior interosseous. The posterior interosseous passes through the supinator brevis and supplies all the muscles on the posterior part of the forearm. The radial branch becomes cutaneous by piercing the deep fascia in the lower third of the forearm between the supinator longus and the extensor carpi radialis. In the hand, the radial nerve supplies with sensation the ball of the thumb and adjacent three and one-half fingers, dorsally. The musculospiral nerve gives off two cutaneous branches to the skin over the insertion of the triceps and anconeus.

Communications. The brachial plexus communicates (1) above with the cervical plexus; (2) below, with the first intercostal nerve, while one part of the first thoracic enters into the formation of the plexus; (3) internally, with the sympathetic vertebral ganglia, by means of gray rami communicantes.

Gray Rami Communicantes. It is an established fact in physiology and anatomy that the bones, fasciæ, and vessels of the trunk and extremities receive their sympathetic nerves through branches called gray rami communicantes. These nerves originate in cells of the vertebral ganglia, and reach the parts they supply with the spinal nerves. Throughout this book the student will be constantly reminded of the nerve-supply to such structures as bones, fasciæ, and unstriped muscle-fibre of vessels; not that he is expected to find gray rami in the coats of an artery, but by constant repetition it is hoped to impress the fact that there is a definite origin, course, and distribution for the gray rami communicantes. The gray rami are indigenous in every region of the spinal cord. Their trophic cells are in the vertebral ganglia of the sympathetic nerve. In descriptive texts on anatomy, students will have occasion to read that certain nerves give branches to certain arteries. For example, the femoral artery receives branches from the obturator and anterior crural nerves. These are the gray rami, departing from their escorts, to accompany the artery to bone, fascia, and vessel. (See Gerrish.)

The Subclavian Artery is (1) below the brachial plexus, on the upper surface of the first rib, between the scalenus anticus and medius, in the first stage of the brachial plexus—the stage of emergence; (2) the artery is in front of the lower trunk and below and anterior to the middle and upper trunks, in the second stage of the plexus—the stage of trunks; (3) the artery is below, internal and anterior to the plexus, beneath the clavicle and subclavius muscle, in the third stage of the plexus—the stage of division of trunks; (4) the artery is surrounded by the outer, inner, and posterior cords, beneath the pectoral muscles, in the fourth stage of the plexus—the stage of cords.

HYPOGLOSSAL NERVE.

The Hypoglossal Nerve. The deep origin is from the whole length of the medulla oblongata by multipolar cells resembling those of the anterior horn of the spinal nerves. Its nucleus lies in line with that of the third, fourth, and sixth cranial nerves. The superficial origin is from a groove between the olivary body and anterior pyramid. In mode of origin it is identical with that of the motor roots of the spinal nerves.

Roots. The hypoglossal nerve roots cross the vertebral artery and pierce the dura in two places. They unite to form one trunk in the anterior condylar foramen, through which the nerve escapes from the cranium. At the base of the skull the nerve is between the internal carotid artery and the internal jugular vein. It passes below the posterior belly of the digastric muscle and around the occipital artery. After leaving the occipital artery, the nerve passes in front of the carotid vessels below the digastric and stylohyoid, lies on the hyoglossus muscle, and disappears behind the mylohyoid muscle to the tongue.

Composite Character. 1. The hypoglossal is purely motor at its origin. 2. Sensory filaments from the first and second cervical nerves. 3. Sensory filaments from the pneumogastric. 4. Vasomotor fibres from the superior cervical ganglion. 5. Motor fibres from the cervical plexus.

Distribution. 1. A meningeal branch to the dura mater and occipital bone. 2. Vasomotor fibres to the tongue, derived from the superior cervical ganglion. 3. Sensory filaments to the tongue, derived from the second cervical nerve. 4. Sensory filaments to the tongue, derived from the vagus. 5. Motor branches to the hyoglossus. 6. Motor branches to the styloglossus. 7. Motor branches to the geniohyoglossus. 8. Motor branches to the superior lingualis. 9. Motor branches to the inferior lingualis. 10. Motor branches to the transverse lingualis. 11. Motor branches to the vertical lingualis.

Communications. 1. With the trunk-ganglion of the vagus. 2. With the superior cervical ganglion. 3. With the second and third cervical nerves. 4. With the lingual branch of the trifacial. 5. With the pharyngeal plexus. 6. According to Gerrish, the nerve to the sternohyoid and the sternothyroid muscles may give a communicating branch to the phrenic nerve.

The Ansa Hypoglossi is formed by the union of a branch of the hypoglossal nerve (descendens hypoglossi) and two branches from the second and third nerves of the cervical plexus (communicantes hypoglossi). These branches meet on the carotid sheath and form a loop, from which branches are given off to the sternohyoid, sternothyroid, omohyoid, and thyrohyoid muscles. In other words, the depressor [illegible] the hyoid bone derive their nerve-supply from the ansa hypoglossi.

SPINAL ACCESSORY NERVE.

The Spinal Accessory Nerve emerges higher than the cervical nerves. It pierces the sternocleidomastoid muscle, crosses the occipital triangle, and enters and supplies the trapezius muscle.

Subdivisions. 1. Spinal, which arises from the lateral columns of the spinal cord as low as the sixth cervical nerve. 2. Accessory, which arises from the medulla. This part joins the vagus, and is distributed with the pharyngeal and laryngeal branches of the same.

The Spinal Part of the Nerve passes either anterior or posterior to the internal jugular vein and behind the digastric and stylohyoid muscles, having left the cranium through the jugular foramen. The nerve pierces the sternomastoid muscle, and, in company with the superior sternomastoid branch of the occipital artery, crosses the occipital triangle and enters the trapezius muscle. The nerve unites with branches of the third and fourth cervical nerves beneath the trapezius muscle to form a plexus.

VAGUS OR PNEUMOGASTRIC NERVE.

To make the identification of certain structures in the neck easier, the following abstract and table of the vagus nerve are appended :

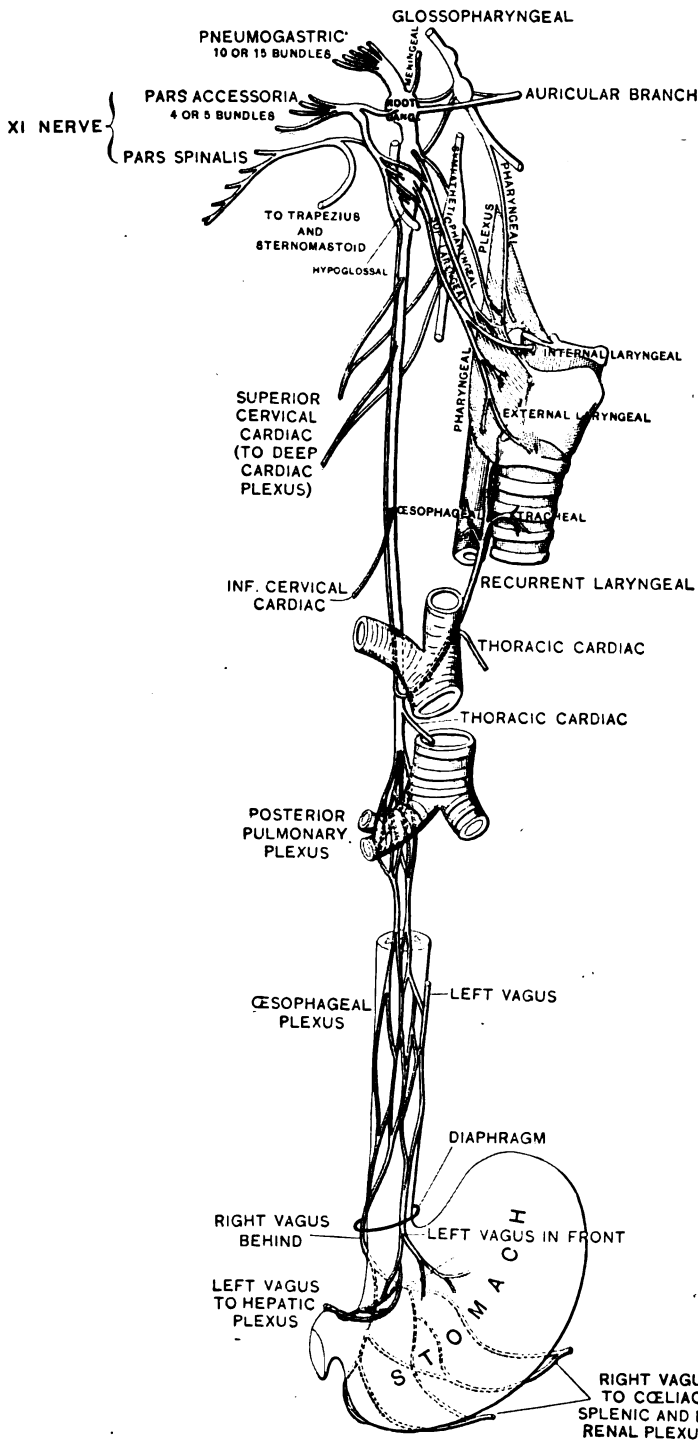
The vagus or pneumogastric nerve has a superficial and a deep origin. The superficial origin is by eight or ten filaments from a groove between the olivary and restiform bodies. The deep origin is from the nucleus vagi in the lower part of the floor of the fourth ventricle, beneath the ala cinerea and continuous with the nucleus of the ninth nerve. The sensory fibres arise in the cells in the ganglia of the root and trunk. *Course:* The vagus nerve escapes from the cranium through the jugular foramen with the ninth and eleventh nerves and the internal jugular vein. It passes vertically down the neck in the carotid sheath, between the internal jugular vein and the internal and common carotid arteries. Thence the courses of the two nerves are different. On the right side, the vagus crosses the subclavian artery (lying between this and the innominate vein) and descends by the side of the trachea to the back part of the root of the lung, where it forms the posterior pulmonary plexus ; whence two cords descend on the œsophagus, forming, with the branches of the opposite side, the plexus gulæ. From here, the nerve passes along the œsophagus to the posterior surface of the stomach. On the left side, the vagus enters the thorax between the left common carotid and the subclavian arteries, beneath the left innominate vein. It crosses the arch of the aorta, passes behind the root of the lung along the anterior surface of the œsophagus, and through the diaphragm to the anterior surface of the stomach.

Ganglia. The vagus nerve has two ganglia (one of the root and one of the trunk), which contain the cells from which the sensory fibres of the vagus arise. These ganglia are derived from the fourth cephalic ganglion of the embryo.

GANGLION OF THE ROOT. This is circular in form, grayish in color, about two lines in diameter, and located in the jugular foramen. To it is connected (1) the accessory portion of the spinal accessory nerve; (2) the petrous ganglion of the ninth nerve ; (3) the facial nerve, through the auricular branch ; (4) the superior cervical ganglion of the sympathetic, through ascending filaments of this latter.

GANGLION OF THE TRUNK. This is about an inch long, cylindrical in form, involving all the fibres of the nerve. The accessory portion of the eleventh nerve passes through this ganglion. It is connected to (1) the twelfth nerve ; (2) the superior cervical ganglion ; (3) the loop between the first and second cervical nerves.

FIG. 70.



Distribution of the right pneumogastric nerve. (W. KEILLER, in Gerrish's Anatomy.)

Table of Branches of the Vagus.

Name.	*Source and Course.*	*Distribution.*
Meningeal nerve.	Ganglion of the root in the jugular foramen; it runs backward into the cranial cavity.	Sensory to the dura mater in the posterior fossa at the base of the skull.
Auricular (Arnold's) nerve.	Ganglion of the root in the jugular foramen; is joined here by the nerve from the petrous ganglion of the glosso-pharyngeal; enters Arnold's canal on the outer wall of the jugular fossa, traverses petrosa, to the auricular fissure, between the mastoid process and the external auditory meatus. It crosses the facial nerve about two lines above the stylomastoid foramen.	1. A branch to the facial nerve, where the auricular crosses this (the seventh) about two lines above the stylomastoid foramen. 2. At the auricular fissure the nerve divides into two branches and supplies the posterior part of the pinna and the posterior part of the external auditory meatus; the other communicates with the posterior auricular branch of the facial nerve. Romberg relates the case of cough and vomiting due to hyperæsthesia of the auricular branch of the vagus.
Superior laryngeal nerve.	Inferior ganglion of the vagus, and consists principally of fibres from the accessory part of the spinal accessory nerve (since this passes through the ganglion). It receives a branch from the superior cervical ganglion, and passes along the pharynx to the side of the larynx, behind the internal carotid artery. It divides into internal and external laryngeal branches.	1. The external laryngeal branch passes beneath the sternothyroid to the crico-thyroid muscle, pharyngeal plexus, inferior constrictor of the pharynx, and communicates with the superior cardiac nerve. 2. The internal laryngeal branch perforates the thyrohyoid membrane, supplies the epiglottis, base of the tongue, mucous membrane of the larynx (as low as the true vocal cords), and gives a communicating branch to the recurrent laryngeal nerve on the inner surface of the thyroid cartilage, beneath the mucous membrane.
Inferior or recurrent laryngeal nerve.	On the right side the nerve arises from the vagus in front of the subclavian artery, winds around this vessel, and ascends to the side of the trachea, behind the common carotid and inferior thyroid arteries. (It may pass in front of the inferior thyroid artery.) It now ascends in the groove between the trachea and œsophagus, and beneath lower border of the inferior constrictor of the pharynx, enters the larynx behind the crico-thyroid articulation.	(1) A communicating twig to the internal branch of the superior laryngeal nerve, which gives a few filaments to the lower part of the larynx; (2) to all intrinsic muscles of the larynx except the crico-thyroid; (3) cardiac filaments unite with similar branches from the sympathetic and vagus; (4) œsophageal branches; (5) tracheal branches to the trachea and pharyngeal branches to the inferior constrictor of the pharynx.
. . .	On the left side the nerve arises from the vagus in front of the aortic arch, passes around the arch internal to the remains of the ductus arteriosus and ascends to the side of the trachea, whence its course is the same as that of the right nerve.	(Same as nerves on the right side.)
Cervical cardiac nerves.	Arise from the vagus at the upper and back part of the neck—are called superior and inferior. On the right side the inferior branch accompanies the innominate artery; on the left it crosses the arch of the aorta.	Superior to deep cardiac plexus with the cardiac branches of the sympathetic, with which they communicate. The inferior branches arise just above the first rib. and are distributed on the right side to the deep cardiac plexus with the cardiac sympathetic; on the left side to the superficial cardiac plexus.
Thoracic cardiac nerves.	On the right side from the trunk of the vagus by the side of the trachea and recurrent laryngeal. On the left side from the recurrent laryngeal.	They pass inward and end in the deep cardiac plexus.
Anterior pulmonary nerves.	From vagus; are small and two or three in number.	Join the filaments of the sympathetic from the superior cervical ganglion and glosso-pharyngeal, and form the anterior pulmonary plexus distributed to the surface of the root of the lung.
Œsophageal nerves.	Vagus both above and below, pulmonary branches; lower more numerous than upper.	Branches of the two sides unite to form the plexus gulæ or œsophageal plexus, from which the branches are distributed to the pericardium and œsophagus.
Gastric nerves.	The vagus ends in the gastric branches.	The right gastric branch is distributed to the posterior surface of the stomach; the left, to the anterior.

CHAPTER VIII.

THE THORACIC AND SHOULDER REGIONS.

Dissection and Identification. Remove integument, as indicated in Figs. 74 and 76. Consult accompanying illustrations and find structures on cadaver in the order in which they are here given.

Sternum. Identify (1) by its location in the mid-line of the front of the thorax; (2) by its articulation with the inner end of the clavicle and the true ribs; (3) by a pronounced notch between the inner ends of the clavicles above and a prominent, movable, xiphoid or ensiform cartilage below.

Clavicle. Identify (1) by its location at the junction of the neck and thorax, extending from the upper end of the sternum outward to the acromion process of the scapula near the tip of the shoulder; (2) by its characteristic shape (italic *f*) and subcutaneous situation; (3) by its attachment to the sternum, acromion, and first rib.

Acromion Process. Identify (1) by its location at the tip of the shoulder; (2) by its continuity with the spine of the scapula; (3) by its articulation with the outer end of the clavicle (acromioclavicular); (4) by its situation at the apex of a V, the limbs of which are formed by the clavicle and scapular spine.

Coracoid Process. Identify (1) by its location under cover of the deltoid beneath the middle third of the clavicle; (2) by its attachment to the upper surface and inner border of the pectoralis minor, its outer border to the coraco-acromial ligament, its apex to the short head of the biceps and coracobrachialis muscles.

Arm-pit. Identify, when arm is at right angles to the thorax, as a depression (covered by hair), limited in front by the pectoralis major, behind by the latissimus dorsi, teres major, and scapula, internally by the ribs and serratus magnus muscle, externally by the humerus.

Superficial Fascia. Identify (1) by its location immediately beneath the skin; (2) by its loose cellulo fibrous structure enclosing fat in its spaces; (3) by its continuity with the superficial fascia of the neck, shoulder, arm, and abdomen; (4) by its non-attachment to bony eminences; (5) by its division into two lamellæ, between which are located the mammary glands.

Cephalic Vein. Identify by location in a groove between the pectoralis major and deltoid muscles with the descending branch of the acromial-thoracic artery. (See table, and illustration of cutaneous veins.)

Deep Fascia. Identify (1) by its location beneath the superficial fascia; (2) by its attachment to the sternum, clavicle, acromion, and scapular spine; (3) by its continuity with the deep fascia of the axilla, thorax, and back; (4) by perforations for transmission of nerves and vessels to skin, and superficial fascia.

Pectoralis Major Muscle. Identify (1) by its location at the upper and forepart of the chest in front of the axilla; (2) by its origin from the inner half of the clavicle, sternum, cartilages of true ribs, and aponeurosis of external oblique muscle.

Pectoralis Minor Muscle. Identify (1) by its location beneath the pectoralis major and its triangular shape; (2) by its origin from the upper margins and outer surfaces of the third, fourth, and fifth ribs near their cartilages, and insertion into the inner border and upper surface of the coracoid process of the scapula; (3) by the attachment of the costo coracoid membrane to its upper border; (4) by the relation of its posterior surface to the axillary vessels and brachial plexus.

Deltoid Muscle. Identify (1) by its triangular shape (apex down) and the rounded outline it confers on the shoulder; (2) by its origin from the outer third of the anterior border and upper surface of the clavicle, from the outer margin and upper surface of the acromion process, and from the lower lip and posterior border of the spine of the scapula; (3) by its insertion into the middle of the outer surface of the humerus; (4) by its extent, covering the anterior, outer, and posterior sides of the shoulder-joint.

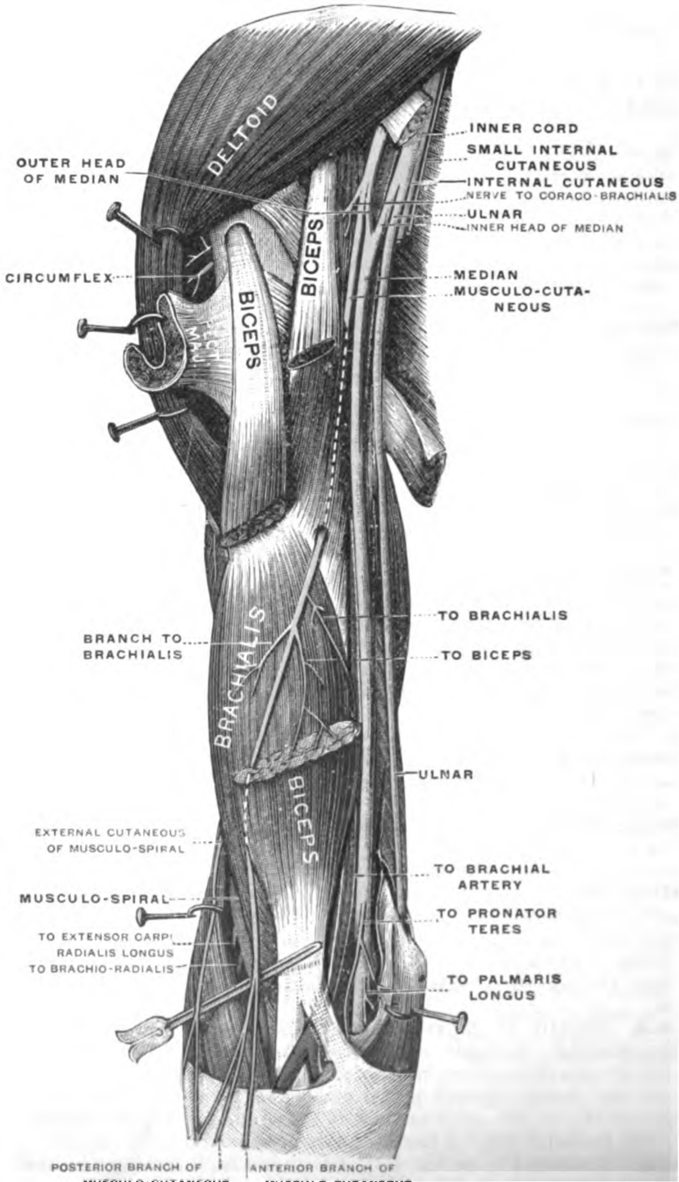
Biceps Muscle. Identify (1) by its fusiform shape and location on the whole anterior surface of the arm; (2) by the two heads of origin—a short from the apex of the coracoid process (in common with the coracobrachialis), a long from the upper margin of the glenoid cavity of the scapula; (3) by its insertion into the bicipital tuberosity of the radius.

Brachial Artery. Identify (1) by its origin (as a continuation of the axillary) at the tendon of the teres major, and termination on the flexor surface, at the bend of the elbow, in the radial and ulnar; (2) by its location internal to the biceps, coracobrachialis, and median nerve.

Coracobrachialis Muscle. Identify (1) by its origin from the apex of the coracoid process [illegible] the scapula with the short head of the biceps; (2) by its insertion into the middle of the [illegible]al surface and internal border of the humerus; (3) by being perforated by the musculo-[illegible] nerve; (4) by the relation of its anterior surface with the pectoralis major muscle, median nerve, and brachial vessels; (5) by the relation of its posterior surface with the anterior circumflex vessels, humerus, inner head of the triceps, teres major, latissimus dorsi, and subscapularis muscles.

Brachialis Anticus Muscle. Identify (1) by its origin from the lower half of the outer and inner surfaces of the humerus; (2) by its insertion into the coronoid process of the ulna; (3) by the relation of its anterior surface with the biceps muscle, brachial vessels, median and musculocutaneous nerves; (4) by the relation of the posterior surface with the humerus and elbow-joint.

FIG. 71.



Deep nerves of the front of the right arm. (GERRISH after TESTUT.)

Musculocutaneous Nerve. Identify (1) by its location between the biceps and brachialis anticus muscles; (2) by passing through the coracobrachialis muscle (usually); (3) by distribution to biceps, coracobrachialis, brachialis anticus, humerus, elbow, and skin of anterior part of forearm.

Circumflex Nerve and Posterior Circumflex Vessels. Cut the deltoid near insertion, turn same upward over the shoulder, and identify the nerve and the vessels emerging from the quadrilateral space and entering the deep surface of the deltoid muscle. (See Fig. ...

INTERMUSCULAR SEPTA.

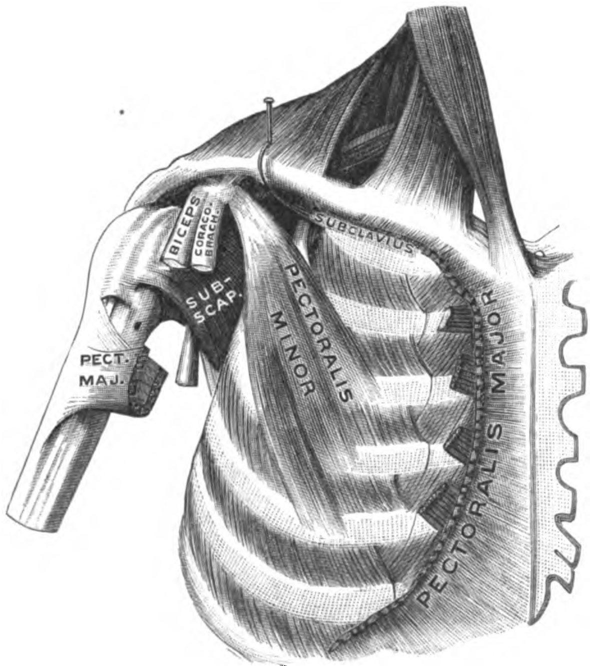
The External Intermuscular Septum, derived from the deep fascia, is attached to the outer lip of the bicipital groove, external condylar ridge of humerus, and outer humeral condyle, and gives attachment to the triceps, brachialis anticus, and supinator longus muscles. It is blended with the tendon of the deltoid muscle and is perforated by the musculospiral nerve and superior profunda artery.

The Internal Intermuscular Septum, a derivative of the deep fascia, is attached to the internal lip of the bicipital groove, internal condylar ridge, internal condyle, and gives attachment to the triceps and brachialis anticus muscles. It blends with the tendon of the coracobrachialis, and is perforated by the ulnar nerve, inferior profunda artery, and certain anastomotic arterial branches.

THE MUSCLES.

The Pectoralis Major Muscle. *Origin:* (1) Inner half of clavicle; (2) anterior surface of sternum; (3) cartilages of second, third, fourth, fifth, and sixth ribs; (4) sheath of rectus muscle. *Insertion:* External lip of bicipital groove, deltoid

FIG. 72.



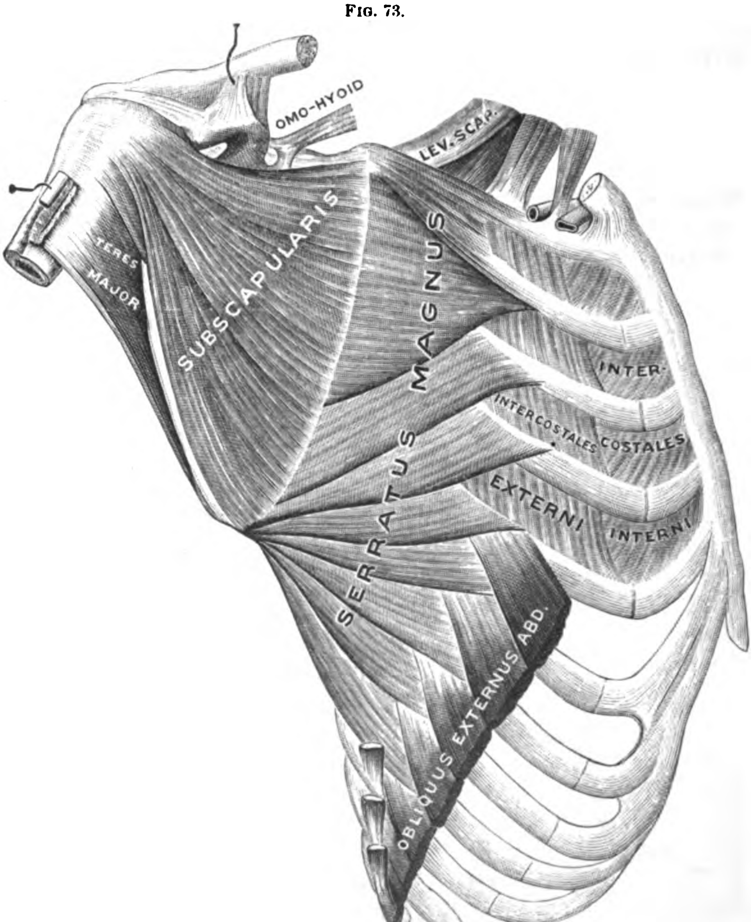
Pectoralis minor of right side. (GERRISH after TESTUT.)

tendon, and adjacent septa. *Action:* Adduction, flexion, and inward rotation of arm. *Synergist:* Subscapularis. *Antagonists:* Deltoid, supraspinatus, teres major, teres minor, latissimus dorsi. *Nerves:* External and internal anterior thoracic from outer and inner cords of brachial plexus. *Arteries:* Internal mammary, long thoracic, acromial-thoracic. The external anterior thoracic nerve from the outer cord of the brachial plexus (fifth, sixth, and seventh cervical nerves) crosses the axillary vessels, pierces the costo-coracoid membrane, and communicates with the internal anterior thoracic nerve.

The Pectoralis Minor muscle arises from the third, fourth, and fifth true ribs, and is inserted into the anterior border of the coracoid process of the scapula. Its nerve is the internal anterior thoracic, a branch of the inner cord of the brachial plexus. The internal anterior thoracic nerve sends filaments to the major pectoral muscle and passes between the axillary artery and vein.

The Subclavius Muscle. *Origin:* Junction of first rib and its cartilage. *Insertion:* Groove on under surface of middle third of clavicle. *Action:* To depress shoulder by drawing clavicle downward and forward. *Nerve:* From upper trunk of brachial plexus. *Synergist:* Serratus magnus. *Antagonist:* Trapezius. The subclavius muscle, brachial plexus, and subclavian vessels are beneath the clavicle.

FIG. 73.



Serratus magnus of right side. The scapula has been turned backward and drawn outward. (Modified from GERRISH after TESTUT.)

The Costo-coracoid Membrane fills the space between the clavicle and pectoralis minor muscle and covers the axillary vessels and nerves. The membrane is attached to clavicle, sheath of subclavius muscle, first rib, coracoid process, and minor pectoral muscle. It is pierced by the cephalic vein, anterior thoracic nerves, and acromial thoracic vessels. The part of the membrane extending from the first rib to the coracoid process is called the costo-coracoid ligament.

The Serratus Magnus Muscle. *Origin:* Outer surface of eight or nine ribs. *Insertion:* Anterior lip of vertebral border of scapula. *Action:* To draw vertebral border of scapula forward. *Synergist:* Pectoralis minor. *Antagonist:* Trapezius. *Nerve:* Posterior thoracic, from brachial plexus above clavicle. *Arteries:*

Intercostals. *Nerve:* The posterior thoracic from fifth, sixth, and seventh cervical nerves, at their emergence from the intervertebral foramina. The nerve passes behind the brachial plexus and axillary vessels, and as it lies on the serratus magnus muscle, gives branches to each digitation thereof.

The Biceps Muscle has two heads (short and long). *Origin of short head:* Apex of coracoid process, with coracobrachialis. *Origin of long head:* Supraglenoid tubercle above glenoid cavity. *Insertion:* Bicipital tuberosity of radius and deep fascia of forearm. *Action:* Flexion of forearm. *Synergists:* Brachialis anticus and supinator longus. *Antagonist:* Triceps. *Nerve:* Musculocutaneous. *Artery:* Brachial. The bicipital fascia, extending from the inner side of the tendon of biceps, opposite bend of elbow, crosses brachial vessels and blends with the deep fascia of upper and inner forearm region.

The Coracobrachialis Muscle. *Origin:* Apex of coracoid process. *Insertion:* Middle third of humerus, inner border. *Action:* Adduction and flexion of humerus. *Synergist:* Pectoralis major. *Antagonists:* Infraspinatus and teres major. *Nerve:* Musculocutaneous, from outer cord of brachial plexus. *Artery:* Acromial-thoracic and brachial. This muscle is pierced by the musculocutaneous nerve.

Brachialis Anticus Muscle. *Origin:* Lower half of internal and external surfaces of humerus. *Insertion:* Coronoid process of ulna. *Action:* Flexion of forearm. *Nerve:* Musculocutaneous, from outer cord of brachial plexus. *Artery:* Brachial. *Synergists:* Biceps and brachio-radialis. *Antagonist:* Triceps.

The Deltoid Muscle. *Origin:* (1) Outer third of clavicle; (2) outer border of acromion process; (3) lower lip of scapular spine. *Insertion:* Outer surface of humerus in lower part of upper third. *Action:* Abduction, extension, and external rotation of humerus. *Synergists:* Supraspinatus, infraspinatus, teres minor. *Antagonists:* Pectoralis major, subscapularis. *Nerve:* Circumflex, from posterior cord of brachial plexus. *Arteries:* Acromial-thoracic, anterior and posterior circumflex.

The Teres Minor Muscle. *Origin:* (1) Upper two-thirds of axillary border of scapula; (2) adjacent intermuscular septa. *Insertion:* Greater tuberosity of humerus and capsule of shoulder-joint. *Action:* External rotation. *Synergist:* Infraspinatus. *Antagonists:* Subscapularis and pectoralis major. *Nerve:* Circumflex. *Artery:* Posterior circumflex.

(**The Quadrilateral Space** is bounded externally by neck of humerus; internally by long head of triceps; above by teres major behind and subscapularis in front; below by teres major and latissimus dorsi. See page 134.)

The Supraspinatus Muscle. *Origin:* (1) Inner two-thirds of supraspinous fossa; (2) spine of scapula and supraspinous fascia. *Insertion:* Greater tuberosity of humerus and capsule of shoulder-joint. *Action:* Abduction. *Synergist:* Deltoid. *Antagonists:* Pectoralis major and subscapularis. *Nerve:* Suprascapular, from brachial plexus (above the clavicle). *Artery:* Suprascapular.

The Infraspinatus. *Origin:* (1) Infraspinous fossa, inner two-thirds; (2) spine of scapula; (3) fascia and intermuscular septum, between it and tereal muscles. *Insertion:* Greater tuberosity of humerus. *Action:* External rotation. *Synergist:* Teres minor. *Antagonists:* Subscapularis and pectoralis major. *Nerve:* Suprascapular. *Artery:* Suprascapular.

The Suprascapular Nerve arises from the upper trunk of the brachial plexus and passes beneath the trapezius muscle through the suprascapular notch. *Distribution:* To supraspinatus and infraspinatus muscles, to shoulder-joint; gray rami communicantes.

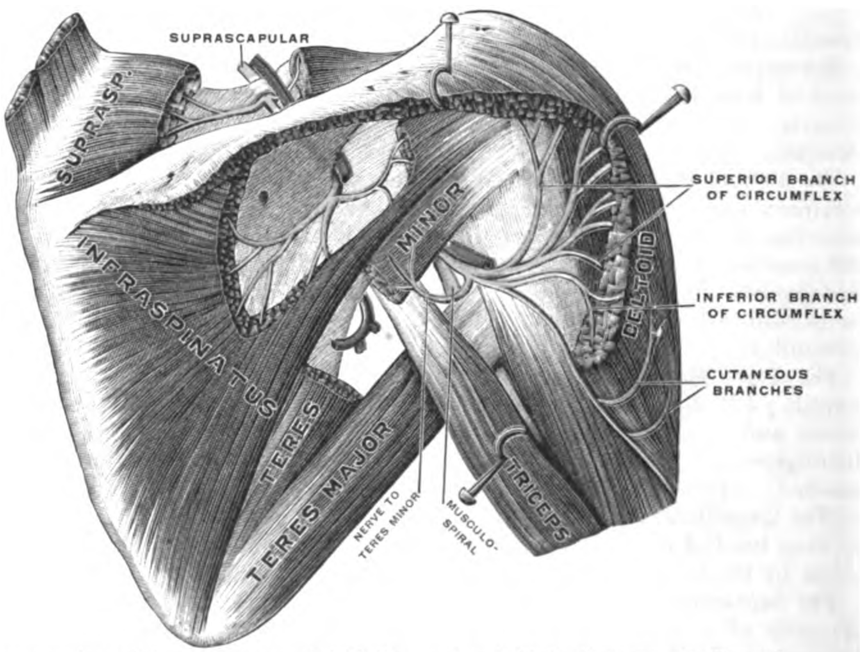
The Suprascapular Artery arises from thyroid axis of the subclavian, passes behind and parallel to the clavicle, beneath the omohyoid muscle to the supraspinous fossa. It does not pass through the suprascapular notch with the suprascapular nerve, but crosses the transverse scapular ligament. The suprascapular artery anastomoses with the acromial-thoracic, posterior circumflex, subscapular, and posterior scapular arteries, and is attended by one or two veins, whose tributaries correspond to branches of the artery, in number and location.

THE NERVES.

The Musculocutaneous Nerve is a branch of the outer cord of the brachial plexus. It pierces coracobrachialis, lies between biceps and brachialis anticus, and becomes cutaneous above elbow to outer side of biceps tendon. There are two nerves for biceps, one for each head. The nerve to coracobrachialis muscle is given off near origin of this muscle. The cutaneous branch is distributed to skin of front and outer part of forearm. The humerus, elbow, and greater part of the brachialis anticus are supplied by this nerve.

The Circumflex Nerve, a branch of the posterior cord of brachial plexus, supplies deltoid, teres minor, shoulder-joint, and integument over lower two-thirds of deltoid. It gains posterior part of arm through quadrilateral space with posterior circumflex vessels. The posterior circumflex artery is a branch of the axillary and

FIG. 74.



Suprascapular and circumflex nerves of right side, seen from behind. (GERRISH after TESTUT.)

has two venæ comites. The anterior circumflex artery, smaller than the posterior, is a branch of the axillary; it passes beneath the coracobrachialis and the short head of biceps to the bicipital groove, whence its branches proceed to the shoulder-joint and head of the humerus.

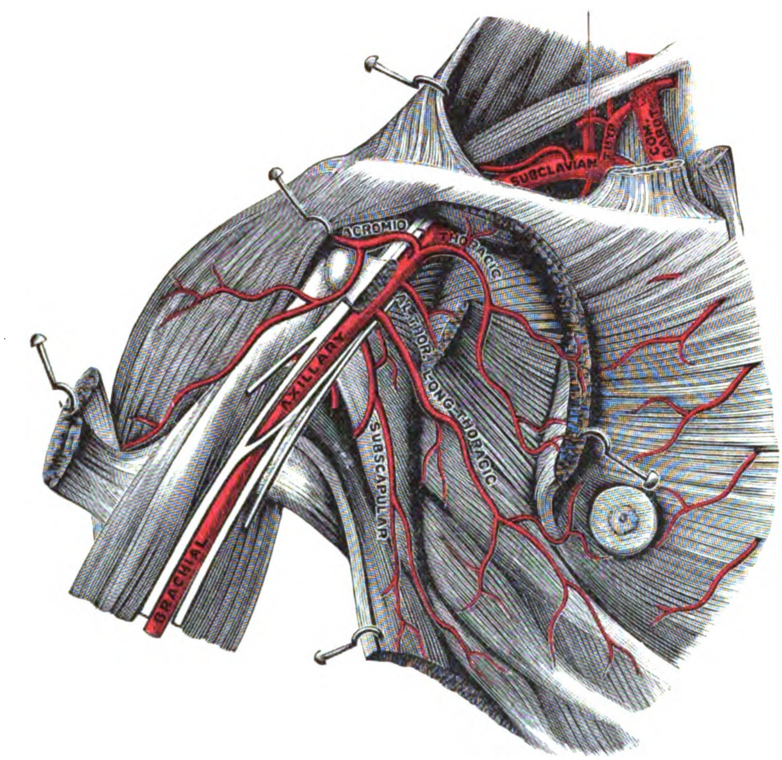
AXILLARY SPACE.

The Axillary Space (analysis, Fig. 75). The apex, the highest part of the space, is bounded by the first rib, clavicle, and superior border of the scapula. The axillary vessels and brachial plexus of nerves pass through it. The apex is a passage connecting root of neck with axillary space. The base of axillary space is the lowest part. It corresponds to the hollow under the arm. The base is composed of hairy skin, superficial and deep fasciæ. The deep fascia of the base is the axillary fascia. The structures forming axillary base extend from lower margin of pectoralis major to latissimus dorsi and teres major muscles. The anterior boundary is formed by skin, superficial fascia, pectoral fascia, pectoralis major muscle, pectoralis minor muscle, costo-coracoid membrane, and subclavius muscle. The posterior boundary is formed by the subscapularis, latissimus dorsi, and teres major muscles. The inner boundary is formed by first four ribs, their intercostal muscles, and a portion of the serratus magnus muscle. The external boundary is narrow and formed by the humerus, biceps, and coracobrachialis muscles. *Contents:* (1) Axillary artery and its branches; (2) axillary vein and its tributaries; (3) brachial plexus and its branches; (4) intercosto-humeral nerve (the lateral cutaneous branch of second intercostal) distributed to skin of arm; (5) ten or twelve lymphatic glands, which surround the axillary vessels. These vessels, nerves, and glands are bound together by connective tissue, within which is more or less fat. (See Gray's *Anatomy*.)

AXILLARY ARTERY.

The Axillary Artery, a continuation of the subclavian, begins at the outer border of the first rib and ends at the base of the axillary space. The artery has

FIG. 75.



Axillary and subclavian arteries. (GERRISH after TESTUT.)

three stages—first, second, and third. The first stage extends from the outer border of the first rib to the upper border of the pectoralis minor muscle. The second stage is beneath the pectoralis minor. The third stage extends from the lower border of the pectoralis minor to the base of the axillary space.

The Axillary Vein has the same course and stages as the artery. It lies internal to and partially obscures the artery. It begins at the base of the axillary space as a continuation of the basilic vein and ends in the subclavian vein. Its tributaries correspond in the main to the branches of the artery. (See Gerrish.)

Relations of Axillary Artery (superficial, internal, external, and posterior). 1. **Superficial:** Skin, superficial and deep fasciæ, pectoral muscles, costo-coracoid membrane, clavicle, subclavius muscle, external anterior thoracic nerve, cephalic vein, acromial-thoracic vessels, and inner head of median nerve. 2. Internal: Axillary vein, inner cord of brachial plexus, ulnar, and internal cutaneous nerves. 3. External: Coracobrachialis muscle, brachial plexus, median and musculocutaneous nerves. 4. Posterior: Subscapularis, teres major, latissimus dorsi, first intercostal space, second and third serrations of serratus magnus, posterior thoracic nerve, internal anterior thoracic nerve, musculospiral and circumflex nerves.

The branches of the axillary artery are: 1. The superior thoracic (from first portion), which passes between the pectoral muscles (to side of the chest), to both of which it is distributed.

2. Acromial thoracic (from first portion), which courses to upper border of the minor pectoral muscle, dividing into acromial, thoracic, and humeral branches for distribution in these respective regions.

3. Long thoracic (from second portion), which courses along the lower border of the minor pectoral muscle to axillary and mammary glands and contiguous regions.

4. Alar thoracic (from second portion), which pass to the axillary space for the supply of the axillary connective tissue and axillary glands.

5. Subscapular (from third portion), which passes along the subscapularis muscle to the posterior wall of the axilla, deltoid, triceps, infraspinatus, and latissimus dorsi.

6. Anterior circumflex (from third portion), which passes beneath the coracobrachialis and short head of the biceps muscle to the head of the humerus and shoulder-joint.

7. Posterior circumflex (from third portion), which, passing through quadrilateral space with the circumflex nerve, is distributed to the deltoid muscle. (See p. 134.)

BRANCHES OF BRACHIAL PLEXUS.

Dissection. The brachial plexus has been described on page 131. It now becomes necessary to dissect its branches of distribution. The following order is advised: 1. Consult Fig. 76 and find the name and location of the particular nerve. 2. Dissect the nerves in the order given below; first, those derived from the outer cord (three); second, those derived from the inner cord (five); third, those derived from the posterior cord (three). 3. Study the relation of median, ulnar, circumflex, and musculospiral to the axillary artery. 4. Trace the musculocutaneous through the coracobrachialis muscle and the circumflex through the quadrilateral space. 5. Associate nerves and arteries in the following cases: (*a*) The median, with the brachial; (*b*) the ulnar (above the elbow), with the inferior profunda; (*c*) the musculospiral, with the superior profunda; (*d*) the radial, with the radiæ; (*e*) the ulnar (below the elbow), with the ulnar; (*f*) the circumflex, with the posterior circumflex.

The three cords of the brachial plexus give off the following branches below the clavicle:

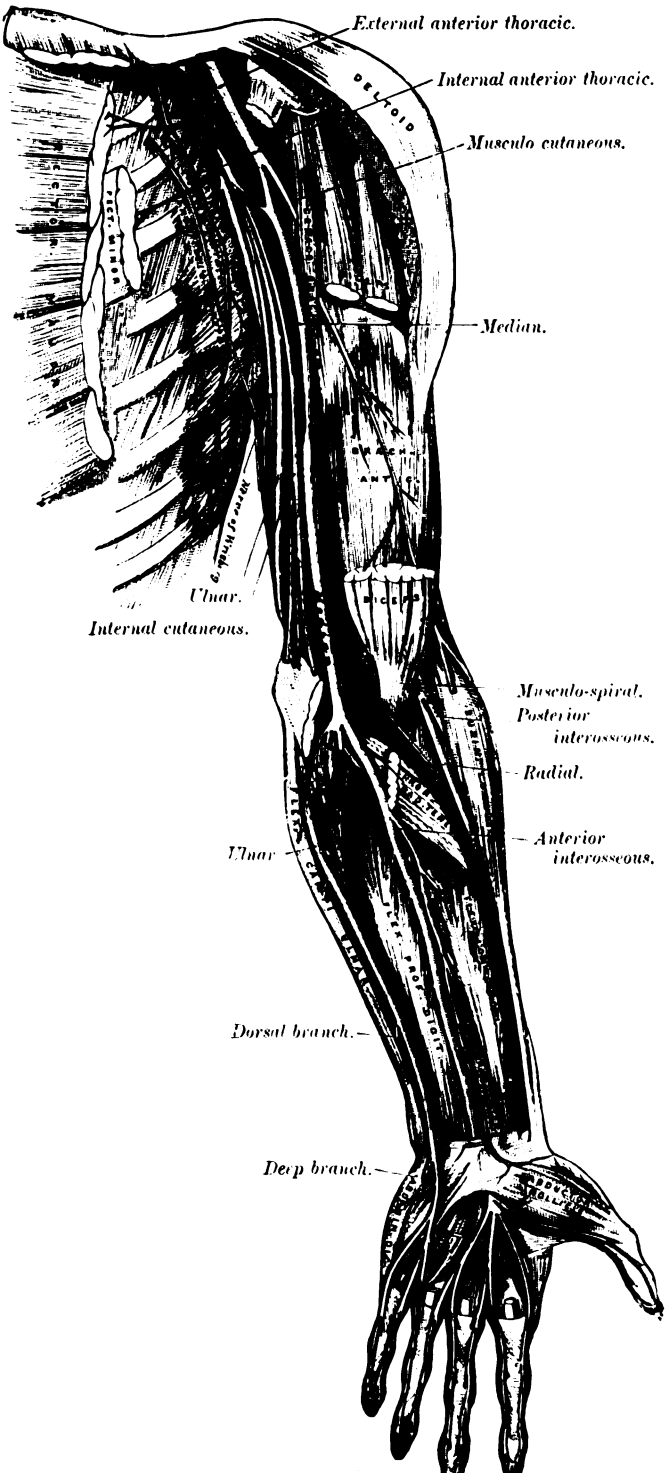
The outer cord. 1. External anterior thoracic, which crosses the axillary vessels, pierces the costo-coracoid membrane, and supplies the pectoralis major, forming communication with the internal anterior thoracic nerve.

2. Musculocutaneous, which perforates the coracobrachialis, passes between the biceps and brachialis anticus to the muscles of the front of the arm, humerus, elbow-joint, and skin of the anterior part of the forearm.

3. Outer head of the median nerve, which unites with the inner head (from inner cord) for the supply of (*a*) all muscles of front of forearm, except flexor carpi ulnaris and inner half of flexor profundus digitorum); (*b*) all muscles of ball of thumb (except adductor pollicis and inner head of flexor brevis pollicis); (*c*) the two outer lumbrical muscles; (*d*) skin of palmar surface of thumb, index, middle, and radial half of ring finger; (*e*) articular branches to certain joints.

The inner cord. 1. Inner head of the median nerve, which unites with the outer head. (See above.)

FIG. 76.



Nerves of the left upper extremity. (GRAY.)

2. Internal anterior thoracic, which passes (between axillary artery and vein) (*a*) to the under surface of the pectoralis minor; (*b*) through the costo-coracoid membrane to the pectoralis major muscle.

3. Internal cutaneous, which passes downward (internal to brachial artery), pierces the deep fascia, with basilic vein, in middle third of arm, and is distributed (*a*) to the skin covering the biceps; (*b*) to the skin of the anterior and posterior surfaces of the forearm on the ulnar side.

4. Lesser internal cutaneous (Wrisberg), which passes behind and internal to the axillary vein, and along brachial artery to the middle of the forearm, where it pierces the deep fascia and is distributed (*a*) to the skin of the back of the lower third of the arm; (*b*) to the skin over the olecranon process and inner condyle.

5. Ulnar, which passes along the inner side of the axillary and brachial arteries to the middle of the arm, where it crosses the inner head of the triceps and pierces the internal intermuscular septum; thence it descends between the olecranon process and internal condyle (with the inferior profunda artery), passes between the two heads of the flexor carpi ulnaris to the forearm, and is distributed (*a*) to the flexor carpi ulnaris and ulnar half of the flexor digitorum profundus; (*b*) to the adductor pollicis and ulnar head of the flexor brevis pollicis; (*c*) to the adductor transversus and obliquus pollicis; (*d*) to the two ulnar lumbricals; (*e*) to all the interossei muscles of the hand; (*f*) to the integument of the little finger and ulnar side of the ring finger, dorsally and palmarly.

The posterior cord. 1. Three subscapular nerves (upper, lower, and middle), distributed as follows: (*a*) the upper, to the subscapularis muscle; (*b*) the lower, to the teres major; (*c*) the middle, to the latissimus dorsi.

2. Circumflex nerve, which passes through the quadrilateral space (with the posterior circumflex artery) to (*a*) deltoid and teres minor muscles; (*b*) skin covering the lower two-thirds of the deltoid muscle; (*c*) skin covering the long head of the triceps.

3. Musculospiral, which passes behind the axillary and upper part of the brachial arteries, thence through the musculospiral groove (on the posterior surface of the humerus) with the superior profunda artery to the following distribution: (*a*) triceps; (*b*) muscles of radial and posterior parts of the forearm; (*c*) skin of posterior part of the arm, forearm, and hand.

BRACHIAL ARTERY.

The Brachial Artery begins at the lower border of the tendon of the teres major (as a continuation of the axillary) and ends at the bend of the elbow in the radial and ulnar. The artery is attended by two veins, which lie one on each side of the artery, and unite just above the lower margin of the tendon of the latissimus dorsi to form the axillary vein. With the exception of the nutrient, branches of the axillary vein correspond in number and location to those of the artery.

Relations: The brachial artery (with its two venæ comites) has the following relations: Anterior: Integument, superficial fascia, deep fascia. Posterior: Triceps muscle, musculospiral nerve, superior profunda artery, coracobrachialis insertion, brachialis anticus muscle. External: Median nerve, coracobrachialis and biceps muscles. Internal: Internal cutaneous nerve, ulnar nerve, median nerve, below, and basilic vein in the upper half.

The brachial artery has the following branches:

1. Superior profunda (from the inner and back part), which passes between the inner and outer heads of the triceps with the musculospiral nerve, to the following distribution: (*a*) anterior and posterior articular; (*b*) nutrient to humerus; (*c*) muscular branches to triceps.

2. Nutrient (middle of arm), which passes through the nutrient canal of the humerus to the medulla of the shaft of this bone, anastomosing with the periosteal arteries.

3. Inferior profunda (below middle of arm), which accompanies ulnar nerve, and anastomoses with the anterior and posterior ulnar recurrent arteries.

4. Anastomotica magna (two inches above elbow), which crosses the brachialis anticus and is distributed to the triceps, and anastomoses with the anterior and posterior ulnar recurrent, superior, and inferior profundæ.

5. Muscular branches (three or four) are given off in its course to the biceps, coracobrachialis, and brachialis anticus.

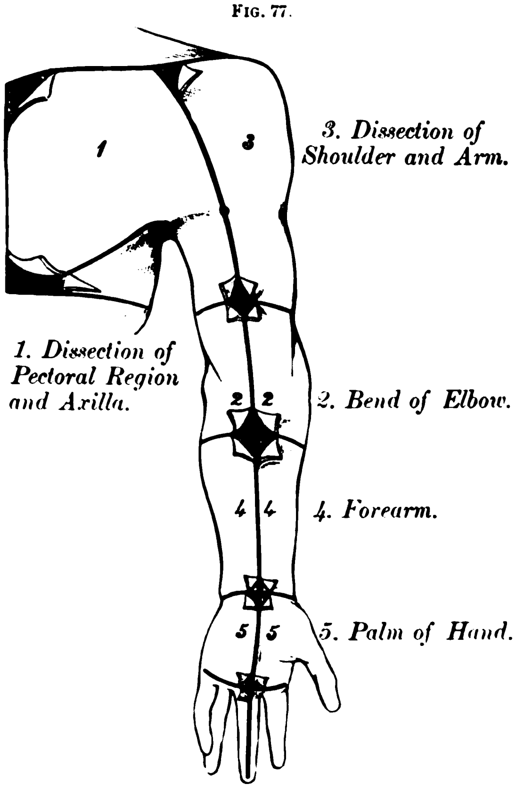
CHAPTER IX.

CUTANEOUS VEINS AND NERVES OF UPPER EXTREMITY—ANTERIOR REGION OF FOREARM.

Dissection, Identification. Remove the integument, as indicated in Fig. 77. Be guided by the illustrations and text in identifying the structures found. When dissecting the nerves and vessels, divide the connective tissue surrounding the same in the direction of the main trunk and its branches. Do not use the scalpel in developing the branches of vessels and nerves.

Superficial Fascia. Identify (1) by its location immediately beneath the integument and a variable amount of fat in its meshes; (2) by the free mobility it confers on the skin (except in the soles and palms); (3) by the presence of a large number of cutaneous arteries, veins, and nerves.

FIG. 77.



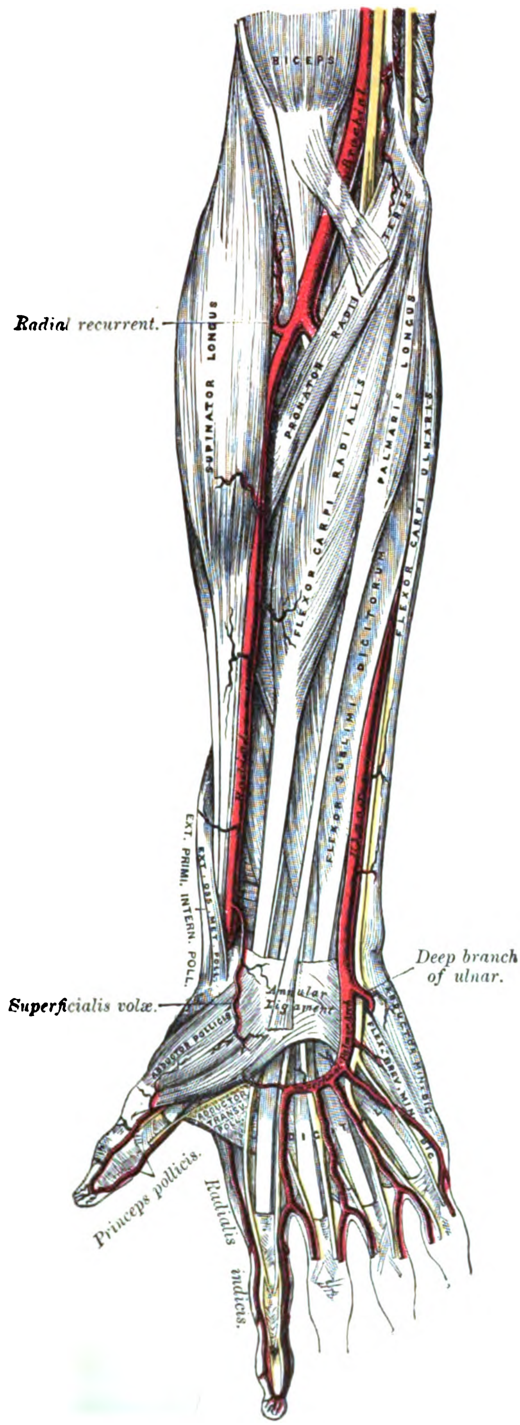
Dissection of upper extremity. (GRAY.)

Deep Fascia. Identify (1) by its location beneath the superficial fascia; (2) by its attachment to the bony eminences about the elbow and wrist, and formation of the septa and sheaths; (3) by the aponeurotic expansion it receives from biceps, triceps, and brachialis anticus; (4) by continuity with the anterior annular ligament at the wrist.

Cutaneous Veins. Identify by its location in the superficial fascia. To make a thorough study of these structures on the cadaver, turn to the proper illustration (Fig. 80) and seek the name of a given vein; then find this name in the first column of the table of cutaneous veins on page 155. In the second, third, and fourth columns study their source, course, and distribution, respectively.

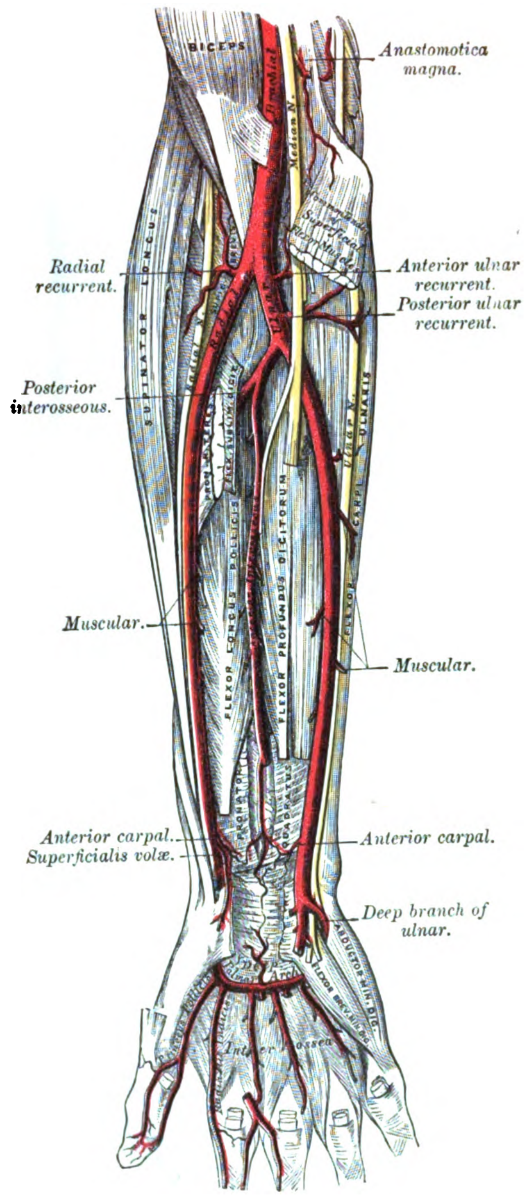
Cutaneous Nerves. Identify (1) by their distribution to skin; (2) by their passage through perforations in the deep fascia and their location in the deep layer of the superficial fascia. Study their source, course, and distribution by the illustrations and the table of cutaneous nerves (Figs. 81, 82), the same as the veins are studied.

FIG. 78.



The radial and ulnar arteries. (GRAY.)

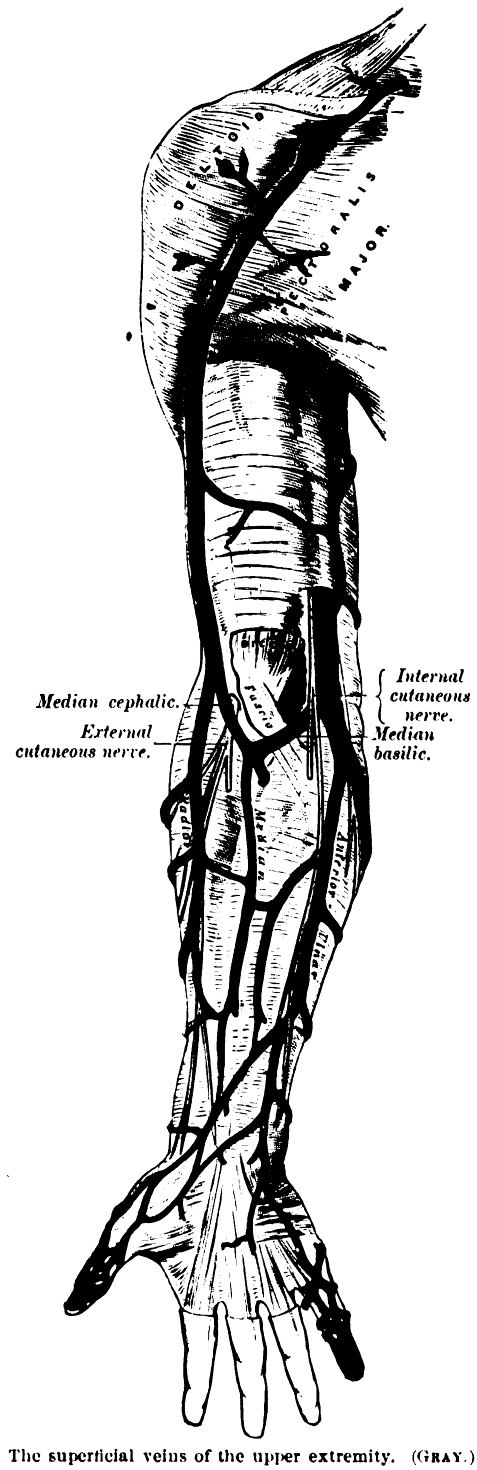
FIG. 79.



Ulnar and radial arteries. Deep view. (GRAY.)

Anterior Annular Ligament. Identify (1) by its location on the front of the carpus, with firm attachments to the carpal bones; (2) by its continuity with the palmar fascia below and the deep fascia of the forearm above; (3) by the presence beneath it of the median nerve, flexor of thumb, and flexors of the fingers beneath.

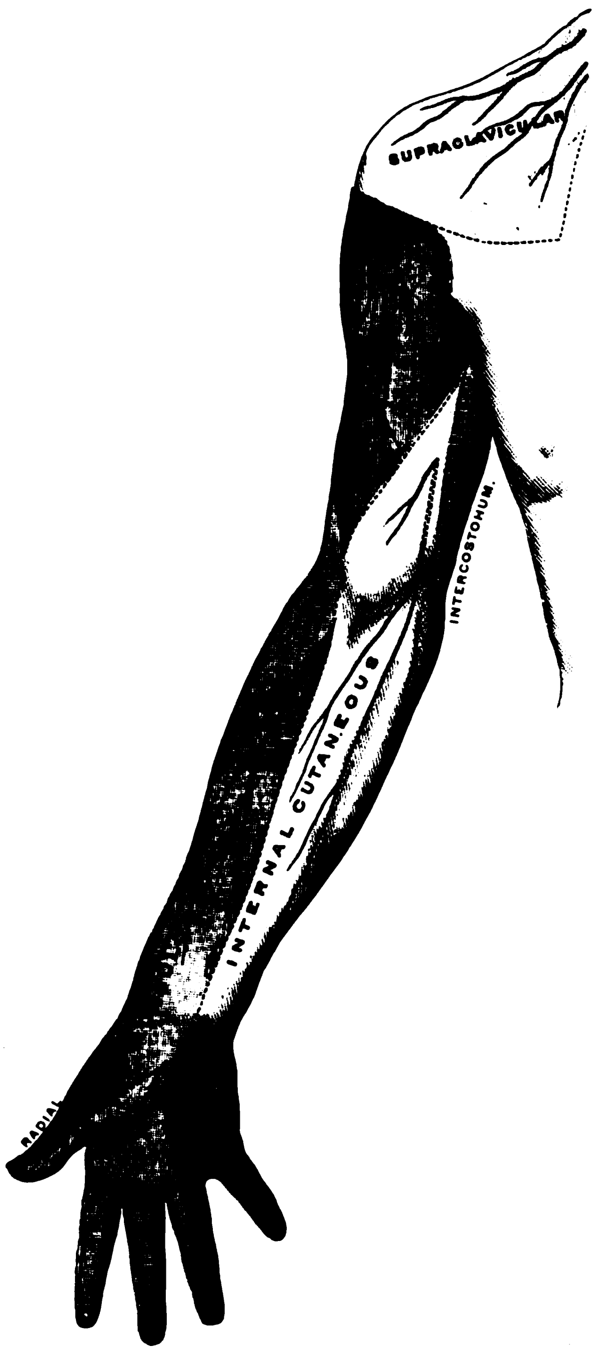
Fig. 80.



The superficial veins of the upper extremity. (Gray.)

Palmar Fascia. Identify (1) by its location on the palmar surface of the hand; (2) by its continuity with the anterior annular ligament above; (3) by its strong, glistening appearance, seen when the superficial fascia and granular fat are removed.

Fig. 81.



Cutaneous nerves of the upper limb, ventral aspect. (GERRISH after W. KEILLER.)

Fibrous Sheaths (ligamenta vaginalia). Identify (1) by the location on the flexor surface of the fingers; (2) by the contents—the tendons of the flexors sublimis and profundus digitorum inverted by a synovial membrane called the theca. (Fig. 84.)

The Common Tendon. This is identified by its attachment to the inner humeral condyle. It gives partial origin to the pronator radii teres, flexor carpi radialis, palmaris longus, flexor sublimis digitorum, and flexor carpi ulnaris.

FIG. 82.

Cutaneous nerves of the upper limb, dorsal aspect. (GERRISH after W. KEILLER.)

Pronator Radii Teres. Identify (1) by its insertion into the middle of the outer surface of the radius; (2) by the two heads, between which the median nerve gains the forearm.

Flexor Carpi Radialis. Identify (1) by its passage through a groove in the os trapezium and insertion into the bases of the second and third metacarpals; (2) by its adjacency to the radial artery.

Palmaris Longus. Identify (1) by its insertion into the anterior annular ligament and palmar fascia; (2) by its delicate tendon (sometimes absent) in the mid-line of the lower part of the forearm.

Flexor Sublimis Digitorum. Identify (1) by its four terminal tendons slit and transmitting the four corresponding tendons of the flexor profundus digitorum; (2) by its insertion into the sides of the second phalanges.

Flexor Carpi Ulnaris Identify (1) by its location on the ulnar side of the forearm; (2) by its insertion into the pisiform and adjacent bones; (3) by the adjacency of the ulnar artery and nerve.

Flexor Profundus Digitorum Identify (1) by its origin from the ulna and interosseous membrane; (2) by its division into four tendons, which pass through the slits in the corresponding tendons of the flexor sublimis digitorum

Flexor Longus Pollicis. Identify (1) by the origin from the anterior surface of the radius; (2) by its insertion into the base of the distal phalanx of the thumb.

Pronator Quadratus. Identify by its quadrate shape and its location on the anterior surface of the lower fourth of the radius and ulna.

Supinator Brevis. Identify (1) by its extensive origin from the outer condyle of the humerus and adjacent structures; (2) by the posterior interosseous nerve passing to the back of the forearm between the upper and deep parts of the muscle.

Cubital Fossa Identify (1) by its location at the bend of the elbow; (2) by the presence of the brachial, ulnar, radial arteries, median nerve, tendon of biceps, and cutaneous veins and nerves. (Figs. 79, 80, 81.)

Median Nerve. Identify (1) by its location to the inner side of the brachial artery in the cubital fossa; (2) by its location beneath the flexor sublimis digitorum in the forearm; (3) by its location beneath the anterior annular ligament with the flexors of the thumb and fingers.

Ulnar Nerve. Identify (1) by its location between the two heads of the flexor carpi ulnaris; (2) by its location in the ulnar groove (with the ulnar vessels), between the flexor carpi ulnaris and the flexor sublimis digitorum.

Radial Artery. Identify (1) by its origin in the cubital fossa (from the bifurcation of the brachial) with the ulnar; (2) by its location in its course downward on the tendon of the biceps, supinator brevis, flexor sublimis digitorum, pronator radii teres, flexor longus pollicis, pronator quadratus, and radius.

Ulnar Artery. Identify (1) by its origin in the cubital fossa from the brachial with the radial; (2) by its course in the upper third of the forearm beneath all the muscles arising from the inner humeral condyle (except the flexor carpi ulnaris); (3) by its course in the lower two-thirds of the forearm in the ulnar groove with the ulnar nerve. (See Ulnar Nerve, p. 164.)

Superficial Palmar Arch. Identify (1) by its source from the ulnar artery near the pisiform bone; (2) by its arched course across the palm and location beneath the skin, fascia, palmaris brevis, palmar fascia, and resting on the flexor tendon of the fingers (Fig. 78); (3) by its distribution to all the digits except the thumb and radial side of the index; (4) by its anastomosis on the radial side of the anterior ligament, with the superficialis volæ of the radial artery.

Deep Palmar Arch. Identify (1) by its source from the radial artery and course between the heads of the first dorsal interosseous muscle, between the adductor and flexor brevis pollicis; across the bases of the metacarpal bones; (2) by the anastomosis with deep branch of the ulnar artery. (Fig. 79.)

TABLE OF CUTANEOUS VEINS OF THE UPPER EXTREMITY. (Fig. 80.)

Name.	*Source.*	*Course and Location.*	*Destination.*
Dorsal plexus of veins.	Formed by veins from the fingers.	Located on the dorsum of the hand, on the radial and ulnar sides.	Terminates in the radial, median, and ulnar veins.
Anterior plexus of veins.	Veins from the palm and thumb.	Located on the anterior part of the wrist.	Terminates in the median and anterior ulnar veins.
Radial vein.	Radial side of the dorsal plexus of veins.	Along the radial side of the forearm to the outer side of the tendon of the biceps muscle.	Joins the median cephalic vein to form the cephalic vein.
Posterior ulnar vein.	The ulnar side of the dorsal plexus.	Back part of the ulnar surface of the forearm to the inner side of the internal condyle.	Is joined by the anterior ulnar vein at the inner side of the internal condyle, to form the common median vein, which latter unites with the median basilic, to form the basilic vein.
Anterior ulnar vein.	The anterior plexus of the veins.	Anterior surface of the forearm, on the ulnar side.	Joins the posterior ulnar near the elbow, to form the common ulnar vein.
Common ulnar vein.	Confluence of the anterior and posterior ulnar veins.	Upward on the inner and flexor part of elbow.	Joins the median basilic to form the basilic vein.

Name.	*Source.*	*Course and Location.*	*Destination.*
Median vein.	The anterior plexus of veins on the front of the wrist.	Along the median front of the forearm to the bend of the elbow.	Divides into the median cephalic and median basilic, which help form the cephalic and basilic veins respectively.
Median basilic vein.	Bifurcation of median vein opposite the elbow.	Crosses the brachial and bicipital fasciæ and internal cutaneous nerves.	Joins the common median vein to form the basilic.
Median cephalic vein.	Bifurcation of median vein opposite the bend of the elbow.	In the groove between the biceps and supinator longus muscles.	Joins the radial vein to form the cephalic vein.
Basilic vein.	Confluence of the common, ulnar, and median basilic, near bend of the elbow.	To the inner side of the biceps, internal to the brachial artery, and up to the middle third of the forearm.	Perforates the deep fascia and joins the venæ comites of the brachial artery, to form the axillary vein.
Cephalic vein.	Confluence of median cephalic and radial.	A groove external to the biceps muscle; a second groove between the pectoralis major and deltoid muscles, with the descending branch of the acromial thoracic artery.	Crosses the first stage of the axillary artery and ends in the axillary vein.

TABLE OF CUTANEOUS NERVES OF THE UPPER EXTREMITY. (Figs. 81, 82.)

Name.	*Spinal Source.*	*Course.*	*Distribution.*
Suprasternal nerve.	3d and 4th cervical, cervical plexus.	Emerges between the sternomastoid and trapezius and crosses the clavicle and sternum.	To integument covering the upper half of the sternum; to the sternoclavicular joint.
Supraclavicular nerve.	3d and 4th cervical, cervical plexus.	Emerges between the sternomastoid and trapezius and crosses the clavicle.	To the integument covering the pectoralis major as far down as the nipple.
Supra-acromial nerve.	3d and 4th cervical, cervical plexus.	Emerges between the sternomastoid and trapezius and crosses the clavicle.	To the integument of the upper and back part of the shoulder; to the acromio-clavicular joint.
Circumflex nerve.	5th and 6th cervical, brachial plexus, from posterior cord.	Passes through the quadrilateral space and divides into anterior and posterior branches.	To the integument covering the lower two-thirds of the deltoid; to shoulder-joint; motor to deltoid and teres minor muscles; skin over long head of triceps.
Internal cutaneous nerve.	8th cervical and 1st dorsal, brachial plexus, inner cord.	Pierces the deep fascia with the basilic vein in the middle third of the arm, and divides into anterior and posterior branches.	To the integument of the inner part of the arm and forearm, as far as the carpus.
Lesser internal cutaneous nerve.	1st thoracic, brachial plexus, inner cord.	Descends on the inner side of the brachial artery and pierces the deep fascia in the middle third of the arm.	To the integument of the back of the lower third of the arm; over the olecranon process; in front of the internal condyle.
Intercosto-humeral nerve.	Lateral cutaneous branch of second intercostal nerve. It does not divide as do the other cutaneous branches into anterior and posterior divisions.	Perforates the external intercostal muscle, crosses the base of the axillary space, and joins the lesser internal cutaneous.	To the integument of the upper half of the inner and back part of the arm.
Cutaneous branch of the musculo-cutaneous nerve.	5th, 6th and 7th cervical, from outer cord of brachial plexus.	Perforates the coracobrachialis, lies between the biceps and brachialis anticus, pierces the deep fascia external to the tendon of the biceps.	To the integument over the anterior and posterior radial regions of the forearm and thenar eminence; articular branch to the elbow; gray ramus to humerus; (motor to coraco-brachial, biceps, and brachialis anticus.)

Name.	*Spinal Source.*	*Course.*	*Distribution.*
Cutaneous of the ulnar.	8th cervical and 1st thoracic.	Pierces the deep fascia near the wrist.	To the integument of the forearm above the wrist.
Cutaneous palmar of the ulnar.	8th cervical and 1st thoracic.	Lies on the ulnar artery.	To the integument of the palm corresponding to one-and-a-half fingers.
Cutaneous dorsal of the ulnar.	8th cervical and 1st thoracic.	Pierces the deep fascia about two inches above the wrist, passes beneath the flexor carpi ulnaris.	To the integument of the dorsum of the hand, wrist, little finger, and the ulnar half of the ring finger.
Cutaneous palmar of the median.	6th, 7th, and 8th cervical and 1st thoracic; brachial plexus.	Pierces the deep fascia above the annular ligament.	Integument of the palm corresponding to three-and-a-half fingers; to the skin over the ball of the thumb.
Cutaneous digital of the median.	6th, 7th, and 8th cervical and 1st thoracic; brachial plexus.	Emerge from beneath the anterior annular ligament, in course of median nerve.	To integument of radial three-and-a-half fingers.
Cutaneous, internal from the musculospiral.	6th, 7th, and 8th cervical from the brachial plexus; posterior cord.	Passes through the axillary space.	To integument of the posterior part of the arm as far as the olecranon; to the front of the elbow.
Cutaneous, external from the musculospiral.	6th, 7th, and 8th cervical from the brachial plexus; posterior cord.	Pierce the outer head of the triceps.	To the posterior surface of the radial side of the forearm; outer and anterior surface of lower half of the arm.
Radial, a branch of the musculospiral.	6th, 7th, and 8th cervical from the brachial plexus; posterior cord.	To outer side of the radial artery beneath the supinator longus.	To integument of the ball of the thumb; to dorsum of the hand, and to three-and-a-half fingers dorsally.

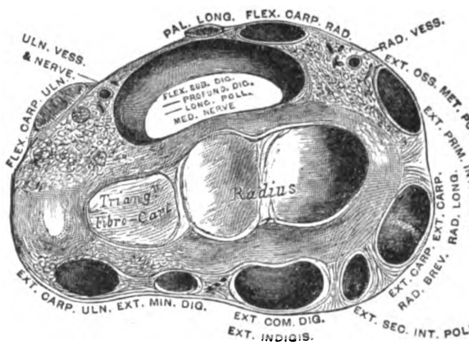
ANTERIOR ANNULAR LIGAMENT. (Figs. 83, 85.)

The anterior annular ligament, a very strong, fibrous band, arches over the front of the carpus and aids this latter in forming an osseoligamentous canal for the median nerve and long flexor tendons of the thumb and fingers. It is attached on the ulnar side to the pisiform bone and unciform process of the unciform bone; on the radial side to the trapezium and tuberosity of the scaphoid. On the ligament are the ulnar and median cutaneous nerve twigs, ulnar nerve, and vessels; beneath the same are two synovial bursæ—one for the flexor tendon of the thumb, the other for the two digital flexors. (Fig. 84.) The palmaris longus and a part of the flexor carpi radialis are inserted into the outer surface, and the small muscles of the thumb and little finger arise therefrom. (Fig. 85.) The cavity beneath the anterior annular ligament consists of one compartment, and contains the following structures: flexor sublimis digitorum, flexor profundus digitorum, flexor longus pollicis, median nerve, and two synovial bursæ, disposed as previously stated.

DEEP PALMAR FASCIA.

The deep palmar fascia consists of a strong fibrous tissue covering the palmar surface of the hand. It has (1) a central portion; (2) two lateral portions. The central portion is far more dense than the lateral. It is attached above to the anterior annular ligament; on the sides, to the lateral portions of the palmar fascia; below, it divides into four slips for the fingers. Each slip gives fibres (1) to the skin of the palm and fingers, which confer stability; (2) to the sides of the glenoid ligaments, at the metacarpophalangeal joints; and from these offsets are so disposed as to form short channels for the flexor tendons in front of the lower ends of the metacarpal bones, akin to fibrous sheaths that form channels for the tendons in the fingers. The intervals between the digital slips transmit the digital vessels, nerves, and lumbrical muscles to the fingers. The palmar fascia sends fibrous processes through the superficial fascia to the skin, and on this depends the immobility of the skin of the palm when the fingers are extended. The lateral portions of the palmar fascia are thin, and cover the muscles of the little finger and ball of the thumb.

FIG. 83.

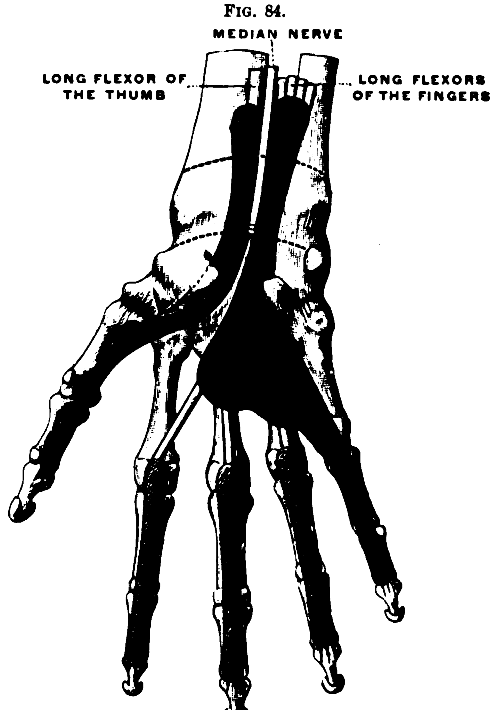


Transverse section through the wrist, showing the annular ligaments and the canals for the passage of the tendons. (GRAY.)

LIGAMENTA VAGINALIA.

Fibrous sheaths for the flexor tendons are so attached to the margins of the phalanges as to form osseo-aponeurotic canals. These sheaths are very

FIG. 84.



Synovial membranes of tendons in the palm, artificially distended. (GERRISH after TESTUT.)

strong opposite the middle of the first and second phalanges, but much thinner opposite the joints. Each sheath is lined by synovial membrane, which is reflected onto the tendons. The synovial sheaths for the tendons of the thumb and little finger are continuous with the two synovial bursæ beneath the anterior annular ligament; those for the intervening digits terminate in blind sacs near the metacarpophalangeal articulations. (Fig. 84.)

MUSCLES OF FRONT OF FOREARM (SUPERFICIAL GROUP).

The Pronator Radii Teres. *Origin of humeral head:* Internal condyle by the common tendon and intermuscular septa. *Origin of ulnar head:* Coronoid

FIG. 85.

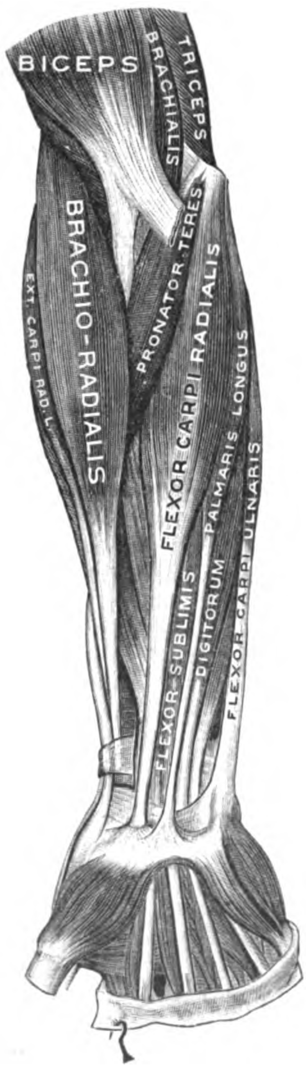


FIG. 86.

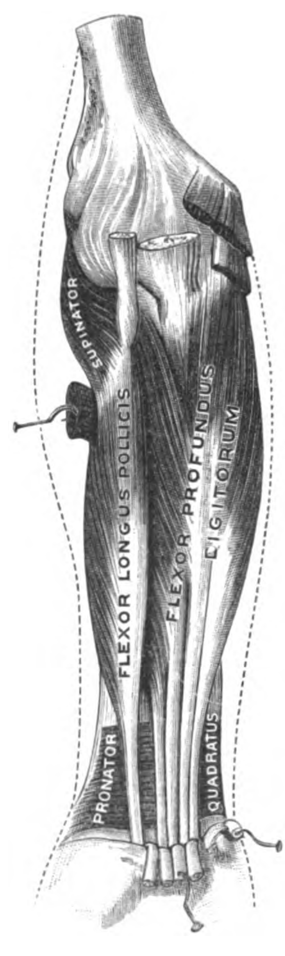


FIG. 85.—Superficial muscles of front of right forearm. (GERRISH after TESTUT.)
FIG. 86.—Muscles in the right forearm, the deepest layer. (GERRISH after TESTUT.)

process. *Insertion:* Middle of outer surface of radius. *Action:* Pronation of radius. *Synergist:* Pronator radii quadratus, located anteriorly just above the wrist. *Antagonists:* Supinators, longus and brevis. *Nerve:* Median, from outer and inner cords of the brachial plexus. *Arteries:* Radial and ulnar.

The Flexor Carpi Radialis. *Origin:* Common tendon, from internal condyle of humerus, and deep fascia. *Insertion:* Bases of second and third metacarpal bones. This tendon passes through a groove in the os trapezium, external to the anterior annular ligament. *Action:* Flexion of carpus. *Synergists:* Flexor carpi ulnaris and palmaris longus. *Antagonists:* Extensor carpi radialis longior, extensor carpi radialis brevior, extensor carpi ulnaris. *Nerve:* Median. *Artery:* Radial artery, a branch of the brachial.

The Palmaris Longus. *Origin:* Common tendon from the internal condyle of the humerus and intermuscular septa. *Insertion:* Anterior annular ligament and palmar fascia. *Action:* Flexion of carpus. *Synergists:* Flexor carpi radialis and flexor carpi ulnaris. *Antagonists:* Three extensors of carpus. *Nerve:* Median. *Artery:* Radial.

The Flexor Sublimis Digitorum has two heads. *Origin:* (1) Internal condyle by the common tendon; (2) oblique line of the radius. *Insertion:* Sides of the second phalanges of the four fingers. These tendons are slit for the transmission of the tendons of the flexor profundus digitorum. *Action:* Flexion of the second phalanges. *Synergists:* Tendons of the flexor profundus. *Antagonists:* Extensor communis digitorum, extensor minimi digiti, extensor indicis. *Nerve:* Median, from outer and inner cords of the brachial plexus. *Arteries:* Radial and ulnar.

The Flexor Carpi Ulnaris has two heads, humeral and ulnar. *Origin:* (1) Common tendon, from the internal condyle of the humerus; (2) olecranon process and upper two-thirds of the posterior border of the ulna. The ulnar nerve passes between these two heads. *Insertion:* (1) Pisiform bone; (2) unciform process of unciform bone; (3) base of fifth metacarpal bone. *Action:* Flexion of carpus. *Synergists:* Flexor carpi radialis and palmaris longus. *Antagonists:* Three carpal extensors. *Nerve:* Ulnar, from inner cord of brachial plexus. This nerve is accompanied by the inferior profunda above the elbow and by the ulnar artery below. *Artery:* Ulnar.

Internal "Common Tendon." The preceding five muscles—pronator radii teres, flexor carpi radialis, palmaris longus, flexor sublimis digitorum, flexor carpi ulnaris —arise by a common tendon from the internal condyle of the humerus. The muscles are often fused near the condyle, so that to individualize is a very difficult task in dissecting.

MUSCLES OF FRONT OF FOREARM (DEEP GROUP).

Flexor Profundus Digitorum. *Origin:* (1) Upper three-fourths of the anterior and internal surfaces of the ulna and the interosseous membrane; (2) aponeurosis on the posterior border of the ulna, common to this muscle, the flexor carpi ulnaris and extensor carpi ulnaris. *Action:* Flexion of the third phalanges. *Synergists:* Tendons of the flexor sublimis digitorum. *Antagonists:* Extensor communis digitorum, extensor minimi digiti, and extensor indicis. *Nerves:* Anterior interosseous, a branch of the median (to the radial half); ulnar nerve to ulnar half of muscle. *Artery:* Ulnar. The four tendons of this muscle pass through slits in the four corresponding tendons of the flexor sublimis digitorum.

The Flexor Longus Pollicis. *Origin:* (1) Anterior surface of the radius below the oblique line; (2) occasionally from the coronoid process of the ulna. *Insertion:* Base of the distal phalanx of the thumb. *Action:* Flexion of the distal phalanx of the thumb. *Synergist:* Flexor brevis pollicis. *Antagonists:* Extensor longus pollicis, extensor brevis pollicis, extensor ossis metacarpi pollicis. *Nerve:* Anterior interosseous, a branch of the median. *Arteries:* Anterior interosseous and radial.

The Pronator Quadratus. *Origin:* Anterior surface of the lower fourth of the ulna. *Insertion:* Anterior surface of the lower fourth of the radius. *Action:* Pronation of the radius. *Synergist:* Pronator radii teres. *Antagonists:* Supinator longus and supinator brevis. *Nerve:* Anterior interosseous, a branch of the median. *Artery:* Anterior interosseous.

The Supinator Brevis. *Origin:* (1) External condyle of the humerus; (2) external lateral ligament; (3) orbicular ligament of the radius; (4) oblique line of the ulna; (5) a triangular depression in front of the oblique line of the ulna; (6) aponeurosis covering the muscle. *Insertion:* Oblique line, tuberosity and back of the inner part of the neck of the radius. *Action:* Supination of forearm. *Synergist:* Supinator longus. *Antagonists:* Pronator radii teres and pronator quadratus. *Nerve:* Posterior interosseous, a branch of the musculospiral, found between the superficial and deep layers of the supinator brevis muscle.

SMALL MUSCLES OF THE HAND.

Muscles of Radial Region.

Adductor Pollicis. *Origin:* Anterior annular ligament, tuberosity of the scaphoid bone, ridge of the trapezium. *Insertion:* Radial side of the base of the first phalanx of the thumb and tendon of the extensor longus pollicis. *Nerve:* Median. *Action:* Abduction of the metacarpal bone.

Opponens Pollicis. *Origin:* Anterior annular ligament and the ridge on the trapezium. *Insertion:* Radial side of the metacarpal bone of the thumb. *Nerve:* Median. *Action:* Metacarpal flexor.

Flexor Brevis Pollicis. *Origin:* Anterior annular ligament, first, metacarpal bone, and tendon of the extensor longus pollicis. *Insertion:* Base of first phalanx of the thumb, internal and external. *Nerves:* Median and ulnar for outer and inner heads, respectively. *Action:* Flexion and adduction of first phalanx.

Adductor Obliquus Pollicis. *Origin:* Os magnum, bases of second and third metacarpals, anterior carpal ligament, sheath of the tendon of the flexor carpi radialis. *Insertion:* Base of first phalanx of the thumb and flexor brevis pollicis. *Nerve:* Ulnar. *Action:* Adduction of the metacarpal bone of the thumb.

Adductor Transversus Pollicis. *Origin:* Lower two-thirds of the metacarpal bone of the middle finger. *Insertion:* Base of the first phalanx of the thumb with adductor and flexor brevis pollicis. *Nerve:* Ulnar. *Action:* Adduction of the metacarpal bone.

Muscles of Ulnar Region.

Palmaris Brevis. *Origin:* Anterior annular ligament and palmar fascia. *Insertion:* Skin of inner part of the palm. *Nerve:* Ulnar. *Action:* Adduction.

Abductor Minimi Digiti. *Origin:* Pisiform bone and tendon of the flexor carpi ulnaris. *Insertion:* Base of the first phalanx of the little finger and extensor minimi digiti. *Nerve:* Ulnar. *Action:* Abduction of the little finger.

Flexor Brevis Minimi Digiti. *Origin:* Anterior annular ligament and unciform process of unciform bone. *Insertion:* Base of the first phalanx of the little finger. *Nerve:* Ulnar. *Action:* Flexion of the little finger.

Opponens Minimi Digiti. *Origin:* Anterior annular ligament and unciform process of unciform bone. *Insertion:* Metacarpal bone of the little finger. *Nerve:* Ulnar. *Action:* Flexion of the little finger and metacarpal bone.

Muscles of Palmar Region.

The Lumbrical Muscles are four in number. They arise from the tendons of the flexor profundus digitorum and are inserted into the tendons of the extensor communis digitorum.

First and Second Lumbricals. *Origin:* Radial side and palmar surface of the flexor profundus digitorum tendons to the index and middle fingers. *Inser-*

tion: Extensor communis tendons of the index and middle fingers. *Nerve:* Median.

Third and Fourth Lumbricals. *Origin:* Contiguous sides of the middle and ring and ring and little fingers, respectively. *Insertion:* Extensor communis tendons of the ring and little fingers. *Nerve:* Ulnar.

The dorsal interossei are four in number:

First Dorsal. *Origin:* Upper half of the ulnar border of the first metacarpal bone and radial border of the second metacarpal bone. *Insertion:* Radial side of the base of the first phalanx of the index finger and tendon of the extensor communis digitorum of the index finger.

The Second, Third, and Fourth Dorsal Interossei arise from the adjacent sides of the second and third, third and fourth, fourth and fifth metacarpal bones, respectively, and are inserted into the corresponding tendons of the extensor communis digitorum. *Nerve:* Ulnar.

Palmar Interossei. There are three palmar interossei muscles. The first arises from the ulnar side of the second metacarpal and is inserted into the base of the first phalanx of the index finger and extensor communis digitorum. The second arises from the radial side of the fourth metacarpal bone, and is inserted into the base of the first phalanx of the ring finger and extensor communis digitorum. The third arises from the radial side of the fifth metacarpal bone, and is inserted into the radial side of the base of the first phalanx of the little finger.

Action of the Lumbrical and Interossei Muscles. "The palmar interossei adduct the fingers to an imaginary line drawn longitudinally through the centre of the middle finger. The dorsal interossei abduct the fingers from that line. In addition to this the interossei, in conjunction with the lumbricals, flex the first phalanges at the metacarpophalangeal joints, and extend the second and third phalanges, in consequence of this insertion, into the expansion of the extensor tendons. The extensor communis digitorum is believed to act almost entirely on the first phalanges."—Gray's *Anatomy*.

CUBITAL FOSSA.

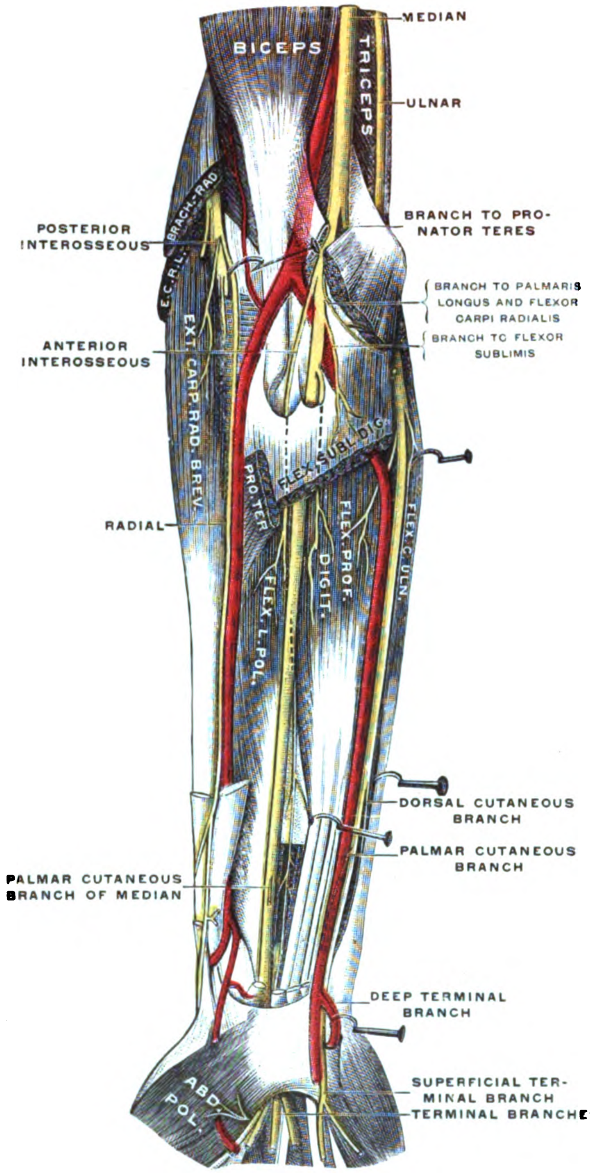
The cubital fossa is a depression on the flexor surface of the elbow; its analysis is given below, as follows: Roof, formed by skin and fascia; floor, formed by brachialis anticus and supinator brevis; superior border, formed by an imaginary line extending from condyle to condyle; outer border, formed by brachioradialis (supinator longus); inner border, formed by pronator radii teres. *Contents:* (1) Brachial artery and veins; (2) radial artery; (3) ulnar artery; (4) tendon of biceps; (5) median nerve; (6) musculospiral nerve; (7) radial recurrent artery; (8) ulnar recurrent artery; (9) common interosseous artery. *Order of contents:* (1) Brachial artery; (2) to inner side of artery, the median nerve; (3) to outer side of artery, the tendon of the biceps; (4) to outer side of tendon of biceps, the musculospiral nerve (deeply located between the brachialis anticus and supinator longus), dividing into the radial and posterior interosseous nerves. Also muscular branches are given off to the pronator radii teres and supinator longus by the median and musculospiral nerves, respectively.

MEDIAN NERVE.

The median nerve arises by an inner and an outer head from the inner and outer cords of the brachial plexus, respectively. The main course of the nerve is with the brachial artery and its venæ comites. In the upper part of its course the nerve is external; in the middle, on; and in the lower, internal to the artery. The nerve passes into the forearm between the two heads of the pronator radii teres, and gives off the following branches:

(1) *Muscular* (near elbow) (*a*) to pronator radii teres, flexor carpi radialis, palmaris longus, and flexor sublimis digitorum ; (2) *muscular* (*b*) (*anterior interosseous*) to flexor longus pollicis, pronator quadratus, and radial half of the flexor profundus digitorum ; (3) *muscular* (*c*) to first and second lumbricals, abductor pollicis, opponens pollicis, and outer head of the flexor brevis pollicis ; (4) *palmar*

FIG. 87.



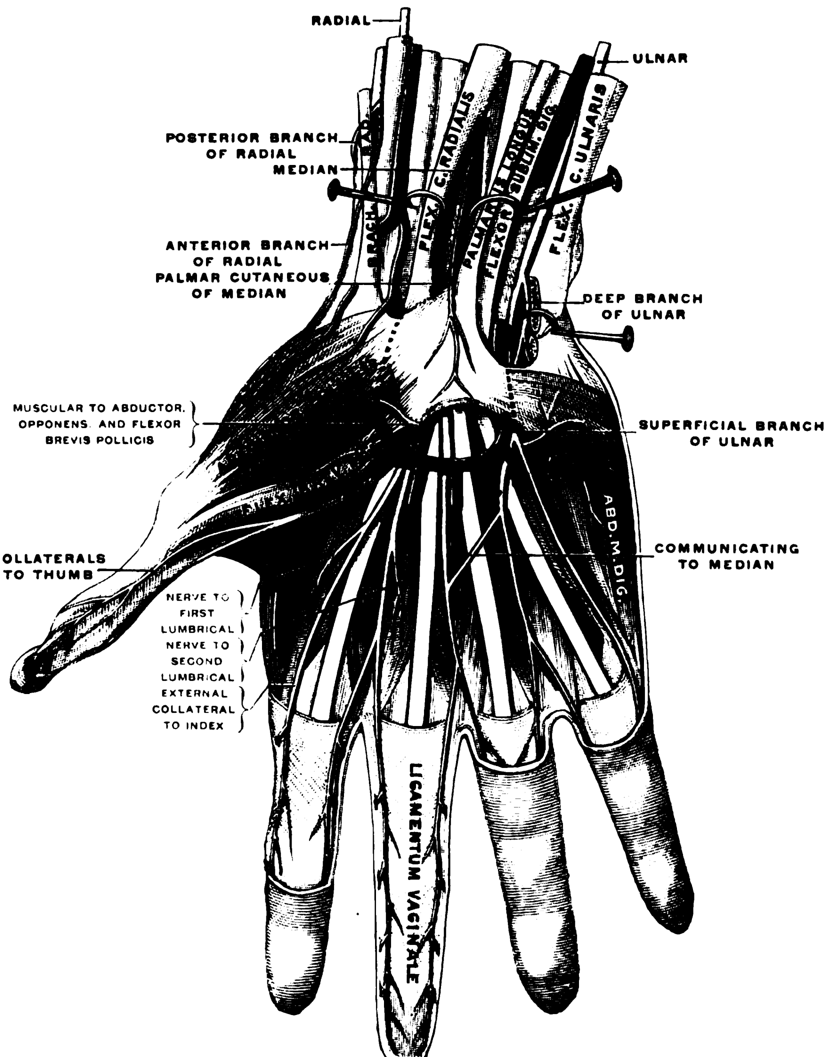
Deep nerves of the front of the right forearm (GERRISH after TESTUT.)

cutaneous to skin of ball of the thumb and of the palm, corresponding to three and one-half fingers on radial side of the hand ; (5) *digital cutaneous* to integument of palmar surface (and also about the nails) of the thumb, index, middle and radial half of ring finger ; (6) (*d*) *articular*, to elbow, radio-ulnar, radiocarpal, carpal, carpo-metacarpal, metacarpophalangeal and interphalangeal articulations.

ULNAR NERVE.

The ulnar nerve is from the inner cord of the brachial plexus. It lies to the ulnar side of the brachial artery, but in the middle of the arm it diverges from this vessel to reach the interval between the olecranon process and the internal condyle. It reaches the forearm between the two heads of the flexor carpi

FIG. 88.



Superficial palmar nerves. (GERRISH after TESTUT.)

ulnaris, and in the upper third joins the ulnar artery, lying to its ulnar side. The nerve crosses the anterior annular ligament, internal to the pisiform bone, and divides into superficial and deep palmar branches.

Branches of the Ulnar Nerve. (1) *Muscular* (near elbow) to (*a*) flexor carpi ulnaris, (*b*) ulnar half of flexor profundus digitorum ; (2) *muscular* (deep palmar) to abductor minimi digiti, flexor brevis minimi digiti, opponens minimi digiti, abductor transversus and obliquus pollicis, inner head of flexor brevis pollicis, the two ulnar lumbricales, and all the interosseous muscles of the hand ; (3) *cuta-*

neous (middle third of forearm) to skin of lower and anterior third of forearm and wrist ; (4) *cutaneous* (lower third of forearm) to wrist and palm, corresponding to the little finger and ulnar half of the ring finger ; (5) *cutaneous* (digital) to skin of little finger and ulnar half of the ring finger ; (6) *cutaneous* (dorsal) to skin of dorsal surface of the little finger and adjacent part of the ring finger ; (7) *articular*, to elbow, medio-carpal, radiocarpal, carpo-metacarpal, metacarpophalangeal, and interphalangeal articulations.

RADIAL ARTERY.

The radial artery begins just below the bend of the elbow, at the bifurcation of brachial, and ends in the deep palmar arch in the palm of the hand. It is accompanied by two venæ comites. The radial artery is found, then, in the forearm, wrist, and hand, and has the following relations in the forearm: Internally, the pronator radii teres and flexor carpi radialis; externally, the supinator longus and middle third of radial nerve; anteriorly, the integument, superficial fascia, deep fascia, and supinator longus; posteriorly, the tendon of the biceps, the supinator brevis, flexor sublimis digitorum, pronator radii teres, flexor longus pollicis, pronator quadratus, and radius. At the wrist, the radial artery lies on the scaphoid, trapezium, and external lateral ligament, and is beneath the extensor tendons of the thumb, branches of the radial nerve, and certain cutaneous veins. In the hand, the artery passes (1) between the heads of the first interosseous muscle; (2) across the palm to the base of the fifth metacarpal bone, where, by inosculating with a communicating branch of the ulnar artery, it forms the deep palmar arch. The deep arch lies on the proximal ends of the metacarpal bones and interossei muscles, and is covered by integument, superficial fascia, palmar fascia, flexor sublimis digitorum, flexor profundus digitorum, lumbricales, flexor brevis minimi digiti, opponens minimi digiti, and adductor obliquus pollicis.

Branches of Radial Artery. Radial recurrent; muscular; anterior carpal; superficialis volæ; posterior carpal; metacarpal or first dorsal interosseous; dorsalis pollicis; dorsalis indicis; princeps pollicis; radialis indicis; superior perforating; palmar interosseous, three or four in number; palmar recurrent; deep palmar arch. (See Dr. Shaw's table of arteries.)

ULNAR ARTERY.

The ulnar artery arises at the bifurcation of the brachial, a little below the bend of the elbow, and ends on the anterior annular ligament (just internal to the pisiform bone), in superficial and deep palmar branches. Between these two points the artery has the following relations: Anteriorly, the superficial flexor muscles, median nerve, superficial fascia, deep fascia; posteriorly, the brachialis anticus and flexor profundus digitorum; internally, the flexor carpi ulnaris and lower two-thirds of the ulnar nerve; externally, the flexor sublimis digitorum. The ulnar artery is attended by two veins having tributaries corresponding to the branches of the artery.

Branches of the Ulnar Artery. Anterior ulnar recurrent; posterior ulnar recurrent; common interosseous; anterior interosseous; posterior interosseous; muscular; anterior carpal; posterior carpal; deep palmar or communicating; superficial palmar arch.

CHAPTER X.

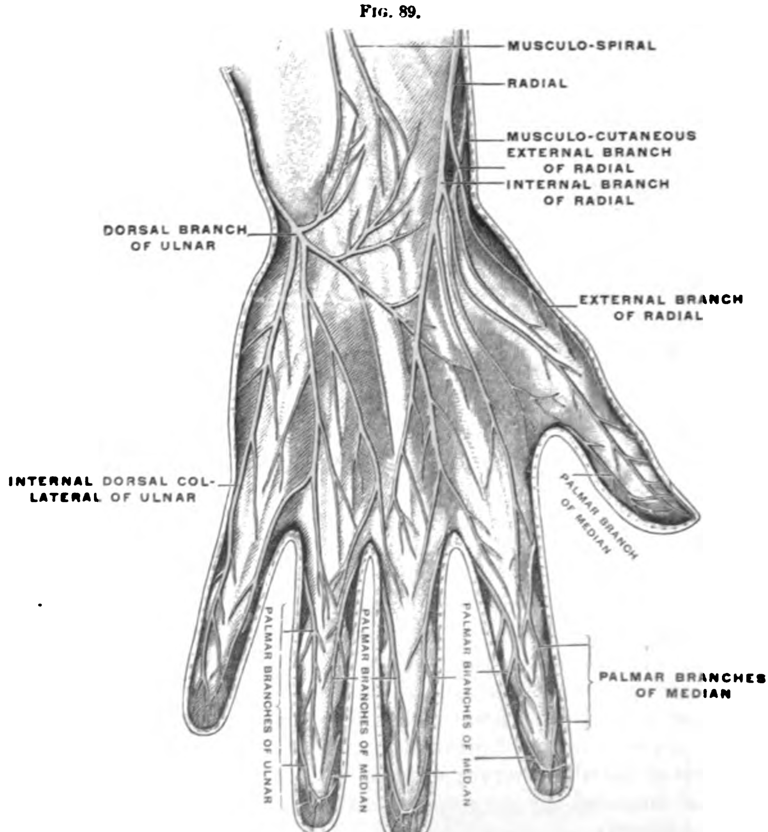
THE POSTERIOR REGION OF ARM AND FOREARM AND RADIAL REGION OF FOREARM.

IDENTIFICATION AND DISSECTION.

Cutaneous Nerves and Vessels. Consult the illustrations to find the names of cutaneous structures; determine the source, course, and distribution of the same by the tables on the cutaneous nerves and veins of the upper extremity in Chapter IX. (pp. 155–157).

Superficial Fascia. Identify (1) by its location beneath the skin and the fat contained in its meshes of cellulo-fibrous structure; (2) by its free mobility and the presence of the cutaneous nerves and vessels; (3) by its non-attachment to bone.

FIG. 89.



Cutaneous nerves of the dorsum of the hand. (GERRISH after TESTUT.)

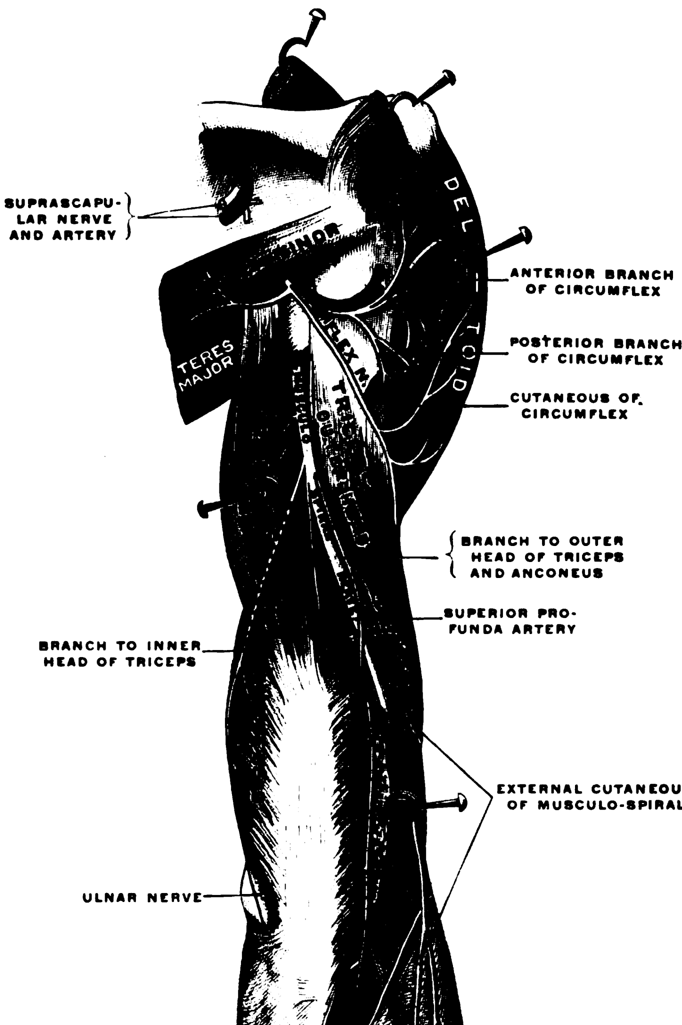
Deep Fascia. Identify (1) by its location beneath the superficial fascia, attachment to bone, and immobility; (2) by its perforations for the cutaneous nerves and vessels; (3) by its great strength on the back part of the forearm and its continuity with the posterior annular ligament.

Radial Nerve. Identify (1) by its emergence through the deep fascia on the radial side of the forearm between the supinator longus and extensor carpi radialis longior muscles; (2) by its distribution to the skin of the ball of the thumb, and the dorsal surface of the thumb, index and middle fingers, and radial half of the ring finger.

Posterior Annular Ligament. Identify (1) by its location on the back of the wrist and firm attachments to the bony eminences; (2) by its continuity with the dorsal fascia of the hand below and the deep fascia of the forearm above; (3) by the formation of six compartments for the transmission of all the tendons on the posterior and radial regions except the supinator longus. (Fig. 83.)

Teres Major. Identify (1) by its extent from the axillary border of the scapula to the inner lip of the bicipital groove of the humerus, with the tendon of the latissimus dorsi; (2) by its

FIG. 90.



Musculospiral and circumflex nerves of right side. (GERRISH after TESTUT.)

location below the circumflex structures emerging from the quadrilateral space; (3) by its attachment to the latissimus dorsi.

Quadrilateral Space. Identify (1) by its boundaries—neck of the humerus, long head of the triceps, teres minor, teres major, and latissimus dorsi; (2) by its contents—posterior circumflex vessels and circumflex nerve.

Musculospiral Nerve. Identify (1) by its location in the spiral groove on the posterior surface of the humerus between the two humeral heads of the triceps muscle with the superior profunda vessels; (2) by its location (in the lower third of the arm on the outer side) between the brachialis anticus and supinator longus.

Posterior Interosseous Nerve. Identify (1) by its derivation from the musculospiral (with the radial); (2) by its course through the supinator brevis muscle; (3) by its distribution to the posterior part of the forearm; (4) by its location between the superficial and deep groups of muscles.

Triceps Muscle. Identify (1) by its location on the posterior surface of the humerus and insertion into the olecranon process of the ulna; (2) by its three heads of origin—from scapula, below glenoid; from humerus, above and below the musculospiral groove.

