Surgical anatomy : a treatise on human anatomy in its application to the practice of medicine and surgery / by John B. Deaver.

Contributors

Deaver, John B. 1855-1931.

Publication/Creation

London : Rebman, 1899-1903.

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SURGICAL ANATOMY

DEAVER

GENERAL ARRANGEMENT OF CONTENTS

VOLUME I.—Upper Extremity—Back of Neck—Shoulder—Trunk—Cranium—Scalp—Face.

VOLUME II.—Neck—Mouth—Pharynx—Larynx—Nose—Orbit—Eyeball—Organ of Hearing—Brain—Male Perineum—Female Perineum.

VOLUME III.—Abdominal Wall—Abdominal Cavity—Pelvic Cavity—Chest—Lower Extremity.

SURGICAL ANATOMY

A TREATISE ON HUMAN ANATOMY IN ITS APPLICATION TO THE PRACTICE OF MEDICINE AND SURGERY

BY

JOHN B. DEAVER, M.D.

SURGEON-IN-CHIEF TO THE GERMAN HOSPITAL, PHILADELPHIA

IN THREE VOLUMES

ILLUSTRATED BY ABOUT 400 PLATES NEARLY ALL DRAWN FOR THIS WORK FROM ORIGINAL DISSECTIONS

VOL. II.

NECK; MOUTH; PHARYNX; LARYNX; NOSE; ORBIT; EYEBALL; ORGAN OF HEARING; BRAIN; MALE PERINEUM, FEMALE PERINEUM.

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SURGICAL ANATOMY.

DISSECTION OF THE NECK.

SURFACE ANATOMY.

The surface anatomy of the region of the neck should be considered in regard to its superficial veins and nerves, the upper portion of the respiratory tract, the prominent muscles, the pulmonary apices, the sterno-clavicular joints, and the large vessels. The skin of the front of the neck may lie either in horizontal or vertical folds, the former being more common, and always seen in infants. In stout persons the deposition of fat in the subcutaneous tissues makes these folds very prominent, producing the condition known as "double chin." Vertical folds occur in the aged, especially in those who have lost much adipose tissue, in consequence of which the old and inelastic skin can no longer adapt itself. The anterior and most prominent ridges of the surface of the neck are due to the anterior border of the platysma myoides muscles.

Length of the neck.—The variability which exists in the length of the necks of different persons is due, as Merkel points out, to three factors: First, to the position of the shoulder girdle; second, to the contour of the border of the trapezius muscle; third, to the thickness of the neck. The superior thoracic aperture is oblique from behind forward and downward; in some persons this obliquity is greater than in others, so that the supra-sternal notch may be on a level with the third thoracic vertebra; this will consequently cause the inner end of the clavicle to lie lower, and the neck will appear longer. When the border of the trapezius muscle slopes gradually toward the shoulder instead of curving rather abruptly outward, the neck will appear longer; a thin neck presents a longer appearance than a thick and muscular one.

The length of the cervical portion of the spinal column does not vary much in different persons.

The **sterno-cleido-mastoid muscle,** because of its prominence throughout its course, is the great landmark of the neck, and extends from the sterno-

clavicular junction to behind the ear. Any movement of the head which draws the ear downward and forward renders the muscle prominent. It divides the side of the neck into the anterior and the posterior triangle. In subcutaneous section of the lower attachments of this muscle it must not be forgotten that the *fossa supraclavicularis minor*, the triangular interval between the sternal and clavicular origins, marks the position of the common carotid artery and internal jugular vein.

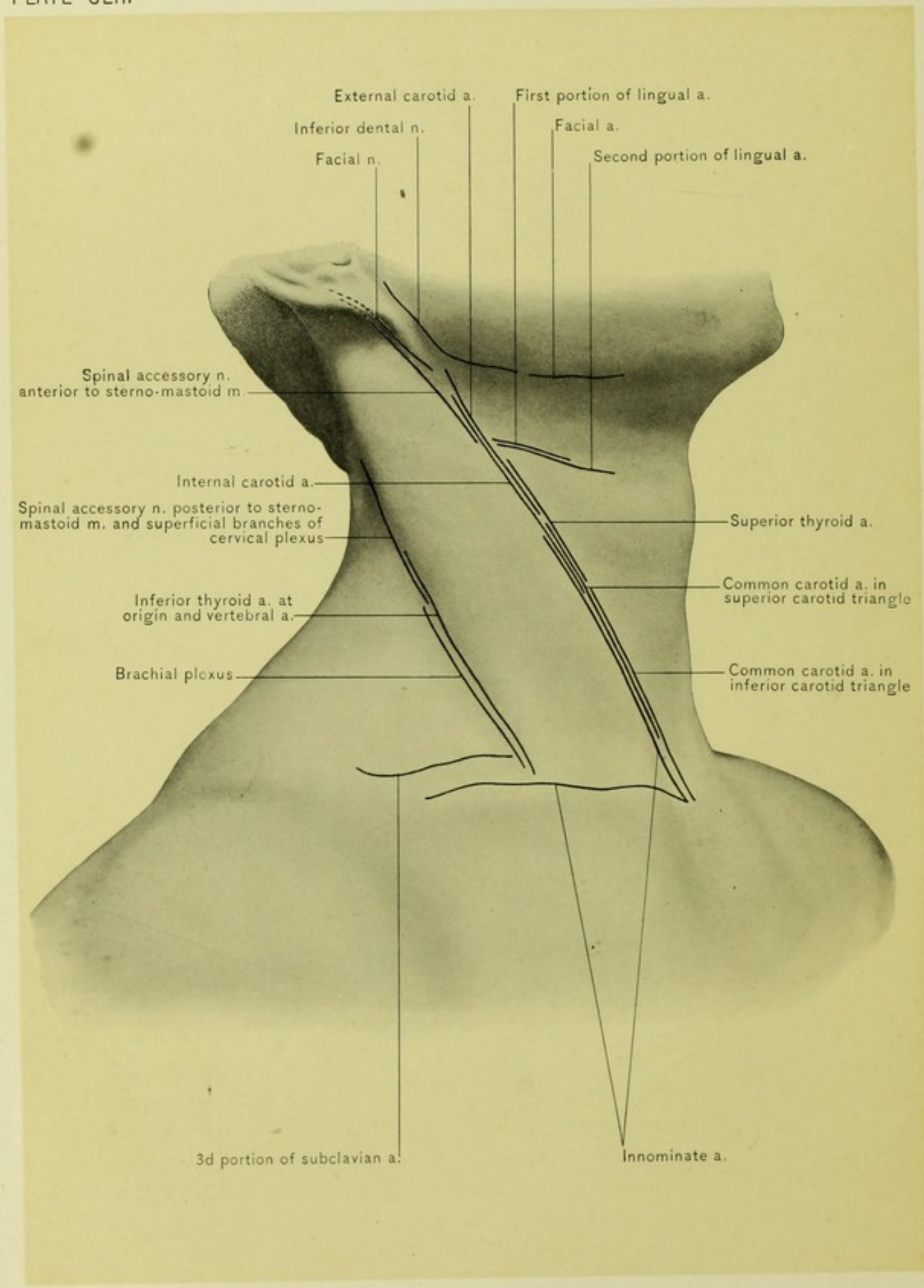
The **supra-sternal fossa,** termed "*fonticulus gutturis*" by the old writers, lies between the sternal origins of the two sterno-mastoid muscles. In beautiful necks it is, of course, filled with fat, but even then the rounded contour of the sternal attachment of this muscle is evident, though graceful withal. When the finger is deeply insinuated into the supra-sternal notch, the pulsations of the innominate artery can often be felt; those of a dilated aortic arch may also be perceived. Retraction of the tissues in the supra-sternal notch during inspiration is often seen in marked dyspnea, as in laryngeal obstruction.

The **sterno-clavicular joint** may be readily identified at the side of the supra-sternal notch—in stout persons by movement, and by sight alone in thin individuals. Its upper border marks the origin of the innominate vein upon both sides, behind which, on the left side, lies the common carotid artery, and on the right side, the bifurcation of the innominate artery; still farther back is the apex of the lung. The innominate artery is relatively higher in children than in adults.