Suprascapular Nerve and Vessels. Identify (1) by their location on the superior border of the scapula; (2) the nerve passes through the suprascapular foramen, the vessels cross the superior transverse scapular ligament. These structures are exposed on turning aside the supraspinatus muscle. (Fig. 90.)

Extensor Carpi Radialis Longior and Extensor Carpi Radialis Brevior Muscles. Identify (1) by their location on the radial side of the forearm; (2) by their location in one compartment of the posterior annular ligament; (3) by their course beneath the three extensor muscles of the thumb; (4) by their insertion into the bases of the second and third metacarpal bones on the radial side. (Fig. 93.)

Extensors of Thumb. Identify (1) the extensor longus pollicis inserted into the base of the distal phalanx; (2) the extensor brevis pollicis into the base of the proximal phalanx; (3) the extensor ossis metacarpi pollicis into the base of the metacarpal bone of the thumb; (4) these three tendons cross the radial artery where this vessel passes to the back of the hand to gain the first interosseous space; (5) the extensor longus pollicis is in a separate compartment; the other two in same compartment. (Fig. 93.)

Extensor Communis Digitorum. Identify (1) by the distribution of its four tendons to the four fingers; (2) by its location in a compartment of the posterior annular ligament with the extensor indicis; (3) by the insertion of each tendon into the bases of the second and third phalanges. (Fig. 92.)

Extensor Indicis. Identify (1) by its location in a compartment of the posterior annular ligament with the extensor communis digitorum; (2) by its insertion, with the tendon of the extensor communis digitorum, into the second and third phalanges of the index finger. (Fig. 93.)

Extensor Minimi Digiti. Identify (1) by its location in a separate compartment of the posterior annular ligament; (2) by its insertion with the tendon of the extensor communis digitorum, into the second and third phalanges of the little finger. (Fig. 91.)

Extensor Carpi Ulnaris. Identify (1) by its location on the ulnar side of the forearm, and by its passage through a separate compartment of the posterior annular ligament; (2) by its insertion into the ulnar side of the base of the fifth metatarsal bone. (Fig. 92.)

The Teres Major. *Origin:* (1) Lower third of the axillary border of the scapula; (2) deep fascia and adjacent intermuscular septa. *Insertion:* Inner lip of the bicipital groove. *Action:* Abductor of arm. *Synergist:* Latissimus dorsi. *Antagonist:* Deltoid. *Nerve:* Subscapular from posterior cord of the brachial plexus. *Artery:* Subscapular.

The Subscapularis. (Figs. 72, 73.) *Origin:* Subscapular fossa. *Insertion:* Lesser tuberosity of the humerus and capsule of the joint. *Action:* Internal rotation and adduction. *Synergist:* Pectoralis major. *Antagonists:* Teres minor and infraspinatus. *Nerve:* Subscapular, from posterior cord of the brachial plexus. *Artery:* Subscapular.

The Latissimus Dorsi. *Origin:* (1) Spinous processes of the six inferior thoracic vertebræ; (2) spines of the lumbar and sacral vertebræ; (3) posterior layer of the lumbar fascia; (4) external lip of the iliac crest, posterior to the attachment of the external oblique muscle; (5) from three or four lower ribs. *Insertion:* Bottom of the bicipital groove, higher on the humerus than insertion of the pectoralis major. Its tendon, about three inches long, is in front of the tendon of the teres major, and separated therefrom by a bursa. *Nerve:* Long subscapular, from posterior cord of the brachial plexus.

The Subscapular Nerves (upper, lower, and middle, or long). The upper supplies the subscapularis; the lower supplies the subscapularis and teres major; the middle, or long, accompanies the subscapular artery and supplies the latissimus dorsi. The subscapular artery is the largest branch of the axillary. It is given off opposite the lower border of the subscapularis muscle, passes along its lower margin to the inferior angle of the scapula, and anastomoses with the long thoracic, intercostals, and posterior scapular. (Fig. 75.)

The Triceps (three heads—long, external, and internal). *Origin of Long Head:* Below glenoid cavity. *Origin of External Head:* Above musculospiral groove on the posterior surface of the humerus. *Origin of Internal Head:* Below musculospiral groove. *Insertion:* Olecranon process and deep fascia contiguous thereto. *Action:* Extension of forearm. *Synergist:* Anconeus. *Antagonists:* Biceps, brachialis anticus, supinator longus. *Nerve:* Musculospiral. *Artery:* Superior profunda. (Fig. 90.)

The Anconeus. *Origin:* External condyle of humerus and posterior ligament of the elbow-joint. *Insertion:* Olecranon and upper third of ulna. *Action:* Extension of forearm. *Synergist:* Triceps. *Antagonists:* Biceps, brachialis anticus, and supinator longus. *Nerve:* Musculospiral, from posterior cord of brachial plexus. *Artery:* Superior profunda. (Fig. 92.)

The Supinator Longus (brachio-radialis). *Origin:* Upper two-thirds of the external condylar ridge of the humerus and the external intermuscular septum. *Insertion:* Base of the styloid process of the radius. This muscle conceals the radial nerve. *Action:* Flexion and supination of the forearm. *Synergist:* Supinator radii brevis. *Antagonists:* Pronator radii teres and pronator radii quadratus. *Nerve:* Musculospiral from posterior cord of the brachial plexus. *Arteries:* Radial and brachial. (Figs. 85, 93.)

The Musculospiral Nerve arises from the posterior cord of the brachial plexus (sixth, seventh, and eighth cervical and first thoracic). Course: (1) Behind the axillary and the upper part of the brachial artery; (2) in front of the tendons of the latissimus dorsi and teres major; (3) in the musculospiral groove on the posterior surface of the humerus (with the superior profunda artery) between the two humeral heads of the triceps muscle; (4) it pierces the external intermuscular septum and lies between the brachialis anticus and the supinator longus; (5) in front of the external condyle of the humerus it divides into the radial and posterior interosseous nerves. *Branches:* Cutaneous, radial, muscular, and posterior interosseous. The radial and other cutaneous branches are described in the table of cutaneous nerves of the upper extremity (p. 156). Muscular branches supply the triceps, anconeus, supinator longus, supinator brevis, extensor carpi radialis longior, extensor carpi radialis brevior, and, usually, the brachialis anticus. The posterior interosseous nerve supplies all the muscles on the posterior part of the forearm. (Figs. 69, 90.)

The Superior Profunda Artery is a branch of the brachial. It accompanies the musculospiral nerve, supplies the triceps and humerus, and anastomoses with the radial recurrent, posterior ulnar recurrent, interosseous recurrent, anastomotica magna, and inferior profunda. (Fig. 90.)

POSTERIOR ANNULAR LIGAMENT.

The Posterior Annular Ligament (Figs. 91, 92, 93) is a strong, fibrous structure at the back of the wrist, so attached as to form six compartments for the passage of tendons. It is attached internally to the cuneiform and pisiform bones, and styloid process of the ulna; externally, to the margin of the radius; dorsally, to the small elevations on the posterior part of the lower end of the radius. The six compartments are:

1. { For the tendon of the extensor ossis metacarpi pollicis muscle.
   For the tendon of the extensor brevis pollicis muscle.
2. { For the tendon of the extensor carpi radialis longior muscle.
   For the tendon of the extensor carpi radialis brevior muscle.
3. { For the tendons of the extensor communis digitorum muscle.
   For the tendons of the extensor indicis muscle.
4. For the tendon of the extensor longus pollicis muscle.
5. For the tendon of the extensor minimi digiti muscle.
6. For the tendon of the extensor carpi ulnaris muscle.

These six compartments are lined by a synovial membrane extending from above the annular ligament to the dorsum of the hand. (Figs. 83, 84.)

POSTERIOR PART OF FOREARM (SUPERFICIAL GROUP OF MUSCLES).

The Extensor Communis Digitorum. (Fig. 92.) *Origin:* (1) External condyle of the humerus, by the common tendon; (2) adjacent intermuscular septa and deep fascia. *Insertion:* Second and third phalanges of the fingers, by four aponeuroses, as follows: The aponeuroses of insertion on the back of the first phalanx are joined by the lumbrical and interossei tendons of insertion. Each aponeurosis breaks up into a central and two lateral parts, opposite the first phalanx. The central part is inserted into the dorsal base of the second phalanx; the lateral parts are inserted into and cover the dorsal surface of the third phalanx. *Action:* Extension of fingers. *Synergists:* Dorsal and palmar interossei and lumbricals. *Antagonists:* Flexor sublimis digitorum and flexor profundus digitorum. *Nerve:* Posterior interosseous, a branch of the musculospiral. *Artery:* A branch of the ulnar.

FIG. 91.

Synovial membranes of tendons in the dorsum of the forearm and hand, artificially distended. (GERRISH after TESTUT.)

The Extensor Minimi Digiti. *Origin:* Common tendon and adjacent intermuscular septa. *Insertion:* Second and third phalanges, with tendon of extensor communis digitorum. *Action:* Extension of little finger. *Synergists:* Extensor communis digitorum, lumbricals, and interossei. *Antagonists:* Flexor brevis minimi digiti, flexor sublimis digitorum, and flexor profundus digitorum. *Nerve:* Posterior interosseous, a branch of the musculospiral. *Artery:* Posterior interosseous.

The Extensor Carpi Ulnaris. *Origin:* (1) Outer condyle, by the common tendon, adjacent intermuscular septa, and deep fascia; (2) middle third of the posterior surface of the ulna; (3) posterior border of the ulna with the flexor carpi ulnaris and flexor profundus digitorum. *Insertion:* Ulnar side of the base of the fifth metacarpal bone. *Action:* Extension of carpus. *Synergists:* Extensor carpi radialis longior and extensor carpi radialis brevior. *Antagonists:* Flexor carpi radialis, flexor carpi ulnaris, and palmaris longus. *Nerve:* Posterior interosseous. *Artery:* Ulnar.

The Anconeus. *Origin:* Back of outer condyle. *Insertion:* (1) Side of olecranon process of ulna; (2) upper fourth of posterior surface of ulna. *Action:* Extension of forearm. *Synergist:* Triceps. *Antagonists:* Biceps, brachialis anticus, and brachio-radialis. *Nerve:* Musculospiral. *Arteries:* Anastomotica magna and radial recurrent. This muscle seems to be a semidismembered part of the triceps. (Fig. 92.)

POSTERIOR PART OF FOREARM (DEEP GROUP OF MUSCLES).

The Supinator Brevis (Fig. 93) is concealed by the supinator longus, extensor carpi radialis longior, and extensor carpi radialis brevior. *Origins:* (1) External condyle of humerus and external lateral ligament; (2) orbicular ligament of radius; (3) a ridge on ulna, extending downward from sigmoid cavity. *Insertion:* (1) Oblique line of radius; (2) external and posterior surfaces of the radius between oblique line and head. *Action:* Supination of radius. *Synergist:* Supinator longus. *Antagonists:* Pronator radii teres and pronator quadratus. *Nerve:* Posterior interosseous, a branch of the musculospiral. *Artery:* Radial recurrent.

Extensor Ossis Metacarpi Pollicis (the strong extensor muscle of the thumb). *Origin:* Posterior surfaces of the radius, ulna, and interosseous membrane. *Insertion:* Dorsal base of the metacarpal bone of the thumb. *Action:* Extension of thumb and metacarpal bone. *Synergists:* Long and short extensors of the thumb. *Antagonists:* Long and short flexors of the thumb. *Nerve:* Posterior interosseous. *Artery:* Posterior interosseous.

The Extensor Brevis Pollicis. *Synonym:* Extensor primi internodii pollicis. *Origin:* Posterior surface of the radius and interosseous membrane. *Insertion:* Dorsal base of first phalanx. *Action:* Extension of first phalanx of thumb. Has no synergists. *Antagonists:* Flexor brevis pollicis. *Nerve:* Posterior interosseous. *Artery:* Posterior interosseous.

The Extensor Longus Pollicis. *Synonym:* Extensor secundi internodii pollicis. *Origin:* Posterior surface of the ulna and interosseous membrane. *Insertion:* Base of distal phalanx of thumb. *Action:* Extension of thumb. Has no synergists. *Antagonists:* Flexor longus pollicis. *Nerve:* Posterior interosseous. *Artery:* Posterior interosseous.

The Extensor Indicis. *Origin:* (1) Posterior surface of the ulna below the extensor longus pollicis. *Insertion:* With extensor communis digitorum, into second and third phalanges. Its tendon joins that of the extensor communis digitorum opposite the lower end of the second metacarpal bone, and lies to the ulnar side of this tendon. *Action:* Extension of the index finger. *Synergists:* Extensor communis digitorum, first lumbrical, first dorsal interosseous, and first palmar interossei muscles. *Antagonists:* Flexor sublimis and flexor profundus digitorum. *Nerve:* Posterior interosseous. *Arteries:* Anterior and posterior interosseous.

The Posterior Interosseous Nerve (Figs. 76, 87) is given off by the musculospiral (with the radial) between the brachialis anticus and supinator longus, in front of the external condyle of the humerus. It passes through the supinator brevis muscle to the back of the forearm, and is distributed to all the muscles of the radial and posterior regions of the forearm, except the anconeus, supinator longus, and extensor carpi radialis longior, which three muscles derive their nerve-supply from the musculospiral, prior to its division into the radial and posterior interosseous branches. *Course:* (1) Between the superficial and deep groups of muscles; (2) beneath the extensor longus pollicis on the interosseous membrane.

FIG. 92.

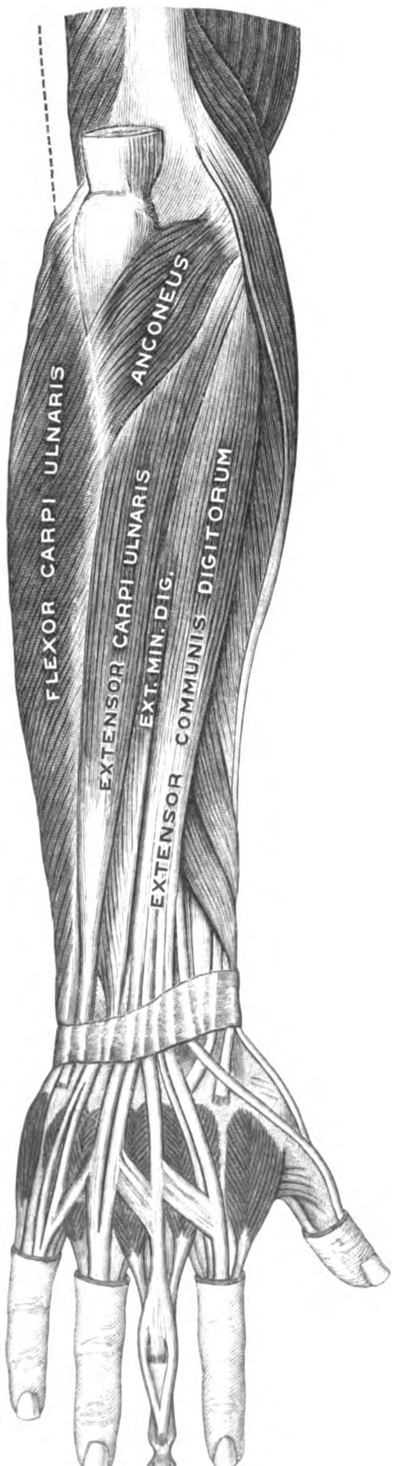


FIG. 93.

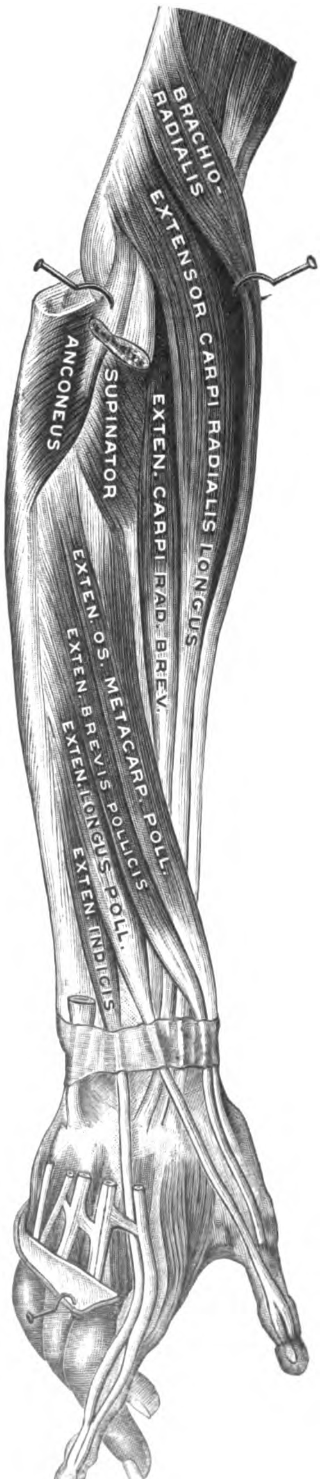


FIG. 92.—Muscles in the dorsum of the right forearm and hand. (GERRISH after TESTUT.)
FIG. 93.—Muscles in radial region of right forearm, and deep muscles in its dorsum. (GERRISH after TESTUT.)

The Posterior Interosseous Artery (Fig. 79) is a branch of the common interosseous of the ulnar artery. It passes to the back of the forearm between the oblique ligament and interosseous membrane. Posteriorly, it is between the supinator brevis and extensor ossis metacarpi pollicis. In the upper third of the forearm the artery is separated from the posterior interosseous nerve by the radius and supinator brevis; in the middle third the nerve and artery are together; in the lower third they are separated by the extensor longus pollicis and extensor indicis.

RADIAL GROUP OF MUSCLES. (Fig. 93.)

The Brachio-radialis (supinator longus). *Origin:* Upper two-thirds of external condylar ridge of the humerus. *Insertion:* Base of the styloid process of the radius. *Arteries:* Radial recurrent and radial. *Nerve:* Musculospiral.

The Extensor Carpi Radialis Longior. *Origin:* Lower third of the external condylar ridge and external intermuscular septum. *Insertion:* Base of the index metacarpal bone on the radial side. *Action:* Extension of carpus. *Synergists:* Extensor carpi radialis brevior and extensor carpi ulnaris. *Antagonists:* Flexor carpi radialis, flexor carpi ulnaris, and palmaris longus. *Nerve:* Musculospiral, from posterior cord of brachial plexus. *Artery:* Radial.

The External "Common Tendon" gives origin to the extensor carpi radialis brevior, extensor communis digitorum, extensor minimi digiti, and extensor carpi ulnaris, and is attached to the outer humeral condyle.

The Extensor Carpi Radialis Brevior. *Origin:* By the common tendon from the external condyle of the humerus. *Insertion:* Base of the third metacarpal bone on the radial side. *Action:* Extension of the carpus. *Synergists:* Extensor carpi radialis longior and extensor carpi ulnaris. *Antagonists:* Flexor carpi radialis, flexor carpi ulnaris, and palmaris longus. *Nerve:* Posterior interosseous, a branch of the musculospiral. *Artery:* Radial.

TABLE OF MUSCLES OF THE UPPER EXTREMITY.

(Names in parentheses in first column are new nomenclature; m. should be read musculus a muscle.)

Name.	*Origin.*	*Insertion.*	*Nerve.*	*Blood-supply.*
Pectoralis major (m. pectoralis major).	1. Anterior surface of the pectoral half of clavicle. 2. One-half the breadth of the anterior surface of the sternum and cartilages of all the true ribs.	Into the outer bicipital ridge of the humerus by a flat tendon about two inches in width.	Filaments[1] from all nerves forming brachial plexus through the anterior thoracic nerves.	Internal mammary intercostals, superior thoracic, acromial thoracic, and long thoracic.
Pectoralis minor (m. pectoralis minor).	1. By three tendinous digitations from the upper margin and outer surfaces of the 3d, 4th, and 5th ribs near their cartilages. 2. From the aponeurosis covering the intercostal muscles.	Inner border and upper surface of the coracoid process of scapula.	Filaments from all nerves forming brachial plexus through the anterior thoracic nerves.	Internal mammary intercostals, superior thoracic, acromial thoracic, and long thoracic.
Subclavius (m. subclavius).	From the 1st rib and its cartilage by a short, thick tendon.	Into a groove on the under surface of clavicle.	Fifth cervical nerve.	First intercostal and short thoracic.
Serratus magnus (m. serratus anterior).	Outer surfaces and upper borders of eight upper ribs, by nine digitations, the 1st rib having two digitations.	Ventral part of the vertebral border of the scapula.	Posterior thoracic from the 5th, 6th, and usually the 7th cervical nerves.	Intercostals, long and short thoracic arteries.

[1] The pectoralis major is a polymeric muscle, hence its nerve filaments are from more than one neural segment. (See Barker.)

Name.	*Origin.*	*Insertion.*	*Nerve.*	*Blood-supply.*
Deltoid (m. deltoideus).	1. Outer one-third of the anterior border and upper surface of the clavicle. 2. Outer margin and upper surface of the acromial process of scapula.	Deltoid ridge on the middle of the outer surface of the humerus.	Circumflex, from posterior cord of brachial plexus.	Posterior, circumflex, and acromial thoracic arteries.
Subscapularis (m. subscapularis).	1. Internal two-thirds of the subscapular fossa. 2. Lower two-thirds of the groove on the axillary border of the scapula.	1. Lesser tuberosity of humerus. 2. Neck of humerus to within one inch below lesser tuberosity.	Upper and lower subscapular.	Subscapular artery.
Supraspinatus (m. supraspinatus).	1. Inner two-thirds of the supraspinous fossa. 2. supraspinous fascia.	Highest of the three facets of greater tuberosity of humerus.	Suprascapular.	Suprascapular.
Infraspinatus m. infraspinatus).	Internal two-thirds of the infraspinous fossa and fascia covering the same.	Middle facet of the greater tubercsity of humerus.	Suprascapular.	Suprascapular.
Teres minor (m. teres minor).	1. Dorsal surface of the upper two-thirds of the axillary border of the scapula. 2. Aponeurotic laminæ.	Lower facet of the greater tuberosity of the humerus.	Circumflex.	Infrascapular, circumflex.
Teres major (m. teres major).	Oval surface on the dorsal aspect of the inferior angle of the scapula.	Inner bicipital ridge of the humerus.	Lower subscapular.	Subscapular.
Coracobrachialis (m. coracobrachialis).	Apex of the coracoid process with short head of the biceps muscle.	Middle of the internal surface and border of the shaft of the humerus.	Musculocutaneous.	Brachial, muscular branches.
Biceps (m. biceps brachii), caput longum, and caput breve.	1. Short head from apex of the coracoid process with coracobrachialis. 2. Long head from the upper margin of the glenoid cavity.	1. Back of tuberosity of radius. 2. Deep fascia of forearm through bicipital fascia.	Musculocutaneous.	Brachial artery, muscular branches.
Brachialis anticus (m. brachialis).	Lower one-half of the outer and inner surfaces of the shaft of the humerus.	Anterior surface of the coronoid process of ulna.	Musculocutaneous.	Brachial artery.
Triceps (m. triceps brachii, caput longum, laterale and mediale).	1. Middle, scapular, or long head from depression below the glenoid cavity. 2. The external or long humeral head from the posterior surface of the shaft of the humerus above the musculospiral groove. 3. The internal or short humeral head from the posterior surface below the musculospiral groove.	The three heads unite and are inserted conjointly into the back of the olecranon process of the ulna.	Musculospiral.	Brachial and superior profunda.
Subanconeus (m. epitrochleoanconeus).	Under surface of triceps.	Capsular ligament of the elbow-joint.		Brachial artery.
Pronator radii teres (m. pronator teres; caput humerale et caput ulnare).	1. Humerus, above internal condyle. 2. Common tendon. 3. Deep fascia of the forearm and intermuscular septum. 4. Inner side of the coronoid process of the ulna.	Middle of the outer surface of the radius.	Median.	Radial.
Flexor carpi radialis (m. flexor carpi radialis).	1. Internal condyle by the common tendon. 2. Deep fascia. 3. Intermuscular septa.	Bases of the metacarpal bones of index and middle fingers.	Median.	Radial.
Palmaris longus (m. palmaris longus).	1. Internal condyle. 2. Deep fascia and intermuscular septa.	Central part of the palmar fascia and lower part of the annular ligament.	Median.	Ra[illegible]

Name.	*Origin.*	*Insertion.*	*Nerve.*	*Blood-supply.*
Flexor carpi ulnaris (m. flexor carpi ulnaris; caput humerale et caput ulnare).	1. Internal condyle of the humerus by the common tendon. 2. Inner margin of the olecranon. 3. Upper two-thirds of the posterior border of the ulna by an aponeurosis common to it, the extensor carpi ulnaris, and flexor profundus digitorum. 4. Intermuscular septum.	1. Pisiform bone. 2. Base of 5th metacarpal and unciform bones. 3. Annular ligament.	Ulnar.	Ulnar.
Flexor sublimis digitorum (m. flexor digitorum sublimis; caput humerale et caput radiale).	1. Internal condyle of the humerus by the common tendon, internal lateral ligament of the elbow-joint, and intermuscular septum. 2. Inner side of the coronoid process of the ulna. 3. Oblique line of the radius.	Side and middle of second phalanges of four inner digits, by four tendons which are perforated by corresponding tendons of flexor profundus.	Median.	Radial and ulnar.
Flexor profundus digitorum (m. flexor digitorum profundus).	1. Upper three-fourths of the anterior and inner surface of the ulna. 2. Inner side of the coronoid process. 3. By aponeurosis in common with the flexor and extensor carpi ulnaris. 4. Ulnar one-half of the interosseous membrane.	Divides into four tendons, which are inserted into the bases of the last phalanges of the four inner digits.	Median and ulnar.	Ulnar.
Flexor longus pollicis (m. flexor pollicis longus).	1. Anterior surface of the shaft of the radius. 2. Interosseous membrane. 3. Inner border of the coronoid process.	Base of the last phalanx of the thumb.	Median.	Radial.
Pronator quadratus (m. pronator quadratus).	1. Lower part of the anterior surface of the shaft of the ulna. 2. Anterior border of the lower one-fourth of the ulnar.	Anterior surface (lower one-fourth) and the anterior border of the shaft of the radius.	Anterior interosseous.	Radial and ulnar.
Supinator longus (m. brachioradialis).	1. Upper two-thirds of the external supracondylar ridge of the humerus. 2. External intermuscular septum.	Base of the styloid process of the radius.	Musculo-spiral.	Brachial and radial.
Extensor carpi radialis longior (m. extensor carpi radialis longior).	1. Lower one-third of the external supracondylar ridge of the humerus. 2. External intermuscular septum.	Base of the metacarpal bone of the index finger on radial side.	Musculo-spiral.	Radial.
Extensor carpi radialis brevior (m. extensor carpi radialis brevior).	1. External condyle of the humerus by the common tendon. 2. External lateral ligament of the elbow joint. 3. Intermuscular septa and deep fascia.	Base of the metacarpal bone of middle finger on the radial side.	Posterior interosseous.	Radial.
Extensor communis digitorum (m. extensor digitorum communis).	1. External condyle of the humerus by the common tendon. 2. Deep fascia and intermuscular septa.	Second and third phalanges of the four inner digits. (For mode of insertion, see text.)	Posterior interosseous.	Posterior interosseous.
Extensor minimi digiti (m. extensor digiti quinti proprius).	1. External condyle by the common tendon. 2. Deep fascia and intermuscular septa.	Second and third phalanges of the little finger.	Posterior interosseous.	Posterior interosseous.

Name.	*Origin.*	*Insertion.*	*Nerve.*	*Blood-supply.*
Extensor carpi ulnaris (m. extensor carpi ulnaris).	1. External condyle of the humerus by the common tendon. 2. Posterior border of the ulna by aponeurosis common to it, flexor carpi ulnaris, and flexor profundus digitorum.	Base of the metacarpal bone of the little finger on the ulnar side.	Posterior interosseous.	Posterior interosseous and radial.
Anconeus (m. anconæus).	1. Continuation of the external part of the triceps. 2. Separate tendon from the back of the outer condyle of the humerus.	Side of olecranon and upper one-fourth of the posterior surface of the shaft of the ulna.	Musculo-spiral.	Radial and superior profunda.
Supinator brevis (m. supinator).	1. External condyle of the humerus. 2. External lateral ligament of the elbow. 3. Orbicular ligament of the radius. 4. Ridge of the ulna extending from the lesser sigmoid. 5. Depression in front of the ridge. 6. Deep fascia.	1. Outer edge of the bicipital tuberosity. 2. Oblique line of the radius.	Posterior interosseous.	Posterior interosseous and radial.
Extensor ossis metacarpi pollicis (m. abductor pollicis longus).	1. Outer part of the posterior surface of the ulna. 2. Interosseous membrane. 3. Middle one-third of the posterior surface of the radius.	Base of the metacarpal bone of the thumb.	Posterior interosseous.	Posterior interosseous.
Extensor brevis pollicis; extensor primi internodii pollicis (m. extensor pollicis brevis).	1. Posterior surface of the shaft of the radius. 2. Interosseous membrane.	Base of the first phalanx of the thumb.	Posterior interosseous.	Posterior interosseous.
Extensor longus pollicis; extensor secundi internodii pollicis (m. extensor pollicis longus).	1. Outer part of the posterior surface of the ulna. 2. Interosseous membrane.	Base of the last phalanx of the thumb.	Posterior interosseous.	Posterior interosseous.
Extensor indicis (m. extensor indicis proprius).	1. Posterior surface of the shaft of the ulna below the extensor longus pollicis. 2. Interosseous membrane.	Second and third phalanges of the index finger with corresponding part of the extensor communis digitorum.	Posterior interosseous.	Posterior interosseous.

CHAPTER XI.

THE THORACIC WALLS.

DISSECTION AND IDENTIFICATION.

REMOVE integument according to incisions in Figs. 77 and 94, study illustration of cutaneous nerves, and remember each is attended by cutaneous vessels of like name, although not shown in the accompanying illustration.

Anterior Cutaneous Nerves. Identify (1) by their location near sternum and distribution to integument; (2) by their serial continuity with the anterior cutaneous nerves of abdomen; (3) by their accompanying perforating branches of the internal mammary artery; (4) by their derivation from the intercostal nerves (Fig. 96); (5) by their communications with the lateral cutaneous branches of the intercostal nerves. (Fig. 94.)

Lateral Cutaneous Nerves. Identify (1) by their location in intercostal spaces in a line slightly behind the anterior axillary fold; (2) by their accompanying the lateral cutaneous branches of the intercostal arteries; (3) by their derivation from the intercostal nerves and distribution to the integument; (4) by their communication with the anterior cutaneous nerves and the posterior primary divisions of the spinal nerves; (5) by their serial continuity with the lateral cutaneous nerves of the abdominal walls. (Fig. 94.)

Internal Mammary Arteries. Identify (1) by their course along the anterior thoracic walls, one-half inch to outer side of sternum; (2) by their derivation from the first stage of the subclavian artery, and anastomosis (in sheath of rectus abdominis muscle) of its superior epigastric branch with the deep epigastric branch of the external iliac artery; (3) by their furnishing two anterior intercostal arteries to each of the six intercostal spaces; (4) by their termination behind the cartilage of the seventh rib in the superior epigastric and musculophrenic arteries; (6) by being accompanied by two veins. (Fig. 95.)

External Intercostal Muscle Identify (1) by its location in an intercostal space and attachment to the ribs; (2) by the downward and forward direction of its fibres; (3) by its extent, from the tubercle of the rib to the costo-chrondral articulation; (4) by the continuance of the anterior intercostal membrane from the end of the muscle forward to the sternum; (5) by eleven muscles on each side of the thorax.

Internal Intercostal Muscle. Identify (1) by its location in an intercostal space and attachment to ribs; (2) by the downward and backward direction of its fibres; (3) by its extent from the angle of the ribs to the margin of the sternum; (4) by continuance of the posterior intercostal membrane backward from the angle to the tubercle of the rib; (5) by its eleven muscles on each side. Remove the external intercostal muscles to expose the internal intercostal muscle and the intercostal nerves and vessels.

Intercostal Artery. (Fig. 95.) Identify (1) by its location in an intercostal space with a nerve of like name; (2) by its derivation from subclavian, internal mammary, and aorta.

The intercostal arteries are derived from (1) the subclavian, which furnishes the superior intercostal artery by which the first and second spaces are supplied; (2) the internal mammary; (3) the thoracic aorta. The aorta gives off ten intercostal arteries. Each, after a short course, divides into an upper and a lower branch. These anastomose with corresponding branches of the internal mammary. The intercostal branches from the aorta are called posterior intercostals; those from the internal mammary artery, anterior intercostals. The twelfth is called subcostal.

The Intercostal Veins are twelve in number on each side. They accompany the arteries, and correspond therewith in course and distribution. The last thoracic vein is called the subcostal. Tributaries are dorsal, from muscles of back; spinal, from neural canal and spinal meninges.

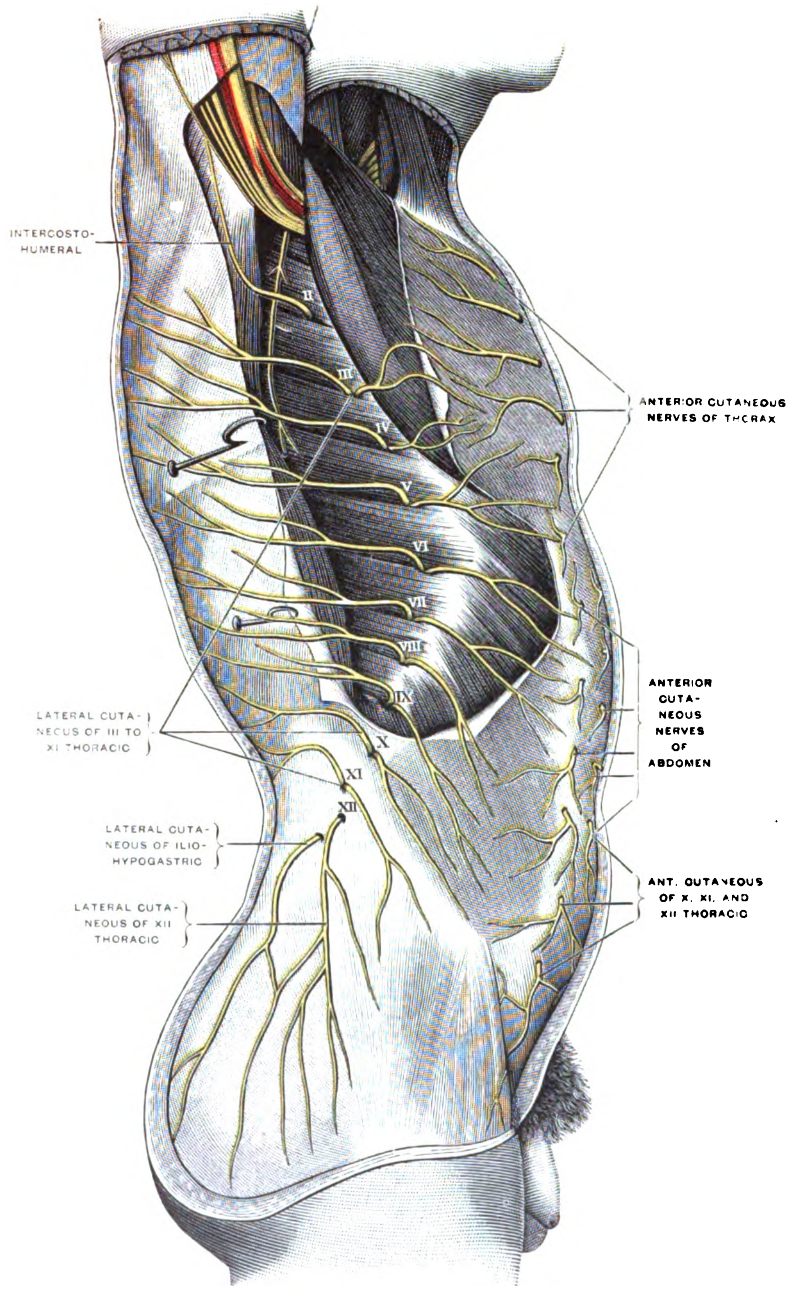
Intercostal Nerves. Identify (1) by its location in the intercostal spaces (except twelfth) with the intercostal vessels; (2) by their derivation from the thoracic nerves; (3) by their extensive distribution.

Superficial Fascia. Identify (1) by its location beneath the skin; (2) by its continuity with the superficial fascia of the neck, abdomen, and back; (3) by its contents: mammary glands, fat, and cutaneous vessels and nerves.

INTERNAL MAMMARY ARTERY. (Fig. 95.)

This is a branch of the first part of the subclavian artery. The artery, accompanied by two veins, passes behind the inner end of the clavicle and the costal cartilages to the sixth intercostal space, where it divides into the superior epigastric and musculophrenic. In its course the artery lies one-half inch to the outer border of the sternum. From without, the artery is covered by skin,

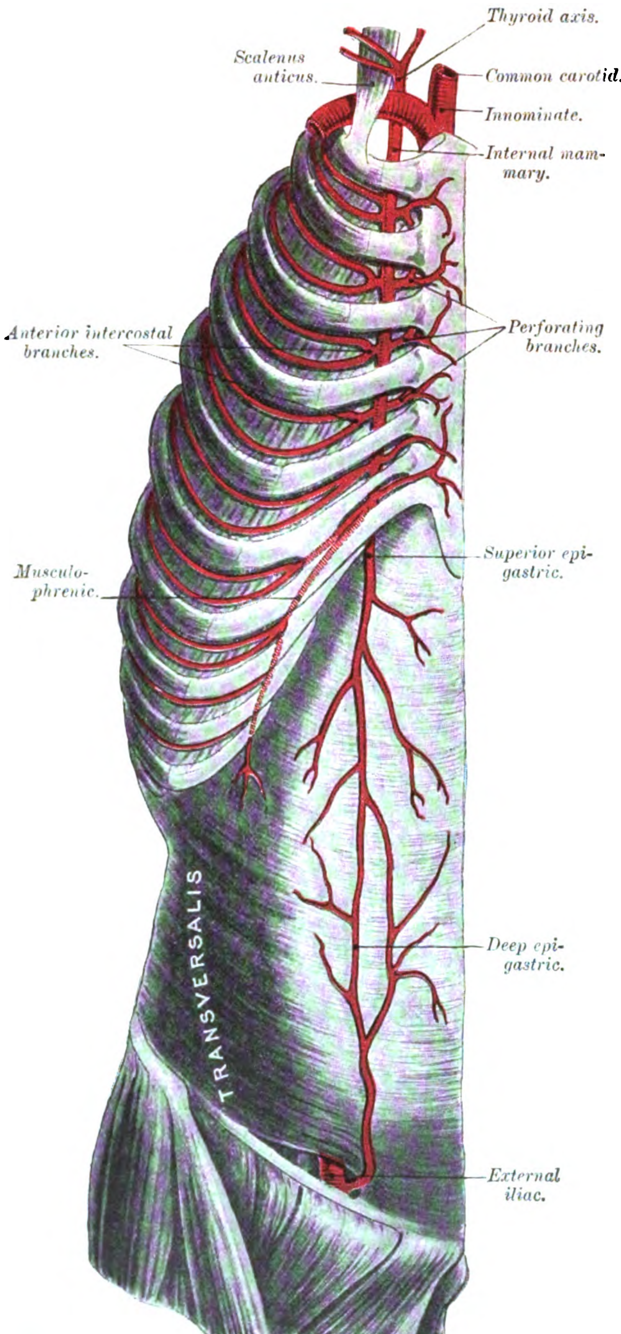
FIG. 91.



Cutaneous distribution of thoracic nerves. (GERRISH after TESTUT.)

superficial fascia, aponeurotic origin of pectoralis major, costal cartilages, anterior intercostal membrane, and external intercostal muscles. The artery is crossed by terminal branches of intercostal nerves. *Branches:* (1) The arteria comes nervi phrenici, accompanies the phrenic nerve; (2) the perforating, accompany the anterior cutaneous nerves; (3) the mediastinal, supply the thymus and mediastinal lymphatics; (4) the anterior intercostals, accompany the intercostal nerves; (5) the

FIG. 95.



The internal mammary artery and its branches. (GRAY.)

superior epigastric, enters the sheath of the rectus muscle ; 6) the musculo-phrenic, supplies the diaphragm and lower intercostal spaces ; (7) the pericardiac, supplies the pericardium. In the female the perforating branches form the principal blood-supply of the mammary glands. The superficial epigastric branch anastomoses with the deep epigastric of the external iliac in sheath of the rectus muscle.

Internal Mammary Veins. Two veins accompany each internal mammary artery, and are fed by tributaries corresponding to the branches of the artery. The veins have numerous valves. Behind the first intercostal space the four internal mammary veins form two main trunks, which open into the innominate veins of their respective sides.

THORACIC OR DORSAL NERVES.

The walls of the thorax and abdomen are supplied by the dorsal or thoracic nerves. These nerves do not form plexuses, as do those in the cervical, lumbar, and sacral regions. Their number is twelve on each side. The first dorsal emerges between the first and second dorsal vertebræ, the twelfth, between the last thoracic and first lumbar. Each nerve arises by an interior motor and a posterior sensory root, which leave the neural canal and unite in the intervertebral foramen, forming a mixed trunk. On emerging from the intervertebral foramen the mixed trunk divides into anterior and posterior primary divisions to supply pre-axial and post-axial parts of the body, respectively.

Posterior Primary Divisions. The posterior primary division (smaller than the anterior), in company with the corresponding dorsal branch of the intercostal vessel, reaches the back through a space bounded by the transverse process of the vertebra, neck of rib, body of vertebra, and superior costo-transverse ligament, and divides into internal and external branches. The internal branch, accompanied by corresponding vessels, passes between the semispinalis dorsi and multifidus spinæ. It supplies the multifidus spinæ, semispinalis dorsi and integument of the back, out to the angles of the ribs, in the upper half of the thorax. The external branch, accompanied by corresponding vessels, emerges between the longissimus dorsi and iliocostalis, supplying these and the musculus accessorius, levatores costarum, and integument of the lower half of the thorax as far outward as the angles of the ribs. The posterior primary divisions also supply the costo-transverse articulations. It will be seen, then, that the posterior primary divisions of the spinal nerves supply the erector spinæ and its divisions, the costo-transverse articulations, and the skin of the back externally to the angle of the ribs, where their cutaneous branches communicate with the lateral cutaneous branches of the anterior primary divisions. (See dissection of the back.)

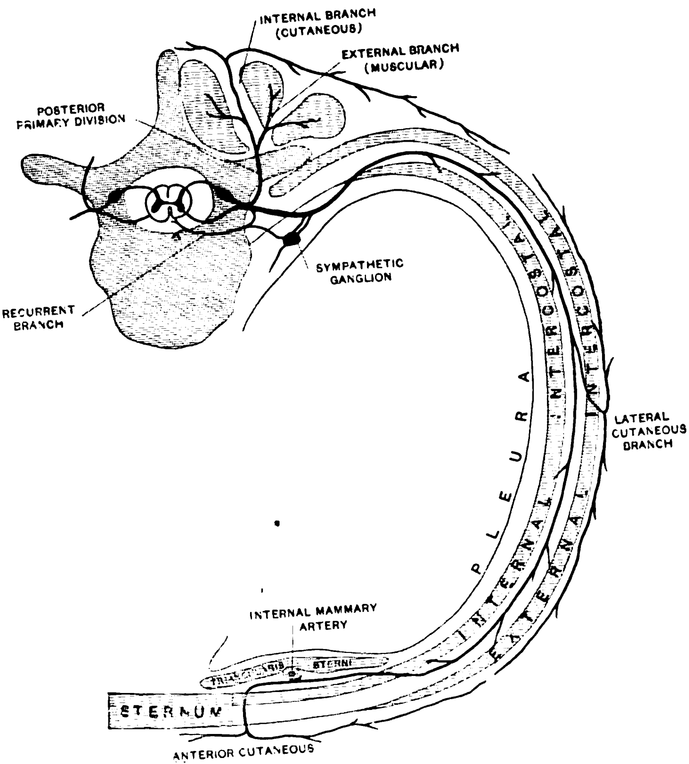
INTERCOSTAL NERVES. (Fig. 96.)

Intercostal Nerves. The anterior primary divisions of the dorsal nerves are called the intercostals, of which the six upper supply the thoracic and the six lower the abdominal walls. Each intercostal nerve is connected to a vertebral ganglion of the sympathetic, by both gray and white rami communicantes, and is accompanied by intercostal vessels. (See sympathetic nerve.)

An intercostal nerve has three stages: (1) from intervertebral foramen to angle of rib; (2) from angle of rib to costo-chondral articulation; (3) from costo-chondral articulation to sternum. In the first stage the nerve is beneath the artery, under cover of the parietal pleura and posterior intercostal membrane, resting on the external intercostal levator, costarum muscles, and superior costo-transverse ligament. In the second stage the nerve is between the internal and external intercostal muscles. In the third stage the nerve passes inward through the internal intercostal muscle (and lies on this latter) under cover of the triangularis sterni muscle, internal mammary vessels, and costal pleura. (**Intercostal** vessels have the same course and stages).

Branches of an Intercostal Nerve. 1. Anterior cutaneous: one in each intercostal space pierces the pectoralis major muscle near the sternum, and is attended by the perforating branches of the internal mammary vessels. (Below the diaphragm these nerves and vessels are serially continuous with the anterior cutaneous nerves and vessels of the abdominal walls.) 2. Lateral cutaneous: one in each intercostal space, attended by similar vessels. These pierce the thoracic wall, a little behind the anterior axillary fold, between the tooth-like processes of the serratus magnus muscle (Fig. 94), and are serially continuous below the diaphragm with the lateral cutaneous branches of the abdominal walls. Each lateral cutaneous nerve divides into a posterior branch (which communicates with cutaneous branches of the posterior primary division), and an anterior branch, which communicates with the anterior cutaneous branch. (Figs. 94, 96.) 3. Articular branches, to costovertebral and chondrosternal articulations. (The nerve that supplies a muscle,

FIG. 96.



Plan of a typical intercostal nerve. (GERRISH after W. KEILLER.)

supplies the joint moved and the integument covering the insertion of the muscle.) 4. Muscular branches, to external and internal intercostals, infracostals, triangularis sterni, and levatores costarum. 5. Sympathetic branches: "Fine sternal branches are given off at the anterior ends of the intercostal spaces to the back of the sternum." (Luschka and Quain.) "Minute subcostal branches perforate the internal intercostal muscles, to reach the inner surface of the ribs, where they are distributed to the periosteum and bone, as well as probably to the costal pleura." (Testut.) "The gray rami communicantes commence as axis-cylinder processes of the ganglion cells, are distributed to spinal nerves, and in them reach the vessels, fasciæ, bones, etc., for which they are destined. The white rami communicantes are derived probably from the motor roots of the spinal and cranial nerves. In man they are derived from the thoracic, and the first (and perhaps the second) lumbar nerves, and furnished to the sympathetic cords." (Gerrish.)

MUSCLES OF THE THORAX.

The External Intercostal Muscles are twenty-two in number, eleven on each side. The fibres of these muscles pass downward and forward, reminding one of the direction of the fibres of the external oblique muscles of the abdominal walls. The muscular fibre of the external intercostal muscles extends from the tubercle of the rib to the costo-chondral articulation. From this point to the sternum, the anterior intercostal membrane is projected, its fibres taking the same direction as the fibre of the muscle. (Fig. 96.) *Origin:* Lower borders of the ribs. *Insertion:* Upper borders of lower eleven ribs, extending from tubercle of rib to costo-chondral junction. *Nerve:* Intercostals, by numerous small branches which enter the inner surfaces of the muscles. The anterior and posterior intercostal membranes are parts of a general subpleural endothoracic fascia.

The Internal Intercostal Muscles are twenty-two in number, eleven on each side. The fibres run downward and backward, reminding one of the internal oblique muscles of the abdominal walls. The muscular fibre extends from the margin of the sternum to the angles of the ribs, thence the posterior intercostal membrane is extended backward. Fibres of the tenth and eleventh intercostal muscles are continuous with the internal oblique muscle.

The Triangularis Sterni Muscle rests on the inner surface of the sternum and costal cartilages. It represents the transversalis abdominis muscle, and is continuous with it. *Origin:* (1) Ensiform cartilage; (2) body of sternum; (3) fifth, sixth, and seventh costal cartilages. *Insertion:* Second, third, fourth, fifth, and sixth costal cartilages. Between this muscle and the bones on which it rests are the internal mammary vessels and intercostal nerves. (Fig. 96.)

Serratus Posticus Superior Muscle. Direction of fibre, downward and outward. *Origin:* (1) Ligamentum nuchæ; (2) spines of seventh cervical, and first and second thoracic vertebræ. *Insertion:* Outer surfaces of second, third, fourth, and fifth ribs. *Action:* Elevation of ribs. *Synergists:* External oblique and internal oblique. *Nerve:* Second and third intercostals—posterior primary division.

The Serratus Posticus Inferior Muscle. Direction of fibres, upward and outward. *Origin:* Spines of eleventh and twelfth thoracic, and first and second lumbar vertebræ. *Insertion:* Lower borders of eighth, ninth, tenth, eleventh, and twelfth ribs. *Synergists:* Infracostals. *Nerves:* Tenth and eleventh intercostals—posterior primary divisions.

The Levatores Costarum are twelve in number on each side, and are continuous with the external intercostals. *Origin:* Tips of transverse processes of last cervical and eleven upper thoracic vertebræ. *Insertion:* Outer surfaces of ribs from tubercles to angles. *Action:* Elevation of ribs. *Nerves:* Intercostals.

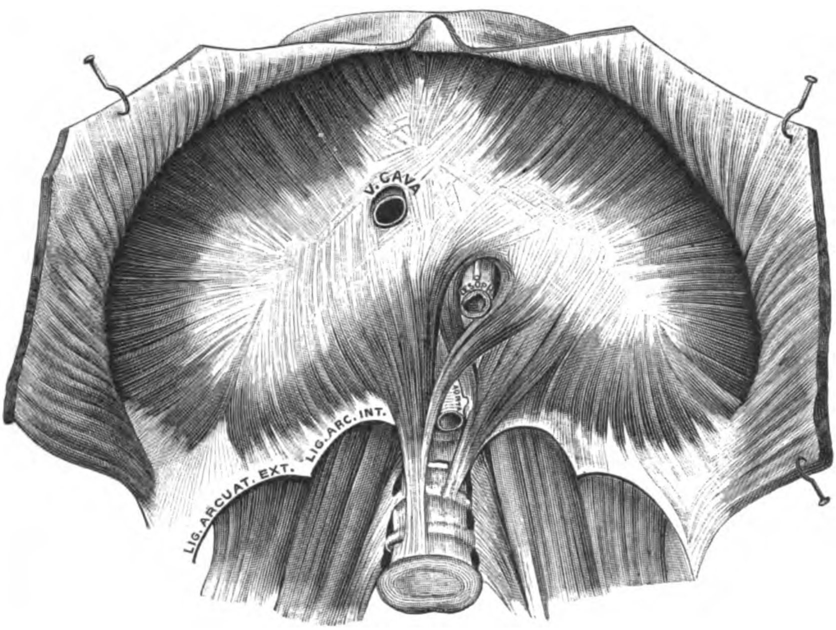
The Infracostals are eleven in number on each side. *Direction:* Upward and outward. *Origin:* Inner surfaces of lateral walls of thorax, external to angles of ribs. *Insertion:* Inner surface of first, second, or third ribs below their origin. *Action:* Depresses ribs. *Nerves:* Intercostals.

THE DIAPHRAGM.

Location. The diaphragm forms the floor of the thorax and the roof of the abdomen, has a very complicated attachment to the abdomino-thoracic walls, and bears important relations to pleura, pericardium, peritoneum, œsophagus, aorta, inferior vena cava, and thoracic duct. It has a central tendon corresponding to the base of the pericardium, and muscular fibres that radiate outward from this to the inferior aperture of the thorax. *Origin:* (1) Back of ensiform; (2) bodies of first, second, and third thoracic vertebræ; (3) anterior lamella of lumbar fascia; (4) ligamenta arcuata externa, extending from the twelfth rib to the transverse process of the first lumbar vertebra; (5) the six lower ribs interdigitating with the transversalis muscle.

The Crura of the Diaphragm (right and left). They descend from the back of the diaphragm to the upper lumbar vertebræ. The right is larger than the left, and attached to the first, second, and third lumbar vertebræ; the left to the first and second vertebræ only. The aorta passes between the crura. Opposite the twelfth thoracic vertebra the two crura are bound together by a fibrous arch from which muscular fibres arise. *Openings in the diaphragm :* (1) The aortic opening in front of the first lumbar vertebra is limited latterly by the crura, in front and behind by a fibrous arch. It gives passage to the aorta, thoracic duct, and vena azygos major. (2) The caval opening, in posterior part of central tendon, is situated opposite the cartilages of the eighth and ninth vertebræ, and gives passage to the ascending vena cava and filaments of the right phrenic nerve. (3) The œsophageal opening lies to the left and in front of the aortic opening, and gives

FIG. 97.



Diaphragm viewed from below. (GERRISH after TESTUT.)

passage to the œsophagus and pneumogastric nerves. Small openings transmit the vena azygos minor and the three splanchnic nerves (great, small, and smallest). The superior epigastric artery passes between the sternal and costal attachments of the diaphragm. *Nerves:* Two phrenics and phrenic plexus of sympathetic (branches that accompany the phrenic arteries). *Arteries:* Phrenic branches of aorta, musculophrenic branches of internal mammary, and arteria comes nervi phrenici. *Action:* (1) Respiratory; (2) expulsive on abdominal hollow organs.

Relations. To aid the memory and gain a clear idea of the subject examine your dissection and demonstrate the following relations of the diaphragm: Above, lungs and heart, with bases of pleural and pericardiac sacs, respectively; below, liver (with coronary, falciform and lateral ligaments), stomach, pancreas, kidneys, suprarenal capsules, and spleen. Demonstrate the aorta, œsophagus, vena cava, thoracic duct, and splanchnic nerves passing through the diaphragm to the abdomen.

CHAPTER XII.

THORAX—SUBDIVISIONS AND CONTENTS.

THE pulmonary part of the thorax contains the lungs and pleural sacs. The space not occupied by the lungs and pleural sacs is called the mediastinum; hence, the thorax consists of two grand divisions, pulmonary and mediastinal, and each has definite contents.

The general mediastinal space is divided into (*a*) superior mediastinum ; (*b*) anterior mediastinum ; (*c*) middle mediastinum ; (*d*) posterior mediastinum.

The Superior Mediastinum is bounded above by a plane passing through the upper border of the first piece of the sternum and the first dorsal vertebra ; below, by a plane passing through the upper border of the second piece of the sternum and the fourth dorsal vertebra; laterally by the pleuræ. This space contains: the sternohyoid, sternothyroid and longus colli muscles; the arch of the aorta and its three large branches; the descending vena cava (upper half), innominate and left superior intercostal veins; the vagus, cardiac, phrenic, and left recurrent laryngeal nerves; the trachea, œsophagus, thoracic duct, thymus and lymphatic glands.

The Anterior Mediastinum is bounded, anteriorly, by the sternum and cartilages of the fourth, fifth, sixth, and seventh ribs of the left side ; posteriorly, by the pericardium, and laterally, by the pleuræ. This space contains connective tissue, lymphatics from the convex surface of the liver, anterior mediastinal glands, and branches of the internal mammary artery.

The Middle Mediastinum is bounded in front and behind by the anterior and posterior mediastina, respectively, laterally by the pleuræ. This space contains the heart and pericardium, ascending aorta, superior vena cava (lower half), vena azygos major, bifurcation of trachea, bronchi, pulmonary arteries and veins, phrenic nerves and bronchial lymph glands.

The Posterior Mediastinum is bounded in front by the pericardium, behind by the vertebral column, laterally by the pleuræ. This space contains the thoracic aorta, the azygos veins, the vagus and splanchnic nerves, the œsophagus, thoracic duct, and lymph glands.

Our study of the contents of the thorax will consist (*a*) of identification of structures *in situ*, (*b*) of dissection of organs.

Identification of Collective Structures in Situ.

The Diaphragm. Identify (1) by its location below the lungs and heart and above the stomach and liver; (2) by its attachment to the sternum, costal cartilages, and vertebral column. These two statements regarding location and attachment apply to no other structure. There are many points that might be cited, but these two are sufficient for identification.

Lungs. Identify (1) by their location on each side of the heart, extending up into the lateral parts of the root of the neck above the level of the first rib and resting on the upper surface of the diaphragm below ; (2) by their spongy feel and dark spots.

Parietal Pleura. Identify (1) by its location on and attachment to the ribs and diaphragm ; (2) by its reflection onto the lungs and lateral part of mediastinum. Diaphragmatic, cervical, costal, and mediastinal are parts of the parietal pleura in these several regions.

Visceral Pleura. Identify (1) by its location on and firm attachment to the lungs ; (2) by its reflection onto the thoracic walls ; (3) by the glistening appearance it confers on the lungs ; (4) by its great elasticity seen when the lungs are passively inflated. The black spots on the lungs are beneath the visceral pleura ; hence this latter is transparent.

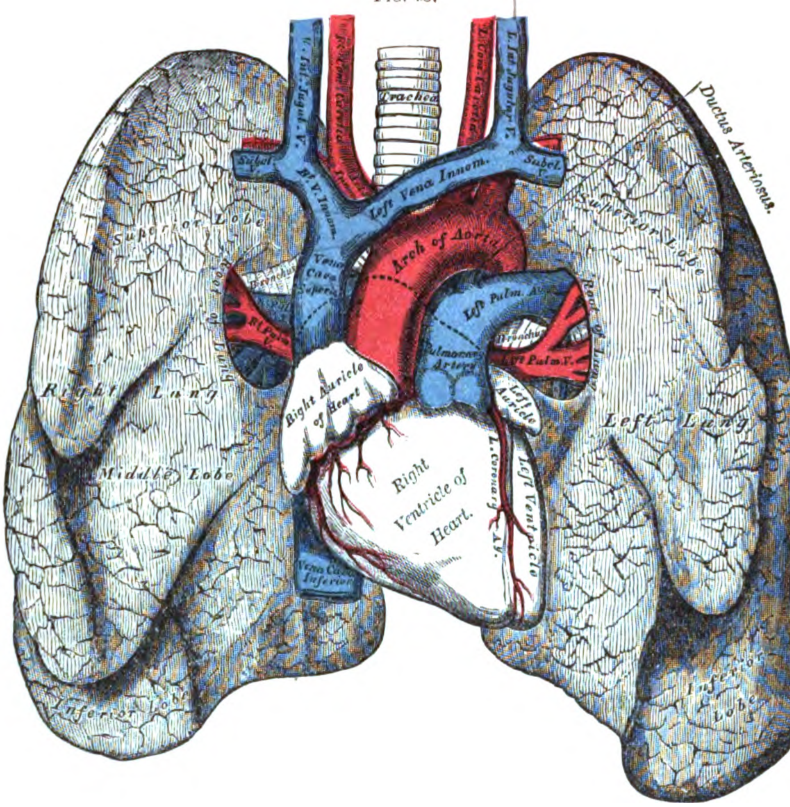
Pleural Cavity. Identify (1) by its location between the parietal and visceral layers of the pleura ; (2) by the small amount of serum contained ; (3) by its extent from the root of the neck to the diaphragm and from the ribs to the mediastinal pleura.

Thymus Gland. Identify in the very young (1) by its two lateral lobes in close contact, near mid-line, extending from the thyroid gland in the neck to the fourth costal cartilage, and resting on the pericardium; (2) by its location on the front and sides of the trachea. Lobes are sometimes separated by intermediary lobules, and occasionally fused in one mass. The glands are formed by evagination from the third pharyngeal pocket, are soft, lobulated, of pinkish-gray color, and at birth weigh about one-half ounce. The thymus is a ductless blood gland, and in the adult obtains as a connective tissue remnant on the upper part of the pericardium, separated from the arch of the aorta and other great bloodvessels by a layer of fascia.

Parietal Pericardium. Identify (1) by its sac-like shape and conical form, attached by its base to the diaphragm, by its truncate apex to the great vessels below the central part of the root of the neck, behind the first piece of the sternum; (2) by its being covered almost completely by the anterior margins of the lungs. (Fig. 98.)

The Visceral Pericardium invests the heart, and cannot be seen until the parietal pericardium has been incised and turned aside. The pericardial cavity is identified as a space between the visceral and parietal layers of the pericardium.

FIG. 98.



Front view of the heart and lungs. (GRAY.)

Internal Mammary Artery. Identify (1) by its location (one on each side) on the anterior wall of the thorax, about one-half inch external to the margin of the sternum; (2) by its origin from the first portion of the subclavian artery; (3) by its two accompanying veins, which unite behind the first intercostal space and form its two common trunks (right and left), and discharge into the corresponding innominate veins. (Fig. 95.)

Phrenic Nerve. Identify (1) by its location beneath the mediastinal pleura, on lateral aspect of the pericardium; (2) by its location anterior to the root of the lungs; (3) by its accompanying artery, a branch of the internal mammary, the arteria comes nervi phrenici.

Root-structures of Lungs. Identify as a constriction or neck connecting the heart and lungs. Develop by dividing the connective tissue along the vessels and bring into view by gently turning the anterior margins of the lungs outward. Root of the lung consists of the bronchus, pulmonary artery, pulmonary vein, pulmonary vessels, and nerves. (Fig. 98.)

Aortic Arch. Identify (1) by its central location between the descending vena cava on the right and the pulmonary artery on the left; (2) by its graceful curve backward and to the left, across the root of the left lung; (3) by the three large arteries (innominate, left common carotid, and left subclavian) arising from the highest part of the arch; (4) by its origin from the left ventricle of the heart.

Descending or Superior Vena Cava. Identify (1) by its location to the right of the aorta and by its blue color (generally); (2) by the adjacency of the phrenic nerve to its outer side; (3) by its formation, the confluence of the right and left innominate veins, beneath the cartilage of the first rib, near the sternum on the right side; (4) by its termination in the upper part of the right auricle of the heart.

Vena Azygos Major. (Fig. 107.) Identify (1) by its arching from behind forward, across the root of the right lung, opposite the fourth dorsal vertebra; (2) by its termination in the descending vena cava, just before this latter pierces the pericardium.

Ascending or Inferior Vena Cava. Identify (1) by its passage through the caval opening in the diaphragm and base of the pericardium; (2) by its termination in the lower part of the right auricle of the heart.

Pulmonary Artery. Identify (1) by its location to the left of the aorta; (2) by its division into the right and left pulmonary arteries. The left pulmonary artery passes directly to the lung above the bronchus; the right, beneath the aorta, vena cava, and right phrenic nerve, to the right lung and below the bronchus.

Pulmonary Veins. Identify (1) by their termination in the posterior wall of the left auricle; (2) by their position as the lowest of the root structures of the lungs.

Apex of Heart. Identify by its characteristic pointed shape and location near the fifth intercostal space of the anterior wall of the thorax, one and a half inches below the nipple, and three and a half inches to the left of mid-sternal line.

The Base of Heart. Identify (1) by its logical remoteness from the apex; (2) by the large vessels arising therefrom; (3) by its relation to the vertebræ—four thoracic vertebræ lie above, four below, and four behind it.

The Posterior Surface of Heart. Identify (1) by its location on the floor of the pericardium on the diaphragm; (2) by its flattened appearance.

The Anterior Surface. Identify (1) by its location behind the gladiolus; (2) by the presence of the third, fourth, and fifth costal cartilages on each side.

Auricular Part of Heart. Identify (1) by its thin, flaccid, collapsed walls; (2) by its characteristic posterior location; (3) by two forward-projecting, ear-like processes—the auricular appendices; (4) by a deep hollow between the two auricular parts, from which the aorta and pulmonary artery spring, behind and in front, respectively; (5) by its receiving tributary the venæ cavæ and pulmonary veins. (Fig. 98.)

Ventricular Part of Heart. Identify (1) by its conical form and firm, fleshy walls; (2) by its giving origin to the aorta and pulmonary artery; (3) by connection with the auricles of the heart; (4) by its apex, base, and right and left borders, anterior and posterior surfaces.

Right Border of the Ventricle is long and sharp, readily identified, and extends from base to apex and from right to left. It separates the surfaces and is called the margo acutus.

The Left Border is short and round, extends from base to apex, and is called margo obtusus.

The Right Ventricle includes superficially (1) right border; (2) about two-thirds of anterior surface; (3) about one-third of posterior surface, thus making the "right heart" anterior.

The Left Ventricle includes superficially (1) left border; (2) about one-third of anterior surface; (3) about two-thirds of posterior surface; (4) apex. This makes the major part of the so-called left heart posterior.

The Auriculo-ventricular Groove. Identify by its location around the circumference of the organ in a transverse direction nearer the base than the apex, and at a place where the auricular and ventricular parts of the heart are joined. This groove contains the right and left coronary arteries.

The Anterior Interventricular Groove begins in the auriculo-ventricular groove to the left of the pulmonary artery, and may be traced along the anterior surface of the heart downward a little to the right of the apex. This groove is occupied by the descending branch of the left coronary artery.

The Posterior Interventricular Groove traverses the posterior surface of the heart, originates above in the auriculo-ventricular groove, and contains the descending branch of the right coronary artery.

Inverse Relation of Borders and Interventricular Grooves of Heart. The anterior interventricular groove, occupied by the descending branch of the left coronary artery, and on the anterior surface of the heart, is nearer the left than the right border. The posterior interventricular groove, occupied by the descending branch of the right coronary artery and on the posterior surface of heart, is nearer the right than the left border of the heart.

Correspondences. The anterior and posterior interventricular grooves correspond to the interventricular septum, by which the two ventricles are completely separated from each other. The auriculo-ventricular groove corresponds to the attachment of the valves in the openings between the auricles and ventricles of the heart (right and left auriculo-ventricular valves).

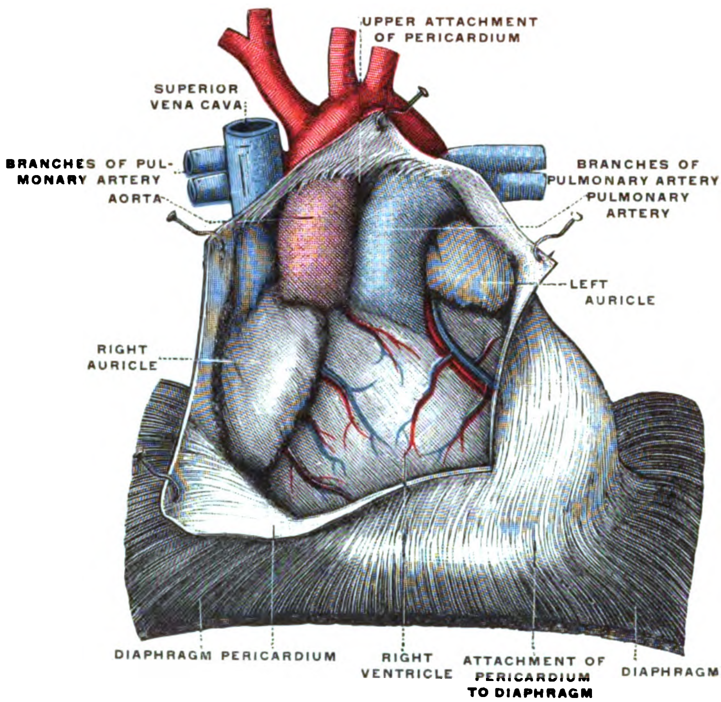
The Left Coronary Artery arises from the left posterior sinus of Valsalva, passes behind the pulmonary artery to the left in the auriculo-ventricular groove to the posterior surface. In its course it gives left auricular and ventricular branches and a large descending branch, which passes along the anterior interventricular groove to the apex of the heart.

The Right Coronary Artery arises from the anterior sinus of Valsalva, traverses the auriculo-ventricular groove to the right until it reaches the posterior surface of the heart. In its course it gives auricular and ventricular branches to the right auricle and ventricle, a large branch to the right margin, and a descending branch in the posterior interventricular groove.

The Superficial Cardiac Plexus, situated in the concavity of the aortic arch, on the bifurcation of the pulmonary artery, gives off the right coronary plexus which accompanies the right coronary artery. The deep cardiac plexus, situated behind the arch of aorta, gives off the left coronary plexus to the left coronary artery.

The Cardiac Veins. The veins of Thebesius are small vessels which return blood from the deep substance of the heart. They open into the right auricle through the minute foramina Thebesii. The anterior cardiac veins are on the front surface of the right ventricle, and open directly into the right auricle of the heart. The coronary sinus is in the groove between the left auricle and left ventricle, and may be identified in this place in fresh bodies by its large size and blue appearance. It opens into the right auricle between the vena cava and the auriculo-ventricular opening, and is guarded by the coronary valve. Tributaries of the coronary sinus: Great cardiac vein in interventricular groove, with descending branch of left coronary artery; middle cardiac vein (a branch of posterior cardiac) in posterior interventricular groove, with descending branch of right coronary artery; right cardiac and oblique vein of Marshall.

FIG. 99.



The heart *in situ*. The pericardium has been cut open in front, and reflected. (GERRISH after TESTUT.)

THE PERICARDIUM.

Dissection. (Fig. 99.) Cut through the visceral layer from diaphragm to arch of aorta. Locate phrenic nerves (on side of pericardium) and trace same to upper surface of the diaphragm. Turn apex of heart upward and examine visceral layer of pericardium (investing the heart). Locate base of pericardium and find ascending vena cava piercing the same. Place borders of lungs in normal position and estimate how much of pericardium is not covered by lung tissue—the area of pericardial dulness.

The Pericardium is a fibroserous sac surrounding the heart. Its base is attached to the central tendon of the diaphragm and perforated by the ascending vena cava. The apex surrounds the descending vena cava, aorta, and pulmonary vessels, and has the following pouches: (1) One between the inferior vena cava and lower pulmonary vein of right side; (2) one between the superior vena cava and upper pulmonary vein of right side; (3) one between the left pulmonary artery and left pulmonary vein. (See Gerrish.)

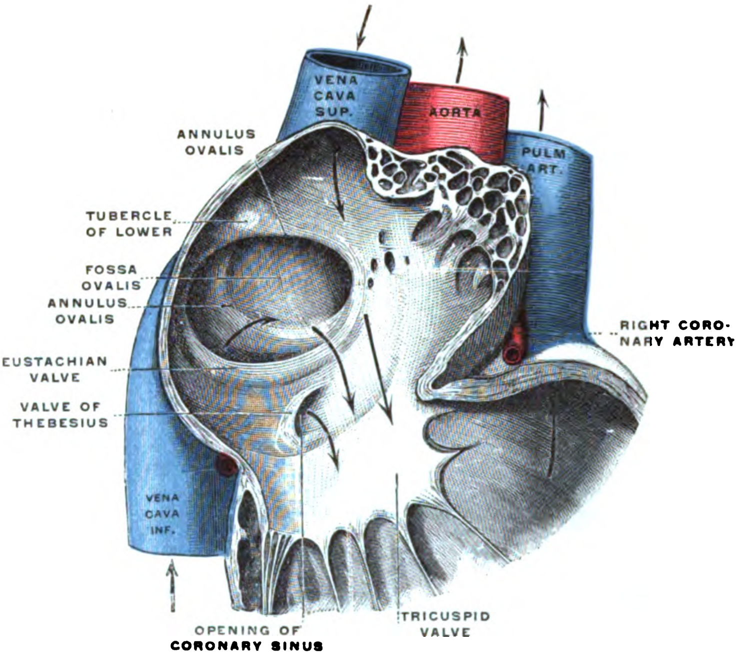
Tubular Prolongations. The ascending aorta and common pulmonary artery are surrounded in common by a tubular prolongation, their adjacent surfaces only remaining uncovered by pericardium. Between these two vessels and the auricular part of the heart is a space (sinus transversus). The inferior vena cava receives a small investment of pericardium. The superior vena cava is invested in part. The pulmonary veins are invested on the front and sides.

Surfaces and Relations. The anterior surface of the pericardium is in relation with the sternum, internal mammary vessels, connective tissue, triangularis sterni, and thymus; the posterior surface with the œsophagus, aorta, vagus nerves, thoracic duct, vena azygos major; the lateral surface with the anterior margins and inner surface of the lungs and mediastinal pleuræ. The pericardium consists of (1) a parietal layer; (2) a reflected or visceral layer: (3) a potential space between the two layers, called the pericardiac cavity. Each layer of the pericardium consists of a fibrous, non-elastic outer part, and a smooth, moist, glistening, secretory inner part. *Arteries:* Internal mammary, arteria comes nervi phrenici, bronchial, œsophageal, pericardiac. *Nerves:* Vagus, phrenic, sympathetic.

THE HEART.

Dissection. (1) Cut directly downward through the superior vena cava, atrium of right ventricle, and inferior vena cava as far as the diaphragm; (2) cut through the auricular appendix in a line at right angles to first incision. These two incisions will permit the right auricle to be studied after having been thoroughly cleansed. (Fig. 100.) (3) Cut about one inch of apex of heart off and pass director downward through the auriculo-ventricular opening into the right ventricle. Now pass a director from right ventricle into pulmonary artery and cut

FIG. 100.



Right auricle and part of right ventricle, the front wall having been removed. (GERRISH after TESTUT.)

down on same. This will afford an opportunity to study the interior of the right ventricle and the pulmonary semilunar valves. Pass director from apex of heart upward into aorta and cut down on same. This will expose the left ventricle and aortic semilunar valves. Trace pulmonary veins into left auricle and open same. Bullocks' hearts should be dissected to give a clear idea of valves, chordæ tendineæ, and columnæ carneæ.

The adult heart has two compartments, right and left, separated by a septum in such a manner that no direct communication exists. Each compartment has an auricle and a ventricle. There are, then, two auricles and two ventricles, which collectively constitute the heart. The heart is lined by endothelium continuous with that of all vessels that enter or depart.

Right Auricle. (Figs. 98, 100.) The right auricle has (1) a small, forward-projecting, ear-shaped, auricular process; (2) an atrium, into which a number of vessels discharge venous blood derived from the substance of the heart and from the regions both above and below the diaphragm. The atrium of the right auricle communicates with the right ventricle through the auriculo-ventricular opening. Tributaries of right auricle: (1) Foramina of Thebesius are openings of small veins (some are blind pouches) which return the blood from the substance of the heart. The largest is the cardiac vein of Galen. (2) The orifices of the anterior cardiac veins, three or four in number, which return the blood from the right ventricle of the heart. (3) The orifice of the ascending or inferior vena cava. This vessel perforates base of the pericardium and the diaphragm, opens into the lower part of the atrium, and returns practically all the venous blood from below the diaphragm. As it passes through the caval opening the hepatic veins become tributary to it. (4) The orifice of the descending vena cava. This vessel opens into the upper part of the atrium. It is formed by the confluence of the two innominate veins, and receives the vena azygos major.

Direction of Currents. The current of blood in the descending vena cava is directed into the auriculo-ventricular opening; that of the ascending vena cava, against the fossa ovalis in the posterior wall of the auricle. The currents are not opposed to each other. In the fœtus the same directions obtained, and blood in the ascending vena cava passed through the foramen ovale to the left auricle.

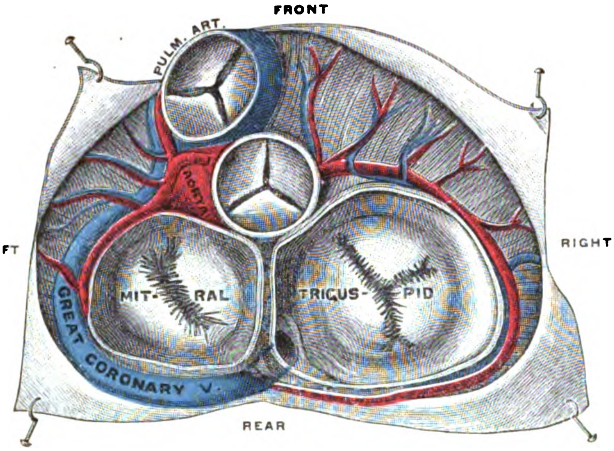
The Eustachian Valve is a fold of endocardium extending from the orifice of the ascending vena cava to the foramen ovale in the fœtal heart. It directs the blood-stream through the foramen ovale into the left auricle. In the adult heart the Eustachian valve (often feebly marked) guards the opening of the ascending vena cava.

The Orifice of the Coronary Sinus is between the opening for the ascending vena cava and the auriculo-ventricular opening. It is guarded by a fold of endocardium called the valve of Thebesius. The valve is imperfect.

The Fossa Ovalis, the remains of the foramen ovale of the fœtal heart, is in the posterior wall of the right auricle. It is surrounded by a margin called the annulus ovalis, and is seen by cleaning the wall (with gauze) and putting same on the stretch.

The Musculi Pectinati and Crista Terminalis. The inner surface of the auricles has a number of parallel ridges called musculi pectinati. They end in a smooth, vertical ridge, the crista terminalis. The whole has, in fancy, the appearance of a comb, and is to the auricles what the columnæ carneæ are to the ventricles of the heart, like mechanical devices for increasing the strength.

FIG. 101.



Valves of the heart and great arteries viewed from above, the auricles having been removed. (GERRISH after TESTUT.)

Function of Right Auricle. This chamber of the heart collects the blood during ventricular systole, and discharges same through the auriculo-ventricular opening into the right ventricle during ventricular diastole.

Right Ventricle. (Fig. 100.) The right ventricle is triangular in shape and its base is at the auriculo-ventricular groove. Its apex does not occupy the apex of the heart, but corresponds to the intersection of the anterior and posterior interventricular grooves in the margo acutus, about one inch above the apex of the heart. Orifices of right ventricle: (1) auriculo-ventricular (guarded by the auriculo-ventricular valve), by which the blood reaches the ventricle from the auricle; (2) pulmonary, by which the blood leaves the ventricle. This orifice is guarded by the pulmonary semilunar valves. The interior surface of the conus arteriosus (see p. 198) is smooth; that of the remainder of the ventricle is made irregular by columnæ carneæ, of which three varieties are recognized.

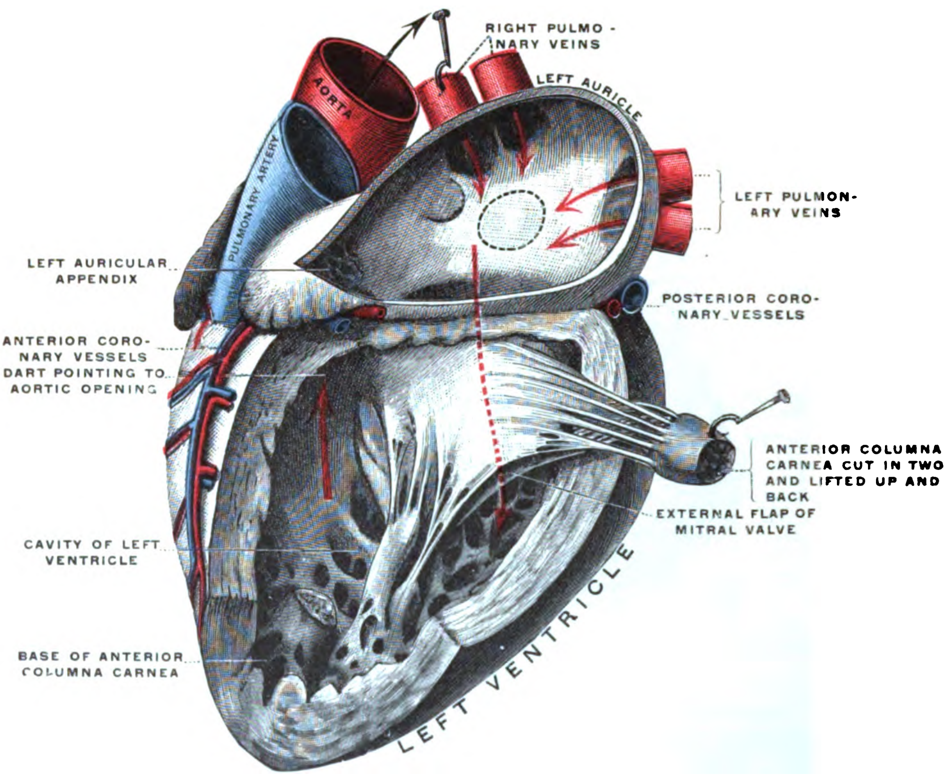
Variety of Columnæ Carneæ. (Fig. 102.) (1) Slightly elevated and elongated ridges of muscular tissue covered by endocardium; (2) fleshy bands of muscular tissue covered by endocardium and attached by two ends to the walls of the ventricle, but free in the rest of their extent; (3) fleshy conical masses, musculi papillares, attached by their bases to the ventricular walls, covered by endocardium and ending in delicate tendons, chordæ tendineæ, which are attached to the auriculo-ventricular valves and arranged into anterior and posterior sets. The so-called moderator band is a muscular structure which stretches across the ventricle from anterior papillary muscle to ventricular substance. Its use is to prevent overdistention of the ventricular cavity of the heart by fixing the anterior walls of the ventricle to a firm septum.

Tricuspid Valve. The right auriculo ventricular or tricuspid valve consists of three triangular cusps, the base of each of which is attached to the margin of the auriculo-ventricular opening. At their bases the three cusps are united in a continuous ring. Histologically these cusps consist of two layers of endocardium united by connective tissue. Each cusp has attachments (1) to the margin of the auriculo-ventricular orifice; (2) to the chordæ tendineæ.

Location and Names of Cusps of Right Auriculo-ventricular Valve. (1) The central cusp, behind the auriculo ventricular opening, is closely related to the septum; (2) the marginal cusp, to the right of the auriculo-ventricular opening, is near the right border of the heart; (3) the infundibular cusp, the largest of the three, is between the auriculo-ventricular opening and the pulmonary orifice. When the left ventricle of the heart contracts and forces blood into the aorta these cusps prevent regurgitation into the right auricle.

Semilunar Valve of Pulmonary Artery. (Fig. 101.) This has three segments, and each segment has two layers of endocardium connected by fibrous tissue. Each segment has an attached and a free margin. The free margins occlude in such a manner as to prevent regurgitation, and occlusion is made more effective by the presence of a nodule of cartilage in the centre of the free margin of each segment (corpus Arantii). The semilunar valve is placed at the beginning of the pulmonary artery, which is slightly dilated above the segments to form

FIG. 102.



Left auricle and ventricle, the hind wall of each having been removed. (GERRISH after TESTUT.)

the sinuses of Valsalva. The arrangement of the segments is as follows: two are in front and one behind the opening of the pulmonary artery.

Left Auricle. The left auricle of the heart, like the right, consists of (1) an auricular appendix (that points forward), and is the only part of the auricle that can be seen from in front (Fig. 98); (2) an atrium, or principal cavity, into which the pulmonary veins discharge. (Fig. 102.) The interior of the left auricle is smooth everywhere except in the auricular appendix, where the musculi pectinati give it a roughened appearance.

Openings in Left Auricle. (1) On posterior wall are openings for the pulmonary veins unguarded by valves. (Fig. 102.) Two pulmonary veins on each side may discharge by a common opening; (2) the auriculo-ventricular opening, guarded by the auriculo-ventricular valve, is in the floor of the auricle and opens into the left ventricle; (3) the remains of the fœtal foramen ovale (fossa ovalis) is in the septum between the auricles. (Fig. 100.)

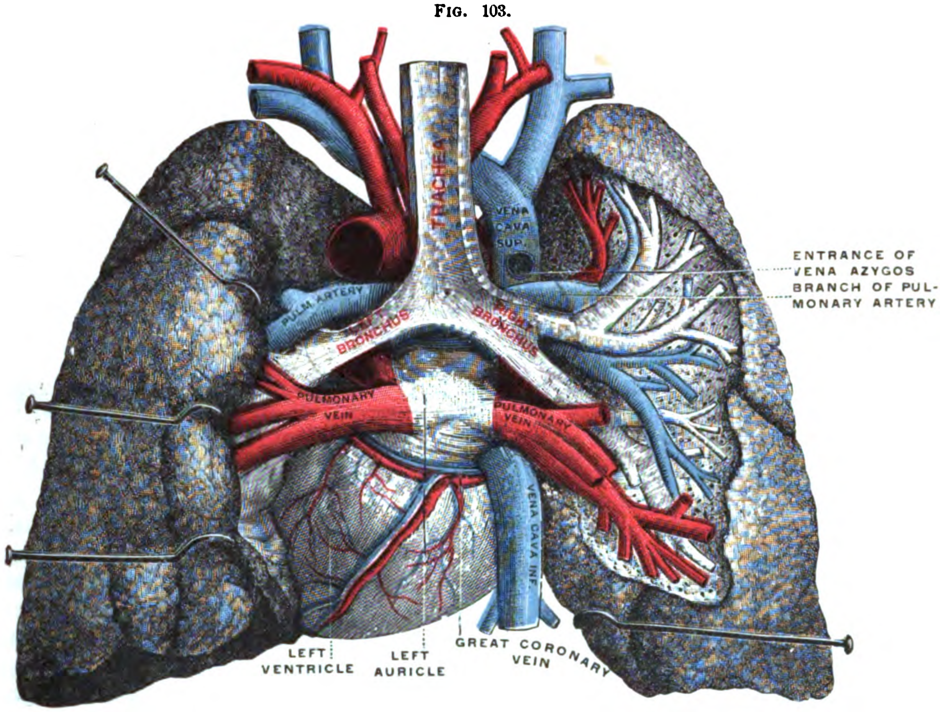
Left Ventricle. (Fig. 102.) The left ventricle has stronger walls than the right and includes the apex of the heart. The ventricular septum and upper part of the anterior wall of the ventricle are smooth; the apex and upper part of the anterior wall have a complex network of columnæ carneæ. The papillary muscles and chordæ tendineæ are larger and stronger in the left than in the right ventricle.

Openings in Left Ventricle. (1) The aortic opening, guarded by the aortic semilunar valve; (2) the left auriculo-ventricular opening, guarded by bicuspid or mitral valves, is between the left auricle and the left ventricle. These two openings are close together, near the base of the heart; that for the aorta is in front and to the right.

The Aortic Valve has three semilunar segments attached to the margins of the aortic opening. (Fig 101.) Each segment has a free or occlusal margin, in the centre of which is a nodule of cartilage (corpus Arantii). Each segment is composed of two layers of endocardium and connective tissue. Segments are similar in structure, but stronger than segments of the semilunar pulmonary valve. The aorta is dilated in the neighborhood of the semilunar valve (above) to form the sinuses of Valsalva. One lies in front and two behind the opening. The right coronary artery originates in the anterior sinus of Valsalva; the left, in the posterior sinus.

The Bicuspid, or left auriculo-ventricular valve, is composed of two layers of endocardium and connective tissue, and attached to the auriculo-ventricular opening and to the chordæ tendineæ of the papillary muscles. The anterior cusp is larger, and located between the aortic and the auriculo-ventricular openings. The function of the bicuspid valve is to prevent regurgitation of blood into the auricle during systole of the left ventricle.

FIG. 103.



Pulmonary veins, seen in a dorsal view of the heart and lungs. (GERRISH after TESTUT.)

TRACHEA AND BRONCHI.

Dissection. Locate the bifurcation of the trachea opposite the fourth dorsal vertebra. Cut longitudinally through its walls at this point, and extend the incision two inches into each bronchial tube. Notice the angle of departure of the bronchi from the trachea, and study the imperfect cartilaginous rings of each. Trace the bronchi into the lungs and identify their relation by comparison with the table, on a subsequent page, of root-structures of the lungs (p. 194). Identify the relations of the trachea by comparison with the table on page 192.

The Trachea and bronchial tubes convey air to and from the lungs. The trachea extends from the sixth cervical vertebra to the fourth dorsal, where it divides into the right and left bronchial tubes. The trachea is nearly an inch in diameter, and about five inches in length. The upper part of the trachea is in the neck; the lower, in the superior mediastinal space. *Arteries:* Inferior thyroids. *Nerves:* Vagus, recurrent laryngeal, and sympathetic.

The Bronchial Tubes begin at the bifurcation of the trachea, opposite the fourth dorsal vertebra, and terminate in the lung. (Fig. 103.) The right bronchus is about one inch, the left about two inches in length. The right bronchus is larger and more vertical in direction than the left; hence the greater liability of foreign bodies lodging in this one.

RELATIONS OF THE TRACHEA. (Fig. 103.)

Posteriorly, the trachea lies on the œsophagus.

Anterior relations.	In neck.	Isthmus of thyroid gland.	
		Inferior thyroid veins.	
		Arteria thyroidea ima.	
		Sternohyoid muscle.	
		Sternothyroid muscle.	
		Cervical fascia.	
		Superficial jugular veins.	
	In thorax.	Manubrium of the sternum.	
		Remains of the thymus gland.	
		Left innominate vein.	
		Arch of the aorta.	
		Innominate artery.	
		Left common carotid artery.	
		Deep cardiac plexus.	
Lateral relations.	In neck.	Common carotid arteries.	
		Lateral lobes of the thyroid.	
		Inferior thyroid arteries.	
		Recurrent laryngeal nerves.	
	In thorax.	Pleura.	Right side.
		Vagus nerve.	Right side.
		Innominate artery.	Right side.
		Recurrent laryngeal nerve.	Left side.
		Aortic arch.	Left side.
		Left common carotid artery.	Left side.
		Left subclavian artery.	Left side.

THE PLEURA.

Dissection. Trace the pleura over the outer surface of the mediastinal space, diaphragm, ribs, and lungs. Strip same from ribs and study the intercostal vessels and nerves near the vertebral column. Tear the pleura from the vertebral column and gain a view of the contents of the posterior mediastinum. Strip the pleura from the dome of the thorax and study the subclavian artery in its relation to the apex of the lung.

The Pleura is a serous membrane investing the lungs and lining the walls of the pulmonary compartment of the thorax. The pleura consists of (1) a visceral layer (pleura pulmonalis) investing the lungs; (2) a parietal layer investing the walls; (3) a potential space between the visceral and parietal layers, called the pleural cavity. The visceral pleura is identified by its smooth, moist, glistening appearance and location on the lungs. It is inseparably attached to the lungs, and dips down into their fissures; it is transparent, since black, carbonaceous spots on the lungs may be seen through it.

Special Names. The pleura that covers the inner surfaces of the ribs and intercostal spaces is called the costal pleura; that covering the upper surface of the diaphragm, diaphragmatic pleura; that investing the dome of the thoracic cavity (extending from one to two inches above the first rib), cervical pleura; that reflected from the back of the sternum to the spine, interrupted only where it invests the lungs and their root-structures, mediastinal pleura; this latter separates the pleural from the mediastinal parts of the thoracic cavity. The ligamentum latum pulmonis is a triangular fold of the pleura, extending from the root of each lung to the diaphragm, and is shown by drawing the lung outward and upward.

The Pleural Cavity is a potential, not an actual space, situated between the visceral and parietal layers. It is occupied normally by a small amount of serum, which lubricates the opposed surfaces of the pleura. An oversecretion of this serum, is hydrothorax. Pus in the pleural cavity, is pyothorax; air in the pleural cavity, is pneumothorax; the presence of pus and air in the pleural cavity, constitutes pyopneumothorax.

General Characters. Pleura is smooth, strong, polished, moist, elastic, glistening, transparent, secretory, absorptive, retentive, laxly attached to walls and firmly attached to the lungs. Removed from its environment, the pleura cannot be distinguished from the peritoneum.

Retentive Medium. The pleura covering the thoracic walls is held in position by subpleural connective tissue, just as peritoneum is retained by subperitoneal connective tissue, to the abdominal walls. The special name for this connective tissue is endothoracic fascia. Arteries that supply the lungs and bronchial tubes supply the visceral pleura; those that supply the walls (intercostals and internal mammary) supply the parietal pleura. *Nerves:* Visceral pleura is supplied by the sympathetic and vagus, the same nerves that supply the lungs. Parietal pleura is supplied by gray rami communicantes of sympathetic origin; these originate in the vertebral ganglia and reach the body walls with the intercostal nerves. (See sympathetic.)

Functions. Pleura strengthens the parts it invests and retains the lungs in position. It secretes a lubricating fluid called serum, it limits the extent of inflammatory products, and, by its high degree of elasticity, confers resiliency on the lungs.

THE LUNGS.

Dissection. Locate the phrenic nerve on the anterior part of the root of the lungs (attached to pericardium) and liberate same by blunt dissection in direction of nerve. Trace pulmonary vessels and bronchial tubes (through the slit-like passage) into the lungs. Examine base of the lung and find same resting on the diaphragm. Find ligamentum latum pulmonis, extending from root of lung to diaphragm. (See p. 192.) Demonstrate two large lobes in the left lung separated by an oblique fissure. Find two fissures and three lobes in the right lung. (Fig. 98.) Identify apex of lung passing through apex of bony thorax. Cut through the visceral pleura and study the interior of the lung. Demonstrate (*a*) parietal and visceral pleura; (*b*) the pleural cavity. Study the relation of the bronchus to the pulmonary vessels on right and left sides and compare dissection with illustration and table on pages 185 and 194, respectively. Cut through root and turn over the lung and gain view of the posterior mediastinum.

The lungs are the major organs of respiration. They are located in the pulmonary subdivision of the thoracic cavity and are firmly bound to the base of the heart by the pulmonary arteries and veins. By means of the bronchial tubes they are in communication with the trachea, and bound thereto. *Analysis:* The apex of the lung is blunt and rounded, and rises from one to two inches above the first rib into the root of the neck, where it is protected by the cervical pleura and fascia. The subclavian artery crosses the front and inner part of the apex of the lung. The base of the lung is in apposition with the upper surface of the diaphragm and diaphragmatic pleura. With the intervention of the diaphragm, the base of the right lung is in relation with the liver; likewise the base of the left, with the liver, stomach, and spleen. The outer surface of the lung is convex, in relation with the ribs and intercostal spaces; the inner is concave and in relation with the pericardium. Between the inner surface of the lung and pericardium is the phrenic nerve with its accompanying artery, descending to the diaphragm in front of the root of the lung, along the mediastinal pleura. The posterior border of the lung rests in a broad groove on each side of the vertebral column, and is long, thick, and rounded. The anterior border is sharp, short, thin, and lies between the pericardium and sternum behind and costal cartilages in front. The anterior border of the left lung is notched, leaving a space called the incisura cardiaca. The left lung is divided by an oblique fissure into two lobes, superior and inferior; the right, by two fissures into superior, inferior, and middle lobes. (Fig. 98.)

Root-structures of Lungs. This is a collective noun by which all structures that enter or depart from the lungs, for carrying on functional and nutritive activities of these organs, are designated. These structures are bound together by connective tissue, and invested by pleura. By means of the root-structures the lungs are held in proper position. The root of the lung is composed of bronchial tubes, bronchial arteries and veins, pulmonary arteries, pulmonary veins, pulmonary nerves (vagus and sympathetic), pulmonary lymphatic vessels and glands, connective tissue, and investing pleura.

RELATIONS OF ROOT-STRUCTURES OF THE LUNGS.

From before, backward	Pulmonary vein. Pulmonary artery. Bronchus.	Both sides.
From above, downward	Bronchus. Pulmonary artery. Pulmonary vein.	Right side.
From above, downward	Pulmonary artery. Bronchus. Pulmonary vein.	Left side.

The Bronchial Arteries nourish the lungs and bronchial tubes. They lie on the posterior part of the bronchial tubes, and are three in number—one on the right, and two on the left side. These arteries are small and variable in origin and course. Both the right and left bronchial arteries may arise by a common trunk from the aorta. The left bronchial arteries usually arise from the aorta; the right, either from the aorta or first intercostal artery. The bronchial veins correspond to the bronchial arteries in distribution, and return the greater part of the blood from the substance of the lung and bronchial tubes, and discharge as follows: The right, into the vena azygos major; the left, into the vena azygos minor superior, or left superior intercostal. (Fig. 104.)

THE GREAT BLOODVESSELS.

Dissection. Dissect down on the ascending aorta until the coronary arteries are reached. Cut through the aorta one inch above the coronary arteries, and study the aortic semilunar valves. Dissect between the arch of the aorta and pulmonary artery, and find the remains of the ductus arteriosus. (Fig. 98.) Study the three large branches given off from the arch of the aorta. Identify the relations of the aorta by comparison with the following tables and illustrations on pages 185 and 191. Divide the connective tissue (blunt dissection) and identify all structures entering both heart and lungs.

Ascending Aorta.

The ascending aorta (Fig. 98) arises from the left ventricle of the heart, where it is guarded by the aortic, semilunar valves, and ends at the beginning of the aortic arch, opposite the upper border of the second sternochondral joint on the right side. The right and left coronary arteries, given off above the free margin of the semilunar valves, are its only branches. The following are its relations:

Anterior.
Pulmonary artery.
Right auricular appendix.
Pericardium.
Right pleura and right lung.
Remains of the thymus gland.

Right side.		*Left side.*
Superior vena cava. Right auricle.	Ascending Aorta.	Pulmonary artery.

Posterior.
Right pulmonary artery.
Left auricle.

Arch of the Aorta.

The Arch of the Aorta (transverse aorta) extends from the upper border of the second sternochondral joint on the right side to the left side of the lower border of the fourth dorsal vertebra, and lies about one inch below the upper margin of the sternum. Its branches are the innominate, left common carotid, and left subclavian arteries. (Fig. 98.)

RELATIONS OF THE ARCH OF THE AORTA.

Above.
Left innominate vein.
Innominate artery.
Left common carotid artery.
Left subclavian artery.

In front.
Pleuræ and lungs.
Remains of the thymus gland.
Left vagus nerve.
Left phrenic nerve.
Superficial cardiac nerves.
Left superior intercostal vein.

Arch of Aorta.

Behind.
Trachea.
Deep cardiac plexus.
Thoracic duct.
Left recurrent nerve.
Œsophagus.

Below.
Bifurcation of the pulmonary artery.
Remains of the ductus arteriosus.
Superficial cardiac plexus.
Left recurrent laryngeal nerve.
Left bronchus.

Innominate Artery.

The innominate artery arises from the arch of the aorta in front of the left common carotid. It is about two inches long, and divides opposite the upper border of the right sternoclavicular joint into the right subclavian and right common carotid arteries. The following are its relations :

In Front.
Sternum.
Sternohyoid and sternothyroid muscles.
Remains of the thymus gland.
Left innominate vein.
Right inferior thyroid vein.
Inferior cervical cardiac branch of right vagus.

Right side.
Right innominate vein.
Right vagus nerve.
Pleura.

Innominate Artery.

Left side.
Remains of the thymus.
Left common carotid.
Left inferior thyroid vein.
Trachea.

Behind.
Trachea.

Left Common Carotid Artery.

The left common carotid artery arises from the arch of the aorta between the innominate and left subclavian. Its relations in the thoracic portion are as follows:

In Front.
Sternum.
Sternohyoid and sternothyroid muscles.
Left innominate vein.
Remains of the thymus gland.

Internally.
Innominate artery.
Inferior thyroid veins.
Remains of the thymus gland.

Common Carotid Artery.

Externally.
Left vagus nerve.
Left pleura and lung.
Left subclavian artery.

Behind.
Trachea.
Œsophagus.
Thoracic duct.
Left subclavian artery.

Left Subclavian Artery.

The left subclavian artery arises from the left end of the arch of the aorta. Study its relations in the following plan :

In Front.

Vagus, cardiac, and phrenic nerves.
Left common carotid artery.
Thoracic duct.
Left internal jugular vein.
Left vertebral vein.
Left innominate vein.
Sternohyoid, sternothyroid, and sternomastoid muscles.

Inner side.		*Outer side.*
Trachea. Œsophagus. Thoracic duct.	Subclavian Artery.	Pleura. Left lung.

Behind.

Œsophagus.
Thoracic duct.
Inferior cervical ganglion.
Longus colli.

Thoracic Aorta.

The thoracic aorta begins opposite the fourth thoracic vertebra as a continuation of the aortic arch, and ends at the aortic opening in the diaphragm at the twelfth dorsal vertebra, and traverses the posterior mediastinal space. In the upper part of its course the artery is to the left of the mid-line of the body. Between the two extreme points it lies on the vertebræ and shares the curves of the spine. Relations :

In Front.

Root of the left lung.
Pericardium.
Œsophagus.
Diaphragm.

Right side.		*Left side.*
Œsophagus. Vena azygos major. Thoracic duct.	Thoracic Aorta.	Pleura. Left lung. Œsophagus (below.)

Behind.

Vertebral column.
Vena azygos minor superior.
Vena azygos minor inferior.

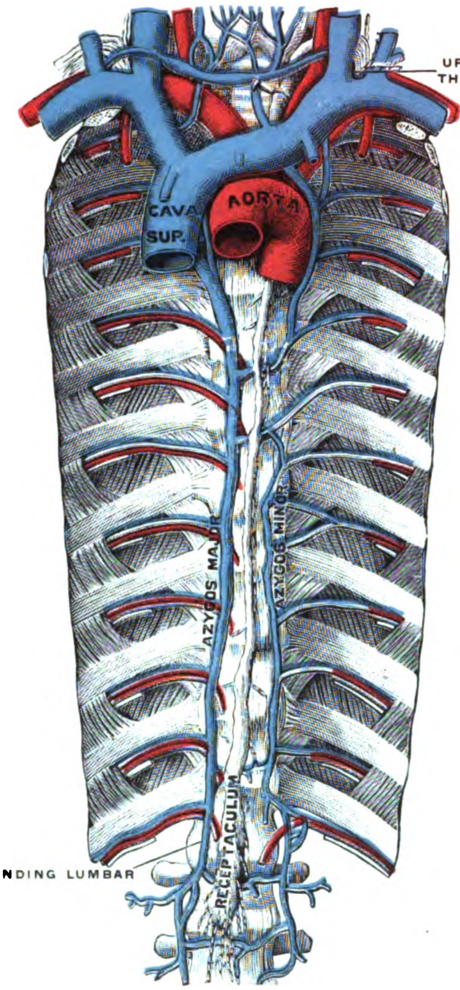
Branches of Thoracic Aorta. (1) Bronchial, three in number, accompany the bronchial tubes and supply the lung substance and bronchi; (2) pericardiac, to the pericardium; (3) œsophageal, to the œsophagus; (4) posterior mediastinal, to the lymphatic glands; (5) the posterior intercostal arteries are described in the dissection of the thoracic walls.

SUPERIOR VENA CAVA.

The Superior Vena Cava (Fig. 104) is three inches long, and extends from the point of confluence of the innominate veins (behind cartilage of first rib on right side) to the right auricle of the heart, opposite the third costal cartilage. Externally it is covered by mediastinal pleura, and is in relation with the right phrenic nerve. The upper half is in the superior mediastinal space: the lower half, enclosed by the pericardium, is in the middle mediastinal space. This vein has no valves. *Tributaries:* Right innominate, left innominate, vena azygos major, pericardiac and mediastinal veins.

Right Innominate Vein. (Fig. 98.) This vein, about one inch long, runs vertically downward and meets the left innominate below the cartilage of the first rib on the right side to form the superior vena cava. *Tributaries:* Right vertebral, right internal mammary, right inferior thyroid and right superior intercostal. It lies in front of and external to the right innominate artery; the phrenic nerve is to its outer side.

FIG. 104.



Azygos and intercostal veins. (GERRISH after TESTUT.)

Left Innominate Vein. (Figs. 98, 104.) The left innominate vein is about two and a half inches long. It begins behind the sternal end of the clavicle on the left side by the confluence of the subclavian and internal jugular veins, and ends in the superior vena cava on the right side, behind the cartilage of the first rib. It lies beneath the manubrium, sternohyoid, sternothyroid, thymus or its remains, and crosses the trachea, left subclavian, left common carotid and innominate arteries. *Tributaries:* Left internal mammary, left vertebral, left inferior thyroid, and left superior intercostal veins.

The Vena Azygos Major (Fig. 104) arises in the ascending lumbar vein on the right side, passes through the aortic opening in the diaphragm to the right of the aorta and thoracic duct. In the thorax it lies on the thoracic vertebræ, crossing the intercostal arteries. At the root of the right lung, opposite the fourth thoracic vertebra, it curves above the bronchus and opens into the superior vena cava just before this vessel perforates the pericardium. *Tributaries:* (1) The right superior intercostal vein; (2) veins of the ten lower intercostal spaces; (3) vena azygos minor superior; (4) vena azygos minor inferior; (5) pericardiac veins; (6) bronchial veins of the right lung; (7) œsophageal veins.

The Vena Azygos Minor Superior (Fig. 104) is formed by the union of the fourth, fifth, sixth, seventh, and eighth intercostal and left bronchial veins. It communicates with the left superior intercostal vein, crosses the aorta and thoracic duct at the eighth dorsal vertebra, and joins the vena azygos major. The vena azygos minor inferior begins in the left ascending lumbar vein, pierces the left crus of the diaphragm and passes behind the aorta and thoracic duct at the ninth thoracic vertebra and opens into the vena azygos major. Its tributaries are the ninth, tenth, and eleventh intercostal veins.

Pulmonary Vessels.

The Pulmonary Artery (Figs. 98, 103), about two inches long, arises from the base of the right ventricle (conus arteriosus). It is at first in front of, later to the left of, the ascending aorta. The artery divides into right and left branches, which convey blood to the lungs for aëration. The right pulmonary artery passes behind the ascending aorta, superior vena cava, and right phrenic nerve to the right lung; the left passes in front of the descending aorta and left bronchus to the left lung. The beginning of the left pulmonary artery is connected to the under surface of the aortic arch, in the embryo, by the ductus arteriosus; in adult life a remnant of this obtains, as the ligamentum arteriosum.

The Pulmonary Veins (Fig. 102), four in number (two for each lung), return blood from the lungs to the left auricle. They have no valves, are but little larger than the pulmonary arteries, and accompany these latter singly. In the lungs the veins lie in front of the pulmonary arteries.

PHRENIC AND VAGUS NERVES.

The Phrenic Nerves. These are right and left, and supply the diaphragm, pericardium, pleura, peritoneum (in part). The phrenic, on either side, in the neck, lies on the scalenus anticus muscle, and passes into the thorax beneath the subclavian vein (crossing the internal mammary artery from without inward, in front of the root of the lung), is covered by mediastinal pleura; it is seen beneath the inner border of the lung on the pericardium. In the superior mediastinal space the left phrenic nerve crosses the arch of the aorta. The right phrenic lies to the outer side of the descending vena cava and innominate vein. Each phrenic nerve is accompanied by an artery, arteria comes nervi phrenici (a branch of the internal mammary), which is distributed coextensively with the nerve.

Vagus, or Pneumogastric Nerves. The left vagus nerve enters the thorax between the left subclavian and the left common carotid arteries. It crosses the aortic arch to the left of and behind the phrenic nerve, and gives off the recurrent laryngeal nerve, passes behind the root of the lung and breaks up into branches which form, with filaments from the third and fourth thoracic ganglia of the sympathetic, the posterior pulmonary plexus. It leaves this plexus in two strands), and soon gains the front of the œsophagus and unites with similar branches of the right vagus to form the plexus gulæ. The nerve leaves this plexus, passes through the diaphragm with the œsophagus and is distributed to the stomach, liver, and intestines. The right vagus nerve enters the thorax between the right innominate vein and the right subclavian artery, and descends with the trachea to the posterior part of the root of the right lung, where it forms with filaments from the third and fourth thoracic ganglia of the sympathetic, the posterior pulmonary plexus. The nerve leaves this plexus as two cords, forms the plexus gulæ and passes through the œsophageal opening in the diaphragm into the abdominal cavity. *Branches in Thorax:* (1) Œsophageal, in the superior and posterior mediastinal spaces to œsophagus; (2) pulmonary, to the anterior and posterior pulmonary plexuses; (3) pericardiac, from the plexus gulæ and the posterior pulmonary plexus to pericardium; (4) thoracic cardiac (from vagus and recurrent laryngeal), to cardiac plexus; (5) recurrent laryngeal, to larynx, trachea and œsophagus.

The Left Recurrent Laryngeal is given off below the arch of the aorta, and loops around the ductus arteriosus to gain the space between the trachea and œsophagus, whence it proceeds to the larynx; the right nerve is given off at the lower border of the subclavian artery, and after winding backward and inward beneath the subclavian artery, pursues a similar course between the trachea and œsophagus.

THORACIC DUCT.

The Thoracic Duct begins on the second lumbar vertebra in the receptaculum chyli. Excepting lymphatic vessels from a part of the convex surface of the liver, the thoracic duct receives all the lymphatic vessels below the diaphragm; above the diaphragm it receives the lymphatic vessels from the left side of the heart, left lung, left side of the head and neck and left upper extremity. *Course:* The thoracic duct passes from the abdomen to the thorax on the right side of the aorta through the aortic opening in the diaphragm. In the posterior mediastinum it lies in front of the vertebral column, between the aorta and the vena azygos major. Opposite the fourth dorsal vertebra the duct passes behind the œsophagus and the aortic arch, ascends to the neck between the œsophagus and the left pleura, ending at the junction of the left subclavian and internal jugular veins.

THE ŒSOPHAGUS.

The Œsophagus begins at the level of the thyroid cartilage as a downward continuation of the pharynx; at the base of the thorax it passes through the œsophageal opening in the diaphragm, and ends in the cardiac extremity of the stomach. It is the narrowest and most muscular part of the alimentary canal. It lies in the neck, superior and posterior mediastinal spaces. Behind the œsophagus are the thoracic duct, vertebral column and longus colli muscles. In front of the œsophagus are the trachea, left bronchus, and diaphragm.

MEDIASTINAL GLANDS.

Superior Mediastinal Lymphatic Glands. There are, in relation with the arch of the aorta, eight or ten lymphatic glands, which collect lymph from the heart, pericardium, and thymus. Lymph vessels leaving these glands are as follows: Those from the right side of the heart discharge into the right lymphatic duct; those from the left into the thoracic duct. The posterior mediastinal lymphatic glands follow the aorta, and are joined by the lymphatic vessels from the œsophagus, heart, and diaphragm. The bronchial lymphatic glands are continuous above with the superior mediastinal glands. They are located principally near the bifurcation of the trachea, and extend into the root of the lungs. They receive lymphatic vessels from the lungs, and the fluid they contain is often black. It will be noticed that the lungs of any adult are very dark; this discoloration is due to atmospheric impurities inhaled, and the peculiar color is carbonaceous.

CHAPTER XIII.

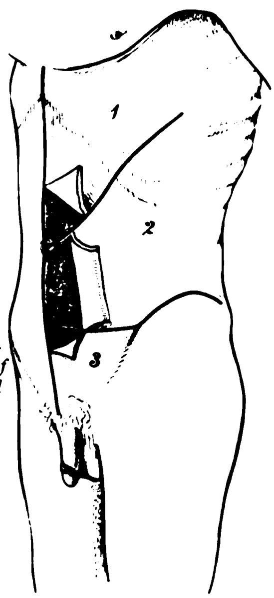
THE ABDOMINAL WALLS.

Dissection. Remove the integument as indicated by the incisions in Fig. 105. Observe the fat, cutaneous vessels, and nerves in the superficial fascia beneath the skin. Be guided by the illustrations, and identify the structures in the order given in the text.

Superficial Fascia. The superficial fascia of the abdominal walls consists of two layers: 1. An upper, containing a variable amount of fat (panniculus adiposus), called Camper's fascia. 2. A lower, free from fat, quite elastic, a rudimentary representative of the elastic abdominal tunic in the horse, and called Scarpa's fascia.

Camper's Fascia is continuous over Poupart's ligament with the superficial fascia of the thigh, and has no deep fascial attachments. Scarpa's fascia, in the region of the pubes, extends over the penis, spermatic cord, and scrotum to the perineum, where it is continuous with Colle's fascia. On either side it blends with the fascia lata, immediately below Poupart's ligament.

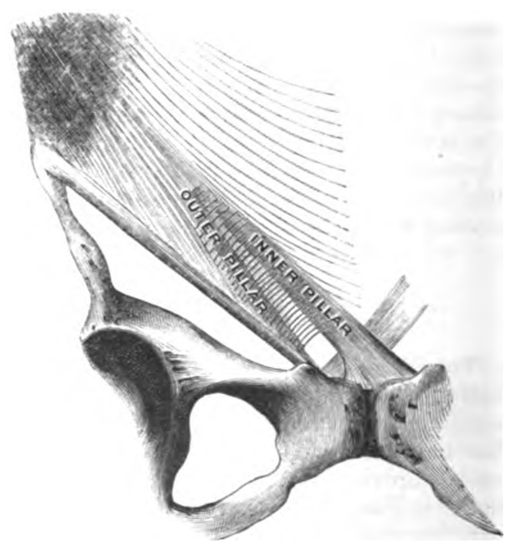
FIG. 105.



3. Dissection of inguinal hernia.

Dissection of abdomen. (GRAY.)

FIG. 106.



External abdominal ring of right side. (GERRISH after TESTUT.)

Anterior Cutaneous Nerves. (Fig. 109.) Identify (1) by the distribution to the skin covering the rectus muscle; (2) by the fact of piercing the sheath of the rectus muscle and serially continuous with similar structures of the thoracic walls; (3) by the derivation from the iliohypogastric and six lower thoracic nerves; (4) by the derivation of attending arteries from the deep and superior epigastric.

Lateral Cutaneous Nerves. Identify (1) by the derivation from the iliohypogastric and six lower thoracic nerves; (2) by serial continuity with similar structures of the thoracic region; (3) by the derivation of attending arteries from four intercostals and lumbars.

Spermatic Cord and Two Nerves. (Fig. 109.) Locate emerging from the external abdominal ring. (*a*) The ilio-inguinal nerve is in front of the cord (sensory nerve to the skin of the scrotum and thigh); (*b*) the genito-crural (sensory to the skin of the thigh and motor to the cremaster muscle) lies behind the cord.

External Abdominal Ring. (Fig. 106.) Identify (1) by the location, external to and above the pubic crest between two strong lateral fibrous pillars, and in the aponeurosis of the external oblique muscle; (2) by the length, about one inch, extending in an inward and downward direction; (3) by the contents: male, the spermatic cord, ilio-inguinal and genito-crural nerves; female, the same two nerves as in the male, and round ligament of the uterus; (4) by the boundaries: pubic crest below, intercolumnar fibres above, pillars internal and external, laterally.

Linea Alba. The linea alba extends from the ensiform or xiphoid cartilage of the sternum to the symphysis pubis. It is formed by the junction of the aponeuroses of the external oblique, internal oblique, and transversalis muscles, and is situated between the recti muscles of the abdominal walls. The linea alba is narrow below, broad above the umbilicus, and has apertures for vessels and nerves. Externally, it is related to the integument; internally, to the transversalis fascia, urachus, and bladder.

Umbilicus and Semilunar Lines. (Fig. 107.) The umbilicus is the largest aperture in the linea alba. In the fœtus it transmits the umbilical vein and hypogastric arteries, structures concerned in aëration of the blood; in the adult the umbilical aperture is represented by a strong scar. The lineæ semilunares correspond to the outer margins of the recti muscles, and extend from the ninth rib to the spine of the pubic bone. Each is formed by the tendons or aponeuroses of the oblique and transversalis muscles.

Osteological Points. The symphysis pubis is in the mid-line, and formed by the junction of the pubic bones. The pubic crest extends from the angle to the spine of the pubic bone, and gives attachment to the rectus abdominis, pyramidalis, and conjoined tendon of the internal oblique and transversalis muscles. The pubic spine is situated at the outer end of the pubic crest, and gives attachment to the inner extremity of Poupart's ligament. The pectineal line extends from the pubic spine to the iliopectineal eminence, and gives attachment to the pectineus muscle and Gimbernat's ligament. The anterior superior iliac spine is at the anterior end of the iliac crest, and gives attachment to the outer extremity of Poupart's ligament. The crest of the ilium is limited by the anterior and posterior superior spinous processes of the ilium. It has three lips (external, middle, and internal), to which are attached, respectively, the external oblique (into the anterior one-half); internal oblique (into the anterior two-thirds); transversalis (into the anterior three-fourths).

Dissection of Inguinal Canal and Contents. (Fig. 110.) To expose the contents and demonstrate the parts of the inguinal canal (roof, floor, inner wall, outer wall, internal and external rings) but little dissecting is required. Introduce a pair of forceps or a director through the external ring and cut the aponeurosis in the direction of the fibres. Now gently dissect the upper part of the aponeurosis and turn it back; pull the lower part down. The muscular structure now exposed is the arch of the internal oblique and the transversalis—the roof of the canal. Fibres given off from this arch to the spermatic cord constitute the cremaster muscle. The spermatic cord may now be lifted from the floor of the canal—Poupart's ligament. Carefully elevate the arched fibres, and the inner wall will come into view. The deep epigastric vessels are on this (the inner) wall, passing inward and upward; and external to these the internal abdominal ring is seen, producing the spermatic cord.

The ilio-inguinal nerve emerges from the inguinal canal, anterior to the spermatic cord, through the external abdominal ring, and supplies the skin of the scrotum and the upper inner part of the thigh. The hypogastric branch of the iliohypogastric nerve pierces the aponeurosis of the external oblique muscle above the external abdominal ring, and is distributed to the integument in the hypogastric region.

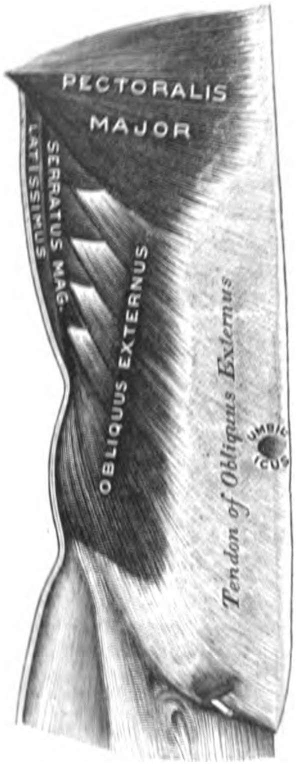
ABDOMINAL MUSCLES IN GENERAL.

The abdominal muscles are called external, or descending oblique; internal, or ascending oblique; transversalis, rectus abdominis, and pyramidalis. The fibres of the external oblique run downward and inward; those of the internal oblique in an opposite direction; those of the transversalis in a horizontal direction. Each muscle consists of (1) an outer muscular part, and (2) an inner tendinous or aponeurotic part; each contributes to the formation of the sheath of the rectus muscle, linea alba, umbilicus, and lineæ semilunares; each has a polymeric innervation and blood-supply, since each arises from more than one myotome. The rectus muscle gives evidences of segmentation in its transverse lines, and has a distinct sheath in the upper three-fourths of its course. The pyramidalis is a small vertical muscle, a tensor of the linea alba.

The External Oblique. (Fig. 107.) The external or descending oblique muscle has its origin in the outer surfaces and lower borders of the eight lower ribs, by fleshy processes, the five upper of which interdigitate with the serratus magnus, the three lower with the latissimus dorsi. *Insertion:* (1) The fibres from the lowest ribs into the anterior half of the outer lip of the iliac crest; (2) the middle and upper fibres into the linea alba, pubic spine, iliopectineal line, forming Poupart's ligament, Gimbernat's ligament, triangular ligament of the abdomen, external abdominal ring, external pillar, internal pillar, and intercolumnar fascia. Each of these will now be described as a part of this muscle.

Poupart's Ligament or Crural Arch. (Fig. 110.) Poupart's ligament is the lower border of the aponeurosis of the external oblique muscle. It extends in an arching, downward direction from the anterior superior iliac spine to the spine of the pubic bone. A part is reflected onto the iliopectineal line for one-half inch (Gimbernat's ligament.) The part reflected from Gimbernat's ligament, beneath the spermatic cord anterior to the conjoined tendon and behind the inner pillar of the external abdominal ring to the linea alba, is the triangular ligament of the abdominal walls. Poupart's ligament is continuous with the fascia lata of the thigh.

Fig. 107.



Obliquus externus abdominis of the right side. (Gerrish after Testut.)

The External Abdominal Ring (Figs. 106, 110) is an interval in the aponeurosis of the external oblique muscle and to the outer side of and above the pubic crest. The ring is triangular, about one inch long, and is bounded below by the pubic crest; above, by the intercolumnar fibres; laterally, by the pillars of the ring. The general direction of the ring corresponds to the direction of the fibres of the aponeurosis—downward and inward. The ring is larger in males than in females, and gives passage to the spermatic cord or its homologue.

Pillars or Columns of the External Abdominal Ring. (Fig. 106.) The external and internal pillars are the margins of the external abdominal ring. The external, or inferior pillar, is that part of Poupart's ligament which is inserted into the pubic spine. It is grooved for the lodgement of the spermatic cord or round ligament. The internal or superior pillar is inserted into the front of the symphysis pubis, and interlaces with the one of the opposite side.

The Intercolumnar Fibres (Fig. 106) prevent divergence of the pillars from one another. They are much stronger in the male than in the female. They extend across the external ring, are bound together by connective tissue, and form the intercolumnar or external spermatic fascia—a covering of the testicle and inguinal hernia.

Internal Oblique Muscle. (Fig. 110.) This muscle has its origin (1) in the anterior two-thirds of the middle lip of the crest of the ilium; (2) outer half of Poupart's ligament; (3) lumbar fascia. *Insertion:* (1) The fibres from Poupart's ligament unite with those of the transversalis muscle from the same source, form the conjoined tendon, and are inserted into the crest and iliopectineal line of the pubic bone; (2) into the lower border of the cartilages of the six lower ribs; (3) into the linea alba, extending from the symphysis pubis to the ensiform cartilage. The aponeurosis of this muscle, together with that of the internal oblique and transversalis, passes anterior to the rectus muscle below a point (the semilunar fold of Douglas) midway between the umbilicus and the crest of the pubic bone. Above this point it splits and forms a sheath for the rectus muscle. (Figs. 108, 109.)

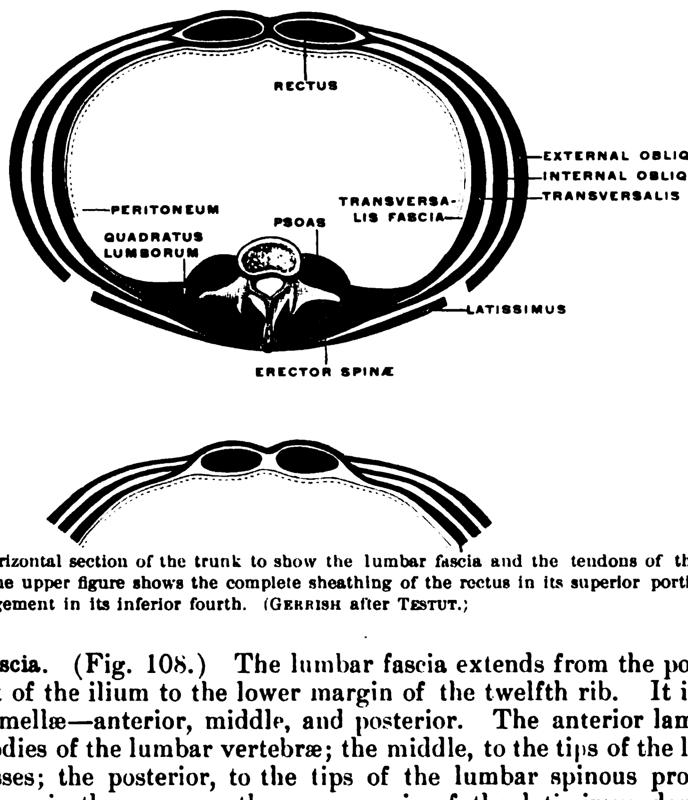
The Conjoined Tendon (Fig. 110) of the internal oblique and transversalis muscles is composed of fibres arising from Poupart's ligament. The tendon is inserted into the pubic crest and iliopectineal line behind the external abdominal ring, which latter it protects and strengthens.

The Cremaster Muscle (cremasteric fascia), found in the male only, is derived from the internal oblique muscle by the descent of the testicle. It is attached (1) to the lower arched border of the internal oblique; (2) to the inner end of Poupart's ligament, and supports the testicle. *Nerve:* Genital branch of the genito-crural.

Transversalis Muscle. (Fig. 109.) *Origin:* (1) Outer third of Poupart's ligament; (2) anterior three-fourths of the inner lip of the crest of the ilium; (3) inner surfaces of the cartilages of the six lower ribs, interdigitating with the costal origin of the diaphragm; (4) middle layer of the lumbar fascia. *Insertion:* (1) Conjoined tendon; (2) lower part of the linea alba.

Transversalis Fascia. The transversalis fascia is that part of the general fascia transversalis covering the inner surface of the transversalis muscle (see general fascia transversalis in the dissection of the iliac region). It is attached to the inner lip of the crest of the ilium; to Poupart's ligament, external to the femoral vessels; to the iliopectineal line, internal to the femoral vessels. It is related externally to the deep epigastric vessels, transversalis muscle, and (below the semilunar fold of Douglas) to the rectus muscle; internally, to the peritoneum. The transversalis fascia is continuous with the iliac, and forms (1) the anterior part of the femoral sheath; (2) a diverticulum, the infundibuliform fascia, beginning at the internal abdominal ring external to the deep epigastric artery and passing around the cord and testicle. (See inguinal hernia, inguinal canal, and femoral sheath, p. 206.)

FIG. 108.



Semidiagrammatic horizontal section of the trunk to show the lumbar fascia and the tendons of the lateral abdominal muscles. The upper figure shows the complete sheathing of the rectus in its superior portions; the lower shows the arrangement in its inferior fourth. (GERRISH after TESTUT.)

The Lumbar Fascia. (Fig. 108.) The lumbar fascia extends from the posterior third of the crest of the ilium to the lower margin of the twelfth rib. It is composed of three lamellæ—anterior, middle, and posterior. The anterior lamella is attached to the bodies of the lumbar vertebræ; the middle, to the tips of the lumbar transverse processes; the posterior, to the tips of the lumbar spinous processes. The posterior layer is the same as the aponeurosis of the latissimus dorsi and serratus posticus inferior, and gives attachment to the internal oblique muscle. The middle and anterior layers give attachment to the internal oblique and transversalis muscles. Three lamellæ form two compartments for the erector spinæ and quadratus lumborum.

The Rectus Muscle (the rectus abdominis muscle). (Fig. 109.) *Origin:* (1) Crest of the pubic bone between the conjoined tendon and the pyramidalis; (2) anterior pubic ligament. *Insertion:* Cartilages of the fifth, sixth, and seventh true ribs. *Nerves:* The lower intercostals. *Arteries:* Deep and superior epigastrics, lumbars, and intercostals. *Action:* Flexion of thorax and pelvis on vertebral column. The rectus has three tendinous bands—lineæ transversæ—which give evidence of segmentation. "As is well known, man, in common with a large series of animals, is a segmented organism. Even in the adult the vertebral column, the roots of the spinal nerves, the ribs, and the transverse bands of connective tissue give evidence of this." (Barker.) The transverse lines in the rectus muscle are attached to the anterior, but not to the posterior part of the sheath.

Sheath of the Rectus. (Fig. 108.) The rectus muscle has a sheath complete in the middle and incomplete, posteriorly, at each end. In the middle part the aponeurosis of the internal oblique muscle splits and lodges the rectus; this is further strengthened in front and behind by the aponeuroses of the external oblique and transversalis muscles, respectively. At its insertional end the muscle pierces the posterior part of the sheath, and is in contact with the cartilages of the fifth, sixth, and seventh ribs. The rectus also pierces the posterior part of its sheath, midway between the umbilicus and the pubic crest, lying posterior to the oblique and transversalis muscles, on the transversalis fascia. The cut margin of the sheath is the semilunar fold of Douglas. The sheath contains the rectus and pyramidalis muscles, the terminal branches of the seven lower thoracic nerves, and the anastomosis of the deep and superior epigastric arteries. *Dissection:* Cut longitudinally through the mid-line of the entire sheath of the rectus and turn the cut margins aside.

The Pyramidalis Muscle is quite small and located in the sheath of the rectus muscle. *Origin:* Front of the pubic bone. *Insertion:* Linea alba. *Function:* Synergistic to the action of the rectus and tensor of the linea alba. *Nerves:* Iliohypogastric and the twelfth thoracic.

VESSELS OF THE ABDOMINAL WALLS.

Vessels. (1) Deep circumflex iliac; (2) intercostals; (3) lumbars; (4) deep epigastric; (5) superficial epigastric; (6) superior epigastric; (7) iliolumbar. In ligation of the external iliac above the circumflex and deep epigastric arteries, the blood reaches the lower extremity (*a*) *via* internal mammary and deep epigastric; (*b*) *via* lumbar and internal circumflex.

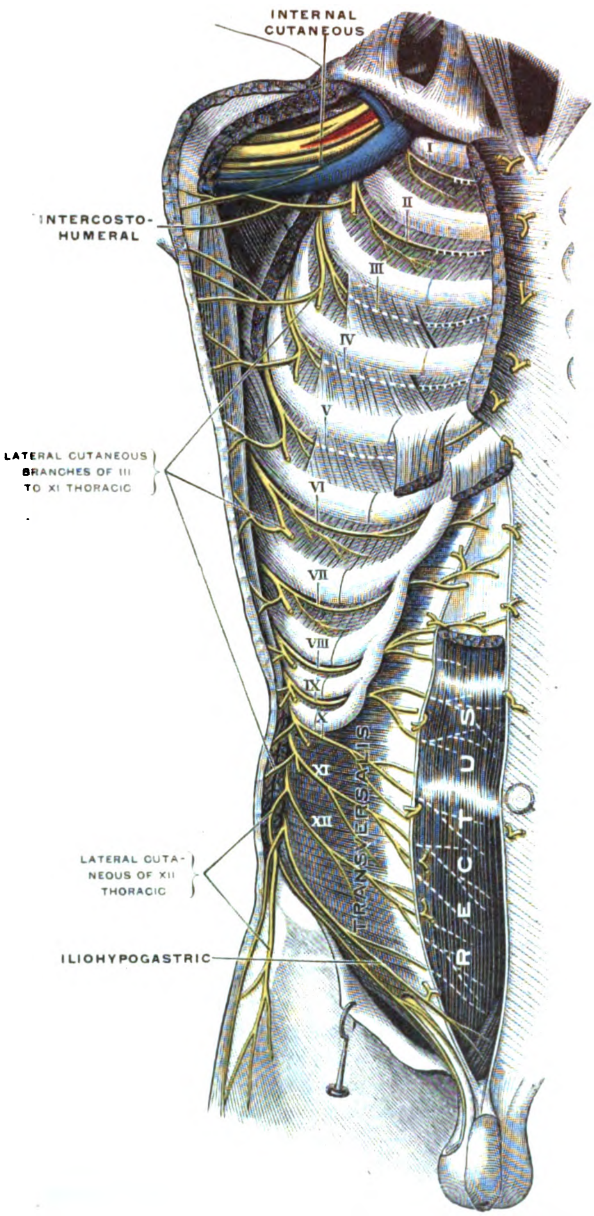
NERVES OF THE ABDOMINAL WALLS.

Nerves. The nerves supplying the abdominal walls (located between the internal oblique and transversalis muscles, Fig. 109) are the iliohypogastric, the ilio-inguinal, and the six lower intercostals. The iliohypogastric nerve gives off (1) a lateral cutaneous branch, which crosses the crest of the ilium and supplies the skin of the gluteal region; (2) a hypogastric branch, which becomes cutaneous above the external abdominal ring. The ilio-inguinal nerve gives off no lateral cutaneous branch. It lies anterior to the spermatic cord and escapes through the external abdominal ring to supply the scrotum and contiguous skin of the thigh. The six lower intercostal nerves supply all the muscles and the skin of the abdominal walls not supplied by the two preceding nerves—the iliohypogastric and ilio-inguinal.

DESCENT OF THE TESTICLE.

Development and Descent of the Testicle. The testicle is developed in the abdomen from the indifferent sexual gland behind the peritoneum, on the psoas magnus muscle, and below the kidney. It is nourished by the spermatic artery, a branch given off below the renal, of which latter, in rare cases, it may be a branch. The spermatic vein opens into the general venous circulation as follows: on the right, into the ascending vena cava; on the left side, into the renal vein. The mesorchium: The peritoneum invests the sides and front of the testicle and binds the organ to the posterior abdominal walls. In this latter capacity the fold of peritoneum consists of two layers resembling the intestinal mesentery, and is called the mesorchium. The space between the two layers of the mesorchium transmits vessels and nerves to the testicle, forming the root-structure of this organ. The gubernaculum testis is concerned in the migration of the testicle from the region of the kidney to the

FIG. 109.



Intercostal nerves, the superficial muscles having been removed. (GERRISH after TESTUT.)

scrotum. It consists of unstriped muscular fibres, and is attached below to the pillars of the external abdominal ring and dartos in the bottom of the scrotum; above, to the testicle and to the peritoneum both below and above the testicle. The peritoneal attachments of the gubernaculum have important pathological interest in infantile hernia. Theory of migratory descent of testicle: (1) The testicle is fixed in position by the gubernaculum; meanwhile the pelvic and lumbar regions grow upward; (2) the lower part of the gubernaculum shortens and lands the testicle in the scrotum *via* inguinal canal. Serial locations of testicle in its descent: third month, in false pelvis; fifth and sixth months, at internal abdominal ring; eighth month, in inguinal canal; ninth month, in scrotum. The processus vaginalis: that part of the gubernaculum inserted into the peritoneum below the testicle draws a process of peritoneum through the inguinal canal into the scrotum. This is the processus vaginalis. In those quadripeds in which the testicle reaches the scrotum, the processus vaginalis remains open and communicates freely with the abdominal cavity. In man the lower part of the processus vaginalis remains and retains the testicle; the upper part is closed.

Tunica Vaginalis Testis. The part of the processus vaginalis which contains the testicle—that part which does not become obliterated—becomes the parietal portion of the tunica vaginalis testis; the original peritoneal investment of the testicle becomes the visceral part of the tunica vaginalis; the space between the parietal and visceral layers becomes the cavity of the tunica vaginalis testis.

CONGENITAL AND INGUINAL HERNIÆ.

Congenital Inguinal Hernia. As previously stated, the upper part of the processus vaginalis becomes obliterated shortly after the testicle has reached the scrotum, and thus the communication between the cavity of the peritoneum and the cavity of the tunica vaginalis testis is shut off. In some cases closure does not occur, and a loop of gut or omentum subsequently passing into the opening, is called a congenital hernia.

Infantile Inguinal Hernia. The student will recall the manner in which the processus vaginalis was drawn down through the inguinal canal into the scrotum prior to the descent of the testicle. Now other fibres of the gubernaculum may in a similar manner draw down a second process of the peritoneum through the inguinal canal. This second process is called a hernial sac, and a viscus that enters it is an infantile hernia.

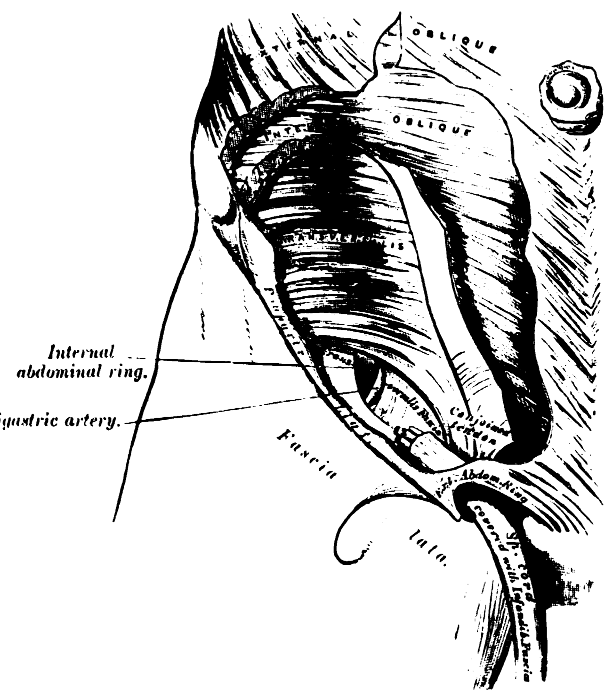
The anatomical varieties of congenital hernia depend on four imperfect varieties of obliteration of the upper part of the processus vaginalis:

1. The processus vaginalis remains open throughout its entire extent, and perfect communication exists between the hernial sac and the cavity of the tunica vaginalis testis.
2. The processus vaginalis is closed below only, and remains open in the rest of its extent; hence a very thin septum intervenes between the hernial sac and the cavity of the tunica vaginalis testis—funicular hernia.
3. The processus vaginalis closes above, there being no communication between the hernial sac and the cavity of the tunica vaginalis testis. This variety is favorable to an encysted hernia.
4. The processus vaginalis closes both above and below, cutting off communication between the hernial sac and the cavity of the tunica vaginalis testis. In this variety may be the seat of a hydrocele of the spermatic cord, and complicate diagnosis. (See Gray.)

INGUINAL CANAL AND INGUINAL HERNIÆ.

The inguinal canal is about one-and-a-half inches in length. It extends in an oblique direction inward, downward, and forward from the inlet (internal abdominal ring in the transversalis fascia) to the outlet (external abdominal ring) in the aponeurosis of the external oblique muscle. The internal abdominal ring (Fig. 110) is located one-half inch above Poupart's ligament, midway between the symphysis pubis and the anterior superior spine of the ilium. The external abdominal ring (Fig. 106) is located above the pubis in the aponeurosis of the external oblique muscle, between the inner and outer pillars of the external abdominal ring. The floor of the inguinal canal is formed by the upper concave part of Poupart's ligament, on which rests the spermatic cord in the male and the round ligament in the female. The roof (Fig. 110) is formed by the lower margin of the arched fibres of the internal oblique and transversalis muscles, extending from the outer half of Poupart's ligament to their insertion into the crest of the pubis and iliopectineal line. The anterior wall of the inguinal canal is formed by (1) integument and superficial fascia; (2) aponeurosis of the external oblique muscle; (3) lower border of the internal oblique in the outer third of the canal. The posterior wall (Fig. 110) is formed by (1) the transversalis fascia; (2) conjoined tendon of the internal oblique and transversalis muscles; (3) triangular fascia.

FIG. 110.



Inguinal hernia. Dissection showing the transversalis muscle, the transversalis fascia, and the internal abdominal ring. (GRAY.)

Contents of the Inguinal Canal. The spermatic cord (male), round ligament of the uterus (female), inguinal branch of the ilio-inguinal nerve (male and female), genital branch of the genito-crural nerve (male and female), peritoneum, infundibulum, cremaster muscle investing cord; and testicle.

Hesselbach's Triangle. This triangle is bounded internally by the outer margin of the rectus muscle; externally, by the deep epigastric artery; below, by Poupart's ligament. The floor is formed by the posterior wall of the inguinal canal, and corresponds to the middle and internal inguinal fossæ, by either of which a direct inguinal hernia may leave the abdominal cavity and reach the inner end of the inguinal canal.

Deep Epigastric Artery. (Fig. 110.) This artery arises one-half inch above Poupart's ligament from the external iliac artery. It runs upward and inward, internal to the internal abdominal ring, and reaches the rectus muscle at the semilunar fold of Douglas, where it enters the sheath of this muscle and anastomoses with the superior epigastric branch of the internal mammary. The artery forms the outer boundary of Hesselbach's triangle. (Fig. 110.) At first the artery is between the peritoneum and transversalis fascia, but subsequently penetrates the latter. Its relations are: 1. Artery is to the inner side of the internal abdominal ring. 2. Spermatic cord lies in front of the artery. 3. Vas deferens passes external to the artery. *Branches:* (1) Cremasteric, supplies the cremaster muscle and anastomoses with the spermatic; (2) pubic, supplies the periosteum back of the pubic bone; (3) muscular, to the rectus abdominis muscle; (4) cutaneous, pierces the abdominal walls and supplies the skin.

Oblique or Indirect Inguinal Hernia is a protrusion of gut or omentum or both, following the course taken by the testicle in its descent through the inguinal canal, and acquiring investments from the successive structures of the abdominal walls. It leaves the abdominal cavity at the external inguinal fossa. (Fig. 112.) Coverings from within out: 1. Parietal peritoneum (hernial sac). 2. Extra-peritoneal fatty tissue (seat of lipomata of the cord). 3. Infundibulum, from the transversalis fascia (internal spermatic fascia). 4. Cremaster muscle, from the internal oblique (middle spermatic fascia). 5. Intercolumnar fascia, from the external oblique (external spermatic fascia). 6. Skin and superficial fascia forming the scrotal sac.

Direct Inguinal Hernia. A direct inguinal hernia is one that passes through Hesselbach's triangle and leaves the abdominal cavity through either the middle or the internal inguinal fossa. (Fig. 112.) The coverings are different in the two, and are determined by the fossæ. Coverings of a direct hernia, in which the protrusion leaves through the middle inguinal fossa: 1. Parietal peritoneum. 2. Extraperitoneal fatty tissue. 3. Transversalis fascia. 4. Cremasteric muscle. 5. Intercolumnar fascia. 6. Superficial fascia and skin. Coverings of a direct inguinal hernia, in which the protrusion leaves through the internal inguinal fossa: 1. Parietal peritoneum. 2. Extraperitoneal fatty tissue. 3. Transversalis fascia. 4. Conjoined tendon. 5. Intercolumnar fascia. 6. Superficial fascia and skin.

CHAPTER XIV.

IDENTIFICATION OF ABDOMINAL ORGANS AND OTHER STRUCTURES IN SITU.

Liver. (Fig. 111.) Identify (1) by the large size, characteristic dark, reddish-brown color; (2) by the location in the right hypochondrium and epigastrium in contact with the under surface of the diaphragm. Developed in the anterior mesogaster as an evagination of the duodenum.

Gall-bladder. Identify (1) by the characteristic green color; (2) by the location in the fossa vesicalis on the under surface of the liver. Also identify the cystic artery, a branch of the hepatic, dividing on the neck of the gall-bladder into superficial and deep branches. Develop in the anterior mesogaster.

Transverse Fissure of the Liver. Identify (1) by the transverse direction and location on the under surface of the liver; (2) by attachment of the lesser omentum to its margins; (3) by the hepatic root structures (bile-ducts, hepatic artery, nerves, and portal vein) it transmits; (4) by its location between the quadrate lobe in front, the caudate and Spigelian lobes behind.

Left Longitudinal Fissure of the Liver. Identify by the presence of the umbilical vein or its remnant, the round ligament of the liver. The fissure is divided by a transverse fissure into an anterior part called the umbilical fissure, and a posterior part for the ductus venosus or its remains, and is sometimes closed in by liver substance called the pons hepatis.

Right Longitudinal Fissure of the Liver. This is parallel to the left, and obtains as (1) the fossa vesicalis for the gall-bladder; (2) the caval fossa for the ascending vena cava. These fossæ are readily identified by their contents, and are on the inferior and posterior surfaces, respectively.

Falciform Ligament of the Liver. Identify by the attachment of the margins (1) to the under surface of the diaphragm and posterior part of the sheath of the right rectus muscle as low as the umbilicus; (2) to the convex surface of the liver, extending from the notch on the anterior border (back between the right and left lobes) to the posterior surface. This ligament contains between its two layers (*a*) the round ligament of the liver; (*b*) branches of the epigastric veins which anastomose with the portal system; (*c*) branches of the phrenic nerve and phrenic arteries.

Round Ligament of the Liver. Identify (1) by the location in the free margin of the falciform ligament; (2) by the extent from the umbilicus to the notch in the anterior border of the liver; (3) by the location in the left longitudinal fissure on the under surface of the liver, and continuing on the posterior surface to the vena cava as the ductus venosus. The round ligament is the obliterated umbilical vein.

Lateral Ligaments of the Liver. Identify by its triangular shape, peritoneal derivation, and attachment to the liver and diaphragm. The left is attached to the upper surface of the liver, and lies in front of the œsophageal opening in the diaphragm. The right is attached to the liver, between its lateral and inferior surfaces.

The Coronary Ligament. Identify (1) when the liver is removed, by the reflection of the peritoneum from the diaphragm onto the upper and lower margins of the posterior surface of the liver; (2) by the continuity with the right and left lateral ligaments.

Stomach. (Fig. 111.) Identify (1) by the large size and characteristic pyriform shape; (2) by the location in the left hypochondrium and epigastrium; (3) by its contact with the diaphragm and anterior abdominal walls; (4) by the lesser omentum, connecting its lesser curvature to the margins of the transverse fissure of the liver; (5) by the great omentum, connecting the greater curvature to the transverse colon.

Gastric Artery. Identify as a branch of the cœliac axis, in the lesser curvature of the stomach, anastomosing with the pyloric branch of the hepatic and giving branches to the anterior and posterior surfaces of the stomach and œsophagus. Artery is accompanied by corresponding veins, and nerves (from vagus and sympathetic).

Great Omentum. (Fig. 111.) Identify (1) as a large fibroperitoneal apron consisting of four peritoneal layers fused, containing fat; (2) by attachment to the greater curvature of the stomach, superior portion of the duodenum, transverse colon, and hanging down over the small intestines, often into the true pelvis. In the region of the greater curvature of the stomach identify the anastomosis between the right and left gastro-epiploic arteries, branches of the gastro-duodenalis, and splenic, respectively.

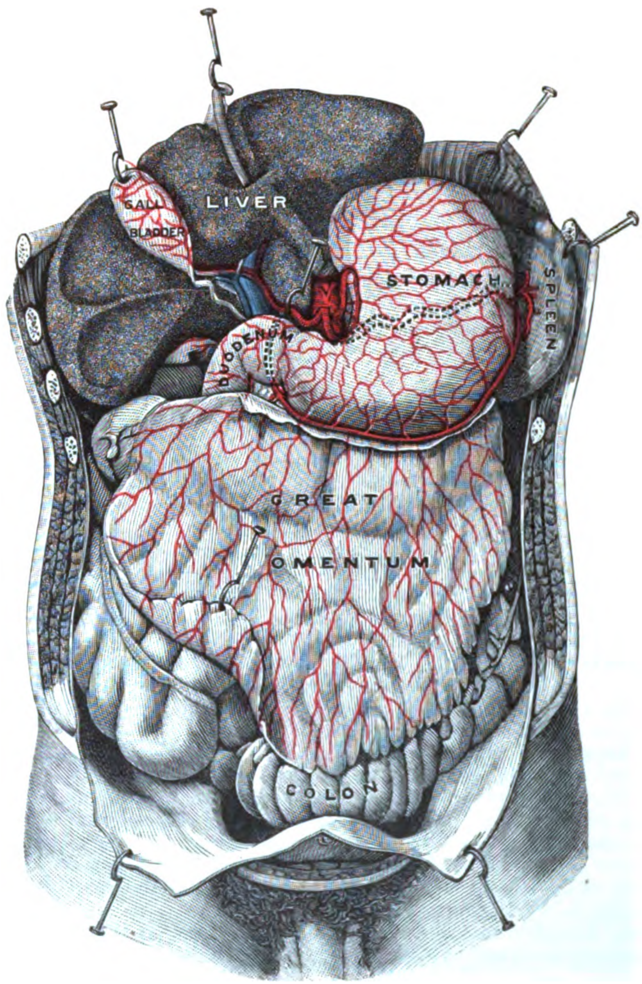
Lesser Omentum. Identify by the attachments to the lesser curvature of the stomach and transverse fissure of the liver. This is an exceedingly frail structure, and consists of two layers. The free right border forms the anterior boundary of the foramen of Winslow, con-[illegible] the root-structures of the liver and the capsule of Glisson, and is called ligamentum [illegible]-duodenale.

[illegible] of Winslow. Identify (1) by the location immediately beneath the free margin [illegible] omentum; (2) by the boundary structures: lesser omentum in front, vena cava behind, caudate and Spigelian lobes of the liver above, duodenum and hepatic artery below. This foramen connects the greater and lesser peritoneal sacs, and will admit one or two fingers into the lesser peritoneal sac.

Distinction between Large and Small Intestines. Large intestine has three characters not possessed by the small. (1) Three bands of longitudinal muscular fibre radiating from the appendix; (2) sacculations produced by the longitudinal bands; (3) appendices epiploicæ, small or large pouches of peritoneum filled with fat of unknown function.

Ileocæcal Junction. Identify by the end of the ileum opening into the back and inner part of the large intestine at the junction of the cæcum and ascending colon. This is usually found in the right iliac fossa. Also identify the ileocolic artery, a branch of the superior mesenteric, dividing into superior and inferior branches.

FIG. 111.



Arteries of the stomach, liver, and great omentum. (GERRISH after TESTUT.)

Cæcum. Identify by the location at the initial end of the ascending colon in the right iliac fossa (usually) and by the presence of an attached appendix vermiformis. It has, as a rule, a mesentery, and is freely movable.

Appendix. Identify by the worm-like appearance and attachment to the cæcum, where the three characteristic longitudinal bands of muscular fibre of the colon meet. Distal end is free; proximal end has mesentery in which may be identified the appendicular artery, a branch of the ileocolic. Locations of appendix: (1) Behind the cæcum; (2) in the true pelvis; (3) to the left, behind the ileum and mesentery.

Ascending Colon. Identify (1) by the connection with the cæcum and transverse colon; (2) by the location on the right kidney, transversalis and quadratus lumborum muscles; (3) by the absence of the mesocolon (generally). Also identify the colica dextra artery, a branch of the superior mesenteric, anastomosing with the colica media above and the ileocolic below.

Transverse Mesocolon. Turn the great omentum and transverse colon upward over the stomach. The broad fold of peritoneum connecting the transverse colon to the posterior wall of the abdomen is the transverse mesocolon. The transverse colon extends from the hepatic to the splenic flexure. Identify between its two layers, the colica media artery, a branch of the superior mesenteric. It supplies the transverse colon and anastomoses on the right with the colica dextra; on the left with the colica sinistra.

Transverse Colon. Identify (1) by the attachment to the great omentum and the greater curvature of the stomach; (2) by its limitations, hepatic and splenic flexures; (3) by the location transversely across the abdomen, at the junction of the epigastric and umbilical regions.

Phrenocolic Ligament. Identify as a fold of peritoneum extending below the spleen from the splenic flexure of the colon to the diaphragm, opposite the tenth and eleventh ribs. It sustains the spleen as in a sling, and is called sustentaculum lienis.

Descending Colon. Identify by the location on the left side on the posterior abdominal wall along the outer border of the left kidney. It ends at the crest of the ilium in the sigmoid. Sides and anterior surface are covered by peritoneum; the posterior surface is attached to the outer border of the kidney, quadratus lumborum and transversalis muscles. No mesocolon, hence no motion. Identify the colica sinistra, a branch of the inferior mesenteric, supplying the descending colon. It divides into an ascending branch which anastomoses with the colica media, and a descending one which anastomoses with the sigmoid artery.

Sigmoid Flexure. Identify by the location in the left iliac fossa, commencing at the end of the descending colon at the iliac crest and ending at the left sacroiliac junction in the rectum. It forms a loop variable in length, and has a mesentery. Identify between the layers of the mesosigmoid, the sigmoid artery. It is a branch of the inferior mesenteric, and anastomoses with the colica sinistra and superior hemorrhoidal.

Mesentery Proper. Identify by its two attachments (1) to the small intestine twenty feet long; (2) to the posterior abdominal wall in an oblique line, extending from the left side of the second lumbar vertebra to the right sacroiliac synchondrosis—six inches long. Distance from one attached margin to the other is about eight inches. Identify between the two layers of the mesentery proper, fat, mesenteric lymphatic vessels and glands, superior mesenteric arteries and veins.

Small Intestine. Identify (1) by the absence of the three characteristics of the colon; (2) by the location, in the free margin of the mesentery proper; (3) by its subjacency to the transverse colon and great omentum. The jejunum is the upper two-fifths of the small intestine below the duodenum; the ileum the lower three-fifths.

Large Intestine. Identify by its horse-shoe shape and relation to the jejunum and ileum. It consists of (1) an ascending colon extending from the right iliac fossa to the lower surface of the liver; (2) a transverse colon, extending in a sagging manner (near the junction of the umbilical and epigastric regions) from the hepatic flexure, across the abdomen, to the lower border of the spleen—splenic flexure; (3) a descending colon, extending from the splenic flexure along the outer border of the kidney and psoas magnus muscle to the crest of the ilium; (4) a sigmoid flexure, extending from the crest of the ilium, as a great or small loop to the left sacroiliac synchondrosis. The cæcum, appendix, and sigmoid havė mesenteries called mesocæcum, mesoappendix, and mesosigmoid, respectively. The transverse colon has an extensive mesentery called transverse mesocolon. The ascending and descending colon usually are covered by peritoneum on the sides and anterior surface only, hence in these cases there is no mesocolon.

Lesser Sac of the Peritoneum. Identify by the boundaries: Right, foramen of Winslow; left, lieno-renal ligament; above, surface of the liver behind the transverse fissure; below, fusion-line between the anterior and posterior layers of the great omentum; behind, the two posterior layers of the great omentum, transverse colon, ascending layer of the transverse mesocolon; in front, lesser omentum, stomach, and the two anterior layers of the great omentum. The finger passed through the foramen of Winslow reaches the lesser sac of the peritoneum.

Greater Sac of the Peritoneum. Identification of this is easy. The greater sac is all the peritoneal cavity not included in the lesser. It communicates with the lesser sac through the foramen of Winslow.

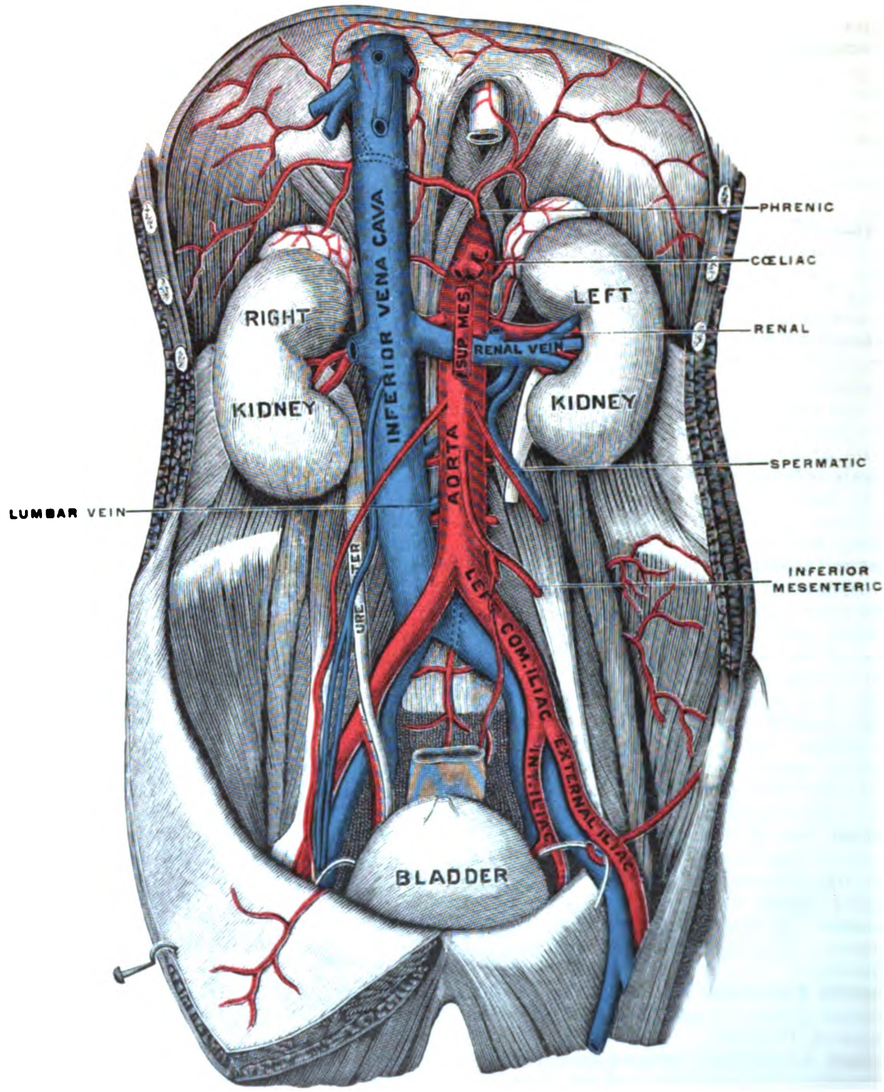
Spleen. Identify (1) by the location in the left hypochondriac and epigastric regions, between the fundus of the stomach and the diaphragm; (2) by the dark, purplish color, oblong, flattened form, and absence of excretory duct. It was developed in the posterior mesogaster. Identify the splenic artery extending with its vein from the cœliac axis along the upper border of the pancreas to the spleen.

Pancreas. Identify (1) by the location on the posterior abdominal walls in the epigastric and left hypochondriac regions, extending from the descending duodenum to the spleen, and crossing the vena cava, aorta, and superior mesenteric vessels; (2) by its long, prismatic shape, resembling a dog's tongue. It was developed, by evagination of the duodenum, in the posterior mesogaster.

Right Kidney. (Fig. 112.) Identify (1) by the location in the right lumbar region near the vertebral column, extending from the upper border of the twelfth dorsal to the third lumbar vertebra; (2) by the relation of its anterior surface to the right lobe of the liver, second part of the duodenum, and hepatic flexure of the colon; (3) by its characteristic reniform shape and situation behind the peritoneum in a mass of fat and areolar tissue; (4) by the ureter and large renal vessels entering at the hilum.

Left Kidney. (Fig. 112.) Identify (1) by the location in the left lumbar region near the vertebral column, extending from the upper border of the twelfth dorsal to the third lumbar vertebra; (2) by the relation of its anterior surface to the stomach, pancreas, splenic vessels, small intestine, and (occasionally) the duodenum; (3) by the characteristic reniform shape and situation behind the peritoneum in a mass of fat and connective tissue; (4) by the ureter and large renal vessels entering at the hilum.

FIG. 112.



Abdominal aorta. (GERRISH after TESTUT.)

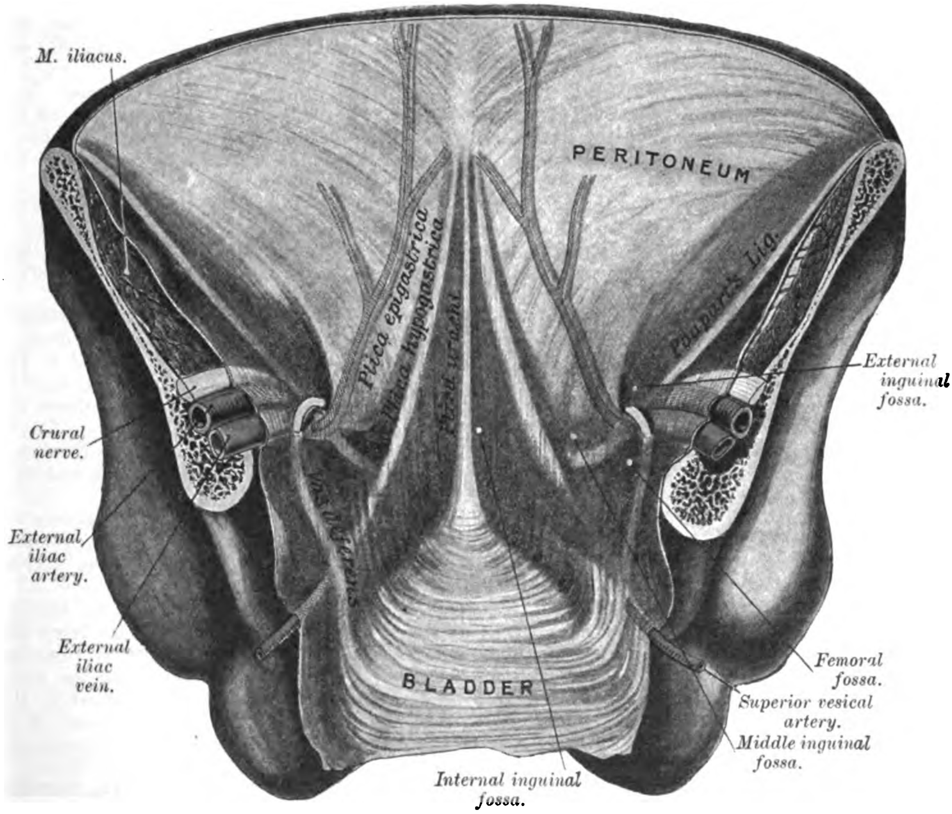
Suprarenal Capsule. Identify (1) by the location above and in front of the upper end of each kidney; (2) by the yellow color and flattened appearance; (3) by their variable size, the average size being from one to two inches long; (4) by the absence of an excretory duct. Also identify numerous small-sized suprarenal arteries, from the aorta, renal, and phrenic arteries.

Right and Left Ureters (Fig. 112.) Identify (1) the right ureter by the extent from the pelvis of the kidney to the bladder; (2) by adjacency to the outer side of the ascending vena cava; (3) by crossing the common or external iliac artery opposite the first piece of the sacrum; (4) by the location behind the ileum; (5) by the location on the psoas magnus muscle, where it is crossed by the spermatic and ovarian vessels. The left ureter has the same identification points, except instead of the ileum it is behind the sigmoid flexure of the colon.

Bladder. (Fig. 112.) Identify (1) by the location in the true pelvis behind the pubic bone and the flattened appearance when empty; (2) by the connection with the umbilicus through the urachus; (3) it is anterior to the rectum in the male and to the uterus in the female. The false ligaments of the bladder are of peritoneal derivation and five in number: The superior is the peritoneum leaving the apex of the bladder with the urachus and obliterated hypogastric arteries. The synonym is plica urachi. The lateral, two in number, extend from the side of the base of the bladder along the hypogastric vestiges, to the iliac fossæ and lateral pelvic walls. The plica hypogastrica is a synonym. The posterior, two in number, extend between the rectum and bladder, limiting, laterally, the rectovesical pouch.

Spermatic Artery. (Fig. 112.) Identify (1) by the location behind the peritoneum on the psoas magnus; (2) the right artery crosses the ascending vena cava, the left passes behind the sigmoid flexure of the colon; (3) by crossing in front of the ureter, from within out; (4) by leaving the abdominal cavity at the internal abdominal ring, in the transversalis fascia, to the outer side of the deep epigastric artery and passing through the inguinal canal to the scrotum; (5) by the origin from the aorta below the renal artery.

FIG. 113.



Posterior view of the anterior abdominal wall in its lower half. The peritoneum is in place, and the various cords are shining through. (GRAY after JOESSEL.)

Spermatic Veins. (Fig. 112.) Identify by the blue color, quite marked, and in company with the spermatic artery; (2) the right vein is tributary to the ascending vena cava, the left to the renal vein; exceptionally, the right may open into the renal vein of the right side. The ovarian vessels are homologous and identified in the same way.

Vas Deferens. (Figs. 112, 113.) Identify (1) as a small, white, round cord, emerging from the pelvis (behind the peritoneum) and crossing the obliterated hypogastric artery and external iliac vessels; (2) by passing to the outer side of the deep epigastric vessels, thence traversing the inguinal canal, and leaving the abdominal cavity through the external abdominal ring with the spermatic vessels.

Internal Abdominal Ring. Identify (1) by the location, in the transversalis fascia, to the outer side of the deep epigastric vessels; (2) by the meeting at the internal ring of the spermatic vessels and vas deferens to form the spermatic cord. To aid in the identification, make firm, steady traction on the testicle, when a dimple in the peritoneum, corresponding to the location of the internal ring, will appear.

Plica Urachi. (Fig. 113.) Identify by the location in the mid-line of the anterior abdominal wall and extending from the summit of the bladder to the umbilicus. The plica urachi is a fold of peritoneum covering the urachus, a remnant of the allantois.

Plica Hypogastrica. (Fig. 113.) Identify by the location extending in an oblique direction from the side of the bladder to the umbilicus, external to the plica urachi. The plica is a fold of peritoneum covering the fibrous remnant of the hypogastric artery.

Plica Epigastrica. (Fig. 113) Identify by the location extending from the external iliac artery beneath Poupart's ligament, obliquely upward and inward to the semilunar fold of Douglas. This plica covers the deep epigastric artery which (artery) forms the outer boundary of Hesselbach's triangle.

Internal Inguinal Fossa. (Fig. 113.) Identify by the location between the plica urachi and plica hypogastrica above the level of Poupart's ligament. It corresponds to the inner part of Hesselbach's triangle, permits direct inguinal hernia, and is also called the fossa supravesicalis.

Middle Inguinal Fossa. (Fig. 113.) Identify by the location between the plica hypogastrica and the plica epigastrica above Poupart's ligament. It corresponds to the outer part of Hesselbach's triangle, permits direct inguinal hernia, and is called the fossa inguinalis mesialis.

External Inguinal Fossa. (Fig. 113.) Identify by the location external to the deep epigastric artery above the level of Poupart's ligament. It permits indirect inguinal hernia, and corresponds to the internal abdominal ring.

Hesselbach's Triangle (Fig. 110) includes the middle and internal inguinal fossæ. It is bounded externally by the deep epigastric artery; internally, by the outer margin of the rectus abdominis muscle; below, by Poupart's ligament. The femoral fossa, below Poupart's ligament, is to the inner side of the femoral vein. (Fig. 113.) Its floor corresponds to the femoral ring, the beginning of the femoralcanal. This fossa permits femoral hernia.

Poupart's Ligament, or superficial crural arch, extends in an archiform manner from the anterior superior iliac spine, externally, to the pubic bone internally, where it has two insertions: (1) Into the spine of the pubes; (2) into the iliopectineal line, as Gimbernat's ligament. Poupart's ligament is the lower thickened border of the aponeurosis of the external oblique muscle of the abdominal walls. The upper border is now exposed. (Fig. 110.)

Gimbernat's Ligament is the reflected insertion of Poupart's ligament into the iliopectineal line. It has an apex inserted intothe pubic spine; a sharp, fine base toward the femoral sheath; an outer margin attachedto Poupart's ligament; an inner margin attached to the iliopectineal line. This ligament forms the inner boundary of the femoral ring, and may be brought into view by pulling theperitoneum backward and inward, and breaking down the connective tissue internal to the femoral vessels. (Fig. 113.)

The Triangular Ligament arises from the attachment of Gimbernat's ligament to the inner end of the iliopectineal line, passes upward behind the internal pillar of the external abdominal ring, and is inserted into the linea alba

False Ligaments of the Uterus, two in number, is a term applied (*a*) to the uterovesical folds of peritoneum which extend from the uterus to the bladder, and limit the uterovesical pouch, laterally; (*b*) to the recto-uterine folds, extending from the rectum to the uterus, limiting laterally the cul-de-sac of Douglas.

The Peritoneum on the Posterior Wall of the Pelvis covers the first part of the rectum completely, and forms the mesorectum. A little lower the peritoneum disappears from the posterior part, then from the sides, and, finally, at the tip of the coccyx is reflected from the sacrum to the vagina and uterus. The peritoneum invests the uterus, connecting the same laterally with the iliac fossæ and pelvic walls by the broad ligament, and is reflected to the bladder. The peritoneum leaves the bladder at the apex of the latter, with the urachus as the superior false ligament; laterally, it leaves along the line of the obliterated hypogastric arteries as the lateral false ligaments of the bladder. (Fig. 113.)

The Uterovesical Pouch is bounded in front by the peritoneum covering the bladder; behind, by that covering the uterus; laterally, by the uterovesical folds of peritoneum, posterior false ligament of the bladder, extending from the uterus to the bladder.

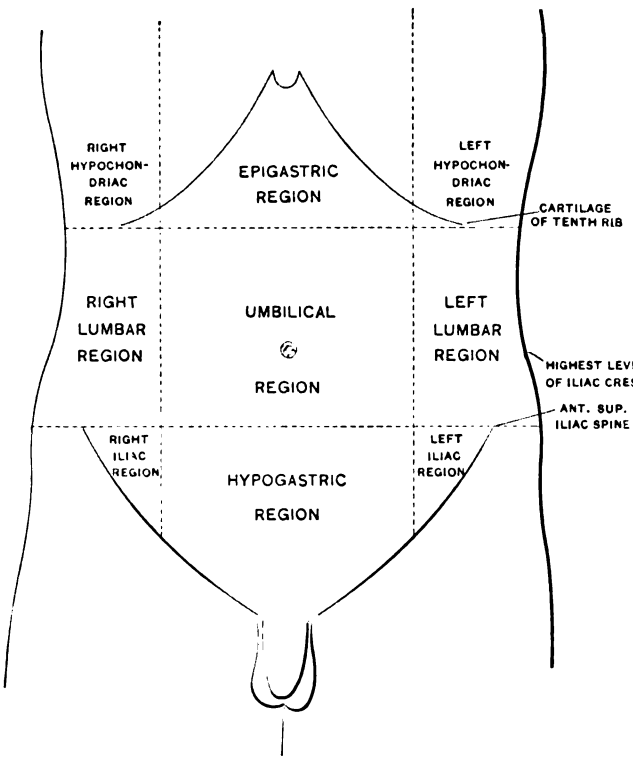
Douglas' Cul-de-sac (rectovaginal pouch) is bounded in front by the peritoneum covering the upper part of the vagina and uterus; behind, by that covering the rectum; laterally, by the recto-uterine ligaments, folds of peritoneum extending from the rectum to the cervix uteri and vagina.

Distinction between the Abdominal and Peritoneal Cavity. Let a tin pint-cup represent the abdominal cavity, and a hollow rubber ball, almost as large as the cup, the peritoneum. Place the ball in the cup and force a large marble into the cup with the ball. The part of the ball displaced by the marble represents the visceral peritoneum; the remainder of the ball represents the parietal peritoneum; the space be ween the part of the ball displaced and the part not displaced represents the cavity of the peritoneum. Contents of the abdominal cavity: (1) Abdominal organs, with their nerve-supply and blood-supply; (2) peritoneum, with its visceral and parietal layers and cavity. The cavity of the peritoneum, represented in the simile by the cavity of the ball, contains only a small quantity of serum for lubricative purposes, secreted by the peritoneum. Serum secreted in an excessive amount is a diseased condition called abdominal dropsy or hydroperitoneum. This serum is clear and yellow; in abdominal dropsy (due to disease of the kidneys) it contains urea.

ABDOMINAL TOPOGRAPHY.

Abdominal Regions. The abdomen consists of nine regions, in which are found collectively all the abdominal organs. There are but few organs confined to any one region; still, certain ones belong more evidently to some regions than to others. Let the student map out nine regions by means of needle and thread, and then be guided by the following table in giving their contents. Directions for mapping regions: 1. Extend the thread from the tenth costal cartilage on the right to the tenth on the left, and secure it in position. 2. Extend the thread from the highest point of the iliac crest on the right to the corresponding point on the left. 3. Extend the thread vertically from the centre of Poupart's ligament on each side, and secure the same in position. This will divide the abdomen into nine regions, with contents, as shown in the table, and represented by Fig. 114.

FIG. 114.



Regions of the abdomen, delimited by Gerrish's method. (F. H. G.)

TABLE OF ABDOMINAL REGIONS AND CONTENTS.

Right Hypochondriac.	*Epigastric Region.*	*Left Hypochondriac.*
1. Greater part of the right lobe of the liver.	1. Greater part of the stomach, including the cardiac and pyloric orifices.	1. Fundus of the stomach
2. Hepatic flexure of colon.	2. Left, and part of right lobe of liver.	2. Spleen.
3. Part of the right kidney.	3. Gall-bladder.	3. Tail of the pancreas.
	4. Pancreas.	4. Splenic flexure of colon.
	5. Duodenum.	5. Part of the left kidney.
	6. Suprarenal capsules; parts of kidneys.	
Right Lumbar.	*Umbilical Region.*	*Left Lumbar.*
1. Ascending colon.	1. Transverse colon.	1. Descending colon.
2. Part of the right kidney.	2. Part of the great omentum.	2. Part of the omentum.
3. Convolutions of the small intestine.	3. Part of the mesentery.	3. Part of the left kidney.
	4. Part of the transverse duodenum.	4. Convolution of the small intestine.
	5. Part of the small intestine; part of each kidney.	
Right Inguinal.	*Hypogastric.*	*Left Inguinal.*
1. Cæcum.	1. Small intestine.	Sigmoid flexure of colon.
2. Vermiform appendix.	2. Bladder in children, and, when distended, in the adult.	
	3. Pregnant uterus.	

CHAPTER XV.

THE PERITONEUM.

Dissection. Turn the abdominal wall (with the parietal peritoneum) aside so as to make the fullest exposure possible of organs in the abdominal cavity. Detach the diaphragm and push the liver upward so as to expose its under surface. Study illustration and text, and remember that the entire peritoneum may be studied without further cutting.

Location and Distribution in the Abdominal Cavity. It covers the under surface of the diaphragm, anterior, posterior, and lateral walls of the abdomen, interior of pelvis, and all organs of pelvis and abdomen, partially or completely.

Layers and Cavities. That part of the peritoneum that covers the walls is called the parietal layer; that covering organs, the visceral layer; the space between parietal and visceral layers is the peritoneal cavity.

Characters. Peritoneum is a thin, translucent, smooth, strong, moist, elastic, serous membrane found in the abdominal cavity only. It differs structurally in nowise from pericardium and pleura. Removed from the abdominal cavity, its identity could not be established; that is, no one could say whether it had once invested a liver or a lung.

Retentive Medium. Peritoneum is held in place by subperitoneal connective tissue. The peritoneum investing the diaphragm adheres closely; that investing the other abdominal walls, loosely, and may be easily removed. The peritoneum covering the stomach, liver, and intestines is firmly adherent. The common medium causing the peritoneum to adhere to walls and viscera is subperitoneal connective tissue.

Blood-supply. Arteries that supply the abdominal walls (intercostals, phrenic, lumbar, circumflex iliac, and deep epigastric) supply the parietal peritoneum. Arteries that nourish organs (gastric, hepatic, splenic, renals, and mesenterics) supply visceral peritoneum.

Nerve-supply. Peritoneum, like other secreting structures associated with vital or vegetative functions of the body, is supplied by the sympathetic nervous system; but here, as with the blood-supply of peritoneum, we recognize a parietal and a visceral sympathetic nerve-distribution. Sympathetic nerves (from the solar plexus) that supply organs in the abdominal cavity supply visceral peritoneum. The parietal peritoneum derives its nerve-supply from the sympathetic through gray rami communicantes.

Functions. The functions are: (1) secretory; (2) absorptive; (3) ligatory; (4) plicate; (5) mesenteric; (6) omental. The distinctions are somewhat arbitrary, but the student should bear in mind that the structure is peritoneum, regardless of name and location.

Secretory and Absorptive Functions. Peritoneum secretes serum for lubrication of its opposed surfaces. It may absorb not only the excess of its own secretion, but also absorbable foreign material introduced by accident or design.

Ligatory Function. Where peritoneum is reflected from a wall to an organ and becomes this latter's visceral peritoneum, and does not contain the nutritive nerves and vessels of the organ, it forms a ligament. Examples: Superior, posterior, and lateral ligaments of the bladder; coronary, falciform, and lateral ligaments of the liver.

Plicate Function. When peritoneum is thrown into a small fold by crossin[illegible] slight elevation, as an artery, the fold is called a plica. Examples: Plica u[illegible] plica hypogastrica, plica epigastrica, superior duodenal plica, inferior du[illegible] plica, iliocolic plica, parieto-colic plica, and plica infundibulo-pelvicum. A plica differs from a peritoneal ligament essentially in size. (Fig. 112.)

Mesenteric Function. Where peritoneum binds organs to walls, and also conducts nutritive nerves and vessels to organs, it is a mesentery. Examples: Mesentery proper, transverse mesocolon, mesosigmoid, and mesorectum. (Figs. 118, 119.)

Omental Function. In some situations peritoneum binds one organ to another, and may or may not contain the nutritive nerves and vessels. Examples: Gastro-hepatic, gastrocolic, gastrosplenic omenta. (Fig. 115.)

Coverings and Fossæ. Peritoneum may form a physiological covering of the testicle, as the tunica vaginalis testis or the sac of a hernia. It also forms the following fossæ, some of which may become the seat of hernia: (1) Lesser sac of peritoneum, whose contracted opening is the foramen of Winslow; (2) superior and inferior duodenal fossæ; (3) subcæcal, iliocolic, iliocæcal; (4) duodeno-jejunal and intersigmoid; (5) retrovesical; retrovaginal and uterovesical.

FIG. 115.

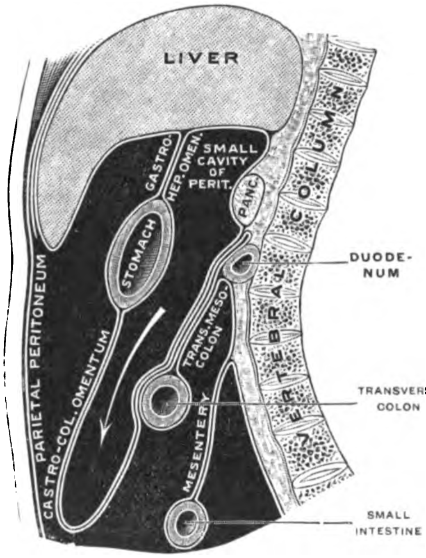


Diagram of a sagittal section of the abdomen of an adult, showing the growth of the small cavity, and the application of its rear wall to the transverse colon and mesocolon. Compare with preceding figure. (GERRISH after TESTUT.)

THE OMENTA.

The Gastrohepatic, or Lesser Omentum (Fig. 115), is a double fold of peritoneum attached above to the transverse fissure of the liver, below to the first part of the duodenum and lesser curvature of the stomach. Between its two folds are the root-structures of the liver: (1) Hepatic artery, with plexus of sympathetic and vagus nerves; (2) vena porta; (3) bile-ducts. The lesser omentum is a remnant of the anterior mesogaster and has the following limitations: The fissure of the ductus venosus on the left; the right margin contains the root-structures of the liver, is called the ligamentum hepatico-duodenale, and forms the anterior boundary of the foramen of Winslow.

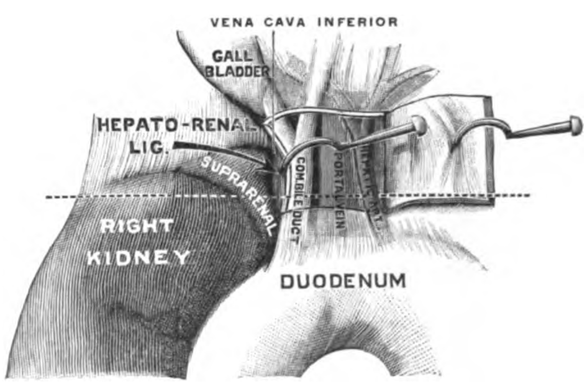
The Gastrocolic, or Great Omentum (Fig. 115), extends from the greater curvature of the stomach and first part of duodenum above to the transverse colon below. It forms a fatty apron, which keeps the small intestine warm, and intervenes between this and the anterior abdominal walls. The lower part of the great omentum occupies the pelvis. It is a part of the posterior mesogaster, which bags to the left and forward. The interior of the bag [illegible] the cavity of the great omentum, also called the lesser sac of the peritoneum. As the pouch increases in length, hanging down from the greater curvature of the stomach, it becomes adherent to the transverse colon and its mesocolon.

The Gastrosplenic Omentum is a very delicate double fold of peritoneum connecting fundus of stomach to margins of hilum of spleen. It contains the vasa brevia of the splenic vessels, passing to the fundus of the stomach. It is a remnant of the posterior mesogaster. That part of the posterior mesogaster between the spleen and posterior abdominal wall in the embryo, obtains in the adult as the phrenosplenic ligament, and contains the splenic vessels and sympathetic splenic plexus of nerves.

FORAMEN OF WINSLOW AND SACS OF PERITONEUM.

The Foramen of Winslow is the communication between the greater and lesser sacs of the peritoneum. (Fig. 116.) It will admit one or two fingers for diagnostic purposes in palpating the bile-ducts. The foramen is bounded in front by the free edge of the lesser omentum ; behind, by the ascending vena cava ; above, by the caudate and Spigelian lobes of the liver ; below, by the duodenum and

FIG. 116.



Dissection to show relations of the foramen of Winslow, to which the dart points. The front of the right portion of the gastrohepatic omentum has been cut and turned off to the left, and the liver lifted up and back, displaying the objects in the front wall of the foramen. The horizontal broken line marks the position of the section from which the next picture was made. (GERRISH after TESTUT.)

hepatic artery. The foramen is brought into view by elevating the liver. The free edge of the lesser omentum (anterior boundary of the foramen of Winslow) contains the bile-ducts, portal vein, hepatic artery, sympathetic and pneumogastric nerve filaments, bound together by connective tissue called the capsule of Glisson.

The Lesser Sac of the Peritoneum has superior, inferior, anterior, posterior, right and left lateral limitations, each of which are here given. Superiorly, it is limited by that part of the under surface of the liver behind the transverse fissure; inferiorly, by adhesions between the anterior and posterior layers of the great omentum; anteriorly, by the lesser omentum, posterior surface of stomach, and the two anterior layers of the great omentum; posteriorly, by the two posterior layers of the great omentum, transverse colon, and ascending layer of the transverse mesocolon; laterally, on the right, by the foramen of Winslow; laterally, on the left, by the lieno-renal ligament.

MESENTERY PROPER.

The Mesentery Proper is a double fold of peritoneum which surrounds and supports the jejunum and ileum. (Fig. 115.) It has (1) a free or intestinal margin about twenty feet in length; (2) an attached margin or root, about six inches in length. The depth of the mesentery (from root to intestine) is about eight or ten inches. The mesenteric attachment extends obliquely from the left side of the second lumbar vertebra to the right iliac fossa (a distance of about six inches), crossing aorta and ascending vena cava. The contents of the mesentery are (1) jejunum and ileum; (2) superior mesenteric artery, its accompanying veins and sympathetic nerves; (3) mesenteric glands; (4) more or less lymphatic glands, fat, and connective tissue.

CHAPTER XVI.

THE ABDOMINAL AND PELVIC ORGANS.

ALIMENTARY CANAL.

The Small Intestine is from sixteen to twenty-four feet long, and includes: the duodenum, about ten inches in length; the jejunum, about eight feet in length; the ileum, about twelve feet in length. The large intestine is four to five feet in length and includes: the appendix, from three to six inches in length; the cæcum, about 2.5 inches in length; the ascending colon, variable in length; the transverse colon, about two feet in length; the descending colon, about twelve inches long; the sigmoid, variable in length; the rectum, about six inches in length. The liver is a compound tubular gland. The pancreas is a compound racemose gland; the spleen is an accessory blood-gland.

Embryology. The abdominal part of the alimentary canal begins at the œsophageal opening in the diaphragm, and ends at the external sphincter ani muscle in the ischiorectal part of the pelvic outlet. The terminal opening is called the anus. The abdominal part of the alimentary canal in the embryo consists of a straight gut-tube, in the mid-line of the posterior abdominal wall, located behind a layer of general dorsal peritoneum. This primitive canal is nourished by three arteries: gastric, superior, and inferior mesenteric. In the embryo, the primitive straight tube, growing up behind (and pushing forward) the peritoneum, is so far removed in appearance and location from the adult type, as to make its recognition a matter of most interesting embryological and morphological study.

Unequal Growths. In the study of the alimentary canal, bear in mind two unequal growths: (1) the rapid growth of the underlying gut-tube; (2) the slow growth of the overlying peritoneum. As a natural sequence of unequal growth, the straight tube becomes convoluted in some places, and when the limits of its growth have been reached certain parts will have been robbed of their primitive peritoneal covering.

THE STOMACH.

Dissection. Introduce a glass tube into beginning of jejunum and inflate duodenum and stomach. (Fig. 117.) To accomplish this, find jejunum beneath transverse colon and its mesocolon. When stomach is fully distended, tie off gut where the inflation was made. Study great omentum attached to greater curvature of stomach and transverse colon. Cut through great omentum along greater curvature of stomach and insert hand into lesser cavity of peritoneum (cavity of great omentum).

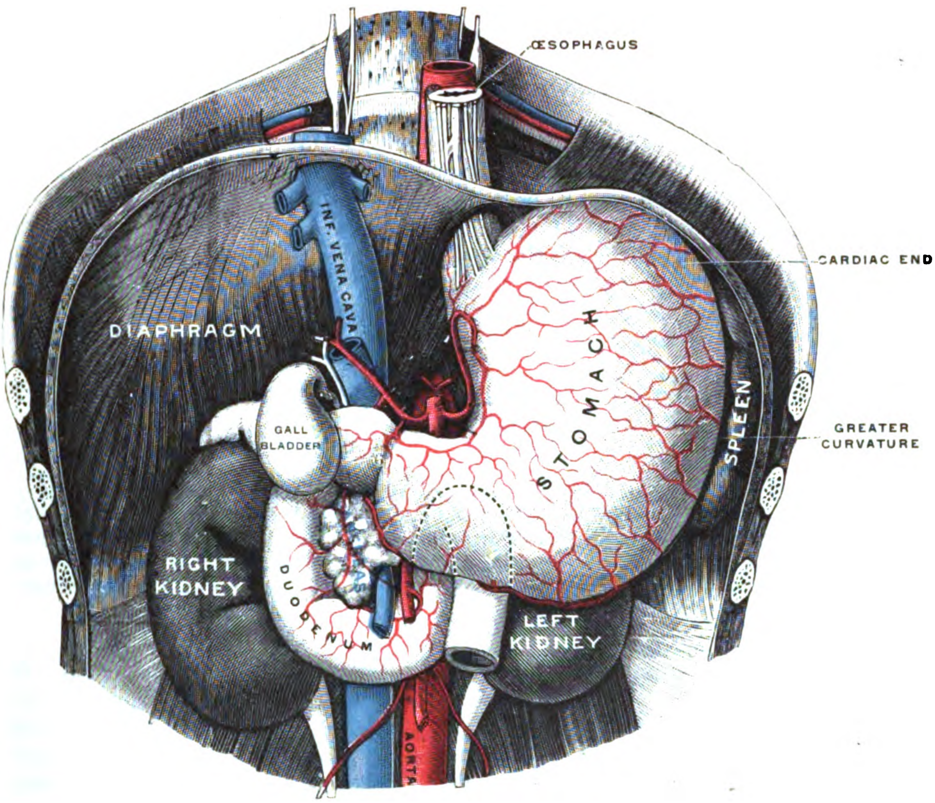
Study attachments of lesser omentum (gastrohepatic) to lesser curvature of stomach and transverse fissure of liver. Cut through lesser omentum and insert hand into lesser cavity of peritoneum. Find root structures of liver between layers of lesser omentum (hepatic artery, portal vein, bile-ducts and nerves). Now, by blunt dissection remove lesser omentum from these root-structures. (Fig. 116.)

Find gastrosplenic omentum connecting fundus of stomach to spleen and demonstrate splenic vessels entering latter organ. (Fig. 117.) Demonstrate spot where œsophagus passes through diaphragm, and locate gastric artery along lesser curvature of stomach. While stomach is inflated study all its relations. Locate thickened band of muscular fibres (the pylorus) and tie strong ligature about same. Cut to left of ligature, leaving duodenum still inflated. Stomach may now be removed and its interior structure and coats studied with a dissecting microscope.

Location and Size. The stomach is located in the epigastric and left hypochondriac regions. When empty it is below the liver and in front of the pancreas; when distended, it presses forward and to the left, and may embarrass the action of the diaphragm and heart. The stomach is five inches wide, twelve inches long, and has an average capacity of five pints.

Analysis. (1) The stomach has two surfaces—anterior and posterior; (2) two borders—upper (three to five inches long), and lower, twelve to twenty inches long; (3) a great cul-de-sac at the cardiac end and a small cul-de-sac at the pyloric end; (4) a pyloric orifice at the extreme right end and a cardiac orifice, three inches from left end. (Fig. 117.) The cardiac orifice is funnel-like and directed upward; the pyloric orifice is one-half inch in diameter, and composed of mucosa and circular muscular fibres. The surfaces of the stomach, anterior and posterior in the adult (were left and right, respectively, in the embryo, before rotation of the alimentary canal occurred), and are completely invested by peritoneum.

FIG. 117.



Stomach and duodenum, the liver and most of the intestines having been removed. (GERRISH after TESTUT.)

Omenta. The stomach is attached to three adjacent organs by modified forms of primitive mesogaster: 1. The lesser omentum is a double fold of peritoneum extending from the lesser curvature of the stomach to the transverse fissure of the liver. It contains the hepatic artery, portal vein, bile-ducts, sympathetic and pneumogastric nerves, bound together by the capsule of Glisson. 2. The great omentum (derived from posterior mesogaster) binds the greater curvature of the stomach to the transverse colon. 3. The gastrosplenic omentum binds the cardiac end of the stomach to the spleen. The nerve-supply of the stomach is from the solar plexus and vagus nerve.

Arteries. (1) Gastric, from cœliac axis of aorta; (2) pyloric, a branch of the hepatic; (3) gastro-epiploica dextra, a branch of the gastroduodenal; (4) gastro-epiploica sinistra, a branch of the splenic; (5) gastroduodenal, a branch of the hepatic; (6) vasa brevia, branches of the splenic.

The student should remember the primitive relation of the liver, stomach, spleen, and pancreas: The liver is in the anterior mesogaster in front of the stomach; the spleen and pancreas in the posterior mesogaster. Cœliac axis gives off three large arteries for these four organs: (1) The gastric, which passes forward to the anterior border of the stomach; (2) the hepatic, which passes beyond the stomach between the layers (right and left) of the gastrohepatic omentum, to the liver; (3) the splenic, which passes backward between the two layers of the posterior mesogaster, to the spleen and pancreas.

General Relations. Above, liver, lesser omentum, and diaphragm; below, the transverse colon and great omentum; in front, the abdominal walls and peritoneum; pylorus, gall-bladder and under part of liver; cardia, spleen and gastrosplenic omentum. The cardiac end is continuous with the œsophagus; the pyloric with the duodenum. Behind the stomach are the pancreas, crura of diaphragm, transverse mesocolon, solar plexus, spleen, left kidney, left adrenal, aorta, and ascending vena cava.

Embryology. Up to the third month of fœtal life, the stomach is a dilatation with its long axis parallel with the vertebral column. During the third month it rotates from left to right, thus making the left surface anterior, and the right, posterior; it also rotates transversely, bringing the pylorus to the right side and the cardia to the left. This double rotation accounts for the presence (in the adult) of the left vagus nerve on the anterior, and the right on the posterior surface of the stomach.

Reflex Phenomena in cancer of the stomach and gastric ulcer may occur as somatic pain in the abdominal walls ("epigastric tenderness" in gastric ulcer, or lower shoulder region) because the stomach is supplied by the solar plexus, and the somatic correspondence of this plexus is from the sixth to the tenth spinal nerves.

THE DUODENUM.

Dissection. While duodenum is inflated study the four parts of the organ (superior, descending, transverse, and ascending). Find the descending part extending to right kidney and making abrupt turn across body as transverse duodenum. Find transverse duodenum passing beneath superior mesenteric vessels and ending in the ascending portion continuous with the initial part of jejunum near point of inflation. For further study and dissection be guided by illustrations and text. (Fig. 117.)

The first eight or ten inches of the small intestine is called duodenum. *Extent*: From pylorus to left side of second lumbar vertebra. *Size:* Diameter, two inches; length, eight to ten inches. *Comparative fixity:* Most fixed part of small intestine. *Comparative diameter:* Widest part of small intestine. *Morphological antecedent:* Embryonal fore-gut. Its general relation to the transverse colon is behind; its retrocolic position is due to rotation from left to right. *General relation to pancreas:* Curves around the same. *Parts:* superior, descending, transverse, ascending. *Arteries:* Pancreatic, duodenal, superior, and inferior.

Superior Portion. *Extent:* From pylorus to neck of gall-bladder; two inches long. *Direction:* Upward and backward to right. *General character:* Very freely movable. Anterior and lateral peritoneal investment entire. Posterior peritoneal investment, near pylorus, incomplete. It is above the foramen of Winslow and in front of the hepatic root-structures.

Descending Portion. *Extent:* From neck of gall-bladder to third lumbar vertebra. *Direction:* Downward, and curving to left. *General character:* More fixed than ascending portion. *Peritoneal investment:* Covered in front only, above and below colon. *Derivation of peritoneum:* Superior transverse mesocolon. It is behind the transverse colon, to the right of the head of the pancreas, and in front of the vena cava, right kidney, and renal vessels. The back part is pierced by the common bile-duct and the pancreatic duct.

Transverse Portion. *Extent:* From right of body of third lumbar vertebra across spine. *Direction:* Obliquely upward and to left. *General character:* Longest and most fixed part. *Peritoneal investment:* Covered in front only. It is behind the transverse mesocolon and superior mesenteric vessels, below the inferior pancreatico-duodenal artery, pancreas and superior mesenteric artery, and in front of the vena cava, aorta, and crura of diaphragm.

Ascending Portion. *Extent:* From side of third lumbar vertebra upward about one inch. *Peritoneal investment:* Covered in front and (partially) on the sides. It is attached to the left crus of diaphragm, this attachment being called musculus suspensorius duodeni.

Embryology. At an early period the duodenum had a dorsal mesentery. Subsequently, with rotation of the stomach, it lost its mesentery, by fusion with the posterior abdominal wall, and became fixed. The transverse mesocolon fuses with the peritoneum of the ventral surface of a part of the duodenum.

Reflex Phenomena in duodenal ulcer, may occur as somatic pain in right hypochondrium and lower shoulder region, because its nerve-supply is from solar plexus, and this plexus has its somatic correspondence in the spinal nerves from the sixth to tenth thoracic.

JEJUNUM AND ILEUM.

Dissection. (Fig. 118.) Begin at end of duodenum with jejunum and trace small intestine to its point of confluence with the larger intestine—the ileocæcal junction. Lift this mass of small intestine and study attachment of its mesentery to posterior abdominal wall. With blunt instrument divide one layer of its mesentery and find vessels, nerves, and mesenteric glands which supply the small intestine. Find small intestine in free margin of mesentery. For further study consult text and illustration.

The upper two-fifths of the small intestine, counting from end of duodenum, is called jejunum. It is about eight feet long, and always more or less empty; hence the name, intestinum jejunum. The diameter of the jejunum exceeds that of the ileum by one-half inch; its walls are thicker, its mucous membrane more complex, and its blood-supply more abundant. Surgical repair on jejunum proceeds more rapidly than on ileum; strangulated hernia of ileum, on the other hand, is less dangerous than that of the jejunum.

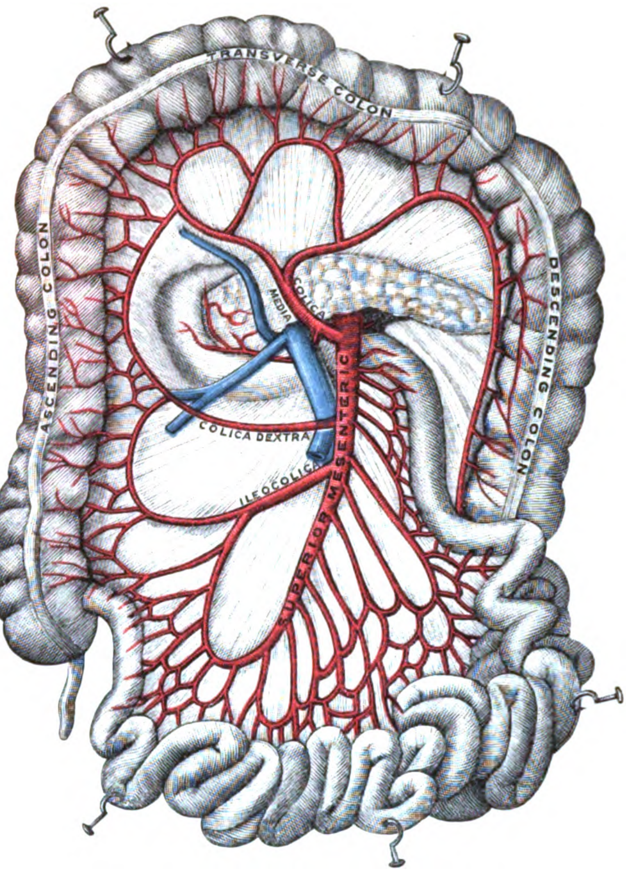
The Mesentery extends from duodenum to ileocæcal region. The upper mesentery is, for reasons comprehensible only when rotation is understood, continuous with the under layer of transverse mesocolon and with peritoneum of ascending colon; the lower layer is continuous with peritoneum of descending colon and sigmoid.

Coats: Serous, muscular, submucous, and mucous. The serous or peritoneal coat is on the outside, and may be easily studied. The mucous coat is thrown into folds called valvulæ conniventes, and can only be seen when the gut is opened and cleansed. (See Gray's *Anatomy.*)

The Blood-supply of the Small Intestine is from the superior mesenteric artery. The arteries are accompanied by veins which ultimately reach the portal vein. The arteries are supplied with sympathetic nerves from the superior mesenteric plexus. The intestine, with all its accessories, is between two layers of the peritoneum called the mesentery.

Meckel's Diverticulum is occasionally found attached to the ileum from one to three feet from the ileocæcal junction. It is most frequently met as a blind tube from one to several inches in length. It may be the cause of congenital fecal fistula, to appreciate which the student should recall the following bit of embryology: The early gut-tube was connected to umbilical vesicle by vitelline duct. During sixth week, vitelline vesicle begins to lose its usefulness. The duct is attached to the ileum near ileocæcal region. The duct may do one of three things: (1) Become obliterated; (2) remain a cul-de-sac; (3) remain patent, connecting interior of ileum, *via* umbilical aperture, with external world.

FIG. 118.



Superior mesenteric artery. (GERRISH after TESTUT.)

LARGE INTESTINE.

Dissection. Introduce glass tube into lower end of ileum (about six inches from cæcum), inflate same and tie off. Study the three distinctive characters of large intestine (longitudinal bands (three), sacculations, and fatty masses). Study attachment of transverse mesocolon to abdominal wall, and its relation to transverse duodenum. Study location and limitations of ascending, transverse, and descending colon. Locate appendix and sigmoid. Be guided by text and illustrations.

The Large Intestine, whose arbitrary subdivisions will presently be described, dates its inception from the sixth week of intra-uterine life, at which time a previously straight gut, uniform in texture, differentiates at a point known as the ileocæcal region, into large and small intestine.

In the adult the large intestine extends from the ileocæcal region to the anus. The ileocæcal region is in the iliac fossa on the iliopsoas muscle. The large intestine almost completely surrounds the small intestine, except the duodenum. For practical purposes in anatomy and surgery we distinguish large from small intestine by the presence in large intestine of the three following structures: (1) Three longitudinal bands of muscular fibre; (2) sacculations produced by the longitudinal bands; (3) fatty masses, called appendices epiploicæ. The function of the appendages of fatty masses is not known. The sacculations are variable in size in different specimens. The gut must be inflated to appreciate appearance of the sacculations. The three longitudinal bands radiate from the appendix and are lost on the rectum, these two extremes being the only parts of the large intestine in which longitudinal bands are not present. The bands are equidistant from one another, and named and located as follows: (*a*) Posterior, on attached border of intestine; (*b*) inner, on lower part of transverse colon and inner part of remainder; (*c*) anterior, on front part of intestine. The surgical importance of longitudinal bands (and also their importance in dissection) is as a guide in locating the appendix. Since these bands radiate from the appendix any band followed toward the right iliac fossa leads to the appendix.

The Cæcum (caput coli) is the initial end of the large intestine and a part of the ascending colon. It is situated below entrance of ileum into large intestine. It is about two and a half inches long and three inches in diameter. In the majority of cases the apex of the cæcum rests on the psoas muscle. The cæcum may be wholly within the true pelvis, or, in cases of faulty rotation (which are rare), it may be on the left of the mid-line of the posterior abdominal walls. The cæcum presents the following four types in the adult: (1) Infantile, conical; (2) appendix at apex; (3) quadrilateral, appendix between two bulging sacculi; (4) right caput undeveloped, apex to left and behind; (5) left caput atrophied, no trace of apex. The cæcum may be insignificant (microcæcum) or overgrown (macrocæcum). The ileum may pass behind the colon and open into the colon on the right side; it may enter the front of the cæcum or the cæcum may be found just under the liver or near the umbilicus. The primitive condition of a common mesentery may obtain. (See Gerrish's *Anatomy*.)

The Vermiform Appendix. This is attached to cæcum near ileocæcal valve, on inner and posterior part. It varies from one to nine inches in length, and is a blind, hollow tube. It is usually behind the ileum. It may hang across the pelvic brim, or lie vertically behind the cæcum. It has a mesentery derived from left mesentery of ileum. Its mesentery is triangular, and has in its free margin the appendicular artery, a branch of the ileocælic. Like the major part of the alimentary canal, the tube grows faster than the peritoneal covering—the mesentery—hence, the twisted condition of the organ. At the time of its first appearance in the embryo, the appendix equals the cæcum in size.

The Ileocæcal Valve (valvula Bauhini) is formed by a double fold of mucous membrane and circular muscular fibre at junction of small and large intestine. The valve is not perfect, as has been noted in clinical practice by ejections from the mouth, of substances injected per rectum. The student should demonstrate in the dissecting-room the fact that water introduced into the ascending colon near the liver will find its way quite readily into the small intestine. There is usually to be found at the beginning of the appendix a small valve formed by a fold of mucous membrane.

Subdivisions. The ascending colon extends from the right iliac fossa to the lower margin of the liver. It begins in a blind pouch, the cæcum, to which is attached the vermiform appendix. The ascending colon is variable in length, usually from four to six inches. A very large liver, or imperfect rotation may account for its shortness. It is held in position by peritoneum, which covers the anterior surface and sides only, and with the exception of a few cases, has no mesocolon. The ascending colon may be absent, in which case the cæcum belongs to the transverse colon. The ascending colon is in relation with right kidney, descending duodenum, quadratus lumborum and transversalis muscles.

The Transverse Colon extends from the hepatic to the splenic flexure of the colon, across the junction of the epigastric and umbilical regions, and makes a sharp bend downward at the lower border of the spleen, called the splenic flexure. It is held in position by the transverse mesocolon. It is in relation above with the liver, gall-bladder, and spleen; behind, with third part of duodenum; below, with small intestine; anteriorly, with abdominal walls. Its artery is the middle colic, a branch of the superior mesenteric.

The Descending Colon extends from the splenic flexure to the sigmoid. It lies in the left hypochondriac and left lumbar regions. It is more movable than the ascending colon. Behind, it is related to outer border of left kidney, diaphragm,

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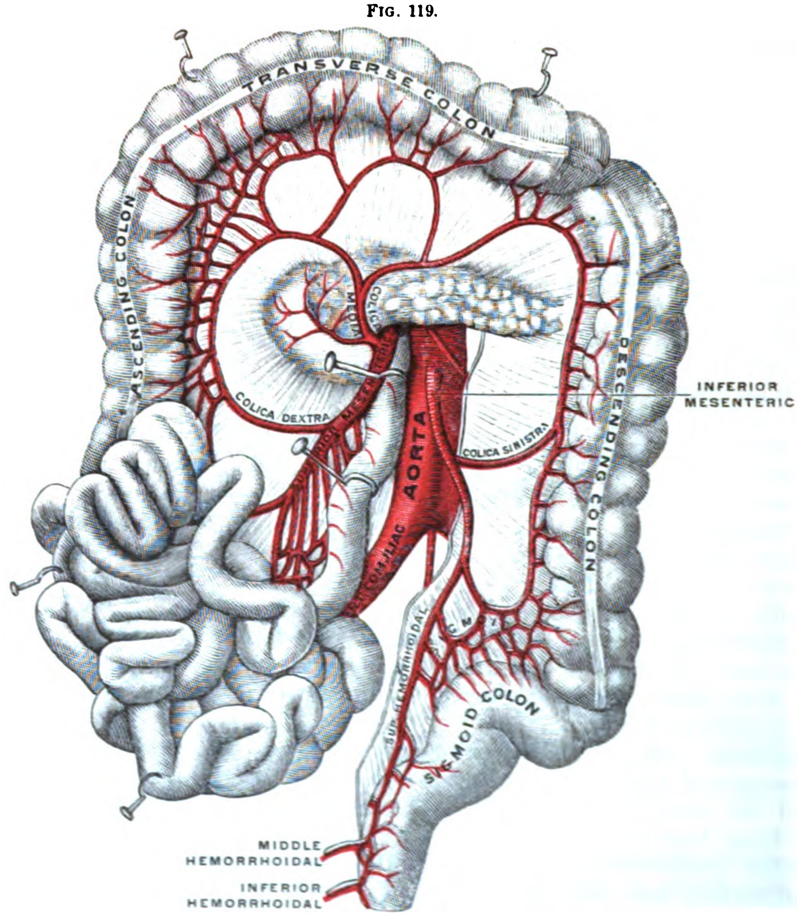
transversalis and quadratus lumborum muscles, while in front of it lies the small intestine. The descending colon has, as a rule, no peritoneum posteriorly. In one hundred dissections, a distinct mesocolon was found in thirty-six bodies. The descending colon receives its blood-supply from the inferior mesenteric artery—colica sinistra.

The Sigmoid Flexure begins at the crest of the ilium and ends opposite the left sacro-iliac synchondrosis. From its resemblance to a Greek letter, the sigmoid is called the omega loop. The normal position of omega loop is in the left iliac fossa, but it may hang down in the true pelvis. As a rule, the sigmoid is in contact with the bladder and hidden from view by the small intestine. The sigmoid has a mesosigmoid from one to four inches in length. The mesosigmoid may be

FIG. 119.



Inferior mesenteric artery. (GERRISH after TESTUT.)

absent over the psoas magnus muscle. At bifurcation of common iliac artery is the intersigmoid fossa, an occasional seat of sigmoid hernia. The fossa is less than two inches deep and formed by the sigmoid artery and folds of the mesosigmoid. The sigmoid is supplied with blood by the sigmoid artery, a branch of the inferior mesenteric.

The Rectum extends from the sacro-iliac synchondrosis to the anus, and has first, second, and third portions. The first portion, four inches long, extends from the left sacro-iliac joint to the level of the third sacral vertebra in mid-line; the second, three inches long, extends from the third sacral vertebra to apex of prostate gland, one inch in front of the tip of the coccyx; the third, one inch long, extends from apex of prostate to anus.

The lower segment of the rectum is not covered by the peritoneum; the levator and muscle are attached to it. It is surrounded by the internal sphincter muscle below the prostate. The external sphincter is at its end. *Arteries:* Superior hemorrhoidal, from inferior mesenteric; middle hemorrhoidal, from internal iliac; inferior hemorrhoidal, from internal pudic. There are two systems of veins in the rectum—portal and iliac; the portal system joins the mesenteric veins, the iliac, the internal iliac veins. The veins are longitudinal in the lower part of the rectum, where they communicate freely, forming the hemorrhoidal plexus of veins. The hemorrhoidal plexus of veins, situated between the mucosa and musculosa, surrounds the lower part of the rectum. The plexus discharges (1) into the internal pudic vein through the inferior hemorrhoidal vein; (2) into the internal iliac vein through the middle hemorrhoidal; (3) into the inferior mesenteric through the superior hemorrhoidal vein.

The Anus is the terminal opening by which the rectum performs its extrusive function. The corrugator cutis ani, external sphincter ani, and levator ani are important accessory muscles. The internal sphincter ani is produced by a thickening of the circular muscular fibre of the rectum for about one-half inch. It is located about an inch above the anus, where it forms a complete muscular ring.

THE LIVER.

Dissection. Study relations, surfaces, borders, and ligaments of liver. Find round ligament in free border of falciform ligament. Review root-structures and locate right and left lateral ligaments. Pass finger through foramen of Winslow into lesser cavity of peritoneum. Dissect (with blunt instrument) branches of hepatic artery, and trace portal vein to its origin. Dissect gall-bladder away from its fissure, inflate and study cystic, hepatic, and common ducts. Consult illustration and identify the following lobes: right and left lateral, Spigelian quadrate and caudate. Also identify the following fissures: longitudinal, transverse, portal, fissure for vena cava, fissure for gall-bladder.

Location: Epigastric, right and left hypochondriac regions. Weight: about five pounds in the male, less in the female. Displacement capacity: ninety-five cubic inches. Specific character: firm, solid, friable, chocolate color. It has two borders—anterior and posterior; two extremities, right and left; three surfaces, superior, inferior, and posterior; five lobes, right, left, caudate, quadrate, Spigelian; five fissures, cystic, caval, transverse, umbilical, and fissure of ductus venosus; five ligaments, broad, round, coronary, and right and left lateral.

The Root-structures of the liver are those nerves and conduits that enter the organ through the transverse fissure, between the anterior and posterior layers of the lesser omentum, supported by connective tissue known as the capsule of Glisson. Names of root-structures of liver: 1. Left vagus nerve filaments, and sympathetic nerves from solar plexus (accompanying vessels under the name of the hepatic plexus) and conferring on the liver sensation, resiliency, and trophic qualities. 2. Hepatic artery, a branch of the cœliac axis of the aorta, dividing into right and left lobe branches; this artery lies to left of common bile-duct and anterior to portal vein; it furnishes the liver and gall-bladder with nutrition. 3. The portal vein (about three inches long) is made up behind the head of pancreas by confluence of splenic and superior mesenteric veins. In transverse fissure of liver the vein dilates to form the portal sinus; it then divides into a right and left branch and enters the liver. The portal vein, in its passage to the liver, lies posterior to and between the hepatic artery and common bile-duct. The tributaries of the portal vein are gastric, cystic, splenic, and superior mesenteric. The inferior mesenteric is tributary to the splenic vein. The portal vein begins in capillaries in the spleen and abdominal digestive organs, and ends in capillaries in the liver. In the liver the portal vein receives the capillaries corresponding to the distribution of the hepatic artery, and leaves on the posterior surface, discharging into the ascending vena cava under the name of venæ cavæ hepaticæ.

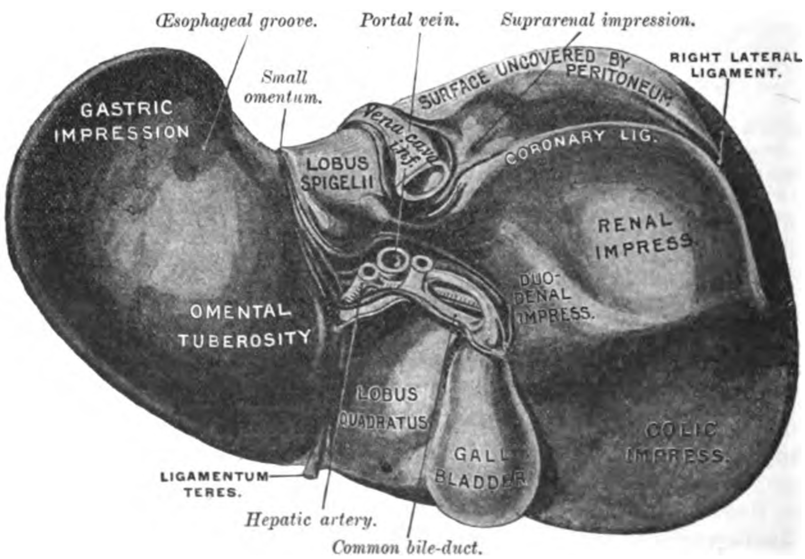
The Anterior Border of the liver is a sharp, thin edge. (Fig. 125) At beginning of the longitudinal fissure is the interlobar notch, which divides the right lobe from the left. This border is freely movable.

The Posterior Border is thick, rounded, fixed, and notched for the ascending vena cava and vertebral column.

The Superior Surface is divided into the right and left lobes by the suspensory ligament, a remnant of the anterior mesogaster. On left lobe is a depression for the heart. This whole surface is moulded to the concave surface of the diaphragm.

The Inferior Surface of the liver includes the transverse fissure and the part in front of the fissure. The parts of this surface not covered by peritoneum are (1) fissure for the gall-bladder, the space between the two layers of the lesser omentum. (On this surface are the longitudinal fissure, which contains the umbilical vein in the embryo, and is, for this reason, called the umbilical fissure. In adults the umbilical fissure contains the round ligament of the liver—the obliterated umbilical vein.) (2) The fissure for the gall-bladder. (3) The transverse fissure, transmitting portal vein, hepatic duct, and hepatic artery. (4) The quadrate lobe, between

FIG. 120.



Posterior and under surfaces of the liver. (GRAY after ELLIS.)

gall-bladder and umbilical fissure. (5) Certain more or less marked surfaces, where adjacent organs impinge on the liver, known as impressio gastrica, impressio renalis, impressio cœlica, and impressio duodenalis.

The Gall-bladder is just to the right of the quadrate lobe in the fissure for the gall-bladder. It may be inflated on the cadaver, and will then touch the front wall of the abdomen at the ninth costal cartilage, where in the living it is accessible for operation. It is from two and a half to four inches long, pyriform in shape, and one and a half inches wide at the fundus; it holds about one ounce. The neck is at the transverse fissure of the liver. It has a right curve above and a left one below. The part of the gall-bladder between the fundus and neck is the body.

The Gall-ducts are (1) the cystic, about one and a half inches long, unites with the hepatic and forms the common bile duct. It lies in front of the portal vein and to the right of the hepatic artery. If this duct is obstructed, bile can neither escape from nor enter the gall-bladder. (2) The hepatic, made up in the transverse fissure of the liver by the junction of right and left hepatic ducts from the right and left lobes, respectively. It is about one and a half inches long and unites with the cystic duct to form the common bile-duct. If this duct is obstructed bile cannot escape from the liver. This duct crosses the hepatic artery and portal vein to join the cystic. (3) The common bile-duct (ductus communis choledochus) is formed by the union of the cystic and hepatic ducts. It is three and a half inches long and a quarter of an inch in diameter. It lies between the two layers of the lesser omentum. Its course is (*a*) behind the first stage of the duodenum; (*b*) in front of portal vein; (*c*) to right of hepatic artery; (*d*) to left of descending duodenum; (*e*) behind head of pancreas and descending duodenum. It perforates the second part of the duodenum and unites with the pancreatic duct, forming a dilatation—the ampulla of Vater.

The Posterior Surface of the liver is behind the transverse fissure. On it are (1) Spigelian lobe, between ascending vena cava and fissure for ductus venosus; (2) ascending vena cava; (3) fissure for ductus venosus; (4) tuber omentale.

Embryology. The liver is a compound tubular gland. Glands in general are formed by an ingrowth of the walls of the cavity to which they pertain. At an early period the ventral wall of gut, below stomach, forms two diverticula, one the future pancreatic, the other the common bile-duct. The common bile-duct evaginates two diverticula; one becomes the gall-bladder, the other grows into the liver ridge located in future diaphragm, and evolves the liver. The liver owes its bile-duct epithelia and proper hepatic cells to the ectodermic evagination; its connective-tissue parts, to the liver ridge. The liver, therefore, consists of two elemental parts, a duodenal and a diaphragmatic. In embryo the liver occupies a position between the two layers of the anterior mesogaster, in front of the stomach. (See Gerrish's *Anatomy.*)

Reflex Phenomena, in biliary colic, cancer of liver, suppurative hepatitis, and many other diseases of the liver, may occur as somatic pain in right shoulder or abdominal walls, since the liver derives its nerve-supply from the solar plexus, and the somatic correspondence of this plexus is in the spinal nerves from the sixth to the tenth thoracic.

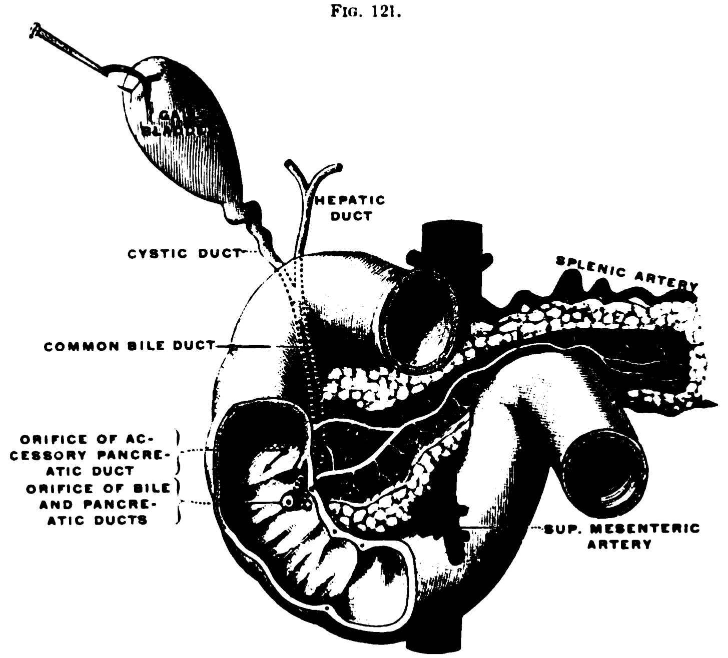
THE PANCREAS.

Dissection. Locate behind the stomach, extending from duodenum across crura of diaphragm, superior mesenteric vessels, aorta and vena cava, splenic vessels, left kidney, adrenal, and portal vein to spleen. (Figs. 116, 121.) Dissect with blunt instrument, the pancreas from these structures. Find duct of pancreas opening into descending or transverse duodenum. Consult illustrations and text.

Location. Epigastric and left hypochondriac regions. *Physiological class:* A compound, racemose gland. *Size:* Length, seven inches; breadth, one and a half inches, and from one-half to one inch thick. *Specific physical character:* Soft, pinkish, cream-colored. *Divisions:* Head, neck, body, tail, and excretory pancreatic duct. The head is embraced by descending and transverse duodenum, and is disk-shaped and flattened. The neck is a slight constriction joining the head and body. *Surfaces of body:* Anterior, inferior, and posterior. *Peritoneum of anterior surface:* Derived from transverse mesocolon. *Anterior visceral relation:* Posterior surface of stomach. *Anterior surface:* Concave, produced by pressure of stomach. The posterior surface is in contact with the crura of the diaphragm, superior mesenteric vessels, aorta, vena cava, splenic artery and vein, left kidney, left adrenal, and commencement of portal vein. The tail touches the inner surface of the spleen. *The pancreatic duct:* Synonym, duct of Wirsung; origin of the duct is in the tail, by smaller ducts; its end is in the descending duodenum, where it may join the common bile-duct. There may be an accessory duct. (Fig. 121.) *Arteries:* Splenic, hepatic, and superior mesenteric. The veins open into the splenic and superior mesenteric.

Embryology. The pancreas is produced by evagination of the dorsal wall of the duodenum. In early embryo it lies behind the stomach between the two layers of the posterior mesogaster, completely invested by peritoneum. With rotation of the alimentary canal, pancreas loses its mesentery and becomes a retroperitoneal organ. The evagination of the duodenal wall, previously referred to, meets embryonic connective tissue in posterior mesogaster, and the result of the meeting is the formation of the pancreas. The pancreas has then, embryologically, two elements—duodenal and embryonal connective tissue.

FIG. 121.



Ducts of the pancreas. Part of the front wall of the duodenum is cut away. (GERRISH after TESTUT.)

THE SPLEEN.