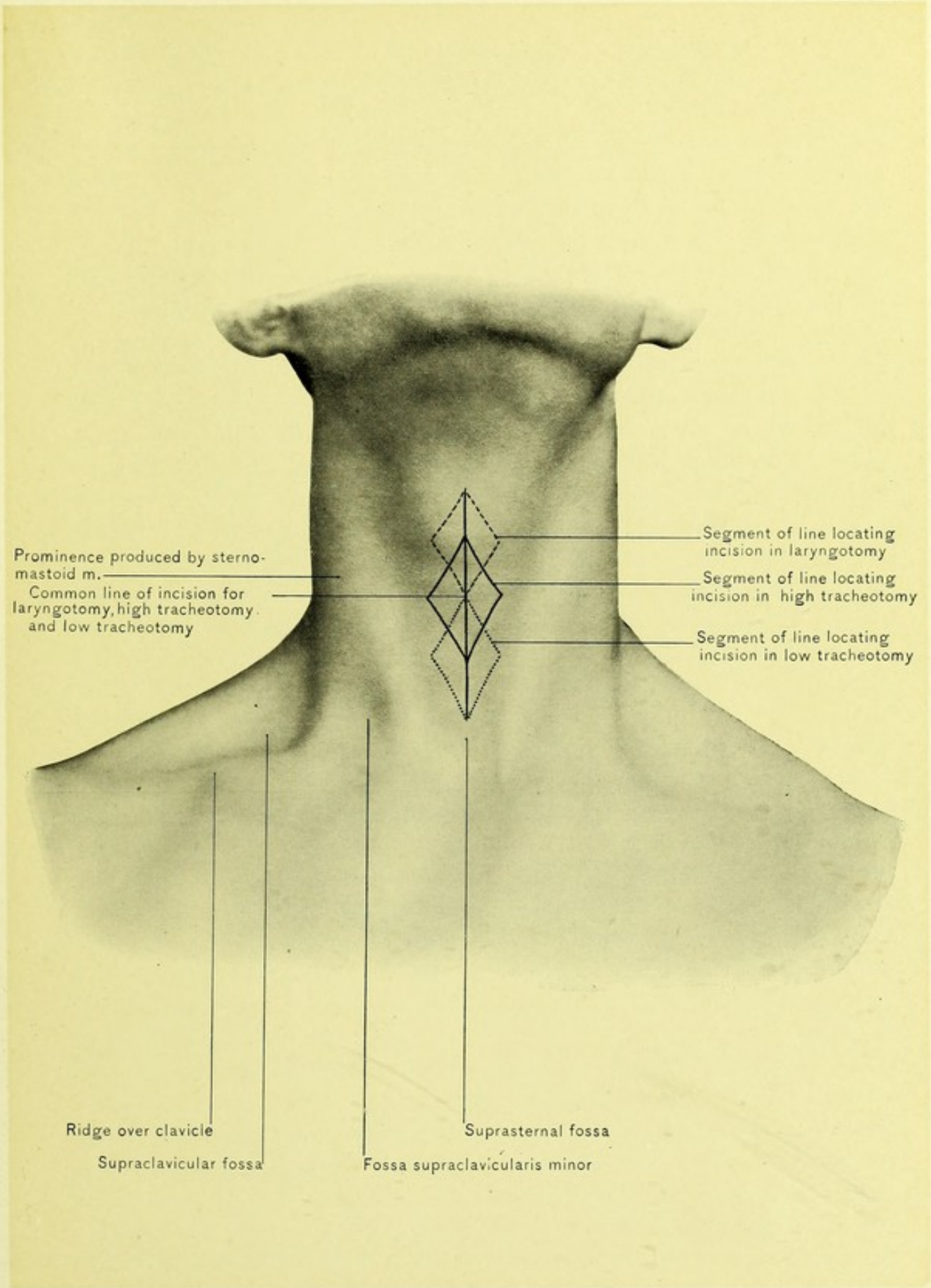
The **apex of the lung** extends from one to two inches above the clavicle, and higher in very long necks; it is also higher in women than in men. It is covered by part of the scalenus anticus, sterno-thyroid, and sterno-cleido-mastoid muscles, and to the inner side of the scalenus anticus muscle it is crossed transversely by the subclavian vessels. This portion of the lung is more commonly the site of tubercular deposits, and should be examined by percussion and auscultation immediately above and below the inner part of the clavicle.

The **supra-clavicular fossa** is the depression above the clavicle between the sterno-mastoid and trapezius muscles. The external jugular vein terminates here. It is well defined in emaciation due to wasting diseases and in old age. It marks the place where the vessels and nerves pass from the neck into the axilla, and a knife thrust backward, downward, and inward through this depression would injure a number of important structures. The transverse processes of the cervical vertebræ may be felt by pressure directed inward through the upper part of the fossa. In thin persons the posterior belly of the omo-hyoid muscle can also be felt in this space, just above and parallel to the clavicle. During inspiration the tension produced by the omo-hyoid muscle on the deep cervical fascia is plainly

PLATE CLII.



LINES OF INCISION FOR EXPOSURE OF ARTERIES AND NERVES.



SURFACE ANATOMY OF NECK, AND LINES OF INCISION IN LARYNGOTOMY, HIGH TRACHEOTOMY, AND LOW TRACHEOTOMY.

discernible. Holden likens its central tendon to a rudimentary cervical rib, its posterior belly to a digitation of the serratus magnus muscle, and its anterior belly to a sterno-hyoid muscle.

The **subclavian artery** extends from one-half of an inch to an inch above the clavicle, in the supra-clavicular fossa, close to the external border of the sterno-mastoid muscle, where, by moderate pressure directed downward, backward, and inward, it can readily be compressed against the first rib; pressure directed otherwise would meet no bony resistance, and bleeding could not be controlled.

The **carotid arteries** are readily found in the neck along the anterior or inner margin of the sterno-mastoid muscle, being covered by its anterior border, particularly in the lower part of the neck. The common carotid artery divides opposite the upper border of the thyroid cartilage. From this point at the anterior border of the sterno-mastoid muscle, a line drawn to the lobe of the ear indicates the course of the external carotid artery. The position of the common carotid artery is represented by a line drawn from the sterno-clavicular articulation to a point midway between the angle of the lower jaw and the mastoid process.

The **external jugular vein** passes down the neck in a line drawn from the angle of the inferior maxilla to the middle of the clavicle. By compression of its lower end the vein may be made to stand out prominently. Occasionally a *jugulo-cephalic branch* passes over the clavicle from the cephalic to the external jugular vein. The **anterior jugular vein** is usually found near the anterior margin of the sterno-mastoid muscle.

The **hyoid bone,** directly behind the lower border of the chin in the ordinary attitude of the head, may be felt in its entirety through the skin. To its upper border are attached the base of the tongue and the genio-hyoid and mylo-hyoid muscles, which form the floor of the mouth. Below the body of the bone are the thyro-hyoid space and membrane, the center of which corresponds to the position of the epiglottis. The greater cornu of the bone is the landmark which locates the origin of the superior thyroid, lingual, and facial arteries. The origin of the superior thyroid artery is just below the level of the greater cornu of the hyoid bone, that of the lingual artery is opposite to the greater cornu, and that of the facial artery is just above.

The **thyroid cartilage** forms the anterior projection in the neck called "Adam's apple"; it is larger in men than in women, so that there is increased length of the vocal cords, which have, therefore, in accordance with a well-established law of physics, a lower pitch, thus accounting for the deeper tones of the male. The entire cartilage is subcutaneous, its borders and cornua being easily traced by the finger. The lateral lobes of the thyroid gland can be indistinctly felt upon each side of the cartilage, and it is said the pulsations of the superior thyroid artery may readily be felt at the tip and front of the lateral lobe; this,

however, is exceptional. Below this cartilage is the crico-thyroid space, which is occupied by the crico-thyroid membrane. It is through this membrane that laryngotomy is performed, care being taken to hug the upper border of the cricoid cartilage, so that the incision may be as far as possible from the vocal cords and the crico-thyroid arteries.

The **vocal cords** are situated slightly below a point midway between the deepest part of the incisura thyroideæ and the lower border of the thyroid cartilage.