Dissection. **(Fig. 110.) Locate attached to fundus of stomach by gastrosplenic omentum. Dissect through omentum and find splenic vessels entering hilum. Locate and study relations of the four borders and two surfaces. Locate costo-colic ligament which supports the organ. Cut through fibro-elastic capsule and examine spleen pulp.**

Physiological Class. A great ductless blood gland. *Situation:* Deep in the left hypochondriac region. *Location:* Between the fundus of the stomach and the diaphragm. It is between the eighth and eleventh ribs; its organic character is bluish red in color, soft, and easily torn. *Shape:* Elliptical, with long axis parallel to line of tenth rib. *Size:* Length, five inches, breadth, three and a half inches, and thickness, one and a half inches. It has a displacement capacity of fifteen cubic inches. *Surfaces:* Outer, convex; inner, concave. Inner surface is divided by hilum (a vertical slit), which transmits splenic vessels. *Borders:* Anterior, posterior, upper, and lower. *Coats:* (1) Fibro-elastic, capsule; (2) peritoneal covering.

The Splenic Artery, a branch of cœliac axis, is large and tortuous and enters the spleen by several branches. The arteries in the substance of the spleen are supported by trabecular connective tissue derived from the fibrocapsule. The splenic artery lies above the splenic vein and passes along the upper border of the pancreas, being partially concealed from view by this gland. The branches of the splenic artery are (1) terminal, five to eight, distributed to spleen pulp; (2) vasa brevia, to greater cul-de-sac of stomach; (3) left gastro-epiploica sinistra, which anastomoses with the gastro-epiploica dextra; (4) the large pancreatic, accompanies the pancreatic duct; (5) small pancreatic to pancreas.

The Splenic Veins begin as capillaries in the splenic pulp; they unite to form four or five small veins, which unite before they reach the hilum, to form the splenic vein. The vein accompanies the splenic artery, lying below same, and becomes confluent with the superior mesenteric vein behind the head of the pancreas to form the portal vein. In its course it receives the following veins: the inferior mesenteric, left gastro-epiploica, pancreatic, and vasa brevia. The nerve-supply of the spleen is from the solar plexus. Nerves are called splenic sympathetic, and accompany splenic artery. The spleen elaborates the albuminous materials of the food and stores them up for future use.

Embryology. In embryo the spleen lies between the two layers of the posterior mesogaster near the pancreas. It is differentiated from the mesodermic tissue. The characteristic part of the spleen is called pulp, which is formed of nucleated cells along the branches of the arteries in the spleen. In addition to the ordinary one there may be several smaller spleens—from one to twenty—developed in the gastrosplenic or even in the gastrocolic omentum.

Visceral Relations. The external surface of the spleen is in relation with the diaphragm, and corresponds to the ninth, tenth, and eleventh ribs. The internal surface is in relation with the cardiac end of the stomach, tail of pancreas, left adrenal, and left crus of diaphragm. The superior border is connected to diaphragm by the suspensory ligament of the spleen. The inferior border is in relation with the splenic flexure of the colon The posterior border is attached to the left kidney by connective tissue. The hilum is connected to the cardiac end of the stomach by the gastrosplenic omentum.

Reflex Phenomena incident to disease of the spleen may occur either in the vicinity of the left shoulder or in the left abdominal walls, as somatic pain, since this organ receives its nerve-supply from the solar plexus, and this plexus has its somatic correspondence in the spinal nerves from the sixth to the tenth thoracic.

THE KIDNEYS.

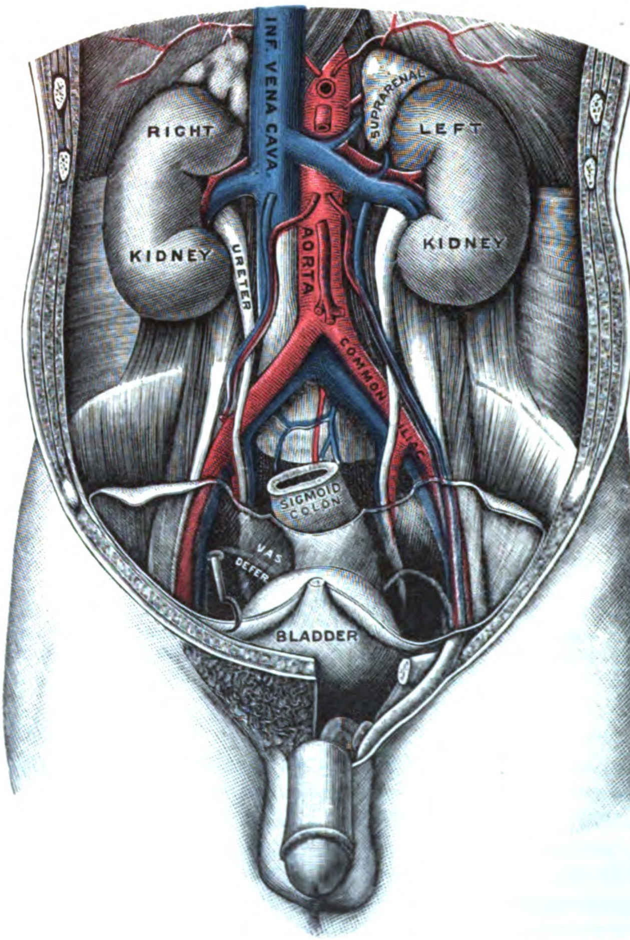
Dissection. Study the anterior and posterior relations. Trace renal vessels and ureter from kidney. Note fatty capsule and fibrous capsule. Search for supernumerary arteries. Identify hilum, borders, and surfaces. Study course of ureter to bladder; note its relation to spermatic vessels (posterior). Study interior of organ in Gray's *Anatomy*.

The kidneys (Fig. 122) are two in number, one on either side of the vertebral column. The adrenal body or suprarenal capsule lies on the upper end of each kidney in a quantity of connective tissue and fat. *Location:* The kidney lies opposite the twelfth thoracic and first, second, and third lumbar vertebræ, principally in the hypochondriac and epigastric regions. Owing to the great size of the right lobe of the liver the right kidney is somewhat lower than the left. The upper end of each kidney is in relation with the twelfth rib; the lower a little above the highest part of the iliac crest. *Size:* The kidney weighs about four and a half ounces; it is about four inches long, two and a half inches broad, and one inch thick. Its shape is characteristic and well understood, but to be perfectly appreciated the dissecting material should be preserved in formalin with the organ in situ. *Analysis:* The kidney has two surfaces, anterior and posterior; two borders, an internal concave, and an external, convex and smooth; two extremities, upper and lower, and a place where the nerves and conduits enter and depart, called the hilum. (See Gray's *Anatomy.*)

The Hilum, or anatomical root of the kidney, is a longitudinal fissure in the centre of the inner concave border. It accommodates the following root-structures enumerated from before backward: (1) renal vein; (2) renal artery; (3) sympathetic nerves; (4) ureter. The hilum is limited by thick anterior and posterior lips, and leads into the renal sinus.

The Anterior Surface of the right kidney has three impressions produced by the three organs in relation with its anterior surface: (1) Hepatic impression, produced by liver, occupying about the upper two-thirds; (2) colic impression, produced by hepatic flexure of colon, occupying about the lower third; (3) duodenal impression, produced by descending and transverse parts of duodenum, occupying a space variable in size in the region of the hilum. The anterior surface of left kidney is in relation with (1) stomach in upper third; (2) colon, in lower third; (3) spleen externally and tail of pancreas internally in middle

FIG. 122.



The kidneys, the ureters, and the bladder, in their normal position. (GERRISH after TESTUT.)

third. The posterior surface of each kidney is in relation with the psoas magnus, crus of diaphragm, diaphragm, quadratus lumborum muscle, twelfth thoracic nerve and accompanying artery, iliohypogastric, and ilio-inguinal nerves.

Peritoneal Areas. The posterior surfaces of both kidneys are non-peritoneal. The left kidney areas, in relation with the colon, spleen, and pancreas, are non-peritoneal; those occupied by the stomach and cœliac vessels are covered by peritoneum. The right kidney areas, in relation with the colon and duodenum, are non-peritoneal; those in relation with the liver and right cœliac vessels are covered by peritoneum. (See Gray's or Gerrish's *Anatomy.*)

The Capsule of the kidney is a strong, closely-fitting fibrous investment, and may be easily stripped off. The capsule enters the hilum and sinus of the kidney, and becomes continuous with the outer coat of the ureter and sheaths of the vessels and nerves.

The Ureter (Figs. 122, 123) is the excretory duct of the kidney. Its length is about sixteen inches; its diameter is about one-fifth of an inch. The ureter begins in the renal sinus by eight or nine tubes called calices. Each calyx embraces a Malpighian pyramid. The expanded funnel-like part of the ureter, embraced by the lips of the hilum, is behind the renal vessels, and is called the pelvis of the ureter. It is nearly an inch wide. The ureter proper begins at the end of the pelvis. Portions of the ureter are abdominal, pelvic, and vesical. The abdominal portion rests on the psoas muscle, genito-crural nerve, and common iliac artery; the pelvic portion crosses the sacro-iliac joint, obturator internus muscle, and its fascia; the vesical portion extends through the walls of the bladder. *Arteries:* Renal, spermatic, internal iliac, and vesical. *Nerves:* Sympathetic, through renal, spermatic, and hypogastric plexuses.

Arteries: Lumbar, phrenic, and renal. The small vessels are chiefly for nutrition of the capsule; they enter in various places and anastomose freely with vessels from the renal artery. The renal vessels enter the hilum, in front of the ureter; the artery is behind the vein. *Nerve-supply:* Solar and renal plexuses and splanchnic, with filaments from vagus and phrenic.

Reflex Pain in stone of pelvis of kidney is excruciating in end of the penis and in the scrotum—far from the irritation. To account for which recall the nerve-supply of the urinary tract: (1) Nerve-supply of the kidney and ureter is from hypogastric and renal plexuses; (2) for bladder and urethra, from hypogastric plexus, third and fourth sacral nerves; (3) for skin of penis and scrotum, from third and fourth sacral. The hypogastric plexus, third and fourth sacral nerves correspond in sacral region. The hypogastric pain is reflected to the internal pudic (third and fourth sacral), and these sensory nerves report pain peripherally. The principal distribution of the internal pudic nerve is to scrotum and penis.

Suprarenal Capsule. For dissection purposes, see this organ under head of Identification of Structures, page 212. For detailed histology and relation of this, as well as other organs, see Gray's *Anatomy*.

THE BLADDER.

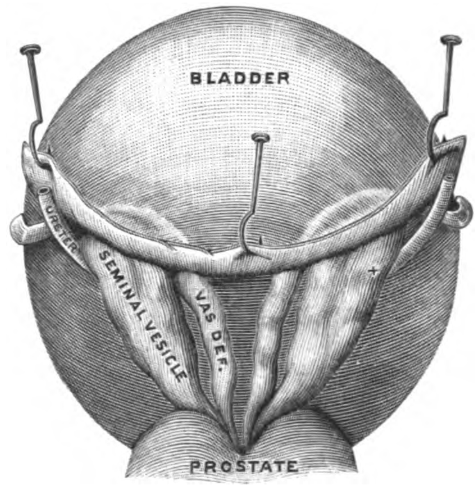
Dissection. Inject with paraffin through urethra. Study ligaments, size, shape, mobility, and relation to rectum and pubic bone. Dissect between bladder and pubic bone (space of Ritzius) and find puboprostatic ligaments, and veins from dorsum of penis. Remove peritoneum and identify vessels (superior, middle, and inferior vesical arteries). Cut through the remaining coats by crucial incision, remove paraffin and study interior. Be guided by text and illustrations.

The Bladder (Figs. 122, 123) is located in the pelvis behind the pubic bone. Through the ureter it receives the urine from the kidneys; by the urethra it discharges its contents.

The Ligaments of the bladder are true and false. The true are derived from the rectovescial fascia and arranged about the base of the organ as follows: Two anterior, or puboprostatic; two lateral; one superior, the urachus. The false are peritoneal: superior, plica urachi—two lateral and two posterior.

The Superior or Intestinal Surface of the bladder is in relation with the ileum and great omentum; the anterior surface is separated from the pubic bone by the space of Ritzius; the posterior surface rests on the rectum in relation with the vesiculæ seminales. (Fig. 123.) *Arteries:* Superior, middle, inferior vesical, and internal iliac. *Nerves:* Third, fourth sacral, and hypogastric plexus.

FIG. 123



Base of the bladder, showing the vasa deferentia and seminal vesicles. The peritoneum is raised by hooks. (GERRISH after TESTUT.)

THE PROSTATE GLAND.

Location. The gland surrounds the prostatic urethra. (Figs. 123, 128, 129.) The apex is on the upper surface of the triangular ligament; the base is on the under surface of the bladder, and continuous with its muscular fibres; the lateral surface is covered by the levator ani muscle and vesicoprostatic plexus; the anterior surface is separated from the symphysis pubis by the prostatic plexus; the posterior surface is on the anterior wall of the rectum, and may be felt through the same above the external sphincter ani. The posterior surface of the prostate has the prostatic fissure which extends inward and forward to the middle of the prostatic part of the urethra. This fissure limits inferiorly the middle lobe of the prostate gland. The prostatic fissure transmits the ejaculatory duct. The prostate has two lateral lobes which surround the urethra and meet posteriorly in the prostatic fissure. The gland is surrounded by a dense capsule derived from the vesical subdivision of the visceral layer of the pelvic fascia. *Arteries:* Prostatic branches from the internal pudic, vesical, and hemorrhoidal arteries. *Nerves:* Pelvic plexus. The prostatico-vesical plexus of veins surrounds the prostate and neck of the bladder. Its tributaries are the right and left divisions of the dorsal vein of the penis; the prostatic and vesical veins. The plexus communicates with the hemorrhoidal plexus, opens by two veins into the internal iliac, and is covered by the rectovesical fascia.

THE FEMALE PELVIS.

Dissection. Locate the uterus low in the true pelvis between bladder and rectum. Pass a thread through upper part of uterus for purpose of moving the organ from place to place. Now demonstrate those structures attached to the upper and outer part of the uterus (Fig. 124): (*a*) the round ligament of the uterus; (*b*) the Fallopian tube; (*c*) the utero-ovarian ligament. Grasp the distal end of the oviduct and study its fimbriæ. Pass a bristle or broom-straw through tube into cavity of uterus, and cut through tube and study interior of same. Trace round ligament to outer side of deep epigastric artery, thence through inguinal canal to labia majora. (Fig. 124.) Examine broad ligament and demonstrate structures between its two layers. Cut through uterus and study interior of same. Find anastomosis of ovarian and uterine vessels. Trace ureter from brim of pelvis to bladder and note its relation to the cervix of the uterus.

The Uterus is the organ of menstruation, of normal gestation for the fertilized ovum, and of expulsion of the viable or non-viable product of conception. **In the**

fetus, the uterus is an abdominal organ, retroperitoneal, a differentiated part of Müller's duct. In the adult it is in the true pelvis in the unimpregnated state, between the two layers of the broad ligament, in front of the rectum and behind the bladder. Its departure from the pelvic cavity occurs under two conditions: (1) In prolapsus uteri; (2) in pregnancy, when its increased size renders its further stay in the limited space between the rectum and bladder a physiological impossibility. The uterus varies in size, according to age, pregnancy, and virginity. In young children the body of the uterus, compared with the neck, is small. In the virgin, the body and neck are equal in length. After the uterus has discharged its first function of gestation, the neck is one-half the length of the body. During the childbearing period the uterus reaches its greatest size and strength, and in old age, atrophies. In a woman who has not borne children the uterus weighs about an ounce, is one and a half inches in breadth, two and one-half inches in length. In one who has borne children the weight is greater.

Analysis. The uterus has an upper part called the body; a lower cylindrical part, the cervix; an intermediary part between the body and cervix, the isthmus. The body has two surfaces—anterior and posterior—covered by peritoneum; three borders—a superior and two lateral. The superior border is covered by peritoneum, and is the transition-region from anterior to posterior surface. The lateral borders of the uterus mark the uterine extremity of the broad ligament, the junction of round and ovarian ligaments, and oviduct to the body of the uterus, and the entrance and departure of uterine nerves and vessels. The cervix consists of a part to which the vagina is attached; a part within vagina; a part immediately above the vaginal attachment.

Ligaments. (Fig. 124.) (1) Utero-vesical, a peritoneal fold which passes from the cervix to the bladder; (2) recto-uterine, a peritoneal fold, limiting laterally the pouch of Douglas and extending from the cervix uteri and vagina to the rectum and sacrum; (3) muscular ligaments, round or uterovaginal and utero-ovarian, extending from the superior angle of the uterus behind oviduct to ovary; uteropelvic, extending from the obturator fascia to the lateral margins of the body of the uterus; (4) two sacro-uterine, in the recto-uterine folds, extending from the uterus to the sacrum along the side of the rectum.

THE BROAD LIGAMENTS are double folds of peritoneum extending from the lateral margins of the uterus and upper part of the vagina to the lateral part of the pelvis, in such a way as to divide the pelvis into an anterior or vesical, and a posterior or rectal part. *Contents of the broad ligament:* (1) Ovary and and utero-ovarian ligament; (2) round or utero-inguinal ligament; (3) Fallopian tube or oviduct; (4) uterine and ovarian vessels and sympathetic nerves; (5) certain fœtal relics. (For description of ovary, see Gerrish's or Gray's *Anatomy.*)

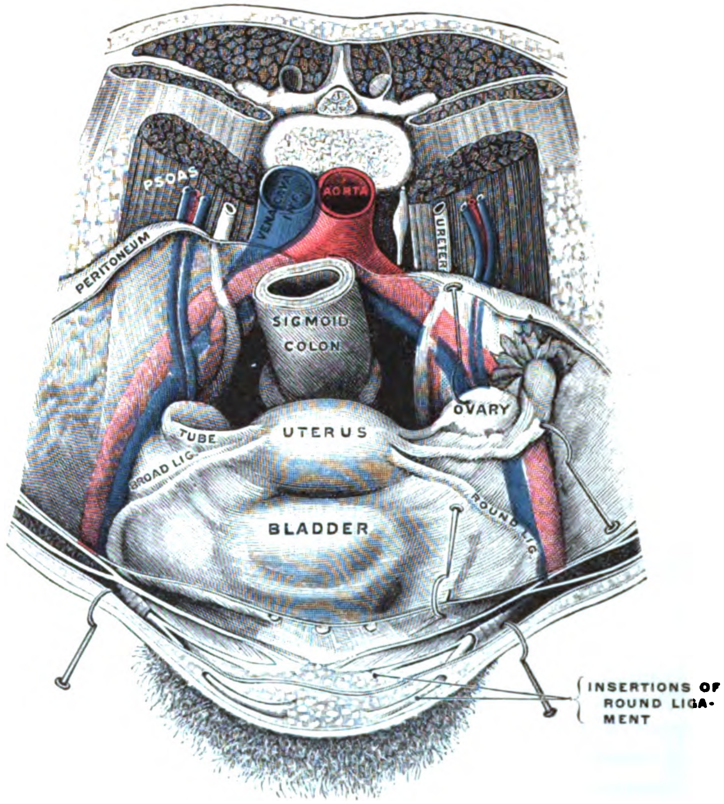
THE ROUND LIGAMENT is about five inches long and extends from the superior angle of the body of the uterus to the labia majora, in which it is lost. In its course the ligament passes successively between the layers of the broad ligament, in front of the Fallopian tube; through the internal abdominal ring in the transversalis fascia to the outer side of the deep epigastric artery; under the roof and along the floor of the inguinal canal; through the external abdominal ring in the aponeurosis of the external oblique muscle. The round ligament and gubernaculum testis represent the inguinal ligament of the primitive kidney, and in the embryo are preceded by an evagination of peritoneum (analogous to the processus vaginalis in the male) called the canal of Nück. This canal usually becomes obliterated, but may obtain in adult life. The round ligament is composed of unstriped muscle fibre.

The Fallopian Tube (Fig. 124) (two in number) extends from the superior angle of the uterus, behind the round ligament, to about one inch beyond the ovary, to which latter it is attached by the ovarian fimbria. The tube is from three to four inches long, and its free end opens into the peritoneal cavity by a constricted orifice—the ostium abdominale. The orifice is surrounded by processes called fimbriæ, one of which is attached to the ovary. The tube has three stages or typical positions: The first lies on the floor of the pelvis; the second, along the anterior border of the ovary, and the third, along the posterior border and inner surface of the ovary.

Nerves. Third and fourth sacral, hypogastric, and renal plexuses; the two latter also supply the ovary and Fallopian tubes. Contraction of the uterus normally occurs at the menstrual period and at the end of gestation. Premature contraction of the uterus in the course of gestation may produce miscarriage. The uterus contracts reflexly on stimulation of the hypogastric plexus, nervi erigentes, nipple, trigeminus, sacral plexus, great sciatic nerve, lumbar plexus, brachial plexus, and intercostal nerves.

The Hypogastric Plexus supplies the rectum, bladder, prostate, vagina, and uterus. In the female it lies on each side of the rectum, bladder, and vagina.

FIG. 124.



Female pelvic viscera, from above. The ovary and tube of the left side have been lifted out of place. (GERRISH after TESTUT.)

Branches of this plexus accompany the arteries to the pelvic organs and take the same name as the arteries. This plexus is continued down from the superior hypogastric plexus, situated in the lumbar and upper sacral regions. It is joined by branches from the third and fourth sacral nerves and from the sacral part of the sympathetic cord. The nervi erigentes, called by Gaskell the pelvic splanchnics, arise from the sacral plexus. (They contain vasodilator fibres, and their stimulation produces erection of the clitoris.) Contraction of the uterus may be induced by stimulation of the nervi erigentes. These nerves also supply the rectum.

Arteries of Uterus and Appendages. The uterine branch of the internal iliac enters the base of the broad ligament and runs toward the cervix in front of the ureter. It gives branches to the bladder and vagina, and runs along the side of the body of the uterus, giving off in its course anastomotic transverse branches to the walls of this organ. At the angle of the uterus the artery anastomoses with the ovarian and funicular. The uterine artery is accompanied by sympathetic nerves from the hypogastric plexus.

The Ovary is connected (*a*) to the posterior layer of the broad ligament; (*b*) to the uterus by the utero-ovarian ligament; (*c*) to the Fallopian tube, by the ovarian fimbria. There are two ovaries, and each has a superior and an inferior surface; an anterior and a posterior border; a superior and an inferior extremity. The ovarian artery supplies the ovary with blood.

The Ovarian Artery is a branch of the aorta, homologous to the spermatic in the male, and, like the spermatic, has a horizontal course in the embryo. The outer margin of the broad ligament, external to the fimbriated end of the Fallopian tube, presents a sharp fold in which is located the ovarian artery. This fold or plica is called the ligamentum infundibulo-pelvicum. (See plicate function of peritoneum, p. 216.) The ovarian artery divides into (*a*) a tubal branch that lies beneath and supplies the oviduct; (*b*) an ovarian branch which supplies the ovary and passes to the angle of the uterus to anastomose with the uterine and funicular. The ovarian artery is accompanied by sympathetic nerves from the renal plexus.

The Funicular Artery is a branch of the vesical, joins the round ligament at the internal abdominal ring (in the transversalis fascia) and divides into an internal branch which runs in the substance of the round ligament to the angle of the uterus, where it anastomoses with the ovarian arteries and an external branch, which passes through the inguinal canal to the labia majora, where it anastomoses with the external pudic, a branch of the femoral artery.

The Uterine Veins are large. They form a plexus in the broad ligament and finally unite to form a vein corresponding to the artery, which opens into the internal iliac. The ovarian veins form the pampiniform plexus around the ovarian artery. The right vein follows the course of the artery and opens into the ascending vena cava; the left opens into the left renal vein.

The Rectum of the male has been described in the dissection of the alimentary canal. (See p. 226.) In the female, the cul-de-sac of Douglas separates the second part of the rectum for a short distance from the cervix uteri and upper part of the vagina; below this the rectum in the female rests on the posterior wall of the vagina.

The Bladder in the female is rounder than in the male. The base is in relation with the cervix uteri and vagina. The neck of the bladder in the female has no prostate; vas deferens and vesiculæ seminales are absent. Its relation to the peritoneum, hypogastric remnants, and pelvic walls are similar to those in the male.

The Female Urethra is about one and a half inches long and extends in a curved manner from the neck of the bladder to the vestibule, where the meatus urinarius externus is located. The urethra is almost entirely embedded in the anterior wall of the vagina.

The Female Ureters have the same nerve-supply, blood-supply, and abdominal course, and relations as in the male. In the pelvis they are longer. After crossing the internal iliac artery the ureter extends forward to the cervix uteri. At the base of the bladder it lies in relation with the vagina for a short distance, and then pierces the bladder obliquely.

The Pelvic Fascia of the Female. The parietal layer differs in one respect from the male; it is reflected onto the urethra and vagina (instead of onto the prostate) to join the vesical layer. The visceral fascia divides into (1) a vesical layer that forms the true lateral ligaments of the bladder; (2) a rectovesical layer which extends between the bladder and rectum; (3) a rectal layer which embraces the lateral and posterior aspects of the bladder; (4) a rectovaginal layer, between rectum and vagina.

CHAPTER XVII.

THE ABDOMINAL VESSELS.

THERE are two varieties of abdominal vessels—arteries and veins. The arteries, derived from the abdominal aorta, are distributed (*a*) to the walls (sacra media and lumbar); (*b*) to the viscera (gastric, hepatic). The veins, tributary to the inferior vena, convey blood from both viscera and walls. We may therefore speak of visceral and parietal vessels. Veins returning blood from the spleen and abdominal organs of digestion form the vena porta, blood in which reaches the vena cava *via* the liver. Blood in the remaining veins reaches the vena cava without interruption in the liver. All abdominal vessels are beneath the peritoneum (in sheaths of connective tissue), and accompanied by sympathetic nerves. With the exception of the hepatic, each abdominal artery has a corresponding accompanying vein.

Dissection. Turn small intestines to right side and expose aorta from diaphragm to its bifurcation below, by cutting through and removing the overlying peritoneum. Compare dissection with illustration and identify each branch as given in the text. Next follow out each branch by stripping off the peritoneum. Observe small nerves accompanying each artery. In same manner remove peritoneum covering the inferior vena cava. Identify each tributary as given in the text and shown in the illustration. Notice that (below the diaphragm) arteries are anterior to their veins, except the renal. Divide the mesentery and find the superior mesenteric artery and vein. Demonstrate formation of portal vein as given in the text. (Fig. 125.)

The Abdominal Aorta. (Fig. 112.) The abdominal aorta enters the abdominal cavity opposite the twelfth thoracic vertebra, through the aortic opening in the diaphragm. In the lumbar region the aorta lies to the left of the mid-line and ends opposite the body of the fourth lumbar vertebra, where it divides into the right and left common iliacs. *Relations:* On right side, inferior vena cava, Spigelian lobe of liver, right crus of diaphragm, right semilunar ganglion, and great splanchnic nerve; on left side, pancreas, left crus of diaphragm, small intestine, left semilunar ganglion, and left great splanchnic nerve; posteriorly, left crus of diaphragm, bodies of vertebræ, anterior common vertebral ligament, and left lumbar veins; anteriorly, stomach, liver, lesser omentum, pancreas, transverse duodenum, left renal vein, splenic vein, spermatic and inferior mesenteric arteries, solar and aortic plexuses, ascending layer of transverse mesocolon, small intestine, and mesentery proper. *Nerves:* Sympathetic, from aortic plexus.

Branches. Phrenic, cœliac axis, gastric, hepatic, splenic, superior mesenteric, suprarenal, renal, spermatic (ovarian), inferior mesenteric, lumbar, and sacra media. Of these, the phrenic, lumbar, and sacra media are parietal branches, the others, visceral. (Fig. 112.)

The Inferior Vena Cava. (Fig. 112.) The inferior vena cava corresponds to the abdominal aorta. Its usual location is to the right of the aorta, but in rare cases of transposition of the thoracic and abdominal organs it is on the left side of the aorta. The vena cava is formed by the common iliac veins on the right side of the fifth lumbar vertebra, and ends in the lower and back part of the rig[illegible] auricle of the heart, where its opening is guarded by the Eustachian valve, [illegible] perforates the central tendon of the diaphragm and base of the pericardium, [illegible] lies in a groove on the posterior border of the liver. (Fig. 120.) *Relations* [illegible] the right, the psoas muscle and right kidney; on the left, the aorta an[illegible] plexus; posteriorly, the vertebral column, right crus of diaphragm, rig[illegible] artery, right lumbar arteries, right semilunar ganglion, and right [illegible] gangliated cord; anteriorly, the liver, portal vein, pancreas, transverse duodenum, right spermatic (or ovarian) artery, and mesentery. Nerves of the vena cava are sympathetic, from the aorta plexus.

The tributaries of the vena cava are (1) right and left common iliacs; (2) lumbar veins, four in number on each side, returning blood from the muscles and skin of the loins and abdominal walls; (3) spermatic, two in number, returning blood from the testicles; (4) renal, two in number, from the kidneys, placed in front of the renal arteries; (5) suprarenal, two in number, returning blood from the suprarenal bodies; (6) phrenic, two in number, returning blood from the diaphragm; (7) hepatic, two in number, commencing in the capillary terminations of the portal vein and hepatic artery. (See hepatic veins.)

The Right Phrenic Artery (Fig. 112) crosses the right crus of the diaphragm, behind the vena cava, gives branches to the diaphragm, vena cava, right adrenal body, liver, and pericardium, anastomoses with the left phrenic, superior phrenic, and intercostals.

The Left Phrenic Artery crosses the left crus of the diaphragm behind the œsophagus, gives branches to the diaphragm, œsophagus, left adrenal, spleen, pericardium, and anastomoses with the right phrenic, superior phrenic, left musculophrenic, and intercostals. The phrenic veins correspond to the distribution of the arteries and open into the inferior vena cava.

The Cœliac Axis (Fig. 112) is about one-half inch long. It arises from the front of the aorta near the diaphragm, divides into the gastric, splenic, and hepatic arteries, and rests on the pancreas. (Fig. 121.) To its left are the stomach and left semilunar ganglion; to its right, the right semilunar ganglion and Spigelian lobe of the liver. The axis lies beneath the lesser omentum.

The Gastric Artery (Figs. 112, 116) runs along the lesser curvature of the stomach, between the two layers of the lesser omentum. It gives branches to the stomach, œsophagus, and left lobe of the liver, and anastomoses with the pyloric branch of the hepatic. The gastric vein returns blood from the territory supplied by the gastric artery, and its branches correspond thereto. It is tributary to the portal vein. The gastric artery and its corresponding vein are attended by sympathetic nerves called the gastric or coronary plexus, from the solar plexus.

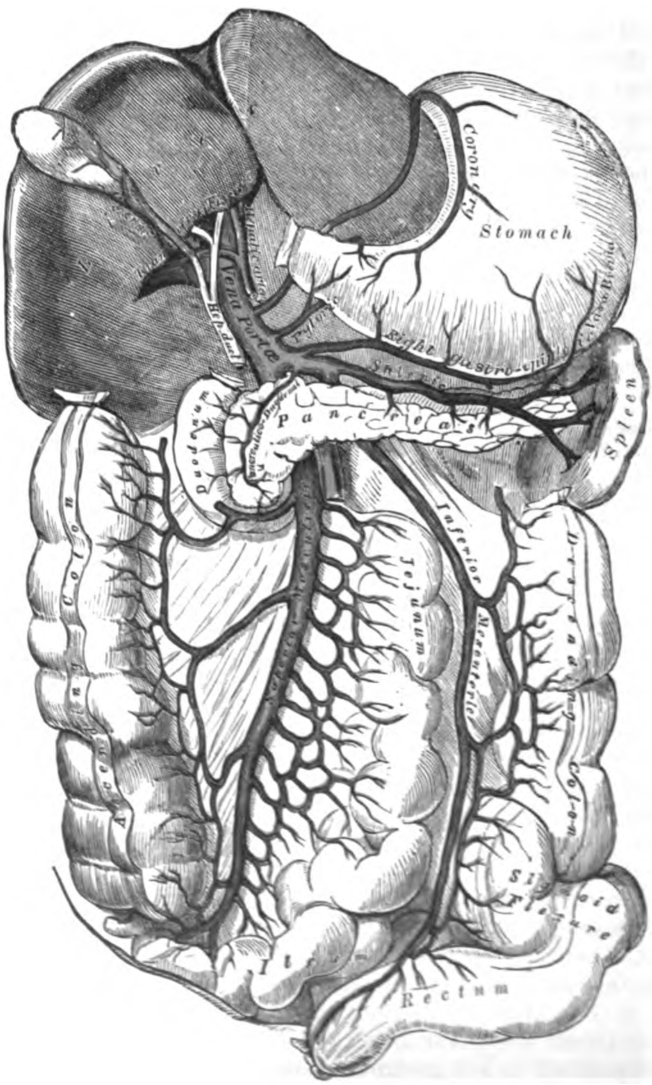
The Hepatic Artery (Fig. 125) (larger than the gastric and smaller than the splenic) arises from the cœliac axis, passes to the pyloric end of the stomach, forms in part the lower boundary of the foramen of Winslow, and then passes in the lesser omentum, with the portal vein and bile-ducts, to the transverse fissure of the liver, and divides into right and left hepatic terminals. The artery and its branches, together with the portal vein and bile-ducts, are accompanied by the hepatic plexus from the solar plexus. "The hepatic artery has directly nothing to do with the elaboration of the special products of the organ, its particular province being to supply blood for the nutrition of Glisson's capsule and of the interlobular structures, including the bloodvessels and the bile-ducts. Minute arterial twigs are distributed to the walls of these tubes, where they end in delicate capillary networks, which in turn, at the periphery of the lobule, pour their contents into the intralobular network of the portal vein." (Green.)

Branches of the Hepatic Artery: Pyloric, gastroduodenal, cystic. The pyloric branch passes along the lesser curvature of the stomach and anastomoses with the gastric artery. The gastroduodenal branch passes behind the duodenum, and at the lower border of the first part of the duodenum divides into (1) the gastro-epiploica dextra, which passes along the greater curvature of the stomach between the layers of the great omentum and anastomoses with the gastro-epiploica sinistra, a branch of the splenic artery; (2) the pancreaticoduodenalis superior, which lies between the duodenum and the pancreas, anastomosing with the pancreaticoduodenalis inferior, a branch of the superior mesenteric artery. The cystic branch of the hepatic artery supplies the gall-bladder.

The Hepatic Veins have no course outside of the liver. They open into the ascending vena cava, on the posterior border of the liver, near the diaphragm.

They return blood taken to the liver by the hepatic artery and portal vein. The hepatic veins differ from the portal, and in transverse section of the liver may be distinguished as follows: They are not attended by other vessels; their mouths are usually open; their walls are exceedingly thin, and, apparently, in direct apposition with the liver substance. The portal veins are always accompanied by a branch of the hepatic duct and a branch of the hepatic artery; their mouths are usually collapsed; their walls are thicker and are separated from the liver substance by Glisson's capsule.

FIG. 125.



Portal vein and its branches. (GRAY.)

The Portal Vein (Fig. 125) is formed between the head of the pancreas and the vena cava by the confluence of the splenic and superior mesenteric veins. It passes between the two layers of the lesser omentum (posterior to the hepatic artery), into the transverse fissure of the liver. *Tributaries:* Gastric, splenic, cystic, superior and inferior mesenterics, and venous blood from the hepatic arterial system, received by numerous small branches of the portal vein while these are still within the interlobular connective tissue. (See Gerrish's *Anatomy*.)

Physiology. The hepatic artery supplies the capsule of Glisson, portal vein, bile-ducts, and other structures in the interlobular spaces. Venous blood from the distribution of the hepatic artery reaches the branches of the portal vein in the interlobular spaces; hence, a mixture of hepatic and portal blood occurs. Branches of the portal vein in the interlobular spaces encircle the hepatic lobules at various places, from which the capillary network comes into relation with the liver cells. "The blood from the portal vein contains soluble products absorbed from the alimentary canal, such as sugar and proteid, and these absorbed products are submitted to the metabolic activity of the liver cells before reaching the general circulation. The hepatic artery brings to the liver cells the arterialized blood. In addition, each lobule gives origin to bile-capillaries which arise between the separate cells and which carry off the bile formed within the cells. In accordance with these facts, the physiology of the liver cell falls naturally into two parts—one treating of the formation, composition, and physiological significance of bile, and the other dealing with the metabolic changes produced in the mixed blood of the portal vein and the hepatic artery, as it flows through the lobules. In this latter division, the main phenomena to be studied are the formation of urea and the formation and significance of glycogen." (*American Text-book of Physiology.*)

The Splenic Artery, large and tortuous, is a branch of the cœliac axis. It passes with and above the splenic vein (Fig. 125), behind the peritoneum, along the upper border of the pancreas to the hilum of the spleen, where it divides into the splenic terminals. *Branches:* Pancreaticæ parvæ, pancreatica magna, vasa brevia, and gastro-epiploica sinistra. The pancreaticæ parvæ are small branches to the body and tail of the pancreas. The pancreatica magna is the largest of the small branches and accompanies the duct of the pancreas. The vasa brevia are short arteries between the layers of the great omentum given off to the greater curvature of the stomach. The gastro-epiploica sinistra passes between the layers of the great omentum to the greater curvature of the stomach and anastomoses with the gastro-epiploica dextra.

The Splenic Vein (Fig. 125) returns blood from the spleen and corresponds with the distribution of the splenic artery. It lies below the artery and behind the pancreas. It crosses the aorta and superior mesenteric artery and joins the superior mesenteric vein, to form the vena porta. Its tributaries are (1) inferior mesenteric; (2) pancreatic; (3) vasa brevia; (4) left gastro-epiploic vein. The splenic artery and vein are accompanied by the splenic plexus of nerves from the solar plexus.

The Superior Mesenteric Artery (Figs. 112 and 117) arises from the aorta, one-quarter inch below the cœliac axis, and supplies all the small intestines except the first part of duodenum, the ascending and transverse colon. It is located in the mesentery proper and attended by a corresponding vein. Both artery and vein are accompanied by the superior mesenteric plexus of sympathetic nerves, derived from the solar plexus. *Branches:* Pancreaticoduodenalis inferior, colica media, colica dextra, ileocolic, appendicular, and vasa intestini tenuis. (1) The pancreaticoduodenalis inferior lies behind the superior mesenteric vein. It passes between the head of the pancreas and the duodenum and anastomoses with the pancreaticoduodenalis superior, a branch of the gastroduodenal. (2) The middle colic (colica media) supplies the transverse colon. It arises below the head of the pancreas, passes in the transverse mesocolon, where it divides into right and left branches, which anastomose respectively with the ascending branches of the right and left colic arteries. (3) The right colic (colica dextra) supplies the ascending colon and anastomoses with the ileocolic and middle colic. (4) The ileocolic divides into two branches: one supplies the cæcum, the other the terminal part of the ileum. (5) The appendicular arises from one or both of the terminal branches (iliac or colic) of the ileocolic. It lies near the free border of the meso-appendix, and sends numerous small vessels to the appendix. (6) Intestinal branches (vasa intestini tenuis) are twelve to sixteen in number.

Each artery divides into two branches, which deviate in their course, but soon inosculate, forming a primary loop. Each loop divides into two branches, which deviate for a short distance and soon inosculate. In this manner, loops are formed, named primary, secondary, and tertiary. Branches are given off from the terminal loops which bifurcate, surround the intestine, and inosculate one with another.

The Superior Mesenteric Vein (Fig. 125) is composed of tributaries from (1) parts of the alimentary canal supplied by the superior mesenteric artery; (2) the right gastro-epiploic vein. The vein lies in front of and to the right of the mesenteric artery, leaves the mesentery, passes in front of the duodenum and behind the pancreas, where it unites with the splenic vein to form the vena porta.

The Inferior Mesenteric Artery (Fig. 119) arises from the left side of the aorta about two inches above its bifurcation, and supplies the descending colon, sigmoid flexure, and the greater part of the rectum. It is accompanied by the inferior mesenteric vein. (Fig. 125.) Both artery and vein are innervated by the inferior mesenteric plexus, from the solar plexus. *Branches:* (1) Left colic (colica sinistra). This vessel divides into ascending and descending branches, which supply the descending colon and anastomose with the middle and sigmoid colic branches respectively. (2) Sigmoid (colica sigmoidea), which supplies the sigmoid flexure and divides into an upper branch which anastomoses with the left colic, and a lower one which anastomoses with the superior hemorrhoidal artery. (3) Superior hemorrhoidal. This is a continuation of the inferior mesenteric artery and supplies the rectum. It enters the pelvis behind the rectum and divides into two branches (one on either side of the rectum), within four or five inches of the anus, where each again divides. The rectal branches pierce the muscular coat and descend between this and the mucosa, anastomosing with the middle hemorrhoidal and with each other, thus forming a series of small vessels which run parallel to each other and longitudinally to the rectum, as far as the internal sphincter; here the vessels anastomose and form loops around the lower part of the rectum. (See Gerrish's *Anatomy.*)

The Inferior Mesenteric Vein (Fig. 125) is composed of tributaries corresponding to the branches of the inferior mesenteric artery. The vein lies to the outer side of the artery on the left psoas magnus muscle. It passes behind the pancreas and becomes tributary to the splenic vein.

The Suprarenal Arteries (Fig. 112) are small in the adult, but as large as the renals in the fœtus. They arise from the aorta, cross the crura of the diaphragm, and enter the under surface of the suprarenal capsule.

The Renal Arteries (Fig. 112) arise from the aorta below the superior mesenteric, and cross the crura of the diaphragm. They are attended by the renal veins; both veins and arteries are accompanied by sympathetic nerves called the renal plexus, derived from the solar plexus. *Branches:* (1) Terminal; three or four branches enter each kidney. Behind the arteries (as they enter the hilum of the kidney) is the beginning of the ureter; in front of the artery, lie the renal veins. The right renal artery is longer and on a lower plane than the left, and passes behind the vena cava. Each renal artery lies posterior to its accompanying vein. (2) Capsular, supplies the proper capsule of the kidney, perirenal fat, and anastomoses with renal branches from contiguous lumbar arteries. (3) Adrenal (suprarenal). The inferior suprarenal branch is given off to the suprarenal capsule. (4) Ureteral, supplies the ureter and anastomoses with similar branches from the spermatic, ovarian, superior vesical, and common iliac arteries. (5) Suprarenal (middle). This branch is the proper artery of the suprarenal body. It crosses the crus of the diaphragm. In the fœtus this is as large as the renal. It anastomoses with the superior suprarenal branch of the phrenic and the inferior suprarenal branch of the renal artery.

The Renal Veins (Fig. 112) return blood from the kidney and adrenals and are tributary to the ascending vena cava. The left vein, longer than the right, crosses in front of the aorta and receives the spermatic or ovarian veins of the same side. The renal veins lie anterior to their arteries.

The Spermatic Arteries (Fig. 112) arise from the aorta below the renal. Each artery lies on the psoas magnus muscle. The right lies in front of the vena cava, crosses the ureter and external iliac artery, to the internal abdominal ring; the left lies beneath the sigmoid, but bears the same relation as the right to the left ureter and left internal abdominal ring. The spermatic arteries are accompanied by the spermatic veins, and both arteries and veins are supplied by the spermatic plexus, derived from the solar plexus. *Branches:* Testicular (Fig. 127), perforate the tunica albuginea posteriorly, and are the proper arteries of the testicle; they anastomose with the arteries of the vas deferens. (2) Epididymal, supplies the epididymis and anastomoses with the artery of the vas deferens. (3) Cremasteric, supplies the cremaster muscle and anastomoses with the cremasteric branch of the deep epigastric artery. (4) Ureteral, supplies the ureter joining the same where the spermatic vessels cross this conduit, and anastomoses with ureteral branches of the common iliac and superior vesical arteries.

The Spermatic Veins (Fig. 112) terminate differently on the two sides. They return blood from the testicles. The left vein is tributary to the left renal; the right, to the ascending vena cava. The ovarian veins are the homologues of the spermatic veins and discharge in like manner.

The Ovarian Arteries are similar in origin from the aorta to the spermatics. The upper part of their course is also similar. At the pelvic brim they pass between the layers of the broad ligament of the uterus and are accompanied by the ovarian veins; both arteries and veins are innervated by the ovarian plexus from the solar plexus. The right ovarian vein opens into the ascending vena cava; the left, into the left renal. *Branches:* (1) Terminal, supplies the ovary. It crosses the common iliac artery, and gains the space between the two layers of the broad ligament, where it lies below the Fallopian tube and anastomoses with the uterine artery. (2) Fallopian, supplies the Fallopian tube. (3) Uterine, accompanies the oviduct to the cornu of the uterus, and is distributed to the fundus uteri. It anastomoses with uterine branches of the internal iliac. (4) Ligamentous, supplies the round ligament of the uterus and anastomoses with the external pudic arteries. (5) Ureteral, are distributed to the ureter. Ovarian veins, as mentioned above, are homologues to the spermatic veins.

The Lumbar Arteries, four in number, on each side, are analogous to the intercostals. They arise from the back part of the aorta and pass behind the psoas magnus muscle and sympathetic nerve. The arteries on the right side are covered by the ascending vena cava. The two upper arteries on each side are covered by the crura of the diaphragm. Each artery divides into a dorsal and an abdominal branch, between the transverse processes of the lumbar vertebræ. *Branches:* (1) Vertebral, to the vertebræ and their ligaments. (2) Renal, to the capsule of the kidney. (3) Muscular, to the psoas, quadratus lumborum, transversalis, internal oblique and external oblique muscles. (4) Dorsal, pass between the transverse processes with the posterior primary divisions of the spinal nerves, supplying the deep muscles of the back (and skin corresponding thereto), spinal cord, cauda equina and walls of the neural canal. The lumbar veins correspond with the arteries both in number and distribution and are tributary to the ascending vena cava. The left lumbar veins pass behind the aorta.

The Sacra Media Artery arises from the back part of the aorta near its bifurcation. It extends along the mid-line of the sacrum and coccyx and ends in the coccygeal or Luschka's gland. It gives branches to the posterior part of the rectum and anastomotic branches to the lateral sacral arteries. (For common, external, and internal iliac arteries and their branches, see chapter on Iliac Region.)

NERVE-SUPPLY OF ABDOMINAL ORGANS.

The organs in the abdominal cavity receive their nerve-supply from the solar plexus, distributed (under the name of specific plexuses) with branches of the abdominal aorta. Hence, phrenic, suprarenal, renal, spermatic, cœliac, gastric, hepatic, splenic, aortic, superior and inferior mesenteric plexuses are self-explanatory; a definition of one plexus will apply to all: The hepatic plexus consists of sympathetic nerves (from the solar or epigastric plexus) which accompany the hepatic artery. (See sympathetic nerve.)

The Solar Plexus consists of nerves and ganglia. *Nerves:* The great and small splanchnic on both sides, and filaments from the right vagus nerve. The plexus is located between the suprarenal capsules and extends from the cœliac axis to the pancreas. *Ganglia:* The principal ganglia are the semilunar.

The Aortic Plexus extends on the front and sides of the aorta, from the superior to the inferior mesenteric artery. It is composed of branches from the solar plexus and semilunar ganglia on each side. From this plexus arise the spermatic plexus (in part), the inferior mesenteric, and hypogastric plexuses.

The Hypogastric Plexus is between the common iliac arteries on the promontory of the sacrum. It consists of filaments from the aortic plexus and lumbar sympathetic ganglia, and ends below in the pelvic plexuses.

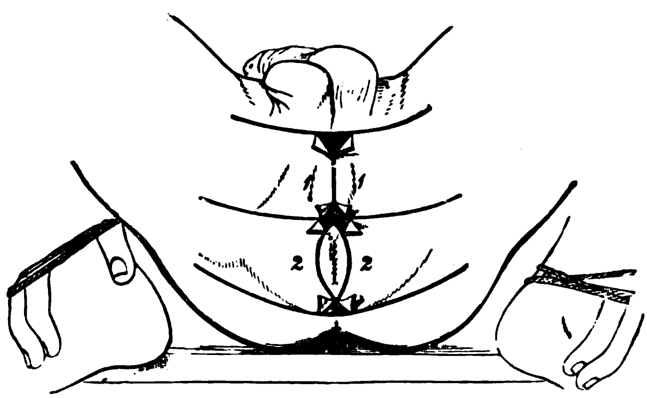
The Pelvic Plexuses, derived from the hypogastric plexus, are joined by branches of the second, third, and fourth sacral nerves; they give off inferior hemorrhoidal, vesical, prostatic, vaginal, and uterine branches, which accompany arteries of like name to parts they are destined to supply.

CHAPTER XVIII.

THE PELVIC OUTLET.

Boundaries. (Fig. 134.) Symphysis pubis, subpubic ligament, rami of the pubes and ischia, ischial tuberosities, greater sacrosciatic ligament, and tip of the coccyx. The anterior triangular part of this diamond-shaped space contains the penis, urethra, testicle and its coverings, and the perineal body; the posterior contains the lower segment of the rectum, with its accessory muscles, and the ischiorectal fossa. To study systematically this region follow the subjoined directions. 1. Place the cadaver in the lithotomy position (Fig. 126), that is, flex the thighs on the abdomen, the legs on the thighs, and place the buttocks slightly over the end of the table, and tie the hands to the feet as represented in Fig. 126. 2. Study the testicles, spermatic cord, penis, and male urethra according to the directions in the text. 3. Remove the skin according to the incisions in Fig. 126 and study Colles' fascia, the anal and genito-urinary muscles, the triangular ligament or deep perineal fascia, and ischiorectal region according to the general and specific directions for "Dissection."

FIG. 126.



Dissection of perineum and ischiorectal region. (GRAY.)

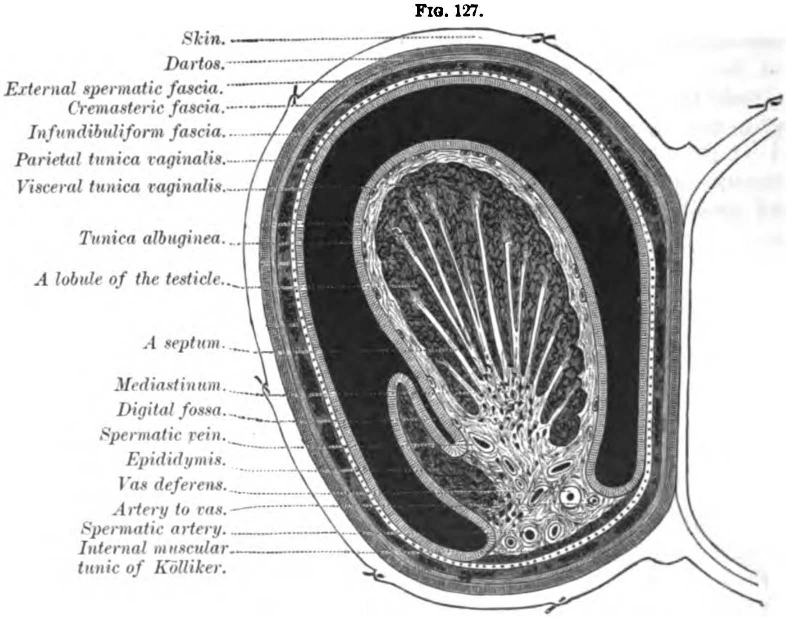
TESTICLES.

Dissection. Draw the testicles and their covering well down (and the penis upward), incise the skin and demonstrate the coverings represented in Fig. 127. Trace the coverings to their abdominal origin as far as possible. Cut through the tunica vaginalis and demonstrate the serous cavity. Cut through the testicle and demonstrate its proper coverings: (*a*) tunica vaginalis (peritoneum); (*b*) tunica albuginea (bluish-white fibrous coat); (*c*) tunica vasculosa, composed of vessels and connective tissue and immediately beneath the preceding coat. Demonstrate the size of the testicle: breadth and thickness, one inch each; length two inches and weight about one ounce.

Coverings of the Testicle. (Fig. 127.) 1. Integument, derived from and continuous with that of the abdomen and thigh, and, taken with the dartos, forms the scrotum. 2. Dartos, derived from and continuous with the superficial fascia of the abdomen and thigh. It consists of unstriped muscle fibre and elastic tissue, by which the transverse scrotal ridges of the skin are formed. 3. Intercolumnar fascia, derived from and continuous with the aponeurosis of the external oblique muscle, at the external abdominal ring. (Fig. 109.) 4. Cremasteric fascia (cremaster muscle), derived from and continuous with the lower border of the internal oblique muscle. 5. Infundibuliform fascia, derived from and continuous with the transversalis fascia. 6. The tunica vaginalis, derived from and continuous with the peritoneum. The first and second coverings constitute the scrotum; the third, fourth, and fifth the external, middle, and internal spermatic fasciæ, respectively. The peritoneum, tunica albuginea, and tunica vasculosa are the proper coverings of the testicle.

Vessels of the Testicle. 1. The spermatic artery, a branch of the abdominal aorta, is the proper artery of the testicle. 2. The deferential, a branch of the superior vesical artery, is the proper artery of the excretory duct of the testicle—the vas deferens. 3. The superficial and deep external pudic from the femoral artery supply the scrotum. 4. The cremasteric, a branch of the deep epigastric artery, supplies the cremaster muscle.

FIG. 127.



Transverse section through the left side of the scrotum and the left testicle. The sac of the tunica vaginalis represented in a distended condition. (DELEPINE.)

Nerves of the Testicle. The testicle itself is supplied by sympathetic nerves from the pelvic plexus. They reach the organ with the spermatic and deferential arteries forming plexuses about these vessels. The coverings of the testicle are supplied by (*a*) the superficial perineal (from the pudic); (*b*) the inferior pudendal (from small sciatic); (*c*) the ilio-inguinal (from the lumbar plexus); the genital branch of the genito-crural (from the lumbar plexus) to the cremaster muscle.

SPERMATIC CORD.

Dissection. (Fig. 109.) Divide the skin in line with the cord as far upward as the external abdominal ring. Make traction on the testicle. The ilio-inguinal nerve is anterior and the genito-crural posterior to the cord. Locate the vas deferens by its cord-like feel, behind the other structures of the cord. Compare the dissection with the text and illustration. With blunt dissection trace the spermatic artery and vas deferens to the testicle.

Composition and Extent. The spermatic cord extends from the internal abdominal ring, in the transversalis fascia, to the summit of the testicle. (Fig. 109.) It is composed of (1) the vas deferens, the excretory duct of the testicle; (2) the deferential artery, behind the vas; (3) the spermatic artery, in front of the vas; (4) the spermatic veins, forming the pampiniform plexus; (5) lymphatic vessels, accompanying the veins; (6) sympathetic nerves, accompanying the spermatic and deferential arteries; (7) the internal cremaster muscle of Henle, a remnant of the gubernaculum; (8) the processus vaginalis, a peritoneal relic of a tube connecting the tunica vaginalis with the peritoneum—the processes vaginalis; (9) fat and connective tissue, derived from the subperitoneal connective tissue; (10) the ilio-inguinal nerve; (11) the genital branch of the genito-crural nerve.

The Spermatic Artery (Fig. 112) is a branch of the aorta, and given off below the renal. In the fœtus the spermatic arteries pass horizontally outward, and subsequently gain the position they occupy in the adult, by the descent of the testicle. After the testicle has descended, the artery crosses the psoas muscle, ureter, and external iliac artery. The right artery is between the end of the ileum and the vena cava; the left, beneath the sigmoid flexure. At the internal abdominal ring, and to the outer side of the deep epigastric, the spermatic artery meets the vas deferens and the other constituent parts of the spermatic cord. In its course, the spermatic artery gives branches to the ureter, cremaster muscle, epididymis, and testicle. The right spermatic vein opens into the inferior vena cava; the left, into the left renal. The deferential arteries are branches of the deep epigastric and spermatic.

The Vas Deferens (Fig. 128) extends from the lower part of the globus minor of the epididymis to the prostatic urethra, and has four stages: (1) Testicular, behind the testicle, one and a quarter inches long; (2) funicular, extending from the top of the testicle to the external abdominal ring, three inches long; (3) inguinal, in the inguinal canal, one and three-quarter inches long; (4) pelvic, extending from the outer side of the deep epigastric artery to the lower end of the vesicula seminalis, ten inches long. The total length is sixteen inches.

The Vesiculæ Seminales are diverticular reservoirs for the semen, situated between the bladder and the rectum. Each vesicula when dissected consists of a central tube, about three inches long, with lateral blind pouches. Its lower end joins the vas deferens to form the ejaculatory duct, which opens on the verumontanum of the prostatic urethra (Fig. 130) by the side of the orifice of the sinus pocularis, or uterus masculinus. The seminal vesicles add to the semen a fluid of their own.

THE PENIS.

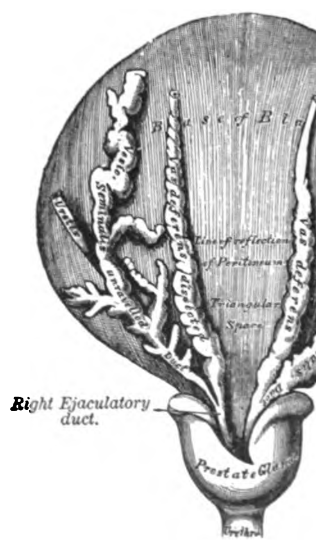
Dissection. Introduce a sound into the bladder and remove the integument of the penis. Find the suspensory ligament extending from the pubic bone to the dorsum. (Fig. 129.) With blunt dissection demonstrate the dorsal vessels and nerves on the back of the penis. These structures pierce the suspensory ligament. Demonstrate the meatus urinarius, corona glandis, cervix, prepuce, and frænum. Put the organ on the stretch, make a transverse incision one inch from the glans (Fig. 129) and demonstrate: (*a*) urethra surrounded by the corpus spongiosum; (*b*) corpora cavernosa; (*c*) dorsal vessels and nerves. Trace the corpus spongiosum downward to where it ends in the bulb; and the corpora cavernosa to the crura, attached to the ischiopubic rami. Demonstrate the bulb covered by the accelerator urinæ and the crus invested by the erector penis. Compare the work with the illustrations, and verify your dissection.

The glans penis is the heart-shaped distal extremity. The base of the glans is the corona glandis; the constriction behind the corona is the cervix, and separates the glans from the body. The end of the urethra—meatus urinarius externus—is in the glans. The root of the penis is attached to the front of the symphysis by a suspensory ligament; to the ischiopubic ramus by the crura of the corpora cavernosa. (Fig. 129.) The body of the penis (the greater part of the organ) is between the glans and the root. It is cylindrical when flaccid, triangular when erect, the broad side, facing upward, being called the dorsum.

Coverings. 1. Skin, pigmented, free from fat, highly elastic, and laxly attached, except over the glans. 2. Dartos, continuous with that of the scrotum, is free from fat, and forms a sphincter about the orifice of the prepuce. 3. Connective-tissue sheath, very elastic, contains the superficial vessels and nerves, and confers mobility on the skin of the penis. 4. Fascial sheath, very elastic, fuses with the skin at the base of the glans (forming the corona glandis), and by virtue of its elasticity aids the dartos, erector penis, and accelerator in compressing the deep veins. This sheath is continuous with the superficial perineal fascia and suspensory ligament. These four tunics surround the penis as a whole. It is now necessary to see the penis divested of its four coverings and study its three cylindrical masses of erectile tissue.

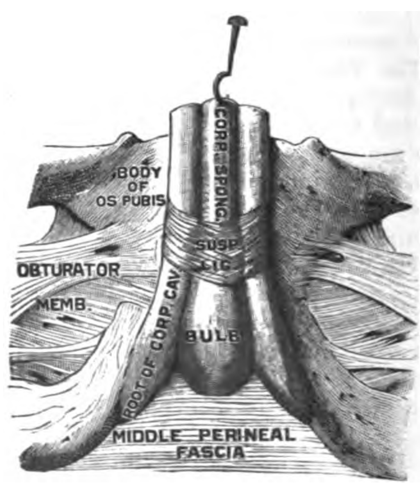
Erectile Masses. Aside from the four coverings previously studied, the penis consists of three masses of erectile tissue, each firmly enclosed in a strong sheath (tunica albuginea), and possesses nerves and vessels. These masses are the corpus spongiosum and two corpora cavernosa. (Fig. 129.) While the specific erectile tissue in each mass is histologically the same, important modifications in its distribution obtain, and new words will be introduced by which to designate it.

FIG. 128.



Base of the bladder, with the vasa deferentia and vesiculæ seminales.

FIG. 129.



The penis, proximal portion, seen from below. (GERRISH after TESTUT.)

A transverse section of the three cylindrical masses has been compared, and not inaptly, in arrangement, to a double-barrelled shotgun, the corpus spongiosum bearing in the simile the same relation to the two corpora cavernosa that the ramrod bears to the barrels of a shotgun.

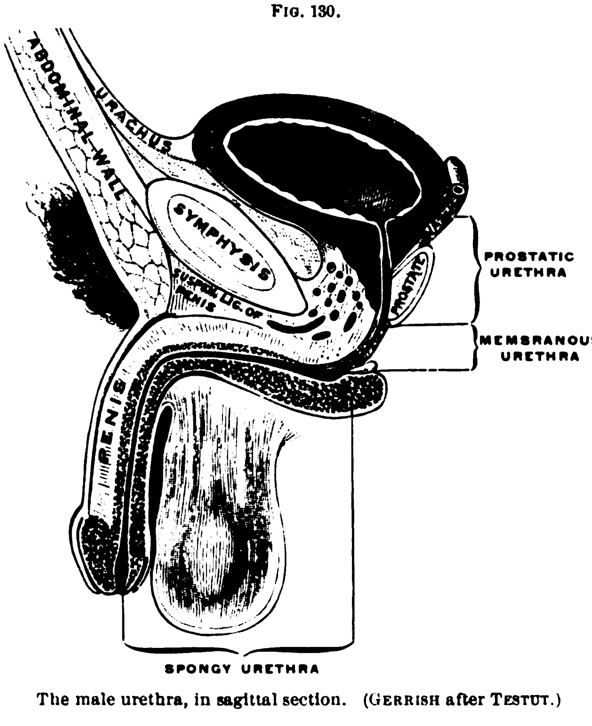
The Corpus Spongiosum forms distally the glans, proximally the bulb, while the intervening part is the body of the corpus spongiosum. (Figs. 129, 130.) The bulb rests on and receives an investment from the anterior layer of the triangular ligament (or middle perineal fascia), and is in the superficial perineal space. (Fig. 129.) The corpus spongiosum is perforated from end to end by the spongy portion of the urethra. The posterior part of the bulb is one-half inch in front of the anus; it is three-quarters of an inch wide and one and a half inches long. The glans is heart-shaped, contains the meatus urinarius externus, and receives the apical part of the corpus cavernosum. The body of the corpus spongiosum lies in a groove between the corpora cavernosa.

The Corpora Cavernosa are two in number. (Fig. 129.) Each is about six inches long and one-half inch in diameter. They are united by the septum pectiniforme along their distal three-fourths; proximally, they diverge (under the name of crura) to their insertions into the middle third of the ischiopubic rami. The crura penis occupy the superficial perineal space, and are inserted as tendinous, flattened masses. Each crus presents an enlargement prior to its insertion (bulb of the crus), and should not be mistaken for the bulb of the corpus spongiosum.

Blood-supply. The four coverings of the penis (skin, dartos, connective tissue, and fascial sheaths) are supplied by the external pudic (a branch of the femoral), superficial perineal, and dorsal arteries, branches of the internal pudic. These arteries are attended by corresponding veins, which lie between the dartos and the fascial sheath, and open into the long saphenous and femoral veins. The corpus spongiosum is supplied by the artery of the bulb and the dorsal artery, branches of the internal pudic. The corpus cavernosum is supplied by the cavernous branch of the internal pudic. The arteries (called deep) to the three cylindrical masses anastomose with each other and with the arteries of the coverings of the penis. The deep veins, corresponding to the deep arteries, anastomose freely with each other and also with the superficial veins, and terminate through the deep dorsal vein in the internal pudic and plexus of Santorini, behind the pubic bone. From this plexus blood reaches the internal iliac vein.

Nerves. The coverings of the penis are supplied (1) by the genital branch of the genito-crural, from the lumbar plexus; (2) by the superficial perineal branches of the internal pudic, a branch of the sacral plexus; (3) the erectile cylindrical masses are innervated by the dorsal nerves of the penis, the superficial perineal branches of the internal pudic, and hypogastric plexus.

FIG. 130.



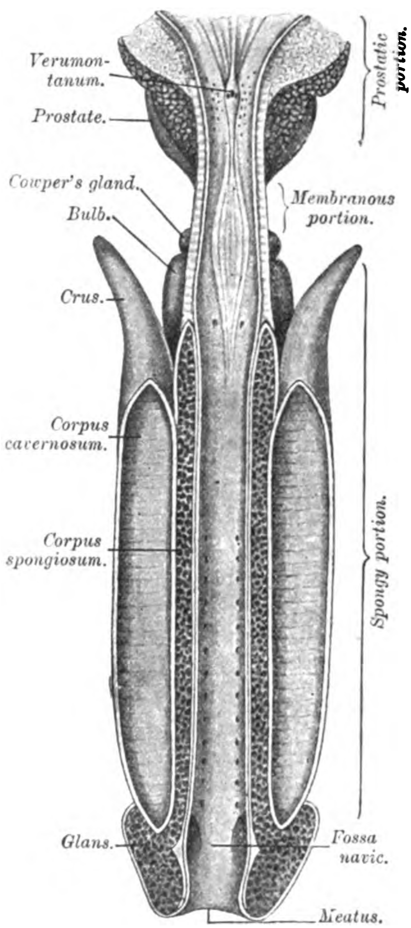
The male urethra, in sagittal section. (GERRISH after TESTUT.)

The Male Urethra.

The male urethra extends from the bladder to the end of the penis. It consists of a prostatic portion, one and a quarter inches long; a membranous, one-quarter inch long; a spongy, four and a half inches long; total length, six and a half inches. The proximal orifice is called the meatus urinarius internus; the distal, the meatus urinarius externus. The urethra perforates (1) the prostate from base to apex;

(2) the deep and superficial parts of the triangular ligament; (3) the compressor urethræ; (4) the corpus spongiosum. The meatus externus is the most constricted part, the prostatic the most distensible part of the urethra. The membranous part is not easily dilated, on account of the unyielding nature of the triangular ligament. The curves of the urethra are (1) the prostatico-membranous part, two inches long, passing almost vertically downward and slightly forward (Fig. 130); (2) about two inches of spongy urethra, passing horizontally forward, then making a sharp bend vertically downward in the region of the suspensory ligament. During erection the second curve is obliterated. The spongy urethra has two dilatations —the pars bulbosa, in the bulb, and the fossa navicularis, in the glans. (Fig. 131.) On the posterior wall of the prostatic urethra is an elevation—verumontanum—having the opening of the uterus masculinus, on the margins of which opening the ejaculatory ducts are located.

FIG. 131.



The male urethra, laid open on its anterior (upper) surface. (TESTUT.)

COLLES' FASCIA.

Dissection. Remove the skin as indicated in Fig. 132, the rectum having been filled with cotton and the margins sewed together. Introduce the sound and permit an assistant to hold the same so as to make the bulb of the urethra prominent. Now make a transverse incision through the superficial fascia (extending from ramus to ramus), and down to the muscle covering the bulb. Force two fingers through this incision, break up the connective tissue, and observe that the superficial fascia cut through is attached both below and on the sides. This is Colles' fascia.

Colles' Fascia is a rather strong lamina of superficial fascia attached to the tuberosity of the ischium, the ischiopubic ramus, and the posterior or lower border of the conjoined anterior and posterior layers of the triangular ligament. Above, this fascia has no bony attachments, but is continuous with the fascial investments of the scrotum and penis. The attachments of this fascia form three sides of a bag or pouch, called the superficial perineal space. The floor of the pouch is at the junction of the triangular ligament and Colles' fascia; the sides of the pouch are at the junction of Colles' fascia with the tuberosity of the ischium and the ischiopubic ramus; the mouth of the pouch is where Colles' fascia becomes continuous with the superficial facial investments of the penis and scrotum; the inner and outer walls of the pouch are formed, respectively, by the anterior layer of the triangular ligament and Colles' fascia.

Extravasation. In rupture of the bulbous urethra, urine may extravasate into the surrounding tissues. When the pouch above described is full, urine finds its way through the mouth of the pouch into the superficial fascia of the scrotum, penis, and abdomen. The structures in the superficial perineal space (Fig. 133) are (1) crura of the corpora cavernosa, invested by the erector penis muscles (musculi ischiocavernosi); (2) bulb of corpus cavernosum, invested by the accelerator urinæ muscle (musculus bulbo-cavernosus); (3) superficial transversus perinæi muscles.

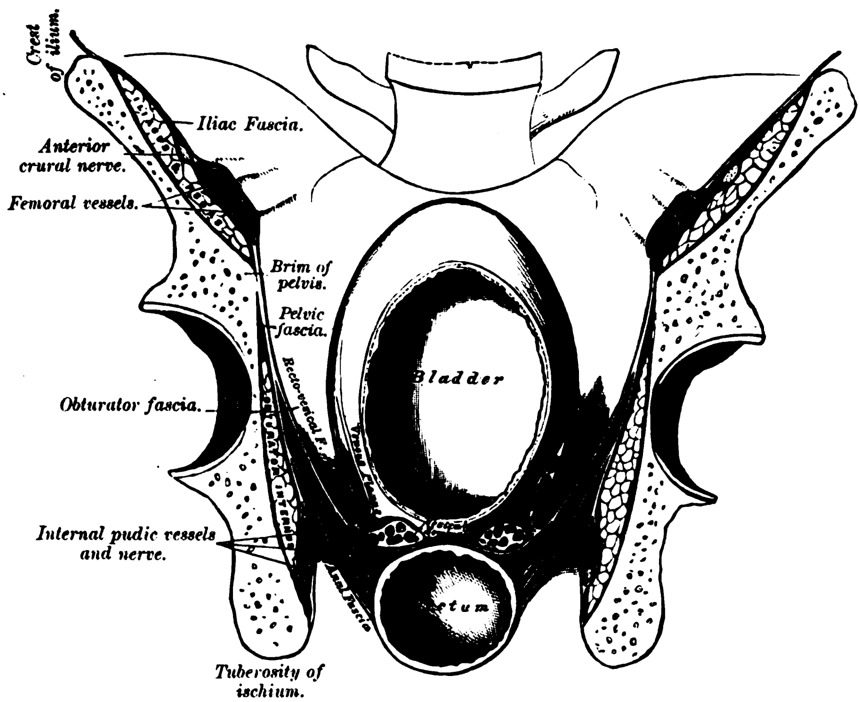
ANAL AND GENITO-URINARY MUSCLES.

Dissection. Remove Colles' fascia and bring into view the corrugator cutis ani, the external sphincter ani, the erector penis, the accelerator urinæ, the superficial transversus perinæi, and levator ani. Compare the dissection with Fig. 133, and identify the structures. Study the attachment of Colles' fascia to the pubic and ischial rami and deep perineal fascia.

The Corrugator Cutis Ani surrounds the anus and throws the skin into ridges. Internally, the fibres are inserted into the submucous tissue; externally, into the skin. Study this muscle with a dissecting microscope.

The External Sphincter Ani (Fig. 133) is a voluntary muscle surrounding the anus, attached to the central perineal point and the tip of the coccyx. The fibres of this muscle are pierced by the longitudinal fibres of the rectum. Superficially, the external sphincter is in relation with the skin; deeply, with the

FIG. 132.



A transverse section of the pelvis, showing the pelvic fascia from behind. (GRAY.)

levator ani; externally, with the ischiorectal fat; internally, with the mucous membrane of the rectum. This muscle receives its blood-supply from the inferior hemorrhoidal, a branch of the internal pudic artery. Its veins terminate in the internal pudic vein. Its nerves are from the internal pudic and fourth sacral. The special function of the muscle is to close the anus in vomiting, parturition, urination, and expiration.

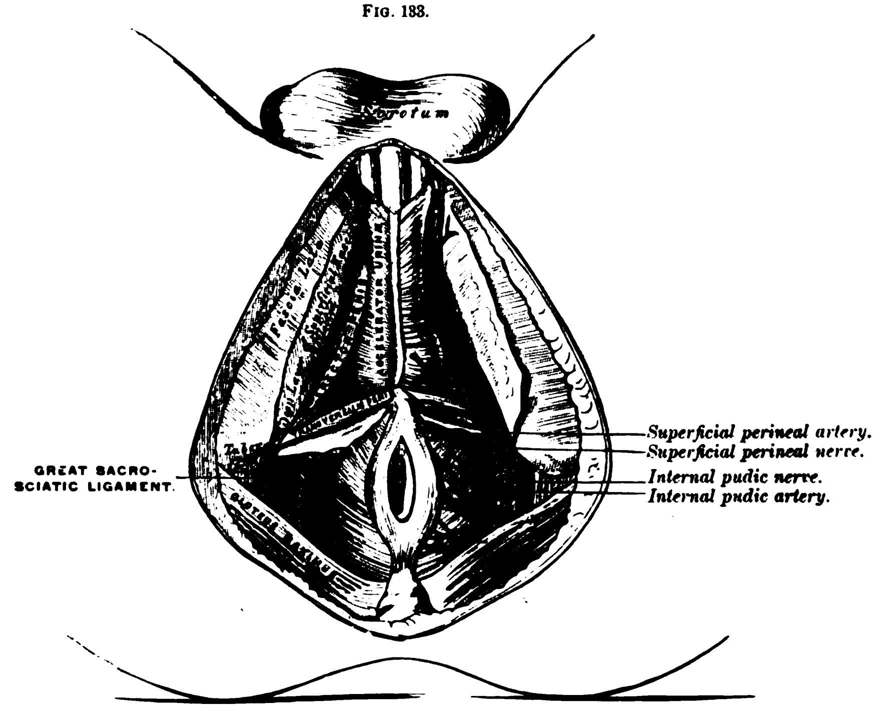
The Erector Penis (Fig. 133) (musculus ischiocavernosus) partially covers the crus penis. *Origin:* (1) Pubic ramus and adjacent part of the crus; (2) inner surface of the ischial ramus and tuberosity. *Insertion:* Tunica albuginea of the corpora cavernosa, near the suspensory ligament of the penis.

The Accelerator Urinæ (Fig. 133), (musculus bulbo-cavernosus), covers the bulb of the corpus spongiosum, and lies between the two erector muscles of the penis. The muscle arises from the median raphe along the whole length of the bulb, and is inserted by three sets of fibres: (1) Posterior, into the bulb and triangular ligament; (2) anterior, into the tunica albuginea of the corpora cavernosa; (3) median, into the dorsum of the penis. This muscle practically surrounds the bulb, and is to it what the hand is to the bulb of a syringe—a compressor.

The Superficial Transversus Perinæi (Fig. 133) is variable in size and location, and accessory in action to the accelerator urinæ, since it fixes the raphe from which the fibres of this latter take origin. This muscle arises from the inner surface of the ramus and the tuberosity of the ischium.

The Levator Ani Muscle (Figs. 132, 133), with its fellow of the opposite side, separates the pelvic cavity from the ischiorectal fossa, and forms the greater part of the muscular floor of the pelvis. It arises from (1) the inner surface of the spine of the ischium; (2) the posterior part of the body of the pubic bone, external to the symphysis pubis; (3) the white line. The muscle is invested above by the rectovesical fascia; below, by the anal fascia, and is inserted as follows: (1) The

FIG. 133.



The superficial muscles and vessels of the perineum. (GRAY.)

posterior fibres, into the tip of the coccyx; (2) with the opposite muscle, into the median raphe; (3) into the side of the rectum, so as to interlace with its longitudinal muscular fibres. The fibres of the levator ani pass downward, backward, and inward to their insertion, giving the pelvic floor a sagging reality. *Nerve:* Fourth sacral supplies this and the coccygeus muscle. *Action:* (1) To elevate the pelvic floor; (2) to constrict the vagina; (3) to compress the rectum; (4) to aid in prostatic excretion.

The Central Point of the perineum is tendinous, located one inch in front of the anus, and is a common meeting-place of the external sphincter ani, accelerator urinæ, superficial transversus perinæi muscles, and triangular ligament. (Fig. 132.) It corresponds to the lower margin of the triangular ligament, and is the objective point in perineal lithotomy.

In Median Perineal Lithotomy the knife is thrust backward and slightly upward, and enters the membranous urethra between the bulb and prostatic urethra. (Fig. 130.) In operation the incision is one and a half inches long and divides skin, Colles' fascia, external sphincter ani, ledge of triangular ligament, membranous urethra (and its compressor muscle), and a few twigs of the transverse perineal vessels and nerves.

In Lateral Perineal Lithotomy the incision is about three inches long. It begins one and a half inches in front of the anus, and is carried into the ischiorectal fossa, midway between anus and tuberosity of ischium. The structures divided are skin, Colles' fascia, transverse perineal vessels and nerves, inferior hemorrhoidal vessels and nerves, superficial and deep transversi perinæi muscles, triangular ligament, membranous urethra, prostatic urethra, lobe of the prostate (with its capsule), and the levator prostatæ muscle.

TRIANGULAR LIGAMENT.

Dissection. Remove the sound from the bladder, make gentle upward and backward traction on the penis and cut through the corpus spongiosum just beyond the bulb of urethra where it rests on the middle perineal fascia. (Fig. 129.) Now turn aside the bulb and the outer layer of the triangular ligament appears. Detach with a sharp knife the two crura from their attachment to the pubes and ischium. Also remove with scissors the outer layer of the triangular ligament and expose the pudic vessels and nerves. (Fig. 133.) The deep perineal space is between the two layers of the triangular ligament. Identify its contents by comparison with the text.

Triangular Ligament of the Urethra and deep perineal fascia are synonymous terms. This structure is a strong, double, fibrous membrane, which occupies the space under the pubic arch, being, therefore, a pelvic floor-structure. It consists of two layers—an anterior and a posterior. These are united at their lower borders; hence, on antero-posterior section the triangular ligament is V-shaped. The anterior (or outer) layer is, beyond doubt, periosteal in derivation and analogous to the obturator membrane; the posterior is morphologically a part of the obturator fascia, although its continuity is interrupted by the pubic bone. The triangular ligament is about one and a half inches in depth. The uses of this ligament are quite numerous, and its attachments and relations are of such a complicated nature that we must consider it analytically as follows: The anterior, or outer layer; the posterior, or inner layer; the deep perineal interspace; Colles' fascia and the superficial perineal space.

The Anterior Layer of the Triangular Ligament is very firmly attached to the posterior lips of the ischiopubic rami, behind the crura penis. Above, it is laxly attached to the subpubic ligament; below, it is connected to the tendinous central point of the perineum, and is continuous externally with the fascia of Colles and internally with the posterior layer of the triangular ligament. The deep surface is intimately related to the compressor urethræ muscle; the superficial surface supports the bulb of the urethra, and forms the inner wall of the superficial perineal interspace. The anterior layer of the triangular ligament is perforated, as follows (1) one inch below the symphysis, for the membranous urethra; (2) for the dorsal nerves and arteries of the penis; (3) for the arteries of the bulb and corpus cavernosum; (4) for the ducts of Cowper's glands. The dorsal vein of the penis passes between the subpubic ligament and the apex of the triangular ligament. (See Gray's *Anatomy*, Fig. 595.)

The Posterior Layer of the Triangular Ligament is a prolongation of the obturator fascia, being continuous below the symphysis with the corresponding layer of the opposite side. It is in relation with the deep transversus perinæi muscle externally; internally, it forms, on each side, the floor of an anterior prolongation of the ischiorectal fossa. It is pierced by the internal pudic artery and vein and dorsal nerve of the penis. Posteriorly, it unites with the anterior layer, to form the perineal ledge.

The Deep Perineal Space is between the anterior and posterior layers of the [illegible]ular ligament. In sagittal section this space is V-shaped, owing to the [illegible]riorly, of the two layers of the triangular ligament. This space contains (1) the membranous urethra, surrounded by a sphincter of smooth muscular fibre, the compressor urethræ; (2) Cowper's glands, with their ducts piercing the anterior layer of the triangular ligament; (3) the internal pudic arteries, giving branches to the bulb, Cowper's gland, and compressor urethræ, and breaking up into the artery to the corpus cavernosum and the dorsal artery of the penis; (4) the internal pudic veins and accompanying lymphatics; (5) the dorsal nerves of the penis, giving branches to the compressor urethræ, then piercing the anterior layer of the triangular ligament and passing to the dorsum of the penis; (6) the compressor urethræ (muscle of Guthrie, or deep transversus perinæi).

The Compressor Urethræ arises from the ischiopubic ramus. The fibres run transversely across the subpubic angle, some behind, others in front of the membranous urethra. *Action:* (1) To assist expulsion of urine and semen; (2) to aid erection of the penis by compressing the dorsal veins; (3) to compress Cowper's glands and facilitate the discharge of their contents during seminal emission.

ISCHIORECTAL REGION.

Dissection. Dissect with blunt instruments the fatty space between the rectum and tuberosity of the ischium. Do not injure the vessels and nerves traversing this space. Make traction on one of the hemorrhoidal nerves and trace the same through the obturator fascia into Alcock's canal. Remove the fat from the under surface of the levator ani muscle and study the anal fascia investing the same. Examine the lower end of the rectum in the embrace of the levatores ani muscles. (Figs. 132, 133.)

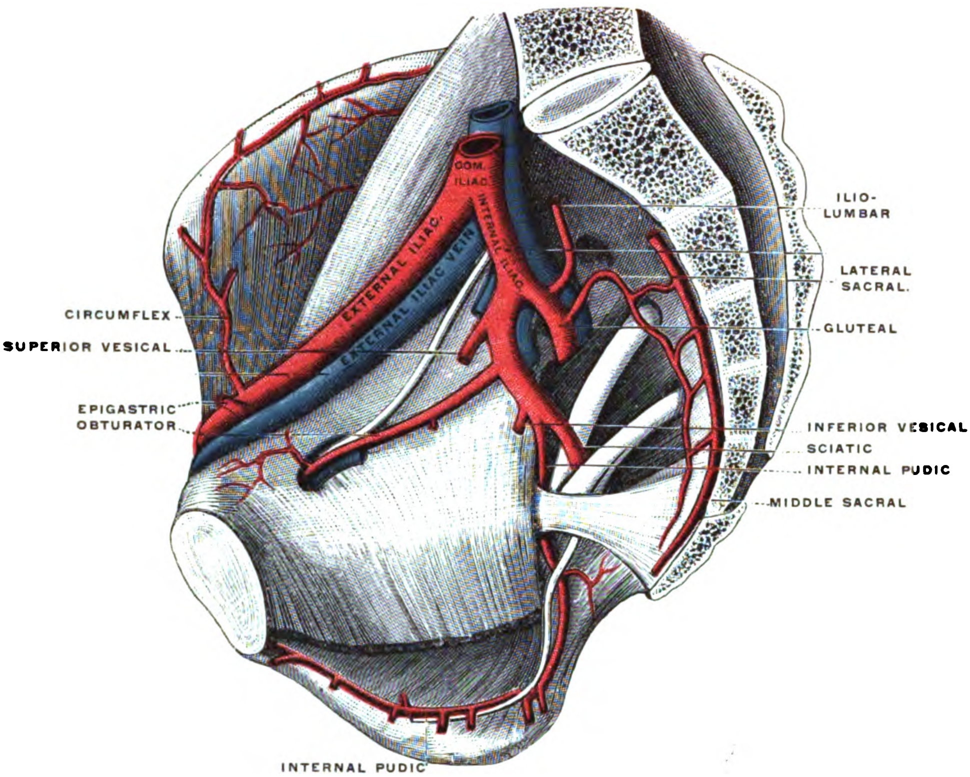
The Ischiorectal Region is triangular, and situated posterior to a line extending from tuberosity to tuberosity of the ischium. It contains a small part of the rectum, the external sphincter ani, and the ischiorectal fossæ, of which latter there are two, separated from each other by the rectum. (Fig. 132.) Distinguish between the ischiorectal region and the ischio-rectal fossa; the former contains the latter.

The Ischiorectal Fossæ (Figs. 132, 133), as previously stated, are two in number, separated from each other by the rectum. In analysis we speak of one fossa only. The ischiorectal fossa has, (1) an apex, formed by the white line extending from the spine of the ischium to the pubic bone; (2) a base, formed by the skin, fasciæ, and a small part of the gluteus maximus muscle; (3) an outer wall, formed by a part of the ischium and the obturator internus muscle and fascia, below the white line; (4) an inner wall, formed by the levator ani and coccygeus muscles, covered by the anal fascia; (5) an anterior recess, extending forward as far as the symphysis, between the triangular ligament and levator ani, limited internally by the prostate and puboprostatic ligament, and externally, by the ischiopubic ramus; (6) a posterior recess, extending toward the sacrum, above the greater sacrosciatic ligament. The ischiorectal fossa contains fat and connective tissue, is traversed from outer to inner wall by the inferior hemorrhoidal vessels and nerves, for the supply of the external sphincter ani muscle and its investing and adjacent skin and fasciæ.

Alcock's Canal (Fig. 132) is situated on the outer wall of the ischiorectal fossa. It is about two inches in length, extending from the lesser sacrosciatic foramen (along the inner surface of the tuberosity and ramus of the ischium) to the lower border of the triangular ligament. It is formed by a delamination of the obturator fascia. In the distal part of its course, the walls of the canal are strengthened by the falciform process of the greater sacrosciatic ligament. (See page 261.) Alcock's canal contains the internal pudic nerve and vessels, in transit to the perineum, rectum, and external organs of generation.

The Internal Pudic Nerve (Fig. 134), (from the second, third, and fourth sacral), has a complex course, and is attended by the internal pudic vessels. It leaves the pelvis through the greater sacrosciatic foramen, below the pyriformis muscle, with the sciatic nerves and vessels. It crosses the lesser sacrosciatic ligament (near the spine of the ischium) and re-enters the pelvis through the lesser sacrosciatic foramen, internal to the pudic vessels. It enters Alcock's canal, gives off the inferior hemorrhoidal nerve, and divides into the perineal nerve and the dorsal nerve of the penis. The perineal nerve pierces the two layers of the triangular ligament, and supplies the erector penis, accelerator urinæ, compressor urethræ, bulb of the urethra, superficial transverse perinæi muscles, scrotum, perineum, and skin on the under surface of the penis and around the anus. The dorsal nerve of the penis pierces the posterior layer of the triangular ligament, traverses the deep perineal space, then pierces the anterior layer of the triangular ligament, and (having supplied the corpora cavernosa) passes between the pubic bone and the crus penis; thence, it passes beneath or through the suspensory ligament of the penis, to skin of the dorsum of this organ.

FIG. 134.



External iliac vein of right side. (GERRISH after TESTUT.)

The Rectum extends from the third piece of the sacrum to the anus. Its termination is in the ischiorectal part of the pelvic outlet, where its opening—the anus—is guarded (1) by the external sphincter ani, a voluntary muscle; (2) by the corrugator cutis ani. This latter muscle consists of longitudinal fibres of the rectum, which have piered the external sphincter and contracted cutaneous insertion at the margin of the anus.

The rectum has two segments: (1) An upper, three and a half inches long, extending from the third piece of sacrum to tip of coccyx; (2) a lower, one and a half inches long, extraperitoneal, and extending from tip of coccyx to anus. *Relations:* Behind, sympathetic nerve, sacrum, and coccyx; in front, bladder, prostate, trigone, and vesiculæ seminales. In the female, the rectum is in relation in front with the upper part of the vagina and cervix uteri. *Arteries:* (*a*) Superior hemorrhoidal, from the inferior mesenteric; (*b*) middle hemorrhoidal, from the internal iliac; (c) inferior hemorrhoidal, from the internal pudic. In the lower part of the rectum arteries are arranged longitudinally, but they communicate freely near the anus.

Hemorrhoidal Plexus of Veins. Venous blood is collected by veins which form a plexus between the mucosa and musculosa of the rectum. In this plexus take origin three large veins, which correspond in name and location to the hemorrhoidal arteries. From the manner in which these veins discharge two systems of venous circulation are recognized in the hemorrhoidal veins: (1) The portal, to which the superior hemorrhoidal belongs, because this vessel discharges into the inferior mesenteric vein, and its blood ultimately reaches the liver; (2) the iliac, to which the middle and inferior hemorrhoidal veins belong, because they discharge into the internal iliac vein; hence their contents reach the general venous circulation *via* the ascending vena cava, without interruption in the liver. The hemorrhoidal veins have no valves. In cirrhosis of the liver the inferior hemorrhoidal veins become enlarged, and are known as piles, or hemorrhoids.

FEMALE PELVIC OUTLET.

Before dissection of the female pelvic outlet is begun remember (1) that the bony and ligamentous parts are practically the same as in the male; (2) that the outlet has an anterior triangular or perineal part, which contains the perineal body and external genito-urinary organs; and a posterior ischiorectal part, containing the rectum and ischiorectal fossæ as in the male; (3) that the corpora cavernosa differ from their homologous structures in the male in size only; (4) that the corpus spongiosum is cleft or replaced by the vulvar orifice, and obtains, on each side of the vulvar cleft, as the erectile bulbi vestibuli; (5) that the accelerator urinæ of the male obtains in the female homologically as the sphincter vaginæ muscle; (6) that the clitoris is, in the main, a diminutive penis, and capable of erection.

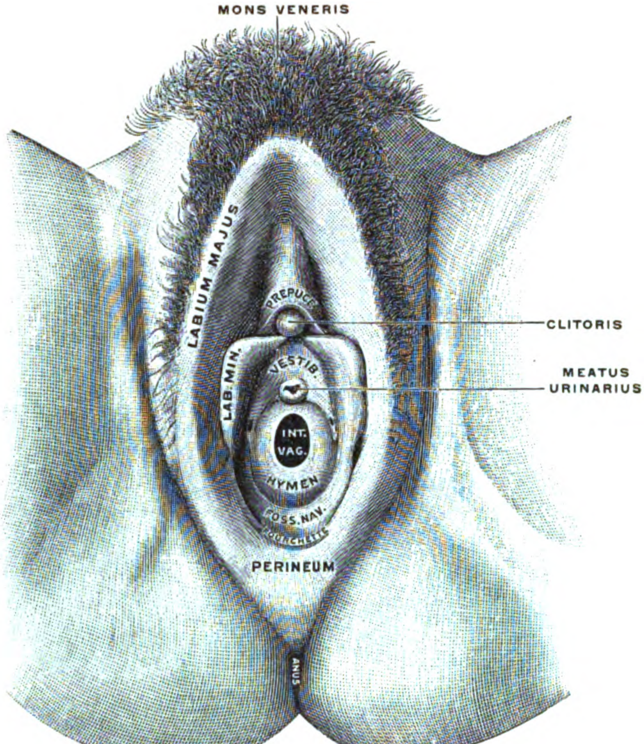
Homologies of the Sexual System.

Male.	*Female.*
Penis	Clitoris.
Glans penis	Glans clitoridis.
Preputium penis	Preputium clitoridis.
Frænum	Labia minora.
Scrotum	Labia majora.
Testicle	Ovary.
Uterus masculinus	Uterus and vagina.
Vas deferens	Duct of Gärtner.
Accelerator urinæ	Sphincter vaginæ.
Erectores penis	Erectores clitoridis.
Tube of epididymis	Long tube of parovarium.
Corpora cavernosa	Corpora cavernosa.
Corpus spongiosum	Bulbi vestibuli and vulvar cleft.
Gubernaculum testis	Round ligament.
Membrano-prostatic urethra	Urethra, vestibule.
Stalked hydatid of Morgagni	Stalked hydatid of Morgagni.
Sessile hydatid	Fimbria of oviduct.
Duct of Rathke	Oviduct.
Rete testis and coni vasculosi	Short tubules of parovarium.
Paradidymis	Paroöphoron.
Cowper's glands	Bartholin's glands.

The Mons Veneris (Fig. 135) is located above the symphysis, and after or about the time of puberty is covered with hair. It is continuous above with the skin and panniculus adiposus of the abdominal walls, below with the labia majora, and laterally, is limited by the genito-crural crease. The mons is composed of pigmented skin, fat, and connective tissue.

The Labia Majora (Fig. 135) are the most prominent parts of the vulva in the adult. They extend from the mons to the posterior commissure of the vulva, which they form by their union posteriorly in the mid-vulvar line. They form an ellipse, enclosing the labia minora, bulbi vestibuli, meatus urinarius externus, vaginal fissure, clitoris, hymen, or its remains, the carunculæ myrtiformes. Each major lip consists of skin, dartos, and a quantity of encapsulated fat, which latter blends above with the round ligament of the uterus. The labia are homologous to the scrotum; the round ligament to the gubernaculum testis. Each labium has (1) an outer pigmented surface, covered with crisp hair; (2) an inner surface, beset with rudimentary hair and sebaceous follicles. The dartos, or second covering of the labia majora, is not so fully developed as in its homologue, the scrotum.

FIG. 135.



Vulva of a virgin. The labia have been widely separated. (GERRISH after TESTUT.)

The Labia Minora (Fig. 135) are homologous to the prepuce and frænum, and are free from hair and fat. They unite above, embracing the clitoris, and forming both prepuce and frænum; below, they end opposite the vaginal fissure. The minor lips are small before puberty and concealed by the major lips, except in the fœtus. They reach their greatest size during pregnancy.

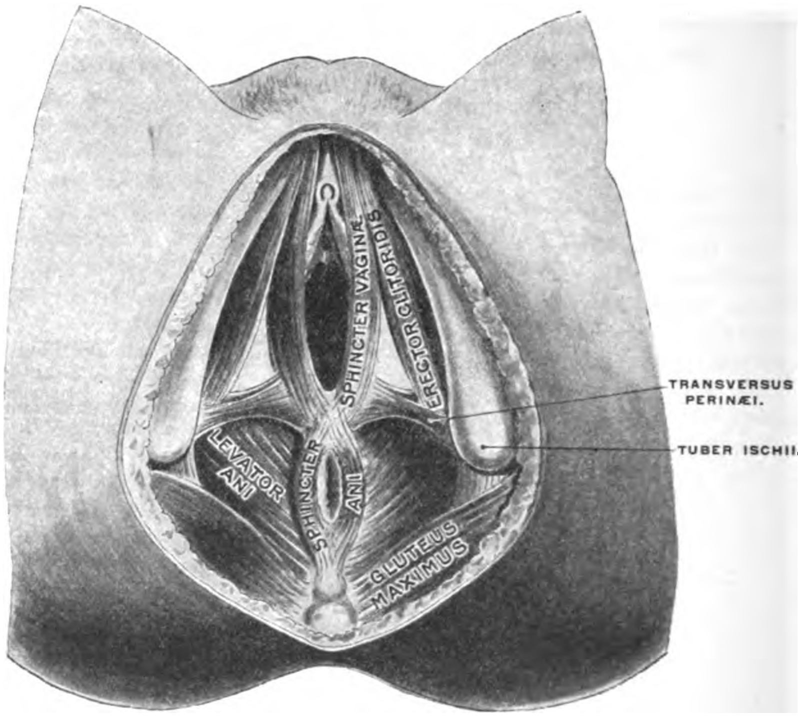
The Vestibule (Fig. 135) is triangular, with its apex at the clitoris; the base is at the vaginal fissure; the sides are formed by the minor lips. It contains the meatus urinarius externus and the openings for the ducts of the glands of Bartholin —two racemose structures which represent Cowper's glands in the male.

The Bulbi Vestibuli and Pars Intermedialis. On either side of the vestibule, beneath the mucous membrane, is a quantity of erectile tissue, the bulbi vestibuli, homologous to the bulb of the corpus spongiosum in the male. This is invested by the tunica albuginea, attached to the orifices of the urethra and vagina, and covered by fibres of the bulbo-cavernosus or sphincter muscle of the vagina.

The Clitoris (Fig. 135) is about one inch long, forms the apex of the vestibule, and is homologous to the penis. It is composed of two corpora cavernosa, which form distally the glans clitoridis by their union. The crura of the corpora cavernosa of the clitoris are attached to the ischiopubic rami, and bound to the symphysis pubis by the suspensory ligament of the clitoris. The clitoris has glans, corona and cervix, but no corpus spongiosum and urethra. The corpus spongiosum of the male is replaced by the vulvar orifice in the female.

Interlabial Cleft. (Fig. 135, 136.) This is the common opening for the genital and urinary organs. It is limited above by the clitoris; below, by the posterior commissure or fourchette; laterally, by the minor and major labia. The floor of the space is formed by the vestibule, meatus urinarius, hymen, fossa navicularis, and vaginal orifice.

FIG. 136.



Muscles of the female perineum. (GRAY.)

The Female Urethra (Fig. 135) is about one and a half inches in length, and extends along the anterior wall of the vagina from the bladder to the vestibule of the vulva. It is a very dilatable canal, and, like the male urethra, is smallest distally. Laterally, and in front, it is surrounded by veins (plexus of Santorini), while posteriorly in the greater part of its course it lies about one-sixth of an inch from the vagina. The vesical end of the female urethra has muscular fibres, homologous to those of the prostate and deep transversus perinæi muscles.

The Vagina is a musculomembranous conduit, extending from the cervix uteri, which it embraces, to the vulvar opening. It gives passage to the menstrual flow, to the mature or abortive product of conception, and is the female organ of copulation. The anterior wall is three, the posterior, four inches in length. (See Gray.)

The Anterior Wall of the Vagina is in relation with the urethra and bladder; the posterior, with the perineal body, rectum, and peritoneal cul-de-sac of Douglas. Laterally, the vagina is crossed in its upper third by the ureters—a fact which should be borne in mind by the operator in vaginal hysterectomy; in its lateral lower two-thirds, the vagina is in relation with the levatores ani muscles. Laterally are located the vaginal arteries and a venous plexus.

The Vaginal Walls are one-sixth of an inch thick, and have three coats: (1) A fibrous, derived from the rectovesical fascia; (2) a non-striated muscular coat, consisting of a longitudinal layer (continuous with the uterus), and a circular layer, very strong, near the vulvar orifice; (3) a mucous, having no true glands, very elastic, and continuous with the mucous membrane of the os uteri and vulva. The striated sphincter vaginæ muscle is homologous to the accelerator urinæ in the male.

The Nerves of the Vagina are from the internal pudic, fourth sacral and hypogastric plexus. The arteries are from the external pudic, internal pudic, uterine, internal iliac, and middle hemorrhoidal. The vessels are arranged along the lateral aspect of the vagina. The veins form the vaginal plexus in the muscular and mucous coats, and finally reach the internal iliacs.

The Perineal Body is situated between the genital canal and the rectum. It is bounded in front by the vagina and vulva; behind, by the anterior wall of the rectum; below, by the skin, between anal and vulvar apertures. The sphincter ani, levatores ani, sphincter vaginæ, and central tendinous point of the perineum enter into its formation.

Dissection. Observe the following steps after having learned the foregoing, including the table of homologues: 1. Place the cadaver in the same position, and care for the rectum as directed in the dissection of the male pelvic outlet. 2. Remove the hair from mons and labia majora with a sharp scalpel and scissors; then thoroughly cleanse the parts with soap and water. 3. Fill the vagina with cotton saturated with carbolized glycerin. 4. Grasp the glans clitoridis with forceps, withdraw it from its surrounding prepuce and secure it by a thread. 5. Remove the labia majora and observe their fatty composition blending with the end of the round ligament superiorly. 6. Remove the integument covering the clitoris and demonstrate this latter's glans, body, prepuce, and crura. 7. Pass a sound into the bladder and palpate anterior vaginal wall to appreciate the relation of the urethra to the vagina. 8. Remove the integument and demonstrate (*a*) the sphincter vagina, (*b*) the meatus urinarius, (*c*) the erectores clitoridis muscles investing the crura clitoridis, (*d*) the transversus perinæi muscles, (*e*) the external sphincter ani muscle and ischiorectal fossæ. 9. After having read the text on the perineal body cut through the same from the vagina to the rectum and demonstrate its composition and relations. The vessels and nerves are homologous to the male structures and may be studied in the description of the male pelvic outlet, page 254.

THE BONY PELVIS.

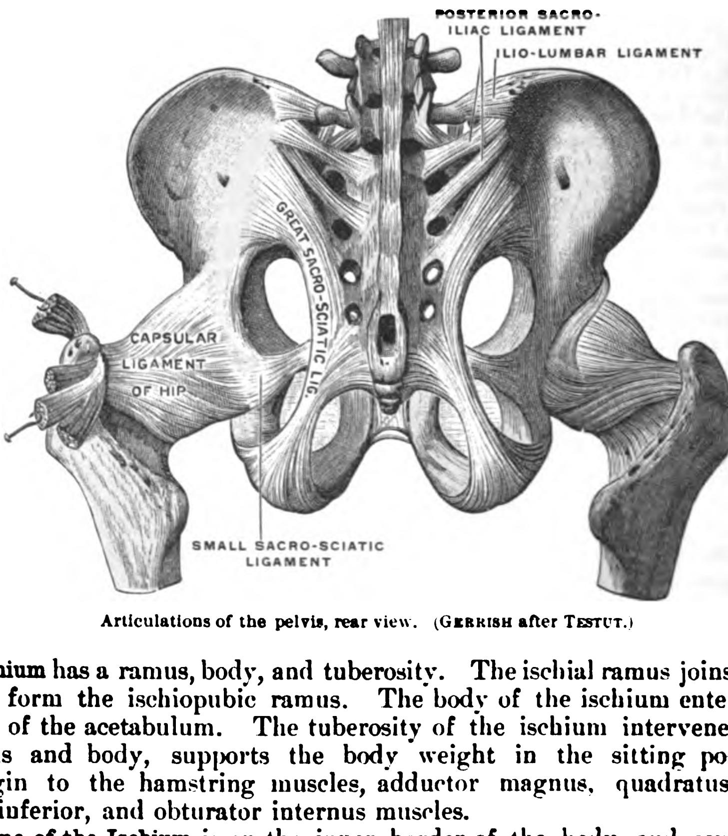
Formation. The pelvis is formed by the sacrum, coccyx, ossa innominata, and certain ligaments. The sacrum is formed by the fusion of five, the coccyx of four vertebræ. The innominate bone is formed by the fusion of the pubis, ilium, and ischium, in such relation as to form the acetabulum at their place of meeting; the pubic part contributes one-fifth, the other parts two-fifths each, to the acetabular circumference. The individual bones forming the sacrum and coccyx have departed so far from a typical vertebra that they are called false vertebræ. The sacrum and coccyx are united by ligaments (analogous to those in the superior regions of the spine) in an amphiarthrodial joint, called the sacrococcygeal. This joint has its nerve-supply from the fourth and fifth sacral and coccygeal, and may be the seat of reflex pain incident to disease of any of the pelvic organs except the ovary.

The Apex of the Sacrum articulates with the coccyx. The base of the sacrum (in the centre) is analogous to and articulates with the body of the fifth lumbar vertebra; laterally, the base of the sacrum expands to form the alæ, which morphologically are the result of fusion of the transverse and costal processes of vertebræ. The promontory is an eminence formed by the union of the sacrum and the body of the fifth lumbar vertebra.

The Anterior Surface of the Sacrum is concave both vertically and horizontally. On this surface are (1) parts corresponding to the bodies of vertebræ; (2) four anterior sacral foramina; (3) four transverse ridges. The foramina are large and give passage to the anterior primary divisions of the sacral nerves; they are continuous outward, interrupting the plane surface of the bone, so that this latter presents an alternating succession of grooves and ridges. From the grooves and ridges, corresponding to the second, third, and fourth sacral vertebræ the pyriformis muscle originates. The value of the coccyx is not intrinsic, but consists in the importance of soft structures attached to it.

The Pubic Part of the Os Innominatum consists of a body and ramus. The ramus descends, fuses with the ramus of the ischium, and separates the subpubic arch from the obturator foramen. The body of the pubis contributes internally to the symphysis and externally to the acetabulum. The symphysis pubis is the junction between the right and left pubic bones. The pubic crest extends from the spine to the angle, is about one inch long, and gives attachment to the conjoined tendon, the pyramidalis, and rectus muscles. The spine of the pubis gives insertion to the crural arch or Poupart's ligament, and is crossed by the spermatic cord or its homologue, the round ligament of the uterus.

FIG. 137.



Articulations of the pelvis, rear view. (GERRISH after TESTUT.)

The Ischium has a ramus, body, and tuberosity. The ischial ramus joins the pubic ramus to form the ischiopubic ramus. The body of the ischium enters into the formation of the acetabulum. The tuberosity of the ischium intervenes between the ramus and body, supports the body weight in the sitting posture, and gives origin to the hamstring muscles, adductor magnus, quadratus femoris, gemellus inferior, and obturator internus muscles.

The Spine of the Ischium is on the inner border of the body, and separates the greater from the lesser sacrosciatic notch. From its outer surface arises the gemellus superior muscle. To its inner surface are attached the coccygeus and levator ani muscles, lesser sacrosciatic ligament, and the pelvic white line, from which latter the levator ani muscle gains its principal origin.

Tip of the Coccyx. Notice the ease with which this bone may be moved forward and backward. It articulates with the sacrum, forming the sacrococcygeal joint. The external sphincter ani is attached to the tip of the coccyx, which may be demonstrated by pulling the coccyx forcibly backward, when the soft structures around the anus will be perceptibly put on the stretch.

The Tuberosities of the Ischium are very prominent, about three inches to the right and left of the anus. When the cadaver is in the lithotomy position the tuberosities are not covered by the gluteus maximus muscle, which, however, is the case when the long axis of the lower limb is in line with the long axis of the trunk. In the lithotomy position there is flexion of the thigh on the abdomen, flexion of the leg on the thigh, flexion of the foot on the leg, and abduction of the knees.

The Bony Extension leading upward from the tuberosity of the ischium to the subpubic arch is the ischiopubic ramus. To the middle part of this is attached that part of the corpus cavernosum called the crus of the penis.

The Symphysis Pubis is the junction between the bodies of the pubic bones. Surmounting the body of the pubic bone is the part called the pubic crest. This crest is limited internally by the angle and externally by the spine. It requires a little practice to locate the pubic spine; the spermatic cord either crosses or passes external to it. Make traction on one testicle and demonstrate the relation of the spermatic cord to the pubic spine.

The Lesser Sacrosciatic Notch (Fig. 137) is between the spine and tuberosity of the ischium, and is converted into a foramen of the same name (in the recent state) by the greater sacrosciatic ligament. Through the foramen pass the tendon of the obturator internus muscle and the internal pudic nerve and vessels.

The Greater Sacrosciatic Notch (Fig. 137) is between the spine of the ischium and the posterior inferior spine of the ilium. This notch is converted into a foramen by the lesser sacrosciatic ligament in the recent state. Through the foramen pass the pyriformis muscle, which divides the same into an upper and a lower compartment; through the upper compartment pass the superior gluteal nerve and vessels; through the lower, the sciatic and internal pudic nerves and vessels.

The Lesser Sacrosciatic Ligament (Fig. 137) is triangular. Its strength and importance as a pelvic floor structure are often underestimated. It is coextensive with an inconsiderable muscle, called the coccygeus, which occupies and is intimately blended with its inner surface. The ligament is firmly attached to the front and sides of the coccyx and sacrum, as high as the fourth anterior sacral foramen. The fibres of the ligament, converging to their insertion into the inner surface and borders of the spine of the ischium, decussate. This ligament converts the greater sacrosciatic notch into a foramen in the recent state.

The Greater Sacrosciatic Ligament (Fig. 137) arises from the upper two pieces of the coccyx, the lower three pieces of the sacrum, the posterior iliac spines, and the posterior part of the iliac crest. It is inserted into the inner border of the tuberosity of the ischium, and is prolonged forward on the ramus of the ischium as the falciform process. The greater sacrosciatic ligament converts the lesser sacrosciatic notch into a foramen in the recent state.

The Obturator Foramen (Fig. 137) is enclosed above and in front by the pubic part, behind and below by the ischial part of the innominate bone. It is covered by a membrane (save a small passage above)—the obturator groove. The obturator membrane is periosteal in derivation, and bears the same relation to the pubis and ischium that interosseous membranes in general bear to the bones between which they are found. The outer surface of the obturator membrane is occupied by the external obturator muscle; the inner, by the internal obturator. The obturator groove transmits the obturator nerve and vessels.

THE PELVIC FLOOR.

Dissection. (1) Review carefully on the skeleton the osteological points given on a preceding page. (2) Cut sagittally through the pelvis with a saw, according to Fig. 134. (3) Thoroughly cleanse the dissection field with warm water. (4) Study the interior of the bladder and rectum, which have been traversed by the cutting instrument. (5) Note the location of the ureters entering the bladder. (6) Note from four to six folds of the mucous membrane—the plica recti or Huston's valves—in the rectum. (7) Cut the rectum on a level with the pelvic floor, and turn the same onto the promontory of the sacrum. (8) Turn the bladder forward onto the pubic bone. (9) Remove the peritoneum from the sides of the pelvis, and with blunt dissection develop vessels and nerves as shown in Fig. 134. (10) Expose the

levator ani muscle and study its origin from the white line and its insertion into the mid-line of the pelvic floor where it embraces the rectum. (11) Now cut through the levator ani, turn the same aside, and expose the obturator internus muscle.

The floor of the pelvis consists of the pyriformis, coccygeus, levator ani muscles, and triangular ligament. To these must be added the obturator internus and obturator fascia covering the same, not that this muscle figures directly as an integral part of the floor of the pelvis, but its fascia—the obturator—is of such far-reaching importance that any demonstration of the pelvic floor would be imperfect in the absence of a thorough knowledge of it.

The Pyriformis Muscle arises from (1) the side of the front of the sacrum, between the first, second, third, and fourth anterior sacral foramina; (2) the great sacrosciatic ligament; (3) the bone at the upper part of the great sacrosciatic foramen. The muscle leaves the pelvis through the great sacrosciatic foramen, and is inserted into the upper border of the greater trochanter. In front of this muscle are the rectum, branches of the internal iliac artery, and the sacral plexus. Above the muscle, the superior gluteal nerve and vessels leave the pelvis; below, the sciatic and internal pudic nerves and vessels escape.