The **cricoid cartilage** is always prominent, and can readily be discerned. It lies opposite the sixth cervical vertebra. Its lower border is on a level with the commencement and narrowest part of the esophagus; for this reason all bodies which have entered the pharynx but are too large to pass through the gullet will lodge behind the cricoid cartilage. The cricoid cartilage is just above the level at which the omo-hyoid muscle and the inferior thyroid artery cross the carotid sheath, the muscle being in front of the sheath and the artery behind. Slightly below the level of this cartilage and beneath the anterior border of the sterno-mastoid muscle is the **carotid tubercle,** against which the common carotid artery may be compressed. This is the anterior tubercle of the transverse process of the sixth cervical vertebra.

The **movements of the larynx** are frequently overlooked. The larynx rises during deglutition, in singing a high note, and in expiration; it descends in singing low notes, in inspiration, after deglutition, and during retching and vomiting. When the larynx is moved from side to side, a grating sensation, due to the friction of the superior cornua of the thyroid cartilage against the spinal column, is perceived. The larynx is pushed forward in the passage of masses through the lower pharynx. The sudden upward rush of vomited matter produces suction upon the larynx, drawing out obstinately adherent false membrane and collections of glairy mucus; this is one reason for giving children emetics in croup.

The **trachea** is situated immediately below the cricoid cartilage. Ordinarily, not more than one and one-half inches of it appear above the sternum; an inch more, however, may be revealed if the neck be in extreme extension. This usually leaves about eight rings in the neck, of which the second, third, and fourth are covered by the thyroid isthmus. The front of the trachea may lie one and one-half inches deep at the top of the sternum, owing to the recession of the lower cervical and upper thoracic vertebræ. Opening of the trachea to relieve dyspnea is beset with many difficulties not all demonstrable in the cadaver—the strong and rapid alternate muscular contractions, the heaving larynx, the distended anterior jugular veins, the flexed neck, the swollen thyroid isthmus, the distended thyroid plexus of veins, and, frequently, a middle thyroid artery. All incisions into the trachea should be in the median line, where fewer important structures need be severed. It is often advisable in cases of dyspnea to incise the crico-thyroid

membrane, and, if necessary, the cricoid cartilage may be divided. If a lower operation be required, it should be done when the patient has become quieted after relief of the dyspnea.

The **back of the neck** presents, above, the external occipital protuberance and the superior curved ridges of the occipital bone; below, the spinous process of the seventh cervical vertebra (vertebra prominens) and the ligamentum nuchæ, extending between the protuberance and the spine of the seventh cervical vertebra. For an inch below the superior curved ridges of the occipital bone the thin cerebellar fossæ of the occiput are not more than one-half of an inch from the surface; their walls are so thin at times that they may easily be penetrated with a sharp knife. About an inch below the external occipital protuberance a sharp, narrow instrument could be pushed forward, either above or below the posterior arch of the atlas, thus severing the upper end of the spinal cord and destroying life. About one or one and one-half inches on each side of the external occipital protuberance the occipital artery pierces the trapezius muscle, below the superior curved ridge, and passes over the occiput to the vertex; it is accompanied by the great occipital nerve. The outer margin of the trapezius muscle merges with the shoulder as it passes to it, and forms the graceful outline of the neck so well exhibited in some of the pictures of noted beauties. Deep pressure in the median line near the occiput reveals the bifid spine of the second cervical vertebra. The spines of the third, fourth, and fifth cervical vertebræ, because of their shortness and recession, are not readily felt. The spine of the sixth, and more especially of the seventh, cervical vertebra may easily be detected. The fifth cervical spine is opposite the cricoid cartilage and the upper end of the esophagus; that of the seventh is behind the apex of the lung, which is higher in women.

Congenital cervical fistulæ.—A brief résumé of the development of the neck is here introduced in order to explain the mode of occurrence of certain interesting and important congenital defects.

The antero-lateral portion of the neck is formed largely from the *branchial* or *visceral* arches, four in number on each side, connected posteriorly with the spinal column, but not at first uniting anteriorly with one another. These arches are separated from one another by the branchial clefts, also four in number on each side, the fourth one being below the last arch.

The first or mandibular arch is concerned in the formation of the maxillæ; it is separated from the second arch by the first branchial cleft, which is the only cleft remaining in the adult.

The first branchial cleft persists as the external auditory meatus, middle ear, and Eustachian tube. Irregularities in development may lead to the formation of fistulous openings, which are usually found in the vicinity of the tragus of the ear.

The lower three arches are concerned in the formation of the tissues of the neck.

The visceral clefts open internally into the pharynx ; no communication of the pharynx with the exterior ever occurs, for a delicate membrane divides the cleft into an inner (pharyngeal pouch) and an outer portion (branchial furrow).

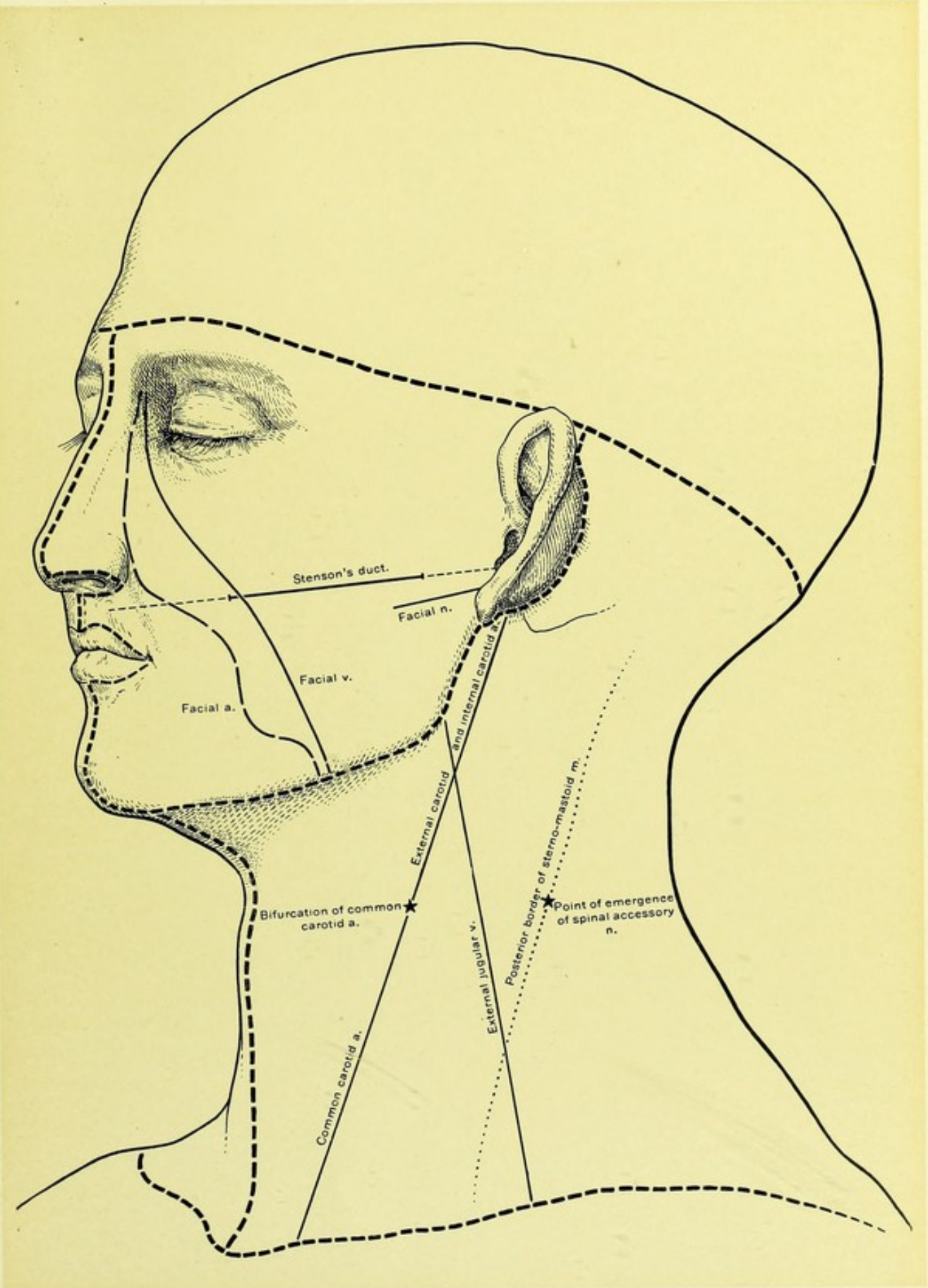
The lower three clefts normally disappear, certain traces found in the pharynx and larynx alone remaining.