The Coccygeus Muscle is supported by and blended with the lesser sacrosciatic ligament. It arises from the inner surface of the spine of the ischium, and is inserted into the side of the coccyx and the last two pieces of the sacrum. The muscle is triangular, with apex at the ischial spine. This muscle aids the levator ani in drawing the coccyx forward. *Nerve:* Fourth sacral.

The Obturator Internus Muscle arises from (1) the body of the pubis; (2) the rami of the pubes and ischium; (3) the surface of bone behind the obturator foramen, corresponding to the acetabulum; (4) the inner surface of the obturator membrane; (5) the obturator and pelvic fasciæ. The muscle leaves the pelvis through the lesser sacrosciatic foramen, is joined outside the pelvis by the two gemelli muscles, and is inserted into the crest of the greater trochanter. This muscle forms a thick pad on the lateral wall of the pelvis.

The Obturator Fascia (Fig 132) derives its name from the obturator muscle, and forms the greater part of the general pelvic fascia. The lesser part covers the sacral plexus and pyriformis muscle, and is called the pyriformis fascia. The attachments of the obturator fascia to the bone are very extensive, but should be studied with bone in hand to be understood and remembered. It is attached in front to the back of the symphysis pubis ; below, to the inner margin of the tuberosity of the ischium and the lower border of the ischiopubic ramus; above, to the posterior lip of the pubic crest and the iliopubic line, as far as the sacroiliac articulation; behind, to the bony border of the greater sacrosciatic foramen. At the lesser sacrosciatic foramen the fascia passes out of the pelvis with the obturator internus muscle; hence this same channel is open for the passage of pus in case of extensive ischiorectal abscess. The outer surface of the obturator fascia is in relation with the obturator internus muscle; the inner is divided by the "white line" into an upper or pelvic and a lower, or ischiorectal part. The upper part is above the "white line;" the lower, below. The lower part forms (1) the outer wall of the ischiorectal fossa: (2) Alcock's canal, for the lodgement of the internal pudic nerve and vessels. The "white line" gives off two thin processes—the rectovesical fascia, which covers the upper surface of the levator ani muscle, and the anal fascia (ischiorectal), investing the under surface of the same muscle.

The "White Line" is formed by a thickening of the obturator fascia along a line extending from the inner surface of the spine of the ischium to the posterior part of the pubic bone. This line is not straight, but conforms to the curve of the pelvic wall, to which it pertains. See page 252 for levator ani muscle.

CHAPTER XIX.

CUTANEOUS VESSELS AND NERVES OF THE LOWER EXTREMITY.

Dissection. Having removed the skin locate the long saphenous vein (by consulting the illustration Fig. 138), and follow it and its tributaries by careful dissection with forceps and scissors as far as possible. As a rule, cutaneous veins and nerves are in the deep layer of the superficial fascia. Next locate the long saphenous nerve accompanying the long saphenous vein below the knee. Consult Fig. 139 as an aid in locating the short saphenous structures. To dissect the cutaneous nerves, consult Figs. 140 and 141, page 267, and study table on pages 265–268.

CUTANEOUS VESSELS.

The Cutaneous Vessels. Arteries convey blood from the heart to the skin; veins, in an opposite direction, toward the heart. Cutaneous arteries are derived from the underlying deep arteries; they pierce the deep fascia and supply not only the skin, but the superficial and deep fasciæ as well. Owing to their small size, but comparatively few cutaneous arteries and veins receive special names. Arteries having special names are: superficial epigastric, superficial circumflex iliac, and superficial external pudic. Veins having special names are: the long saphenous and the short saphenous. The long saphenous has the following tributaries: External femoral cutaneous, internal femoral cutaneous, superficial external pudic, superficial epigastric, superficial circumflex iliac, and deep communicating veins.

Action and Source of Gray Rami Communicantes. Vessels derive their power of dilating and contracting, under certain conditions, from sympathetic nerves, called gray rami communicantes. These nerves originate in cells in the vertebral ganglia of the sympathetic, and pass with spinal nerves for the supply of bone, cartilage, fasciæ and unstriped muscle fibre of hair, glands, and vessels. (See sympathetic nerve.)

The Cutaneous Veins. (1) Digital, returning blood from the skin of the toes; (2) the dorsal arch of the foot, formed largely by the digital veins; (3) the long saphenous vein, tributary to the common femoral; (4) the external and internal femoral cutaneous; (5) the superficial external pudic; (6) the superficial epigastric; (7) the superficial circumflex iliac; (8) veins communicating with deep veins; (9) the short saphenous, tributary to the popliteal.

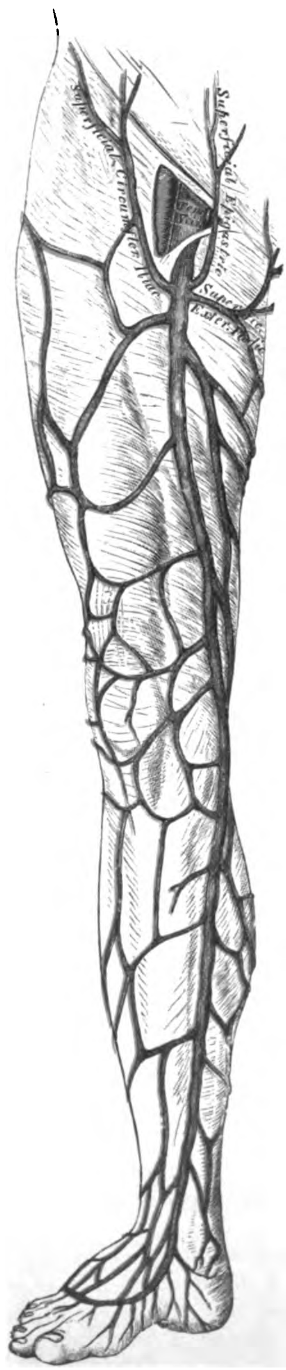
1. **The Digital Veins** (Fig. 138) are in the superficial fascia of the toes. They form, by their confluence, a venous arch on the back of the foot from which the long and short saphenous veins originate.

2. **The Dorsal Arch** (Fig. 138) of the foot is homologous to the dorsal arch of the hand. It is situated on the back of the foot, about midway between the ends of the toes and the instep. The arch is formed by veins from the skin of the toes, has outer and inner ends, terminating respectively in the short and long saphenous veins and rests on the cutaneous nerves of the back of the foot. The arch communicates with the venæ comites of the dorsalis pedis artery by a deep communicating vein.

3. **The Long Saphenous** (Fig. 138) is the largest and longest superficial vein in the body. It begins at the inner end of the dorsal arch of the foot, passes in front of the internal malleolus of the tibia, along the inner side of the leg to the knee, where it winds behind and internal to the inner tuberosity of the tibia and inner condyle of the femur. It now pursues an upward course on the front and inner aspect of the thigh, and having perforated the cribriform fascia covering the saphenous opening, becomes tributary to the common femoral vein. Below the knee, the vein is accompanied by the long saphenous nerve, a branch of the anterior crural.

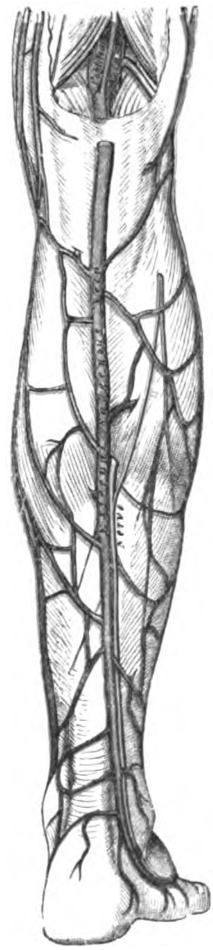
Source of Tributaries of Long Saphenous Vein. (Fig. 138.) (1) The external femoral cutaneous vein returns blood from the skin of the outer part of the thigh; (2) the internal femoral cutaneous, returns blood from the skin of the posterior and inner parts of the thigh; (3) the superficial external pudic, returns blood from the skin of the penis, scrotum, and inguinal region; (4) the superficial epigastric, returns blood from the skin of the abdominal walls, in the region of the umbilicus; (5) the superficial circumflex iliac, returns blood from the skin of the abdominal walls and upper part of the thigh; (6) frequent communications with the deep veins in its entire course.

Fig. 138.



The internal or long saphenous vein and its branches. (Gray.)

Fig. 139.



External or short saphenous vein. (Gray.)

4. **The Short Saphenous Vein** begins at the outer end of the dorsal arch of the foot, passes behind the external malleolus of the fibula, and gaining the posterior mid-line of the leg, passes between the two heads of the gastrocnemius muscle and opens into the popliteal. This vein is attended by the short saphenous nerve, formed by the union of the communicans tibialis and communicans fibularis.

Source of Tributaries of Short Saphenous Vein. (1) Many small veins from the skin of the heel; (2) veins from the outer side of the foot and leg; (3) veins from the back of the leg; (4) communicating branches to the venæ comites of the peroneal artery; (5) a branch from the posterior part of the thigh. The blood from the skin of the lower extremity, therefore, is collected by the two saphenous veins, and through these reaches the deep veins.

CUTANEOUS NERVES.

Dissection. The skin having been removed, according to incisions in Fig. 143, locate in the deep fascia the emergence points of the nerves (Figs. 140, 141, 142) and trace same by blunt dissection and scissors to their distribution. Having located any particular nerve, study its source, course, and distribution in the subjoined table.

Cutaneous Nerves supply the skin with sensation. They are dendritic processes of cells in the posterior root ganglia of the spinal nerves. They are derived from the thoracic, lumbar, and sacral regions as given in the following table, and are distributed as indicated in the illustrations on pages 267 and 268. Hilton demonstrated that nerve trunks supplying muscles that move joints also supply the joints with articular branches, and the skin covering the insertions of the muscles, with sensory branches.

CUTANEOUS NERVES OF ANTERIOR AND LATERAL REGIONS. (Fig. 140.)

Nerve.	*Source.*	*Course.*	*Distribution.*
Genito-crural (cutaneous branch) (n. lumbo-inguinalis).	First and second lumbar, branch of the genito-crural.	Passes in the femoral sheath anterior to the femoral artery and pierces the fascia lata.	To the integument of the central upper part of the anterior surface of the thigh (motor branch to cremaster muscle).
External cutaneous (n. cutaneus femoris lateralis).	Second and third lumbar, a divorced branch of the anterior crural nerve.	Enters the thigh beneath Poupart's ligament near the anterior superior iliac spine, and divides into anterior and posterior divisions; descends beneath the fascia lata and perforates the deep fascia four inches below Poupart's ligament.	To the outer and posterior aspect of the thigh as far as the knee.
Internal cutaneous (ramus cutaneus femoris).	Second and third lumbar, a branch of the anterior crural nerve.	Divides in front of the femoral artery into an anterior and a posterior branch; the anterior branch lies on the sartorius, and perforates the deep fascia in the lower third of the thigh; the posterior follows the inner border of the sartorius, and perforates the deep fascia near the knee.	Supplies the skin on the inner and anterior parts of the thigh as far as the knee.
Middle cutaneous (ramus cutaneus anterior).	Second and third lumbar, a branch of the anterior crural nerve.	Pierces the deep fascia about four inches below Poupart's ligament, and divides into two branches.	To the integument of the anterior part of the thigh as low as the knee.
Ilio-inguinal (n. ilio-inguinalis).	First lumbar, a branch of the ilio-inguinal.	Lies in front of the spermatic cord or its homologue in the inguinal canal; it escapes through the external abdominal ring.	To the integument of the inner and upper part of the thigh; to the scrotum or its homologue, the labia majora.
Long saphenous (n. saphenus).	Third and fourth lumbar, anterior crural nerve.	In Scarpa's triangle, external to the femoral artery; in Hunter's canal, crosses the femoral artery; pierces the deep fascia between the gracilis and sartorius, and accompanies the long saphenous vein below the knee.	To the skin of the front and inner side of the leg; to the patellar plexus; to the plexus on the inner side of the thigh formed by the obturator and internal cutaneous; to the ankle joint; to the inner side of ankle and foot.
Musculocutaneous (n. peroneus superficialis).	Fourth and fifth lumbar, a branch of the external popliteal.	Given off with the anterior tibial, on the neck of the fibula; passes between the peronei muscles and extensor longus digitorum, and pierces the deep fascia on the front and outer side of the leg in its lower third; divides into internal and external branches.	To dorsum of foot, great, second, third, and one-half of little toe (motor part supplies peroneus longus and peroneus brevis muscles).

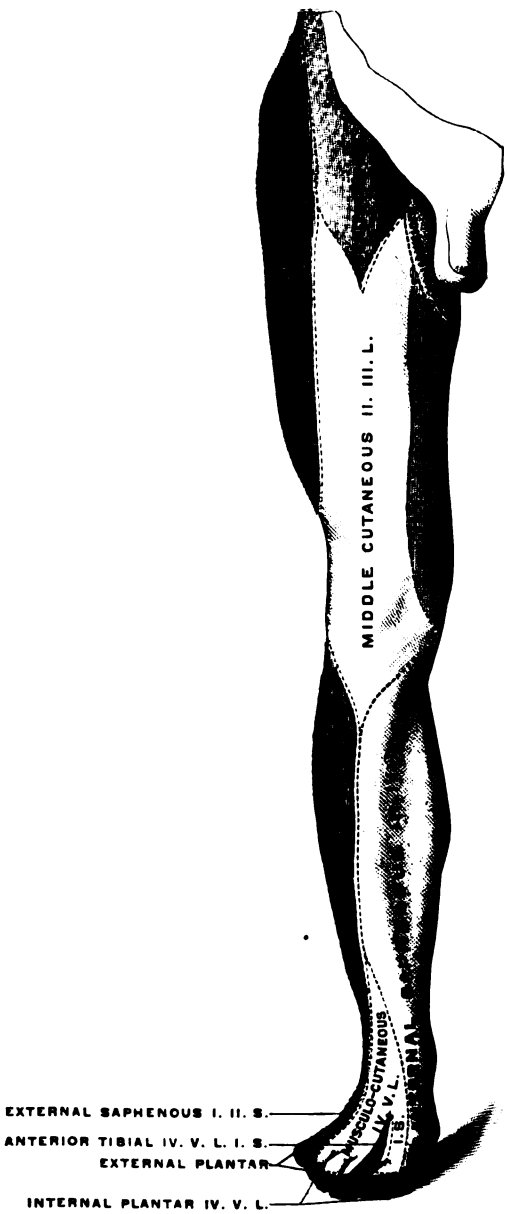
Nerve.	*Source.*	*Course.*	*Distribution.*
Anterior tibial (n. peroneus profundus).	Fourth and fifth lumbar and first sacral, a branch of the external popliteal.	Given off with musculo-cutaneous, on neck of fibula, between peroneus longus and fibula; passes beneath the extensor longus digitorum to the interosseous membrane, and reaches the outer side of the anterior tibial artery; in upper third of leg, external to artery; in middle third, on artery; in lower third, external to artery.	To adjacent surfaces of the great and second toes; to ankle-joint (muscular branches to tibialis anticus, extensor proprius hallucis, extensor longus digitorum and peroneus tertius). External branch to extensor brevis digitorum, to tarsal and metatarsophalangeal joints of second, third, and fourth toes, and second dorsal interosseous muscle. The internal branch supplies the first dorsal interosseous muscle, metatarsophalangeal joint of great toe, and adjacent surfaces of great and second toes).
Lateral cutaneous (ramus cutaneous suræ lateralis).	External popliteal or peroneal.	Pierces the deep fascia near the neck of the fibula.	To the skin of the outer side and upper two-thirds of the leg.

CUTANEOUS NERVES OF POSTERIOR REGION AND SOLE OF FOOT. (Figs. 141, 142.)

Nerve.	*Source.*	*Course.*	*Distribution.*
Small sciatic (n. cutaneus femoris posterior).	First, second, and third sacral, a divorced branch of the great sciatic, and may be adherent to the sheath of the inferior gluteal.	Leaves the pelvis through the greater sacrosciatic foramen below the pyriformis muscle, and behind the great sciatic nerve.	To the back part of the thigh as far down as the lower part of the popliteal space; to scrotum or its homologue, as the inferior pudendal; to outer part of thigh, femoral cutaneous branches; to skin covering lower half of gluteus maximus muscle.
Cutaneous branch of pudic (n. clunii).	Fourth sacral, a branch of nerve to levator ani.	Pierces the levator ani; appears in the ischiorectal fossa anterior to the coccyx.	To the integument between the anus and coccyx.
Perforating cutaneous nerve (n. perforans).	Fourth sacral.	Pierces the great sacrosciatic ligament.	To the skin of the buttock, near the median line and below the distribution of the dorsal divisions of the sacral nerves.
Dorsal cutaneous (nn. clunium medii).	Sacral nerves, three in number, from posterior primary divisions.	Pierce the gluteus maximus in a line extending from the posterior superior iliac spine to the tip of the coccyx.	To the skin in the region of the sacral origin of the gluteus maximus.
Dorsal cutaneous (nn. clunium superiores).	Lumbar nerves, three in number, posterior primary divisions.	Cross crest of the ilium external to the iliac origin of the erector spinæ muscle, and descend vertically.	To the skin of the upper gluteal region.
Lateral cutaneous (n. cutaneus lateralis).	Iliohypogastric, first lumbar.	Crosses the crest of the ilium and descends vertically.	To the integument of the upper gluteal region, anterior to the distribution of dorsal branches of the lumbar nerves.
Lateral cutaneous (n. intercostalis xii).	Twelfth dorsal, anterior primary division.	Crosses the crest of the ilium and descends vertically.	To the skin of the gluteal region, anterior to the distribution of ilio-hypogastric.

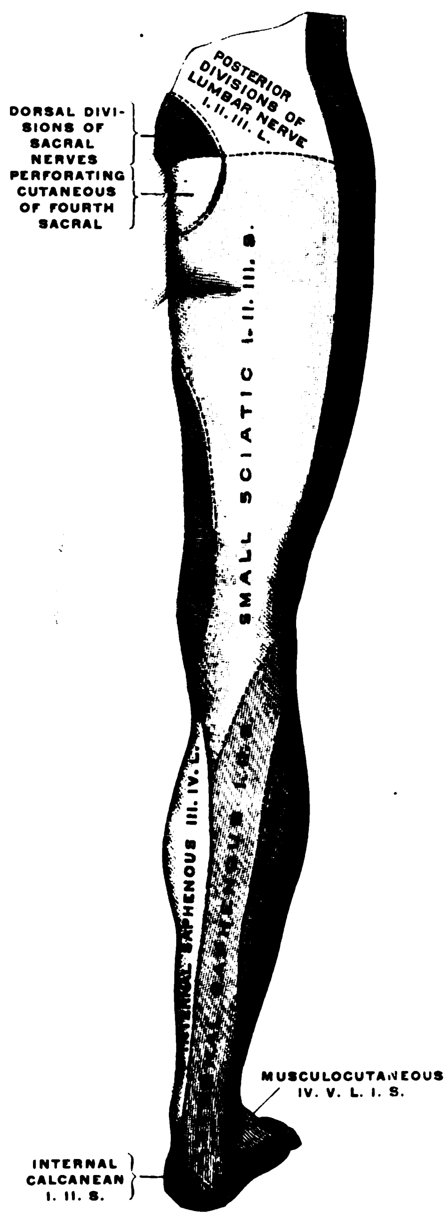
Nerve.	*Source.*	*Course.*	*Distribution.*
Short saphenous (n. suralis).	First and second dorsal, communicans poplitei and communicans peronei, branches of the internal and external popliteal nerves, respectively.	Pierces the deep fascia in the middle third of the posterior surface of the leg; accompanies the short saphenous vein down the back of the leg to the outer side of the ankle and foot.	To back of leg; to outer part of ankle, heel, and foot as far forward as the little toe; to the astragalo-calcaneal articulation.

FIG. 140.



Areas of distribution of cutaneous nerves of the front of the lower limb. (GERRISH after W. KEILLER after TESTUT.)

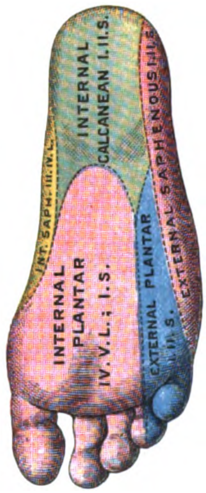
FIG. 141.



Areas of distribution of the cutaneous nerves of the back of the lower limb. (GERRISH after TESTUT.)

Nerve.	*Source.*	*Course.*	*Distribution.*
External plantar, cutaneous branches (n. plantaris lateralis).	External plantar branch of posterior tibial.	Pierce the plantar fascia with the corresponding vessels, between the abductor minimi digiti and flexor brevis digitorum.	To the skin of the anterior two-thirds of the sole of the foot, corresponding to the little and one-half of the adjacent toe; also to the skin of the same toe on the dorsal surface around the nail.
Internal plantar, cutaneous branches (n. plantaris medialis).	Internal plantar, a branch of the posterior tibial nerve.	Pierce the plantar fascia with corresponding vessels between the abductor hallucis and flexor brevis digitorum.	To the skin of the anterior two-thirds of the sole of the foot corresponding to the inner 3.5 toes; also to the skin of the same toes around the nail.
Internal calcanean branches (rami calcanei mediales).	Calcaneo-plantar, a branch of the posterior tibial.	Pierce the internal annular ligament.	To the skin of the heel and sole as far forward as the distribution of the plantar nerves.

FIG. 142.



Areas of distribution of the cutaneous nerves of the sole of foot. (GERRISH after W. KEILLER.)

CHAPTER XX.

THE ILIAC REGION.

Dissection and Identification. Remove the peritoneum by careful manipulation and read iliac and pelvic fasciæ, p. 272. To dissect the lumbar plexus (Fig. 145), study relation of its nerves to the psoas, then dissect longitudinally through the psoas magnus until the plexus is fully developed and can be demonstrated. To dissect the sacral plexus (Fig. 147), remove the parietal branches of the internal iliac artery and dissect through the pelvic fascia covering the plexus and pyriformis muscle.

Bifurcation of Aorta. (Fig. 147.) Identify (1) by the location on and a little to the left of the body of the fourth lumbar vertebra; (2) by the two large arteries—common iliacs—derived therefrom.

Ascending Vena Cava. Identify (1) by its location on the vertebral column, to the right of the aorta; (2) by its formation, the confluence of the common iliac veins; (3) by its blue color, flabby walls, and flattened appearance.

Right Common Iliac Artery. (Fig. 132.) Identify (1) by its crossing the confluence of the common iliac veins; (2) by the formation, the confluence of the internal and external iliac arteries, opposite the sacro-iliac joint; (3) by its attending vein of same name and course.

External Iliac Artery. (Fig. 132.) Identify (1) by its location along the pelvic brim, extending from the sacro-iliac joint to Poupart's ligament; (2) by the derivation of the deep epigastric and deep circumflex iliac arteries therefrom; (3) by its attending vein of same name and course.

Internal Iliac Artery. (Fig. 132) Identify (1) by its location on the outer wall of the pelvis between the bifurcation of the common iliac and great sacrosciatic foramen; (2) by its distribution to the pelvic organs and region of the hip; (3) by its attending vein of same name. Identify its branches by illustrations and description in text.

Fascia Transversalis. Identify (1) by its location immediately beneath the parietal peritoneum; (2) by its special features in areas described in text, page 272.

Psoas Magnus Muscle. (Fig. 143.) Identify (1) by its extensive attachment to the twelfth thoracic and all the lumbar vertebræ; (2) by its insertion with the iliacus into the lesser trochanter; (3) by its relation to the genito-crural, obturator, iliohypogastric, ilio-inguinal, external cutaneous, and anterior crural nerves. (Fig. 145.)

Lumbar Plexus and Branches. Identify (1) by the location of the plexus in the substance of psoas magnus muscle; (2) by the distribution of the branches according to the table dealing therewith on pages 274–276.

Sacral Plexus. Identify (1) by its location on the sacrum and pyriformis muscle (Fig. 147); (2) by its triangular shape and extending as low as the greater sacrosciatic foramen; (3) by its formation—the lumbosacral cord and subsequent sacral nerves. Identify its branches by description of same given in the table on pages 278–280.

ILIAC VESSELS AND BRANCHES.

The iliac vessels are: (1) Common iliac arteries and veins; (2) external iliac arteries and veins; (3) internal iliac arteries and veins. These are bilaterally located and designated right and left. The common iliac arteries begin at the bifurcation of the abdominal aorta, on the fourth lumbar vertebra, and end at the sacro-iliac joint in the external and internal iliac arteries. Each common iliac artery is about two inches long.

The Right Common Iliac Artery crosses the confluence of the common iliac veins. In front of the artery are the ureter, small intestine, and branches of the sympathetic; to the outside, the vena cava, psoas magnus muscle, and right common iliac vein.

The Left Common Iliac Artery is crossed by the ureter, superior hemorrhoidal artery, and sympathetic nerves, and covered by the small intestine. The left common iliac vein is behind and internal to the artery. The psoas magnus muscle is external to it. The common iliac arteries give small branches to the psoas, ureters, and peritoneum.

The Common Iliac Veins correspond to the common iliac arteries, and occupy a plane posterior to them. The left is beneath both left and right common iliac arteries; the right, behind and external to its corresponding artery. The common iliac veins are formed by the external and internal iliacs, and form by their confluence, on the fourth or fifth lumbar vertebra, the beginning of the ascending vena cava.

The External Iliac Artery (Fig. 134) begins at the bifurcation of the common iliac, opposite the sacro-iliac joint, and ends under Poupart's ligament, in the common femoral artery. On the right side, the artery is in relation with the ileum; on the left, with the sigmoid flexure. The genito-crural nerve is on the outer side, the external iliac vein on the inner. *Branches:* Deep epigastric, deep circumflex iliac. (Fig. 133.)

The External Iliac Vein (Fig. 134) begins under Poupart's ligament and ends in the common iliac, opposite the sacro-iliac joint. This union takes place beneath the internal iliac artery. *Branches:* Deep epigastric and deep circumflex veins.

The Internal Iliac Artery (Fig. 134) begins at the bifurcation of the common iliac, and ends opposite the great sacrosciatic foramen, in anterior and posterior branches. It is about one inch long. It is covered by the peritoneum and crossed by the ureter. (Fig. 124.) In the adult, this artery is smaller than the external iliac; in the embryo, much larger, and gives origin to the hypogastric, which conveys blood to the placenta. Behind the internal iliac artery lie the internal iliac veins, the pyriformis muscle, and the lumbosacral cord.

The Internal Iliac Vein (Fig. 134) joins the external to form the common iliac. It is short and extends from the greater sacrosciatic foramen to the sacro-iliac joint. It is behind and internal to its artery. With the exception of the umbilical vein, which in the adult is vestigial, the tributaries of the internal iliac vein correspond to those of the internal iliac artery. *Branches:* Iliolumbar, lateral sacral, gluteal, hypogastric, superior vesical, middle vesical, inferior vesical, middle hemorrhoidal, uterine, vaginal, obturator, sciatic, internal pudic.

Branches of the Internal Iliac Artery.

The Iliolumbar branch (Fig. 134) passes between the obturator nerve and the lumbosacral cord, crosses behind the common iliac artery, and thence between the psoas muscle and vertebral column. At the pelvic brim it divides into an iliac and a lumbar branch. The iliac branch supplies the ilium and iliacus muscle, and anastomoses with the obturator, lumbar, gluteal, external, and deep circumflex iliac arteries. The lumbar branch supplies the psoas and quadratus lumborum muscles, anastomoses with the lumbar arteries, sends off spinal arteries, and is analogous to the lumbar arteries.

The Lateral Sacral branches (Fig. 134) are two in number—upper and lower. The upper branch enters the first anterior sacral foramen, supplies the spinal membranes, and leaves the sacral canal through the posterior sacral foramina to supply the skin over the sacrum. The lower branch descends internal to the anterior sacral foramina to the coccyx, and anastomoses with the middle sacral artery. It gives off branches to the rectum, sacral plexus, spinal cord, and muscles of the pelvic floor.

The Gluteal Artery (Fig. 134) is the largest branch of the internal iliac. It passes between the first sacral nerve and the lumbosacral cord, and leaves the pelvis through the greater sacrosciatic foramen, above the pyriformis muscle, with the superior gluteal nerve. It divides (external to the pelvis) into a superficial branch, which lies between the gluteus maximus and medius, and a deep branch, which lies between the gluteus medius and minimus. (Fig. 157.) The superficial branch supplies the gluteus maximus. In the pelvis, branches are distributed to the pelvic bones, levator ani, coccygeus, obturator internus, and pyriformis. The gluteal artery anastomoses with the lateral sacral, circumflex, and sciatic arteries.

The Hypogastric Artery is the most important artery in the fœtus, but in the adult it is vestigial. In the fœtus it conveys blood to the placenta. It p along the side of the pelvis, enters the false ligament of the bladder, and passes with the urachus to the umbilicus. The umbilical vein returns the blood from the placenta, and obtains in the adult as the round ligament (ligamentum teres) of the liver. (Fig. 120.)

The Superior Vesical Artery (Fig. 134) is the unobliterated part of the hypogastric, and supplies the bladder, vas deferens, uterus, ureter, and occasionally gives off the middle vesical.

The Middle Vesical Artery (Fig. 134), as previously stated, may be a branch of the superior vesical; it usually rises separately from the internal iliac, however, and is distributed to the bladder.

The Inferior Vesical (Fig. 134) branch supplies the bladder, and arises from the internal iliac with the middle hemorrhoidal artery. It gives branches to the prostate, vesiculæ seminales, vagina, and sometimes an artery to the vas deferens.

The Middle Hemorrhoidal branch supplies the rectum, and arises with the inferior vesical. It anastomoses above with the superior, and below with the inferior hemorrhoidal.

The Uterine branch arises near or with the middle hemorrhoidal. It runs in the infundibulo-pelvic ligament, crosses the ureter one-half inch external to the cervix, turns upward, becomes tortuous, and anastomoses with the uterine branch of the ovarian artery.

The Vaginal branches are three or four in number. They arise separately from the internal iliac, or may even come from the uterine, inferior vesical, or middle hemorrhoidal. They pass to the side of the vagina and anastomose with the artery of the cervix and with the arteries of the opposite side. The lower vaginal arteries anastomose with the internal pudic in the bulb of the vagina—bulbi vestibuli.

The Obturator (Fig. 134) is below the brim of the pelvis, with the obturator nerve. It lies between the peritoneum and the pelvic fascia, and is crossed by the vas deferens. It leaves the pelvis through the obturator canal. *Branches:* Iliac to the ilium, vesical to the bladder, pubic to the pubes, muscular to the obturator muscles, articular to the ligamentum teres and synovial membrane of the hip-joint. The artery anastomoses with the deep epigastric, internal circumflex, and sciatic.

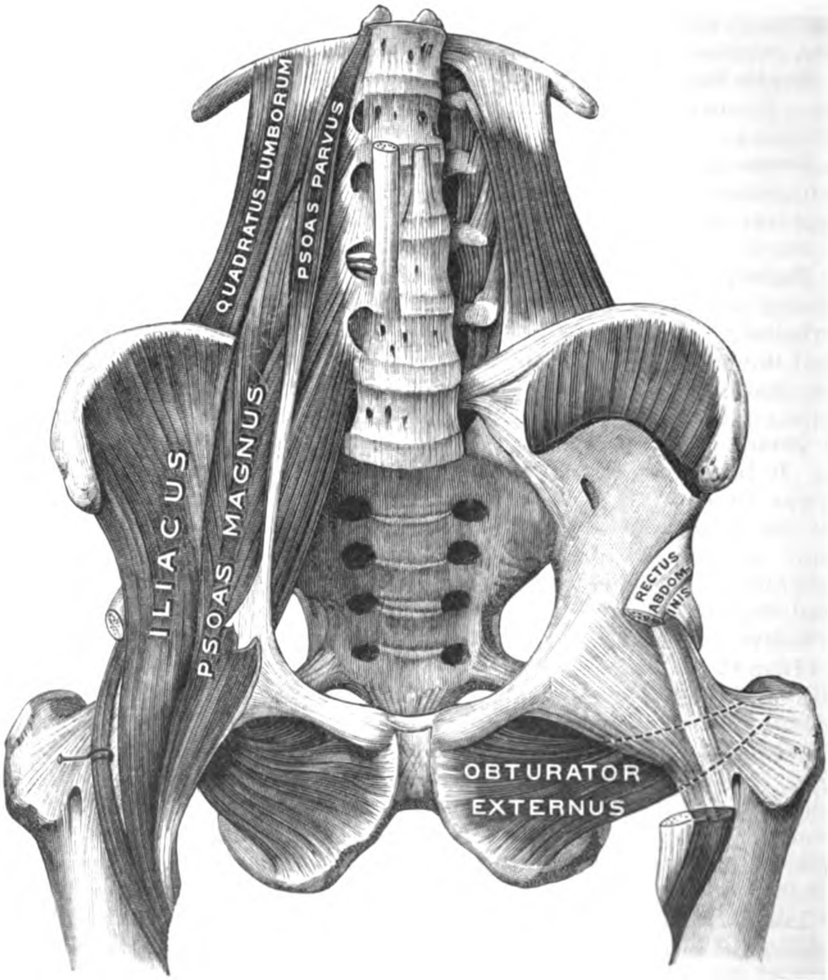
The Sciatic branch (Fig. 134) crosses the sacral plexus and pyriformis muscle escapes from the pelvis behind the internal pudic artery, through the greater sacrosciatic foramen, and anastomoses with the internal circumflex and profunda. Branches within the pelvis are: to the rectum, bladder, prostate, vesiculæ seminales, and muscles of the floor of the pelvis. *Branches* outside of the pelvis are: coccygeal, inferior gluteal to the gluteus maximus, muscular to the external rotators, articular to the hip, cutaneous to the skin over the gluteus maximus, comes nervi ischiadici, which anastomoses with the internal circumflex and the four perforating branches of the profunda. In ligation of the femoral artery, the parts below may receive blood through this anastomotic channel.

The Internal Pudic (Fig. 134) branch leaves the pelvis through the greater sacrosciatic foramen, below the pyriformis muscle, and crosses the outer surface of the spine of the ischium. It re-enters the pelvis through the lesser sacrosciatic foramen, and enters Alcock's canal in the outer wall of the ischiorectal fossa; it traverses this latter to the posterior layer of the triangular ligament, which it perforates. Between the two layers of the triangular ligament it gives off the artery of the bulb, the artery of the corpus cavernosum, and the dorsal artery of the penis. These three arteries pierce the anterior layer of the triangular ligament. The pudic artery in Alcock's canal gives off the inferior hemorrhoidal artery, crosses the spine of the ischium and gives branches to the obturator internus and gluteus maximus.

GENERAL FASCIA TRANSVERSALIS.

The general fascia transversalis lines the pelvic and abdominal cavities. It is dense and thick over the iliacus and obturator internus muscles; thin on the under surface of the levator ani and diaphragm; and fairly strong where it forms test-tube-like prolongations about vessels and organs leaving the pelvis—the femoral sheath and infundibuliform fascia. Subdivisions: (1) That part covering the anterior and lateral abdominal walls is called the transversalis fascia; (2) that

FIG. 143.



Psoas, iliacus, and obturator externus muscles. (GERRISH after TESTUT.)

lining the back part of the abdominal cavity and covering the psoas and iliacus muscles—the iliac fascia; (3) that lining the true pelvis both above and below the white line—the pelvic fascia. (See dissection of abdominal walls for transversalis fascia, page 203.)

The Iliac Fascia consists of two portions: (1) that covering the psoas muscles; (2) that covering the iliacus muscle. Since this fascia determines the course of purulent discharges in lumbar abscesses, its attachments and also its prolongations out of the pelvic cavity must be thoroughly learned.

ATTACHMENTS OF THE ILIAC FASCIA. The iliac fascia covering the psoas muscle is attached (1) to the ligamentum arcuatum internum of the diaphragm (Fig. 97);

(2) to the bodies and transverse processes of the vertebræ; (3) to the upper part of the sacrum; (4) to the lumbar fascia, covering the quadratus lumborum muscle. The two portions—psoas and iliac—are continuous below the iliac crest. The portion of the iliac fascia covering the iliacus muscle is attached (1) to the inner lip of the crest of the ilium; (2) to Poupart's ligament, external to the femoral vessels; (3) to the iliac and pubic parts of the iliopectineal line; (4) to the pubic portion of the fascia lata, posterior to the femoral vessels. The iliac fascia behind the femoral vessels is prolonged out of the pelvis, and forms the posterior part of the femoral sheath; the anterior part of this sheath is derived from a prolongation of the transversalis fascia. The iliac fascia is prolonged into the thigh with the iliacus and psoas muscles.

In psoas abscess pus is directed by the attachments of the iliac fascia into the deep part of the thigh, along the common tendon of the psoas and iliacus muscles. From here it is directed by the internal intermuscular septum of the fascia lata into the lower third of the thigh, whence it may burrow into the popliteal space and ultimately reach the ankle by passing between the superficial and deep layers of muscles of the back of the leg. (See fascia lata, page 286.)

The Pelvic Fascia is that part of the general fascia transversalis which lines the true pelvis both above and below the pelvic floor. It is attached to the anterior surface of the sacrum, the brim of the pelvis, the lower part of the symphysis, and the surface of bone around the obturator internus muscle. A prolongation of this fascia accompanies the obturator internus muscle through the lesser sacrosciatic foramen.

Obturator and Rectovesical Portions. (Fig. 132.) The pelvic fascia divides along a line extending from the spine of the ischium to the lower part of the symphysis pubis, into an obturator and a rectovesical portion.. The place of division is called the white line, and gives origin to the levator ani muscle. (Fig. 147.) The obturator fascia below the white line covers the obturator internus muscle, on the outer wall of the ischiorectal fossa, and also invests the under surface of the levator ani muscle, forming the anal fascia. The rectovesical portion of the pelvic fascia descends on the upper surface of the levator ani muscle to the rectum, bladder, and prostate. (See dissection of pelvic organs and pelvic outlet.)

Canal for the Pubic Nerve and Vessels. (Fig. 132.) The obturator fascia on the outer wall of the ischiorectal fossa splits to form a canal for the pudic nerve and vessels. This canal is about an inch above the inner border of the tuberosity of the ischium, and extends from the lesser sacrosciatic foramen to the triangular ligament. All branches of the internal iliac artery, on emerging from the pelvis, are surrounded by tubular prolongations of pelvic fascia, just as the femoral vessels derive their sheaths from the transversalis and iliac fasciæ.

MUSCLES OF THE ILIAC REGION.

Psoas Magnus. (Fig. 143.) *Origin:* (1) Intervertebral cartilages, between the twelfth thoracic and first lumbar vertebra; (2) sides of the bodies of the twelfth thoracic and all the lumbar vertebræ. *Insertion:* Lower and back part of the lesser trochanter of the femur. *Action:* Flexion of the thigh on abdomen. *Synergists:* Iliacus, pectineus, sartorius. *Nerves:* Second and third lumbar. The lumbar plexus is in the fleshy part of this muscle. The psoas is covered by the peritoneum and (a thin layer of) the iliac fascia. The lumbar part of the sympathetic gangliated cord lies along the inner margin of the psoas, obscured on the right by the ascending vena cava; on the left, by the abdominal aorta. (Fig. 145.) Behind the psoas muscle are the lumbar arteries and veins, four in number, on either side, analogous to the intercostal vessels.

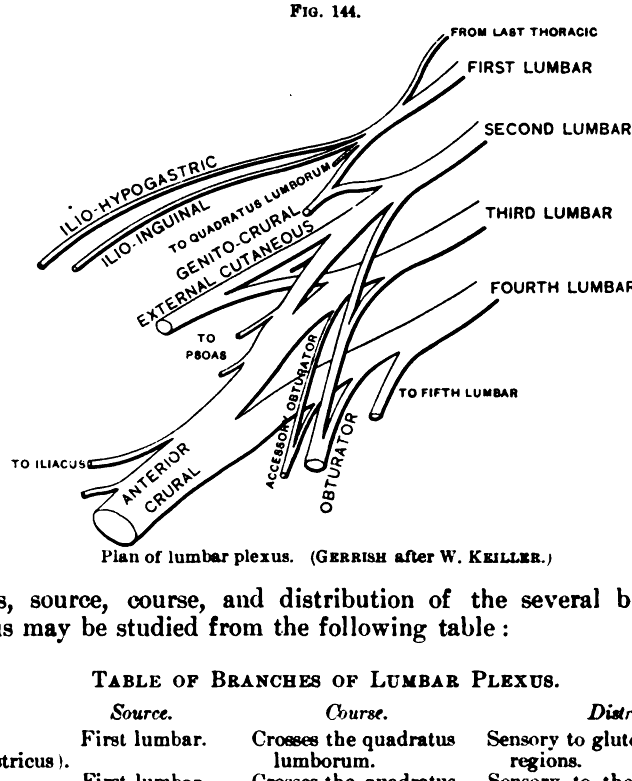
The Psoas Parvus. (Fig. 143.) This muscle is often absent. *Origin:* Side of the intervertebral disk, between the twelfth thoracic and the first lumbar and the adjacent borders of the same vertebræ. *Insertion:* Iliopectineal line. *Action:* To flex the pelvis on the thorax. *Nerve:* First lumbar.

The Iliacus. (Fig. 143.) *Origin:* (1) Wing of the sacrum; (2) iliolumbar, lumbosacral, and anterior sacro-iliac ligaments; (3) upper and outer half of the ventral surface of the ilium. *Insertion:* Back of lesser trochanter and back of femur, below lesser trochanter. *Action:* A flexor of the thigh. *Synergists:* Iliacus, pectineus, and sartorius. *Antagonists:* The gluteal muscles. *Nerve:* Anterior crural. *Artery:* Iliolumbar branch of the internal iliac.

THE LUMBAR PLEXUS (PLEXUS LUMBALIS).

This plexus of nerves is in front of the transverse processes of the lumbar vertebræ in the substance of the psoas magnus muscle. (Fig. 145.) It is formed by the union of the anterior primary divisions of the first, second, third, and fourth lumbar nerves and a branch of the twelfth thoracic. (Fig. 144.) The plexus communicates with the twelfth thoracic nerve, through the dorsilumbar nerve; with the sacral plexus, through the lumbosacral cord; with the lumbar part of the sympathetic, through both the gray and white rami communicantes.

FIG. 144.



Plan of lumbar plexus. (GERRISH after W. KEILLER.)

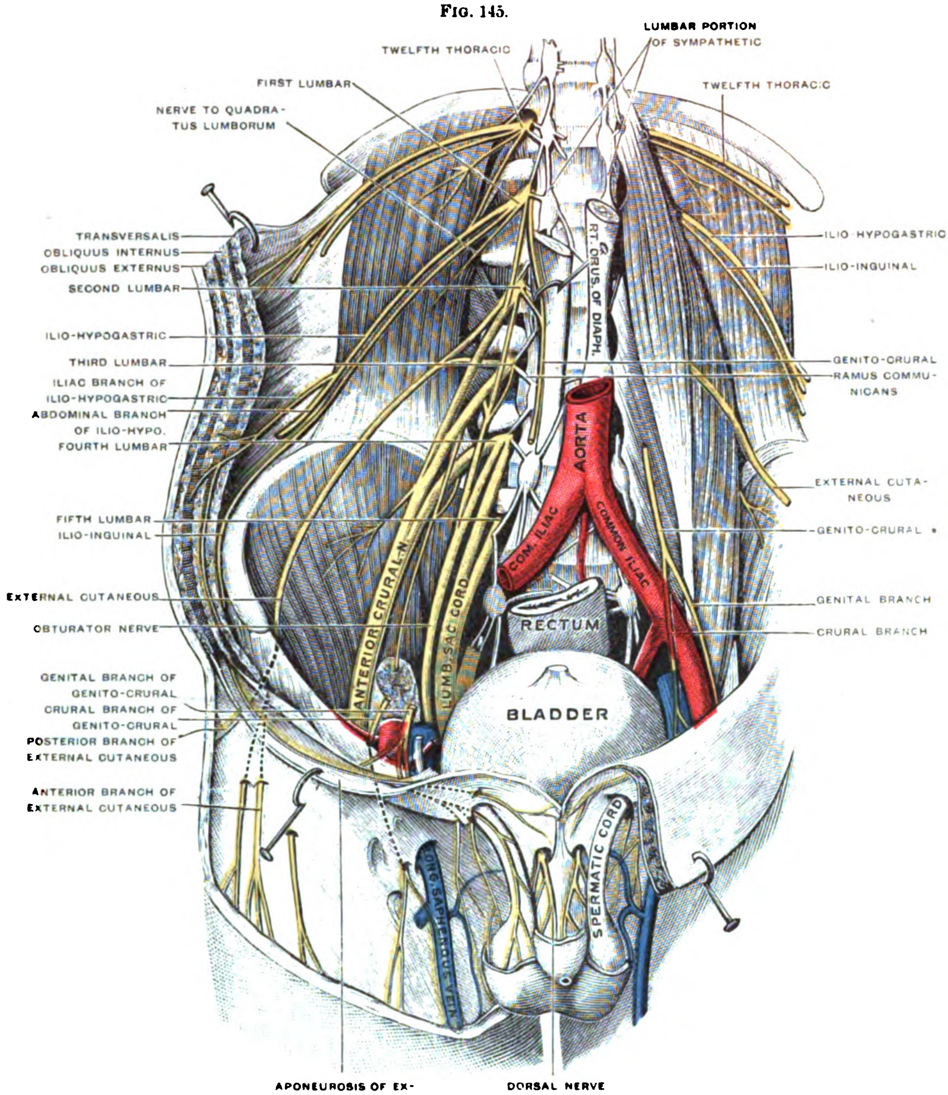
The names, source, course, and distribution of the several branches of the lumbar plexus may be studied from the following table:

TABLE OF BRANCHES OF LUMBAR PLEXUS.

Branch.	*Source.*	*Course.*	*Distribution.*
Iliohypogastric (n. iliohypogastricus).	First lumbar.	Crosses the quadratus lumborum.	Sensory to gluteal and hypogastric regions.
Ilio-inguinal (n. ilio-inguinalis).	First lumbar.	Crosses the quadratus lumborum.	Sensory to the upper and inner parts of the thigh, contiguous to the scrotum, and to the integument of the scrotum or its homologue.
Genito-crural (n. genitofemoralis), dividing into a genital and a crural branch—n. spermaticus and n. lumbo-inguinalis, respectively.	First and second lumbar.	Descends on the psoas and divides into two branches on same. Genital branch passes through the inguinal canal behind the cord or its homologue; the crural branch accompanies the external iliac artery.	Motor, to the cremasteric muscle; sensory to the skin of the upper part of the thigh in the region of the femoral vessels, near the distribution of the external cutaneous nerve; vasomotor to the femoral artery.

Branch.	*Source.*	*Course.*	*Distribution.*
External cutaneous (n. cutaneous femoris lateralis).	Second and third lumbar.	Crosses the iliacus, leaves the pelvis beneath Poupart's ligament below the anterior superior iliac spine.	Sensory to the postero-external part of the thigh. It may be considered a dismembered part of the anterior crural nerve.

FIG. 145.



Deep and superficial dissection of the lumbar plexus. (GERRISH after TESTUT.)

Obturator (n. obturatorius).	Second, third, and fourth lumbar.	Runs along lateral wall of pelvis above obturator vessels, and escapes into the thigh through the obturator canal.	Sensory, to knee and hip; motor, to adductor muscles of thigh and occasionally to pectineus muscle; vasomotor, to femoral artery.
Accessory obturator (n. obturatorius accessorius).	Third and fourth lumbar.	Inner border of psoas; crosses the horizontal ramus of the pubic bone; passes under the pectineus and divides into numerous branches.	Sensory, to hip-joint; motor, to pectineus muscle. The nerve is often absent.

Branch.	*Source.*	*Course.*	*Distribution.*
Anterior crural (n. femoralis).	Second, third, and fourth lumbar.	Passes between the psoas and iliacus; enters the thigh beneath Poupart's ligament external to the femoral vessels.	Sensory, to hip-, knee-, and ankle-joints through articular branches; sensory, to inner part of leg and foot through long saphenous; sensory, to front surface of thigh through internal and middle cutaneous nerves; motor, to pectineus, sartorius, and quadriceps extensor cruris, through muscular branches.
Muscular branches to certain polymeric muscles (rami musculares).	Whole plexus.	Direct into substance of muscles to which they are distributed.	Motor, to psoas, iliacus, and quadratus lumborum muscles.

Dissection and Identification. First remove the peritoneum and the thin layer of fascia, if this has not been previously done, and study the following branches with relation to the psoas magnus muscle (Fig. 145):

1. The genito-crural nerve emerges from the inner border of the psoas muscle, descends on the same, and divides into two branches—genital and crural.
2. The obturator and accessory obturator nerves emerge from the inner border of the muscle; the latter may be absent. The obturator nerve crosses the lateral pelvic wall below the brim and escapes through the obturator canal into the adductor region of the thigh.
3. The iliohypogastric, ilio-inguinal, external cutaneous, and anterior crural nerves emerge from the outer border of the psoas; the two former cross the quadratus lumborum; the two latter cross the iliacus. The anterior crural, the largest branch beneath Poupart's ligament, is in a groove between the psoas and iliacus muscles. (Fig. 143.)

Specific Distribution of Branches of Lumbar Plexus.

The Iliohypogastric Nerve arises from the first lumbar nerve and emerges from the outer border of the psoas magnus. It crosses the quadratus lumborum, perforates the transversalis muscle, and divides into its two terminal branches between this muscle and the internal oblique. *Branches:* (1) The iliac—a lateral cutaneous—crosses the crest of the ilium and supplies the skin over the upper gluteal region (Fig. 141); (2) the hypogastric (Fig. 109) pierces the internal and external oblique muscles and supplies the skin of the hypogastric region; (3) muscular branches to the internal oblique and transversalis; (4) gray rami communicantes.

The Ilio-inguinal Nerve arises from the first lumbar, in common with the ilio-hypogastric. It emerges from the outer border of the psoas and crosses the quadratus lumborum. It perforates the transversalis muscle and lies between this and the internal oblique. Near the internal abdominal ring, this nerve pierces the internal oblique muscle and passes along the inguinal canal in front of the spermatic cord. It leaves the inguinal canal through the external abdominal ring and divides into the following branches (Fig. 109): (1) Iliac and inguinal, to skin of the scrotum and adjacent upper part of skin of the thigh; (2) muscular, to the internal oblique and transversalis muscles; (3) communicating, to the iliohypogastric; (4) gray rami communicantes.

The Genito-crural Nerve arises from the first and second lumbar, lies on the psoas muscle to the outer side of the external iliac artery. It divides into the following branches: (1) A genital, which passes through the inguinal canal, behind the spermatic cord, to the cremaster muscle; (2) a crural, which passes in front of the femoral artery in the femoral sheath, to the skin of the upper, front, and central parts of the thigh; (3) gray rami communicantes.

The External Cutaneous Nerve arises from the second and third lumbar nerves, crosses the iliacus muscle, leaves the pelvis below the anterior superior iliac spine (Fig. 151), and gives off: (1) Cutaneous, anterior and posterior, to skin of the outer part of the thigh; (2) nerves to the patellar plexus; (3) gray rami communicantes. This nerve may be regarded as a divorced cutaneous branch of the anterior crural.

The Anterior Crural Nerve (Fig. 145) arises from the second, third, and fourth lumbar nerves. It passes downward in the psoas muscle to Poupart's ligament, where it lies in a groove between the psoas and the iliacus muscle. It leaves the pelvis beneath Poupart's ligament, one-half inch to the outer side of the femoral sheath, and enters Scarpa's triangle. (Fig. 151.)

The branches of the anterior crural nerve are divided into an anterior and a posterior set by the external circumflex artery. (Fig. 152.) In the anterior set are said to be the middle cutaneous, internal cutaneous, and muscular branches to the pectineus and sartorius muscles; in the posterior set the long saphenous, articular branches to the hip, knee, and ankle, and muscular branches to the rectus, vasti, and crureus. Branches to the iliacus muscle and the femoral artery are given off within the pelvis.

Summary of Articular Branches of the anterior crural nerve: (1) To the hip-joint, from the muscular branch to the rectus femoris; (2) to the knee-joint, from muscular branches to the vastus internus; (3) to the ankle-joint, from the long saphenous nerve.

The Obturator Nerve arises from the third and fourth lumbar nerves. It passes between the psoas muscle and the fifth lumbar vertebra, and crosses the outer wall of the pelvis to the obturator foramen. The nerve divides, external to the pelvis, into an anterior and a posterior division. (Fig. 151.) The anterior division crosses the obturator externus, passes between the pectineus and adductor brevis, and gives off (1) an articular branch, to the hip; (2) a branch, to the femoral artery; (3) a cutaneous twig, to the subsartorial plexus; (4) muscular branches, to the adductor longus, brevis, gracilis, and pectineus muscles. The posterior division gives branches to (1) the hip; (2) the knee; (3) muscular branches, to the obturator externus and adductor magnus muscles.

The Accessory Obturator Nerve, when present, arises from the third and fourth lumbar nerves, passes along the inner border of the psoas, and gives off (1) articular branches, to the hip; (2) branches to the pectineus muscle; (3) gray rami communicantes.

Muscular Branches are given off in the substance of the psoas magnus to the iliacus, quadratus lumborum, psoas magnus and psoas parvus muscles.

Blood-supply. The lumbar plexus derives its nourishment from the lumbar branches of the iliolumbar arteries.

Polymeric Nerve-supply of Muscles. Some muscles—as the pectorals, latissimus dorsi, external and internal oblique, transversalis, rectus abdominis, psoas, quadratus lumborum, and iliacus—are derived from more than one myotome, and "muscles derived from more than one myotome are innervated by nerves derived from the ventral roots belonging to more than one neurotome." (Barker: *The Nervous System.*)

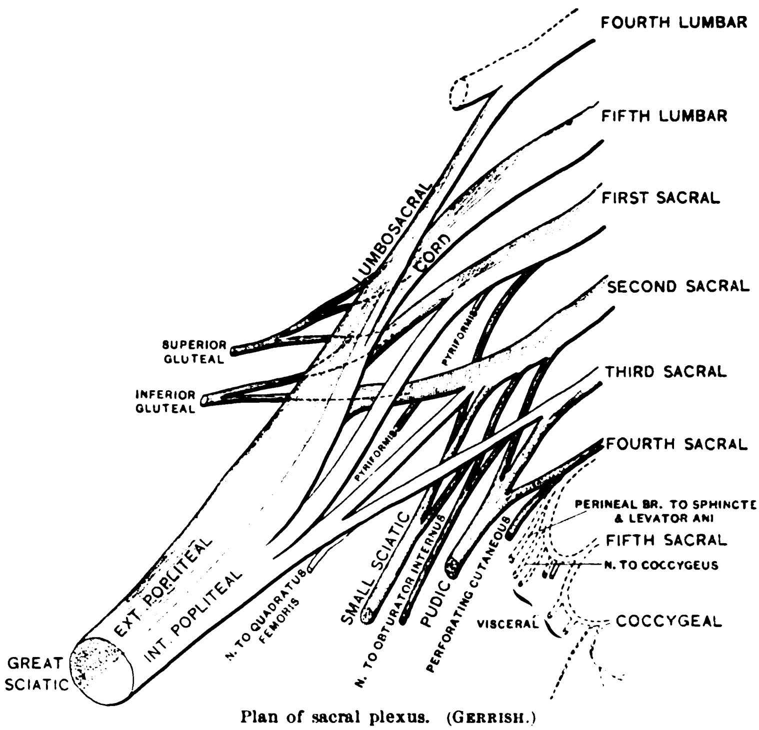
Rami Communicantes. The upper lumbar nerves are connected to the vertebral ganglia of the sympathetic by both gray and white rami communicantes; the lower by gray only. "The gray rami communicantes are distributed to the spinal nerves, and in them reach the vessels, fasciæ, and bones for which they are destined." (Gerrish.) For the purpose of impressing this principle on the student, gray rami are considered in this book as accompanying each spinal nerve. (See sympathetic nerve.)

THE SACRAL PLEXUS (PLEXUS SACRALIS).

The sacral plexus (Figs. 146, 147) is formed by the union of the lumbosacral cord and the anterior primary divisions of the first, second, third (and a part of the fourth) sacral nerves. The lumbosacral cord (Fig. 146) is formed by the anterior primary division of the fifth lumbar nerve and a part of the fourth; the fourth lumbar nerve, therefore, contributes to both lumbar and sacral plexuses. The sacral plexus is triangular in shape, its base corresponding to the exit foramina of the lumbar and sacral nerves entering into its formation, and its apex to the greater sacrosciatic foramen. The plexus rests on the wing (ala) of the sacrum and the anterior surface of the pyriformis muscle, and is covered by the pelvic fascia. (Fig. 147.) The nerves of the sacral plexus receive their nourishment through small arteries, called vasa nervorum, from the lateral sacral branches of the internal iliac artery.

Communications of the sacral plexus (Fig. 145) are with the lumbar plexus above, through the lumbosacral cord; with the fifth sacral nerve below; with the sacral part of the sympathetic, through gray rami communicantes.

FIG. 146.



Plan of sacral plexus. (GERRISH.)

The names, source, course, and distribution of the branches of the sacral plexus may be studied in the following table :

TABLE OF BRANCHES OF SACRAL PLEXUS.

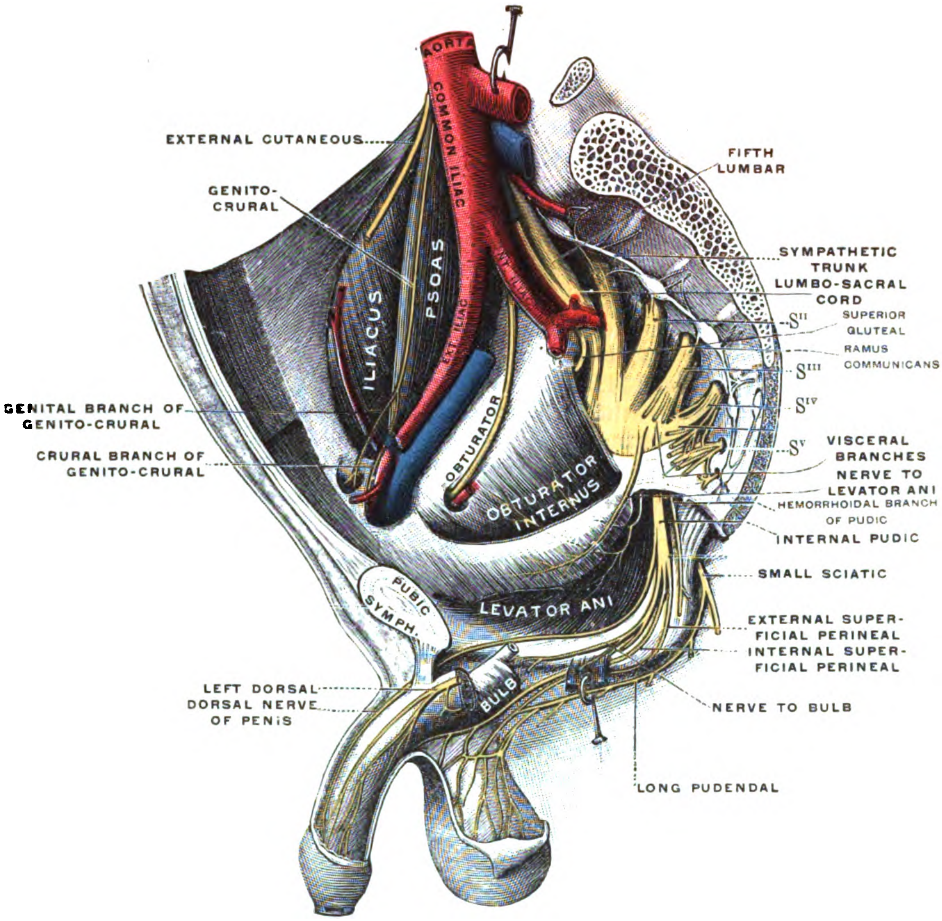
Branch.	*Source.*	*Course.*	*Distribution.*
Muscular (ramus muscularis).	First and second sacral.	Direct.	Motor, to pyriformis. (Fig. 146.)
Muscular (ramus muscularis).	First and second sacral and lumbosacral cord.	Leaves the pelvis through the great sacrosciatic foramen; re-enters through the lesser sacrosciatic foramen.	Motor, to obturator internus muscle; distributed to the inner surface. (Fig. 146.)
Muscular (ramus muscularis).	First and second sacral and lumbosacral cord	Through the greater sacrosciatic foramen as a part of the nerve to the obturator internus.	Motor, to the gemellus superior. (Fig. 146.)
Muscular (ramus muscularis).	First sacral and lumbosacral cord.	Through the greater sacrosciatic foramen; beneath tendons of gemelli and obturator internus.	Motor, to the gemellus inferior and quadratus femoris; distributed to their deep surfaces; sensory, to the hip-joint.
Superior gluteal (n. glutæus superior).	First sacral and lumbosacral cord.	Through the greater sacrosciatic foramen above the pyriformis.	Motor, to gluteus medius, gluteus minimus, and tensor vaginæ femoris. (Fig. 146.)

Branch	*Source.*	*Course.*	*Distribution.*
Inferior gluteal (n. glutæus inferior).	First and second sacral and lumbosacral cord.	Greater sacrosciatic foramen beneath the pyriformis.	Motor, to gluteus maximus; distributed to the under surface of the muscle. (Fig. 146.)
Perforating cutaneous (n. cutanei perforantes).	Second and third sacral.	Perforates the great sacrosciatic ligament.	Sensory, to the skin of the buttocks.
Pudic (n. pudendus).	Third and fourth sacral; occasionally, also, first and second sacral. (Fig. 146.)	Through the greater sacrosciatic foramen beneath the pyriformis muscle; crosses the spine of the ischium and re-enters the pelvis through the lesser sacrosciatic foramen; passes along Alcock's canal in the outer wall of the ischiorectal fossa (Fig. 132), and divides into: 1. Perineal. 2. Dorsal nerve of penis. 3. Inferior hemorrhoidal.	1. Perineal branch is sensory to skin of scrotum or its homologue; sensory to urethra; vasomotor to corpus spongiosum; motor to accelerator urinæ, superficial transversus perinei, erector penis, external sphincter ani, levator ani, and deep internal transversus perinei, or compressor urethræ. 2. Dorsal nerve of penis is sensory to glans, prepuce, dorsum, and sides of penis; vasomotor to corpora cavernosa. 3. The inferior hemorrhoidal crosses the ischiorectal fossa, and is sensory to skin around anus.
Small sciatic (n. cutaneus femoris posterior). (Fig. 160.)	Second and third sacral.	Through the great sacrosciatic foramen beneath the pyriformis muscle.	1. Perineal cutaneous branches to perineum and upper, inner posterior part of thigh. 2. The inferior pudendal supplies the scrotum or its homologue with sensation. 2. Femoral cutaneous branches supply the inner and outer aspects of the thigh posteriorly as far as its middle third; middle part of posterior aspect of thigh, popliteal region, and upper third of posterior part of leg. 2. The ascending cutaneous branches supply the skin of the gluteus maximus with sensation.
Great sciatic (n. ischiadicus). This nerve divides in the upper part of the popliteal space into internal and external popliteal nerves. (Fig. 160.)	First, second, and third sacral and lumbosacral cord. (Fig. 146.)	Through the great sacrosciatic foramen with the inferior gluteal nerve, the small sciatic nerve, the sciatic vessels and the pudic nerve and vessels; beneath the pyriformis, it rests between the tuber ischii and greater trochanter of the femur.	1. Main trunk gives articular branches to the hip-joint; motor branches to the biceps, semitendinosus, semimembranosus, and adductor magnus muscles.
Internal popliteal (n. tibialis). (Fig. 160.)	Begins in the upper part of the popliteal space at the bifurcation of the great sciatic nerve.	Passes through the centre of the popliteal space vertically downward, and ends in the upper part of the leg in the posterior tibial nerve.	1. Articular, three in number, to knee-joint. 2. Communicans tibialis, which joins communicans fibularis to form short saphenous (n. suralis). 3. Muscular (rami musculares) to gastrocnemius, plantaris, soleus and popliteus.
Posterior tibial (n. tibialis). (Fig. 160.)	Begins at the lower part of the popliteal space as a continuation of the internal popliteal.	Passes between the superficial and deep groups of muscles of the back of the leg downward and slightly inward, to the inner part of the ankle, where it divides into the internal and external plantar.	1. Motor, to tibialis posticus, flexor longus digitorum, flexor longus hallucis, and all muscles of sole (through its plantar branches). 2. Articular (rami articulares) to ankle-joint. 3. Calcaneo-plantar (internal calcanean) to integument of heel and inner side of sole. 4. Internal plantar (n. plantaris medialis). 5. External plantar (n. plantaris lateralis).

Branch.	*Source.*	*Course.*	*Distribution.*
Internal plantar (n. plantaris medialis). (Fig. 142.)	Begins beneath the internal annular ligament as a terminal branch of the posterior tibial.	Passes between the first and second layers of the muscles of the sole to the toes.	1. Cutaneous (nn. plantares) to skin of sole. 2. Muscular (nn. musculares) to abductor hallucis and flexor brevis digitorum. 3. Articular (nn. articulares) to tarsal and metatarsal joints. 4. Digital (nn. digitales plantares proprii (four). (*a*) To inner border of great toe and flexor brevis hallucis. (*b*) To adjacent sides of first and second toes and first lumbrical muscle. (*c*) To adjacent sides of second and third toes. (*d*) To adjacent sides of third and fourth toes and receives filament from external plantar. (*e*) Articular (from digital cutaneous branches) to joints of the toes.
External plantar (n. plantaris lateralis). (Fig. 142.) Notice: "This distribution of digital branches to the toes from the plantar nerves is precisely similar to that of the median and ulnar nerves in the hand." (Gray.)	Begins beneath the internal annular ligament as a terminal branch of the posterior tibial.	Passes between the first and second layers of the muscles of the sole to the toes.	1. Muscular (rami musculares) to flexor accessorius, abductor minimi digiti, interossei (except those of the fourth space), three outer lumbricales, adductor obliquus hallucis, and adductor transversus hallucis. 2. Cutaneous to little toe and outer half of adjacent one. Each digital cutaneous branch furnishes articular branches to the joints. 3. Articular (from digital cutaneous nerves) to joints of toes.
External popliteal (n. peronæus communis). (Fig. 160.)	Begins in the upper part of the popliteal space at the bifurcation of the great sciatic.	Passes downward and outward along the tendon of the biceps, leaves the popliteal space between the biceps tendon and outer head of the gastrocnemius muscle, runs behind the head of the fibula, turns inward on the neck of the fibula, and divides into several branches.	1. Articular (three in number) to the knee. 2. Cutaneous, to back and outer parts of leg in upper and middle thirds. 3. Communicans fibularis (n. cutaneus suræ lateralis), which joins communicans tibialis (n. cutaneus suræ medialis), to form short saphenous. 4. Anterior tibial (n. peronæus profundus). 5. Musculocutaneous (n. peronæus superficialis).
Short saphenous (n. suralis). (Figs. 139 and 162.)	Begins by union of communicans tibialis (n. cutaneus suræ medialis) and communicans fibularis (n. cutaneus suræ lateralis) from internal and external popliteal nerves, respectively.	The nerve (or its constituent parts) pierces the deep fascia at a variable distance below the knee.	1. Cutaneous, to back of leg, outer part of ankle, heel, and foot as far forward as the little toe. 2. Articular to astragalo-calcanean articulation.
Anterior tibial (n. peronæus profundus). (Fig. 166.)	Begins as a branch of the external popliteal on the neck of the fibula with the musculo-cutaneous.	Passes deeply down front of the leg with anterior tibial artery, and gives off its branches.	1. Motor (rami musculares) to all muscles of anterior part of the leg and to the first dorsal interosseous and extensor brevis digitorum muscles. 2. Cutaneous to skin between great and second toes (nn. digitales dorsales hallucis laterales et digiti secundi medialis). (Fig. 140.) 3. Articular (rami articulares) to ankle, tarsal, and metatarso-phalangeal joints.

Branch.	*Source.*	*Course.*	*Distribution.*
Musculocutaneous (n. peronæus superficialis). (Fig. 166.)	Begins as a branch of the external popliteal on the neck of the fibula with the anterior tibial.	Passes through the substance of the peroneus longus muscle, and divides into its terminal branches.	1. Motor (rami musculares) to peroneus longus and brevis muscles. 2. Sensory, to outer side of leg and dorsum of foot.

FIG. 147.



Sacral plexus of the right side. (GERRISH after TESTUT.)

Specific Distribution of Branches of Sacral Plexus.

Pyriformis. (Fig. 146.) The nerve to this muscle arises from the first and second sacral nerves. It leaves the pelvis through the great sacrosciatic foramen, crosses the spine of the ischium, enters the pelvis through the lesser sacrosciatic foramen, and is distributed to the internal surface of the muscle.

Obturator Internus. (Fig. 146.) The nerve to this muscle arises from the first and second sacral nerves and lumbosacral cord. It leaves the pelvis through the great sacrosciatic foramen, re-enters the pelvis through the lesser sacrosciatic foramen, and is distributed to the inner surface of the muscle.

Gemellus Superior. (Fig. 146.) The nerve to this muscle arises from the first and second sacral nerves and the lumbosacral cord. It leaves the pelvis through the great sacrosciatic foramen as a part of the nerve to the obturator internus, and reaches the gemellus superior; external to the pelvis.

Gemellus Inferior and Quadratus Femoris. (Fig. 146) These two muscles are supplied by the same nerve, which arises from the first sacral nerve and the lumbosacral cord. It leaves the pelvis through the great sacrosciatic foramen and passes beneath the tendons of the gemellus and obturator internus, to the quadratus femoris. Twigs from this nerve are given off to the gemellus inferior as the nerve passes beneath the tendons of the gemelli and obturator internus muscles. This nerve gives a branch to the hip-joint.

The Superior Gluteal Nerve (Fig. 146) arises from the lumbosacral cord and first sacral nerve. It leaves the pelvis with the superior gluteal vessels through the greater sacrosciatic foramen, above the pyriformis muscle, and gives off (1) muscular branches to the gluteus medius, gluteus minimus, and tensor vaginæ femoris; (2) sympathetic branches—gray rami communicantes—to bone, ligament, fasciæ and vessels in the course of the superior gluteal. (Fig. 162.)

The Inferior Gluteal Nerve arises from the first, second, and third sacral and fifth lumbar nerves. It leaves the greater sacrosciatic foramen below the pyriformis muscle with the sciatic and pudic vessels and nerves, and gives muscular branches to the gluteus maximus and gray rami communicantes to bone, ligament, fasciæ, and vessels in its course. (Fig. 162.)

The Perforating Cutaneous Nerve (Fig. 141) arises from the second and third sacral nerves. It perforates the greater sacrosciatic ligament, and supplies the integument covering the lower and inner parts of the gluteus maximus muscle.

The Pudic Nerve (Figs. 144, 147, and 154) arises from the third and fourth sacral nerves. It leaves the pelvis through the greater sacrosciatic foramen, crosses the spine of the ischium, and re-enters the pelvis through the lesser sacrosciatic foramen, where it enters Alcock's canal (Fig. 132), in the outer wall of the ischiorectal fossa, and breaks up into three terminal branches—the hemorrhoidal, perineal, and dorsal nerve of the penis. Each of these three nerves has a definite course and distribution, as follows:

The Inferior Hemorrhoidal pierces the inner wall of Alcock's canal, crosses the ischiorectal fossa with vessels of like name, and is distributed to the skin around the anus.

The Perineal Branch divides into cutaneous and muscular parts. The cutaneous part—the superficial perineal nerve—leaves Alcock's canal in the anterior portion of the ischiorectal fossa, pierces the base of the triangular ligament, and is distributed to the skin of the scrotum or its homologue, the labia majora.

The Dorsal Nerve of the penis pierces the posterior layer of the triangular ligament and traverses the deep perineal space along the inner margin of the ramus of the pubic bone; it then pierces the anterior layer of the triangular ligament, gives a vasomotor branch to the corpus cavernosum, lies between the crus penis and pubic bone, and passes to the dorsum of the penis. It supplies the integument, glans, and prepuce of the penis or its homologue, the clitoris.

The Small Sciatic Nerve (Fig. 160) arises from the first, second, and third sacral nerves, and leaves the pelvis through the great sacrosciatic foramen, below the pyriformis muscle, in company with the great sciatic nerve and sciatic vessels, inferior gluteal nerve, internal pudic nerve and vessels. *Branches:* (1) Perineal cutaneous, to the skin of the upper, inner, and posterior aspects of the thigh and perineum (the inferior pudendal, the longest of these branches, crosses the tuberosity of the ischium to supply the scrotum); (2) the femoral cutaneous branches supply the inner, central, and outer sides of the posterior part of the thigh and also the skin of the popliteal space and upper third of the posterior part of the leg; (3) the ascending cutaneous branches of the small sciatic supply the skin over the gluteus maximus.

The Great Sciatic has the most extensive distribution of any nerve in the body. It supplies (1) the leg; (2) the flexor and extensor muscles of the knee; (3) the adductor magnus, in part; (4) the hip, knee, ankle, and joints of the foot. The main trunk gives off certain articular and muscular branches, and then divides into the internal and external popliteal divisions, which, as the following table shows, have a number of branches each:

1. Branches of main trunk . . .	Articular, to hip. Muscular, to flexors of knee and adductor magnus.
2. Branches of internal popliteal .	Articular, to knee-joint. Muscular, to popliteus and superficial group of muscles of posterior part of leg. Communicans poplitei, to short saphenous. The posterior tibial and its branches.
3. Branches of external popliteal	Articular, to knee-joint. Cutaneous branches, to leg. The communicans popliteal, to short saphenous. The anterior tibial and its branches. The musculocutaneous and branches.

Branches of the Main Trunk. (Fig. 162.) Articular branches to the hip are given off immediately after its exit from the pelvis. They perforate the posterior part of the capsule of the joint with the articular branches of the sciatic artery.

Muscular Branches (Fig. 162) are given off in the upper third of the thigh, to the adductor magnus, semitendinosus, semimembranosus, and long head of the biceps; in the middle third, to the short head of the biceps.

The Internal Popliteal (Fig. 163), the larger of the two terminal divisions of the great sciatic, passes through the centre of the popliteal space, and ends beneath the fibrous arch of the soleus muscle, in the posterior tibial nerve. In the upper part of the popliteal space the nerve is external to the popliteal vessels; opposite the knee it crosses to the inner side of the same. Its branches are:

(*a*) Articular, to the knee-joint, three in number—superior internal, superior external, and azygos.

(*b*) Muscular, to the gastrocnemius, soleus, plantaris, and popliteus, given off between the two heads of the gastrocnemius muscle.

(*c*) The communicans poplitei unites with the communicans peronei, a branch of the external popliteal, to form the short saphenous, for the supply of the integument of the posterior part of the leg and the outer surface of the foot. (Fig. 141.)

(*d*) The posterior tibial nerve (Fig. 163) is a continuation of the internal popliteal. It begins at the lower part of the popliteal space beneath the fibrous arch of the soleus muscle, and ends in the plantar nerves, beneath the internal annular ligament at the ankle. In the upper third of its course the nerve crosses from the inner to the outer side of the posterior tibial vessels. In the lower third of the leg, the posterior tibial nerve and vessels are very superficial and lie parallel to the inner margin of the tendo-Achillis. *Branches:* Muscular, to the flexor longus digitorum, flexor longus hallucis, tibialis posticus; the internal calcanean (a cutaneous branch) accompanies an artery of the same name, and supplies the skin and fasciæ of the heel and a part of the sole; articular, to the ankle; internal and external plantar nerves for the supply of the bottom of the foot. These latter nerves are accompanied by arteries of the same name, and are found in a neurovasal area between the first and second layers of muscles of the sole of the foot.

The External Popliteal Nerve (Figs. 163, 166) begins at the bifurcation of the great sciatic with the internal popliteal nerve, in the superior angle of the popliteal space, and lies in contact with the biceps tendon, on the outer wall of the space. At the knee the nerve lies between the biceps tendon and the outer head of the gastrocnemius muscle, and ends on the neck of the fibula. *Branches:* (1) The superior and inferior external articular; (2) the recurrent articular, to head of the tibia, the knee, and superior tibiofibular articulation; (3) the communicans peronei, unites with the communicans poplitei (a branch of the internal popliteal) to form the short saphenous nerve; (4) the musculocutaneous, which begins on the neck of the fibula, passes downward in the substance of the peroneus longus, and gives off muscular branches to the peroneus longus and brevis, a cutaneous branch to the skin of the dorsum of the foot, and gray rami communicantes to bone, fasciæ, and vessels; (5) the anterior tibial, which begins on the neck of the fibula, passes through the peroneus longus, intermuscular septum, and extensor longus digitorum, descends on the interosseous membrane, between the extensor longus digitorum and tibialis anticus. *Branches of anterior tibial:* (*a*) Muscular, to the tibialis anticus, extensor proprius hallucis, extensor longus digitorum, and one or more dorsal interossei; (*b*) articular, to the tarsal, metatarso-phalangeal, and interphalangeal joints; (*c*) cutaneous, to the skin of the adjacent sides of the great and second toes (Fig. 140); gray rami communicantes, to bone, fasciæ, and vessels.

Relations of the Great Sciatic. (Fig 160.) Superficial: long head of the biceps, gluteus maximus, small sciatic nerve, fasciæ, and integument; deep: ischium, tendon of the obturator internus, gemelli, quadratus femoris, and adductor magnus. The comes nervi ischiadici (the proper artery of the great sciatic nerve), a branch of the sciatic artery, anastomoses with the first, second, third, and fourth perforating branches of the profunda and internal circumflex.

The Visceral Branches of the sacral plexus (Fig. 146) arise from the third and fourth sacral nerves, and represent the white rami communicantes in the thoracic region. There are no white rami communicantes in the sacral region, except those from the thoracic and lumbar regions. (See Gerrish.) *Distribution:* To the longitudinal muscle fibre of the bladder; longitudinal muscle fibre of the rectum; circular inhibitory fibres of the rectum; motor fibres of the uterus; secretory fibres of the prostate gland; vasodilator fibres for the erectile tissue of the penis.

The Nerve to the Quadratus Femoris (Fig. 146) and gemellus inferior arises from the fourth and fifth lumbar and first sacral nerves. It leaves the pelvis through the greater sacrosciatic foramen (below the pyriformis muscle), passes under the obturator internus tendon and the gemelli, and gives muscular branches to the gemellus inferior and quadratus femoris, and gray rami to bone, fasciæ, and vessels.

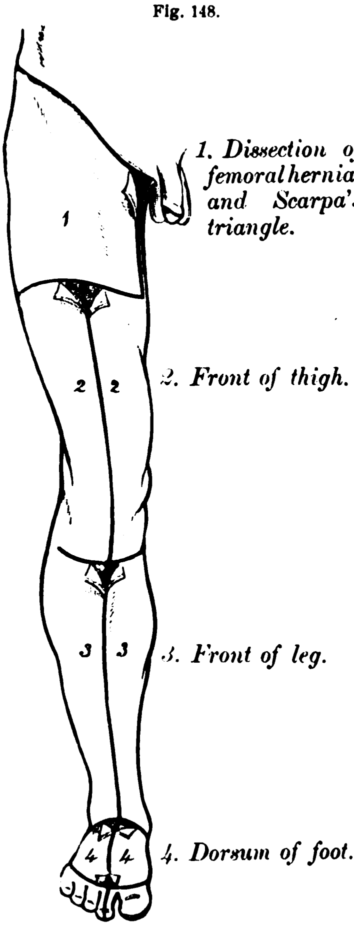
The Anterior Primary Divisions of the Fifth Sacral and coccygeal nerves unite with the fourth sacral, and form a small plexus behind the second part of the rectum. *Branches:* (*a*) To the hypogastric plexus; (*b*) to the posterior part of the coccyx. (Fig. 146.)

CHAPTER XXI.

THE ANTERIOR FEMORAL REGION.

Dissection. The superficial vessels and nerves having been dissected (pages 263–268), proceed now to remove all fat and superficial fascia, in order to make exposure of the deep fascia. Consult the illustration and identify structures in the order in which they are given in the text. Always employ blunt dissection in tracing branches of vessels and nerves.

Fig. 148.



Dissection of lower extremity. Front view. (GRAY.)

Superficial Fascia. Identify (1) by its location immediately beneath the skin and containing a variable amount of fat; (2) by the presence of a large vein on the inner and anterior part—long saphenous. (Fig. 138.)

Cutaneous Nerves and Vessels. Identify (1) by study of the chapter dealing therewith (page 263); (2) by their location in the superficial fascia.

Fascia Lata. (Fig. 149.) Identify (1) by its location beneath the superficial fascia; (2) by its great density and firm attachments to bone and Poupart's ligament.

Inguinal Lymphatic Glands. Identify (1) by their location in the inguinal region; (2) by their adjacency to the femoral vessels and Poupart's ligament.

Tensor Vaginæ Femoris. (Figs. 150, 151.) Identify (1) by its location on the outer part of the ilium and origin from the outer lip of its crest; (2) by its insertion into the fascia lata on the outer part of the thigh.

Sartorius Muscle. (Figs. 150, 151.) Identify (1) by its origin from the anterior superior iliac spine and its insertion into the upper third of the tibia; (2) by its diagonal course across the anterior and inner parts of the thigh.

Rectus Femoris. (Figs. 150, 151.) Identify (1) by its central location on the front of the thigh; (2) by its origin from the ilium and insertion into the patella.

Vastus Externus. (Figs. 150, 151.) Identify (1) by its location external to and contact with rectus femoris; (2) it overlaps the outer part of the vastus internus and is inserted into the patella.

Vastus Internus. (Figs. 150, 151.) Identify (1) at the great muscular mass occupying the inner, anterior, and outer surfaces of the shaft of the femur; (2) by its insertion into the patella.

Crureus. (See Gray and Gerrish.) Identify by its location beneath the rectus femoris and forming a part of the vastus internus.

Ligamentum Patellæ. (Fig. 150.) Identify (1) by its location just below the patella; (2) by its attachment to the tubercle of the tibia and patella; (3) by its muscles inserted thereby into the tibia (rectus crureus, and vasti).

Anterior Crural Nerve. (Fig. 151.) Identify (1) by the distribution of large branches to the integument (Fig. 140) and muscles on the anterior region of the thigh; (2) by its location external to the femoral artery, in the groove between the iliacus and psoas magnus muscles.

SUPERFICIAL FASCIA OF THE THIGH.

The superficial fascia is beneath the integument and forms an investment for the entire thigh. It is continuous with that of the leg and abdomen, and consists of an upper and a lower layer, between which are the superficial vessels and nerves.[1] The superficial fascia is attached (1) to the margin of the saphenous

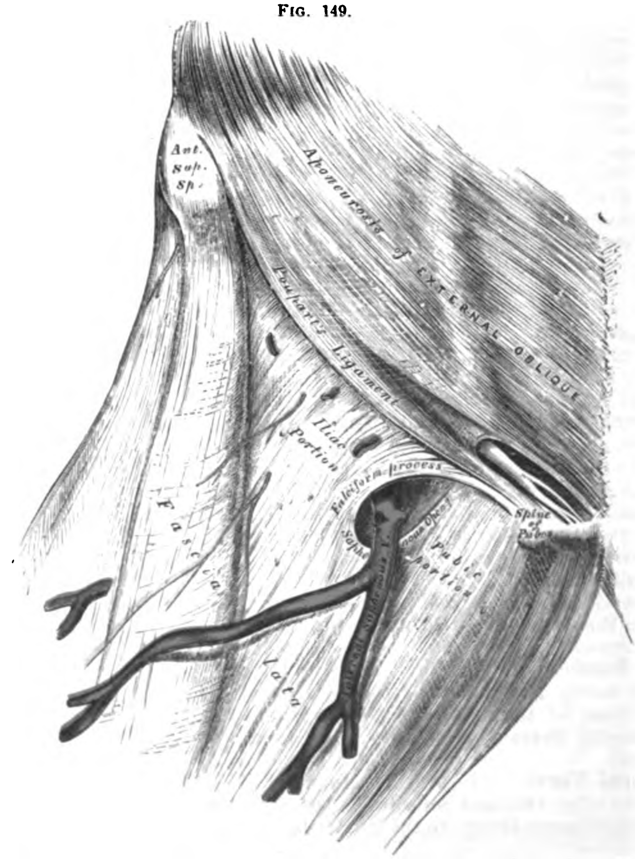
[1] Technically these structures are in the lower layer, but the line of distinction cannot be closely drawn between the upper and lower layers.

opening (Fig. 149); (2) to the femoral sheath, through the saphenous opening; (3) very intimately to the fascia lata, a little below Poupart's ligament. That part of the superficial fascia which covers the saphenous opening is called the cribriform fascia, and forms one of the coverings of a femoral hernia. The cribriform fascia is perforated by a number of vessels, among which is the long saphenous vein. The very intimate attachment of the superficial to the deep fascia below Poupart's ligament, accounts for the fact that in extravasation of urine, this fluid cannot pass down into the superficial fascia of the thigh. (See extravasation of urine, page 250.)

DEEP FASCIA OF THE THIGH—FASCIA LATA.

The Deep Fascia (fascia lata) (Fig 149) is beneath the skin and superficial fascia and forms a strong covering for the thigh. It is thin over the inner and back parts of the thigh, but thick in front and externally. The fascia lata receives fibrous

FIG. 149.



Femoral hernia, showing fascia lata and saphenous opening. (GRAY.)

expansions from the gluteus maximus, tensor vaginæ femoris, biceps, sartorius, quadriceps muscles, which add to both its strength and symmetry.

Attachments of the Fascia Lata. To Poupart's ligament and the body of the pubic bone, in front; to the tuberosity of the ischium, the pubic and ischial rami, internally; to the back of the sacrum and coccyx, behind; to the head of the fibula, tuberosities of the tibia and condyles of the femur, in the region of the knee.

Intermuscular Septa. The fascia lata gives off from its deep surface two strong intermuscular septa—an external and an internal—which afford origin to muscles, delimit their physiological groups, and determine the direction of pus in deep-seated abscesses. The external intermuscular septum is attached to the linea aspera, extends from the insertion of the gluteus maximus to the outer femoral condyle, separates the vastus externus from the short head of the biceps, and gives partial origin to both these muscles. The internal intermuscular septum is attached to the linea aspera, extends from the lesser trochanter of the femur to the adductor tubercle, and separates the vastus internus from the pectineus and adductors. This septum, thinner than the external, is pierced by the perforating branches of the profunda artery on their way to the hamstring muscles, and by the superficial femoral artery, passing to the popliteal space, through an opening in the adductor magnus. (Fig. 153.) Purulent discharges, originating in the lumbar region, in psoas abscess, are directed by the iliac fascia into the deep part of Scarpa's triangle, whence they pass down the inner side of the thigh, between the vastus internus on the outer side and the pectineus and adductors, internally. (See page 272.) The fascia lata gives off smaller septa that ensheath each muscle in each group.

Special Parts of Fascia Lata. (Fig. 149.) (1) Iliotibial band; (2) gluteal aponeurosis; (3) iliac portion; (4) pubic portion. The iliotibial band corresponds in origin to the tensor vaginæ femoris (tensor fasciæ latæ, Fig. 150), ensheaths this muscle between its outer and inner layers, in the upper fourth of the thigh, and is inserted into the outer tuberosity of the tibia. The gluteal aponeurosis takes origin from the outer lip of the iliac crest, posterior to the iliotibial band, covers the gluteus medius muscle, and at the anterior border of the gluteus maximus divides and encloses this muscle.

The Iliac Portion of the Fascia Lata (Fig. 149) is in front of the pubic portion and behind the femoral vessels. The saphenous opening is a passage between the iliac and pubic portions of the fascia lata, leading from the space of the superficial fascia to the femoral vessels. *Attachments:* The iliac portion of the fascia lata is attached to the crest of the ilium and to the whole length of Poupart's ligament; to the iliopectineal line with Gimbernat's ligament, where it is continuous with the iliac fascia. The pubic portion is attached above, to the iliopectineal line. It crosses the gracilis, adductor longus, and pectineus, passes beneath and is attached to the sheath of the femoral vessels. The iliac and pubic portions meet at the lower part of the saphenous opening, the margin of which is called the falciform process.

The Inguinal Lymphatic Glands are (1) superficial, situated along Poupart's ligament and around the saphenous opening; (2) deep, situated near the upper end of the femoral vessels. (See Gerrish and Gray.)

MUSCLES.

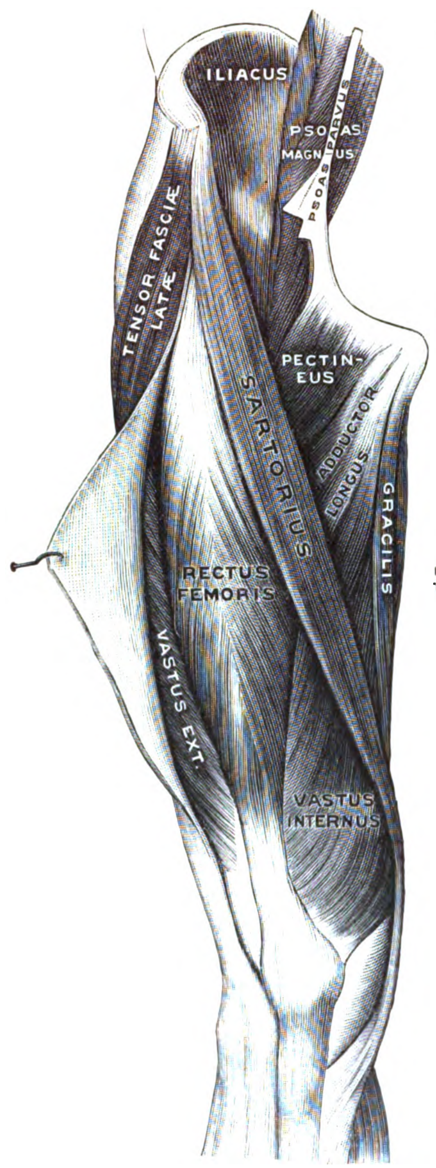
The Tensor Vaginæ Femoris (tensor fasciæ latæ). (Figs. 150, 151.) *Origin:* Outer lip of the crest of the ilium for about two inches. *Insertion:* Upper fourth of the fascia lata on outer surface of the thigh. *Nerve:* Superior gluteal. *Artery:* Superior gluteal. *Action:* Abductor and internal rotator of the thigh.

The Sartorius (Figs. 150, 151) extends across the thigh from the anterior superior iliac spine to the inner surface of the upper third of the tibia; it is the longest muscle in the body. *Origin:* (1) Anterior superior spine of ilium; (2) superior iliac notch. *Insertion:* (1) Internal surface of the tibia; (2) deep fascia and periosteum of upper part of the leg. The aponeurotic insertion covers the tendons of the gracilis and semitendinosus muscles. *Action:* (1) To flex and abduct the thigh and rotate the same outward; (2) to flex the knee and rotate the same inward; (3) to make tense the inner part of the fascia lata; (4) to flex the pelvis on the thigh. *Nerve:* Anterior crural. *Artery:* Femoral.

Rectus Femoris. (Figs. 150, 151.) *Origin by two heads:* (1) Straight head, anterior inferior iliac spine; (2) reflected head, acetabular brim, and external part of the capsule of the hip. *Insertion:* Front border of patella. *Action:* To extend the leg. *Synergists:* Vasti. *Antagonists:* Biceps, semitendinosus, and semimembranosus. *Nerve:* Anterior crural. *Artery:* Femoral.

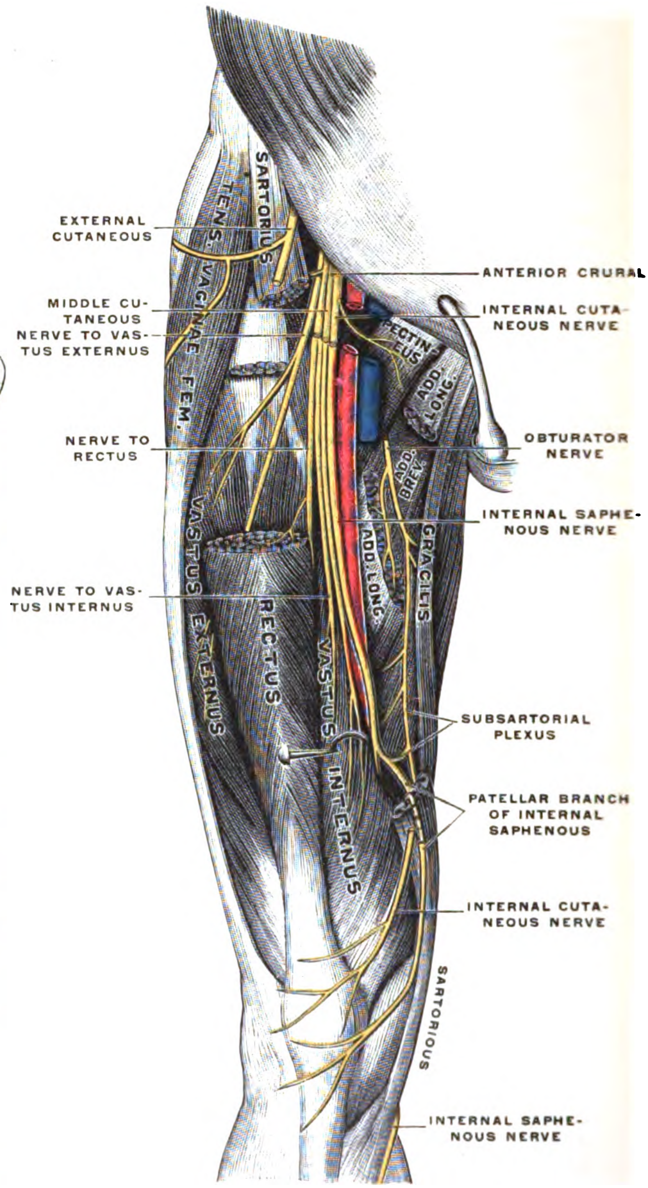
Vastus Externus. (Figs. 150, 151.) *Origin:* (1) Anterior intertrochanteric line and surface of femur in front of the greater trochanter; (2) lower border of

FIG. 150.



Superficial muscles in front part of the right thigh. (GERRISH after TESTUT.)

FIG. 151.



Deep nerves of the front of the thigh. (GERRISH after TESTUT.)

the greater trochanter; (3) outer lip of the gluteal ridge; (4) outer lip of the linea aspera, upper half; (5) external intermuscular septum. *Insertion:* (1) Upper and outer border of patella; (2) external tuberosity of tibia and deep fascia of leg. *Action:* To extend the leg. *Nerve:* Anterior crural. *Artery:* External circumflex. (Fig. 152.)

Vastus Internus. (Figs. 150, 151.) *Origin:* (1) Outer lip of the linea aspera, lower half; (2) external condylar ridge; (3) lower part of the anterior intertrochanteric and spiral lines; (4) inner lip of the linea aspera; (5) internal condylar ridge; (6) greater part of the inner, outer, and anterior surfaces of the femur. *Insertion:* (1) Upper half and upper border of patella; (2) inner tuberosity of tibia and deep fascia of leg. *Nerve:* Anterior crural. *Artery:* Superficial femoral. (Fig. 152.)

The Crureus is that part of the vastus internus beneath the rectus femoris. The subcrureus consists of fibres of the crureus inserted into the upper part of the synovial membrane of the knee. Quadriceps femoris is a term by which the rectus, the two vasti, and the crureus are designated collectively. *Action:* To extend the leg.

The Ligamentum Patellæ (Figs. 150, 151) is the common tendon by which the muscles of the quadriceps extensor femoris are inserted into the tubercle of the tibia. It is attached above to the apex and lower part of the posterior surface of the patella. *Size:* One-quarter of an inch thick, one inch broad, and from two to three inches long.

ANTERIOR CRURAL NERVE.

The anterior crural is the large nerve external to the femoral artery, in a groove between the psoas and iliacus muscles. (Fig. 151.) It has an immense distribution to muscles, integument, articulations, and unstriped muscular fibre. The following table gives its intrapelvic and extrapelvic branches:

Intrapelvic portion . . .	Muscular, to the iliacus muscle. Gray rami, to the femoral artery.
Anterior division	Middle cutaneous. Internal cutaneous. Muscular, to the sartorius and pectineus.
Posterior division	Long saphenous. Muscular, to the extensor muscles. Articular, to the hip and knee-joints.

The Anterior Crural Nerve is a branch of the lumbar plexus, from the second, third, and fourth nerves. The constituent parts of the nerve unite in the groove between the psoas magnus and iliacus muscles, under the iliac fascia. The nerve passes beneath Poupart's ligament (external to the sheath of the femoral vessels) into Scarpa's triangle, and divides into (1) a superficial; (2) a deep group of branches separated by the external circumflex artery. (Fig. 152.)

The Superficial Branches of the anterior crural nerve supply (1) the pectineus muscle, by a branch which passes behind the femoral sheath; (2) the sartorius muscle; (3) the skin of the inner side of the thigh, through the internal cutaneous; (4) the front of the thigh, through the middle cutaneous. The anterior crural sends a twig to the femoral artery, and also to the iliacus muscle before it emerges from the pelvis. (Figs. 140, 151.)

The Deep Branches of the anterior crural nerve are (1) to the vastus internus muscle in Scarpa's triangle, on the outer side of the long saphenous nerve; (2) to the subcrureus muscle and knee; (3) to the crureus, entering the upper part of the muscle; (4) to the vastus externus and knee; (5) to the rectus femoris and hip; (6) the long saphenous nerve in Scarpa's triangle is between the nerve to the vastus internus and the femoral artery; in Hunter's canal it lies successively external to, in front of, and internal to the femoral artery. It becomes cutaneous at the inner side of the knee, passing between the sartorius and gracilis. (Fig. 154.) It supplies the skin of the inner and anterior part of the leg, passes in front of the inner malleolus to a point two inches below the ankle.

Gray Rami Communicantes in General are described with the spinal nerves. They originate in the ganglion cells of the vertebral ganglia, and pass with the spinal nerves to bone, fasciæ, and unstriped muscle fibre, and are ultimately distributed to the above structures with the vessels. In the case under consideration the gray rami, destined to accompany the ramifications of the femoral artery, come down with the anterior crural nerve and figure as "a branch to the femoral artery." (See Gray.)

The anterior and posterior divisions of the anterior crural nerve (as seen in the table of branches) are separated from each other by the external circumflex artery. This artery lies on the iliacus and pectineus muscles, and much care is necessary, with blunt dissection, to properly develop this region.

FEMORAL ARTERY AND VEIN.

The Femoral Artery (Fig. 152), a continuation of the external iliac, is in Scarpa's triangle and Hunter's canal. It begins midway between the anterior superior iliac spine and the symphysis pubis, and ends at the opening in the adductor magnus, where it becomes the popliteal artery. (Figs. 153, 164.) The femoral artery has the following branches:

Common femoral	Superior epigastric. Superficial circumflex iliac. Superficial external pudic. Deep external pudic.
Profunda femoris	External circumflex. Internal circumflex. Three perforating.
Superficial femoral	Muscular branches. Anastomotica magna.

The Femoral Vein (Fig. 152) has the same course and stages as the artery, and its tributaries, in the main, correspond to the branches of the artery. The relations of the vein to the arteries may be thus generalized : 1. In the upper third of the thigh, the vein and artery are on the same plane. 2. In the middle third, the vein is behind the artery. 3. In the lower third, the vein is somewhat external to and behind the artery. The femoral vein has four or five valves. (Consult the following table for tributaries of the femoral vein) :

TRIBUTARIES OF THE FEMORAL VEIN.

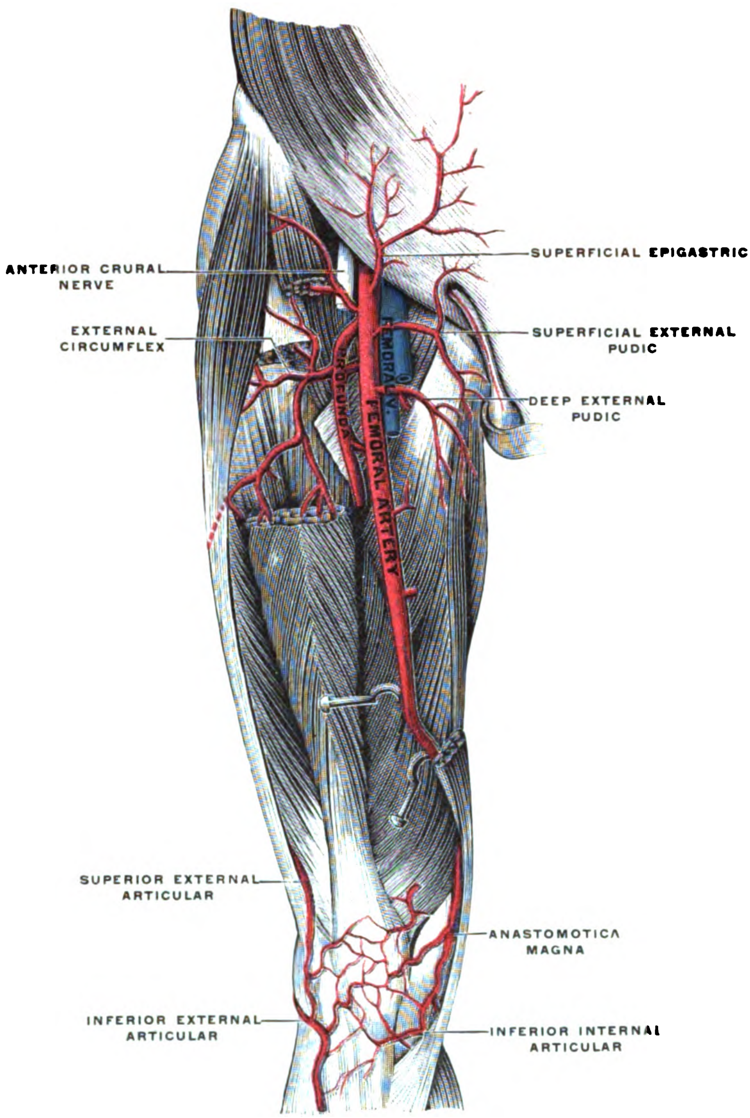
Common femoral vein . . .	Superficial epigastric. Superficial circumflex iliac. Superficial external pudic. Deep external pudic. Long saphenous.
Profunda femoris vein . . .	External circumflex. Internal circumflex. Three perforating.
Superficial femoral vein . .	Muscular branches. Anastomotica magna.

The object of the above table is to impress on the student the fact that each branch of the femoral artery is attended by a vein of similar course and name. As will be seen on dissection, the long saphenous vein has no corresponding artery. (Fig. 138.)

The Femoral Sheath invests the femoral artery and vein, and contains an unoccupied space (internal to the vein) called the femoral canal. The sheath is formed by two fasciæ—the iliac and transversalis—which come down from the abdomen under Poupart's ligament, into the thigh. (See femoral sheath and general fascia transversalis, pages 203, 272.)

In Scarpa's triangle the anterior crural nerve lies to the outer side of the femoral artery in a groove between the psoas and iliacus muscles; to the inner side of the artery, is the femoral vein; in Scarpa's triangle, the artery is crossed by a branch of the internal cutaneous nerve. In Hunter's canal, the long saphenous nerve crosses the artery from without inward. (Fig. 151.) On leaving the pelvis, the femoral vessels are invested by the femoral sheath.

FIG. 152.



Femoral artery. (GERRISH after TESTUT.)

BRANCHES OF THE FEMORAL ARTERY.

1. **The Superficial Epigastric Artery** (Fig. 152) is given off one-half inch below Poupart's ligament. It passes through the saphenous opening and crosses in the superficial fascia of the abdomen, toward the umbilicus. A vein of like name attends the artery. The artery supplies the skin and superficial lymphatic glands in this region.

2. **The Superficial Circumflex Iliac** (Fig. 152), attended by a vein of like name, runs below and parallel with Poupart's ligament, giving branches to the skin, fasciæ, inguinal lymphatics, iliacus, and sartorius muscles.

3. **The Superficial External Pudic** (Fig. 152) passes inward in front of the spermatic cord, and supplies the penis and the skin of the pubes.

4. **The Deep External Pudic** (Fig. 152) crosses the pectineus and adductor longus muscles, and supplies the skin of the scrotum or its homologue, the labia majora.

5. **The Profunda Femoris** (Fig. 152) arises from the outer and back part of the femoral, and passes downward and inward behind the parent artery. In the middle third of the thigh, it passes behind the adductor longus, pierces the adductor magnus, and ends in the flexor muscles of the back of the thigh. (Figs. 157, 159.) The artery lies on the iliacus, pectineus, adductor brevis, and adductor magnus muscles, and is the principal source of nourishment to the thigh. Its internal circumflex branch supplies the adductors; its external circumflex, the extensors of the knee; its perforating branches, the hamstring muscles and the femur. The profunda has the following branches: (*a*) *External circumflex.* (Fig. 152.) This branch runs outward under the rectus and sartorius muscles and divides into three branches—ascending, transverse, and descending. The ascending branch, anastomoses with the superior gluteal and deep circumflex iliac between the gluteus medius and minimus. The transverse branch, pierces the vastus externus and anastomoses with the sciatic and internal circumflex. (Fig. 159.) The descending branch accompanies the nerve to the vastus externus muscle and anastomoses with the superior articular branches of the popliteal artery. (Fig. 159.) The branches of the external circumflex supply principally the extensor muscles of the knee. (*b*) *Internal circumflex.* (Fig. 152.) The internal circumflex branch arises from the back and inner part of the artery and supplies the adductors and obturator externus muscles. The course of the vessel is between the psoas and pectineus; between the adductor brevis and obturator externus; between the quadratus femoris and adductor magnus, where it anastomoses with the sciatic, external circumflex, and superior perforating arteries, to form the crucial anastomosis. (*c*) *Perforating branches.* (Fig. 159.) These are four in number—superior, middle, inferior, and fourth. They pass through the adductor group of muscles, principally to supply the biceps, semitendinosus, and semimembranosus; they anastomose with one another, with the gluteal, sciatic and internal circumflex above, and with the muscular and articular branches of the popliteal below. (Figs. 153, 159.) The first, second, and third are given off near or behind the adductor longus, and are seen by cutting this muscle near its insertion and turning the same aside.

6. **Muscular Branches** are given off from the superficial femoral in its whole course; they supply the sartorius and vastus internus muscles.

7. **The Anastomotica Magna** (Fig. 152) arises from the lower end of the superficial femoral artery and divides into a superficial and a deep branch. The superficial branch passes with the long saphenous nerve between the sartorius and gracilis muscles, supplies the skin of the leg and anastomoses with the inferior internal articular branch of the popliteal artery. The deep branch runs in front of the tendon of the adductor magnus to the inner condyle, and anastomoses with the internal superior articular, the external superior articular (articular branches of the popliteal), and the anterior tibial recurrent arteries.

CHAPTER XXII.

THE INTERNAL FEMORAL REGION.

Dissection and Identification. Abduct the limb and remove the integument. (Fig. 148.) Notice the long prominence on the inner part of the thigh produced by the gracilis muscle. The long saphenous vein (Fig. 138) skirts the outer boundary of this region to reach the femoral vein. The cutaneous nerves (Fig. 140) are the ilio-inguinal, internal cutaneous, and a cutaneous branch of the obturator. The deep fascia is thin. (Fig. 149.) The anterior division of the obturator nerve is between the adductor longus and adductor brevis; the posterior, between the adductor brevis and magnus. (Fig. 151.)

Gracilis Muscle. (Fig. 154.) Identify (1) by the location on the innermost region of the thigh and its slender form; (2) by the origin from the pubic body and ramus and the insertion into the upper third of the tibia.

Pectineus Muscle. (Figs. 153, 154.) Identify (1) by the location on the pubic bone beneath the femoral canal and femoral vein; (2) by the location beneath the pubic part of the fascia lata and its insertion into the femur, behind the lesser trochanter.

Adductor Longus Muscle. (Figs. 153, 154.) Identify (1) by the origin from the anterior surface of the pubic bone and the insertion into the middle third of the femur; (2) by its adjacency to the pectineus and gracilis muscles.

Adductor Brevis Muscle. (Fig. 153.) Identify (1) by the origin from the pubic bone lower than the origin of the adductor longus; (2) by the location beneath the adductor longus and in front of the adductor magnus.

Adductor Magnus. (Fig. 153.) Identify (1) by the great size, and its location; (2) by the origin from the ischiopubic ramus and tuber of the ischium; (3) by the insertion into the adductor tubercle and linea aspera. Make full exposure of this muscle by cutting through the adductor brevis in the region of the director (Fig. 153) and turning it aside.

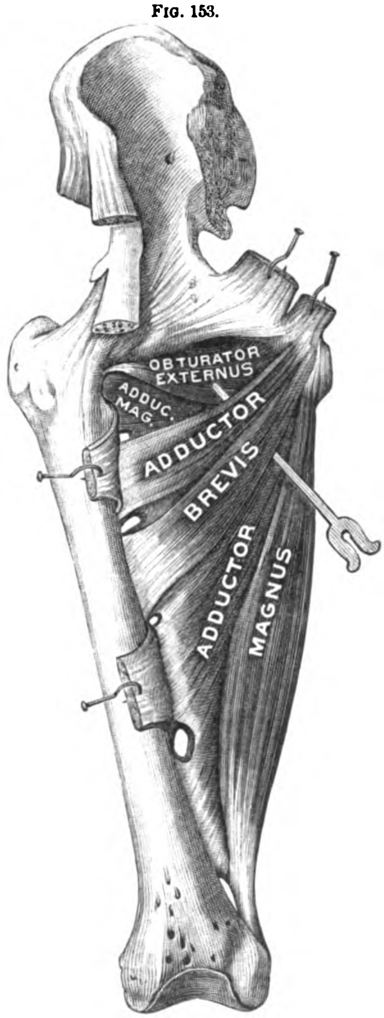
Obturator Nerve. (Fig. 154.) Identify (1) by its anterior division located between the longus and adductor brevis; (2) by its posterior division, between the adductor brevis and adductor magnus; (3) by its distribution to the adductor muscles.