The third and fourth arches are small, are gradually overlapped by the second arch, and lie in a depression known as the *sinus cervicalis.* It is through imperfect closure of this sinus that most of the congenital cervical fistulæ occur. *These* are narrow, epithelium lined tracts, opening externally near the anterior border of the sterno-mastoid muscle. When complete, they open internally into the pharynx. If the internal portion of a branchial cleft fail to become obliterated, while the outer portion is closed as normally, a *pharyngeal* or *esophageal diverticulum* may form. Furthermore, if the cleft become closed externally and internally and an intermediate, unobliterated portion persist, the epithelium lining this cavity may proliferate and undergo various changes, and thus a so-called *branchial cyst* result. These branchial cysts occur in the submaxillary and supraclavicular regions and at the borders of the sterno-mastoid muscle.

Dissection.—The neck should be extended and made prominent by placing a block beneath the shoulders. An incision should be carried from the symphysis of the lower jaw down the middle line of the neck, to the middle of the top of the sternum ; a second and a third incision should be made, the former along the clavicle to the acromion process, the latter along the lower border of the lower jaw to the angle of the jaw, thence to the lobe of the ear, and behind the ear to the transverse incision made in dissecting the scalp. The face should then be turned away from the side on which the dissection is being made, and retained in position with hooks, the skin being raised and reflected from before backward to beyond the anterior border of the trapezius muscle.

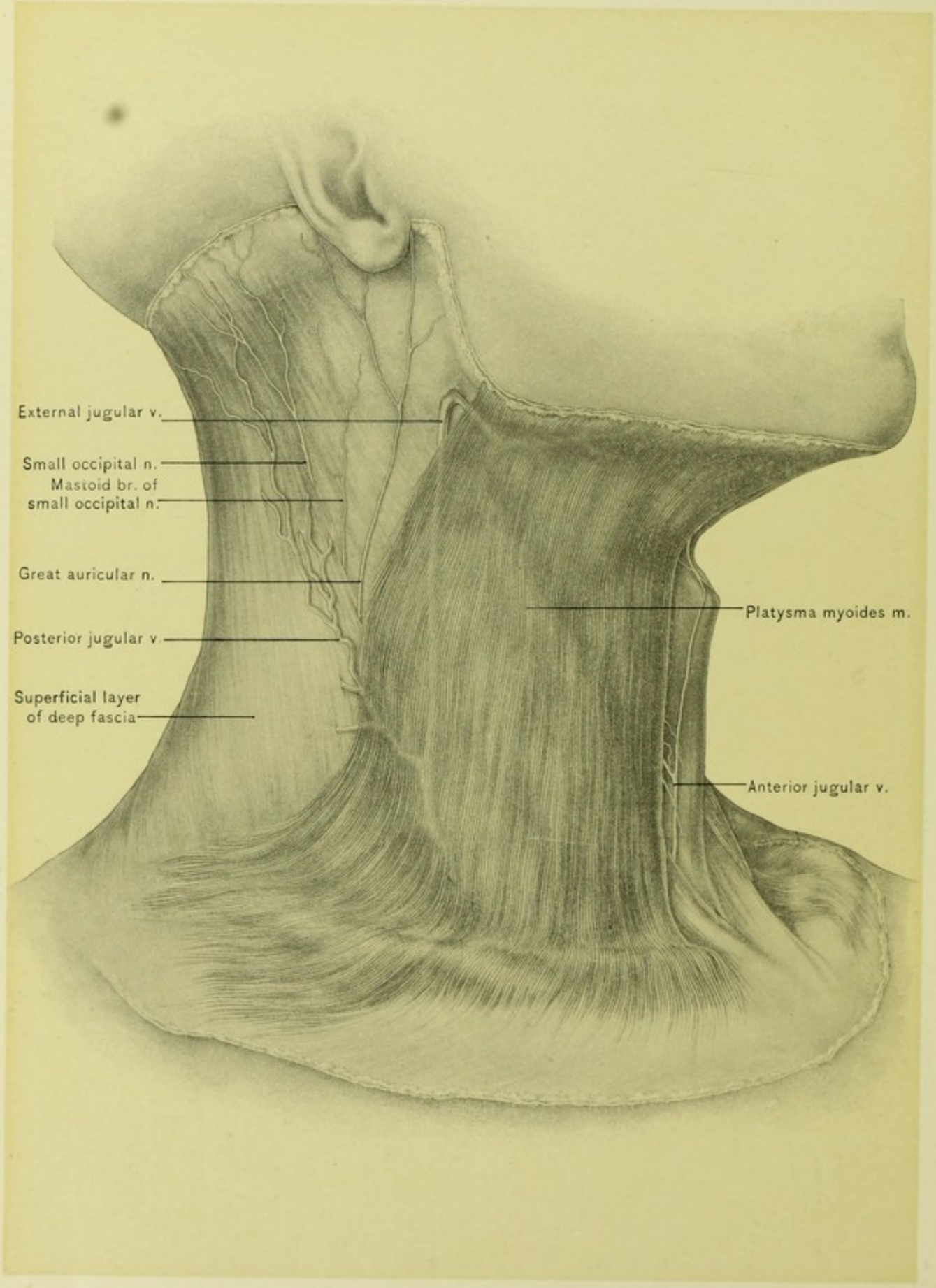
The **skin covering the side of the neck** is thin, quite elastic, and can readily be raised into folds, which always contain the platysma myoides muscle ; these conditions favor the performance of plastic operations. In these respects it differs from the skin over the nape of the neck, which is very dense and adherent and more freely supplied with nerves, but not nearly so well supplied with blood vessels. *Carbuncle* is usually seen at the lower part of the back of the neck near the median line. The nape of the neck was formerly a common site for the introduction of *setons* and the application of *issues.*

The **superficial fascia** now exposed is a very thin lamina of areolar and adipose tissue, divisible, as elsewhere, into two layers, the deep one being a very deli-



INCISIONS FOR DISSECTION AND LINES FOR VESSELS AND NERVES.

PLATE CLV.



PLATYSMA MYOIDES MUSCLE.

cate layer of laminated tissue. Between these two layers are the platysma myoides muscle, the external, anterior, and posterior jugular veins, the superficial branches of the cervical plexus of nerves, and the infra-maxillary branch of the cervico-facial division of the facial nerve. The fat in the superficial fascia above the hyoid bone may be extensively developed and produce the condition known as "double chin."

Dissection.—The superficial layer of the superficial fascia should be removed in the manner practised in reflecting the skin. This dissection exposes the platysma myoides muscle.

The **platysma myoides muscle** (the superficial cervical), a broad, thin muscle, lies immediately beneath the skin and the superficial layer of the superficial fascia; it covers the front and side of the neck, extending from the summit of the shoulder and front of the chest to the face. This muscle is a member of the panniculus carnosus group. It arises from the deep fascia covering the pectoralis major, deltoid, and trapezius muscles, and ascends obliquely forward along the side of the neck, for insertion into the lower border of the lower jaw, the superficial fascia of the cheek, the muscles at the angle of the mouth, and the integument of the chin. The anterior fibers cross those of the opposite side just below the symphysis of the lower jaw, and are inserted into the integument of the chin; the middle fibers are attached to the lower border of the lower jaw; the posterior fibers are prolonged over the masseter muscle, and are inserted into the superficial fascia of the cheek and the muscles at the angle of the mouth. Those fibers passing transversely to the angle of the mouth constitute the **risorius muscle.**

Nerve Supply.—From the infra-maxillary branch of the cervico-facial division of the facial and the superficial cervical nerves.

Blood Supply.—From the vessels ramifying in the superficial fascia of the neck.

Action.—It draws the lower lip downward and outward by contraction of its upper fibers; when all the fibers are contracted, however, the skin and superficial fascia of the neck between the clavicle and lower jaw are raised, being made taut between these two bones; it also helps to depress the lower jaw, or, if the jaw be fixed, assists the opposite sterno-mastoid muscle in flexion and rotation of the head toward its own side. The anterior edge of the muscle is distinctly visible in emaciated and aged persons, forming, with the platysma of the opposite side, two divergent folds descending from a little below the chin. As the muscle dips into a depression above the clavicle, by elevation of skin and fasciæ at the root of the neck, it relieves pressure upon the veins and favors the return circulation.