Obturator Artery. (Fig. 134.) Identify (1) by the location in the adductor region and its course with the obturator nerve; (2) it leaves the pelvis through the obturator canal with the obturator nerve.

Scarpa's Triangle. (Figs. 150, 151.) Identify (1) by the location in the upper and anterior part of the thigh; (2) by the boundary structures—Poupart's ligament, adductor longus and sartorius muscles; (3) by the contents—femoral vessels and anterior crural nerve.

Hunter's Canal. (Figs. 151, 152.) Identify (1) by the location in a hollow, bounded on the outside by the vastus internus, on the inside by the adductor longus and magnus muscles; (2) by extending from the apex of Scarpa's triangle to the popliteal space; (3) by the contents—femoral vessels and long saphenous nerve.

FIG. 153.



Adductores magnus and brevis of right side. The pectineus (above) and the adductor longus (below) are turned aside and held by hooks. The openings transmit the femoral artery to the popliteal space and the perforating branches of the profunda artery to the back of the thigh. (GERRISH after TESTUT.)

THE ADDUCTOR MUSCLES. (Figs. 151, 153.)

The Gracilis Muscle. (Figs. 151, 154.) *Origin:* Inner edge of the anterior surface of the body and descending ramus of the pubic bone. *Insertion:* Below the inner tuberosity of the tibia, under cover of the sartorius, and on a plane above, and anterior to insertion of the semitendinosus. *Action:* Adduction of the thigh and flexion of the knee. *Nerve:* Anterior division of obturator. *Artery:* Profunda. Note the long, ribbon-shape of this muscle.

The Pectineus Muscle. (Figs. 153, 154.) *Origin:* (1) Iliopectineal line and the bone in front of this line; (2) deep surface of the pubic portion of the fascia lata. *Insertion:* Back of the femur, and into a vertical line behind the lesser trochanter. *Action:* Flexion, adduction and external rotation of the thigh. *Arteries:* Internal circumflex and obturator. *Nerves:* Obturator, accessory obturator, and anterior crural. (Fig. 151.)

Adductor Longus Muscle. (Fig. 153, 154.) *Origin:* Front of the body of the os pubis below the crest and angle. *Insertion:* Middle lip of the linea aspera and middle third of femur. *Action:* Adduction, flexion and outward rotation of femur. *Nerve:* Anterior division of the obturator. *Arteries:* Obturator (a branch of the internal iliac), internal circumflex, and superior perforating branch of deep femoral.

Adductor Brevis Muscle. (Fig. 153.) *Origin:* Body and descending ramus of the os pubis. *Insertion:* Inner lip of the linea aspera, extending from below the lesser trochanter to the middle of the back of the femur. *Action:* Flexion, adduction, and outward rotation of the thigh. *Nerve:* Anterior division of the obturator. *Arteries:* Obturator (from internal iliac), internal circumflex, and superior perforating branch of the deep femoral.

Adductor Magnus Muscle. (Fig. 153.) *Origin:* (1) Outer part of the lower border of the tuber ischii; (2) outer surface of the ascending ramus of the ischium; (3) outer surface of the descending ramus of the pubes. *Insertion:* (1) Back of the femur, into a line beginning at the lower end of the linea quadrati, and extending along the inner border of the gluteal ridge and the middle lip of the linea aspera, down to the latter's bifurcation; (2) the adductor tubercle on the inner femoral condyle; (3) the lower part of the internal intermuscular septum. *Action:* Adduction and internal rotation of the thigh. *Nerves:* Obturator (posterior division) and great sciatic. *Arteries:* Internal circumflex, obturator, perforating branches of profunda and superior sural branches of the popliteal. This muscle is pierced by the first, second, third, and fourth perforating branches of the profunda artery and by the femoral vessels, gaining the popliteal space to become the popliteal vessels. (Fig. 153.)

THE OBTURATOR NERVE.

The Obturator Nerve (Figs. 144, 154) arises from the third and fourth lumbar and receives a branch from the second. *Course:* (*a*) Between the psoas muscle and fifth lumbar vertebra; (*b*) to the outer side of the internal iliac vessels and ureter; (*c*) below the external iliac vessels; (*d*) on the outer wall of the pelvis, above the obturator artery. The nerve passes through an opening in the obturator membrane and divides into an anterior and a posterior division. (Fig. 154.) The anterior division passes between the pectineus and adductor brevis muscles and gains the space between the adductor longus and adductor brevis. The posterior division pierces the obturator externus and gains the space between the adductor brevis and adductor magnus.

Branches of Anterior Division: An articular branch, to the hip-joint; a muscular branch, to the adductor longus; a muscular branch, to the adductor brevis; a muscular branch, to the gracilis; a muscular branch, to the pectineus; a cutaneous branch, to the subsartorial plexus; a branch to the femoral artery (a gray ramus communicans).

Branches of Posterior Division: Articular branches, to the hip-joint; a geniculate branch, to the knee-joint; a branch to the obturator externus muscle; several branches to the adductor magnus. The twig to the hip-joint passes through the cotyloid notch. The branch for the knee-joint—the geniculate—pierces the adductor magnus muscle, near the opening for the femoral artery, and descends on the popliteal artery.

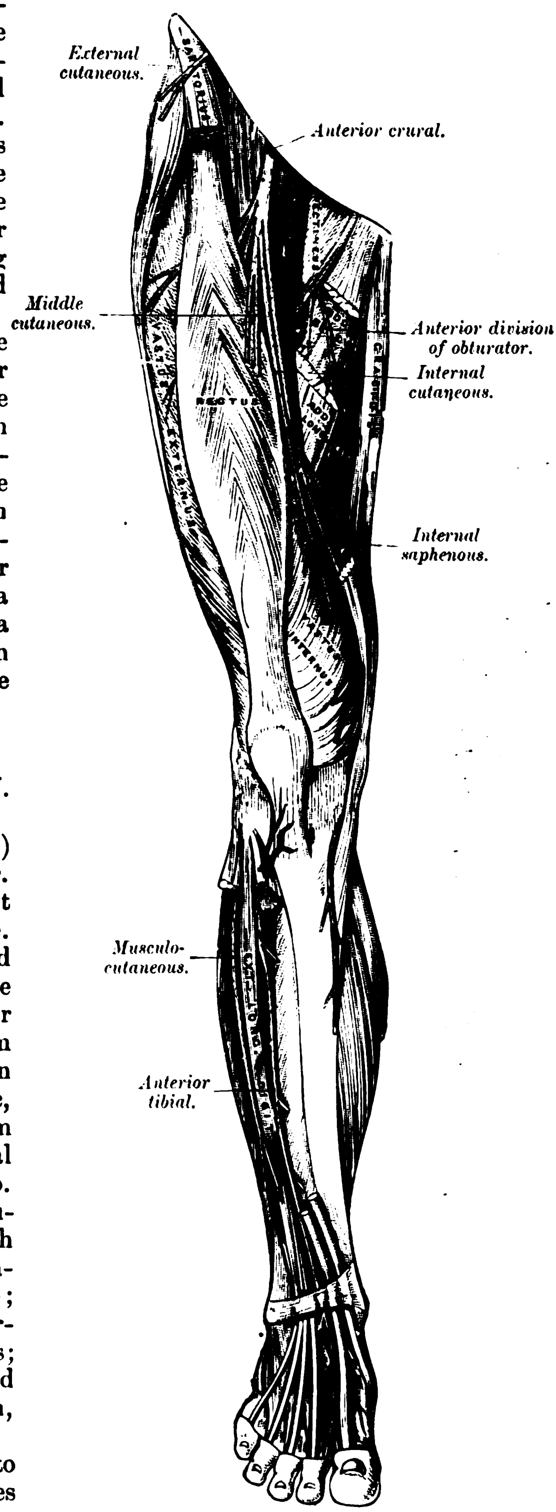
Gray Rami Communicantes. The anterior crural and obturator nerves contribute twigs to the femoral artery. It is through these twigs that the non-medullated axis-cylinder processes of the sympathetic ganglion cells reach the vessels, fasciæ, bones, cartilages, and periosteum of the lower extremity. (Gerrish.) Wherever a somatic nerve gives a twig to a vessel, this same interpretation applies. (See Chapter on the Sympathetic Nerve.)

THE OBTURATOR ARTERY.

The Obturator Artery (Fig. 134) is a branch of the internal iliac. On the outer wall of the pelvis it lies below the obturator nerve. It pierces the obturator fascia, and leaves the pelvis through the obturator canal, with the obturator nerve. The artery may arise from the deep epigastric, one case in thirty-five; from the external iliac, one case in seventy-two; from both deep epigastric and external iliac, one case in seventy-two. The usual branches of the obturator artery are: a vesical, which reaches the bladder *via* false ligament; a pubic, to the pubic bone; an internal, to the obturator externus, pectineus, and adductors; an external, to the hip-joint and obturator muscles; an iliac branch, to the ilium and iliacus muscle.

The Obturator Vein opens into the internal iliac. Its tributaries correspond to the branches of the obturator artery both in number

FIG. 154.



Nerves of the lower extremity. Front view. (GRAY.)

and location. On the outer wall of the pelvis the vein lies below the obturator artery. (Divided structures in this region may now be replaced as well as possible, so as to gain an idea of Scarpa's triangle.)

SCARPA'S TRIANGLE.

Scarpa's Triangle (Figs. 150, 154) occupies the upper and anterior part of the thigh. It is triangular, the base being above and the apex down. It derives its surgical importance, in part, from the following pathological conditions: Diseased inguinal lymphatic glands; inguinal and femoral herniæ; fractures of neck of femur; dislocation of head of femur; varicose scrotal and spermatic veins; ligation of femoral vessels; primary and secondary abscesses; obliteration of long saphenous vein; bloodless amputation at hip; injection of tubercular hip-joint. *Analysis:* Scarpa's triangle is bounded superiorly, by Poupart's-ligament; externally, by the sartorius muscle; internally, by the adductor longus muscle. The roof consists of integument, superficial fascia, and fascia lata. The saphenous opening (Fig. 149) is in the fascia lata; the superficial fascia covering this opening is the cribriform fascia. The floor is formed, from without in, by the iliacus, psoas magnus, pectineus, and adductor longus muscles. In females and thin males, an interval persists between the pectineus and adductor longus muscles, hence in these cases the adductor brevis may be seen on the floor of the triangle. The apex of the triangle is at the junction of the adductor longus and sartorius muscles.

Contents. (Figs. 151, 154). The common femoral artery and vein; the profunda artery and vein; the superficial femoral artery and vein; the anterior crural nerve and its branches; the femoral sheath and femoral canal; the saphenous opening and cribriform fascia; the termination of the long saphenous vein; the spermatic cord or round ligament; the superficial and deep inguinal lymphatic glands; the ilio-inguinal and genito-crural nerves.

HUNTER'S CANAL. (Fig. 151.)

Location. Hunter's canal is a groove extending from the apex of Scarpa's triangle to the aperture in the adductor magnus muscle, at the junction of the middle and lower thirds of the thigh. The canal is bounded externally by the vastus internus muscle, internally by the adductor longus and adductor magnus. The roof is formed by a dense aponeurosis, the sartorius muscle, the skin, superficial and deep fasciæ. *Contents:* The superficial femoral vessels and the long saphenous nerve (external to the vessels), but not in their sheath. This nerve accompanies the femoral vessels as far as the opening in the adductor magnus; here it passes through the roof of the canal and becomes cutaneous, on the inner side of the knee, between the sartorius and gracilis muscles.

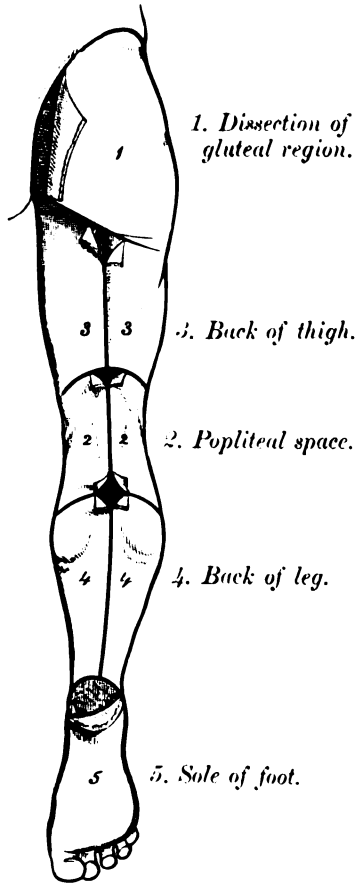
CHAPTER XXIII.

THE GLUTEAL REGION.

Dissection and Identification. Place a block under cadaver in such a manner as to elevate hips and put the gluteal region on the stretch. Remove skin (leaving the superficial fascia in place) in accordance with skin incisions in Fig. 155. To aid in learning the cutaneous nerves, consult Fig. 141 and refer to table of cutaneous nerves, pages 166–168.

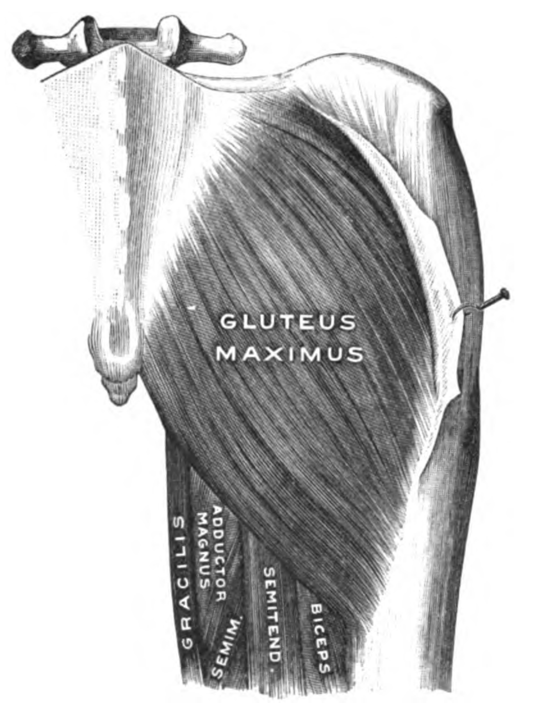
The Superficial Fascia in the gluteal region contains much fat. It is tough and elastic, over the tuberosity of the ischium; thick, along the lower border of the gluteus maximus. The cutaneous nerves, as shown in the table, are (*a*) the posterior branch of the external cutaneous;

Fig. 155.



Dissection of lower extremity. Posterior view. (Gray.)

Fig. 156.



Gluteus maximus of right side. (Gerrish after Testut.)

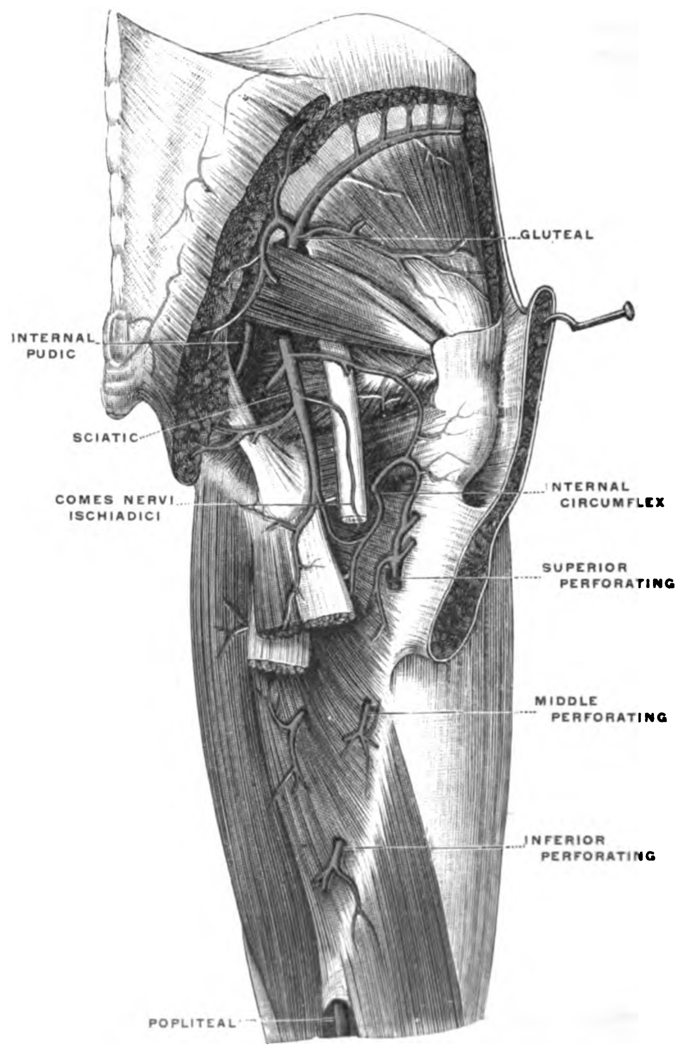
(*b*) the lateral cutaneous branch of the twelfth thoracic; (*c*) the iliac branch of the iliohypogastric; (*d*) the ascending and long pudendal branches of the small sciatic; (*e*) the three posterior divisions of the sacral nerves; (*f*) the three posterior divisions of the lumbar nerves, and other branches of minor importance. (See table of cutaneous nerves of lower extremity, pages 166–168.)

The Deep Fascia of the gluteal region is a part of the fascia lata. (Fig. 149.) It descends from the crest of the ilium, ensheaths the tensor vaginæ femoris, covers the gluteus medius, and at the anterior border of the gluteus maximus splits and encloses this muscle. Over the posterior part of the gluteus maximus muscle the fascia is thin. In Fig. 156 the deep fascia is represented as held aside by a hook, thereby making exposure of the fibres of the gluteus maximus muscle.

Remove with a sharp scalpel the deep fascia from the gluteus maximus muscle. (Fig. 156.) Divide the deep fascia along the lower border of the muscle and elevate same so as to expose the great and small sciatic nerves, semitendinosus, semimembranosus muscles, and the long head of the biceps, all of which muscles originate from the tuber of the ischium. Cut vertically through the gluteus maximus in a line with the great sciatic nerve, carefully turn aside the two parts of the muscle and expose and identify following structures (Fig. 157, 159) :

The Great Sciatic Nerve (Fig. 160) emerges from the pelvis below pyriformis muscle through the great sacrosciatic foramen, and rests successively on the gemellus superior, obturator internus, gemellus inferior, obturator externus, quadratus femoris, and adductor magnus muscle. The obturator externus is concealed by the quadratus femoris.

FIG. 157.



Arteries of the back of the hip and thigh. (GERRISH after TESTUT.)

The Small Sciatic Nerve (Fig. 160) leaves the pelvis below the pyriformis muscle and lies behind the great sciatic. The sciatic vessels emerge below the pyriformis and lie internal to the great sciatic.

The Internal Pudic Nerve and Vessels (Figs. 157, 160) emerge from the greater sacrosciatic foramen, below the pyriformis, cross the spine of the ischium, and re-enter the pelvis through the lesser sacrosciatic foramen.

The Superior Gluteal Nerve and Vessels (Fig. 157) emerge from the pelvis above the pyriformis, through the great sacrosciatic foramen. The vessels divide into (1) superficial branches which pass between the gluteus maximus and gluteus medius; (2) deep branches which pass between the gluteus medius and gluteus minimus. The nerve passes between the gluteus medius and minimus, supplying these muscles and the tensor vaginæ femoris.

The Gluteus Medius (Fig. 158) lies above the pyriformis. Cut its insertion into the oblique line of the greater trochanter, and on turning the muscle aside, the deep branches of the superior gluteal vessels, resting on gluteus minimus, appear. (Fig. 157.)

The Synovial Bursæ, under the gluteus maximus: Identify (1) one between the aponeurosis of this muscle and the greater trochanter; (2) one between the tendon of the muscle and the gluteal ridge; (3) one between the muscle and the tuber of the ischium.

THE GLUTEAL MUSCLES.

The Gluteus Maximus. (Figs. 156, 160.) *Origin:* (1) Outer lip of the iliac crest; (2) iliac surface between the superior gluteal line and outer lip of the crest; (3) lumbar aponeurosis, between the posterior superior iliac spine and sacrum; (4) lateral surface of the fourth and fifth sacral vertebræ; (5) side of the coccyx; (6) back of the great sacrosciatic ligament; (7) fascia lata investing the gluteus medius. *Insertion:* Gluteal ridge of femur, leading from greater trochanter, to the linea aspera and fascia lata. *Action:* Extension of hip. *Antagonists:* Psoas, iliacus, pectineus, and sartorius. *Nerves:* Inferior gluteal and sacral plexus. *Arteries:* Sciatic and superior gluteal, from internal iliac. (Figs. 134, 157.)

Gluteus Medius. (Figs. 158, 159.) *Origin:* (1) Outer lip of the iliac crest, anterior four-fifths; (2) iliac surface between the middle and superior gluteal lines; (3) investing deep fascia, which also separates this from the gluteus maximus; (4) intermuscular septa between the gluteus medius and gluteus maximus. *Insertion:* Oblique line on the outer surface of the greater trochanter. (Fig. 159.) *Action:* Abduction and inward rotation of the hip. *Synergists:* Tensor vaginæ femoris and gluteus maximus. *Antagonists:* Adductor longus, adductor brevis, adductor magnus, adductor gracilis, and obturator externus muscles. *Nerves:* Superior gluteal, and sacral plexus. *Arteries:* Superior gluteal internal and external circumflex.

The Gluteus Minimus. (Figs. 159, 160.) *Origin:* (1) Outer surface of the ilium, between the middle and inferior gluteal lines; (2) intermuscular septum between the gluteus medius and gluteus minimus; (3) capsule of the hip. *Insertion:* Anterior border of the greater trochanter. *Action:* Abduction and inward rotation of the thigh. *Synergists:* Gluteus medius and tensor vaginæ femoris. *Antagonists:* Adductors and external rotators. *Nerve:* Superior gluteal. *Arteries:* Superior gluteal, internal and external circumflex.

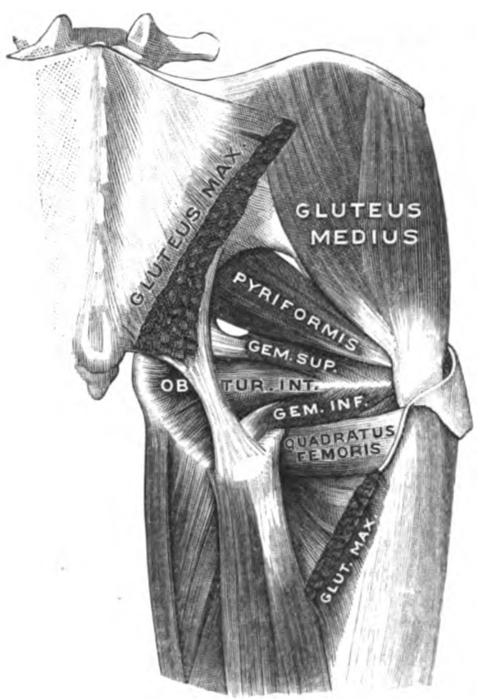
EXTERNAL ROTATOR MUSCLES.

The six external rotator muscles of the thigh are: the pyriformis, gemellus superior, obturator internus, gemellus inferior, obturator externus, and quadratus femoris. They are all inserted about the greater trochanter and are in relation with the posterior part of the capsule of the hip-joint. When the long axis of the limb is parallel to that of the trunk, they are external rotators. When, however, the thigh is at right angles to the trunk, as in the sitting posture, all the external rotators, except the obturator externus and quadratus femoris, become abductors of the thigh.

The Pyriformis. (Figs. 158, 160.) *Origin:* (1) Front of the sacrum between first, second, and third anterior sacral foramina; (2) deep surface of the great sacrosciatic ligament; (3) posterior border of the os innominatum. *Insertion:* Muscle leaves the pelvis through the greater sacrosciatic foramen and is inserted into the inner surface of the superior border of the greater trochanter. *Action:* Outward rotation of the thigh. *Synergists:* The remaining five external rotators. *Antagonists:* Gluteus medius, gluteus minimus, and tensor vaginæ femoris. *Nerve:* Second sacral. *Arteries:* Sciatic and internal circumflex.

Obturator Internus. (Fig. 158.) *Origin:* (1) Posterior surface of the body of the pubic bone; (2) ischiopubic ramus; (3) inner surface of the obturator membrane; (4) surface of the bone corresponding to the acetabulum, externally; (5) pelvic and obturator fasciæ. *Insertion:* Greater trochanter. *Action:* External rotation. *Synergists:* The remaining external rotators, five in number. *Antagonists:* The tensor vaginæ femoris, gluteus medius, and gluteus minimus. *Nerves:* First and second sacral. *Arteries:* Sciatic and internal circumflex.

FIG. 158.



Muscles of the right hip viewed from behind, the gluteus maximus having been cut away. (GERRISH after TESTUT.)

Gemellus Superior. (Fig. 158.) *Origin:* (1) Outer surface of the ischial spine; (2) upper half of the outer edge of the lesser sacrosciatic notch. *Insertion:* Tendon of the obturator internus. *Action:* External rotation of the hip. *Synergists:* The five remaining external rotators. *Antagonists:* Tensor vaginæ femoris, gluteus medius and gluteus minimus. *Nerves:* First and second sacral. *Arteries:* Sciatic and internal circumflex.

The Gemellus Inferior. (Fig. 158.) *Origin:* (1) Inner border of the tuber ischii; (2) lower half of the outer edge of the lesser sacrosciatic foramen. *Insertion:* Tendon of the obturator internus. *Action:* External rotation. *Synergists:* Five remaining external rotators. *Antagonists:* Tensor vaginæ femoris, gluteus medius, and gluteus minimus. *Nerve:* Sacral plexus. *Artery:* Internal posterior circumflex. (Fig. 159.)

The Quadratus Femoris. (Fig. 158.) *Origin:* Outer border of the tuber of the ischium. *Insertion:* Linea quadrati of the femur. *Action:* External rotation. *Synergists:* The five remaining external rotators. *Antagonists:* Tensor vaginæ femoris, gluteus medius, and gluteus minimus. *Nerve:* Sacral plexus. *Arteries:* Internal circumflex and sciatic. (Figs. 157, 159.)

Obturator Externus. (Fig. 153.) *Origin:* Inner half of the outer surface of the obturator membrane; (2) ischiopubic ramus. *Insertion:* Digital fossa of the femur, on the inner surface of the greater trochanter. *Action:* Adduction and outward rotation of the thigh. *Nerve:* Posterior division of the obturator. *Artery:* Obturator. To expose this muscle posteriorly, cut through the insertion of the quadratus femoris and turn the same aside.

VESSELS AND NERVES.

The Gluteal Artery (Figs. 157, 159) is a branch of the internal iliac. It leaves the pelvis through the great sacrosciatic foramen above the pyriformis, with the superior gluteal nerve and veins. On emerging, it divides into a superficial and a deep branch. (The superior gluteal nerve undergoes a like division and has a similar distribution.) The superficial branch supplies the gluteus maximus and anastomoses with the lateral sacral, sciatic, and circumflex iliac arteries. The deep branch sends one part between the gluteus medius and the bone; another between the gluteus medius and the gluteus minimus. The gluteal veins accompany the artery, and open into the internal iliac veins.

The Superior Gluteal Nerve (Fig. 160) arises from the lumbosacral cord and first sacral nerve. (Fig. 146.) It leaves the pelvis through the great sacrosciatic foramen above the pyriformis muscle with the gluteal artery, and divides into an upper and a lower branch ; the upper branch terminates in the gluteus medius ; the lower branch supplies both the gluteus medius and the gluteus minimus, and terminates in the tensor vaginæ femoris. The nerve to the obturator internus and gemellus superior arises from the first and second sacral. (Fig. 146.) It leaves the pelvis through the greater sacrosciatic foramen, and as it crosses the spine of the ischium, gives a branch to the gemellus superior. The nerve now re-enters the pelvis through the lesser sacrosciatic foramen and supplies the obturator internus.

The Inferior Gluteal Nerve (Fig. 146) is from the first and second sacral and lumbosacral cord. It leaves the pelvis through the greater sacrosciatic foramen, below the pyriformis muscle with the sciatic and internal pudic vessels and nerves. It is often adhered to the sheath of the small sciatic. The nerve is distributed to the gluteus maximus.

The Sciatic Artery (Figs. 157, 159) is a branch of the internal iliac. It emerges from the pelvis through the great sacrosciatic foramen, below the pyriformis muscle. It is to the inner side of the great sciatic nerve and midway between the tuber of the ischium and the greater trochanter. It crosses in its course from above downward, the gemelli, the obturators, the quadratus femoris, and the upper part of the adductor magnus. It is accompanied by veins of the same name, which unite to form one trunk, before the internal iliac vein is reached. *Branches:* In the pelvis, to the levator ani, the coccygeus, and the pyriformis muscles ; to the rectum, the bladder, the prostate, and the vesiculæ seminales ; external to the pelvis, to the obturator internus, the gemelli, and the pyriformis ; to the posterior part of the capsule of the hip; the inferior gluteal, to the gluteus maximus muscle; and the comes nervi ischiadici, which accompanies the great sciatic nerve and anastomoses with the first, second, third, and fourth perforating, and internal circumflex arteries.

The Internal Pudic Nerve arises from the second, third, and fourth sacral, and, accompanied by its own vessel, emerges from the pelvis through the greater sacrosciatic foramen below the pyriformis muscle with the sciatic vessels and nerves. The nerve crosses the lesser sacrosciatic ligament near the ischial spine, and re-enters the pelvis through the lesser sacrosciatic foramen internal to its vessels. It now enters and traverses Alcock's canal in the outer wall of the ischiorectal fossa. In Alcock's canal it gives off inferior hemorrhoidal branches, which, piercing the wall of the canal, gain and traverse the ischiorectal fossa to the anus. At the triangular ligament the internal pudic nerve divides into the perineal nerve and the dorsal nerve of the penis.

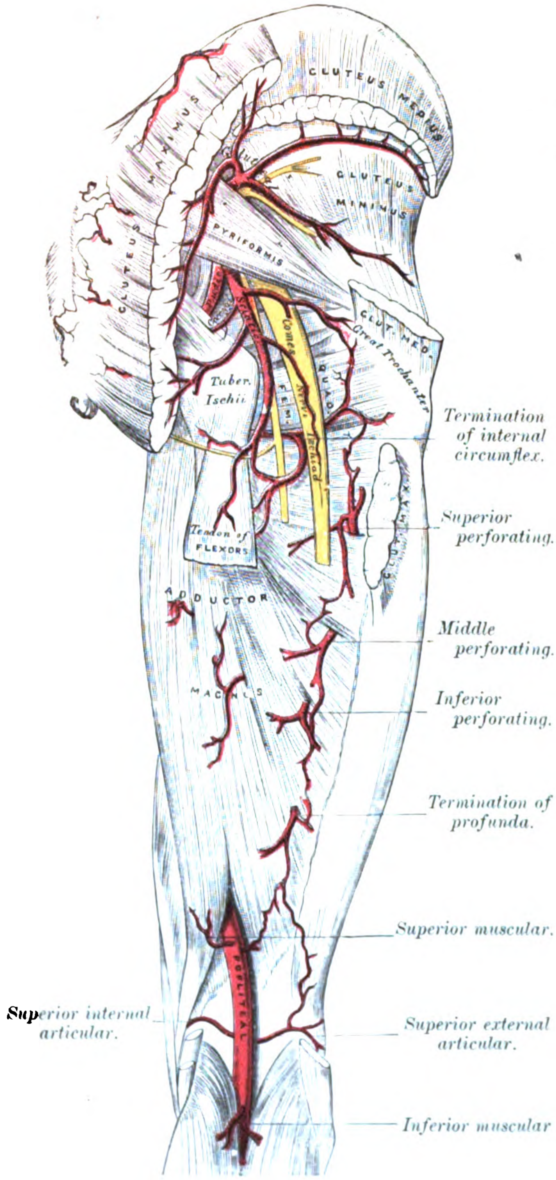
The perineal branch of the internal pudic nerve pierces the two layers of the triangular ligament and supplies the erector penis, the superficial transversus perinæi, the accelerator urinæ, the compressor urethra, the corpus spongiosum, the scrotum, and the skin on the under surface of the penis, and around the anus.

The dorsal nerve of the penis perforates the posterior layer of the triangular ligament and passes through the deep perineal interspace ; it then pierces the anterior layer of the triangular ligament, and having given branches to the corpora cavernosa, passes between the crus penis and the pubic ramus, and is distributed to the skin of the dorsum, sides, and prepuce of this organ. (See dissection of the pelvic outlet.)

The Pudic Artery is a branch of the internal iliac. It accompanies the pudic nerve. In the pelvis the artery crosses the pyriformis muscle and sacral plexus. On the spine of the ischium the pudic nerve is internal, and the nerve to the obturator internus, external to the artery and under cover of the greater sacrosciatic ligament. In Alcock's canal the pudic artery gives off the internal hemorrhoidal which crosses the ischiorectal fossa with the inferior hemorrhoidal nerve to the anus; the superficial perineal to the scrotum and perineum ; in the deep perineal interspace, branches to the bulb of the corpus spongiosum and to Cowper's gland. The terminal branch of the internal pudic is the dorsal artery of the penis.

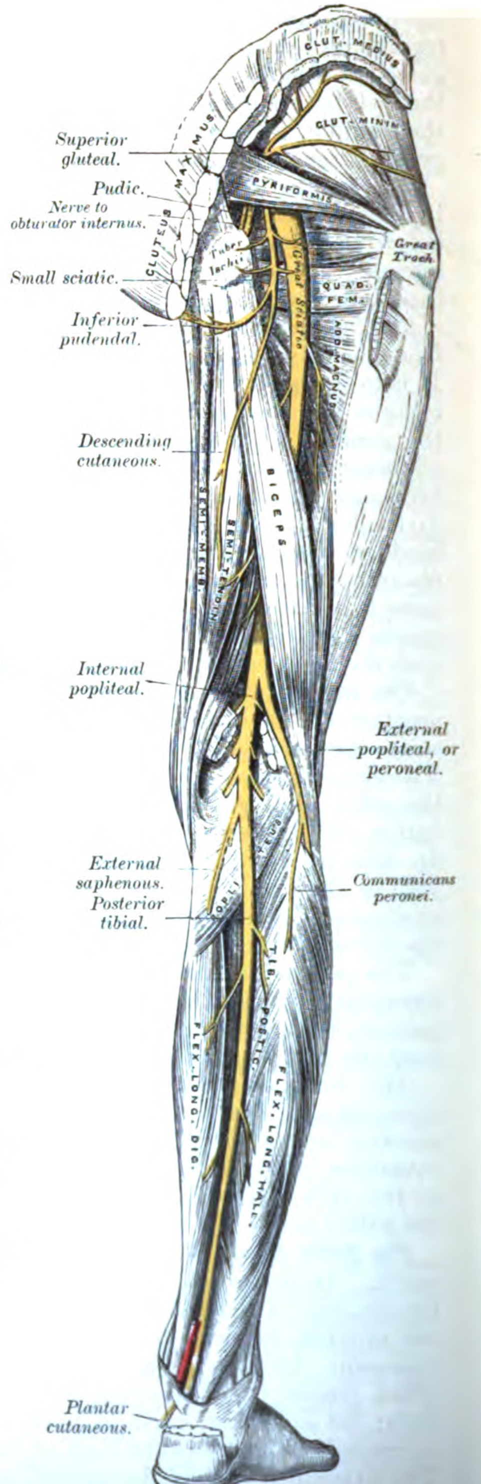
The Pudic Vein begins in the corpus cavernosum, but its minute radicals communicate with the dorsal vein of the penis. With the exception just mentioned, the internal pudic vein accompanies this artery and receives corresponding tributaries.

FIG. 159.



The arteries of the gluteal and posterior femoral regions. (GRAY.)

FIG. 160.



Nerves of the lower extremity.[1] Posterior view. (GRAY.)

[1] In this diagram the external saphenous and communicans peronei are not in their normal position. They have been displaced by the removal of the superficial muscles.

CHAPTER XXIV.

THE POSTERIOR FEMORAL REGION.

Dissection and Identification. Remove skin according to the incisions in Fig. 155. Do not remove the superficial fascia with the integument. Find the following structures and identify by comparison with the illustrations.

The Superficial Fascia contains fat in large meshworks of connective tissue. There are no arteries in this region with special names; they are small and simply called cutaneous, because they supply the skin. The cutaneous nerves, as shown by the table (p. 266) are the descending branches of the small sciatic; the anterior branch of the external cutaneous; small branches, on the inner aspect, from the obturator and internal cutaneous nerves.

The Small Sciatic Nerve. (Fig. 160.) Find this nerve in the mid-line of the posterior part of the thigh, and trace same to the middle third of the leg.

The Short Saphenous Vein. (Fig. 139.) This is in the mid-line of the posterior part of the leg, usually in company with the short saphenous nerve. The vein perforates the deep fascia and opens into the popliteal. Find opening in the deep fascia through which the vein passes.

The Popliteal Fascia. The deep fascia covering the popliteal space is the popliteal fascia. It extends across the space and binds its boundary structures together.

The Communicans Poplitei and Communicans Peronei Nerves pass through this fascia, and unite to form the short saphenous nerve; these two nerves are traceable to the internal and external popliteal nerves, respectively, and have been previously identified. (Fig. 162.)

The Internal Popliteal Nerve and its Branches. (Fig. 160.) Cut through the popliteal fascia, midway between the femoral condyles, and find the internal popliteal nerve, a branch of the great sciatic. Elevate the nerve on the index finger, trace its muscular branches to the popliteus, gastrocnemius, plantaris, and soleus muscles, and the communicans poplitei to the short saphenous nerve.

The Popliteal Vessels are an artery and a vein. (Fig. 164.) The artery is deeply placed; the vein is superficial to it, and both are in the centre of the popliteal space, behind the internal popliteal nerve. The vessels are in fat and connective tissue, and give off lateral branches above, below, and opposite the knee.

The External Popliteal Nerve (Figs. 160, 162), like the internal, a branch of the great sciatic, lies in contact with the biceps muscle on the outer wall of the popliteal space, and leaves this space between the tendon of the biceps and the outer head of the gastrocnemius.

The Boundary Muscles of the Popliteal Space. (Fig. 161.) Carefully separate the biceps from the semitendinosus, and this latter from the semimembranosus. Separate the two heads of the gastrocnemius.

The Great Sciatic Nerve passes from without inward, beneath the long head of the biceps muscle to the popliteal space. (Fig. 160.) Turn the biceps outward and find muscular branches from this nerve to the adductor magnus and hamstring muscles. The great sciatic divides at a variable level above the knee, into the internal and external popliteal nerves, and is attended by a small artery, the comes nervi ischiadici, a branch of the sciatic.

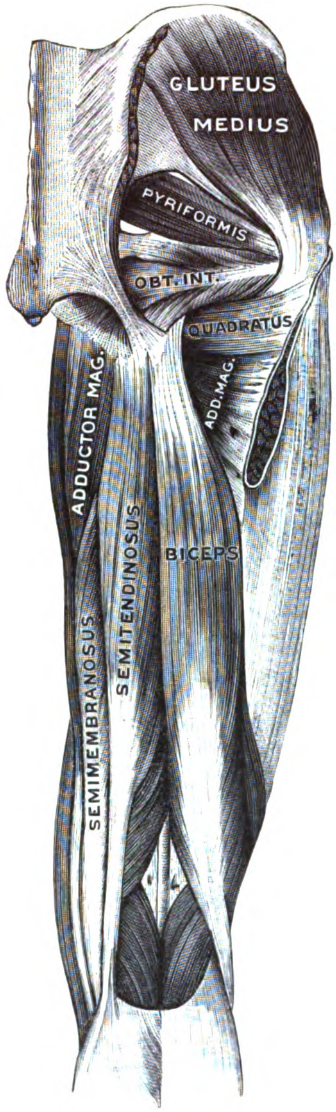
FLEXOR MUSCLES ON BACK OF THIGH.

The Biceps Femoris Muscle. (Figs. 161, 162.) *Origin:* Long head: lower and inner facet at the back of the tuber ischii, in common with the semitendinosus. Short head: (1) Outer lip of the linea aspera in the middle third of the femur; (2) external condylar ridge, upper two-thirds; (3) external intermuscular septum. *Insertion:* (1) Fossa below and in front of the styloid process of the head of the fibula; (2) fascia covering the peronei muscles; (3) outer tuberosity of the tibia. *Action:* Extension of the hip and flexion of the knee. *Synergists:* Semitendinosus, semimembranosus, and sartorius. *Antagonists:* Quadriceps femoris and iliopsoas. *Nerve:* Great sciatic. *Arteries:* Perforating branches of the profunda and superior muscular branches of the popliteal artery. (Fig. 159.)

Long Head of Biceps and Great Sciatic Nerve. (Fig. 162.) The great sciatic nerve passes behind the long head of the biceps in the upper third of the thigh. A fibrous arch unites the two heads of the biceps in the middle third of the thigh. The nerve to the short head of the biceps is given off from the great sciatic in the middle third of the thigh; the nerve to the long head of the biceps (in company with the nerves to the semitendinosus, semimembranosus, and adductor magnus) is given off from the great sciatic in the upper third of the thigh.

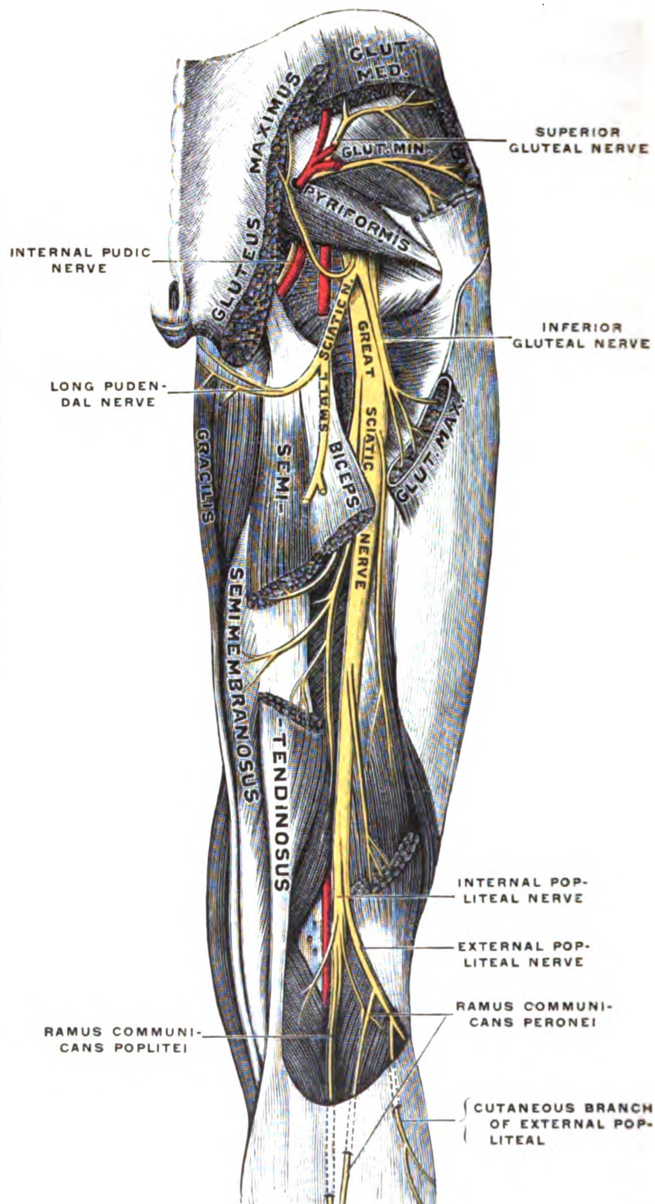
The Semitendinosus Muscle. (Fig. 161.) *Origin:* Common tendon with the long head of the biceps, from the inner and lower facet of the back of the tuber ischii.

FIG. 161.



Muscles in the dorsum of the right thigh. (GERRISH after TESTUT.)

FIG. 162.



Deep nerves of buttock and back of thigh. (GERRISH after TESTUT.)

Insertion: (1) Inner surface of the upper part of the tibia, below and behind the insertion of the gracilis; (2) deep fascia of the leg. *Action:* Extension of hip and flexion of knee. *Synergists:* Biceps, semimembranosus, sartorius. *Antagonist:* Quadriceps extensor. *Nerve:* Great sciatic. *Arteries:* Perforating branches of the profunda and superior muscular branches of the popliteal.

Semimembranosus Muscle. (Fig. 161.) *Origin:* Upper and outer facet of the back of the tuberosity of the ischium. *Insertion:* (1) Groove on the back of the inner tuberosity of the tibia; (2) posterior ligament of the knee; (3) internal lateral ligament of the knee; (4) oblique line of the tibia (forming the popliteal aponeurosis). *Action:* Extension of the hip and flexion of the knee. *Synergists:* Biceps, semitendinosus, and sartorius. *Antagonist:* Quadriceps femoris. *Nerve:* Great sciatic. *Arteries:* Peforating branches of the profunda and superior muscular branches of the popliteal. The preceding muscles (biceps, semitendinosus, semimembranosus) are called collectively the hamstring muscles.

GREAT SCIATIC NERVE.

The Great Sciatic Nerve (Fig. 160), the largest nerve in the body, includes the greater part of the sacral plexus, and begins at the lower border of the great sacrosciatic foramen. It ends in name in the upper part of the popliteal space, in the internal and external popliteal nerves. The nerve leaves the pelvis through the greater sacrosciatic foramen, below the pyriformis muscle, and crosses successively the gemellus superior, ischium, obturator internus tendon, gemellus inferior, quadratus femoris, and adductor magnus. The long head of the biceps crosses the nerve. Internal to the great sciatic, are the pudic nerve, sciatic artery, and small sciatic nerve. In the region of the hip the nerve is about midway between the tuber of the ischium and the greater trochanter of the femur. (Fig. 162.)

Branches: (1) Articular, to the hip, perforates the posterior part of the capsule; (2) muscular, to the biceps, semitendinosus, semimembranosus, and adductor magnus, given off beneath the biceps; (3) the external popliteal; (4) the internal popliteal.

EXTERNAL POPLITEAL NERVE. (Figs. 162, 163.)

The external popliteal nerve passes from the superior angle of the popliteal space, along the inner border of the biceps, to the interval between the biceps and the outer head of the gastrocnemius muscle, where it leaves the popliteal space, crosses the popliteus muscle, passes behind the head, and winds forward around the neck of the fibula, and divides into the following branches: Recurrent articular, superior external articular, inferior external articular, external cutaneous, communicans peronei, anterior tibial, and musculocutaneous.

The Recurrent Articular accompanies the anterior tibial recurrent artery through the upper part of the tibialis anticus, to the front of the knee. The nerve is given off on the neck of the fibula in the substance of the peroneus longus muscle.

The Superior and Inferior External Articular branches accompany the vessels of like name to the knee, and their successful dissection depends on a faithful dissection of the articular arteries. (See table of nerves and vessels of the knee, page 310.) The external cutaneous nerve supplies the skin of the upper and outer part of the leg. The [illegible]municans peronei unites with the communicans poplitei, a branch of the i[illegible]liteal, to form the short saphenous nerve. (See cutaneous nerves of [illegible]emity, page 264 et seq.)

[illegible]rior [illegible]ig. 166) is given off from the external popliteal on th[illegible] the peroneus longus muscle, with the recurrent [illegible] It passes beneath the extensor longus digitorum [illegible]ior tibial artery on the interosseous membrane. [illegible]of its course the nerve is to the outer side of the [illegible]middle third it lies on the artery. *Branches:* [illegible]nsor longus digitorum, peroneus tertius, and first do[illegible]us muscles; articular, to the ankle, tarsal, and metatarsophalangeal to the first, second, third, and fourth toes; cutaneous, to the skin between the first and second toes.

The Musculocutaneous Nerve (Figs. 165, 166) begins (as a branch of the external popliteal) with the anterior tibial and the recurrent articular, on the neck of the fibula. It passes down the leg between the extensor longus digitorum and the peronei muscles to the lower third of the leg, where its cutaneous branch pierces the deep fascia and divides into the internal and external cutaneous. *Branches:* (1) Muscular, to the peroneus longus and peroneus brevis; (2) sensory, to the lower anterior part of the leg; (3) sensory, to the dorsum of the third and fifth toes, except the distal phalanges; (4) sensory, to the inner side of the great toe; (5) sensory, to the inner side of the foot and ankle; (6) sensory, to the outer side of the foot and ankle; (7) sensory, to the whole dorsum of the foot.

INTERNAL POPLITEAL NERVE.

The Internal Popliteal Nerve (Figs. 160, 163) begins at the bifurcation of the great sciatic in the upper part of the popliteal space, and ends at the lower part of the popliteal space in the posterior tibial nerve, under the fibrous arch of the soleus muscle. In the upper part of the popliteal space the nerve is external to the popliteal vessels; opposite the knee, it crosses to their inner side. This nerve is the direct continuation of the great sciatic. *Branches:* (1) Articular, to the knee; (2) communicans poplitei, to the short saphenous; (3) muscular, to the gastrocnemius, plantaris, soleus, and popliteus; thence the nerve is continued downward between the superficial and deep layers of the muscles of the back of the leg as the posterior tibial.

The Articular Branches of the internal popliteal nerve are three in number: (1) Superior internal articular; (2) inferior internal articular; (3) azygos articular. These nerves accompany arteries of the same name. (See table of nerves and vessels of the knee-joint, page 310.) The communicans poplitei unites with the communicans peronei to form the short saphenous. The posterior tibial and its branches will be considered in the dissection of the leg. Muscular branches are given off between the two heads of the gastrocnemius muscle as stated in the foregoing paragraph.

The Nerve to the Popliteus Muscle gives off the following branches: An articular branch, to the superior tibiofibular joint; a branch to the nutrient artery of the tibia; a branch to the interosseous membrane; a branch to the anterior and posterior tibial arteries.

The dissected parts should now be replaced in their natural position as far as possible, and the following important surgical area—the popliteal space—studied according to the subjoined analysis.

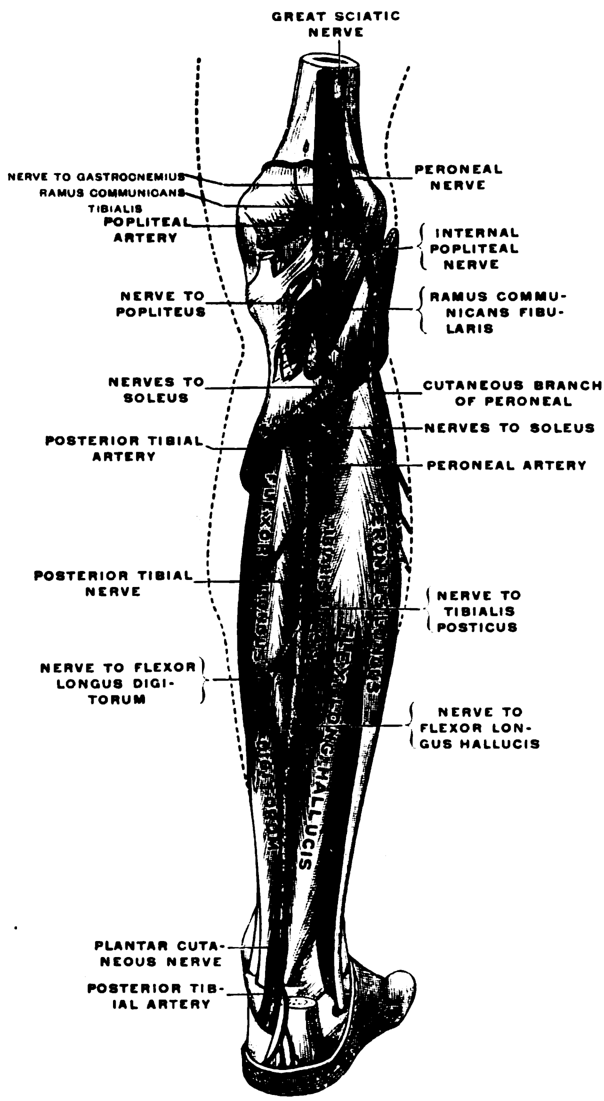
THE POPLITEAL SPACE.

The Popliteal Space (Figs. 161, 164) occupies approximately the lower posterior third of the thigh and the upper posterior sixth of the leg. It is somewhat diamond-shaped and has boundary structures both above and below the knee-joint. The space communicates superiorly with Hunter's canal and inferiorly with the leg, between the superficial and deep groups of muscles. To gain a comprehensive idea of the space, study and locate its roof, floor, superior and inferior boundaries, and contents on the dissection.

The Roof is formed by skin, superficial and deep fasciæ. In the superficial fascia the short saphenous vein pierces the deep fascia and enters the popliteal vein. It is through the roof that incisions may be made by the surgeon for operative purposes. The floor of the popliteal space is formed by (1) the popliteal surface of the femur; (2) the posterior ligament of the knee; (3) the popliteus muscle and its fascia. On the floor of the space, in a bed of fatty connective tissue, are the popliteal vessels and lymphatic glands.

Boundaries and Contents. The superior boundary of the popliteal space is formed, on the outside, by the biceps muscle; on the inside, by the semitendinosus, semimembranosus, gracilis, and sartorius muscles. The inferior boundaries on both inner and outer sides are formed by the convergence of the two heads of the gastrocnemius muscle. The space contains (1) the termination of the short

FIG. 163.

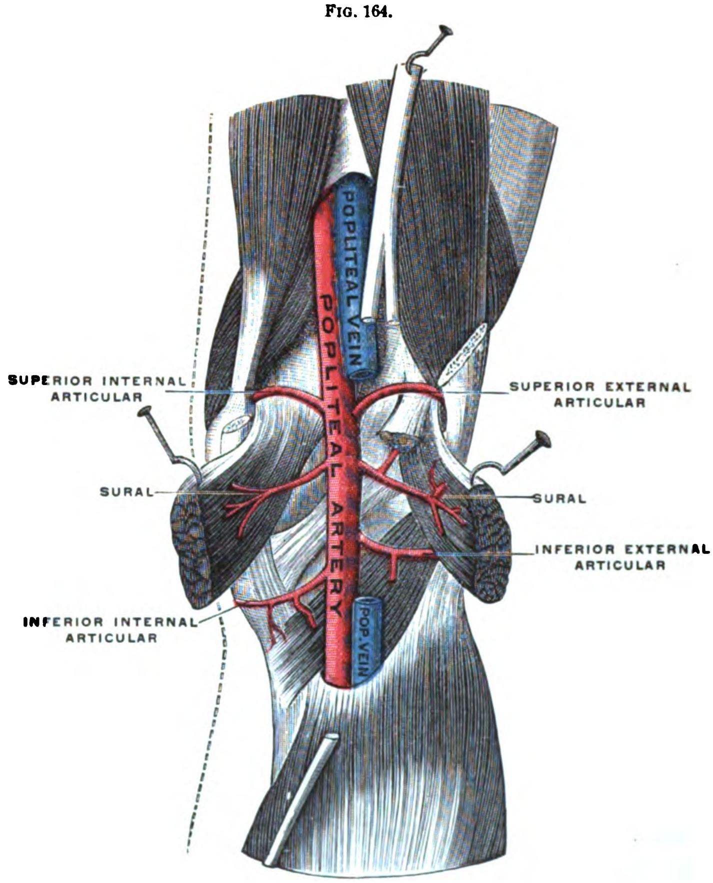


Deep nerves of the back of the leg. (GERRISH after TESTUT.)

saphenous vein; (2) the descending branch of the small sciatic nerve; (3) the communicans poplitei and communicans peronei nerves; (4) the internal popliteal nerve; (5) the external popliteal nerve; (6) the popliteal artery and its muscular, glandular, and articular branches; (7) the popliteal vein and its tributaries; (8) several lymphatic glands; (9) a large amount of fat and connective tissue; (10) the plantaris muscle.

The Internal Popliteal Nerve (Figs. 160, 162) extends through the centre of the popliteal space, bisecting the same vertically. It begins in the superior angle at the bifurcation of the great sciatic nerve, and ends in the inferior angle at the lower border of the popliteus muscle, whence it is continued to the inner ankle as the posterior tibial nerve. In the upper third of the space the nerve is external to the popliteal vessels; in the middle third it crosses them; in the lower third it is internal to and behind the vessels. *Branches:* (1) Three articular, to the knee; (2) the communicans poplitei; (3) muscular, to the popliteus, gastrocnemius, plantaris, and soleus. The muscular branch to the popliteus gives a twig to the superior tibiofibular articulation.

FIG. 164.



Popliteal artery. (GERRISH after TESTUT.)

THE POPLITEAL ARTERY.

The Popliteal Artery, a continuation of the femoral, extends from the opening in the adductor magnus to the lower border of the popliteus muscle. (Fig. 164.) Here the artery bifurcates, forming the anterior and posterior tibials. The popliteal artery is attended by the popliteal vein and the articular branch of the obturator nerve, to the knee. The artery lies on the femur, posterior ligament of the knee, and popliteal fascia, and has the following branches:

TABLE OF BRANCHES OF THE POPLITEAL ARTERY.

Cutaneous	To skin of back of leg.
Superior muscular	To adductors and hamstrings.
Inferior muscular (sural)	To muscles of calf of leg.
Articular (superior internal)	To knee-joint.
Articular (superior external)	To knee-joint.
Articular (inferior internal)	To knee-joint.
Articular (inferior external)	To knee-joint.
Articular (azygos)	To knee-joint.

Function of Articular Branches: (1) To supply the contiguous bones and soft structures of the knee-joint; (2) to supply the skin and fasciæ about the knee; (3) to establish a collateral circulation in ligation of the popliteal or femoral artery. The superficial anastomosis is between the skin and fasciæ; the deep is on the bones around and external to the attachment of the capsule.

Collateral Circulation about the Knee in Ligation of the Popliteal and Femoral Arteries. The four articular branches of the popliteal concerned are given off above and below the joint on each side. These four arteries communicate with one another in such a manner as to form a frame, about the patella, as a centre-piece. The anterior tibial recurrent artery opens into the lower part of this arterial frame. The anastomotica magna (a branch of the superficial femoral), the external circumflex, and the fourth perforating branches of the profunda, open into the upper part of the arterial frame. In ligation of the popliteal artery, blood from the femoral artery reaches the arterial frame, through the anastomotica magna, the external circumflex, and the fourth perforating branch of the profunda. From this circle, blood reaches the anterior tibial artery through the anterior tibial recurrent. In ligation of the superficial femoral artery (either in Scarpa's triangle or Hunter's canal), blood reaches the circle, through the descending branch of the external circumflex and the fourth perforating.

The Popliteal Vein (Fig. 164) is the strongest vein in the body; it accompanies and lies superficial to its artery. Its tributary branches correspond to the branches of the popliteal artery, both in number and location, with the addition of the short saphenous vein. Lymphatic glands, five or six in number, are in the fat and connective tissue in the neighborhood of the popliteal vessels.

THE KNEE-JOINT.

Dissection. Learn and locate the twelve synovial bursæ described in the text. Divide the ligamentous muscles of the knee, near their attachments. Having removed the muscles, study the anterior, posterior, and lateral ligaments. Cut through the capsule below the patella and study the articular surfaces and crucial ligaments. Study the table of nerves and vessels of the knee on page 310.

Bursæ. Where muscles or their tendons play over bony eminences, a synovial bursa is interposed to prevent friction. This is especially true about the knee-joint. Synovial bursæ about the knee are: (*a*) One between the skin and patella (patellar bursa); (*b*) one between the ligamentum patellæ and the tubercle of the tibia; (*c*) one between the skin and tubercle of the tibia; (*d*) one between the inner femoral condyle and the inner head of the gastrocnemius; (*e*) one between the internal lateral ligament and the gracilis, semitendinosus, and sartorius muscles; (*f*) one between the internal lateral ligament and the semimembranosus; (*g*) one between the semitendinosus and semimembranosus; (*h*) one between the semimembranosus and the inner tuberosity; (*i*) one between the outer head of the gastrocnemius and the external femoral condyle; (*j*) one between the biceps tendon and the external lateral ligament; (*k*) one between the popliteus and external lateral ligament; (*l*) one between the popliteal tendon and the outer condyle of the femur.

Nerves supplying groups of muscles that move a joint, supply the joint moved; hence the knee derives its nerve-supply from the obturator, anterior crural, internal and external popliteal. The nerves pierce the capsule with the arteries.

Ligaments of Joints in General: (1) Ligamentous muscles, or those muscles that cross and aid in moving the joints; they are also called the elastic ligaments; (2) fibrous or periosteal, the basis and simplest form of which is a capsule. They derive their nerve-supply from the gray rami communicantes. (See Sympathetic.) The capsule is lined by synovial membrane. There are in the knee, as well as in other major joints, certain bony structures, muscles, and ligamentous attachments [to] be memorized.

The Long External Lateral Ligament of the knee is morphologically the obsolete upper end of the peroneus longus muscle; likewise the internal lateral ligament is the fibrous remnant of the adductor magnus muscle.

TABLE OF NERVES AND VESSELS OF THE KNEE.

Nerve.	*Source.*	*Course.*	*Distribution.*	*Attending. Artery.*
Superior internal articular.	Internal popliteal nerve.	Above inner head of gastrocnemius, beneath semimembranosus, through tendon of adductor magnus.	Femur, patella, capsule, and joint.	Superior internal articular from popliteal artery.
Inferior internal articular.	Internal popliteal nerve.	Below internal tuberosity of the tibia; beneath the internal lateral ligament and around the head of the fibula.	Lower and inner part of knee-joint.	Inferior internal articular from popliteal artery.
Superior external articular.	External popliteal nerve.	Above the outer head of the gastrocnemius, beneath the biceps tendon and across the femur.	Femur, patella, and outer part of knee-joint.	Superior external articular from popliteal artery.
Inferior external articular.	External popliteal.	Above the head of the fibula and outer head of the gastrocnemius; under the tendon of the biceps and between the long and short external lateral ligaments.	Outer and lower part of knee-joint.	Inferior external articular from the popliteal artery.
Azygos articular.	Internal popliteal.	Through Winslow's ligament.	Crucial ligaments; ligamenta alaria and ligamenta mucosa.	Azygos articular artery, a branch of the deep part of the popliteal.
Recurrent articular.	External popliteal.	Through upper part of the tibialis anticus.	Anterior part of the knee.	Anterior tibial recurrent artery.
Articular branches.	Obturator; from branch to adductor magnus.	Through the ligament of Winslow.	Knee-joint.	Superior internal articular from the popliteal.
Articular branches.	Anterior crural; from nerve to vastus externus.	Through the anterior part of the capsule.	Knee-joint.	Superior external articular artery.
Articular branches.	Anterior crural; from nerve to vastus internus.	Through the internal part of the capsule.	Knee-joint.	Deep branch of the anastomotica magna.

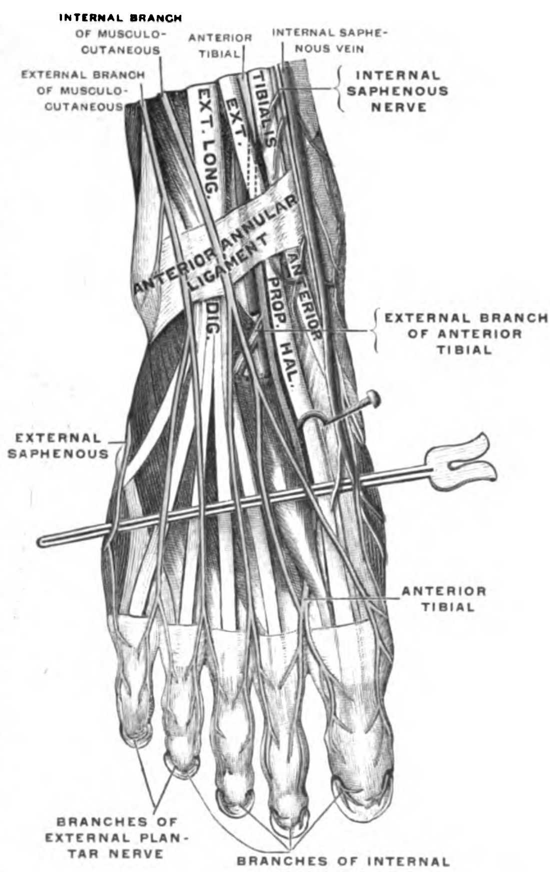
CHAPTER XXV.

THE ANTERIOR TIBIOFIBULAR REGION.

Dissection and Identification. Place a block under the knee, extend the foot, and render the skin of the leg and foot tense. Make incisions in the skin in accordance with Fig. 148, page 285. Exercise care to leave superficial fascia in place. Compare dissection with illustrations and follow order given in text. Review pages 263–268 on cutaneous structures.

The Superficial Fascia varies in thickness according to the amount of fat, and is very dense and tough in the sole. The superficial fascia contains in its deep layer, near the deep fascia, the cutaneous vessels and nerves.

FIG. 165.



Nerves of the dorsum of the foot. (GERRISH after TESTUT.)

The Digital Veins and Dorsal Arch. (Fig. 138) The digital veins are made up in the skin of the toes, and by their confluence form an arch on the dorsum of the foot—arcus dorsalis pedis.

The Long Saphenous Vein (Fig. 138) begins at the inner end of the dorsal arch and passes in front of the inner malleolus; posterior to the inner tuberosity of the tibia and internal condyle of the femur; along the inner part of the thigh to the saphenous opening in the fascia lata, through which it passes and becomes tributary to the femoral vein. This vein is attended by the long saphenous nerve below the knee, and great care must be exercised in its dissection.

The Cutaneous Branch of the Musculocutaneous Nerve pierces the deep fascia in the lower third of the leg, and divides into internal and external branches, which pass beneath the dorsal arch to the toes. (Fig. 165.)

The Deep Fascia is very thick and strong over the tibiofibular muscles, and between the internal and external malleoli it forms the anterior annular ligament. (Fig. 165.) The deep fascia should be cut longitudinally to expose the deep structures.

The Anterior Annular Ligament (Figs. 165–167) has vertical and horizontal parts; these bind the tendons in place and form compartments, lined by synovial membrane, for their easy transmission to the tarsus and toes.

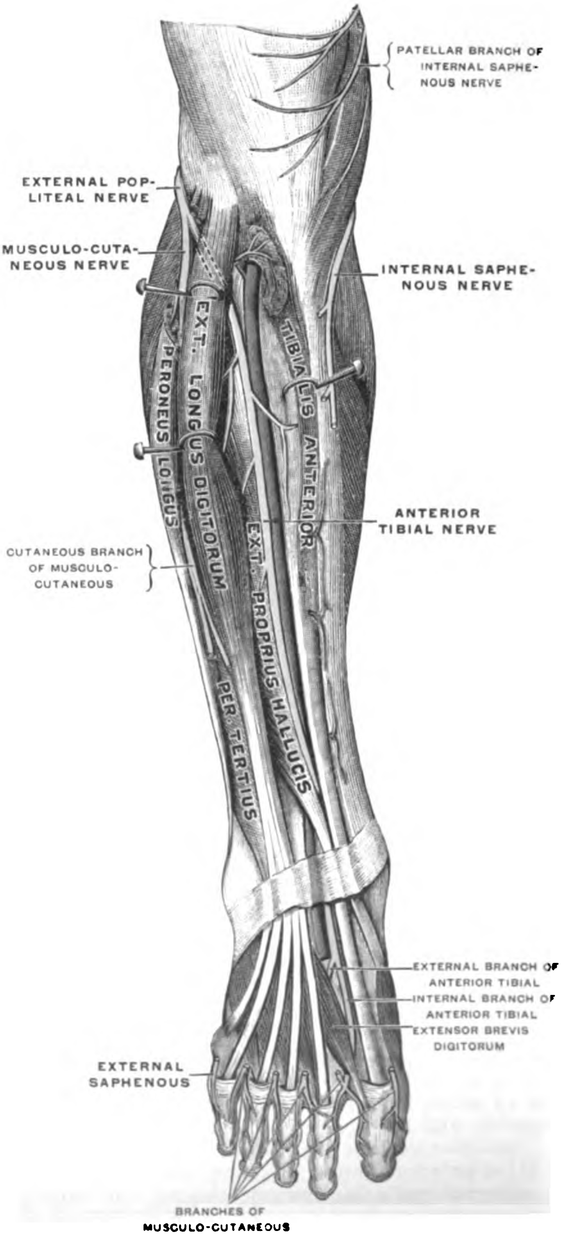
The vertical part of the anterior annular ligament extends from the tibia to the fibula, immediately above the malleoli, and is but little stronger than the general deep fascia, with which it is continuous above, and of which it is only a special part. Beneath it are the tendons of the anterior tibiofibular muscles, with the anterior tibial nerve and vessels. The tibialis anticus has a synovial sheath; the other tendons beneath the vertical part have none. (Fig. 165.)

The horizontal part of the anterior annular ligament arises on the outer side of the os calcis, and passes below the external malleolus, inward; it splits and forms a compartment for the peroneus tertius and extensor longus digitorum—one part in front of the other behind these muscles. At the inner border of the extensor longus digitorum the ligament divides into an upper and a lower part; the latter crosses the remaining structures in this region. The upper part is inserted into the internal malleolus, the lower, into the scaphoid and internal cuneiform bones and plantar fascia. There are three synovial compartments beneath the horizontal portion of the anterior annular ligament—one for the tibialis anticus, one for the extensor proprius hallucis, and one in common for the extensor longus digitorum and peroneus tertius. The anterior tibial nerve and vessels are beneath the anterior annular ligament.

MUSCLES.

Tibialis Anticus. (Fig. 166.) *Origin:* (1) Outer tuberosity of the tibia; (2) outer surface of the tibia, upper two-thirds; (3) interosseous membrane; (4) deep fascia of the leg; (5) intermuscular septum, between it and the extensor longus

Fig. 166.



Deep nerves of the front of the leg. (GERRISH after TESTUT.)

digitorum. *Insertion:* (1) Internal cuneiform bone; (2) base of the first metatarsal. *Action:* To flex the foot. *Synergist:* The peroneus tertius. *Antagonists:* Tibialis posticus, peroneus longus and peroneus brevis. *Nerve:* Anterior tibial. *Artery:* Anterior tibial, a branch of the popliteal.

Extensor Proprius Hallucis. (Fig. 166.) *Origin:* (1) Middle half of the anterior surface of the fibula; (2) interosseous membrane. *Insertion:* Dorsal base of the second phalanx of the great toe. *Synergist:* The extensor brevis tendon to great toe. *Antagonists:* The flexor longus and the flexor brevis pollicis. *Nerve:* Anterior tibial. *Artery:* Anterior tibial.

Extensor Longus Digitorum. (Fig. 166.) *Origin:* (1) External tuberosity of the tibia; (2) anterior surface of the fibula, upper three-fourths; (3) interosseous membrane; (4) deep fascia of the leg; (5) intermuscular septa. *Insertion:* (1) Dorsal bases of the second and third phalanges of the four outer toes; (2) lateral ligaments of the metatarsophalangeal joints. *Action:* To extend the four outer toes. *Synergist:* Extensor brevis digitorum. *Antagonists:* Flexor longus and flexor brevis digitorum. *Nerve:* Anterior tibial. *Artery:* Anterior tibial. (Fig. 166.)

Peroneus Tertius. (Fig. 166.) *Origin:* (1) Anterior surface of the fibula, lower fourth; (2) interosseous membrane; (3) deep fascia and intermuscular septum. *Insertion:* Dorsal base of the fifth metatarsal. *Action:* To flex the foot. *Synergist:* Tibialis anticus. *Antagonists:* The peroneus longus, peroneus brevis, tibialis posticus. *Nerve:* Anterior tibial. *Artery:* Anterior tibial.

Extensor Brevis Digitorum. *Origin:* (1) Upper surface of the os calcis; (2) anterior annular ligament. *Insertion:* Four inner toes; one tendon independently into the base (dorsal) of the first phalanx; the remaining three conjointly with the tendons of the extensor longus digitorum into the second and third phalanges. *Action:* Extends the four inner toes. *Synergist:* Extensor longus digitorum. *Antagonist:* The flexor longus digitorum. *Nerve:* Anterior tibial. *Artery:* Anterior tibial.

ANTERIOR TIBIAL NERVE.

The Anterior Tibial Nerve Proper begins on the neck of the fibula as a terminal branch of the external popliteal. (Fig. 166.) *Course:* (1) Pierces the intermuscular septum, between the peronei muscles and the muscles on the front of the leg; (2) it passes through the upper part of the extensor longus digitorum to the anterior surface of the interosseous membrane and joins the anterior tibial artery; (3) it lies, at first, between the extensor longus digitorum and the tibialis anticus, a little later between the extensor proprius hallucis and the tibialis anticus; (4) it ends in front of the ankle, in the internal and the external branches. In the upper and lower thirds the nerve is external to the artery; in the middle third it lies on the artery.

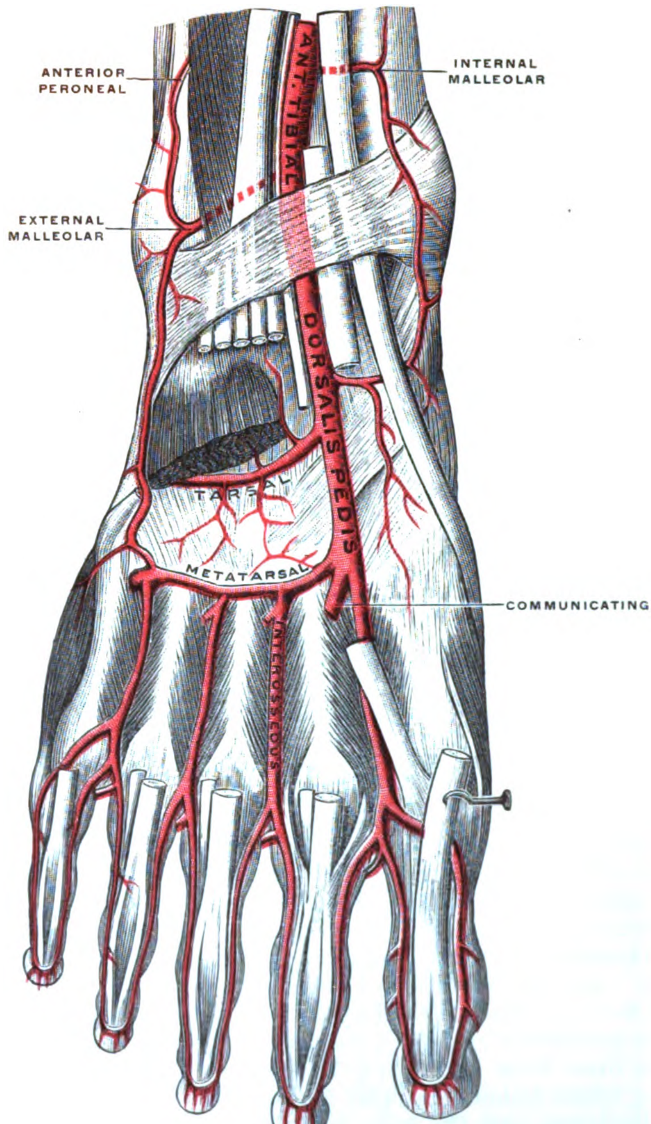
Branches: (1) Articular, to the ankle-joint; (2) muscular, to the tibialis anticus, extensor proprius hallucis, extensor longus digitorum and peroneus tertius; (3) the external branch to the extensor brevis digitorum and tarsal articulations. This nerve develops a ganglion beneath the extensor brevis digitorum, from which branches supply the tarsometatarsal articulation and the first and second interossei muscles; (4) the internal branch supplies the contiguous margins of the great and second toes.

Serial Course. This nerve consists of fibres from the fourth and fifth lumbar and the first sacral nerves. They leave the pelvis through the greater sacrosciatic foramen below the pyriformis muscle, as a part of the great sciatic nerve. In the popliteal space these fibres leave the great sciatic, forming a part of the external popliteal nerve, which follows the inner border of the tendon of the biceps; they lie between the biceps and the outer head of the gastrocnemius; they cross the popliteus behind the head of the fibula and wind forward on the neck of the fibula, between the bone and the peroneus longus muscle. Here the fibres leave the external popliteal and form the anterior tibial nerve proper.

ANTERIOR TIBIAL ARTERY.

The Anterior Tibial Artery. (Figs. 166, 167.) A line drawn from the head of the fibula to a point midway between the malleoli, indicates the course of the artery. The artery is a terminal branch of the popliteal. It is given off at the lower border of the popliteus muscle and passes forward between the two heads of the tibialis anticus muscle, between the tibia and fibula, above the interosseous membrane. From this point to the ankle, the artery lies in a canal having definite boundaries: The floor of the canal, in the upper two-thirds of its course, is the interosseous membrane; in the lower third, the tibia and ankle; the inner wall is

FIG. 167.



Arteries of the dorsum of the foot. (GERRISH after TESTUT.)

the tibialis anticus; the outer wall, the extensor longus digitorum and extensor proprius hallucis; the roof is formed by skin, superficial and deep fasciæ.

Branches: (1) Muscular, ten or twelve in number, to the muscles of the front of the leg; (2) the superior fibular, to the soleus and peroneus longus muscles; (3) the posterior tibial recurrent, to the tibiofibular joint; (4) the anterior tibial recurrent, which figures in the collateral circulation at the knee, and passes through the upper part of the tibialis anticus muscle and over the outer tuberosity of the tibia; (5) the internal and external malleolar. (Fig. 167.)

The Dorsalis Pedis Artery (Fig. 167) is a continuation of the anterior tibial and lies between the extensor proprius hallucis and the extensor longus digitorum. It gives off (1) a communicating branch to the external plantar, by which the plantar arch is completed; (2) a tarsal branch, to the extensor brevis digitorum and tarsus; (3) the dorsalis hallucis, to the great toe; (4) interosseous arteries, to the interosseous spaces.

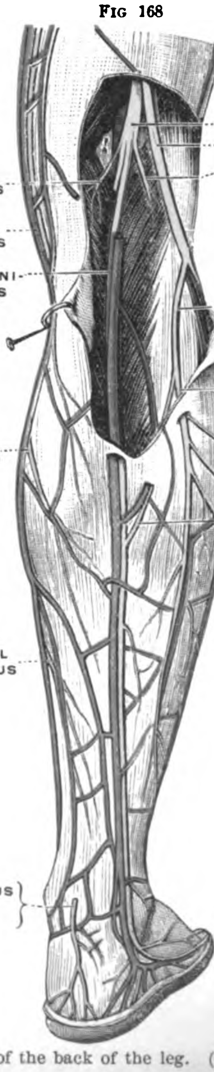
CHAPTER XXVI.

THE POSTERIOR TIBIOFIBULAR REGION.

The Short Saphenous Vein (Fig. 168) is in the mid-line, with a nerve of like name. The vein is blue, as large as a lead-pencil, pierces the deep fascia, disappears behind the knee, and is traceable between the os calcis and external malleolus, to the outer side of the foot.

The Short Saphenous Nerve (Fig. 168), somewhat larger than a knitting needle, is in the mid-line on the posterior part of the leg, with the short saphenous vein. Trace the nerve upward to a variable distance below the knee, where it is formed by the union of two branches—one

FIG 168



Superficial nerves of the back of the leg. (GERRISH after TESTUT.)

from the internal, the other from the external popliteal nerve. Also trace both nerve and vein between the external malleolus and os calcis to the outer side of the foot. Other cutaneous nerves in this region are (*a*) descending branches of the small sciatic; (*b*) a cutaneous branch of the posterior tibial; (*c*) the posterior branch of the internal cutaneous; (*d*) long saphenous, which are to be studied in the table of cutaneous nerves of the lower extremity, pages 163–168, and in Fig. 141.

The Tendo Achillis is in the mid-line, very prominent, quite strong, and inserted into the os calcis. Parallel with its inner border are the posterior tibial nerve and vessels. Two muscles of the superficial group of the posterior tibiofibular region are inserted into the heel bone through this tendon.

The Popliteal Vessels and internal popliteal nerve pass between the two heads of the gastrocnemius muscle beneath the fibrous arch. Force the index finger under the arch between the gastrocnemius and soleus, cut lengthwise six inches downward through the middle of the gastrocnemius, and separate the two halves of the muscle; the tendon of the plantaris, lying on the soleus, will come into view. This (plantaris) is often mistaken for a nerve. There is a synovial bursa between the inner head of the gastrocnemius and the tendon of the semimembranosus muscle.

The Popliteal Fascia is the only part of the deep fascia on the posterior part of the lower extremity that receives a special name. It covers the popliteal space and occupies the lower posterior third of the thigh and upper posterior sixth of the leg. It contains transverse muscular fibres, and is sometimes called muscular fascia. It is pierced by the short saphenous vein and the communicating branches from the internal and external popliteal nerve that unite to form the short saphenous nerve. The descending branch of the small sciatic nerve rests on the popliteal fascia. This fascia is attached laterally to the boundary muscles of the popliteal space, and in Fig. 168 is represented as being held aside by hooks.

Gastrocnemius. (Fig. 169.) Identify (1) by the location on the back of the leg as the most superficial muscle; (2) by the insertion through the tendo Achillis in the os calcis; (3) two heads of origin from the femoral condyles.

Plantaris. Identify (1) by the location between the gastrocnemius and the soleus and the insertion with the tendo Achillis into the os calcis; (2) by the very long, slender tendon.

Soleus. Identify (1) by the location beneath the gastrocnemius and plantaris; (2) by the origin from the tibia and fibula (Fig. 171); (3) by the insertion with the gastrocnemius and plantaris into the os calcis.

Deep Transverse Fascia of the Leg. Identify (1) by the location immediately beneath the superficial group of muscles identified; (2) by its attachments to the tibia and fibula; (3) by its high degree of transparency, permitting the subjacent structures to be seen.

Popliteus. (Fig. 169.) Identify (1) by the location below the knee and insertion into the oblique line of the tibia; (2) by the strong investing aponeurosis.

Flexor Longus Digitorum. (Fig. 171.) Identify (1) by the location on the posterior surface of the tibia; (2) by the location of the tendon beneath the internal annular ligament, next to the tendon of the tibialis posticus.

Flexor Longus Hallucis. (Fig. 171.) Identify (1) by the location on the posterior surface of the fibula; (2) by the insertion into the distal phalanx of the great toe; (3) by the four grooves which it traverses.

Tibialis Posticus. (Fig. 171.) Identify (1) by its origin from the tibia, fibula, and interosseous membrane; (2) by the location between the two preceding flexor muscles; (3) by the insertion into the scaphoid bone and location of its tendon on the internal malleolus.

Internal Annular Ligament. (Fig. 170.) Identify (1) by the location at the inner side of the ankle and attachment to the tibia and os calcis; (2) by the posterior tibial nerve and vessels and three flexor tendons beneath the ligament.

Posterior Tibial Nerve. Identify (1) by the location beneath the deep transverse fascia of the leg, with the posterior tibial nerve and vessels; (2) by its derivation from the internal popliteal nerve.

Posterior Tibial Artery. Identify (1) by the location beneath the deep transverse fascia of the leg with the posterior tibial nerve; (2) by its derivation from the popliteal artery.

SUPERFICIAL GROUP OF MUSCLES.

The Gastrocnemius (Fig. 169) has two heads connected by a fibrous arch. *Origin of the Outer Head:* (1) An impression upon the upper and posterior part of the outer surface of the external condyle; (2) posterior surface of the femur above the outer condyle. *Origin of the Inner Head:* (1) Impression on the posterior surface of the femur, above the internal condyle; (2) adductor tubercle. *Insertion:* By the tendo Achillis, into the posterior surface of the os calcis, with the plantaris and the soleus. *Action:* Extension of the foot. *Synergists:* Soleus, plantaris, tibialis posticus, peroneus longus, peroneus brevis. *Antagonists:* Tibialis anticus and peroneus tertius. *Nerve:* Internal popliteal. *Arteries:* Inferior sural branches of the popliteal.

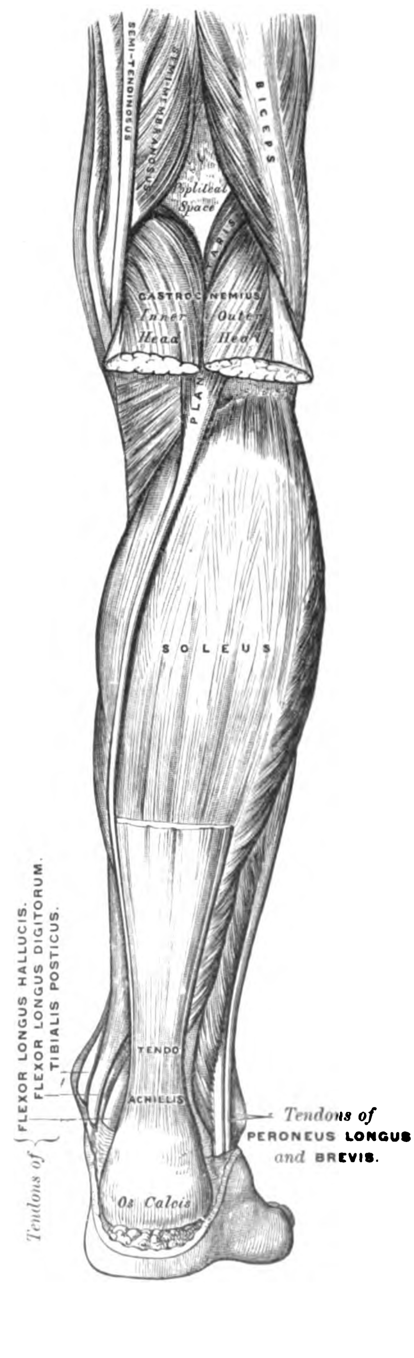
The Plantaris (Fig. 171) is occasionally attached to the plantar fascia, hence [illegible] name. *Origin:* (1) Lower two-thirds of the external condylar ridge of the [illegible] adjacent surface of the femur and the posterior ligament of the knee.

Insertion: Posterior surface of the os calcis. *Action:* Extension of the foot. *Synergists:* Gastrocnemius, soleus, tibialis posticus, peroneus longus, peroneus

FIG. 169.

Gastrocnemius of the right side. (GERRISH after TESTUT.)

FIG. 170.



Muscles of the back of the leg. Superficial layer. (GRAY.)

brevis. *Antagonists:* Tibialis anticus, peroneus tertius. *Nerve:* Internal popliteal. *Arteries:* Inferior, muscular, or sural branches of the popliteal.

The Soleus. (Fig. 170.) *Origin:* (1) Middle lip of the oblique line of the tibia; (2) inner border of the posterior surface of the tibia, extending from the lower end of the oblique line to a point below the middle of the tibia; (3) the back of the head of the fibula; (4) the upper third of the outer border of the posterior surface of the fibula; (5) the external intermuscular septum. *Insertion:* Tendo Achillis. *Action:* Extension of the foot. *Synergists:* Gastrocnemius, plantaris, tibialis posticus, peroneus longus, peroneus brevis. *Antagonists:* Tibialis anticus and peroneus tertius. *Nerve:* Internal popliteal, a branch of the great sciatic. *Arteries:* Inferior sural branches of the popliteal. The tibial and fibular origins of the soleus are connected by a fibrous arch. Under the soleus muscle the deep transverse fascia of the leg extends from the tibia to the fibula. Beneath this fascia are the posterior tibial vessels and nerve and the tibialis posticus, flexor longus digitorum, and flexor longus hallucis muscles.

The tendo Achillis, a common tendon of insertion of the gastrocnemius, plantaris, and soleus, is about three-fourths of an inch broad, and inserted into the lower part of the posterior surface of the os calcis. A bursa intervenes between it and the upper part of the os calcis. The narrowest part of the tendon is on a level with the internal malleolus and is where tenotomy is performed. (Fig. 170.)

Nerve-supply. The muscles of the superficial group derive their nerves from the internal popliteal. To dissect these nerves properly, elevate the internal popliteal on the left index finger and trace its several branches (which are now brought into view) to the muscles. Locate the popliteal artery on the floor of the popliteal space and trace certain of its branches to the superficial group of muscles.

DEEP GROUP OF MUSCLES.

Dissection. Detach the soleus from the tibia and fibula (Fig. 173), cut the tendo Achillis two inches above its insertion into the os calcis and turn the superficial group to one side. (Fig. 172.) Identify the deep transverse fascia as a thin fascial covering through which the posterior tibial nerve and vessels may be seen. Demonstrate the two heads of the tibialis posticus arising from tibia and fibula. Identify the origin of the flexor longus digitorum from the tibia, that of the flexor longus pollicis from the fibula. Trace muscular branches of nerves and vessels to their ending. Demonstrate relation of posterior tibial nerve and artery to each other. (Fig. 172.)

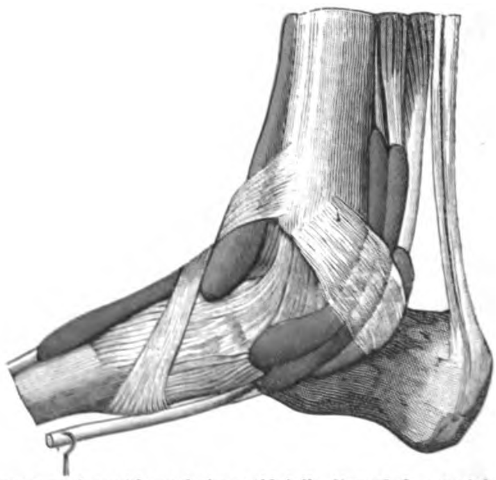
Deep Transverse Fascia of the Leg. (Fig. 172.) If the preceding dissection has been properly performed the deep fascia covering the deep group of muscles with their vessels and nerves is now exposed. This fascia is thick above, where it covers the popliteus muscle and receives one of the aponeurotic insertions of the semimembranosus muscle; below, where it covers the tendons, passing behind the malleoli of the tibia and fibula. In the middle third of the leg, the fascia is thin, and permits the posterior tibial nerve and vessels to be seen through it. The fascia is attached latterly to the tibia and fibula; above to the tibia, fibula, and ligament of Winslow; below, it blends with the internal lateral ligament.

The Popliteus Muscle. (Fig. 172.) *Origin:* (1) Lower part of the external surface of the outer femoral condyle; (2) posterior ligament of the knee-joint. *Insertion:* (1) Posterior surface of the tibia, above the oblique line; (2) popliteal aponeurosis. The tendon of origin of this muscle passes beneath the external lateral ligament of the knee, and is surrounded by a synovial membrane. *Action:* A feeble flexor and internal rotator of the leg when the knee is flexed. *Synergists:* Biceps, semitendinosus, semimembranosus, sartorius. *Antagonists:* Quadriceps extensor femoris. *Nerve:* Internal popliteal. *Artery:* Popliteal. This muscle is covered by an expansion of the aponeurosis of the semimembranosus. The plantaris, popliteal vessels, and internal popliteal nerve cross the muscle.

Flexor Longus Digitorum. (Fig. 172.) *Origin:* (1) Inner part of the posterior surface of the tibia, below the oblique line, extending to within three inches of the ankle; (2) deep fascia of the leg; (3) intermuscular septum, between this muscle and the tibialis posticus. *Insertion:* Under surface of the distal phalanx of each of the four outer toes. The tendon of the muscle passes in a compartment of the internal annular ligament, behind the tibialis posticus; in the sole of the foot, the muscle receives the muscular fibres of the accessorius and a tendinous slip from the flexor longus hallucis. The muscle divides into four tendons, about the middle of the foot, and each tendon passes through a slit in the corresponding tendon of the flexor brevis digitorum. The lumbrical muscles arise from the tendon of this muscle. *Action:* Flexion of the third phalanges of the four outer toes. *Synergists:* Tendons of the flexor brevis digitorum. *Antagonists:* Extensor longus and extensor brevis digitorum. *Nerve:* Posterior tibial. *Artery:* Posterior tibial.

Flexor Longus Hallucis. (Fig. 172.) *Origin:* (1) Lower two-thirds of the postero-internal surface of the fibula; (2) intermuscular septa between this and the peronei muscles; (3) deep fascia and interosseous membrane. *Insertions:* (1) Under surface of the base of the distal phalanx of the great toe; (2) Flexor longus digitorum. *Course:* The tendon of this muscle passes through the following grooves: (1) A groove on the posterior surface of the tibia; (2) a groove on the posterior surface of the astragalus; (3) a groove in the under surface of the sustentaculum tali; (4) a groove between the two sesamoid at the metatarsophalangeal

FIG. 171.



The internal annular ligament of the ankle and the artificially distended synovial membranes of the tendons which it confines. (GERRISH after TESTUT.)

articulation of the great toe. Under the internal annular ligament the tendon lies deeply buried in a special compartment lined by synovial membrane. (Fig. 171.) *Action:* Flexion of the second phalanx of the great toe. *Synergist:* Flexor brevis hallucis. *Antagonists:* The extensor proprius and extensor brevis hallucis. *Nerve:* The posterior tibial. *Arteries:* Posterior tibial and peroneal.

Tibialis Posticus. (Figs. 172, 173.) *Origin:* (1) Interosseous membrane and adjacent surface of the tibia; (2) internal surface of the fibula; (3) deep fascia and intermuscular septa. *Insertion:* (1) Tuberosity of the scaphoid bone; (2) sustentaculum tali and the under surfaces of all the tarsal bones except the astragalus; (3) the bases of the second, third, and fourth metatarsals. *Course:* In the lower third of the leg the muscle passes beneath the tendon of the flexor longus digitorum, enters a groove in the inner malleolus and passes in a synovial sheath to its insertion. *Action:* Extension of the foot. *Synergists:* Peroneus longus, peroneus brevis, gastrocnemius, plantaris, soleus. *Antagonists:* Tibialis anticus, peroneus tertius. *Nerve:* Posterior tibial. *Arteries:* Posterior tibial and peroneal.

[Observe that the muscle that flexes the great toe (the flexor longus hallucis) arises from the posterior surface of the bone on the opposite side of the leg, the fibula; and the muscle that flexes the four outer toes (the flexor longus digitorum) arises from the posterior surface of the bone of the opposite side of the leg, the tibia. Hence, the tendons of these two muscles cross, a verification to be made in dissection of the sole of the foot.]

INTERNAL ANNULAR LIGAMENT.

The Internal Annular Ligament (Fig. 171) is a very strong band of fibrous tissue extending from the internal malleolus to the os calcis. It converts three grooves into three canals for three tendons, and forms a neurovasal space for the posterior tibial nerve and vessels. The grooves are (1) on the posterior border of the internal malleolus, for the tendons of the tibialis posticus and flexor longus digitorum; (2) on the posterior part of the lower end of the tibia; (3) on the posterior surface of the astragalus. The grooves on the tibia and astragalus are continuous, and transmit the tendon of the flexor longus hallucis. Each of the three grooves is lined by a separate synovial membrane. (Fig. 171.) The space for the nerve and vessels is midway between the os calcis and internal malleolus and superficial to the groove containing the flexor longus hallucis; hence, to liberate this tendon it is necessary to turn the nerve and vessels aside.

POSTERIOR TIBIAL NERVE.

The Posterior Tibial Nerve (Fig. 172), a continuation of the internal popliteal, begins at the lower border of the popliteus muscle and ends midway between the internal malleolus and os calcis in the internal and external plantar nerves. The nerve crosses the posterior tibial artery from within out, an inch and a half below the origin of the artery, and remains on the outer side of the same for the rest of its course. The nerve is covered by deep fascia and rests successively on (1) the tibialis posticus; (2) the flexor longus digitorum; (3) the tibia, in the lower part of its course, and lies parallel with the inner border of the tendo Achillis.

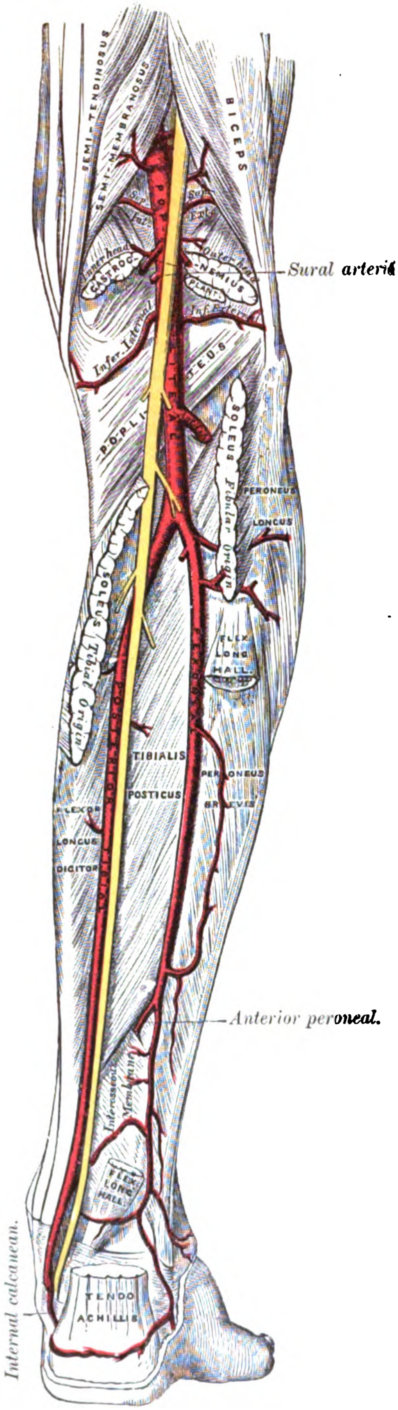
Branches: (1) Muscular, to the tibialis posticus, flexor longus digitorum, flexor longus hallucis, and soleus; (2) articular (one or two), to the ankle-joint; (3) cutaneous (internal calcanean), to the skin and fascia of the heel and adjacent part of the sole; (4) the internal and external plantar, to the structures of the sole of the foot.

POSTERIOR TIBIAL ARTERY.

The Posterior Tibial Artery (Fig. 172) begins at the bifurcation of the popliteal, at the lower border of the popliteus muscle, and ends under the internal annular ligament, midway between the internal malleolus and the os calcis, in the internal and external plantar arteries. It is accompanied by the posterior tibial nerve and two venæ comites, which anastomose freely across the artery. The artery lies on the tibialis posticus, flexor longus digitorum, and lower part of the tibia. About an inch and a half below its origin, the artery is crossed from within out by the internal popliteal nerve.

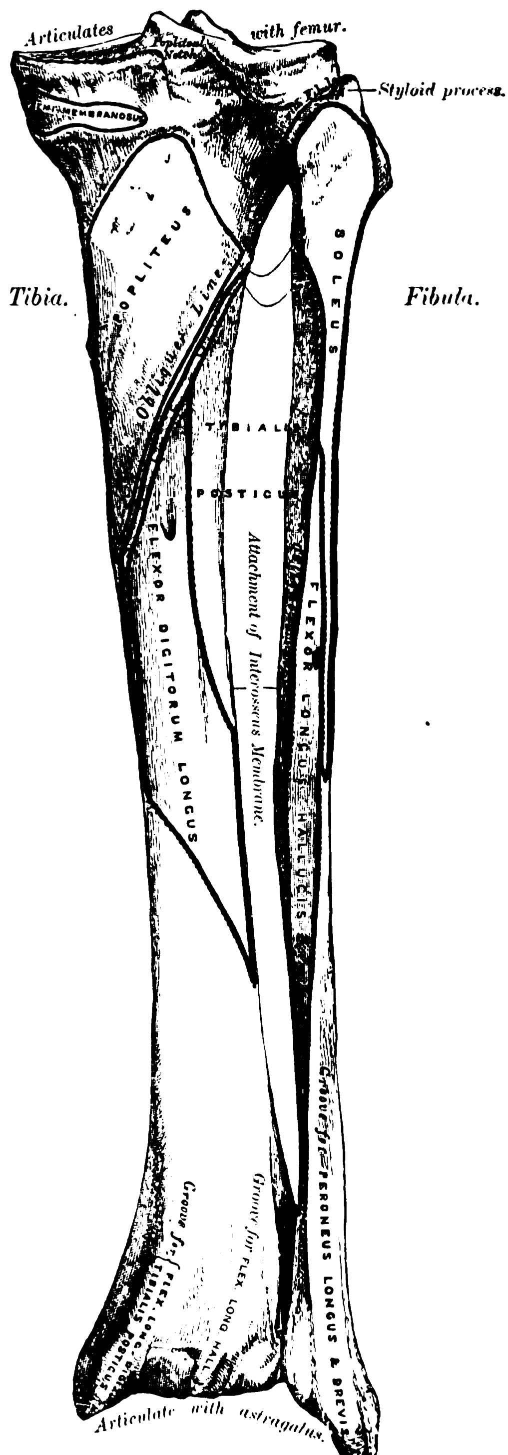
Branches: (1) Muscular, to tibialis posticus, flexor longus digitorum, and soleus; (2) cutaneous, to the skin of the inner part of the leg; (3) communicating (given off two inches above the internal malleolus), passes beneath the flexor longus hallucis and tendo Achillis, and anastomoses with the communicating branch of the peroneal; (4) malleolar, to the skin over the internal malleolus; (5) calcanean, to the soft parts on the inner side of the os calcis; (6) internal and external plantar; (7) a nutrient, to the tibia, enters the nutrient foramen, at the lower end of the oblique line of the tibia, on a ridge separating the origin of the tibialis posticus from the flexor longus digitorum; (8) peroneal, the largest branch of the posterior tibial (given off one inch below the popliteus muscle); it passes close to

FIG. 172.



The popliteal, posterior tibial, and peroneal arteries. (GRAY.)

FIG. 173.



Bones of the right leg. Posterior surface. (GRAY.)

the fibula, to the lower part of the interosseous membrane, and is attended by two venæ comites.

Branches of the Peroneal Artery: (1) Nutrient to the fibula; (2) cutaneous, to the outer side of the leg; (3) external calcanean, to the outer surface of the os calcis; (4) posterior peroneal, to the external malleolus and the heel; (5) anterior peroneal (passes through the lower part of the interosseous membrane), to the peroneus tertius and the inferior tibiofibular joint, anastomosing with the external plantar and anterior tibial arteries.

CHAPTER XXVII.

THE FIBULAR REGION.

Dissection and Identification. Adduct and extend the foot to render the skin and peronei tendons tense. Remove the integument. (Fig. 148.) Cut longitudinally, through the fasciæ covering the peronei muscles in the upper two-thirds of the outer surface of the fibula. Find the peroneal, or external popliteal nerve on the neck of the fibula, dividing into (1) a recurrent branch, to the knee; (2) the anterior tibial, to the muscles on the front of the leg; (3) the musculocutaneous, to the peronei muscles and skin of the dorsum of the foot. Trace tendons of the peronei muscles beneath the external annular ligament, posterior to the external malleolus. (Fig. 175.) The superficial fascia contains cutaneous branches of the external popliteal nerve. The deep fascia is quite strong.

External Malleolus. Identify (1) by the location, very prominent on the outer side of the ankle; (2) by continuity with the fibular shaft; (3) by the presence of the tendons of the peroneus longus and brevis, in the groove on the posterior border. (Fig. 174.)

External Annular Ligament. Identify (1) by the location on the outer side of the ankle, extending from the posterior border of the external malleolus to the outer surface of the os calcis. (Fig. 174.)

Peroneus Longus and Brevis Muscles. (Fig. 175.) Identify (1) by the location on the outer surface of the fibula and origin chiefly therefrom; (2) by the location of their tendons beneath the external annular ligament, posterior to the external malleolus. (Fig. 174.)

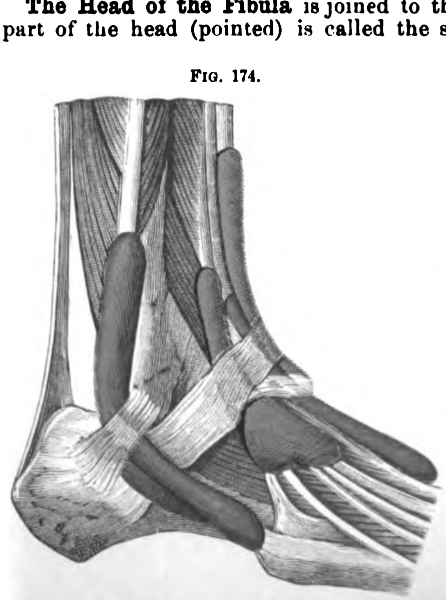
Musculocutaneous Nerve. (Fig. 166.) Identify (1) by the location between the outer head of the gastrocnemius and the tendon of the biceps; (2) by the location on the neck of the fibula, in the substance of the peroneus longus muscle; (3) by the distribution to the peronei muscles (longus and brevis), and the dorsum of the foot.

Peroneal Artery. (Fig. 172.) Identify (1) by the location near the fibula and distribution to the peronei muscles; (2) by the derivation from the posterior tibial artery (largest branch).

Head of Fibula. Identify (1) by the location below the knee and on the outer side of the leg; (2) by the continuity with the shaft of the fibula; (3) by insertion of the tendon of the biceps.

The Head of the Fibula is joined to the shaft of the bone, by the neck. The posterior part of the head (pointed) is called the styloid process; into the styloid is inserted the short external lateral ligament, morphologically, the divorced tendon of the peroneus longus. The posterior surface gives attachment to the soleus; the outer, to the peroneus longus; the anterior, to the extensor longus digitorum; the internal articulates, with the outer tuberosity of the tibia, and gives attachment to the capsule of the superior tibiofibular joint. Behind the head of the fibula is the external popliteal nerve, which a little lower crosses the neck of the bone and divides into the recurrent articular, anterior tibial, and musculocutaneous.

FIG. 174.



The external annular ligament of the ankle and the artificially distended synovial membrane of the tendons which it confines. (GERRISH after TESTUT.)

The External Malleolus is the lower end of the fibula. (Fig. 174.) The upper part of the malleolus is the base; the lowest part, the apex. To the apex is attached the middle band of the external lateral ligament of the ankle. The outer surface of the malleolus is subcutaneous. The inner surface above and in front articulates with the astragalus. Below and behind, this surface forms the digital fossa, into which is inserted the posterior band of the external lateral ligament and the transverse inferior tibiofibular ligament; the anterior border of the malleolus gives attachment to the anterior band of the external lateral ligament of the ankle. The posterior border is grooved for passage of the tendons of the peroneus longus and brevis muscles.

EXTERNAL ANNULAR LIGAMENT.

The External Annular Ligament (Figs. 174, 175) extends from the posterior border of the outer malleolus to the outer surface of the os calcis and peroneal tubercle. Beneath this ligament pass the tendons of the peroneus longus and brevis muscles in a synovial sheath. The external saphenous nerve and vein, embedded in the superficial fascia, lie on the ligament. (Fig. 139.)

PERONEI MUSCLES—LONGUS AND BREVIS.

The Peroneus Longus Muscle. (Fig. 175.) *Location:* Outer side of the leg and sole of the foot. *Origin:* (1) Outer surface of the upper two-thirds of the fibula; (2) head of the fibula; (3) outer tuberosity of the tibia; (4) deep fascia of the leg. *Insertion:* (1) Plantar base of the first metatarsal bone; (2) internal cuneiform bone. *Course:* (1) Behind the outer malleolus and beneath the external annular ligament in a synovial sheath with the peroneus brevis; (2) outer surface of the os calcis, below the peroneus brevis, in a special synovial sheath; (3) in an osseo-aponeurotic canal on the under surface of the cuboid bone; (4) across the bottom of the foot to its insertion into the plantar base of the first metatarsal. *Action:* Extends the foot. *Synergists:* Peroneus brevis, tibialis posticus, gastrocnemius, plantaris, soleus, and tendo Achillis. *Antagonists:* Peroneus tertius and tibialis anticus. *Nerve:* Musculocutaneous, a branch of the external popliteal. *Artery:* Peroneal branch of the posterior tibial. The plantar stage of this muscle will be studied in the dissection of the sole of the foot. (Figs. 178, 179.)

The Peroneus Brevis. (Fig. 175.) *Location:* Outer side of the leg. *Origin:* (1) Outer surface of the fibula, lower two-thirds; (2) deep fascia. *Insertion:* Dorsal base of the fifth metatarsal. *Course:* (1) Behind the outer malleolus with the peroneus longus; (2) above the peroneus longus, in a special synovial sheath, on the outer surface of the os calcis. *Action:* Extends the foot. *Synergists:* Peroneus longus, tibialis posticus, gastrocnemius, soleus, plantaris, and tendo Achillis. *Antagonists:* Peroneus tertius and tibialis anticus. *Nerve:* Musculocutaneous. *Artery:* Peroneal branch of the posterior tibial.