Injuries of the neck, with destruction of considerable portions of the integument and platysma, as in burns, are usually followed by deformity from cicatricial contraction. Pus in the loose tissues under the platysma may burrow extensively,

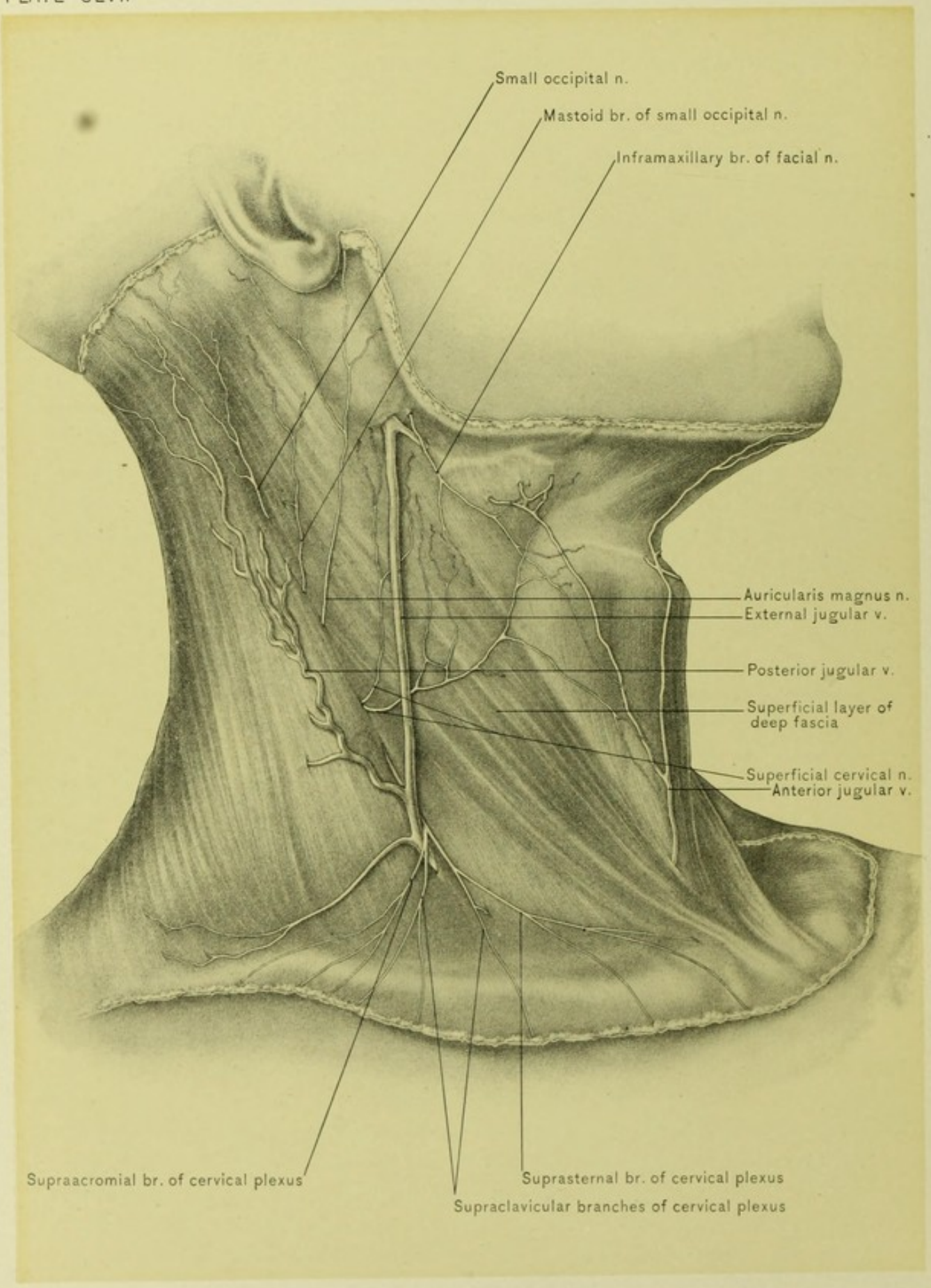
descending from the submaxillary region to the upper part of the chest-wall, where pointing may occur.

Dissection.—The platysma should now be removed, cutting it across near the clavicle and reflecting it upward to its insertion into the jaw, thus exposing the subcutaneous portions of the superficial branches of the cervical plexus of nerves, the infra-maxillary branch of the cervico-facial division of the facial nerve, and the anterior, external, and posterior jugular veins.

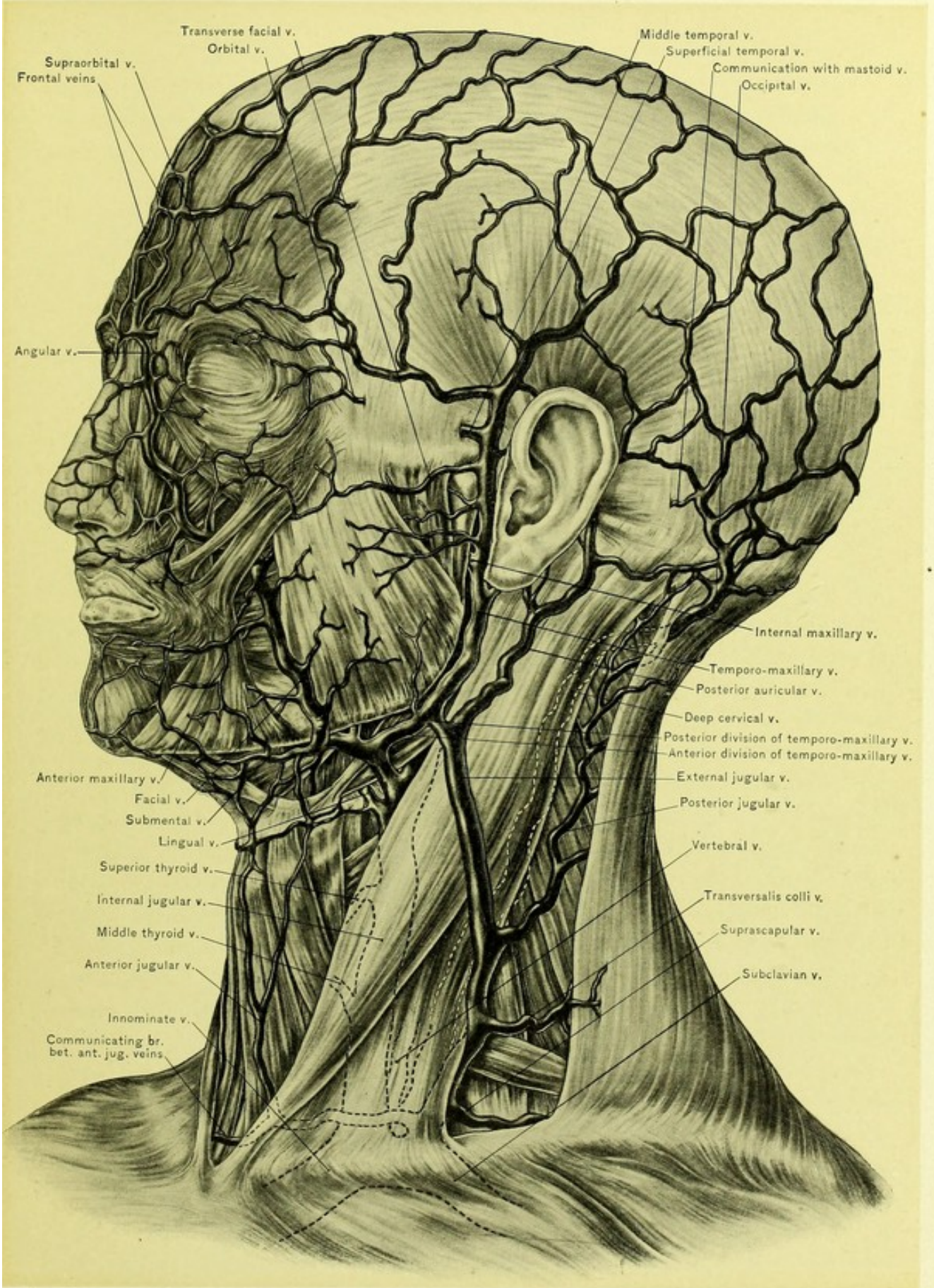
The **external jugular vein** arises in the substance of the parotid gland, and is formed by the union of the posterior auricular vein and the posterior division of the temporo-maxillary vein. It runs down the neck in a *line* drawn from the angle of the lower jaw to the middle of the clavicle, first passing over the sterno-mastoid muscle, and then along its posterior border to the root of the neck, there piercing the superficial layer of the deep cervical fascia to enter the subclavian vein in the subclavian triangle. This fascia is so closely attached to the vein that at the root of the neck, if the vein be divided, it will remain open. The **auricularis magnus nerve,** a branch of the cervical plexus, accompanies the vein in its upper part, and the superficial cervical branch of the same plexus passes beneath it at about the middle of the course of the vein. The posterior external jugular, transversalis colli, and supra-scapular veins empty into the external jugular vein. Near the angle of the lower jaw the external jugular communicates with the internal jugular vein by a large branch, farther down with the anterior jugular, and, at times, with the cephalic vein by a branch (jugulo-cephalic) which passes over the clavicle. The anterior jugular vein occasionally empties into the external jugular instead of into the subclavian vein. The external jugular vein contains a pair of valves at its point of entrance into the subclavian, and another pair about one inch or one and one-half inches above this point; these valves can not prevent the reflux of blood into the external jugular vein, and in certain cardiac and aortic diseases, especially in tricuspid insufficiency, a pulsation in the external jugular vein synchronous with the cardiac systole may be observed. The portion of the vein between the valves is dilated; this portion is called the **sinus.** The external jugular vein varies in size—when the anterior and posterior jugular veins are large, the external jugular vein is small, and vice versâ. In some instances two external jugular veins may be observed upon each side of the neck. The superficial cervical nerve may, at times, be seen to pierce the wall of the vein.

Venesection.—The operation of phlebotomy, or venesection, may be performed upon the external jugular vein. When the lower portion of the vein is selected for the operation, the direction the fibers of the platysma myoides muscle should be borne in mind, and the incision be made across them. They will then retract and pull the wound open, thus allowing the blood to flow freely and

PLATE CLVI.



SUPERFICIAL LAYER OF DEEP FASCIA, SUPERFICIAL VEINS AND NERVES.



VEINS OF SCALP, FACE, AND NECK.

avoiding its extravasation beneath the platysma. The vein is incised obliquely, not transversely, and should not be completely severed, as hemorrhage from a partially divided vessel is more copious. The hemorrhage may be checked by relieving the pressure applied to the vein at the root of the neck, and by application of a sterile compress over the wound. When the upper portion of the external jugular is selected, the incision should be carried in the line of the fibers of the sterno-mastoid muscle. The external jugular vein may be selected as one of the channels for the intra-venous injection of saline solution.

A chain of small lymphatic glands (superficial cervical), varying in number from four to six, lies along the course of the external jugular vein.

The **posterior external jugular vein** commences in the upper and back part of the neck, between the splenius and trapezius muscles, draining this territory and entering the lower portion of the external jugular vein. It occasionally receives the occipital vein. In the fetus it drains the intra-cranial region through a vein transmitted by the post-glenoid foramen, the remnant of which vein is the **mastoid vein.** The transversalis colli and supra-scapular veins frequently empty into the posterior external jugular vein.

The **anterior jugular vein** arises beneath the chin. It is formed by the mental, submental, inferior labial, and inferior hyoid veins, and passes downward, almost to the sternum, in advance of the anterior border of the sterno-mastoid muscle. Here it pierces the superficial layer of the deep cervical fascia, and occupies the interval (supra-sternal intra-aponeurotic space of Grüber) above the sternum, made by the division of the superficial layer of the deep cervical fascia into two layers; it then turns outward beneath the sterno-mastoid muscle, and enters the external jugular or the subclavian vein. It drains the skin and muscles of the anterior or median region of the neck. In making a subcutaneous section of the sterno-mastoid muscle for the correction of wryneck (torticollis), the tenotome must hug the under surface of the origins of the muscle closely, otherwise the anterior, external, and internal jugular veins may be injured. There are usually two anterior jugular veins, one upon each side of the median line of the neck, connected just above the sternum by a transverse branch. This branch also occupies the interval between the two layers of the superficial layer of the deep cervical fascia, and being quite large at times, should be borne in mind when performing the low operation of tracheotomy. In labored breathing, due either to laryngeal or tracheal obstruction, these veins will be much dilated, and care will be required in incising the median line of the neck, to prevent opening one or the other. Should this accident occur in the operation of tracheotomy, while not a serious complication, it may cause some embarrassment. Division of the transverse branch connecting the anterior jugulars at the root of the neck

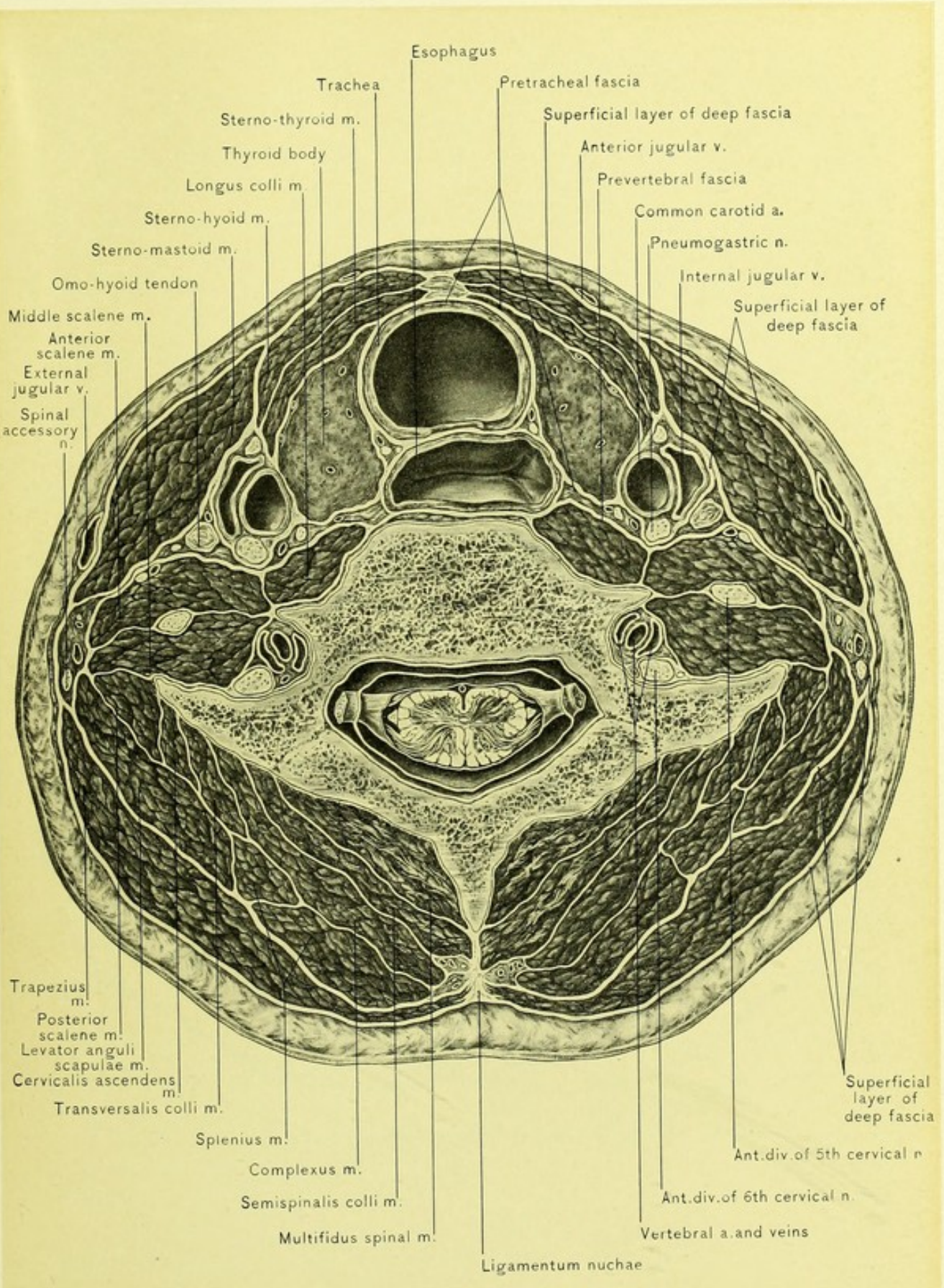
will occasion very free bleeding; this might mislead the surgeon in performing his first tracheotomy, leading him to think that he had opened an anomalously high left innominate vein. The anterior jugular vein contains no valves, and its variation in size, in inverse proportion to the other jugular veins, should be remembered.