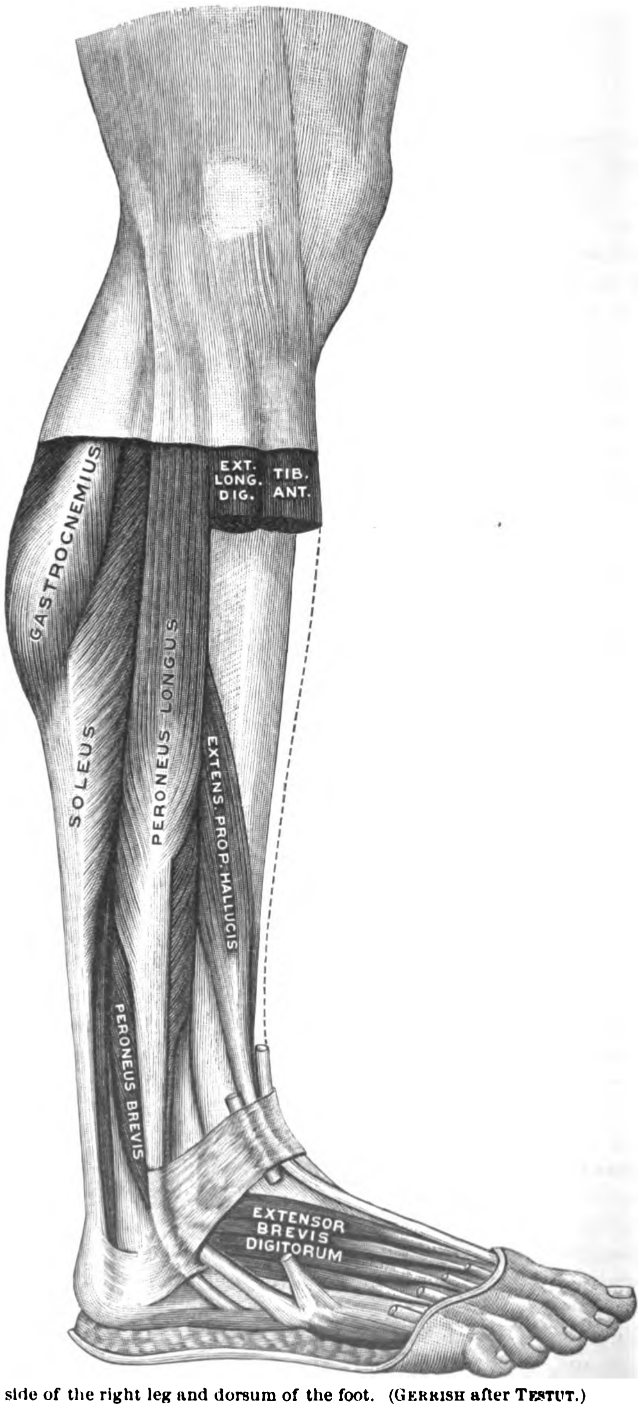
MUSCULOCUTANEOUS NERVE. (Figs. 160, 166.)

The Musculocutaneous Nerve (serial course). This nerve consists of fibres from the fourth and fifth lumbar and the first sacral, which leave the pelvis as a part of the great sciatic nerve. In the popliteal space these fibres depart from the great sciatic nerve with the external popliteal, passing along the inner margin of the biceps tendon; between the biceps and the outer head of the gastrocnemius; also behind the head and across the neck of the fibula; and, lastly, between the fibula and peroneus longus, where they leave to form the musculocutaneous nerve proper.

The musculocutaneous nerve proper begins on the neck of the fibula as a branch of the external popliteal. It passes through the peroneus longus muscle and gains its way between the peroneus longus and the extensor longus digitorum. It supplies the peroneus longus and brevis and ends in internal and external cutaneous branches, which, piercing the deep fascia in the middle third of the leg, become cutaneous and supply the dorsum of the foot, communicating with the internal and external saphenous and anterior tibial nerves. (Fig. 140.)

The Peroneal Artery (the largest branch of the posterior tibial) is given off one inch below the popliteus muscle. (Fig. 172.) Its course is downward close to the bone, as far as the lower limit of the interosseous membrane. Here the artery gives off the anterior peroneal and passes downward across the tibiofibular joint and ends in a network about the os calcis and outer malleolus. *Branches:* (1) Muscular, to the soleus, peronei, tibialis posticus, and flexor longus hallucis; (2) nutrient, to the fibula; (3) communicating to the posterior tibial; (4) cutaneous, to the outer side of the leg; (5) external calcanean, to the outer surface of the os calcis; (6) posterior peroneal, to the outer side of the os calcis.

FIG. 175.



Muscles on the outer side of the right leg and dorsum of the foot. (GERRISH after TESTUT.)

CHAPTER XXVIII.

THE SOLE OF THE FOOT.

Dissection and Identification. Hastily read the whole chapter on this subject, and carefully study the illustrations showing the successive strata as revealed by dissection. Make skin incisions as in Fig. 155. Remove the integument with a very sharp scalpel. Study distribution of cutaneous nerves in Fig. 142.

The Integument of the plantar surface of the foot, like that of the palm of the hand, is wanting in free mobility, a peculiarity due to the presence of fibrous processes extending from the deep fascia to the skin.

The Superficial Fascia of both the sole and palm contains granular fat, and is thickest over the heel.

The Cutaneous Nerves are derived from the long and short saphenous, internal and external plantar, and internal calcanean nerves. The blood-supply is from the plantar arteries.

The Deep Fascia (Fig. 176) of the sole of the foot (called the plantar) is dense, strong, and homologous to the palmar fascia. It is divided into three parts, central, outer, and inner, but these are not entirely separate. Each division corresponds to a muscle: the central, to the flexor brevis digitorum; the outer, to the abductor minimi digiti; the inner, to the abductor hallucis.

The Central Part (Fig. 176) of the plantar fascia is thick, strong and triangular, and extends from the under surface of the os calcis to the heads of the metatarsal bones, where it divides into slips for the toes. The slips are united imperfectly by transverse fibres, and are continued forward along the plantar surfaces of the toes as fibrous sheaths for the flexor tendons. Each sheath is lined by synovial membrane, which is reflected onto the tendon.

The Outer Part (Fig. 176) of the plantar fascia covers the abductor minimi digiti muscle, is continuous with the dorsal fascia of the foot externally, and blends with the central part internally. *Origin:* (1) Lesser tubercle of the os calcis; (2) external annular ligament. *Insertion:* (1) Base of first phalanx of the fifth toe; (2) deep fascia of the instep.

The Inner Part (Fig. 176) of the plantar fascia is thin, invests the abductor hallucis, and is continuous internally with the dorsal fascia of the foot. It blends with the central part. *Origin:* (1) Under surface of the os calcis; (2) internal annular ligament. *Insertion:* (1) Base of the first phalanx of the great toe; (2) deep fascia of the instep.

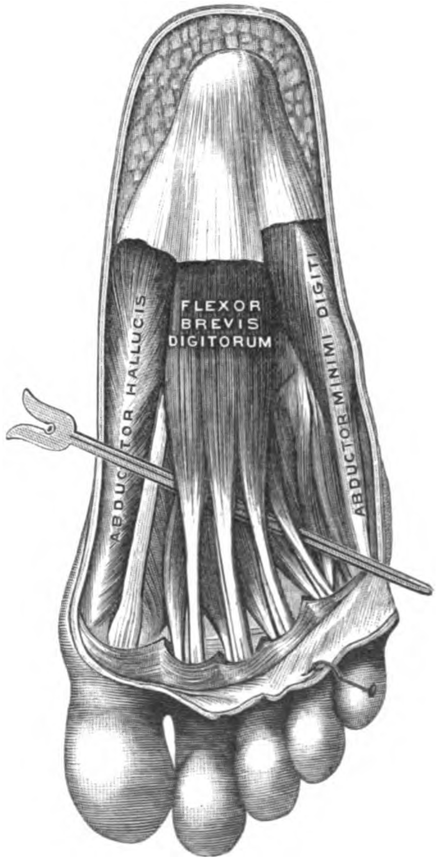
TABLE OF STRUCTURES IN SOLE OF FOOT ACCORDING TO LAYERS.

1. Skin and fasciæ. (Fig. 176) . . .	1. Integument. 2. Superficial fascia. 3. Plantar fascia.
2. First layer of muscles. (Fig. 176) .	Abductor hallucis. Flexor brevis digitorum. Abductor minimi digiti.
3. Neurovasal layer. (Fig. 177) . . .	Internal plantar nerve. Internal plantar vessels. External plantar nerve. External plantar vessels.
4. Second layer of muscles. (Fig. 177)	Flexor accessorius muscle. Four lumbrical muscles. Flexor longus digitorum. Flexor longus hallucis.
5. Third layer of muscles. (Fig. 179)	Flexor brevis hallucis. Adductor obliquus hallucis. Adductor transversus hallucis. Flexor brevis minimi digiti.
6. Fourth layer of muscles. (Figs. 180, 181)	Plantar interossei (three). Dorsal interossei (four).
7. Layer of tendons and ligaments. (Fig. 182)	Tendon of peroneus longus. Tendon of tibialis posticus. Long calcaneo-cuboid ligament. Short calcaneo-cuboid ligament.

FIRST LAYER OF MUSCLES.

The Abductor Hallucis. (Fig. 176.) *Origin:* (1) Under surface of the os calcis and its inner tuberosity; (2) inner part of the plantar fascia; (3) internal intermuscular septum; (4) internal annular ligament; (5) tuberosity of the scaphoid bone and tendon of tibialis posticus. *Insertion:* Base of the under surface of the first phalanx of the great toe. *Action:* Abduction of the great toe. *Synergists:* None. *Antagonists:* Adductor hallucis. *Nerve:* Internal plantar. *Artery:* Internal plantar, a branch of the posterior tibial.

FIG. 176.



Muscles of the superficial layer of the right foot. The plantar fascia remains near the heel. (GERRISH after TESTUT.)

The Flexor Brevis Digitorum. *Origin:* (1) Inner tuberosity of the os calcis; (2) central part of the plantar fascia; (3) internal and external intermuscular septa of the plantar fascia. *Insertion:* Sides of the middle phalanges of the four outer toes. *Action:* Flexion of the second phalanges of the toes. *Synergists:* Tendons of the flexor longus digitorum. *Antagonists:* Extensor brevis and extensor longus digitorum. *Nerve:* Internal plantar. *Arteries:* Plantar.

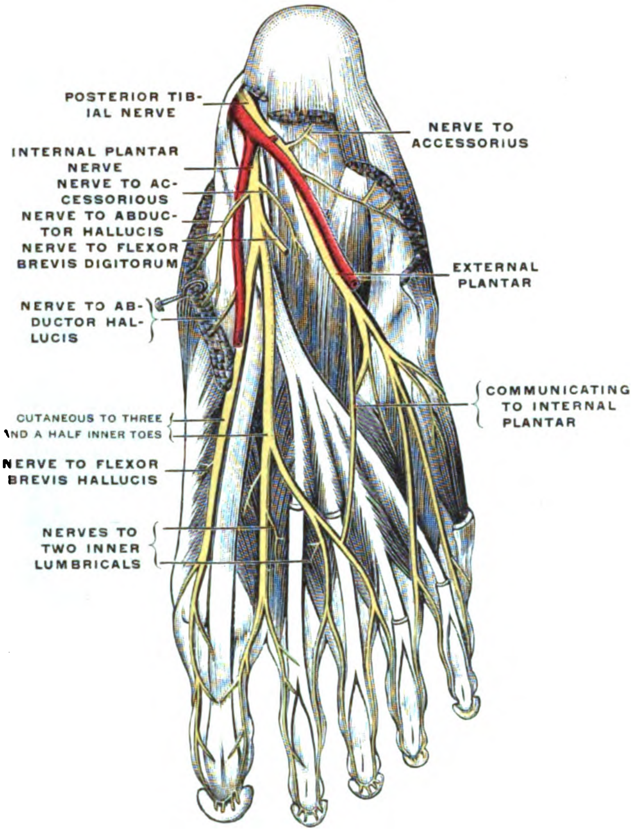
The Abductor Minimi Digiti. *Origin:* (1) Under surface and lesser tuberosity of the os calcis; (2) outer part of the plantar fascia; (3) external intermuscular septum of the plantar fascia. *Insertion:* Under surface of the base of the first phalanx of the little toe. *Synergists:* None. *Antagonist:* Third plantar interosseous muscle. *Nerve:* External plantar. *Artery:* External plantar.

LAYER OF NERVES AND VESSELS.

The Neurovasal Region consists of the plantar vessels and nerves, and is exposed on turning aside the three muscles of the first layer. The plantar nerves begin at the bifurcation of the posterior tibial, between the os calcis and internal malleolus, beneath the internal annular ligament. The plantar arteries begin in a similar manner and place, at the bifurcation of the posterior tibial. (Fig. 177).

The Internal Plantar Nerve (Fig. 177) begins beneath the internal annular ligament, at the bifurcation of the posterior tibial. It lies between the first and second layers of muscles of the sole of the foot. It accompanies the internal plantar artery, and has the following branches: (1) Articular, to tarsal, metatarsal, and

FIG. 177.



Plantar nerves. (GERRISH after TESTUT.)

phalangeal articulations; (2) cutaneous, to the heel; (3) digital, to the inner three and a half toes; (4) muscular, to the abductor hallucis, flexor brevis hallucis, flexor brevis digitorum, and the innermost part of the lumbrical muscles. The distribution of the internal plantar nerve resembles that of the median in the hand. (See Gray.)

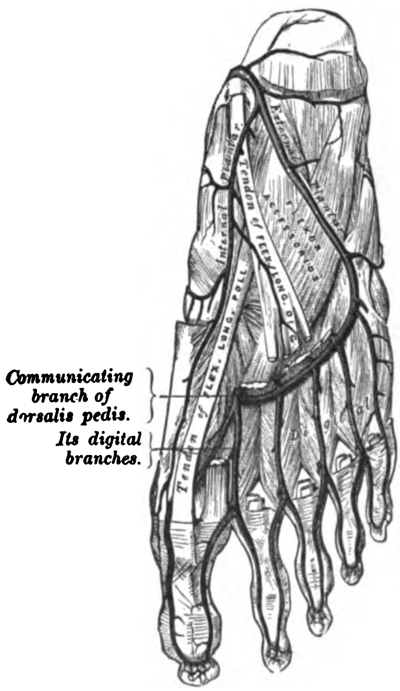
The External Plantar Nerve (Fig. 177) begins at the bifurcation of the posterior tibial. It accompanies the external plantar artery, and is similar in distribution to the ulnar in the hand. It supplies a larger number of muscles than the internal plantar. *Branches:* (1) To the interossei; (2) to the two lumbricals on the outer side; (3) to the abductor hallucis; (4) to the transversus pedis; (5) to the flexor accessorius; (6) to the abductor minimi digiti. This nerve has a cutaneous distribution to one and a half toes on the fibula side of the foot.

The Internal Plantar Artery (Fig. 178) begins with the external plantar, at the bifurcation of the posterior tibial, beneath the internal annular ligament, between the internal malleolus and the os calcis, and is accompanied by the internal plantar nerve.

The External Plantar Artery (Fig. 178) is larger than the internal. It crosses the sole of the foot obliquely to the head of the metatarsal bone of the little toe, where it turns abruptly inward and forward to a space between the first and second metatarsal bones, and anastomoses with the communicating branches of the dorsalis pedis, to form the plantar arch.

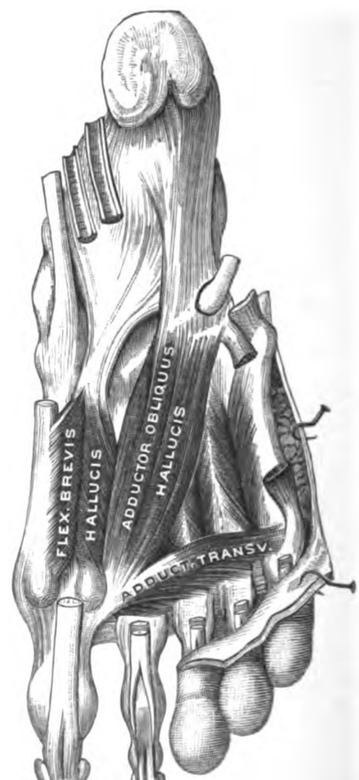
SECOND LAYER OF MUSCLES. (Fig. 178.)

FIG. 178.



The plantar arteries. Deep view. (GRAY.)

FIG. 179.



Muscles in the third layer of the right sole. (GERRISH after TESTUT.)

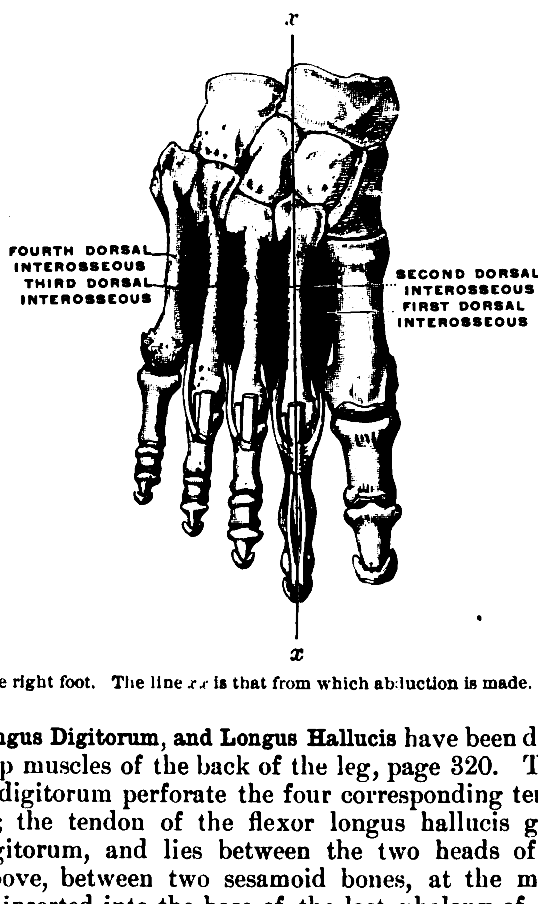
The Plantar Arch is a continuation of the external plantar artery, and is formed by the external plantar and dorsalis pedis. It lies on the interossei muscles. It sends off digital branches to three and a half outer toes. At the clefts of the toes these send off perforating branches, which pass through the interosseous spaces, and communicate with the metatarsal artery, on the dorsum of the foot. (The external plantar artery is accompanied by the deep branch of the external plantar nerve and venæ comites. The digital branches to the three and a half toes are homologous to branches of the superficial palmar arch of the hand. The blood-supply for the great toe and adjacent half of the second toe (dorsal surface) comes from the dorsalis pedis, through two arteries which are homologous to the arteria princeps pollicis and radialis indicis in the hand.) (See Gerrish's *Anatomy.*)

The Flexor Accessorius Muscle. *Origin:* (1) Inner surface of the os calcis, below the groove for the flexor longus hallucis; (2) the os calcis, in front of the outer tuberosity; (3) the long plantar ligament. *Insertion:* Upper surface and outer border of the flexor longus digitorum. *Action:* Flexion of the last phalanges of the four outer toes. *Synergist:* Flexor longus digitorum. *Antagonists:* Extensor longus and extensor brevis digitorum. *Nerve:* External plantar. *Artery:* External plantar.

The Four Lumbrical Muscles. (Fig. 177.) *Origin:* The first arises from the inner border of the inner tendon of the flexor longus digitorum; (2) the other three, from the adjoining surfaces of the first, second, third, and fourth tendons of the flexor longus digitorum. *Insertion:* Inner border of the tendons of the extensor longus digitorum. *Action:* (1) Flexion of the metatarsophalangeal joints; (2) extension of the first and second phalangeal joints. *Synergists:* Flexor longus and flexor brevis digitorum and interossei muscles. *Antagonists:* Extensor longus and extensor brevis digitorum. *Nerve:* The inner one, by the internal plantar; the three external ones, by the external plantar. *Arteries:* Plantar.

THIRD LAYER OF MUSCLES. (Fig. 179.)

FIG. 180.



Interossei dorsales of the right foot. The line *xx* is that from which abduction is made. (GERRISH after TESTUT.)

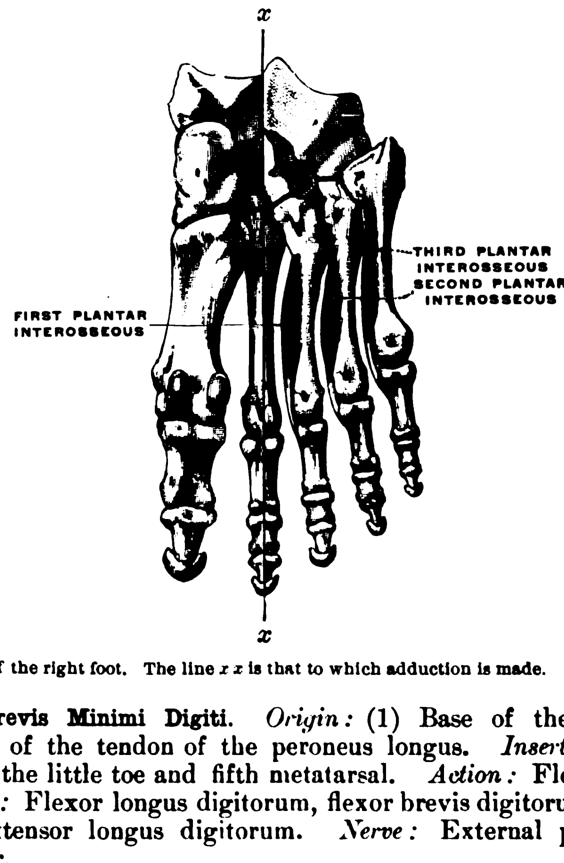
The Flexors, Longus Digitorum, and Longus Hallucis have been described in the dissection of the deep muscles of the back of the leg, page 320. The four tendons of the flexor longus digitorum perforate the four corresponding tendons of the flexor brevis digitorum; the tendon of the flexor longus hallucis gives a slip to the flexor longus digitorum, and lies between the two heads of the flexor brevis hallucis in a groove, between two sesamoid bones, at the metatarsophalangeal articulation; it is inserted into the base of the last phalanx of the great toe.

The Flexor Brevis Hallucis. (Fig. 179.) *Origin:* (1) Plantar ligament and continuation of the tendon of the tibialis posticus; (2) under surface of the cuboid bone. *Insertion:* Inner and outer border of the base of the first phalanx of the great toe. *Synergist:* Flexor longus hallucis. *Antagonists:* The extensor longus and extensor brevis hallucis. *Nerve:* Internal plantar. *Arteries:* Internal and external plantar.

The Adductor Obliquus Hallucis. (Fig. 179.) *Origin:* (1) Sheath of the peroneus longus, formed by the long plantar ligament (Fig. 182); (2) bases of the second, third, and fourth metatarsal bones. *Insertion:* Base of the first phalanx of the great toe. *Action:* Adduction of the great toe. *Synergist:* Transversus pedis (obliquus transversus hallucis). *Antagonist:* Abductor hallucis. *Nerve:* External plantar. *Artery:* External plantar.

The Adductor Transversus Hallucis. *Origin:* (1) Plantar ligaments of the three outer metatarsophalangeal joints; (2) deep transverse metatarsal ligament. *Insertion:* Base of the first phalanx of the great toe. *Action:* Adduction of the great toe. *Synergist:* Adductor obliquus hallucis. *Antagonist:* Abductor hallucis. *Nerve:* External plantar. *Arteries:* Plantar.

FIG. 181.



Interossei plantares of the right foot. The line $x\,x$ is that to which adduction is made. (GERRISH after TESTUT.)

The Flexor Brevis Minimi Digiti. *Origin:* (1) Base of the fifth metatarsal bone; (2) sheath of the tendon of the peroneus longus. *Insertion:* Base of the first phalanx of the little toe and fifth metatarsal. *Action:* Flexion of the little toe. *Synergists:* Flexor longus digitorum, flexor brevis digitorum and interossei. *Antagonist:* Extensor longus digitorum. *Nerve:* External plantar. *Artery:* External plantar.

FOURTH LAYER OF MUSCLES. (Figs. 180, 181.)

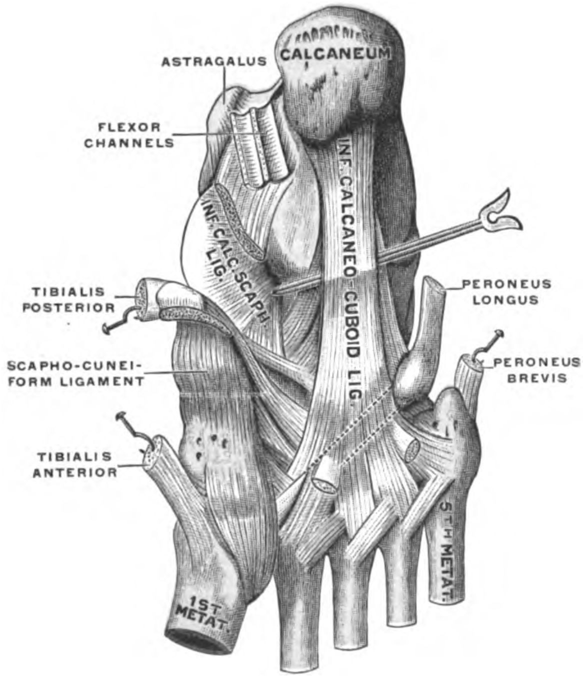
The Interossei Muscles, named from their position between the metatarsal bones, are, like those of the hand, seven in number—three plantar and four dorsal. The plantar are small, fusiform bundles; the dorsal are bipenniform. The interossei of the foot differ from those of the hand in that they adduct and abduct with respect to the longitudinal axis through the line of the second toe; whereas in the hand this axis passes through the middle finger. (Figs. 180, 181.)

Plantar Interossei (interossei plantares). *Origin:* (1) Inner and lower surfaces of the three outer metatarsal bones; (2) adjacent part of the sheath of the peroneus longus tendon. *Insertion:* Inner side of the bases of the first phalanges of the three outer toes and inner border of the expansions of the long extensor tendons on the back of the first phalanges of the same toes.

The Dorsal Interossei (interossei dorsales) arise from the adjacent surfaces of the metatarsal bones. The first differs in its internal head, which arises from the base only of the first metatarsal bone and the adjacent outer surface of the internal cuneiform bone. *Insertion:* (1) Inner side of the base of the first phalanx of the second toe; (2) inner edge of the aponeurosis of the extensor longus digitorum tendon, back of the first phalanx. The second, third, and fourth are inserted respectively into (*a*) the outer side of the bases of the first phalanges of the second, third, and fourth toes; (*b*) the outer border of the extensor tendon, on the back of the same phalanges. *Action:* Interossei, acting with the lumbricales, produce flexion of (1) the metatarsophalangeal articulation of the four outer toes; (2) extension of the second and third phalanges. *Synergists:* Lumbricales. Special action of the plantar interossei, adduction of the three outer toes; special action of the dorsal interossei, abduction of the second, third, and fourth toes. *Nerve:* External plantar. *Arteries:* Plantar.

LAYER OF TENDONS AND LIGAMENTS. (Fig. 182.)

FIG. 182.



The plantar ligaments. (GERRISH after TESTUT.)

Tendon of Tibialis Posticus. (Fig. 182.) *Insertion:* (1) Tuberosity of the scaphoid bone; (2) fibrous slips to every bone of the tarsus except the astragalus, and also the bases of the second, third, and fourth metatarsal bones. A sesamoid bone is in this tendon under the head of the astragalus.

The Tendon of the Peroneus Longus passes through a groove in the under surface of the cuboid bone, thence, through an osseo-aponeurotic canal, to the base of the metatarsal bone of the great toe and the internal cuneiform bone, into both of which it is inserted. The osseo-aponeurotic canal is lined by a synovial membrane. (Fig. 182)

The Long Calcaneo-cuboid Ligament (long plantar) is attached posteriorly to the under surface of the calcaneum (os calcis). Most of its fibres pass directly forward and are fixed to the outer two-thirds of the oblique ridge, behind the peroneal groove on the cuboid, while some pass further forward and inward, expanding into a broad layer, and are inserted into the bases of the second, third, fourth, and inner half of the fifth metatarsals. This anterior expanded portion completes the canal of the peroneus longus tendon. From the under surface of the ligament arise the adductor obliquus hallucis and the flexor brevis minimi digiti muscles.

The Short Calcaneo-cuboid Ligament (short plantar) is attached to the rounded eminence of the upper surface of the calcaneum, to the bone in front of it, and to the inferior surface of the cuboid, behind the oblique ridge. (Fig. 182.)

TABLE OF MUSCLES OF THE LOWER EXTREMITY.

Name.	*Origin.*	*Insertion.*	*Nerve.*	*Blood-supply.*
Psoas magnus (m. psoas major).	1. Front of bases and lower borders of transverse processes of lumbar vertebræ by five slips. 2. Sides of bodies and intervertebral disks of twelfth dorsal and all the lumbar vertebræ.	Lesser trochanter of femur, after having received nearly all the fibres of the iliacus muscle.	Anterior branches of second and third lumbar nerves.	1. Iliolumbar branch of internal iliac. 2. Lumbar branches of aorta.
Psoas parvus (may be absent) (m. psoas minor.)	Sides of bodies of the twelfth dorsal and first lumbar vertebræ and their intervertebral disk.	Iliopectineal eminence and iliac fascia.	Anterior branch of first lumbar nerve.	Lumbar branches of abdominal aorta.
Iliacus (m. iliacus).	1. Upper two-thirds of iliac fossa. 2. Inner margin of iliac crest. 3. Iliolumbar ligament and base of sacrum. 4. Anterior superior and anterior inferior spines of ilium and notch between. 5. Capsule of hip.	1. Outer side of tendon of psoas magnus. 2. Shaft of femur, below and in front of lesser trochanter.	Anterior branches of second and third lumbar nerves through the anterior crural.	Iliolumbar branch of internal iliac.
Tensor fasciæ femoris (m. tensor fasciæ latæ).	1. Anterior part of outer lip of iliac crest. 2. Outer surface of anterior superior spinous process of ilium. 3. Gluteal fascia.	Between two layers of fascia lata, in upper one-third of outer surface of thigh.	Superior gluteal.	Superior gluteal and external circumflex.
Sartorius (m. sartorius).	Anterior superior spine of ilium and upper one-third of notch below.	Upper part of inner surface of shaft of tibia by aponeurosis which covers insertion of semitendinosus and gracilis.	Anterior crural.	Femoral.
Rectus femoris (m. rectus femoris).	1. Anterior inferior iliac spine. 2. Groove above acetabulum.	Tubercle of tibia through ligamentum patella with vasti.	Anterior crural.	Femoral.
Vastus externus (m. vastus lateralis).	1. Upper one-half of anterior intertrochanteric line. 2. Anterior and inferior borders of root of great trochanter. 3. Anterior lip of gluteal ridge. 4. Upper one-half of outer lip of linea aspera.	Outer border of patella.	Anterior crural.	Femoral, through external circumflex.

Name.	*Origin.*	*Insertion.*	*Nerve.*	*Blood-supply.*
Vastus internus (m. vastus medialis).	1. Lower one-half of anterior intertrochanteric line. 2. Spiral line. 3. Inner lip of linea aspera. 4. Upper part of supracondylar line. 5. Tendon of adductor magnus. 6. Internal intermuscular septum.	Inner border of patella and quadriceps extensor tendon.	Anterior crural.	Femoral.
Crureus (m. vastus intermedius).	1. Front and outer part of upper two-thirds of shaft of femur. 2. Lower part of external intermuscular septum.	Aponeurosis forming deep part of quadriceps femoris.	Anterior crural.	Femoral.
Subcrureus (m. articularis genu).	Anterior surface of lower part of shaft of femur.	Upper part of capsular ligament of knee.	Anterior crural.	Femoral.
Gracilis (m. gracilis).	1. Lower one-half of margin of symphysis. 2. Anterior one-half of pubic arch.	Upper part of inner surface of shaft of tibia below tuberosity and beneath sartorius.	Obturator.	Obturator and femoral.
Pectineus (m. pectineus).	1. Iliopectineal line. 2. Pectineal fascia.	Line leading from lesser trochanter to linea aspera.	Anterior crural and accessory obturator.	Femoral and obturator.
Adductor longus (m. adductor longus).	Front of os pubis below pubic crest.	Linea aspera between vastus internus and adductor magnus.	Obturator.	Obturator; perforating branches of profunda femoris.
Adductor brevis (m. adductor brevis).	1. Outer surface of body and descending ramus of pubic bone, between gracilis and obturator externus.	Line leading from lesser trochanter to linea aspera.	Obturator.	Obturator; perforating branches of profunda femoris.
Adductor magnus (m. adductor magnus).	1. Descending ramus of pubic bone. 2. Ramus of ischium.	1. Line leading from greater trochanter to linea aspera internal to gluteus maximus. 2. Linea aspera and internal condylar ridge; adductor tubercle of femur.	Obturator and great sciatic.	Femoral; perforating branches of profunda femoris.
Gluteus maximus (m. glutæus maximus).	1. Superior curved line of ilium. 2. Iliac crest behind superior curved line. 3. Posterior surface of lower part of sacrum. 4. Side of coccyx. 5. Aponeurosis of erector spinæ. 6. Great sacrosciatic ligament. 7. Fascia covering gluteus medius.	1. Fascia lata on outer side of thigh. 2. Line leading from greater trochanter to linea aspera.	Inferior gluteal.	Superior and inferior gluteal.
Gluteus medius (m. glutæus medius).	1. Outer surface of ilium, between superior and middle curved lines. 2. Outer lip of iliac crest, between superior and middle curved lines. 3. Gluteal aponeurosis.	Oblique line of greater trochanter.	Superior gluteal.	Superior gluteal.
Gluteus minimus (m. glutæus minimus).	1. Outer surface of ilium, between middle and inferior curved lines. 2. Margin of greater sacrosciatic notch.	Anterior border of greater trochanter.	Superior gluteal.	Superior gluteal; external circumflex.

Name.	*Origin.*	*Insertion.*	*Nerve.*	*Blood-supply.*
Pyriformis (m. pyriformis).	1. Front of sacrum by three digitations between first, second, third, and fourth anterior sacral foramina. 2. Margin of great sacrosciatic foramen.	Upper border of great trochanter.	First and second sacral nerves.	Sciatic.
Obturator internus (m. obturator internus).	1. Inner surface of anterior and external wall of pelvis. 2. Obturator membrane. 3. Arch of obturator canal.	Forepart of inner surface of greater trochanter.	Fifth lumbar, first and second sacral.	Sciatic.
Gemellus superior (m. gemellus superior).	Outer surface of ischial spine.	With obturator internus into inner surface of greater trochanter.	Fifth lumbar, first and second sacral.	Sciatic and external circumflex.
Gemellus inferior (m. gemellus inferior).	Upper part of ischial tuberosity.	Inner surface of greater trochanter with obturator internus.	Last lumbar and first sacral.	Sciatic and external circumflex.
Quadratus femoris (m. quadratus femoris).	External lip of ischial tuberosity.	Linea quadrata of femur.	Last lumbar and first sacral.	Sciatic and internal circumflex.
Obturator externus (m. obturator externus).	1. Margin of obturator. 2. Obturator membrane. 3. Arch of obturator canal.	Digital fossa of femur.	Obturator.	Obturator and femoral.
Biceps (m. biceps femoris; caput longum; caput breve).	1. Lower and inner impression on back of tuberosity of ischium and greater sacrosciatic ligament. 2. Outer lip of linea aspera. 3. External condylar ridge. 4. External intermuscular septum.	1. Outer side of head of fibula. 2. Lateral surface of external tuberosity of tibia.	Great sciatic—a nerve for each head.	Perforating branches of profunda femoris.
Semitendinosus (m. semitendinosus).	1. Lower and inner impression of ischial tuberosity with long head of biceps. 3. Deep fascia.	Upper part of inner surface of shaft of tibia.	Great sciatic.	Perforating branches of profunda femoris.
Semimembranosus (m. semimembranosus).	Upper and outer impression on back of ischial tuberosity.	1. Groove on inner and back part of inner tuberosity of tibia beneath internal lateral ligament. 2. Outer condyle of femur, forming a part of Winslow's ligament. 3. Oblique line of tibia. 4. Internal lateral ligament of knee.	Great sciatic.	Perforating branches of profunda femoris.
Tibialis anticus (m. tibialis anterior).	1. Outer tuberosity and upper two-thirds of external surface of shaft of tibia. 2. Interosseous membrane and investing deep fascia. 3. Adjacent intermuscular septum.	Inner and under surface of internal cuneiform bone. 2. Base of first metatarsal bone.	Anterior tibial.	Anterior tibial artery.
Extensor proprius hallucis (m. extensor hallucis longus).	1. Middle two-fourths of anterior surface of fibula. 2. Interosseous membrane.	Base of last (second) phalanx of great toe.	Anterior tibial.	Anterior tibial artery.

Name.	*Origin.*	*Insertion.*	*Nerve.*	*Blood-supply.*
Extensor longus digitorum (m. extensor digitorum longus).	1. Outer tuberosity of tibia. 2. Upper three-fourths of anterior surface of fibula. 3. Interosseous membrane. 4. Deep fascia and intermuscular septa.	Second and third phalanges of four lesser toes. The tendons of the second, third, and fourth toes are joined by tendons of the extensor brevis digitorum.	Anterior tibial.	Anterior tibial artery.
Peroneus tertius (m. peronæus tertius).	1. Lower one-fourth of anterior surface of fibula. 2. Interosseous membrane. 3. Deep fascia and intermuscular septa.	Dorsal surface of base of fifth metatarsal bone.	Anterior tibial.	Anterior tibial artery.
Gastrocnemius (m. gastrocnemius: caput laterale; caput mediale).	1. Depression on upper and back of inner condyle. 2. Impression on outer side of external condyle and posterior surface of femur above condyle.	Unites with soleus, forming tendo Achillis, which is inserted into the posterior surface of os calcis.	Internal popliteal.	Popliteal artery.
Soleus (m. soleus: arcus tendineus musculi solei).	1. Back of head of fibula. 2. Upper one-third of posterior surface of shaft of fibula. 3. Oblique line of tibia and middle one-third of internal border.	Joins gastrocnemius, to form the tendo Achillis.	Internal popliteal and posterior tibial.	Popliteal artery.
Plantaris (m. plantaris).	Lower part of external supracondylar ridge. 2. Ligament of Winslow.	Posterior surface of os calcis; internal annular ligament or plantar fascia.	Internal popliteal.	Popliteal artery.
Popliteus (m. popliteus).	1. Depression on outer side of external condyle of femur. 2. Posterior ligament of knee.	Inner two-thirds of triangular surface above oblique line of tibia. 2. Tendinous expansion of semimembranosus covering this muscle.	Internal popliteal.	Popliteal artery.
Flexor longus hallucis (m. flexor hallucis longus).	1. Lower two-thirds of posterior surface of fibula. 2. Interosseous membrane. 3. Intermuscular septa and fascia covering tibialis posticus.	Base of last phalanx of great toe.	Posterior tibial.	Posterior tibial artery.
Flexor longus digitorum (m flexor digitorum longus).	1. Posterior surface of shaft of tibia below oblique line. 2. Fascia of tibialis posticus.	By four tendons into bases of distal phalanges of four outer toes.	Posterior tibial.	Posterior tibial artery.
Tibialis posticus (m. tibialis posterior).	1. Interosseous membrane. 2. Outer part of posterior surface of shaft of tibia. 3. Upper two thirds of internal surface of fibula. 4. Deep transverse fascia and intermuscular septa.	1. Tuberosity of navicular and internal cuneiform. 2. Sustentaculum tali, middle and external cuneiform, and cuboid. 3. Bases of second, third, and fourth metatarsal bones.	Posterior tibial.	Posterior tibial artery.
Peroneus longus (m. peronæus longus).	1. Head and upper two-thirds of outer surface of fibula. 2. Deep fascia and intermuscular septa.	Outer side of base of metatarsal bone of great toe.	Muscular branches of musculo-cutaneous.	Peroneal artery.
Peroneus brevis (m. peronæus brevis).	1. Lower two-thirds of external surface of fibula. 2. Intermuscular septa.	Tuberosity of base of metatarsal bone of little toe.	Muscular branches of musculo-cutaneous.	Peroneal artery.

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Name.	*Origin.*	*Insertion.*	*Nerve.*	*Blood-supply.*
Extensor brevis digitorum (m. extensor digitorum brevis).	1. Forepart of upper and outer surface of os calcis. 2. External calcaneo-astragaloid ligament. 3. Annular ligament.	1. The innermost tendon into the dorsal surface of base of first phalanx of great toe. 2. The three other tendons into the second and third phalanges of the second, third, and fourth toes with tendons of extensor longus digitorum.	Anterior tibial.	Dorsalis pedis artery.
Abductor hallucis (m. abductor hallucis).	1. Inner tubercle on under surface of os calcis. 2. Internal annular ligament, plantar fascia, and intermuscular septum.	Inner side of base of first phalanx of great toe with flexor brevis hallucis.	Internal plantar.	Internal plantar artery.
Flexor brevis digitorum (m. flexor digitorum brevis).	1. Inner tubercle of os calcis. 2. Central part of plantar fascia. 3. Intermuscular septum.	Sides of second phalanges of four outer toes—about their middle.	Internal plantar.	Plantar arteries.
Abductor minimi digiti (m. abductor minimi digiti).	1. Outer and inner tubercles of os calcis and ridge of bone between. 2. Plantar fascia and intermuscular septum.	Outer side of base of first phalanx of little toe with flexor brevis minimi digiti.	Externa plantar.	External plantar artery.
Flexor accessorius (m. quadratus plantæ).	1. Inner surface of os calcis below groove for tendon of flexor longus hallucis. 2. Outer surface of os calcis in front of outer tubercle. 3. Long plantar ligament.	Outer margin, upper and under surfaces of tendon of flexor longus digitorum.	External plantar.	External plantar artery.
Lumbricals, four in number (mm. lumbricales).	Tendons of flexor longus digitorum, each arising by two heads, except the inner.	Tendons of extensor longus digitorum, on inner side of dorsum of first phalanx.	The internal plantar supplies the innermost muscle; the external, the other three.	Plantar arteries.
Flexor brevis hallucis (m. flexor hallucis brevis).	1. Under surface of cuboid bone 2. External cuneiform bone. 3. Tendon of tibialis posticus.	Inner and outer sides of base of first phalanx of great toe.	Internal plantar.	Internal plantar artery.
Adductor obliquus hallucis (m. adductor hallucis: caput obliquum and caput transversum).	1. Tarsal ends of second, third, and fourth metatarsal bones. 2. Sheath of tendon of peroneus longus.	Outer side of base of first phalanx of great toe with outer part of flexor brevis hallucis.	External plantar.	Plantar arteries.
Flexor brevis minimi digiti (m. flexor digiti quinti brevis).	1. Base of first metatarsal bone of little toe. 2. Sheath of peroneus longus.	Base of first phalanx of little toe on outer side.	External plantar.	External plantar artery.
Adductor transversus hallucis (transversus pedis).	Inferior metatarso-phalangeal ligaments of three outer toes.	Outer side of first phalanx of great toe.	External plantar.	External plantar artery.
First dorsal interosseous muscle (m. interosseus dorsalis I.).	Adjacent surfaces of first and second metatarsal bones.	1. Inner side of base of first phalanx of second toe. 2. Common extensor tendon.	External plantar.	Plantar arteries.

Name.	*Origin.*	*Insertion.*	*Nerve.*	*Blood-supply.*
Second dorsal interosseus muscle (m. interosseus dorsalis II.).	Adjacent surfaces of second and third metatarsal bones.	1. Outer side of base of first phalanx of second toe. 2. Aponeurosis of common extensor tendon.	External plantar.	Plantar arteries.
Third dorsal interosseous muscle (m. interosseus dorsalis III.).	Adjacent surfaces of third and fourth metatarsal bones.	1. Outer side of base of first phalanx of third toe. 2. Common extensor tendon.	External plantar nerve.	External plantar artery.
Fourth dorsal interosseous muscle (m. interosseus dorsalis IV.).	Adjacent surfaces of fourth and fifth metatarsal bones.	1. Outer side of base of first phalanx of fourth toe. 2 Common extensor tendon.	External plantar.	Plantar arteries.
First plantar interosseous muscle.	Base and inner side of third metatarsal bone.	1. Inner side and base of first phalanx of third toe. 2. Common extensor tendon.	External plantar.	External plantar artery.
Second plantar interosseous muscle.	Inner side and base of fourth metatarsal bone.	1. Inner side and base of first phalanx of fourth toe. 2. Common extensor tendon.	External plantar.	External plantar artery.
Third plantar interosseous muscle.	Inner side and base of fifth metatarsal bone.	1. Inner side and base of first phalanx of fifth toe. 2. Common extensor tendon.	External plantar.	External plantar artery.

CHAPTER XXIX.

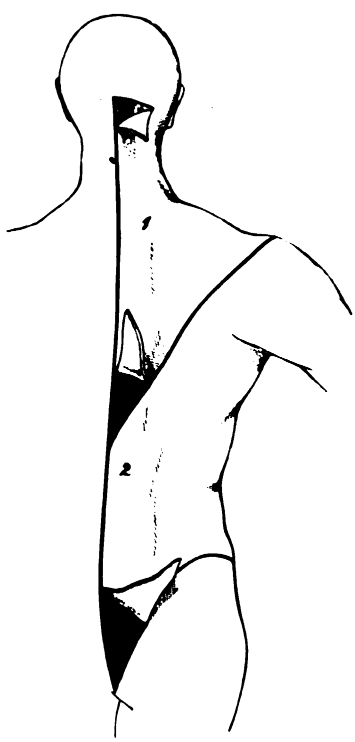
THE BACK.

Dissection and Identification. Remove integument. Study carefully illustrations, so as not to overlook the cutaneous vessels and their accompanying nerves. (Fig. 185.) Study origin and insertion, nerve-supply and blood-supply of muscles in the tables. Consult Gray and Gerrish for function and details. Make skin incisions according to Fig. 183. Dissect structures in the order given in the following identification. Consult the illustrations and study the text.

Superficial Fascia. (Fig. 183.) Identify (1) by the location immediately beneath the integument and the presence of granular fat; (2) by the free mobility it confers on the skin, even in very emaciated persons.

Six Upper Dorsal Cutaneous Nerves (Fig. 185) (rami cutanei dorsales). Identify (1) by the location near the six upper dorsal spines and distribution to the integument; (2) by piercing the trapezius and rhomboidii muscles. These nerves are from the internal branches of the posterior divisions of the dorsal nerves, and emerge between the multifidus spinæ and semispinalis dorsi.

FIG. 183.



Dissection of the muscles of the back. (GRAY.)

Six Lower Dorsal Cutaneous Nerves (Fig. 185) (rami cutanei dorsales). Identify (1) by the location in line with the angles of the ribs; (2) by piercing the latissimus dorsi, serratus posticus inferior, and ramifying in the integument. They are derived from the external branches of the posterior divisions. Identify the lumbar cutaneous nerves in the same way.

Dorsal Cutaneous Vessels (rami cutanei dorsales). Identify (1) by the location and association with the cutaneous nerve above identified. (Fig. 185.) They are derived from the dorsal branches of the intercostal and lumbar nerves.

Suboccipital Nerve (Fig. 184) (n. suboccipitalis), posterior division of the first cervical nerve. Identify (1) by the location in the suboccipital triangle, which it enters between the vertebral artery and the arch of the atlas; (2) by the distribution of the muscular branches to the boundary and roof-muscles of the suboccipital triangle. (This nerve is one of the most deeply located, as well as the most difficult structure in this region to dissect, and its identification is given in this place with the cutaneous nerves as a matter of routine only.)

Great Occipital Nerve (Fig. 184) (n. occipitalis major), posterior division (internal branch) of the second cervical nerve. Identify (1) by the large size and distribution to the scalp; (2) by piercing the trapezius and complexus near the superior curved line, about two inches from the external occipital protuberance; (3) by association with the occipital artery in the scalp distribution. See table, page 352, for third occipital, fourth, fifth, sixth, seventh, and eighth cervical nerves, posterior divisions.

Occipital Artery (Figs. 184 and 189) (a. occipitalis). Identify (1) by the location near the superior curved line, where it pierces the fascia at the junction of the trapezius and sternomastoid muscles; (2) by association with the great occipital nerve and general location somewhat external to this latter. The occipital vein and its tributaries correspond to the occipital artery and its branches.

Deep Fascia (fascia profunda). Identify (1) by the location immediately beneath the superficial fascia with its mass of granular fat; (2) by its very frail structure and attachment to the occipital bone, spinous processes, scapular spine, and iliac crest. The muscles [illegible] group (trapezius and latissimus dorsi) are readily seen through the deep fasci[illegible] is continuous with the deep fascia of the axilla, chest, and abdominal wal[illegible]

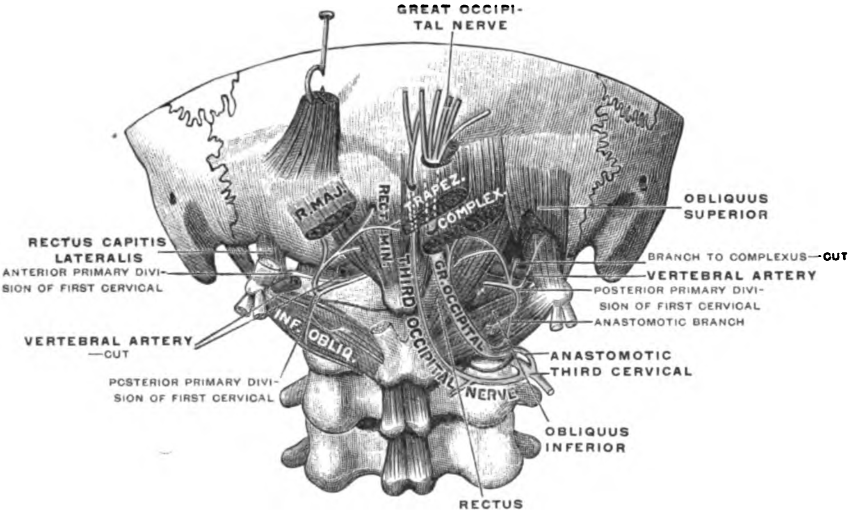
Latissimus Dorsi Muscle. (Fig. 185) Identify (1) by the broa[illegible] sacral, lumbar, and six lower dorsal spines; (2) by the upward, forw[illegible] across the inferior angle of the scapular to the humerus.

Ligamentum Nuchæ. (Fig. 185.) Identify (1) by the location between the muscles of the right and left sides of the back of the neck; (2) by the extent from the external occipital protuberance to the spine of the seventh cervical vertebra; (3) by the attachment to the cervical spines and external occipital crest.

Vertebral Aponeurosis (fascia lumbodorsalis). Identify (1) by the location between the muscles acting on the shoulder girdle and those acting on the head and neck; (2) by its attachments—internally, to the dorsal spines; externally, to the angles of the ribs; below, to the serratus posticus inferior; above, to the deep cervical fascia.

The Lumbar Fascia (or vertebral aponeurosis of the transversalis muscle) divides into an anterior thin layer attached to the front of the lumbar transverse processes and twelfth rib, forming the ligamentum arcuatum externum; a middle layer, attached to the apices of the spinous processes; the quadratus lumborum lies between the anterior and middle layers; the erector spinæ between the middle and posterior layers; the posterior layer receives the attachment of the internal oblique, and, blending with the aponeuroses of the serratus posticus inferior and latissimus dorsi, forms the lumbar fascia.

FIG. 184.



Dorsal primary divisions of the upper three cervical nerves. (GERRISH after TESTUT.)

Trapezius Muscle. (Fig. 185.) Identify (1) by the extensive central attachment to the occipital bone, ligamentum nuchæ, vertebra prominens, and dorsal spines; (2) by the insertion into the scapular spine, acromion, and clavicles. Having thoroughly identified the muscle, put the same on the stretch, and with a sharp scalpel remove the deep fascia so as to demonstrate the direction of its muscular fibres.

Spinal Accessory Nerve and Branches of the Third and Fourth Cervical Nerves to the Trapezius Muscle. (Fig. 59.) Identify (1) by the location, entering beneath the anterior margin of the trapezius; (2) the spinal accessory nerve pierces the sternomastoid muscle, crosses the posterior triangle of the neck, and enters the trapezius with the branches of the third and fourth cervical.

Subtrapezial Region. (Fig. 186.) Removal of the trapezius exposes, partially or completely, the complexus, splenius, levator anguli scapulæ, rhomboidei minor and major, supraspinatus, infraspinatus, vertebral aponeurosis, spinal accessory nerve, third and fourth cervical nerves, and the superficial cervical artery, a branch of the arteria princeps cervicis of the occipital artery. (Fig. 190.)

Transversalis Colli Artery. Identify (1) by the course through the subclavian triangle across the scaleni muscles, phrenic nerve, and brachial plexus to the anterior margin of the trapezius; (2) by the division of the artery beneath the anterior margin of the trapezius, into the superficial cervical and posterior scapular. The posterior scapular passes beneath the levator anguli scapulæ, along the posterior border of the scapula, beneath the rhomboid muscles, anastomosing with the suprascapular, subscapular, and posterior branches of the intercostal arteries.

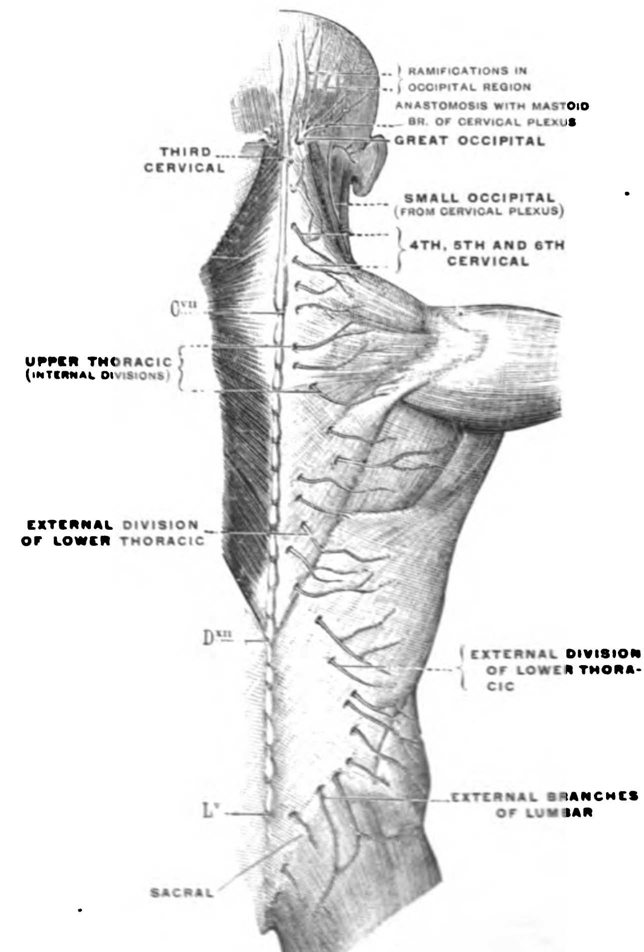
Levator Anguli Scapulæ. (Fig. 186.) Identify (1) by the insertion into the posterior border of the scapula, between its superior angle and the root of the spine; (2) by the origin from the transverse processes of the upper five cervical vertebræ; (3) by the presence of [illegible] scapular artery, which passes beneath this muscle and the rhomboids.

[illegible] **Muscles.** (Fig. 186.) Identify (1) by the insertion into the posterior border of [illegible] tween the root of the scapular spine and the inferior angle; (2) by the origin from the spinous processes extending from the seventh cervical to the fifth dorsal; (3) by the presence of the posterior scapular artery (branch of the transversalis colli of the thyroid axis) beneath these, and the levator anguli scapulæ; (4) by the presence of the nerve for these muscles in the cellular interval between the levator anguli scapulæ and rhomboids.

Posterior Scapular Artery. Identify (1) by the location beneath the levator anguli scapulæ and rhomboidei muscles, near the posterior border of the scapula; (2) by the derivation from the transversalis colli (with the superficial cervical artery) beneath the anterior border of the trapezius muscle.

Serratus Posticus Superior. (Fig. 186.) Identify (1) by the origin from the ligamentum nuchæ and spines of the seventh cervical, first, second, third, and fourth upper dorsal vertebræ; (2) by the direction of its fibres downward and outward, and their insertion into the upper borders of the second, third, fourth, and fifth ribs, external to their angles; (3) by the location beneath the trapezius, rhomboids, and levator anguli scapulæ muscles.

FIG. 185.



Dorsal primary divisions of the spinal nerves. (Gerrish after Testut.)

Serratus Posticus Inferior. (Fig. 186.) Identify (1) by the origin from the eleventh and twelfth dorsal, first, second, and third lumbar spines; (2) by the insertion into the lower borders of the ninth, tenth, eleventh, and twelfth ribs, beyond their angles; (3) by the direction of the fibres upward and outward; (4) by the location beneath the latissimus dorsi.

Splenius. (Fig. 186.) Identify (1) by the origin from the seventh cervical and sixth upper dorsal spines and lower half of the ligamentum nuchæ; (2) by the insertion into the mastoid process of the temporal bone and the posterior tubercles of the transverse processes of the first, second, and third cervical vertebræ; (3) by the location beneath the trapezius, rhomboids, and serratus posticus superior.

Complexus. (Fig. 187.) Identify (1) by the origin from the transverse processes of the six or seven upper dorsal and seventh cervical vertebræ, and the articular processes of the fourth, fifth, and sixth cervical; (2) by the insertion into the occipital bone, between the two curved lines.

Anastomosis, Superficial. Identify (1) by the location between the splenius and complexus muscles; (2) by its composition: superficial branch of the arteria princeps cervicis (occipital branch) and the superficial cervical artery (from the transversalis colli).

Anastomosis, Deep. (Fig. 190.) Identify (1) by the location between the complexus and semispinalis colli; (2) by its composition: deep branch of the arteria princeps cervicis and the deep cervical artery (superior intercostal branch).

The remaining muscles are to be identified by reference to the consecutive illustrations and the table of muscles.

TABLE OF MUSCLES OF THE BACK.

FIRST LAYER.

Name.	*Origin.*	*Insertion and Nerve-supply.*
Trapezius. It has three varieties of fibres founded on direction toward their insertion (m. trapezius). (Fig. 185.)	1. External occipital protuberance. 2. Inner third superior curved line. 3. Ligamentum nuchæ. 4. Vertebra prominens. 5. The twelve dorsal spines. 6. Supraspinous ligament.	The superior fibres are inserted into outer third of posterior border of clavicle; the middle fibres, into inner margin of acromion process and superior lip of posterior border of scapular spine; the inferior fibres into tubercle at inner end of scapular spine. Nerves: anterior divisions of third and fourth cervical, spinal accessory (the eleventh cranial).
Latissimus dorsi. The upper fibres of this muscle are horizontal; the middle, oblique; the lower, vertical (m. latissimus dorsi). (Fig. 185.)	1. From sacral, lumbar, and six lower dorsal spines. 2. Outer lip of iliac crest. 3. The four lower ribs. 4. Posterior layer of lumbar aponeurosis.	Inserted into bottom of bicipital groove of humerus, higher than insertion of teres major. The muscle curves around teres major, so that the superior fibres are posterior and inferior in succession, and the vertical fibres anterior and superior. Nerve: long subscapular from posterior cord of brachial plexus.

SECOND LAYER.

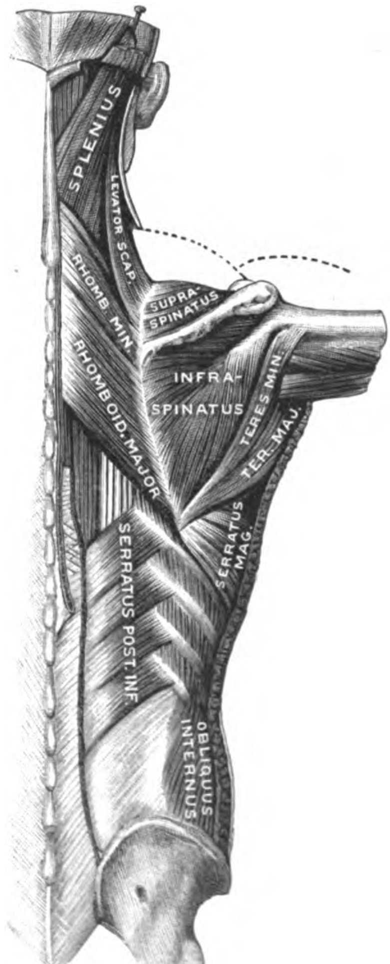
Levator anguli scapulæ (m. levator anguli scapulæ). (Fig. 186.)	1. Transverse process of atlas and second, third, and fourth cervical vertebræ; posterior tubercles.	Inserted into posterior border of scapula, between superior angle and root of spine. Nerves: anterior divisions of third and fourth cervicals.
Rhomboideus minor (m. rhomboideus minor). (Fig. 186.)	1. Ligamentum nuchæ. 2. Seventh cervical and first dorsal spines. 3. Supraspinous ligament.	Inserted into margin of triangular, smooth surface at root of scapular spine. Nerve: anterior division of fifth cervical.
Rhomboideus major (m. rhomboideus major). (Fig. 186.)	1. Spinous processes of four or five upper dorsal vertebræ. 2. Supraspinous ligament.	Inserted into a narrow tendinous arch, extending from root of scapular spine to inferior scapular angle. Nerve: anterior division of fifth cervical.

THIRD LAYER.

Serratus posticus superior (m. serratus posterior superior). Find beneath rhomboid muscles. (Fig. 186.)	1. Ligamentum nuchæ. 2. Spinous processes of seventh cervical and first, second, third, and fourth upper dorsal vertebræ. 3. Supraspinous ligament.	Inserted into upper borders of second, third, fourth and fifth ribs, beyond their angles. Nerves: posterior divisions of spinals.
Serratus posticus inferior (m. serratus posterior inferior).	1. Spinous processes of eleventh and twelfth dorsal and first, second, and third lumbar vertebræ. 2. Supraspinous ligament.	Inserted into lower borders of ninth, tenth, eleventh, and twelfth ribs, beyond their angles. Nerves: posterior divisions of spinals.
Splenius (m. splenius). (Figs. 186 and 187.)	1. Lower one-half of ligamentum nuchæ. 2. Spinous processes of seventh cervical and six upper dorsal vertebræ. 3. Supraspinous ligament.	Inserted into (1) head (splenius capitis); (2) neck (splenius colli). See below splenius capitis, splenius colli. Nerves: posterior divisions of the spinals.
Splenius capitis (m. splenius capitis).	Splenius. See above.	Inserted into (1) mastoid process of temporal bone; (2) occipital bone beneath the superior curved line. Nerves: posterior divisions of the spinals.

Name.	*Origin.*	*Insertion and Nerve-supply.*
Splenius colli (m. splenius colli).	Splenius. See above.	Inserted into transverse processes of first, second, and third cervical vertebræ, posterior tubercles. Nerves: posterior divisions of spinals.

FIG. 186.

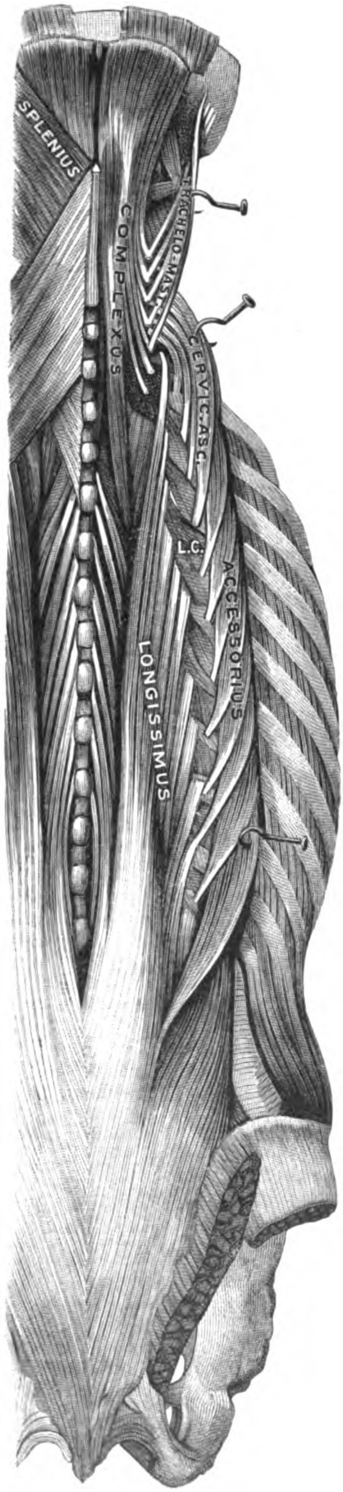


Muscles in the second layer of the back and on the dorsum of the shoulder. (GERRISH after TESTUT.)

FOURTH LAYER.

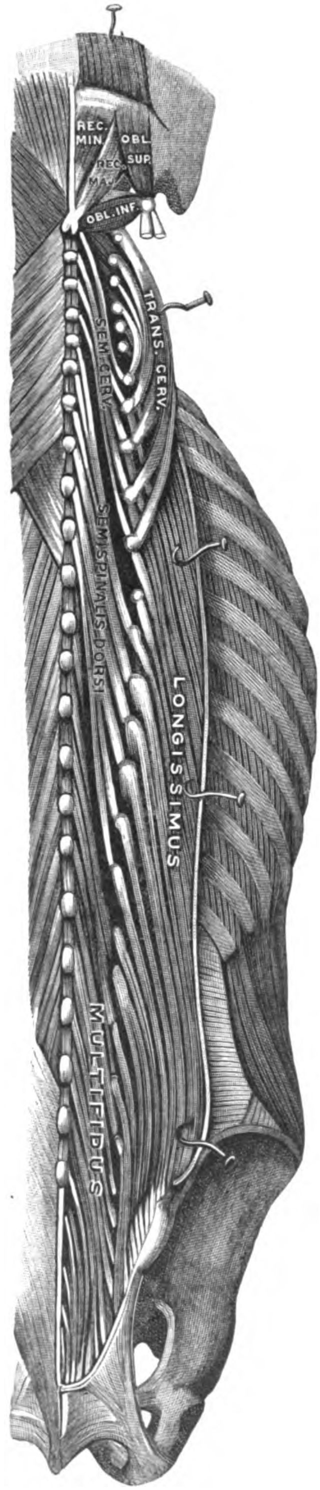
Erector spinæ. (Fig. 187.) Opposite last rib; this muscle divides into the iliocostalis and longissimus dorsi. The spinalis dorsi is derived from the longissimus dorsi (m. iliocostalis lumborum).	1. Spines of eleventh and twelfth dorsal and all the lumbar and sacral spines and their supraspinous ligaments. 2. Back part of inner lip of iliac crest. 3. Posterior surface of sacrum, external to spinous processes.	See insertions of iliocostalis, longissimus dorsi, spinalis dorsi and their continuations to head and neck. Nerves: posterior divisions of spinals.
Iliocostalis (Fig. 187) (m. iliocostalis dorsi).	Outer part of erector spinæ.	Inserted into the inferior borders of the angles of the six or seven lower ribs by flattened tendons. Nerves: posterior divisions of spinals.
The musculus accessorius ad iliocostalem, is the upward continuation of iliocostalis. (Fig. 187.)	Upper borders of angles of the six lower ribs, by separate tendons.	Insertion: (1) upper borders of angles of six upper ribs; (2) back of transverse process of seventh cervical vertebra. Nerves: posterior divisions of spinals.

FIG. 187.



Erector spinæ. The outer series is pulled outward. (GERRISH after TESTUT.)

FIG. 188.



Erector spinæ. The middle series is pulled outward. (GERRISH after TESTUT.)

Name.	*Origin.*	*Insertion and Nerve-supply.*
Cervicalis ascendens, a continuation of accessorius into neck (m. iliocostalis cervicis). (Fig. 187.)	Angles of four or five upper ribs.	Insertion: posterior tubercles of transverse processes of fourth, fifth, and sixth cervical vertebræ. Nerves: posterior divisions of spinals.
Longissimus dorsi, the middle and largest part of erector spinæ (m. longissimus dorsi). (Fig. 187.)	1. Middle part of erector spinæ. 2. Transverse processes of lumbar vertebræ. 3. Middle lamella of lumbar fascia.	Insertion: (1) tips of transverse processes of dorsal vertebræ; (2) lower ribs (seventh to eleventh) between tubercles and angles. Nerves: posterior divisions of spinals.
Transversalis cervicis, or transversalis colli, the cervical continuation of longissimus dorsi (m. longissimus cervicis). (Fig. 188.)	Summits of transverse processes of six upper dorsal vertebræ.	Insertion: posterior tubercles of transverse processes of cervical vertebræ, second to sixth inclusive. Nerves: posterior divisions of spinals.
Trachelomastoid, the internal continuation of longissimus dorsi to cranium (m. longissimus capitis). (Fig. 187.)	1. Transverse processes of five or six upper dorsal vertebræ. 2. Articular processes of three or four lower cervical vertebræ.	Posterior margin of the mastoid process beneath insertion of splenius and sternomastoid. Nerves: posterior divisions of spinals.
Spinalis dorsi, situated at the inner border of the longissimus dorsi and intimately blended therewith (m. spinalis dorsi).	Spinous processes of eleventh and twelfth dorsal and first and second lumbar vertebræ.	Insertion: spinous processes of six or eight upper dorsal vertebræ. Nerves: posterior divisions of spinals.
Spinalis colli, analogous to the spinalis dorsi (m. spinalis cervicis).	Spinous processes of fifth, sixth, and seventh cervical vertebræ; occasionally from first and second dorsal spines.	Insertion: spine of axis and occasionally spines of third and fourth cervical vertebræ. Nerves: posterior divisions of spinals.
Complexus (Fig 187) (m. semispinalis capitis).	1. Tips of transverse processes of from two to seven upper dorsal vertebræ, and the seventh cervical vertebra. 2. Articular processes of fourth, fifth, and sixth cervical.	Inserted into innermost depression of occipital bone between the two curved lines. Nerves: posterior divisions of spinals.
Biventer cervicis, situated to inner side of complexus, and may form part thereof. (Fig. 187.)	Transverse processes of from two to four upper dorsal vertebræ.	Insertion: superior curved line of occipital bone. Nerves: posterior divisions of spinals.
	FIFTH LAYER.	
Semispinalis dorsi (m. semispinalis dorsi). (Fig. 188.)	By series of tendons, from transverse processes of fifth, sixth, seventh, eighth, ninth, and tenth dorsal vertebræ.	Insertion: spinous processes of seventh and eighth cervical and first, second, third, and fourth dorsal vertebræ. Nerves: posterior divisions of spinals.
Semispinalis colli (m. semispinalis colli). (Fig. 188.)	Transverse processes of upper five or six dorsal vertebræ.	Insertion: spinous processes of second, third, fourth, and fifth cervical vertebræ. Nerves: posterior divisions of spinals.
Multifidus spinæ (m. multifidus). (Fig. 188.)	Sacral origin: 1. Back of sacrum, as low as fourth sacral foramen. 2. Aponeurosis of erector spinæ muscle. 3. Posterior superior iliac spine. 4. Posterior sacro iliac ligament. Lumbar origin: articular processes. Dorsal origin: transverse processes. Cervical origin: articular processes of three or four lower cervical vertebræ.	Insertion: laminæ and spinous processes of all vertebræ, except atlas. Nerves: posterior divisions of spinals.
Rotatores spinæ, eleven in number on each side. The first muscle is between the first and second; the last, between the eleventh and twelfth dorsal spine (m. rotatores).	Upper and back parts of transverse processes in dorsal region of spine.	Insertion: lower border and outer surface of the first lamina above the origin. Nerves: posterior divisions of spinals.
Supraspinales are found in the cervical region only.	Spinous process, and extend to process immediately above.	Insertion: spinous process immediately above. Nerves: posterior divisions of spinals.

Name.	*Origin.*	*Insertion and Nerve-supply.*
Interspinales, cervical region, six pairs; dorsal region, three pairs; lumbar region, four pairs (mm. interspinales).	Spinous process below.	Insertion: spinous process above. Nerves: posterior divisions of spinals.
Extensor coccygis.	Last sacral or first coccygeal vertebra.	Insertion: lower part of coccyx. Nerves: posterior divisions of spinals.
Intertransversales. In cervical region, most developed; in dorsal, least. In pairs in lumbar region (mm. intertransversales)	In a transverse process below.	Insertion: transverse process immediately above.
Rectus capitis posticus major (m. rectus capitis posterior major). (Fig. 184.)	Spinous process of axis.	Insertion: inferior curved line of occipital bone and surface of bone below. Nerves: posterior divisions of spinals.
Rectus capitis posticus minor (m. rectus capitis minor). (Fig. 184.)	Tubercle on posterior arch of atlas.	Insertion: occipital bone beneath inferior curved line. Nerves: posterior divisions of spinals.
Obliquus capitis inferior (m. obliquus capitis inferior). (Fig. 184.)	Apex of spine of axis.	Insertion: lower and back part of transverse process of atlas. Nerves: posterior divisions of spinals.
Obliquus capitis superior (m. obliquus capitis superior). (Fig. 184.)	Upper surface of transverse process of atlas.	Insertion: occipital bone between superior and inferior curved lines, external to insertion of complexus muscle. Nerves: posterior divisions of spinals.

THE SUBOCCIPITAL TRIANGLE. (Fig. 178.)

This space, situated in the deep posterior part of the junction of the head and neck, is bounded externally by the obliquus superior, below by the obliquus inferior, internally by the rectus capitis posticus major. The complexus muscle forms its roof; the floor is formed by the posterior occipito-atlantal ligament and the posterior arch of the atlas. *Contents:* (1) The vertebral artery lies in a groove on the upper surface of the posterior arch of the atlas; (2) the suboccipital nerve enters the triangle between the vertebral artery and the arch of the atlas; (3) the posterior occipito-atlantal ligament and the posterior arch of the atlas are contents as well as floor-structures; (4) the deep cervical vein begins in the suboccipital triangle, by the confluence of small veins, and, as a rule, receives the occipital vein. It passes between the complexus and semispinalis colli with the arteria princeps cervicis, and becomes tributary to either the vertebral or the innominate vein. The great occipital nerve passes through the roof of the triangle—the complexus muscle. The occipital artery skirts the external boundary of the triangle and rests on the insertion of the complexus muscle. (Figs. 184, 189.)

BLOODVESSELS OF THE BACK.

The back is supplied with blood by the occipital, vertebral, intercostal, subclavian, and lumbar arteries. In the main, the veins correspond to the arteries. The occipitals and vertebrals have complicated relations. The vessels of the trunk (intercostals and lumbars) are typical angeiotomes, and correspond to the other component parts of an ursegment. Each intercostal artery supplies the skin and subjacent fasciæ (dermatome); muscle (myotome); nerve roots and spinal cord pertaining thereto (neurotome); vertebræ and ribs (sclerotome). Adjacent segments overlap, and on this depends anastomoses of vessels and communications of nerves

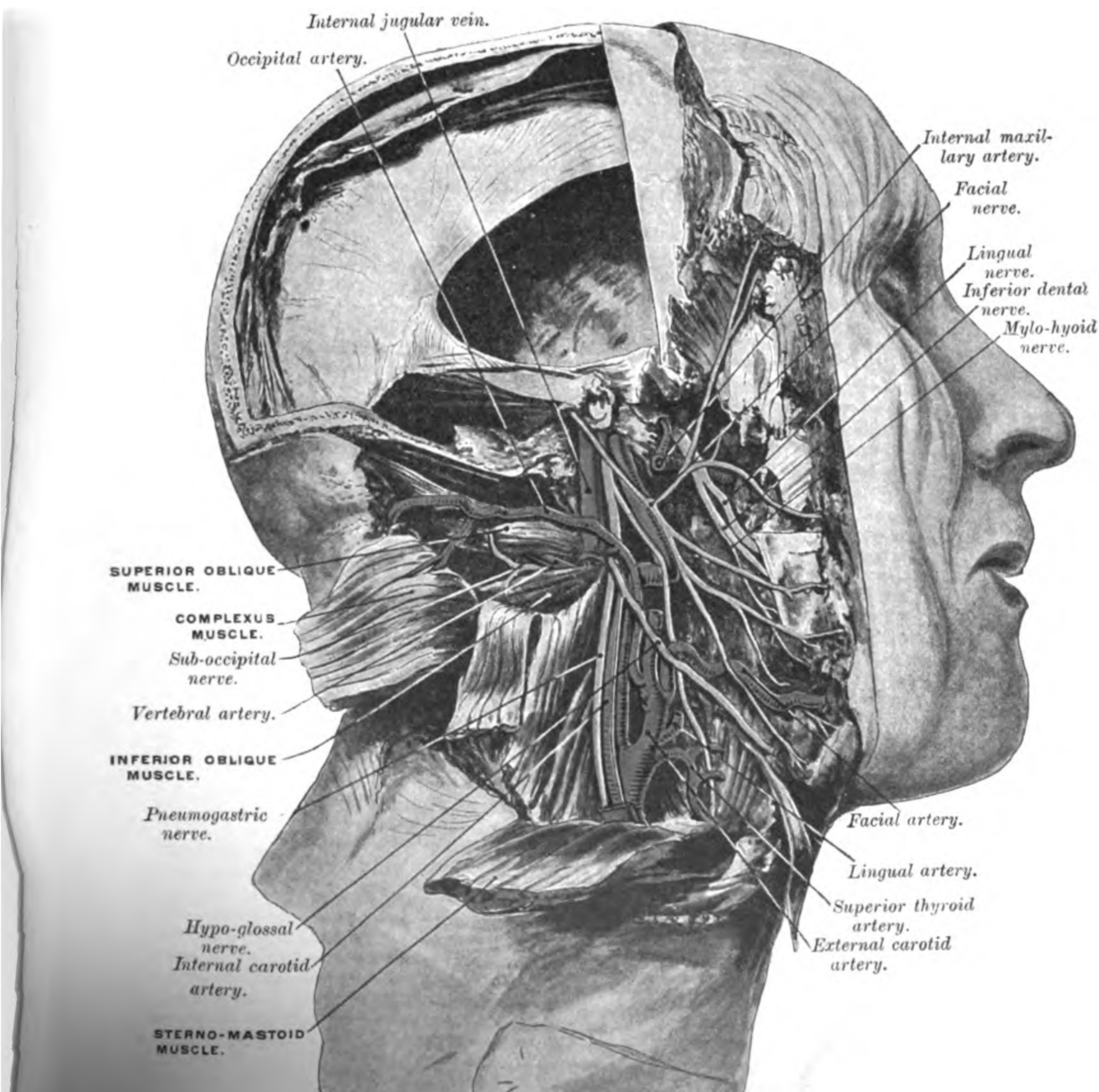
In the following table the source, course, and branches of the arteries supplying the back are given. With the exception of the vertebral, the veins correspond to the arteries. (The vertebral vein is made up in the deep parts of the occipital region. Radicals of the vertebral vein meet in the foramen of the transverse process of the atlas, whence there is correspondence between the vertebral artery and the vertebral vein.

TABLE OF VESSELS OF THE BACK.

Name.	*Source.*	*Course.*	*Distribution and Branches.*
Occipital artery (Figs. 184 and 189) (a. occipitalis).	External carotid, opposite facial artery (Fig. 190.)	1. Beneath the twelfth nerve, and digastric and stylohyoid muscles. 2. Crosses the internal carotid artery, internal jugular vein, vagus, and spinal accessory nerves. (Fig. 189.) 3. Lies between the transverse process of the atlas and mastoid. 4. Lies beneath the sternomastoid, splenius, trachelomastoid, and digastric. 5. Rests on the rectus capitis lateralis, superior oblique, and insertion of the complexus. 6. Pierces the fascia between the trapezius and sternomastoid.	1. The anteria princeps cervicis descends and divides into a superficial and a deep branch: (*a*) The superficial branch lies beneath the splenius, and gives off branches which, perforating the splenius, supply the trapezius and anastomose with the superficial cervical artery (a branch of the transversalis colli; (*b*) the deep branch lies between the complexus and the semispinalis colli, and anastomoses with the deep cervical artery (a branch of the superior intercostal). 2. Muscular, to digastric, stylohyoid, splenius, and trachelomastoid. 3. Sternomastoid accompanies the spinal accessory nerve. 4. Auricular, to concha. 5. Posterior meningeal, accompany internal jugular vein and supply dura in posterior fossa. (Figs. 189 and 190.)
Vertebral artery (Fig. 184) (a. vertebralis).	First portion of subclavian—the largest branch.	1. Enters the foramen in the transverse process of the sixth cervical vertebra. 2. Ascends to the base of the skull in the remaining foramina of the transverse processes. 3. Lies in a groove on the upper surface of the posterior arch of the atlas. (Fig. 184.) 4. Passes beneath the posterior occipito-atlantal ligament, pierces the dura and arachnoid, and enters the skull through the foramen magnum.	1. Muscular, to deep muscles of the neck. 2. Lateral spinal, enter the intervertebral foramina and supply the cord, meninges, vertebræ, and ligaments. 3. Anterior spinal, one on each side, unite in front of the medulla and cord, and, reinforced by small arteries in successive segmental regions, form a single anterior median artery, located in the pia mater along the anterior median fissure of the spinal cord. 4. Posterior spinal branches arise at the side of the medulla and pass down the cord behind the posterior roots of the spinal nerves. They receive accessions similar to those received by the anterior spinals. 5. Bulbar to medulla. 6. Posterior meningeal, supply the dura in the posterior fossa and the falx cerebelli. 7. Posterior inferior cerebellar, crosses the restiform body to the under surface of the cerebellum.
Deep cervical artery (Fig. 190) (a. cervicalis profunda).	Posterior branch of first intercostal (from subclavian artery).	1. Passes between the transverse process of the seventh cervical vertebra and first rib. 2. Lies between the complexus and the semispinalis colli muscles.	Anastomoses with the arteria princeps cervicis, a branch of the occipital, and supplies the deep muscles of the neck and back.

Name.	*Source.*	*Course.*	*Distribution and Branches.*
Dorsal branches of the intercostal arteries (Fig. 96) (rami dorsales arteriarum intercostalium).	**Intercostal arteries from the thoracic aorta (aa. intercostales).**	**1. Given off anterior to space bounded by vertebra, rib, transverse process and anterior costo-transverse ligament. 2. Divides into muscular and spinal branches.**	**1. The muscular branch passes through a quadrilateral space to the back, and divides into external and internal branches. The external branch passes between the longissimus dorsi and iliocostalis muscles, with corresponding nerves from the posterior divisions of the spinal nerves. The internal branch emerges between the longissimus dorsi (near the spine) with corresponding nerves. 2. The spinal branches enter the neural canal and supply the cord, meninges, bone, and ligaments.**

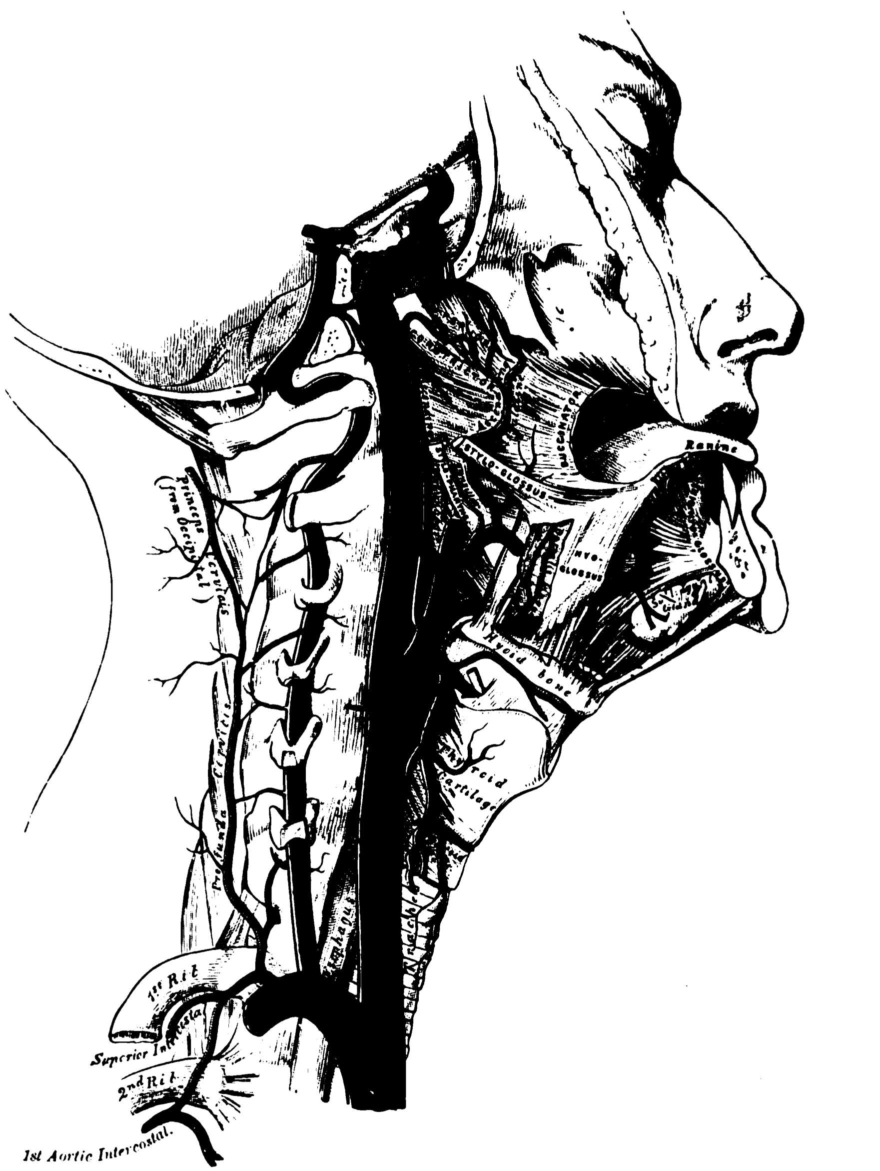
FIG. 189.



The occipital artery and its relations. (From a dissection by Mr. Gerald S. Hughes.) (GRAY.)

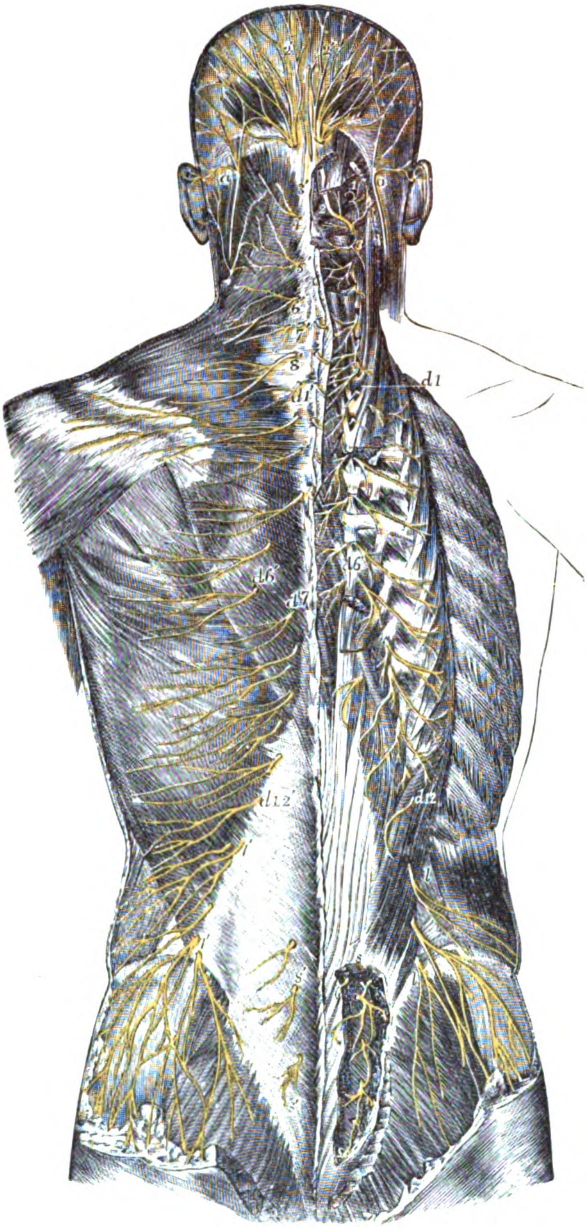
Name.	*Source.*	*Course.*	*Distribution and Branches.*
Dorsal branches of the lumbar arteries (rami dorsales).	Lumbar arteries from abdominal aorta (aa. lumbales).	Similar to the dorsal branches of the intercostals.	Similar in distribution to the dorsal branches of the intercostal arteries. (Fig. 96.)
Superficial cervical artery.	Transversalis colli from subclavian artery.	Given off beneath the anterior margin of the trapezius muscle, in the subclavian triangle of the neck.	To trapezius, levator anguli scapulæ, cervical glands, and anastomoses with the superficial branch of the arteria princeps cervicis. (Fig. 190)

FIG. 190.



The internal carotid and vertebral arteries. Right side. (GRAY.)

FIG. 191.



Superficial and deep distribution of the posterior divisions of the spinal nerves (after Hirschfeld and Leveillé). On the left side the cutaneous branches are represented lying on the superficial layer of muscles. On the right side the superficial muscles have been removed, the splenius capitis and complexus divided in the neck, and the erector spinæ divided and partly removed in the back, so as to expose the posterior divisions of the spinal nerves near their origin. *a a.* Lesser occipital nerve from the cervical plexus. 1. External muscular branches of the first cervical nerve, and union by a loop with the second. 2. Placed on the rectus capitis posticus major muscle, marks the great occipital nerve, passing around the short muscles and piercing the complexus; the external branch is seen to the outside. 3. External branch from the posterier division of the third nerve. 3′. Its internal branch, sometimes called the third occipital. 4′ to 8′. The internal branches of the several corresponding nerves on the left side. The external branches of these nerves, proceeding to muscles, are displayed on the right side, *d* 1 to *d* 6, and thence to *d* 12. External muscular branches of the posterior divisions of the twelve dorsal nerves on the right side, *d* 1′ to *d* 6′. The internal cutaneous branches of the six upper dorsal nerves on the left side, *d* 7′ to *d* 12′. Cutaneous twigs from the external branches of the six lower dorsal nerves. *l l.* External branches from the posterior divisions of several lumbar nerves on the right side, piercing the muscles, the lower descending over the gluteal region. *l′ l′.* The same, more superficially, on the left side. *s s.* The issue and union by loops of the posterior divisions of four sacral nerves on the right side. *s′ s′.* Some of those distributed to the skin on the left side. (GRAY.)

Name.	*Source.*	*Course.*	*Distribution and Branches.*
Posterior scapular artery.	Transversalis colli of the subclavian artery.	Beneath the levator anguli scapulæ to the superior angle of the scapula, thence along the posterior border of the scapula to the inferior angle beneath the rhomboids.	To trapezius, rhomboids, latissimus dorsi, and anastomoses with the suprascapular, subclavian, and intercostals (dorsal branches).
Deep cervical artery (Fig. 190.)	Superior intercostal; occasionally from subclavian.	1. Between the first rib and transverse process of the seventh cervical vertebra. 2. Upward between the 'complexus and semispinalis colli.	1. Muscular, to adjacent muscles. 2. Spinal, to neural canal and its contents. 3. Anastomotic to the deep branch of the arteria princeps cervicis.

NERVES OF THE BACK.

Posterior divisions of the spinal nerves (rami posteriores) supply (1) the integument of the back of the scalp, trunk, and gluteal regions; (2) all muscles of the back except those attached to the shoulder-girdle or humerus; (3) joints moved by the muscles of the back supplied by the posterior divisions.

These nerves pursue a definite course to reach the parts they are to supply, and in the dorsal region of the spine, in company with corresponding vessels, they pass through a four-sided space bounded internally by the body of a vertebra; externally, by the anterior costotransverse ligament; above, by a transverse process; below, by the neck of a rib. (Fig 96.)

The general plan of the arrangement of the posterior divisions of the spinal nerves is the same throughout; still, some minor variations must be noted and studied in the subjoined table. It will be seen in the table (in the third column) that the first cervical, the fourth and fifth sacral, and coccygeal nerves do not divide into internal and external branches, which, with these four exceptions, is the rule. Again, the six upper cutaneous nerves of the back are derived from the internal branches; the six lower, from the external branches. (Fig. 185.) In other words, there are twelve dorsal nerves; each divides into internal and external branches, but the external branches of the six upper and the internal branches of the six lower nerves have no cutaneous distribution. The three upper lumbar nerves give branches, which, crossing the crest of the ilium, reach the gluteal region. (Fig. 141, page 267.) The fourth and fifth sacral and coccygeal nerves supply the integument covering the coccyx. (See also table of cutaneous nerves of the lower extremity, pages 264–268.)

TABLE OF POSTERIOR DIVISION OF SPINAL NERVES. (Fig. 96.)

(Rami posteriores nervorum spinalium.)

Name.	*Course.*	*Special Feature.*	*Distribution and Branches.*
First cervical, posterior division, suboccipital nerve (Fig 184) (n. suboccipitalis).	It passes between the arch of the atlas and vertebral artery, and enters the suboccipital triangle.	It does not divide into internal and external branches. (In this regard it resembles the fourth and fifth sacral and coccygeal nerves.)	1. A cutaneous branch is occasionally given off, which accompanies the occipital artery and communicates with the occipitalis major and occipitalis minor nerves. 2. A communicating branch to the second cervical nerve. 3. Muscular branches to the complexus, rectus capitis posticus major and minor, superior and inferior oblique muscles.

Name.	*Course.*	*Special Feature.*	*Distribution and Branches.*
Second cervical nerve, posterior division. The great occipital nerve (Fig. 184) (n. occipitalis major).	It emerges from the spinal canal between the atlas and axis, below the inferior oblique muscle, divides into internal and external branches, and pierces the complexus muscle.	1. It pierces the complexus and trapezius and accompanies the occipital artery to the scalp. 2. The internal branch passes between the inferior oblique and complexus, pierces the trapezius, and is joined by filaments from the third cervical nerve (posterior division).	1. The internal branch (called the occipitalis major) gives an auricular branch to the ear, a muscular branch to the complexus, a cutaneous branch to the scalp, a communicating branch to the occipitalis minor. 2. Has an external branch joined by the external branch of the third occipital nerve; supplies the splenius, complexus, and trachelomastoid.
The third cervical nerve, posterior division (Fig. 184) (n. occipitalis tertius).	It divides into internal and external branches. 1. Internal branch passes between the complexus and semispinalis colli, pierces the splenius and trapezius. 2. External branch joins the external branch of the second cervical.	The third differs from the remaining cervical nerves in furnishing a filament—the third occipital nerve—to the skin of the occiput.	1. Internal branch supplies the integument over the trapezius muscle. 2. External branch of the third, having joined the external branch of the second, supplies the splenius, complexus, and trachelomastoid.
The fourth, fifth, sixth, seventh, and eighth cervical nerves, posterior division (Figs. 185 and 191) (rami posteriores nn. cervicalium).	They emerge from the neural canal by the intervertebral foramina, reach back, and divide into internal and external branches. (Fig. 96.)	1. The internal branches from the fourth and fifth pass between the complexus and semispinalis, and perforate the splenius and trapezius. 2. Internal branches from the sixth, seventh, and eighth lie beneath the semispinalis colli.	1. Internal branches from the fourth and fifth supply the skin over the trapezius. 2. Internal branches from the sixth, seventh, and eighth supply the semispinalis colli, interspinales, multifidus spinæ, complexus, and twigs to the skin near the spinous processes. 3. The external branches supply the cervicalis ascendens, transversalis colli, and trachelomastoid.
Dorsal nerves, posterior divisions, twelve in number (Figs. 185 and 191) (rami posteriores nn. thoracalium).	They emerge from the neural canal by the intervertebral foramina, pass through a four-sided space to the back, with dorsal branches of the intercostal vessels. (Quadrilateral space is bounded internally by the body of the vertebra; externally by the anterior costotransverse ligament; above by a transverse process; below by the neck of the rib.) They divide into internal and external branches.	1. The external branches of the six upper dorsals are wanting in the cutaneous nerves. 2. The internal branches of the six lower dorsals are wanting in the cutaneous nerves.	1. Internal branches of the six upper, having passed between the semispinalis dorsi and multifidus spinæ (Fig. 96), and pierced the trapezius and rhomboids, supply the multifidus spinæ, semispinalis dorsi, and integument of the upper region of the back. 2. The external branches of the six upper supply the longissimus dorsi, iliocostalis, and their continuations to the head. (See Gray.) 3. The internal branches of the six lower give off no cutaneous nerves, but supply the multifidus spinæ. 4. The external branches of the six lower supply the skin of the lower region of the back. They pierce the serratus posticus and latissimus dorsi, in a line with the angles of the ribs.

Name.	*Course.*	*Special Feature.*	*Distribution and Branches.*
Lumbar nerves, posterior divisions, five in number (Figs. 185 and 191) (rami posteriores nn lumbalium).	They emerge from the neural canal by the intervertebral foramina, pass between the transverse processes with the dorsal branches of the lumbar vessels, and divide into internal and external branches.	They contribute three cutaneous nerves to the gluteal region (Fig. 141.) (Read pages 264-268.)	1. The internal branches supply the multifidus spinæ and interspinales. 2. The external branches supply the erector spinæ and intertransversales. 3. The external branches of the first, second, and third give off cutaneous branches, which, piercing the latissimus dorsi, cross the iliac crest, and supply the integument of the gluteal region. (Fig. 141.)
Sacral nerves, posterior divisions, five in number (Figs. 185 and 191) (rami posteriores nn. sacralium).	They emerge from the sacral canal (except the fifth) by the posterior sacral foramina, and all, except the fourth and fifth, divide into internal and external branches.	The fourth and fifth do not divide into internal and external branches. (In this regard they resemble the coccygeal and first cervical.) The fourth and fifth sacral unite with the coccygeal and supply the extensor coccygis and the skin over the coccyx.	1. The internal branches of the three upper supply the multifidus spinæ. 2. The external branches of the three upper unite with the fourth sacral and fifth lumbar on the posterior surface of the sacrum and form a second series of loops on the outer surface of the greater sacrosciatic ligament, from which three cutaneous nerves (having pierced the gluteus maximus) reach the skin over the back of the coccyx. (Fig. 141)

SUMMARY OF DISTRIBUTION OF NERVES OF BACK.

The integral parts of the back (including the back part of the scalp, neck, and trunk) are supplied as follows: (1) The skin, by posterior divisions of the spinal nerves; (2) the trapezius muscle, by the spinal accessory (eleventh cranial nerve) and third and fourth cervical nerves (anterior divisions); (3) the latissimus dorsi muscle, by the long subscapular, a branch of the posterior cord of the brachial plexus; (4) the levator anguli scapulæ, by the anterior divisions of the third and fourth cervical nerves; (5) the rhomboid muscles, by the anterior division of the fifth cervical nerve; (6) the muscles of the third, fourth, and fifth layers, by the posterior divisions of the spinal nerves; (7) the occipito-atlantal articulation, by suboccipital nerve; (8) the atlanto-axial articulation, by the first and second cervical nerves; (9) the costo-central articulations, by the anterior divisions of the spinal nerves; (10) the costo-transverse articulations, by the posterior divisions of the spinal nerves; (11) the sacrovertebral articulation, by the fourth and fifth lumbar and sympathetic nerves; (12) the sacro-iliac articulations, by the posterior divisions of the first and second sacral nerves, superior gluteal nerve, and sacral plexus; (13) the sacrococcygeal articulation, by the fourth and fifth sacral and coccygeal nerves; (14) the ribs and vertebræ, by gray rami communicantes; (15) the spinal dura mater, by recurrent branches from the spinal nerves in the several regions and by sympathetic fibres from the vertebral ganglia.

CHAPTER XXX.

THE SYMPATHETIC NERVOUS SYSTEM.

Dissection and Identification. The great prevertebral plexuses—cardiac, solar, and hypogastric—have been studied with the viscera which they innervate (pages 186, 187, and 243). Their branches accompany the arteries, and are distributed with them under the name of plexuses; hence, gastric, hepatic, and splenic plexuses refer to sympathetic nerves derived from the prevertebral plexuses (accompanying arteries) (Fig. 192), and distributed with them to the organs.

The Gangliated Cord Proper should be studied according to the following steps: (1) Turn the viscera to the opposite side of the body—or remove them entirely, if their dissection has been completed—and strip off both pleura and peritoneum in the region of the vertebral column; (2) bear in mind the ganglia, interganglionic communicating branches, gray rami, connecting the ganglia to the spinal nerves and branches of distribution.

Cervical Ganglia (superior, middle, and inferior). Identify (1) by the location in the neck, behind the carotid sheath; (2) by the superior branches accompanying the internal carotid artery and the inferior ganglion communicating with the first thoracic ganglion.

Superior Cervical Ganglion. Identify (1) by the location behind the internal carotid artery, near the base of the skull; (2) by the size, one-quarter of an inch in diameter and about one inch in length; (3) by the numerous filaments to the branches of the external carotid artery; (4) by the rami communicantes to the spinal nerves and a communicating branch to the middle cervical ganglion.

Middle Cervical Ganglion. Identify (1) by the location opposite the sixth cervical vertebra, where the sympathetic crosses the inferior thyroid artery; (2) by communicating with the superior and inferior cervical ganglia.

Inferior Cervical Ganglion. Identify (1) by the location between the neck of the first rib and the transverse process of the seventh cervical vertebra; (2) by the attachment to the seventh and eighth cervical nerves by rami communicantes. (Fig. 192.)

COMPOSITION AND FUNCTION.

Composition. A gangliated cord, having (*a*) forty-six ganglia, twenty-three on each side; (*b*) ascending and descending interganglionic trunks; (*c*) rami communicantes, connecting the ganglia to the spinal nerves; (*d*) rami efferentes, supplying the bloodvessels and viscera; (*e*) gray rami communicantes, supplying the involuntary muscular fibre in trunk and extremities; (*f*) sporadic ganglia, on the trifacial nerve; (*g*) the three great prevertebral plexuses; (*h*) secondary plexuses in the heart, uterus, and intestines; (*i*) white rami, from the motor, cranial and spinal nerves.

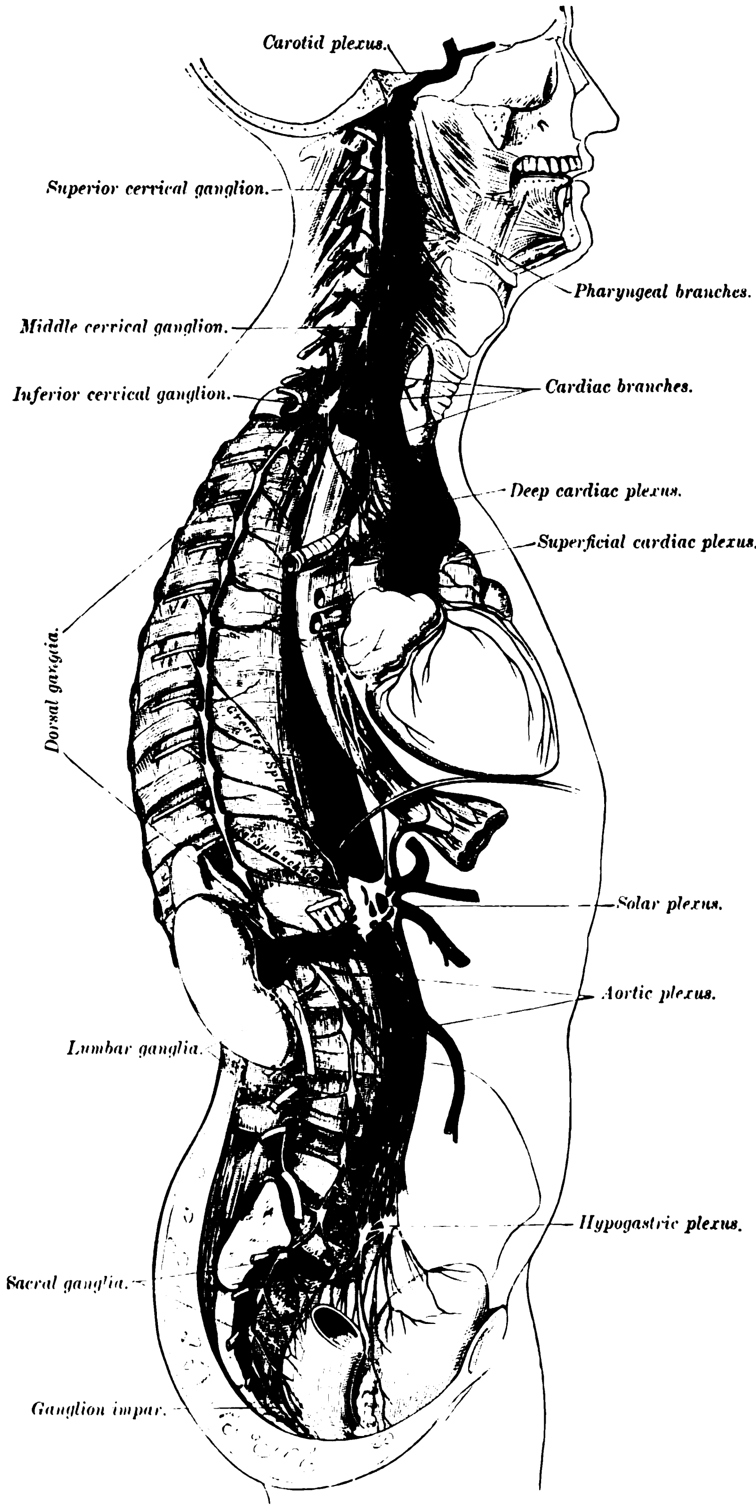
Function. To innervate viscera, glands, unstriped muscle fibre, bones, cartilages, fasciæ, and conduits generally not under control of the will.

The Gangliated Cord consists of two rows of vertebral ganglia, connected by interganglionic trunks, situated one on either side of the vertebral column, and communicating with each other (1) above, on the anterior communicating artery, in the ganglion of Ribes; (2) below, on the coccyx, in the ganglion impar.

Number of Ganglia in Each Region. Morphologically, there is one ganglion for each spinal nerve, thirty-one on each side; in some regions, however, adjacent ones fuse, thus making the total number of ganglia on a side less than the number of spinal nerves. In the following table the number of ganglia, morphological and actual, is given in each region, showing the number lost by fusion.

Region.		*Morphological Number.*		*Actual Number.*	*Number Lost by Fusion.*	
Cervical	8	Ganglia	8	Ganglia	3	5
Thoracic	12	Ganglia	12	Ganglia	11	1
Lumbar	5	Ganglia	5	Ganglia	5	0
Sacral	5	Ganglia	5	Ganglia	4	1
Coccygeal	1	Ganglia	1	Ganglia	0	1
Total	31		31		23	8

FIG. 192.



The sympathetic nerve. (GRAY.)

Location of Ganglia in Each Region. The three cervical ganglia and their connecting interganglionic trunks lie behind the carotid sheath, on the rectus capitis anticus major muscle; they are connected to the spinal nerves by white rami communicantes only.

The Eleven Thoracic Ganglia and their connecting interganglionic trunks lie posterior to the pleura, in a line corresponding to the heads of the ribs. The first thoracic is beneath the first rib; the eleventh is on the side of the twelfth thoracic vertebra, connected to the spinal nerves by both white and gray rami communicantes.

The Five Lumbar Ganglia, with their connecting interganglionic trunks, lie along the inner margin of the psoas magnus muscle, obscured on the right side by the ascending vena cava; on the left, by the abdominal aorta. The first and second ganglia are connected to the spinal nerves by white and gray rami communicantes; the third, fourth, and fifth, by gray rami communicantes only.

The Four Sacral Ganglia and their connecting interganglionic trunks lie internal to the anterior sacral foramina, connected to the sacral nerves by white rami communicantes only. These white rami are not indigenous in the sacral region, but reach it by descending from the thoracic and lumbar regions. The visceral branches of the sacral plexus, arising from the third and fourth nerves, represent the white rami of the sacral nerves.

Recapitulation of White Rami of the Sacral Region. First, the four sacral ganglia are connected to the sacral nerves by white rami communicantes, which do not originate in the sacral nerves, but descend from the thoracic and lumbar regions; second, branches of the sacral nerves themselves (that would have been called white rami had they joined the sacral ganglia) are the visceral branches of the sacral plexus, and supply vasodilator fibres of the penis, secretory fibres of the prostate, inhibitory fibres of the circular muscles of the rectum, and longitudinal fibres of the rectum and bladder.

COMPOSITION OF VERTEBRAL GANGLIA.

(*a*) Nerve cells, giving origin to gray rami communicantes; (*b*) white rami, from motor spinal nerves; (*c*) connective tissue, for sustentation; (*d*) vessels for nutritional purposes.

Gray Rami Communicantes originate as axis-cylinder process in the ganglion cells of the vertebral ganglia, and are distributed as follows: (1) To neighboring ganglia; (2) directly to the viscera and vessels; (3) to the prevertebral plexuses; (4) some reach the spinal nerves and accompany the same to the extremities and body wall, for the supply of the bones, fasciæ, cartilage, periosteum, parietal serous membranes, and vessels of these parts.

(Two examples of gray rami doing terminal work over somatic nerve routes: (1) Obturator and anterior crural nerves contribute branches to the femoral artery; (2) the branch of the internal popliteal nerve to the popliteus muscle gives a gray ramus communicans to the tibia.)

The Nerve-supply to Bone, cartilage, fascia, and vessels of the trunk and extremities is sympathetic, and reaches the same through gray rami, travelling to the part with the spinal nerve of this region. Gray rami communicantes arise as axis-cylinders of cells in the vertebral ganglia of the gangliated cord of the sympathetic. [illegible] Gerrish.)

[illegible]ITE RAMI COMMUNICANTES.

[illegible]tor roots of the cranial and spinal nerves. Some pass [illegible]lia without interruption; others arborize with cells in [illegible]he white rami communicantes are indigenous in the [illegible] regions only, and are distributed as follows:

"The nerves that act on the iris to produce dilatation of the pupil arise as white rami in the motor roots of the first, second, and third thoracic nerves, and pass up in the sympathetic cord to the superior cervical ganglion, where they arborize around their cells, whence fibres pass with the carotid plexus to the Gasserian ganglion, and reach the eye through (1) the ophthalmic; (2) the long ciliary branches of the nasal division of the ophthalmic." (Gerrish.)