Dissection.—Next trace the superficial branches of the cervical plexus and the infra-maxillary branch of the cervico-facial division of the facial nerve.

The **superficial branches of the cervical plexus of nerves** are divided into the ascending, transverse, and descending branches. The ascending branches are the occipitalis minor and auricularis magnus nerves. The transverse branch is the superficial cervical nerve. The descending branches are the supra-sternal, supra-clavicular, and supra-acromial nerves.

The **occipitalis minor nerve** arises from the anterior division of the second cervical nerve. It forms beneath the sterno-mastoid muscle a loop which embraces the spinal accessory nerve; it also furnishes a branch to the spinal accessory nerve, and emerges from beneath the posterior border of the sterno-mastoid just above the middle of the muscle. This loop acts as a guide in locating the spinal accessory nerve. The occipitalis minor nerve ascends along the upper half of the posterior border of the sterno-mastoid muscle to the occiput, where it pierces the superficial layer of the deep cervical fascia. It is distributed to the integumen covering the occipitalis muscle, and communicates with the great occipital, the auricularis magnus, and the posterior auricular branch of the facial nerve. It also gives off an auricular branch which supplies the skin of the upper and back part of the auricle.

The **auricularis magnus nerve,** the largest of the superficial branches of the cervical plexus, arises from the anterior division of the second and third cervical nerves, and curves around the posterior border of the sterno-mastoid muscle immediately above the superficial cervical nerve. Here it pierces the superficial layer of the deep cervical fascia, ascends in relation with the upper part of the external jugular vein, and passes obliquely over the sterno-mastoid and beneath the platysma myoides muscle. Reaching the lobule of the ear it divides into the following branches: a *facial* or anterior, distributed to the skin over the parotid gland, and communicating with branches from the facial nerve through this gland, which it also supplies; an *auricular* or posterior, distributed to the integument on the back of the auricle, and communicating with the posterior auricular branch of the facial and the auricular branch of the pneumogastric nerve; and a *mastoid branch,* distributed to the skin over the mastoid process, communicating with the occipitalis minor and the posterior auricular branch of the facial nerve.



SECTION OF NECK AT SIXTH CERVICAL VERTEBRA.

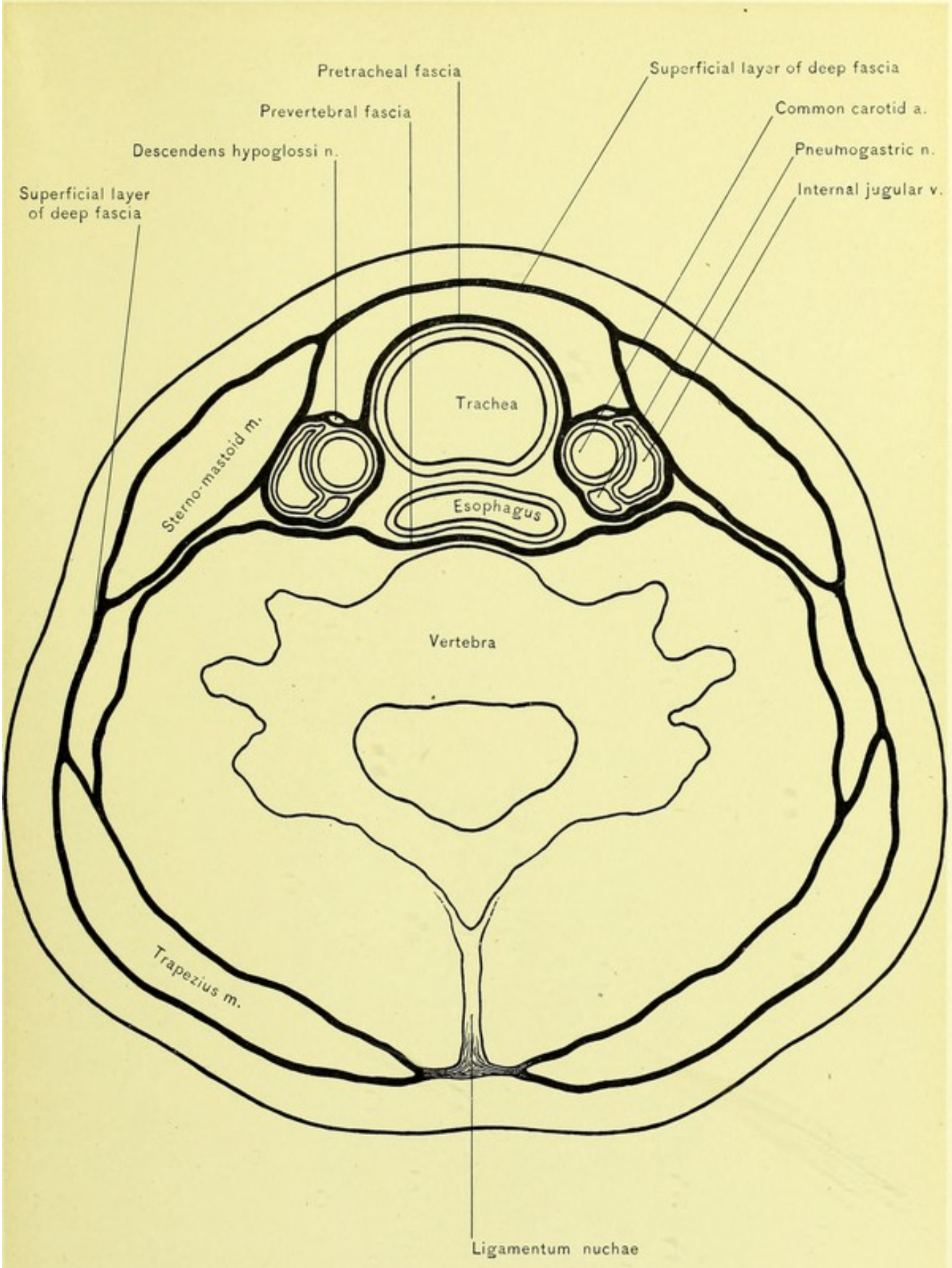
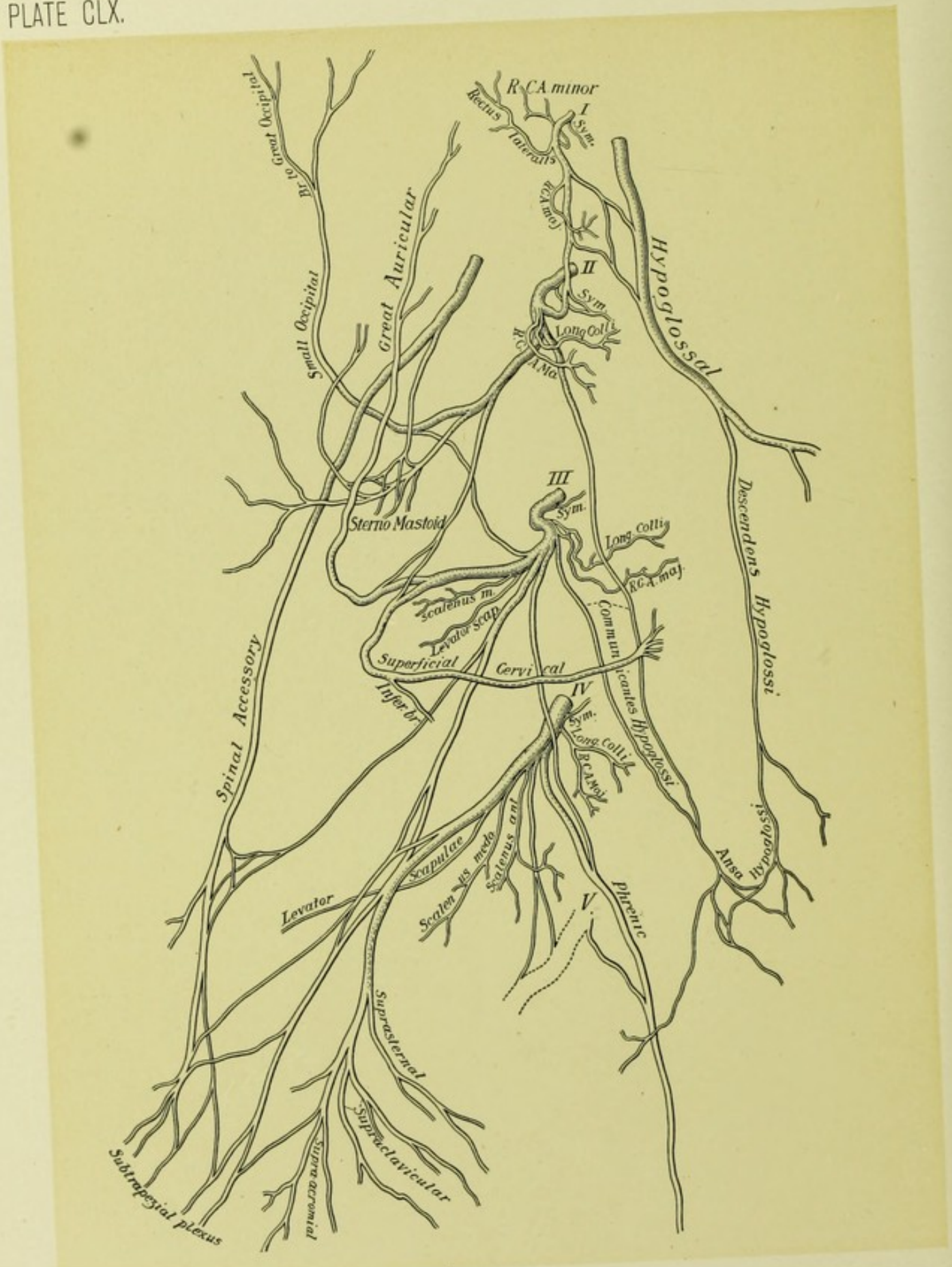