Motor fibres that supply the involuntary muscle of the eyelids and orbitalis muscles of Müller (a muscle crossing the sphenomaxillary fissure) are supplied by white rami communicantes which arise in the motor roots of the fourth and fifth thoracic nerves. These rami communicantes pass up the sympathetic cord to the superior cervical ganglion, where they arborize around its cells, thence to the Gasserian ganglion, from which they reach the eye in a similar manner as set forth in the preceding paragraph. Paralysis of these nerves in any part of their course may cause (1) narrowing of the palpebral fissure; (2) dropping of the upper lid; (3) recession of the globe. "Irritation of the cervical sympathetic causes protrusion of the globe, while section of the sympathetic in the neck causes retraction of the eyeball." (Treves.)

Vasomotor fibres to the head, secretory fibres to the submaxillary gland, pilomotor fibres to the head and neck (all of which reach these several areas, accompanying branches of the external carotid artery) are derived from the motor roots in the upper thoracic region, and arborize with ganglion cells in the superior cervical ganglion.

The accelerator fibres of the heart are derived from the motor roots of the upper thoracic nerves. They arborize around the ganglion cells in the superior, middle, and inferior ganglia, whence fibres in the cervical cardiac nerves complete the circuit.

Symptoms in Paralysis of the Cervical Ganglia: (1) Narrowing of the palpebral fissure; (2) drooping of the upper lid; (3) recession of the globe and contraction of the pupil may ensue on injury to the thoracic region of the spine, since the nerves that supply the involuntary muscular fibres of the eye and orbit have their origin in the motor roots of the spinal nerves in the thoracic region.

THE CERVICAL SYMPATHETIC CORD.

There are three ganglia in this region: (1) The superior, formed by fusion of the (morphological) four upper ganglia; (2) the middle, formed by fusion of the fifth and sixth ganglia; (3) the inferior, formed by fusion of the seventh and eighth ganglia. (See table, page 355.)

The Superior Cervical Ganglion is behind the internal carotid artery, near the base of the skull, on a level with the transverse processes of the second and third cervical vertebræ. To expose the ganglion turn the artery aside. The ganglion is one and a half inches long, about one-quarter of an inch in diameter, and connected to the first, second, third, and fourth anterior primary divisions of the cervical nerves by gray rami communicantes. *Branches*: (*a*) Superior, which accompanies the carotid artery to the cranium, where it divides into a smaller or internal branch, which ends in the cavernous plexus, and a larger or external, which ends in the carotid plexus; (*b*) anterior, which are given off from the anterior part of the superior cervical ganglion. These nerves accompany the external carotid and all its branches—facial, lingual, superior thyroid, ascending pharyngeal, posterior auricular, occipital, temporal, and internal maxillary; (*c*) external branches to the third, fourth, fifth, sixth, seventh, ninth, tenth, eleventh, and twelfth cranial and the four upper spinal nerves; (*d*) internal, from which pharyngeal branches pass behind the internal and external carotid arteries, to join the pharyngeal plexus, which supplies the mucous membrane and muscles of the pharynx; (*e*) superior cervical cardiac and laryngeal branches are given off from the lower part of the ganglion. The right cardiac nerve passes behind the subclavian artery, and terminates in the deep cardiac plexus above the right pulmonary artery, on the bifurcation of the trachea; the left enters the thorax in front of the common carotid, crosses the arch of the aorta, and ends in the superficial cardiac plexus in front of the right pulmonary artery in the concavity of the aortic arch; (*f*) inferior, which communicates with the middle cervical ganglion.

The Cavernous Plexus is located in the cavernous sinus, between the internal carotid artery and the pituitary body. Its branches are (1) fine twigs to the pituitary body; (2) the sympathetic root of the lenticular ganglion; (3) communicating, to the third and fourth cranial nerves, and ophthalmic division of the fifth cranial nerve; (4) terminal, to the ophthalmic artery and cerebral branches of the internal carotid. (Fig. 193.)

FIG. 193.

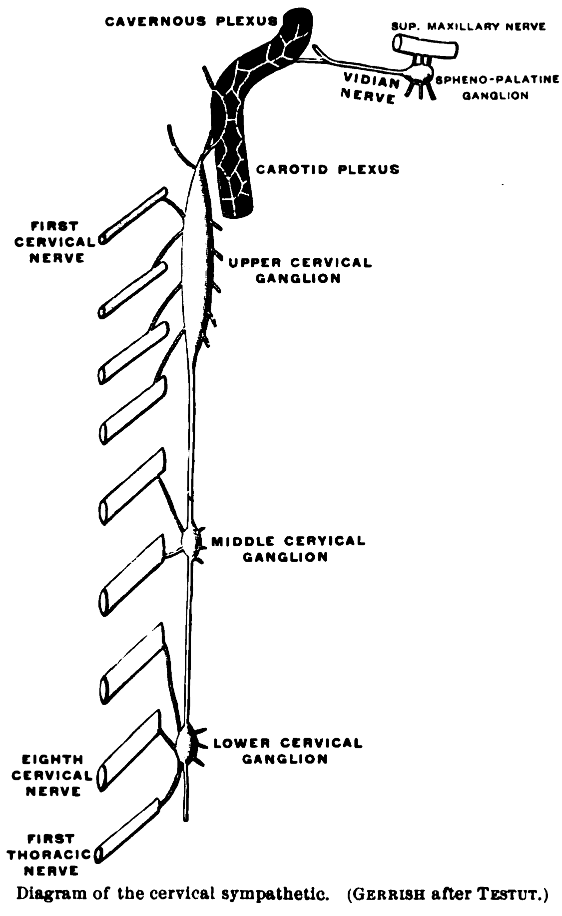


Diagram of the cervical sympathetic. (GERRISH after TESTUT.)

The Carotid Plexus is on the outer side of the internal carotid artery, in the cavernous sinus, with the sixth nerve. *Branches:* (1) To the sixth nerve, received as this crosses the carotid artery in the cavernous sinus; (2) to the Gasserian ganglion, received as the artery enters the cavernous sinus; (3) tympanic, or small deep petrosal, passes through the carotico-tympanic canal in the petrosa to join the tympanic plexus; (4) great deep petrosal branch leaves the cranium through the cartilage in the foramen lacerum medium, and joins the great superficial petrosal of the facial nerve, to form the vidian.

The Middle Cervical Ganglion is located opposite the sixth cervical vertebra (where the sympathetic cord crosses the inferior thyroid artery) and is connected by gray rami communicantes, to the corresponding fifth and sixth cervical nerves. *Branches:* (1) Gray rami communicantes, to the fifth and sixth cervical nerves; (2) the middle cervical cardiac to the heart; (3) thyroid, which accompany the inferior thyroid artery to the thyroid gland; (4) communicating, to the vertebral ganglia above and below—the superior and inferior.

The Inferior Cervical Ganglion is between the neck of the first rib and the transverse process of the seventh cervical vertebra, behind the vertebral artery, and connected to the seventh and eighth cervical nerves by gray rami communicantes. *Branches:* (1) Gray rami communicantes, to the seventh and eighth cervical nerves; (2) the inferior cervical cardiac to the heart; (3) to the vertebral artery; (4) communicating, to the vertebral ganglia above and below.

The Thoracic Sympathetic Cord. As previously stated, there are eleven ganglia in the thoracic part of the gangliated cord. The last cervical and first thoracic ganglia fuse. *Branches:* (1) To the corresponding spinal nerves, by rami communicantes, gray and white; (2) the upper four or five ganglia give branches to the aorta, vertebral ligaments, and posterior pulmonary plexus; (3) the lower six or seven form the three splanchnic nerves—great, small, and least. The great splanchnic, formed by the sixth, seventh, eighth, and ninth, pierces the crus of the diaphragm and joins the semilunar ganglion; the small splanchnic, formed by the ninth and tenth, passes beneath the diaphragm and joins the renal plexus; the least splanchnic, formed by the twelfth, joins the renal plexus.

The Lumbar Sympathetic Cord. There are four to five ganglia in this region, situated along the inner margin of the psoas magnus muscle. They are hidden on the left side by the abdominal aorta; on the right by the ascending vena cava. *Branches:* (1) Rami communicantes, white and gray in the upper region (gray only in the lower region), by which the ganglia are connected to the corresponding spinal nerves; (2) to the aortic plexus; (3) to the hypogastric plexus; (4) to the vertebræ and their ligaments.

The Sacral Sympathetic Cord. The ganglia are four in number and lie internal to the anterior sacral foramina. The two gangliated cords meet at the ganglion impar. *Branches:* (1) Gray rami, from the corresponding spinal nerves; (2) to the hypogastric plexus.

THE PREVERTEBRAL PLEXUSES.

There are three prevertebral plexuses—cardiac, solar, and hypogastric. Each is single and situated near the mid-line of the posterior wall of the trunk, and has the following composition: (*a*) Nerves from the gangliated cord; (*b*) nerves from the brain and spinal cord; (*c*) ganglion cells and indigenous nerves; (*d*) a connective-tissue meshwork.

The Cardiac Plexuses. *Location:* (1) Below the arch of the aorta, internal to the ductus arteriosus; (2) between the bifurcation of the trachea and the arch of the aorta; the former is called the superficial, the latter, the deep cardiac plexus. *Formation:* (1) Cervical cardiac branches of the vagus; (2) a thoracic cardiac branch of the vagus; (3) branches from the recurrent laryngeal nerves; (4) cardiac branches from the cervical sympathetic cord. This plexus gives off branches which accompany the vessels to the heart and lungs.

The Solar Plexus is formed by (1) two semilunar ganglia; (2) by nerve cords. It is located at the commencement of the abdominal aorta, around the cœliac axis. Each semilunar ganglion is composed of (*a*) nerve cells; (*b*) nerves from the vagus; (*c*) nerves from the great splanchnic; (*d*) indigenous nerve origins from the ganglion cells and (*e*) connective tissue. *Smaller plexuses from the solar plexus.* (1) The aortic, accompanies the aorta downward; (2) the splenic; (3) the hepatic; (4) the gastric; (5) the phrenic; (6) the suprarenal; (7) the renal; (8) the superior mesenteric; (9) the inferior mesenteric; (10) the spermatic or ovarian. Branches from each plexus accompany the artery to the organ or organs the artery supplies. (See Gray.)

The Hypogastric Plexus is in front of the body of the fifth lumbar vertebra. It is formed by two or three branches from the lower part of the sympathetic cord, which unite with similar ones of the opposite side. These are joined by branches of the aortic plexus. The hypogastric plexus passes into the pelvis and divides into two lateral parts, which lie on the side of the rectum. This plexus receives branches from the sacral part of the sympathetic and from the third and fourth sacral nerves. *Smaller plexuses derived from the hypogastric.* (1) The middle hemorrhoidal; (2) the vesical; (3) the prostatic; (4) the large cavernous, which, with the small, supplies the erectile tissue of the generative organs; (6) the vaginal; (7) the uterine. Each plexus accompanies the artery of the organ to the part.

CHAPTER XXXI.

THE BLOOD VASCULAR SYSTEM.

By De Lee Shaw, M.D.

The blood vascular system consists of (1) heart, (2) arteries, (3) capillaries, (4) veins, and (5) fœtal circulation.

1. **The Heart** (cor, cordis), the central organ of the system, is a hollow muscle divided by a septum into two halves, right and left, each of which is made up of two cavities—an auricle above and behind, a ventricle below and in front. Right half of heart contains venous blood and left half arterial blood. Auricles receive blood from veins and convey it to ventricles, which force it into arteries.

Right Auricle (auricula dextra), little larger than left, with thinner walls, capacity about two ounces, has projecting, forward and to left, from main portion, sinus venosus or atrium, the appendix auriculæ which overlaps the aorta.

Openings. (*a*) Superior cava (vena cava superior), returning blood from upper half of body. (*b*) Inferior cava (vena cava inferior), from lower half of body. (*c*) Coronary sinus (sinus coronarius), from substance of heart. (*d*) Foramina Thebesii (foramina venarum minimarum), mouths of small veins of heart. (*e*) Auriculo-ventricular, large, oval, establishes communication between auricle and ventricle.

Valves. (*a*) Eustachian (valvula venæ cavæ), in fœtus, directs blood from inferior cava through foramen ovale. (*b*) Coronary (valve of Thebesius, valvula sinus coronarii), protects orifice of coronary sinus. (*c*) Fossa ovalis, depression in septum auricularum, showing position of foramen ovale in fœtal heart. (*d*) Annulus ovalis (limbus fossæ ovalis) is the margin of the fossa ovalis.

Tuberculum Loweri (tuberculum intervenosum) is a projection situated between the openings of the venæ cavæ.

Musculi Pectinati are parallel ridges of muscle resembling the teeth of a comb found on the inner wall of the appendix.

Right Ventricle (ventriculus dexter), somewhat triangular, forms larger part of anterior surface of heart. Below it rests upon the diaphragm.

Openings. (*a*) Auriculo-ventricular (ostium venosum dextrum), guarded by tricuspid valve, is about one and a half inches in diameter. (*b*) Opening of pulmonary artery, circular, guarded by pulmonary semilunar valves.

Valves. (*a*) Tricuspid (valvula tricuspidalis), three triangular segments (cuspis anterior, posterior, and medialis), formed by the lining membrane, strengthened by fibrous layer, connected by their bases to a fibrous ring surrounding the auriculo-ventricular orifice. Central portion of each cusp is thick and strong, lateral margins are thin. (*b*) Semilunar (valvulæ semilunares), three semilunar folds, structure same as tricuspid, guarding orifice of pulmonary artery, are attached by convex margin to wall of artery at junction with ventricle. Free straight margin, projecting upward in lumen of vessel, is thickened by tendinous fibres forming the corpus Arantii. Behind each semilunar valve, in pulmonary artery, is a pouch or dilatation, sinus of Valsalva (lunulæ valvularum semilunarum), which is filled when blood regurgitates toward the heart. When these three pouches are filled the valves are approximated and the opening closed.

Columnæ Carneæ, muscle columns, projecting from surface of ventricle, are of three varieties: the first are attached by one side as well as by both extremities; the second by both extremities, sides being free; the third, musculi papillares, by one extremity, the other giving attachment to the chordæ tendineæ.

CHORDÆ TENDINEÆ are fibrous bands or strings which pass from musculi papillares to under surface of valves and prevent them from turning backward into auricle.

Left Auricle (auricula sinistra), like right, consists of principal cavity or sinus and an appendix auriculæ, which, projecting forward and to right, overlaps pulmonary artery.

OPENINGS. (*a*) Openings of four pulmonary veins, two from each lung. These are not protected by valves. (*b*) Auriculo-ventricular, large, oval, opens into left ventricle.

MUSCULI PECTINATI are confined to inner surface of appendix. Lunated impression (fossa ovalis), on septum auricularum, shows position of foramen ovale in fœtal heart and is guarded by the valvula foraminis ovalis.

Left Ventricle (ventriculus sinister), longer and more conical than right, forms small part of anterior and large part of posterior surface of heart. It alone forms apex, as it projects beyond right ventricle. Walls are three times as thick as those of right, and hence on section its cavity appears circular, while cavity of right ventricle shows a crescentic form.

OPENINGS. (*a*) Auriculo-ventricular (ostium venosum sinistrum), smaller than right, is guarded by mitral valve (valvula bicuspidalis). (*b*) Aortic, circular, is guarded by three semilunar valves (valvulæ semilunares, aortæ, and individually designated valvula semilunaris posterior, dextra and sinistra).

VALVES. (*a*) Mitral (valvula bicuspidalis), two segments of unequal size, thicker than tricuspid, but is of same construction. Two smaller segments are usually found at angles of junction of larger. (*b*) Semilunar (valvulæ semilunares aortæ), guard aortic opening. Similar in structure and action to pulmonary semilunar valves.

CHORDÆ TENDINEÆ resemble in every way those of right ventricle. Columnæ carneæ, smaller and more numerous than those of right ventricle, are subdivided in same manner.

2. **Arteries** (arteriæ), dense, strong, elastic, cylindrical vessels, carry blood from ventricles, and when cut remain open. Vessel wall comprises three coats; inner or intima, middle or media, and outer or adventitia. Intima consists of endothelial lining, subendothelial layer, and elastic membrane, which constitutes the principal portion. Media is muscular coat, consisting of involuntary fibres, mostly circular, as well as some fibro-elastic tissue. Adventitia is made up of fibro-elastic tissue and forms a protective sheath.

3. **Capillaries** (vasa capillares), forming connecting link between arteries and veins, consist of single layer of endothelial cells. In these vessels blood undergoes changes; in capillaries of lung, venous is changed to arterial blood; in capillaries of other tissues, arterial blood is changed to venous. (For exception, see portal circulation.)

4. **Veins** (venæ) comprise same coats as arteries, but are thinner and contain more connective than muscular tissue. When cut, veins collapse, as elastic property is generally absent. Many veins contain valves consisting of crescentic folds of the intima strengthened by fibrous tissue, which resemble, in action, the semilunar valves of the heart.

The circulation of blood is best described in two cycles, pulmonary and systemic. Pulmonary cycle comprises the passage of venous blood through pulmonary artery (from right ventricle) to lungs, in capillaries of which it is transformed into arterial blood and is then returned through pulmonary veins to the left auricle. It will be noted that pulmonary arteries carry venous blood and pulmonary veins carry arterial blood.

Systemic cycle comprises the passage of arterial blood from left ventricle through aorta and its branches to capillaries throughout the body, where it is changed to venous blood, and returned by veins to right auricle.

PULMONARY CIRCULATION.

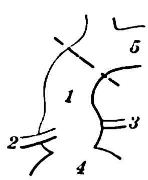
Name.	*Description.*	*Branches.*	*Distribution.*
Pulmonary artery (a. pulmonalis).	From right ventricle to under surface of arch of aorta, where it divides.	Right pulmonary (ramus dexter).	To right lung.
		Left pulmonary (ramus sinister).	To left lung.
Right pulmonary artery (ramus dexter).	Longer and larger than left. From below arch of aorta to root of right lung.	Upper.	To upper lobe of lung.
		Lower.	To middle and lower lobes of lung.
Left pulmonary artery (ramus sinister).	From below aorta to root of left lung.	Upper.	To upper lobe of lung.
		Lower.	To lower lobe of lung.

Pulmonary veins (venæ pulmonales), two from each lung, pass to and open by separate orifices into the left auricle.

SYSTEMIC CIRCULATION. ARTERIES.

Name.	*Description.*	*Branches.*	*Distribution.*
Aorta.	Main trunk from left ventricle, divided into ascending aorta, arch, and descending aorta.	See below.	To entire body.
Ascending aorta (aorta ascendens).	Length two inches, extending from left ventricle to upper border of second right costal cartilage.	Right coronary (a. coronaria dextra).	To heart muscle.
		Left coronary (a. coronaria sinistra).	To heart muscle.

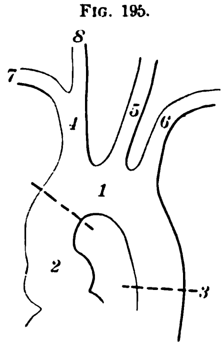
FIG. 194.



1. Ascending aorta.
2. Right coronary artery.
3. Left coronary artery.
4. Left ventricle.
5. Arch of aorta.

Name.	*Description.*	*Branches.*	*Distribution.*
Arch of aorta (arcus aortæ).	Extends from upper border of right, second chondrosternal articulation to left side of lower border of body of fourth thoracic vertebra. Upper border about one inch below upper border of sternum.	Innominate (a. anonyma).	To right upper extremity and right side of head.
		Left common carotid (a. carotis communis sinistra).	To left side of head.
		Left subclavian (a. subclavia sinistra).	To left upper extremity.

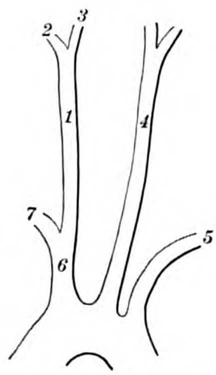
FIG. 195.



1. Arch of aorta.
2. Ascending aorta.
3. Fourth thoracic vertebra (lower border).
4. Innominate artery.
5. Left common carotid.
6. Left subclavian.
7. Right subclavian.
8. Right common carotid.

Name.	*Description.*	*Branches.*	*Distribution.*
Innominate, or brachio-cephalic (a. anonyma). (See Fig. 195.)	From aorta to upper border of right sternoclavicular articulation.	**A. thyroidea ima (occasionally).**	**To thyroid gland.**
		Right common carotid (a. carotis communis dextra)	**To right side of head.**
		Right subclavian (a. subclavia dextra).	**To right upper extremity.**
Common carotid (a. carotis communis).	Right, from bifurcation of innominate to upper border of thyroid cartilage. Left, from arch of aorta to same point on left side.	**External carotid (a. carotis externa).**	**To outside of head.**
		Internal carotid (a. carotis interna).	**To brain.**

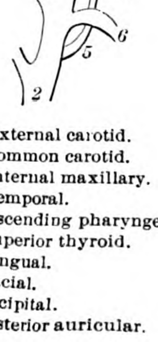
FIG. 196.



1. Right common carotid.
2. Right internal carotid.
3. Right external carotid.
4. Left common carotid.
5. Left subclavian.
6. Innominate.
7. Right subclavian.

Name.	*Description.*	*Branches.*	*Distribution.*
External carotid (a. carotis externa).	From upper border of thyroid cartilage to the space between the neck of the condyle of the jaw and the external auditory meatus, where it divides into the temporal and the internal maxillary arteries.	**1. Superior thyroid (a. thyroidea superior).**	**To thyroid gland.**
		a. Hyoid (ramus hyoideus).	**To muscles of hyoid bone.**
		b. Sternomastoid (ramus sternocleidomastoideus).	**To sternomastoid muscle.**
		c. Superior laryngeal a. laryngea superior).	**To larynx.**
		d. Crico-thyroid (ramus crico-thyroideus).	**To crico-thyroid membrane.**
		2. Lingual (a. lingualis).	
		a. Hyoid (ramus hyoideus).	**To muscles of hyoid bone.**
		b. Dorsalis linguæ (ramus dorsalis linguæ).	**To dorsum of tongue.**
		c. Sublingual (a. sublingualis).	**To muscles and mucous membrane of mouth.**
		d. Ranine (a. profunda linguæ).	**To deep parts of tongue.**
		3. Facial (a. maxillaris externa) (cervical branches).	
		a. Ascending palatine (a. palatina ascendens).	**To soft palate, tonsil, and superior constrictor.**
		b. Tonsillar (ramus tonsillaris).	**To tonsil.**
		c. Submaxillary (rami glandulares).	**To submaxillary gland.**
		d. Submental (a. submentalis).	**To muscles of floor of mouth and chin.**
		e. Muscular (rami musculares). (Facial branches.)	**To internal pterygoid and stylohyoid muscles.**
		f. Muscular (rami musculares).	**To masseter and buccinator.**

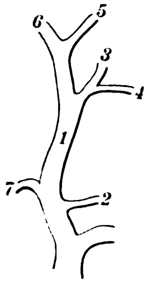
FIG. 197.



1. External carotid.
2. Common carotid.
3. Internal maxillary.
4. Temporal.
5. Ascending pharyngeal.
6. Superior thyroid.
7. Lingual.
8. Facial.
9. Occipital.
10. Posterior auricular.

Name.	*Description.*	*Branches.*	*Distribution.*
		g. Inferior labial (a. labialis inferior).	To lower lip.
		h. Inferior coronary (a. coronaria inferior).	To lower lip.
		i. Superior coronary (a. labialis superior).	To upper lip.
		j. Lateral nasal (a. lateralis nasi).	To side of nose.
		k. Angular (a. angularis).	To inner angle of orbit.
		4. Occipital (a. occipitalis).	
		a. Muscular (rami musculares).	To digastric, stylohyoid, splenius, and trachelo-mastoid.
		b. Sternomastoid (ramus mastoideus)	To sternomastoid.
		c. Auricular (ramus auricularis).	To back of concha.
		d. Meningeal (ramus meningeus).	To meninges through posterior lacerated foramen.
		e. Arteria princeps cervicis (rami occipitales).	To muscles of neck.
		5. Posterior auricular (a. auricularis posterior).	
		a. Stylomastoid (a. stylomastoidea).	Through stylomastoid foramen to tympanum and mastoid cells.
		b. Auricular (ramus auricularis).	To cartilage of ear.
		c. Mastoid (rami mastoidei).	To posterior part of occipitofrontalis muscle.
		6. Ascending pharyngeal (a. pharyngea ascendens).	
		a. Prevertebral (rami prevertebrales).	To longus colli and recti muscles.
		b. Pharyngeal (rami pharyngei).	To pharynx.
		c. Tympanic (a. tympanica inferior).	To tympanum.
		d. Meningeal (a. meningea posterior).	To dura mater through several small foramina.
		7. Superficial temporal (a. temporalis superficialis). (See below.)	To side of head.
		8. Internal maxillary (a. maxillaris interna). (See below.)	To deep structures of face.
Superficial temporal (a. temporalis superficialis).	Extends from the division of the external carotid to a point two inches above the zygoma, where it divides into anterior and posterior temporals.	1. Transverse facial (a. transversa faciei).	To parotid gland, masseter muscle, and integument.
		2. Middle temporal (a. temporalis media).	To temporal muscle.
		3. Orbital (ramus orbitalis), occasionally.	To outer angle of orbit.
		4. Anterior auricular (rami auriculares anteriores).	To anterior portion of pinna and external meatus.
		5. Anterior temporal (a. temporalis anterior).	To forehead.
		6. Posterior temporal (ramus temporalis posterior).	To side of head.

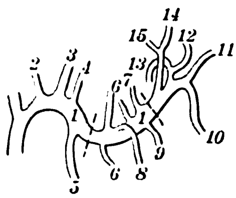
FIG. 198.



1. Temporal.
2. Transverse facial.
3. Middle temporal.
4. Orbital.
5. Anterior temporal.
6. Posterior temporal.
7. Anterior auricular.

Name.	*Description.*	*Branches.*	*Distribution.*
Internal maxillary (a. maxillaris interna).	Extends from the division of the external carotid to the sphenomaxillary fossa. Divided into three portions—maxillary, pterygoid, and sphenomaxillary.	1. Tympanic (a. tympanica anterior).	To membrana tympani.
		a. Deep auricular (a. auricularis profunda.)	To external auditory canal.
		2. Middle meningeal (a. meningea media).	To meninges, through foramen spinosum.
		3. Small meningeal (ramus meningeus accessorius).	To Gasserian ganglion and dura, through foramen ovale.
		4. Inferior dental (a. alveolaris inferior).	To teeth of lower jaw.
		a. Anterior superior dental incisor (aa. alveolares superiores anteriores).	To incisor teeth.
		b. Mental (a. mentalis).	To chin.
		c. Mylohyoid (ramus mylohyoideus).	To mylohyoid muscle.
		d. Lingual.	To mucous membrane.
		5. Deep temporal (a. temporalis profunda).	To temporal muscle.
		6. Pterygoid (rami pterygoidei).	To pterygoid muscles.
		7. Masseteric (a. masseterica).	To masseter.
		8. Buccal (a. buccinatoria).	To buccinator.
		9. Alveolar or posterior dental (a. alveolaris superior posterior).	To molar and bicuspid teeth.
		10. Infra-orbital (a. infraorbitalis).	To front teeth and structures of the face anteriorly.
		11. Posterior or descending palatine (a. palatina descendens).	To gums and mucous membrane of hard palate.
		12. Vidian (a. canalis pterygoidea).	To pharynx and Eustachian tube.
		13. Pterygopalatine (a. palatina major).	To pharynx and Eustachian tube.
		14. Nasopalatine or sphenopalatine (a. sphenopalatina).	To nasal septum and mucous membrane of lateral wall of nose.

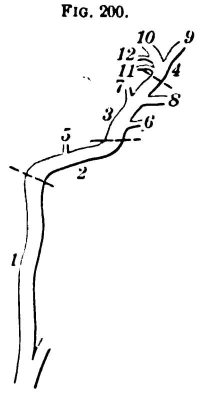
FIG. 199.



1. Internal maxillary.
2. Tympani.
3. Middle meningeal.
4. Small meningeal.
5. Inferior dental.
6. Pterygoid.
7. Deep temporal.
8. Masseteric.
9. Buccal.
10. Alveolar.
11. Infra-orbital.
12. Sphenopalatine.
13. Descending palatine.
14. Vidian.
15. Pterygopalatine.

Name.	*Description.*	*Branches.*	*Distribution.*
Internal carotid (a. carotis interna).	From the bifurcation of the common carotid to the fissure of Sylvius, where it divides into anterior and middle cerebral; divided into cervical, petrous, cavernous, and cerebral portions; passes into the cranial cavity through the carotid canal, in the petrous portion of the temporal bone.	1. Tympanic (ramus caroticotympanicus).	To tympanum.
		2. Arteriæ receptaculi.	To cavernous sinus.
		3. Anterior meningeal (a. meningea anterior).	To dura of anterior fossa.
		4. Ophthalmic (a. ophthalmica).	
		a. Lacrymal (a. lacrymalis).	To lacrymal gland.
		b. Supra-orbital (a. supra-orbitalis).	To structures above the orbit.
		c. Posterior ethmoid (a. ethmoidalis posterior).	To posterior ethmoid cells.
		d. Anterior ethmoid (a. ethmoidalis anterior).	To anterior ethmoid cells.
		e. Palpebral (aa. palpebrales mediales et laterales).	To eyelids.
		f. Frontal (a. frontalis).	To structures above the orbit.
		g. Nasal (a. dorsalis nasi).	To dorsum of nose.
		h. Short ciliary (aa. ciliares posteriores breves).	To choroid and ciliary processes.
		i. Long ciliary (aa. ciliares posteriores longæ).	To iris.
		j. Anterior ciliary (aa. ciliares anteriores).	To iris.

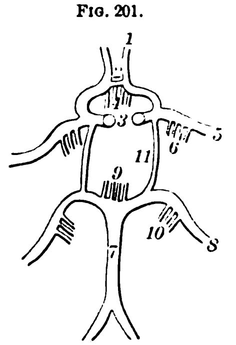
FIG. 200.



1. Cervical portion.
2. Petrous portion.
3. Cavernous portion.
4. Cerebral portion.
5. Tympanic.
6. Arteriæ receptaculi.
7. Anterior meningeal.
8. Ophthalmic.
9. Anterior cerebral.
10. Middle cerebral.
11. Posterior communicating.
12. Anterior choroid.

Name.	*Description.*	*Branches.*	*Distribution.*
		k. Arteria centralis retinæ.	To retina.
		l. Muscular (rami musculares).	To muscles of eye.
		5. Anterior cerebral (a. cerebri anterior).	See circle of Willis.
		a. Anterior median ganglionic.	See circle of Willis.
		b. Inferior internal frontal.	To orbital surface of frontal lobe.
		c. Anterior internal frontal.	To marginal. superior, middle, and descending frontal convolutions.
		d. Middle internal frontal.	To corpus callosum and its convolutions; first and ascending frontal convolutions.
		e. Posterior internal frontal.	To lobus quadratus.
		6. Anterior communicating (a. communicans anterior).	See circle of Willis.
		7. Middle cerebral (a. cerebri media).	
		a. Antero-lateral ganglionic.	See circle of Willis.
		b. Inferior internal frontal (ramus frontalis inferior externus).	To inferior frontal and outer part of orbital surface of frontal lobe.
		c. Ascending frontal (ramus frontalis ascendens).	To ascending frontal convolution.
		d. Ascending parietal (ramus parietalis ascendens).	To ascending parietal convolution.
		e. Parieto-temporal (ramus parieto-temporalis).	To supramarginal, superior, and middle temporal convolutions and angular gyrus.
		f. Posterior communicating (a. communicans posterior).	See circle of Willis.
Circle of Willis (circulus arteriosus).	Formed by the internal carotids and basilar, which is formed by the junction of the vertebrals. From it pass three large trunks for the cortex of each hemisphere, and the ganglionic branches for the basal ganglia.	1. Anterior choroid (a. choroidea anterior).	To choroid plexus.
		2. Anterior cerebral (a. cerebri anterior).	See above, to anterior portion of brain.
		3. Anterior communicating (ramus communicans anterior).	Connects anterior cerebrals.
		4. Antero-median (a. antero-mediana).	To basal ganglia.
		5. Middle cerebral (a. cerebri media).	See above, to lateral areas of brain.
		6. Antero-lateral (a. antero-lateralis).	To basal ganglia.
		7. Posterior communicating (a. communicans posterior).	Connects middle and posterior cerebral arteries.
		8. Posterior cerebral (a. cerebri posterior).	To posterior portion of brain.
		9. Postero-median (a. postero-mediana).	To basal ganglia.
		10. Postero-lateral (a. postero-lateralis).	To basal ganglia.

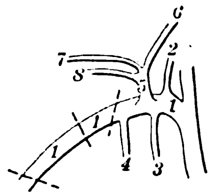
FIG. 201.



1. Anterior cerebral.
2. Anterior communicating.
3. Internal carotids.
4. Antero-median ganglionic.
5. Middle cerebral.
6. Antero-lateral ganglionic.
7. Basilar.
8. Posterior cerebral.
9. Postero-median ganglionic.
10. Postero-lateral ganglionic.
11. Postorior communicating.

Name.	*Description.*	*Branches.*	*Distribution.*
Subclavian (a. subclavia).	Right, from bifurcation of the innominate to the lower border of the first rib. Left arises direct from the arch of the aorta, hence is much longer than the right.	1. Vertebral (a. vertebralis).	To circle of Willis.
		a. Lateral spinal (rami spinales laterales).	To spinal cord and membranes.
		b. Muscular (aa. musculares).	To deep muscles of neck.
		c. Posterior meningeal (a. meningea posterior).	To dura in posterior fossa.
		d. Anterior spinal (a. spinalis anterior).	To spinal cord, anterior surface.
		e. Posterior spinal (a. spinalis posterior).	To spinal cord, posterior surface.
		f. Posterior inferior cerebellar (a. cerebelli inferior posterior).	To under surface of cerebellum.
		g. Bulbar.	To medulla oblongata.
		h. Basilar (a. basilaris).	See circle of Willis.
		2. Internal mammary (a. mammaria interna).	Anastomoses with deep epigastric.
		a. Comes nervi phrenici (a. pericardiacophrenica).	To diaphragm.
		b. Mediastinal (aa. mediastinales anteriores).	To anterior mediastinum.
		c. Pericardiac (aa. thymicæ).	To pericardium.
		d. Sternal (rami sternales).	To posterior surface of sternum.
		e. Anterior intercostal (rami intercostales).	To upper intercostal spaces.
		f. Perforating (rami perforantes).	To pectoralis major and skin.
		g. Musculophrenic (a. musculophrenica).	To lower intercostal spaces.
		h. Superior epigastric (a. epigastrica superior).	To diaphragm and rectus abdominis.
		(Thyroid axis, truncus thyreocervicalis).	Common trunk for three following arteries
		3. Inferior thyroid (a. thyroidea inferior).	To thyroid gland.
		a. Inferior laryngeal (a. laryngea inferior).	To larynx, muscles, and mucous membrane.
		b. Tracheal (rami tracheales).	To trachea.
		c. Œsophageal (rami œsophagei).	To œsophagus.
		d. Ascending cervical (a. cervicalis ascendens).	To deep muscles of the neck.
		e. Muscular (rami musculares).	To muscles of neck, anterior.
		4. Suprascapular (a. cervicalis profunda).	To scapular muscles.
		5. Transversalis colli (a. transversa scapulæ).	To neck.
		a. Superficial cervical (a. cervicalis superficialis).	To trapezius and skin.
		b. Posterior scapular (a. scapularis posterior).	To rhomboid, latissimus dorsi, and trapezius muscles.
		6. Superior intercostal (a. intercostalis suprema).	To first intercostal space
		a. Profunda cervicis (a. profunda cervicis).	To deep muscles of the neck.

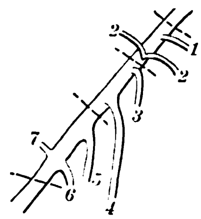
FIG. 202.



1-1-1. Subclavian (right).
2. Vertebral.
3. Internal mammary.
4. Superior intercostal.
5. Thyroid axis.
6. Inferior thyroid.
7. Transversalis colli.
8. Suprascapular.

Name.	*Description.*	*Branches.*	*Distribution.*
Axillary (a. axillaris).	From the lower border of the first rib to the lower border of teres major.	1. Superior thoracic (a. thoracicalis suprema).	To pectoral muscles.
		2. Acromial thoracic (a. thoracoacromialis).	To muscles of the shoulder.
		3. Long thoracic (a. thoracalis lateralis).	To serratus magnus.
		4. Alar thoracic (a. thoracica alaria).	To axillary glands.
		5. Subscapular (rami subscapulares).	To subscapular muscles.
		a. Dorsalis scapulæ (a. circumflexa scapulæ).	To scapular muscles.
		6. Posterior circumflex (a. circumflexa humeri posterior).	To deltoid and shoulder-joint.
		7. Anterior circumflex (a. circumflexa humeri anterior).	To deltoid and shoulder-joint.

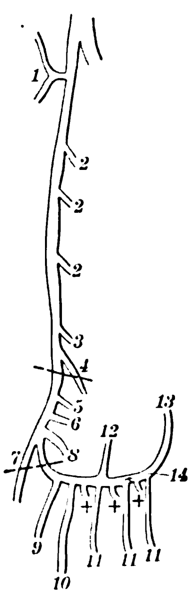
FIG. 203.



1. Superior thoracic.
2. Acromial thoracic.
3. Alar thoracic.
4. Long thoracic.
5. Subscapular.
6. Posterior circumflex.
7. Anterior circumflex.

Name.	*Description.*	*Branches.*	*Distribution.*
Radial (a. radialis).	From bifurcation of brachial, along radial side of forearm to wrist, winds backward around outer side of carpus to upper end of first interosseous space, passes forward between the heads of the first dorsal interosseous muscle to the palm of the hand, where it crosses the metacarpal bones to the ulnar border, forming a deep arch.	(In forearm.)	To elbow-joint and muscles.
		1. Radial recurrent (a. recurrens radialis).	
		2. Muscular (rami musculares).	To radial side of forearm.
		3. Anterior carpal (ramus carpeus volaris).	To articulations of wrist.
		4. Superficialis volæ (ramus volaris superficialis).	To complete superficial arch.
		(In wrist.)	
		1. Posterior carpal (ramus carpeus dorsalis).	Partially forms posterior carpal arch, which gives off dorsal interosseous arteries for third and fourth spaces.
		2. Metacarpal (aa. metacarpæ dorsales).	To first dorsal interosseous space.
		3. Dorsales pollicis (aa. dorsales pollicis).	To dorsum of thumb.
		4. Dorsalis indicis (a. dorsalis indicis).	To radial side, dorsum of index finger.
		(In hand.)	
		1. Princeps pollicis (a. princeps pollicis).	To palmar surface of thumb.
		2. Radialis indicis (a. volaris indicis radialis).	To palmar surface of index finger.
		3. Perforating (rami perforantes).	Three, to communicate with fingers.
		4. Palmar interosseous (aa. metacarpeæ volares).	To interosseous spaces.
		5. Palmar recurrent (aa. palmares recurrentes).	To carpal articulations.
		6. Deep palmar arch (arcus volaris profundus).	The preceding five branches are from this arch.

FIG. 204.



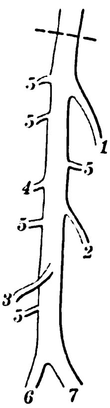
1. Recurrent.
2. Muscular.
3. Anterior carpal.
4. Superficialis volæ.
5. Posterior carpal.
6. Metacarpal.
7. Dorsalis pollicis.
8. Dorsalis indicis.
9. Princeps pollicis.
10. Radialis indicis.

\+ Perforating.

11. Palmar interosseous.
12. Palmar recurrent.
13. Deep branch of ulnar.
14. Deep arch.

Name.	*Description.*	*Branches.*	*Distribution.*
Brachial (a. brachialis).	From lower border of teres major to half inch below bend of elbow, where it divides into radial and ulnar.	1. Superior profunda (a. profunda brachii superior).	To triceps, humerus, and anconeus.
		2. Nutrient (a. nutricia humeri).	To humerus.
		3. Inferior profunda (a. profunda brachii inferior).	To triceps.
		4. Anastomotica magna (a. collateralis media).	To anastomosis about elbow.
		5. Muscular (rami musculares).	To coracobrachialis, biceps, and brachialis anticus.

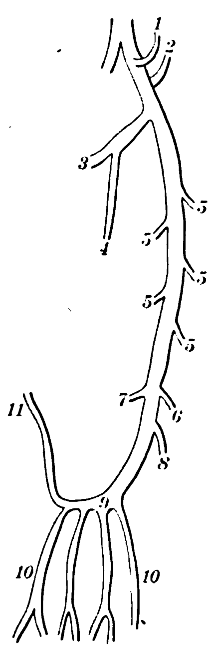
FIG. 205.



1. Superior profunda.
2. Inferior profunda.
3. Anastomotica magna.
4. Nutrient.
5-5-5. Muscular.
6. Radial.
7. Ulnar.

Name.	*Description.*	*Branches.*	*Distribution.*
Ulnar (a. ulnaris).	From bifurcation of brachial, crosses to inner side of forearm, then descends to wrist, crosses annular ligament, and forms superficial arch.	(In forearm).	
		1. Anterior ulnar recurrent (a. ulnaris recurrens anterior).	To form anastomosis about elbow.
		2. Posterior ulnar recurrent (a. ulnaris recurrens posterior).	To form anastomosis about elbow.
		3. Interosseous (a. interossea communis).	
		a. Anterior (a. interossea volaris).	To deep structures of forearm, anterior.
		b. Posterior (a. interossea dorsalis).	To deep structures of forearm, posterior.
		c. Recurrent (a. interossea recurrens).	To anastomosis about elbow.
		4. Muscular (rami musculares).	To ulnar side of forearm.
		(In wrist.)	
		1. Anterior carpal (ramus carpeus volaris).	To wrist, through anterior carpal arch.
		2. Posterior carpal (ramus carpeus dorsalis).	Helps form posterior carpal arch. (*a*) Metacarpal. Is dorsal interosseous to ulnar side of little finger.
		(In hand.)	
		1. Deep palmar or communicating (ramus volaris profundus).	Helps form deep palmar arch.
		2. Superficial arch (arcus volaris superficialis).	
		a. Digital (aa. digitales, volares, communes).	To ulnar side of little and contiguous sides of little, ring, middle, and index fingers.

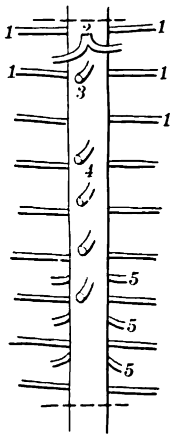
FIG. 206.



1. Anterior recurrent.
2. Posterior recurrent.
3. Posterior interosseous.
4. Anterior interosseous.
5. Muscular.
6. Posterior carpal.
7. Anterior carpal.
8. Deep palmar.
9. Superficial arch.
10. Digital.
11. Superficialis volæ of radial.

Name.	*Description.*	*Branches.*	*Distribution.*
Thoracic aorta (aorta thoracicalis).	From lower border of fourth thoracic vertebra to opening in the diaphragm.	1. Pericardiac (rami pericardiaci).	To pericardium.
		2. Bronchial (aa. bronchiales).	To lungs, nutrient vessels.
		3. Œsophageal (aa. œsophageæ).	To œsophagus.
		4. Posterior mediastinal (rami mediastinales posteriores).	To glands in mediastinum.
		5. Intercostal[1] (aa. intercostales).	Nine on each side. To intercostal spaces. Twelfth called subcostal.
		a. Posterior (rami posteriores).	To muscles and skin of back.
		b. Spinal (rami spinales).	To spinal cord and membranes.
		c. Collateral (aa. collaterales).	To walls of chest.
		Muscular (rami musculares).	

FIG. 207.



1. Intercostals (9) on each side.
2. Bronchial.
3. Pericardiac.
4. Œsophageal (4).
5. Posterior mediastinal (6).

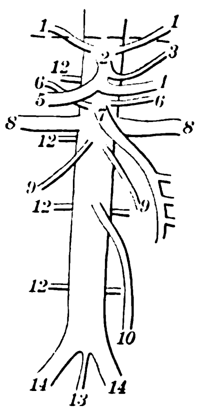
Name.

Abdominal aorta (aorta abdominalis). From opening in diaphragm to body of fourth lumbar, where it divides into common iliacs.

Branches and Distribution.

1. Phrenic (a. phrenica inferior). To diaphragm.
   (Cœliac axis) (a. cœliaca). Common trunk for three following arteries.
2. Gastric (a. gastrica). To less curvature of stomach.
3. Hepatic (a. hepatica). To liver, capsule of Glisson, and gall-bladder.
   a. Pyloric. To pyloric end of stomach.
   b. Gastroduodenalis (a. gastroduodenalis).
      a. Gastro-epiploica dextra (a. gastro-epiploica dextra). To greater curvature of stomach.
      b. Pancreaticoduodenalis superior (a. pancreaticoduodenalis superior). To pancreas.
   c. Cystic (a. cystica). To gall-bladder.
4. Splenic. To spleen.
   a. Pancreaticæ parvæ. To pancreas.
   b. Pancreatica magna. To pancreas.
   c. Gastric (vasa brevia). To stomach.
   d. Gastro-epiploica sinistra. To stomach.
5. Superior mesenteric (a. mesenterica superior).
   a. Inferior pancreaticoduodenalis (a. pancreaticoduodenalis inferior). To pancreas and duodenum.
   b. Vasa intestini tenuis (aa. intestinales). To small intestine.
   c. Ileocolic (a. ileocolica). To right iliac fossa.
   d. Colica dextra (a. colica dextra). To ascending colon.
   e. Colica media (a. colica media). To transverse colon.
6. Suprarenal (a. suprarenalis). To suprarenal capsule.
7. Renal (a. renalis). To kidneys.
8. Spermatic (a. spermatica interna). To testicle.
   Ovarian (a. ovarica). To ovary.
9. Inferior mesenteric (a. mesenterica inferior).
   a. Colica sinistra (a. colica sinistra). To descending colon.
   b. Sigmoid (aa. sigmoideæ). To sigmoid flexure of colon.
   c. Superior hemorrhoidal (a. hemorrhoidalis superior). To upper portion of rectum.
10. Lumbar (aa. lumbales, four on each side). Analogous to intercostals.
   a. Dorsal (ramus dorsalis). To muscles and skin of back.
   b. Spinal (ramus spinalis). To spinal cord and membranes.
   c. Abdominal (rami abdominales). To abdominal walls.
11. Sacra media (a. sacralis media). To Luschka's gland (coccygeal gland).
12. Common iliacs. To pelvis and lower extremity.

FIG. 208.

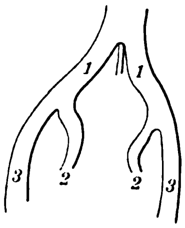


1. Phrenic.
2. Cœliac axis.
3. Gastric.
4. Splenic.
5. Hepatic.
6-6. Suprarenal.
7. Superior mesenteric.
8-8. Renal.
9-9. Spermatic.
10. Inferior mesenteric.
12. Lumbar.
13. Sacra media.
14. Common iliacs.

[1] There are eleven intercostal spaces and a *region* below the twelfth rib occupied by an intercostal artery. The first and second spaces are occupied by intercostal arteries from the subclavian. The succeeding nine spaces are occupied by intercostal arteries from the thoracic aorta. The region beneath the twelfth rib is occupied by the so-called twelfth intercostal artery, which, in reality, is not an intercostal, because not located between the ribs; hence, as stated in the above table, the twelfth is called the subcostal artery.

Name.	*Description.*	*Branches.*	*Distribution.*
Common iliac, right and left (a. iliaca communis).	From bifurcation of aorta to margins of intervertebral substance between last thoracic vertebra and sacrum.	Internal iliac (a. iliaca interna). (See below.)	To pelvic structures.
		External iliac (a. iliaca externa). (See below.)	To lower extremity.

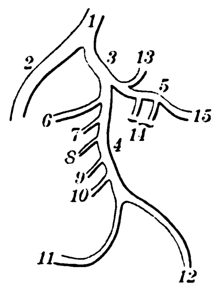
FIG. 209.



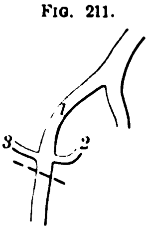
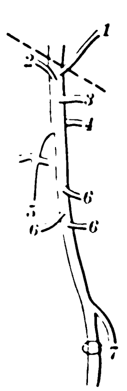
1-1. Common iliac.
2-2. Internal iliac.
3-3. External iliac.

Name.	*Description.*	*Branches.*	*Distribution.*
Internal iliac (a. iliaca interna).	From bifurcation of common iliac to upper margin of great sacrosciatic foramen, where it divides into an anterior and posterior trunk. Anterior trunk supplies viscera of pelvis; posterior trunk supplies walls.	(From anterior trunk).	
		1. Superior vesical (aa. vesicales superiores).	To apex and body of bladder.
		2. Middle vesical (a. vesicalis media).	To base of bladder and vesiculæ.
		3. Inferior vesical (a. vesicalis inferior).	To base of bladder and prostate gland.
		4. Vaginal (in female) (a. vaginalis).	To vagina and cervix uteri.
		5. Uterine (a. uterina).	To uterus.
		6. Middle hemorrhoidal (a hæmorrhoidalis media).	To anus.
		7. Obturator (a. obturatoria).	To iliac fossa.
		a. Iliac (ramus iliacus).	To bladder.
		b. Vesical (ramus vesicalis).	To posterior surface of os pubis.
		c. Pubic (ramus pubicus).	To obturator externus pectineus, etc.
		a. Internal.	
		b. Externus.	To these muscles and hip-joints.
		8. Internal pudic (a. pudenda interna).	
		a. Muscular (rami musculares).	To muscles outside of pelvis.
		b. Inferior hemorrhoidal (a. hæmorrhoidalis inferior).	To anus.
		c. Superficial perineal (a. perinei superficialis).	To muscles and skin of perineum.
		d. Transverse perineal (a. perinei transversa).	To structures behind bulb.
		e. Artery of bulb (a. bulbi urethræ).	To bulb of urethra and Cowper's gland.
		f. Artery of corpus cavernosum (a. urethralis)	To corpus cavernosum.
		g. Dorsal artery of penis (a. dorsalis penis).	To penis.
		h. Arteria dorsalis clitoridis (in female).	To clitoris.
		9. Sciatic (a. glutea inferior).	To muscles at back of pelvis.
		a. Coccygeal (ramus coccygis).	To gluteus maximus.
		b. Inferior gluteal (ramus inferior).	To gluteus maximus.

FIG. 210.

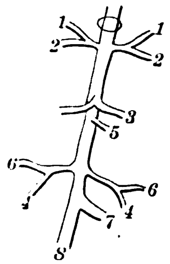


1. Common iliac.
2. External iliac.
3. Internal iliac.
4. Anterior trunk.
5. Posterior trunk.
6. Obturator.
7. Superior vesical.
8. Middle vesical.
9. Inferior vesical.
10. Middle hemorrhoidal.
11. Internal pudic.
12. Sciatic.
13. Iliolumbar.
14. Lateral sacral.
15. Gluteal.

Name.	*Description.*	*Branches.*	*Distribution.*
		c. Comes nervi ischiadici (a. comitans nervi ischiadici).	To great sciatic nerve.
		d. Muscular (rami musculares).	To gluteus maximus.
		e. Anastomotic (a. anastomotica).	To branches of femoral.
		f. Articular (ramus articularis).	To hip-joint.
		(From posterior trunk.)	
		10. Iliolumbar (a. iliolumbalis).	
		a. Lumbar (ramus lumbalis).	To psoas and quadratus lumborum.
		b. Iliac (ramus iliacus).	To iliacus.
		11. Lateral sacral (a. sacralis lateralis).	
		a. Superior.	To sacral canal.
		b. Inferior.	To sacral canal and structures on dorsum of sacrum.
		12. Gluteal (a. glutæa superior).	
		a. Superficial (ramus superior).	To gluteus maximus.
		b. Deep (ramus inferior).	To glutei and hip-joint.
External iliac (a. iliaca externa). FIG. 211.  1. External iliac. 2. Deep epigastric. 3. Deep circumflex iliac.	From bifurcation of common iliac to Poupart's ligament, where it becomes the femoral artery.	1. Deep epigastric (a. epigastrica inferior).	To abdominal walls.
		a. Cremasteric (a. spermatica externa).	To spermatic cord and cremaster.
		b. Pubic (ramus pubicus).	To femoral ring.
		c. Muscular (rami musculares).	To abdominal muscles and skin.
		2. Deep circumflex iliac (a. circumflexa ilium profunda).	To internal oblique and transversalis.
Femoral (a. femoralis). FIG. 212.  1. Superior epigastric. 2. Superior circumflex iliac. 3. Superior external pudic. 4. Deep external pudic. 5. Profunda femoris. 6-6. Muscular. 7. Anastomotica magna.	From Poupart's ligament to opening in adductor magnus, where it becomes the popliteal.	1. Superficial epigastric (a. epigastrica superficialis).	To inguinal glands and skin of abdomen.
		2. Superficial circumflex iliac (a. circumflexa ilium superficialis).	To skin of groin.
		3. Superficial external pudic (aa. pudendæ externæ).	To skin of groin, penis, and scrotum.
		4. Deep external pudic (aa. pudendæ externæ).	To skin of scrotum and perineum.
		5. Profunda (a. profunda femoris).	
		a. External circumflex (a. circumflexa femoris lateralis).	To muscles of front of thigh.
		b. Internal circumflex (a. circumflexa medialis).	To adductors, gracilis, obturator externus, and hip-joint.
		c. Peforating (four) (a. perforans prima, secunda, tertia).	To muscles on posterior surface of thigh.
		6. Muscular (rami musculares).	To sartorius and vastus externus.
		7. Anastomotica magna (a. genu suprema).	To skin and knee-joint.

Name.	*Description.*	*Branches.*	*Distribution.*
Popliteal (a. poplitea).	From opening in adductor magnus to lower border of popliteus, where it divides into anterior and posterior tibial.	1. Muscular (rami musculares).	
		a. Superior (aa. musculares laterales et mediales).	To adductor magnus and flexors of thigh.
		b. Inferior or sural (aa. surales laterales et mediales).	To gastrocnemius and plantaris.
		2. Cutaneous (a. cutanea).	To integument of the calf.
		3. Superior articular (aa. genu superiores).	
		a. Internal (a. genu superior medialis).	To vastus internus, inner hamstring, and knee-joint.
		b. External (a. genu superior lateralis).	To vastus externus and knee-joint.
		4. Azygos articular (a. genu media).	To knee-joint.
		5. Inferior articular (a. genu inferior medialis).	To popliteus, head of tibia, and knee-joint.
		a. Internal (a. genu inferior medialis).	To knee.
		b. External (a. genu inferior lateralis).	To knee-joint.

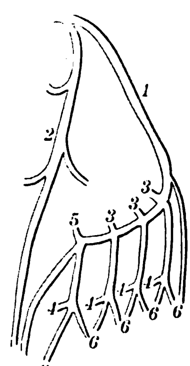
FIG. 213.



1. Superior muscular.
2-2. Superior articular, internal and external.
3. Sural—inferior muscular.
4. Cutaneous.
5. Azygos articular.
6-6. Inferior articular, external and internal.
7. Anterior tibial.
8. Posterior tibial.

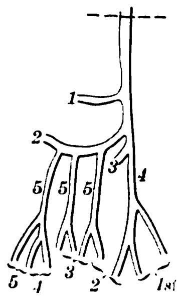
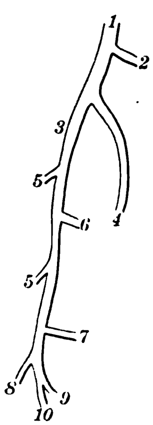
Name.	*Description.*	*Branches.*	*Distribution.*
Internal plantar (a. plantaris medialis).	Smaller than the external; passes forward along the inner side of the foot to the inner side of the great toe.	Muscular and cutaneous branches (rami musculares et cutanei).	To the structures on the inner side of the foot and great toe.

FIG. 214.



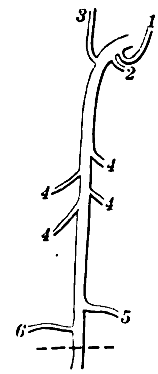
1. External plantar.
2. Internal plantar.
3-3. Posterior perforating.
4-4. Anterior perforating.
5. Communicating.
6-6. Digital.

Name.	*Description.*	*Branches.*	*Distribution.*
External plantar (a. plantaris lateralis).	Passes obliquely outward and forward to the base of the fifth metatarsal bone, then turns inward to the space between the bases of the first and second metatarsal bones.		To muscles, integument, and fasciæ of sole.
		1. Posterior perforating (three) (rami perforantes).	To anastomose with interosseous branches from metatarsal artery.
		2. Digital (four) (aa. digitales plantares).	To three outer and half of second toes.
		3. Anterior perforating (rami perforantes).	To anastomose with interosseous branches from metatarsal artery.

Name.	*Description.*	*Branches.*	*Distribution.*
Dorsalis pedis (a. dorsalis pedis). FIG. 215.  1. Tarsal. 2. Metatarsal. 3. Communicating. 4. Dorsal hallucis. 5. Interosseous.	From bend of ankle to posterior part of first intermetatarsal space.	1. Tarsal (aa. tarseæ mediales et laterales).	To extensor brevis digitorum and tarsal joints.
		2. Metatarsal (a. arcuata). *a.* Interosseous (three) (aa. metatarsales dorsales).	
		b. Digital (aa. digitales).	To dorsum and contiguous sides of four outer toes and outer side of little toe.
		3. Dorsalis hallucis (a. dorsalis hallucis).	To great toe.
		4. Digital (aa. digitales dorsales).	To dorsum and contiguous sides of first and second, also inner side of first toe.
		5. Communicating (ramus plantaris profundus).	To complete plantar arch by dipping between two heads of first dorsal interosseous muscle and anastomosing with external plantar.
Posterior tibial (a. tibialis posterior). FIG. 216.  1. Popliteal. 2. Anterior tibial 3. Posterior tibial. 4. Peroneal. 5-5. Muscular. 6. Nutrient. 7. Communicating. 8. Internal calcanean. 9. Internal plantar. 10. External plantar.	From bifurcation of popliteal to fossa between internal malleolus and heel, where it divides into internal and external plantar.	1. Peroneal (a. peronæa). *a.* Muscular (rami musculares).	To muscles on posterior and outer surfaces of leg.
		b. Nutrient (a. nutritia fibulæ).	To fibula.
		c. Anterior peroneal (a. malleolaris posterior medialis).	Passes to tarsus on anterior surface of interosseous membrane.
		d. Communicating (ramus communicans).	Joins with branch of posterior tibial.
		e. Posterior peroneal (a. malleolaris posterior lateralis).	To external malleolus and os calcis.
		f. External calcanean (ramus calcanei lateralis).	To outer side of heel.
		2. Muscular (rami musculares).	To soleus and deep muscles.
		3. Nutrient (a. nutritia tibiæ).	To tibia.
		4. Communicating (rami communicantes).	Join branch of peroneal.
		5. Internal calcanean (rami calcanei mediales).	To heel and inner side of sole of foot.

Name.	*Description.*	*Branches.*	*Distribution.*
Anterior tibial (a. tibialis anterior).	From bifurcation of popliteal; passes between two heads of gastrocnemius, and through the interosseous ligament; descends to bend of ankle, and becomes dorsalis pedis.	1. Posterior recurrent tibial (a. recurrens tibialis posterior) (not constant).	To popliteus and tibiofibular joint.
		2. Superior fibular (ramus fibularis).	To soleus and peroneus longus.
		3. Anterior recurrent (a. recurrens tibialis anterior).	Assists in anastomosis about patella.
		4. Muscular (rami musculares).	To muscles on anterior surface of leg.
		5. Internal malleolar (a. malleolaris anterior medialis).	To inner side of ankle
		6. External malleolar (a. malleolaris lateralis).	To outer side of ankle.

FIG. 217.



1. Posterior recurrent tibial.
2. Superior fibular.
3. Anterior recurrent tibial.
4. Muscular.
5. Internal malleolar.
6. External malleolar.

SYSTEMIC VEINS.

Name.	*Description.*	*Tributaries.*	*Source.*
Superior vena cava (vena cava superior). (See page 185.)	From junction of right and left innominates to right ventricle, two and one-half to three inches in length.	1. Right innominate (v. anonyma dextra).	Right side of head and right upper extremity.
		2. Left innominate (v. anonyma sinistra).	Left side of head and left upper extremity.
		3. Mediastinal.	From mediastinal space.
		4. Pericardiac (vv. pericardiacæ).	From pericardium.
		5. Azygos major (v. azygos major).	From lower ten intercostal spaces of right side.
		a. Azygos minor (v. azygos minor).	From four or five lower intercostal spaces of left side.
		a. Left upper azygos.	From three or four upper spaces in left side below superior intercostal.
		b. Œsophageal (vv. œsophageæ).	From œsophagus.
		c. Mediastinal (vv. mediastinales).	From mediastinal space.
		b. Œsophageal (v. œsophagea).	From œsophagus.
		c. Mediastinal (vv. mediastinales).	From mediastinum.
		d. Pericardiac (vv. pericardiacæ).	From pericardium.
		e. Right bronchial (vv. bronchiales dextræ).	From right lung.
		f. Right superior intercostal (v. intercostalis superior dextra).	From two or three upper intercostal spaces of right side.
Right innominate or brachiocephalic (v. anonyma dextra). (See page 185.)	From junction of internal jugular and subclavian on right side to opposite first costal cartilage of right side, one inch in length. No valves. At angle of junction receives right lymphatic duct.	1. Internal jugular (v. jugularis interna). (See below.)	
		2. Right subclavian (v. subclavia dextra). (See below.)	
		3. Inferior thyroid (v. thyroidea inferior).	From thyroid gland.
		4. Right vertebral (v. vertebralis dextra).	From cranial cavity, spinal canal, and deep muscles of the neck.

Name.	Description.	Tributaries.	Source.
		5. Right internal mammary (v. mammaria interna dextra).	From phrenic nerve, mediastinal glands, pericardium, sternum, anterior portion of intercostal spaces, and upper part of abdominal walls.
Left innominate (v. anonyma sinistra). (See pages 185 and 197.)	From junction of internal jugular and subclavian on left side to opposite first costal cartilage of right side, two-and-one-half inches in length. No valves. At angle of junction receives thoracic duct.	1. Left internal jugular (v. jugularis sinistra). (See below.)	
		2. Left subclavian (v. subclavia sinistra). (See below.)	
		3. Left inferior thyroid (v. thyroidea inferior sinistra).	*a.* From thyroid gland.
		4. Left vertebral (v. vertebralis sinistra).	*b.* From cranial cavity, spinal canal, and deep muscles of the neck.
		5. Left internal mammary (v. mammaria interna).	*c.* From phrenic nerve, mediastinal glands, pericardium, sternum, anterior portion of intercostal spaces, and upper part of abdominal walls.
		6. Left superior intercostal (v. intercostalis superior sinistra).	From two or three upper intercostal spaces of left side.
		a. Left bronchial (v. bronchialis sinistra).	From left lung.
		b. Superior phrenic (v. phrenica superior).	From phrenic nerve.
Internal jugular (v. jugularis interna). (See pages 26 and 106.)	From jugular foramen to root of the neck. Formed by junction of lateral and inferior petrosal sinuses. One pair of valves. Lies in sheath with carotid artery and pneumogastric nerve.	1. Lateral sinus.	From brain.
		2. Inferior petrosal sinus.	From brain.
		3. Facial (common) (v. facialis communis).	From face.
		a. Anterior division of temporomaxillary).	See external jugular vein.
		b. Facial (v. facialis).	
		a. Angular (v. angularis).	From side of nose.
		b. Frontal (v. frontalis).	From forehead.
		c. Supra-orbital (v. supra-orbitalis).	From above orbit.
		d. Deep facial (v. facialis profunda).	From muscles of face.
		e. Internal palpebral (v. palpebralis inferior).	From lower lid.
		f. Superior labial (v. labialis superior).	From upper lip.
		g. Inferior labial (v. labialis inferior).	From lower lip.
		h. Buccal (v. buccalis).	From side of mouth.
		i. Masseteric (v. masseterica).	From masseter muscle.
		j. Submental (v. submentalis).	From chin.
		k. Inferior palatine (v. palatina inferior).	From soft palate.
		l. Submental, maxillary (v. submaxillaris).	From submaxillary gland.
		m Ranine (v. dorsalis linguæ).	From tongue.
		4. Lingual (v. lingualis).	From tongue.
		5. Pharyngeal (v. pharyngea).	From pharyngeal plexus.
		6. Superior thyroid (v. thyroidea superior).	From thyroid gland.
		7. Middle thyroid (v. thyroidea media).	From thyroid gland.
		8. Occipital (v. occipitalis).	From posterior surface of head.

Name.	*Description.*	*Tributaries.*	*Source.*
Lateral sinus (sinus lateralis). (See Figs. 26 and 27, pages 54 and 55.)	Venous channel, inside of cranial cavity; outer coat formed by dura, inner by lining membrane of vein. Situated in attached margin of tentorium cerebelli. From torcular Herophili to jugular foramen.	1. Superior longitudinal sinus (sinus sagittalis superior).	From brain and pericranium.
		a. Superior cerebral veins.	From upper surface of brain.
		b. Veins of diploë.	From bones of cranium.
		2. Straight sinus (sinus rectus).	
		a. Inferior longitudinal (sinus sagittalis inferior).	From free margin of falx cerebri.
		b. Median cerebral veins (vv. cerebrales medianæ).	From surface of brain along longitudinal fissure.
		c. Venæ Galeni (v. cerebri magna).	From ventricles of brain.
		a. V. corporis striati.	From corpus striatum.
		b. Choroid vein.	From choroid plexus.
		c. Basilar.	From base of brain.
		d. Superior cerebellar.	From upper portion of cerebellum.
		3. Occipital (v. occipitalis).	From falx cerebelli.
		4. Superior petrosal (sinus petrosus superior).	From base of brain.
		5. Inferior cerebellar vein.	From lower portion of cerebellum.
		6. Petro-squamous.	From lower portion of brain.
		7. Veins of diploë (vv. diploicæ).	From bones of cranium.
Inferior petrosal sinus. (See Fig. 26, page 54.)	From termination of cavernous sinus to jugular foramen. Lies along lower border of petrous portion of temporal bone.	1. Cavernous sinus (sinus cavernus).	From base of brain.
		a. Inferior cerebellar veins (vv. cerebelli inferiores).	From base of cerebellum.
		b. Ophthalmic (v. ophthalmica).	From orbit.
		a. Superior ophthalmic (v. ophthalmica superior).	From contents of orbit.
		b. Inferior ophthalmic (v. ophthalmica inferior).	From floor of orbit.
		2. Circular sinus (sinus circularis).	Connect two cavernous sinuses.
		a. Anterior.	
		b. Posterior.	
		3. Small veins (vv. minimæ).	From internal ear, medulla, and pons.
Emissary veins.	Pass through apertures in cranial wall and connect outside veins and sinuses).	4. Transverse sinus (sinus transversus).	Connect two inferior petrosal sinuses.
		See emissary system, Eckley's *Anatomy of Head and Neck*, pp. 100-102.	
Subclavian. (See Fig. 104, page 197.)	Is continuation of axillary from outer border of first rib to inner end of clavicle, where it unites with the internal jugular to form the innominate.	1. External jugular (v. jugularis externa).	From exterior of cranium and deep portion of face.
		2. Posterior division of temporomaxillary.	From anterior division. (See fascial.)
		a. Temporal (v. temporalis).	From temporal region.
		I. Parotid (v. parotidea).	From parotid gland.
		II. Articular (v. articularis).	From articulation of inferior maxillary.
		III. Anterior auricular (v. auricularis anterior).	From ear.
		IV. Transverse facial (v. transversa).	From side of face.
		V. Middle temporal (v. temporalis media).	From side of head.
		VI. Orbital (v. orbitalis).	From eyelids.
		b. Internal maxillary (v. maxillaris interna).	From sphenomaxillary fossa.

Name.	*Description.*	*Tributaries.*	*Source.*
		I. Middle meningeal (v. meningea media).	From meninges.
		II. Deep temporal (v. perforans).	From temporal muscle.
		III. Veins of diploë.	From bones of cranium.
		IV. Pterygoid (v. pterygoidea).	From pterygoids.
		V. Masseteric (v. masseterica).	From masseter.
		VI. Buccal (v. buccalis).	From buccinator.
		VII. Alveolar (v. alveolaris).	From alveolar process of superior maxillary.
		VIII. Palatine (v. palatina).	From hard and soft palate.
		IX. Inferior dental.	From inferior maxillary bone, teeth, etc.
		3. Posterior auricular.	From behind ear.
		4. Posterior external jugular.	From upper and back part of neck.
		5. Suprascapular.	From posterior scapular region.
		6. Transversalis colli.	From side of neck.
		7. Anterior jugular (v. jugularis anterior).	From submaxillary region.
		8. Branch of cephalic.	From arm.
Axillary (v. axillaris).	Continuation of basilic from lower border of teres major to outer border of first rib. Basilic passes from bend of elbow upward, pierces deep fascia half-way up arm, and then lies in relation with brachial vessels.	1. Cephalic (v. cephalica).	From superficial portion of arm.
		a. Median cephalic (v. mediana cephalica).	Connects median and cephalic veins.
		b. Radial (superficial) (v. radialis).	From dorsal surface of fingers, wrist, and radial side of forearm.
		2. Superior thoracic.	From walls of thorax.
		3. Acromial thoracic (v. thoracoacromialis).	From muscles about the shoulder.
		4. Long thoracic (v. thoracicalis lateralis).	From side of thorax and axillary glands.
		5. Alar thoracic.	From lymph glands of axilla.
		6. Subscapular (v. subscapularis).	From muscles about scapula.
		7. Posterior circumflex (v. circumflexa posterior).	From deltoid and shoulder-joint.
		8. Anterior circumflex (v. circumflexa anterior).	From humerus and shoulder-joint.
		9. Basilic (v. basilica).	From superficial structures of forearm.
		a. Common ulnar (superficial) (anterior ulnar, posterior ulnar).	From forearm and hand through anterior and posterior ulnar.
		b. Median basilic (v. mediana basilica).	Connects median and basilic veins.
		10. Median (v. mediana).	From superficial structures on front of forearm.
		11. Brachial.	
Brachial (v. brachialis).	Venæ comites formed by junction of deep radial and ulnar veins just below bend of elbow, extend upward with brachial artery, and empty into axillary vein near teres major muscle.	1. Superior profunda (v. profunda superior).	From muscles on posterior surface of arm.
		2. Nutrient (v. nutricia).	From humerus.
		3. Inferior profunda (v. profunda inferior).	From structures back of elbow-joint.
		4. Anastomotica magna (v. collateralis ulnaris inferior).	From elbow-joint.
		5. Muscular (rami musculares).	From muscles on anterior surface of arm
		6. Radial (deep) (vv. radiales). (See below.)	
		7. Ulnar (deep) (vv. ulnaris profundæ). (See below.)	
Radial (vv. radiales).	Venæ comites from right side of hand and forearm to elbow in relation with radial artery.	(In forearm.) 1. Radial recurrent (ramus recurrens).	From elbow-joint.
		2. Muscular (rami musculares).	From deep muscles.

Name.	*Description.*	*Tributaries.*	*Source.*
		3. Anterior carpal (rami carpeæ anteriores).	From anterior surface of wrist and hand.
		4. Superficialis volæ.	From anterior surface of thenar eminence.
		(In wrist.)	
		5. Posterior carpal (rete carpi dorsale).	From posterior surface of wrist and hand.
		6. Metacarpal (vv. metacarpeæ dorsales).	From second interosseous space and fingers.
		7. Dorsalis pollicis (v. dorsalis pollicis).	From posterior surface of thumb.
		8. Dorsalis indicis (v. dorsalis indicis).	From posterior surface of index finger.
		(In hand.)	
		9. Princeps pollicis (v. princeps pollicis).	From thumb.
		10. Radialis indicis (v. volaris indicis radialis).	From index finger.
		11. Perforating (vv. perforantes).	Communicate with dorsal interosseous veins.
		12. Palmar interosseous (vv. digitales volaris communes).	From interosseous spaces.
		13. Palmar recurrent.	From carpal articulations.
Ulnar (vv. ulnares)	Venæ comites from ulnar side of hand to elbow, where they empty with radial into brachial. Are in relation with ulnar artery.	(In forearm.)	
		1. Anterior ulnar recurrent (ramus recurrens).	From elbow-joint.
		2. Posterior ulnar recurrent (rami recurrentes anteriores).	From elbow-joint.
		3. Anterior interosseous (vv. interosseæ anteriores).	From deep muscles on anterior surface of forearm.
		4. Posterior interosseous (vv. interosseæ posteriores).	From deep muscles on posterior surface of forearm.
		5. Muscular (rami musculares)	From muscles on ulnar side of forearm.
		(In wrist.)	
		6. Anterior carpal (rete carpi volare).	From anterior surface of wrist and hand.
		7. Posterior carpal (rete carpi dorsale).	From posterior surface of wrist and hand.
		(In hand.)	
		8. Deep palmar (communicating) (ramus communicans).	Communicates with deep radial veins.
		9. Superficial palmar arch (arcus volaris superficialis).	From palm of hand and fingers.
Inferior vena cava (vena cava inferior). (See Figs. 112 and 122, pages 212 and 232.)	Formed by junction of the common iliac veins on right side of fifth lumbar vertebra, and passes upward, emptying into right auricle.	1. Hepatic (three usually) (vv. hepaticæ).	From liver.
		2. Phrenic (v. phrenica inferior).	From diaphragm.
		3 Suprarenal (vv. suprarenales).	From adrenal tissue. Left vein usually empties into left renal or phrenic.
		4. Renal (v. renalis).	From kidney. Left renal receives left spermatic.
		5. Right spermatic (v. spermatica dextra).	From right testicle.
		(Ovarian vein, right (v. ovarica) forms plexus in broad ligament and terminates same as spermatic vein).	From ovary.
		6. Lumbar (four on each side) (vv. lumbales).	From muscles and integument of loins.
		7. Right common iliac.	From pelvis and right lower extremity.
		8. Left common iliac.	From pelvis and left lower extremity.

Name.	*Description.*	*Tributaries.*	*Source.*
Common iliac (vena iliaca communis). (See Fig. 134, page 255.)	Formed by union of external and internal iliac veins in front of sacro-iliac articulation, and terminate in inferior vena cava.	1. Lateral sacral (vv. sacrales) (occasionally).	From pelvic wall.
		2. Iliolumbar (v. iliolumbalis).	From iliacus and quadratus lumborum.
		(Left common iliac also receives middle sacral.)	From posterior wall of pelvis.
		3. Internal iliac (v. hypogastrica).	
		a. Gluteal (vv. glutеæ superiores).	From muscles and integument of gluteal region.
		b. Sciatic (v. glutеæ inferior).	From posterior surface of thigh.
		c. Internal pudic (v. pudenda interna).	From perineum and external genitals.
		d. Obturator (vv. obturatoriæ).	From pelvis and inner surface of thigh.
		e. Hemorrhoidal plexus (plexus hemorrhoidalis).	From rectum.
		f. Vesicoprostatic plexus.	From bladder and prostate.
		Dorsal vein of penis or clitoris.	From erectile tissue of penis.
		g. Hemorrhoidal plexus (plexus hemorrhoidalis).	From rectum.
		h. Uterine and vaginal plexus.	From uterus and vagina.
		4. External iliac (v. iliaca externa). (See below.)	
External iliac (v. iliaca externa). (See Fig. 134, page 255.)	From termination of femoral at Poupart's ligament to sacro-iliac articulation.	1. Deep epigastric (v. epigastrica inferior).	From anterior abdominal wall.
		2. Deep circumflex iliac (v. circumflexa ilium profunda).	From abdominal wall in iliac region.
		3. Pubic (v. pubica) (occasionally).	Small branch from pubic region.
Femoral (v. femoralis). (See Figs. 150, 151, and 152, pages 288 and 291.)	From opening in adductor magnus to Poupart's ligament.	1. Internal saphenous (v. saphena magna).	From inner side and dorsum of foot and inner side of leg and thigh.
		a. Superficial epigastric (v. epigastrica superficialis).	From abdominal wall—superficial.
		b. Superficial circumflex iliac (v. circumflexa ilium superficialis).	From upper portion of thigh and abdominal wall.
		c. External pudic (v. pudenda externa),	From inner side of thigh and pubic region
		2. Profunda femoris (v. profunda femoris).	From deep structures of thigh.
		a. External circumflex (v. circumflexa externa).	From muscles on front of thigh.
		b. Internal circumflex.	From adductor muscles.
		c. Perforating.	From muscles on posterior surface of thigh.
		d. Nutrient.	From femur.
		3. Muscular (rami musculares).	From muscles of anterior surface of thigh.
Popliteal (vv. poplitеæ). (See Fig. 164, page 308.)	Formed by junction of anterior and posterior tibial venæ comites, at lower border of popliteus muscle; extends upward to opening in adductor magnus.	1. Sural veins (vv. surales).	From gastrocnemius.
		2. Articular (several) (vv. genu, laterales et mediales superiores ac inferiores).	From knee-joint.
		3. External saphenous (v. saphena parva).	From outer side and dorsum of foot, and outer and posterior portions of leg.
		4. Anterior tibial (vv. tibiales anteriores). (See below.)	
		5. Posterior tibial (vv. tibiales posteriores). (See below.)	

Name.	*Description.*	*Tributaries.*	*Source.*
Anterior tibial (vv. tibiales anteriores). (See page 312.)	Continuation upward of venæ comites of dorsalis pedis artery to junction with posterior tibial.	1. Muscular (rami musculares).	From muscles on anterior surface of leg.
		2. Internal malleolar (v. malleolaris medialis).	From inner side of ankle.
		3. External malleolar (v. malleolaris lateralis).	From outer side of ankle.
Dorsalis pedis (vv. dorsales pedis). (See page 314.)	Venæ comites from base of first interosseous space to bend of ankle, where they become anterior tibial.	1. Tarsal (vv. tarsæ).	From tarsal articulations.
		2. Metatarsal (v. metatarsæ).	From joints and muscles.
		a. Interosseous (v. perforantes).	From interosseous spaces.
		I. Digital (vv. digitales).	From toes.
		3. Dorsalis hallucis.	From great toe.
		4. Communicating (ramus plantaris profundus).	Connects with plantar veins.
Posterior tibial (vv. tibiales posteriores). (See page 322.)	Venæ comites from junction of internal and external plantar between heel and internal malleolus to lower border of popliteus, where they unite with anterior tibial to form popliteal.	1. Peroneal (page 322).	
		a. Muscular.	From muscles on fibular side of leg.
		b. Nutrient.	From fibula.
		c. Anterior peroneal.	From deep structures on anterior surface of leg.
		d. Communicating (vv. communicantes).	Connects with posterior tibial venæ comites.
		e. Posterior peroneal.	From behind external malleolar.
		f. External calcanean.	From outer side of heel.
		2 Muscular (rami musculares).	From muscles on posterior surface of leg.
		3. Nutrient (vv. nutriciæ).	From tibia.
		4. Communicating (vv. communicantes).	Connects with peroneal venæ comites.
		5. Internal calcanean.	From inner side of heel.
		6. Internal plantar (v. plantaris medialis). (See below.)	
		7. External plantar (v. plantaris lateralis). (See below.)	
Internal plantar (v. plantaris medialis). (See pages 329 and 330.)	Venæ comites along inner side of foot to junction with external plantar to form posterior tibial.	Superficial digital branches (vv. digitales superficiales).	From great toe and inner side of foot.
External plantar (v. plantaris lateralis). (See pages 329 and 330.)	Venæ comites which extend across the bases of metatarsal bones and along the outer side of foot, with external plantar artery, to join internal plantar to form posterior tibial.	1. Posterior perforating (vv. perforantes) (three).	Communicate with metatarsal veins on dorsum of foot.
		2. Digital (vv. digitales) (four).	From interosseous spaces and toes.
		3. Anterior perforating (vv. perforantes anteriores).	Communicate with interosseous veins on dorsum of foot.
Portal vein (vena portæ). (See Fig. 125, page 240.)	From behind upper border of head of pancreas to transverse fissure of liver; lies between layers of lesser omentum behind common duct and hepatic artery, three or four inches in length.	1. Superior mesenteric (v. mesenterica superior).	From small intestines.
		a. Colica media (v. colica media).	From transverse colon.
		b. Ileocolic (v. ileocolica).	From cæcum.
		c. Colica dextra (v. colica dextra).	From ascending colon.
		2. Splenic (v. lienalis).	From spleen.
		a. Pancreatic (vv. pancreaticæ).	From pancreas.
		b. Vasa brevia (vv. gastricæ breves).	From stomach.
		c. Gastro epiploica dextra.	From greater curvature of stomach.
		d. Inferior mesenteric (v. mesenterica inferior).	From colon.
		a. Colica sinistra.	From descending colon.
		b. Sigmoid (vv. sigmoideæ).	From sigmoid flexure.

Name.	*Description.*	*Tributaries.*	*Source.*
		c. Superior hemorrhoidal (v. hemorrhoidalis superior).	From hemorrhoidal plexus.
		3. Cystic (v. cystica) (occasionally).	From gall-bladder.
		4. Coronary.	From lesser curvature of stomach.
		5. Pyloric.	From pylorus.
Spinal veins (venæ spinales).	Numerous plexuses placed upon and within spinal column. Terminate in vertebral in neck, intercostal in thorax, lumbar and sacral in loins and pelvis.	1. Dorsi spinal (venæ spinales dorsales).	From skin and muscles of back.
		2. Meningorachidian.	From between vertebræ and membranes of cord.
		a. Anterior longitudinal.	From whole length of spinal canal behind bodies.
		b. Posterior longitudinal.	From whole length of canal behind cord.
		3. Venæ basis vertebrarum.	From bodies of vertebræ.
		4. Medulli spinal.	From spinal cord.
Cardiac veins (vv. cardiacæ). (See Fig. 98, page 185.)	Veins which return blood from substance of heart.	1. Coronary (vv. coronaria).	From both ventricles and left auricle.
		2. Posterior cardiac (v. cardiaca posterior).	From both ventricles.
		3. Left cardiac (three or four) (v. cardiaca sinistra).	From left ventricle.
		4. Anterior cardiac (three or four) (vv. cardiacæ anteriores).	From right ventricle.
		5. Right coronary (v. coronaria dextra.	From back part of right auricle and ventricle.
		6. Coronary sinus (sinus coronarius).	Dilated portion of coronary vein.
		7. Venæ Thebesii (numerous).	From walls of right auricle —open directly into cavity.

THE FŒTAL CIRCULATION.

1. The foramen ovale, situated in the posterior wall of the right auricle, establishes a free communication between the auricles of the heart, and is usually closed in the adult by a membrane proceeding from below upward, called the valvula foraminis ovalis.

2. The Eustachian valve (valvula venæ cavæ inferioris) is large, formed of endocardium and muscular fibres, and directs blood from the inferior vena cava through the foramen ovale into the left auricle. In the adult it is commonly small and identified by its cribriform appearance, situated between the anterior margin of the inferior vena cava and the right auriculo-ventricular orifice.

3. The ductus arteriosus (Botalli) forms a direct opening between the pulmonary artery and the aorta. Through it venous blood is deflected into the arterial circulation. Its period of usefulness is during intra-uterine life. In the adult it obtains as a fibrous connective-tissue cord. It occasionally remains open in the adult.

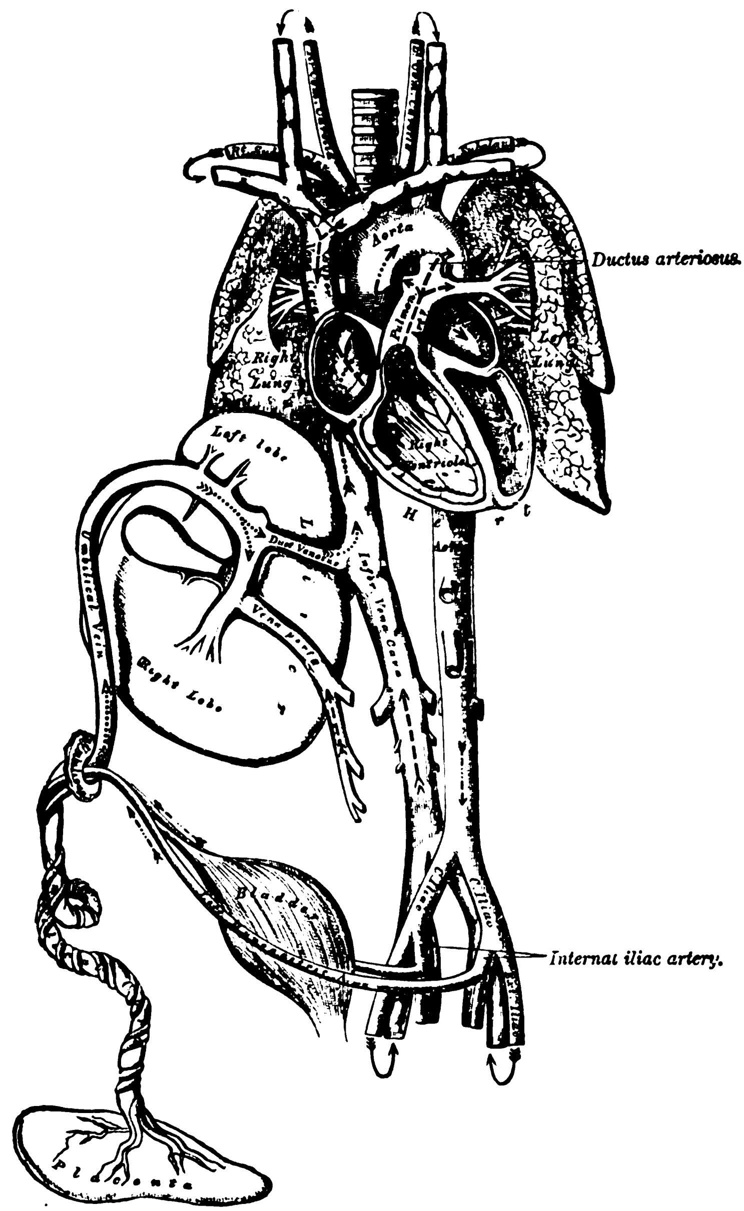
4. The hypogastric arteries (aa. umbilicales), one on either side, pass from the internal iliac arteries to the upper surface of the bladder, thence through the umbilical opening (annulus umbilicalis) to the placenta, through the umbilical cord. The portions of these vessels remaining patulous after birth are the superior vesical arteries.

5. The umbilical vein (vena umbilicalis) passes from the placenta through the umbilical opening, through the umbilical cord to the transverse fissure of the liver. This vessel returns aerated blood from the placenta, and, obliterated after birth, forms the round ligament of the liver.

6. The ductus venosus (Arantii) forms a communication between the umbilical vein and the inferior vena cava. It obtains in the adult as a fibrous cord in the fissure for the ductus arteriosus, on the posterior surface of the liver.

Course of fœtal circulation: Blood passes from the placenta, where it is purified, to the transverse fissure of the liver through the umbilical vein. Here a part is mixed with the blood of the portal vein (ramus sinistra venæ portæ), and follows the usual course of this vessel. The remainder passes through the ductus venosus to the inferior vena cava, and is mixed with blood coming from the lower portions of the body. This blood reaches the right auricle, and is partially

FIG. 218.



Plan of the fœtal circulation. In this plan the figured arrows represent the kind of blood, as well as the direction which it takes in the vessels. Thus, arterial blood is figured >— ······· —>; venous blood >— — — —> mixed (arterial and venous) blood > ·· — ·· —>.

mixed with the contents of the superior vena cava, and directed by the Eustachian valve through the foramen ovale to the left auricle. From here it passes into the left ventricle, thence through the aorta, principally to the head and upper extremities; that which does not leave the vessel through the branches of the arch of the aorta is mixed with venous blood, which has passed from the superior vena cava, right auricle, right ventricle, and pulmonary artery, where the ductus arteriosus empties into the aorta. From this point the blood (principally venous) is distributed to all other portions of the body, and part of it passes to the placenta through the internal iliac and hypogastric arteries. It will be noticed that the liver receives purified blood direct from the placenta, hence its large size in the fœtus. The head and upper extremities receive richer blood than the lower extremities; this accounts for the relatively large size of these members. The lungs receive blood only for nourishment (this through the bronchial arteries), hence practically all blood which passes into the pulmonary artery reaches the aorta through the ductus arteriosus. (Fig. 218.)

CHAPTER XXXII.

SENSORY AND MOTOR CONDUCTION PATHS BETWEEN THE SPINAL CORD AND THE CEREBRAL CORTEX.

By C. M. Jackson, M.D.

1. Sensory (afferent) conduction paths from the spinal cord to the cerebral cortex.
   - *A.* Direct route (without traversing the cerebellum).
     - *a.* *Via* tracts of Goll and Burdach (fasciculus gracilis et cuneatus).
     - *b.* *Via* anterolateral ground bundle (fasciculi proprii).
     - *c.* *Via* tract of Gowers (anterolateral ascending).
   - *B.* Indirect route (*via* cerebellum).
     - *a.* *Via* tracts of Goll and Burdach (fasciculus gracilis et cuneatus).
     - *b.* *Via* direct cerebellar tract (fasciculus spinocerebellaris dorsolateralis).
     - *c.* *Via* tract of Gowers (fasciculus spinocerebellaris ventrolateralis).
2. Motor (afferent) conduction paths from the cerebral cortex to the spinal cord.
   - *A.* Direct route (without traversing the cerebellum).
     - *a.* *Via* pyramidal tract.
     - *b.* *Via* corpus striatum and mid-brain.
   - *B.* Indirect route (through cerebellum).
     - *a.* *Via* pyramidal tract, nuclei pontis, cerebellum, and bulbar nuclei.

The conduction paths within the central nervous system have, as yet, been very incompletely worked out. Of the paths between the periphery of the body (exclusive of the cranial nerve regions) and the cerebral cortex, the more important of the well-established afferent and efferent conduction paths are given in the above list. These paths are indicated in a diagrammatic way in Fig. 219, page 389. Each path is made up of a chain of neurone systems (a neurone system including a group of homologous nerve fibres and their cells of origin). Each system, as a rule, is indicated in the figure by a single neurone.

Let us first consider the sensory (afferent) paths from the periphery to the cerebral cortex. Sensory impulses pass into the spinal cord over the neurones, whose cell-bodies are located in the dorsal ganglia (sensory neurones of the first order). From the spinal cord to the cerebral cortex there are six paths over which the impulse may pass, three *indirect* (*via* cerebellum) and three *direct* (not traversing the cerebellum).

In the direct sensory route, *A a* (see list above), the fibres pass up the tracts of Goll and Burdach, *fasciculus gracilis et cuneatus* (*f*), over neurones of the first order, to end in the *nuclei gracilis et cuneati.* (These tracts transmit the *muscle* and *joint* sensations, not the *cutaneous* or *painful.*) Neurones of the second order, arising in the nuclei gracilis et cuneati, continue the sensory path upward through fibres of the *mesial fillet* (*m*), which cross to the opposite side and give off collaterals to the *bulbar nuclei* (inferior olive, formatio reticularis, etc.) and to the mid-brain, the axones terminating in the *optic thalamus.* A few axones continue uninterrupted to the cerebral cortex. In general, however, the path is continued by sensory neurones of the third order, arising in the optic thalamus and extending to the cerebral cortex. Thus, in route *A a* three neurone systems transmit the impulse from the periphery to the cortex.

In sensory route, *A b*, the impulse is transmitted from the neurones of the first order, *via* collaterals, to the gray matter of the anterior horn. Neurones of the second order, arising here, continue the path upward through the *anterolateral* *ground bundle* (fasciculi proprii), *h*, of the spinal cord, thence into the posterior longitudinal bundle (*fasciculus longitudinalis medialis*), giving off collaterals (and partly ending) in bulbar nuclei and mid-brain, terminating in optic thalamus. Neurones of third order continue path to cortex, as in *A a*.

In sensory route, *A c*, the impulse is transmitted, *via* collaterals, to cells of gray matter of spinal cord. Neurones of the second order continue the path upward through the *anterolateral ascending tract*, *g* (Gowers'), through dorsal region of medulla and pons, to end in mid-brain and optic thalamus, etc. From the optic thalamus, neurones of the third order continue to cerebral cortex, as in *A a* and *A b*. Routes *A b* and *A c probably* transmit cutaneous and painful sensations.

In the indirect route, *B a*, the impulse passes upward, as in *A a*, to the nuclei gracilis et cuneati. From these, neurones of the second order ascend through the inferior peduncle, *k*, of the same and opposite side, to the *vermis*, giving off collaterals to the *nucleus dentatus*, etc. From the vermis, neurones of the third order pass to the nucleus dentatus; and neurones of the fourth order proceed from the nucleus dentatus, *via* superior peduncle, to the *red nucleus* of opposite side (a few fibres proceeding uninterrupted to the thalamus). From the red nucleus, neurones of the fifth order ascend to the optic thalamus; and thence neurones of the sixth order to the cerebral cortex, as in direct routes.

In indirect sensory route, *B b*, the neurones of the first order transmit the impulse, *via* collaterals, to the cells of the *column of Clarke*. These, the neurones of the second order, send axones upward in the *direct cerebellar tract* (*fasciculus spinocerebellaris dorsolateralis*), *via* inferior peduncle, to the vermis of same and opposite sides, giving off collaterals to the nucleus dentatus, etc. From the vermis, neurones of the third, fourth, fifth, and sixth orders proceed to the cerebral cortex, just as in route *B a*.

In indirect sensory route, *B c*, neurones of the first order give collaterals to cells of gray matter. From these, the neurones of the second order, the path is continued up Gowers' tract (*fasciculus spinocerebellaris ventrolateralis*), as in direct route, *A c*. On reaching the mid-brain, however, the fibres here concerned leave those of the direct route and curve upward, reaching the superior vermis *via* the superior peduncle of the cerebellum. Thence to the cerebral cortex the path is continued by neurones of the third, fourth, fifth, and sixth orders, as in routes *B a* and *B b*.

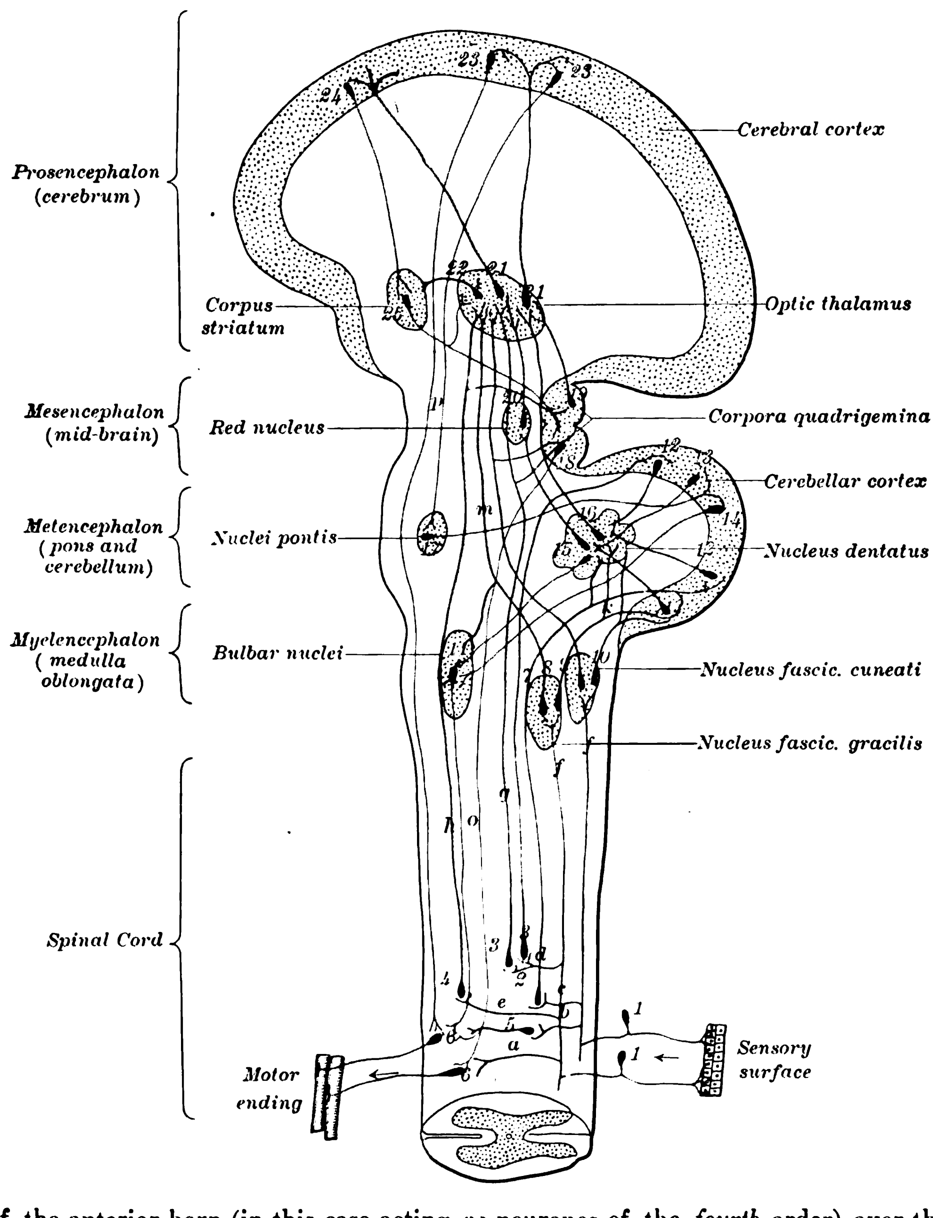
It will be observed that the indirect sensory routes are more complex, involving, in general, six neurone systems, while the direct routes require only three.

Having traced the various paths of a sensory impulse ascending to the cerebral cortex, let us now consider the various paths by which a motor impulse may pass from the cerebral cortex downward through the spinal cord to the peripheral muscles. We may classify these efferent paths, as we did the afferent, as *indirect* (*via* cerebellum) and *direct* (not traversing cerebellum).

Direct motor route, *A a*, begins with motor neurones of the first order, the pyramidal cells in the motor areas of the cerebral cortex. The axones from these descend in the corona radiata, internal capsule, and pyramidal tracts to the lower end of the medulla oblongata. Here they diverge into three separate paths: (1) The majority of the fibres cross to the opposite side (pyramidal decussation) and descend in the *crossed pyramidal tract* (*fasciculus cerebrospinalis lateralis*), ending in the gray matter of the anterior horn; (2) a small proportion of the fibres descend in the *direct pyramidal tract* (*fasciculus cerebrospinalis ventralis*), ending in the gray matter of the anterior horn, chiefly of the same side; (3) a few fibres descend in the crossed pyramidal tract of the same side, to end in gray matter of anterior horn. In all three cases, neurones of the second order are the motor cells of the anterior horn, whose axones pass out of the spinal cord in the ventral (motor) roots of the spinal nerves, to end in the peripheral muscles of the body. Thus only two neurone systems are necessary to carry a motor impulse from the cerebral cortex to a peripheral muscle. (The same holds good for motor *cranial* nerves.)

In direct motor route, *A b*, the neurones of the first order are cells of the cerebral cortex (chiefly the frontal region), sending axones downward, to end in the *corpus striatum.* From the corpus striatum, neurones of the second order descend to the mid-brain (Edinger). From the mid-brain, neurones of the third order descend to the spinal cord in various ways, chiefly *via anterolateral descending tract,* to end in the gray matter of the anterior horn; thence *via* the motor cells

FIG. 219.



of the anterior horn (in this case acting as neurones of the *fourth* order) over the ventral roots of spinal nerves to peripheral muscle, as in motor route, *A a.*

In *indirect* motor route, *B a,* the neurones of the first order are cells of the motor area of the cerebral cortex, similar to those in motor route *A a.* The axones, after descending through internal capsule and pyramidal tracts to the pons, end in (or give collaterals to) the *nuclei pontis.* These, the neurones of the second order, proceed *via* middle peduncle to the cortex of cerebellar hemisphere of the opposite side; thence, *via* neurones of third order, to nucleus dentatus (some fibres not interrupted here). From nucleus dentatus, neurones of fourth order descend to bulbar nuclei (formatio reticularis, inferior olive, etc.). From the bulbar nuclei, neurones of the fifth order descend in various ways, to end in gray matter of the anterior horn; thence, *via* motor anterior horn cells (in this case, neurones of the sixth order), to muscles, as in motor routes *A a* and *A b*. Thus it will be seen that the same neurones may act as a system of one order in one path and of a different order in another path.

SOME GENERAL PROPOSITIONS CONCERNING NERVE IMPULSES.

1. All nerve impulses conform to the reflex type.
2. A reflex path is provided connecting every sensory point of the body with every motor point.
3. Between any given sensory point and motor point of the body a reflex impulse may pass over many different paths. For example, between the peripheral sensory and motor points shown in Fig. 219, page 389, reflex paths may readily be traced as follows:
   a. Directly across the cord, *via* collaterals, to motor cells.
   b. Indirectly across the cord in many ways, *via* association neurones.
   c. Reflected from medulla, returning *via* bulbar nuclei.
   d. Reflected from cerebellum, ascending over various paths, returning *via* bulbar nuclei.
   e. Reflected from mid-brain, ascending in various ways, returning *via* anterolateral descending tract.
   f. Reflected from basal ganglia, *via* thalamus and corpus striatum, etc.
   g. Reflected from cerebral cortex (as stated above).

DESCRIPTION OF FIG. 219, page 389.

Diagram to represent some of the principal paths between the spinal cord and the cerebral cortex.

1, 1. Cell-bodies of sensory neurones of the first order. Their axones give off collaterals: (*a*) To motor cells (*6*) permitting direct spinal reflex; (*b*) to association cells, permitting indirect spinal reflex; (*c*) to cells of Clarke's column sending axones through direct cerebellar tract to cerebellar cortex; (*d*) to cells whose axones ascend through Gowers' tract to the cerebellum, etc.; (*e*) to cells whose axones ascend through the anterolateral ground bundle and posterior longitudinal bundle to optic thalamus; (*f*) the main trunks terminating above in the nuclei gracilis and cuneati.

2. Cell of Clarke's column, sending axone through direct cerebellar tract to cer bellar cortex.

3. Sensory cells of gray matter, whose axones ascend through Gowers' tract (*g*) to the cerebellar cortex or to the optic thalamus.

4. Sensory cell of anterior horn, whose axone ascends through the anterolateral ground bundle (*h*) and posterior longitudinal bundle to reach the optic thalamus, giving collaterals to the nuclei of the bulb and mid-brain.

5. Association cell of spinal cord, connecting afferent and efferent neurones.

6, 6. Lowest motor neurones, whose axones emerge through motor roots of spinal nerves.

7, 8, 9, 10. Cells of nuclei gracilis and cuneati, whose axones ascend to the cerebellar cortex (*via* inferior peduncle, *k*); and to the optic thalamus, *via* mesial fillet (*m*), giving collaterals to bulbar and mesencephalic nuclei.

11. Motor cell of bulbar nuclei (formatis reticularis, olive, etc.), whose axone descends in anterolateral descending tract (*o*) to the motor cells in anterior horn of cord.

12, 13. Cells of cerebellar cortex, sending axones to nucleus dentatus.

14. Cell of cerebellar cortex, whose axone descends to bulbar nuclei.

15, 16. Cells of nucleus dentatus, sending axones to red nucleus and thalamus, respectively.

17. Cell of nuclei pontis, sending axone to cerebellar cortex, *via* middle peduncle.

18. Motor neurone from corpora quadrigemina to spinal cord, *via* anterolateral descending tract (similar neurones occur in red nuclei).

19. Neurone from corpora quadrigemina to optic thalamus.

20. Neurone from red nucleus to optic thalamus.

21. Neurones from optic thalamus to cerebral cortex.

22. Neurone from optic thalamus to corpus striatum,

23. Pyramidal motor neurones from cortex to spinal cord and nuclei pontis *via* pyramidal tracts (*p*).

24. Neurone from cerebral cortex to corpus striatum.

25. Neurone from corpus striatum to corpora quadrigemina, etc.

METAMERISM.

By C. M. Jackson, M.D.

The human body, like that of most of the lower animals, exhibits a segmental type of structure; that is to say, the body is built up of a number of successive segments (metameres), which, although modified in the various body regions, present each the same fundamental plan of structure. This segmentation (metamerism) is somewhat masked in the adult human body, but is very clearly shown in the embryonic development, and especially in the structure of the lower animals. In many of the worms, for example, the body is almost entirely made up of segments, which are exactly alike. Each metamere has its own distinct muscular segment (myomere, myotome), skeletal segment (scleromere, sclerotome), vascular segment (angeiomere), neural segment (neuromere), intestinal segment (enteromere), excretory segment (nephromere), and segmental reproductive organs.

In the development of the human embryo a similar arrangement appears, except that the alimentary and reproductive systems show but slight traces of segmentation. Each primitive metamere (*ursegment* of the Germans) includes typically myomere, scleromere, neuromere, angeiomere, enteromere, nephromere,

Fig. 220.

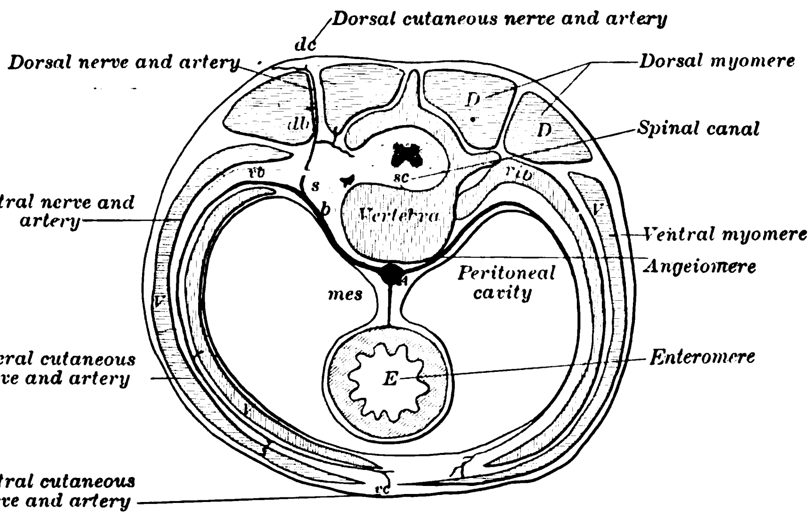


Diagram of cross-section through a metamere in the trunk region. On the left side of the figure the rib is omitted, and branches of the nerve and artery are shown. Veins not shown in the figure.

D. Dorsal division of myomere. *V.* Ventral division of myomere. *s c.* Spinal canal, containing spinal cord and roots of a pair of spinal nerves. *d b, v b.* Dorsal and ventral branches of spinal nerves and corresponding arteries. *d c, l c, v c.* Dorsal, lateral, and ventral cutaneous nerves and vessels. *s.* Sympathetic ganglion. *r.* Recurrent branch. *b.* Visceral branch. *A.* Section of aorta with branches (angeiomere). *mes.* Mesentery. *E.* Section of alimentary canal (enteromere).

and is enclosed in its own skin segment, or dermatomere. Aside from the head, in which the number of segments is uncertain, there are about thirty-five to thirty-eight primitive metameres in the human embryo, of which eight are cervical; twelve, thoracic; five, lumbar; five, sacral; and five to eight, caudal. The primitive segmental arrangement of the embryo is modified in the adult body by: (1) The reduction or disappearance of certain portions (as in coccygeal region); (2) excessive development of special regions (head, extremities, etc.); (3) fusion of successive segments (spinal cord, various muscles, etc.), and (4) migration of certain structures (muscles, nerves, etc.).

In the trunk region, however, the adult body still exhibits characteristic metamerism. If we except the limbs, which are budded off laterally in the pectoral and pelvic regions, the relations of the various constituents of a typical metamere are indicated in Fig. 220. The skeletal segment (scleromere) is represented by the vertebra dorsally, and the ribs laterally. The muscular segment (myomere), aside from the visceral constituent in the intestinal wall, appears in two divisions, dorsal and ventral. The dorsal division (*D*) forms the muscular group, filling the costo-vertebral groove on each side. The ventral division (*V*) splits into several layers in the ventrolateral body-walls, and is represented (in part) by the intercostal and abdominal oblique muscles. The neural segment (neuromere) includes the corresponding section of the spinal cord, a pair of spinal nerves with their branches, and a pair of sympathetic ganglia. The spinal nerve on each side is formed by a dorsal (posterior) sensory root bearing a ganglion, and a ventral (anterior) motor root. The two roots unite to form a mixed trunk which passes out through the intervertebral foramen, and, often giving off a small recurrent meningeal branch, divides into the dorsal (posterior) and ventral (anterior) divisions. The dorsal division supplies the dorsal muscular division and the overlying skin. The ventral division supplies the remainder of the body-wall, and sends a branch (ramus communicans) to join the sympathetic ganglion. The sympathetic ganglion on each side gives off a recurrent branch to the meninges, and sends branches ventrally through the mesentery to supply the visceral segment. The vascular segment (angeiomere) includes the corresponding section of the aorta, a visceral branch to the intestine, and a pair of lateral arteries. Each of the latter (*e. g.*, intercostals) divides into a dorsal (posterior) and a ventral (anterior) branch. These branches accompany the corresponding branches of the spinal nerves, and agree with them in distribution. The corresponding veins are, of course, included in the angeiomere, although not shown in the diagram. The enteromere and dermatomere include the corresponding segments of the alimentary canal and skin, respectively.

INDEX.

B.

C.

G.

[illegible]