DIAGRAM OF DEEP CERVICAL FASCIA.

PLATE CLX.



CERVICAL PLEXUS.

The **superficial cervical nerve** (superficialis colli) is a branch of the anterior divisions of the second and third cervical nerves. It winds around the middle of the posterior border of the sterno-mastoid muscle, pierces the superficial layer of the deep cervical fascia, and passes transversely over the muscle beneath the external jugular vein, receiving a communicating branch from the infra-maxillary branch of the facial nerve. It divides into an *ascending* and a *descending* branch; the former sends filaments to the external jugular vein, communicates with the infra-maxillary branch of the facial nerve, and supplies the platysma myoides muscle and the skin of the front of the neck as far as the chin; the latter supplies the skin of the lower half of the front of the neck.

The **descending branch of the plexus** arises from the anterior divisions of the third and fourth cervical nerves, emerges from beneath the posterior border of the sterno-mastoid muscle, pierces the superficial layer of the deep cervical fascia, and divides into the supra-sternal, supra-clavicular, and supra-acromial nerves. The inner or *supra-sternal* twigs pass over the clavicular and sternal origins of the sterno-mastoid muscle, and supply the integument over the inner end of the clavicle and the upper part of the sternum; the middle or *supra-clavicular* branches cross the middle of the clavicle, supply the integument over the upper fore part of the deltoid and upper part of the pectoralis major muscle and the mammary gland, and communicate with the small cutaneous branches of the upper intercostal nerves; the external or *supra-acromial* branches cross the upper surface of the trapezius muscle and the acromion process, and supply the integument of the upper, outer, and back part of the shoulder. Herpetic eruptions in the area of distribution of the superficial branches of the cervical plexus (herpes cervico-occipitalis) are occasionally seen. In caries of the cervical vertebræ pain may be referred to the areas of skin supplied by these nerves. It is through the descending branches of the cervical plexus that pain is referred to the neck in carcinoma of the mammary gland.

The **infra-maxillary branch of the cervico-facial division of the facial nerve** emerges from the lower border of the parotid gland, and passes downward and forward under the platysma myoides muscle, which it supplies, and communicates with the superficial cervical nerve.

The **deep cervical fascia,** like the deep fascia in other portions of the body, consists of a superficial layer which surrounds the underlying muscles, vessels, and nerves, and of processes prolonged inward to form separate sheaths for the muscles and vessels, thus isolating and helping to retain them in their proper positions. It varies in strength, being strongest below the angle of the lower jaw, above the clavicle, and in front of the trachea. In studying this fascia it will be found more satisfactory to trace it from behind, where it is attached to the ligamentum nuchæ

and the spinous process of the seventh cervical vertebra (vertebra prominens). At the ligamentum nuchæ the *superficial layer* immediately begins as two layers, which inclose the trapezius muscle. From the anterior border of the trapezius it passes as a single layer across the posterior triangle of the neck to the posterior border of the sterno-mastoid muscle. This portion of the superficial layer is attached above to the mastoid process of the temporal and superior curved line of the occipital bone, and below to the clavicle. It is pierced by the external jugular vein directly above the clavicle, behind the clavicular origin of the sterno-mastoid muscle. At the posterior border of the sterno-mastoid muscle it again splits into two layers to inclose the muscle, from the anterior border of which it is continued as a single layer across the anterior triangle of the neck to the middle line, where it joins the corresponding layer of fascia of the opposite side. This portion of the superficial layer is attached above to the lower border of the lower jaw and the styloid process of the temporal bone, and in front to the hyoid bone. Near the upper border of the sternum this layer of fascia divides into two layers, an anterior and a posterior, which are attached respectively to the anterior and posterior margins of the upper border of the sternum. Between these two layers is an interval (the supra-sternal intra-aponeurotic space of Grüber) containing some fat, perhaps one or two small lymphatic glands, the sternal head of the sterno-mastoid muscle, the anterior jugular veins, and the transverse branch connecting them. The layer of fascia overlying the sterno-mastoid muscle is continued upon the face over the parotid gland and the masseter muscle as the parotid and masseteric fasciæ, which are attached to the lower border of the zygomatic arch.

The portion of the superficial layer covering the trapezius and sterno-mastoid muscles is so thin that their fibers can be seen through the fascia. At the angle of the lower jaw this layer of fascia sends a process inward which is attached to the styloid process, and is known as the **stylo-maxillary ligament.** This ligament separates the parotid from the submaxillary gland. From the superficial layer two processes are given off, a posterior and an anterior. The *posterior process* (*prevertebral fascia*) arises from the superficial layer at the anterior border of the trapezius muscle, and covers the splenius, levator anguli scapulæ, scaleni and prevertebral muscles, subclavian, vertebral, inferior thyroid, supra-scapular, and transversalis colli vessels, cervical trunks of the axillary or brachial plexus, phrenic nerve, and cervical sympathetic nerve. This process of fascia passes behind the common carotid artery, internal jugular vein, pharynx, and esophagus. It is attached above to the base of the skull; below, to the first rib, as far forward as the anterior margin of the scalenus anticus muscle. To the inner side of this muscle it passes downward into the chest over the longus colli muscle and bodies of the vertebræ. To the outer side of the scalenus anticus muscle it splits to

envelop the subclavian vessels, which it accompanies into the axilla, where, with a process from the costo-coracoid membrane, it forms the sheath of the axillary vessels. As it passes behind the common carotid artery and internal jugular vein it reinforces the sheath of these vessels. The *anterior process* (*pretracheal fascia*) arises from the superficial layer near the anterior border of the sterno-mastoid muscle, passes beneath the sterno-hyoid and sterno-thyroid muscles, and in front of the trachea, enveloping the thyroid gland. It is attached to the first rib, to which it binds the tendon of the omo-hyoid muscle. This, with the posterior process just described, and the layer of deep fascia beneath the sterno-mastoid muscle, complete the formation of the sheath of the common carotid artery and internal jugular vein. The portion of the deep cervical fascia which envelops the trachea and great vessels extends downward along the great vessels into the chest, where it is continuous with the fibrous layer of the pericardium.

The superficial layer of the deep cervical fascia, with its two deep processes, divides the neck into three compartments: an anterior, a middle, and a posterior. The anterior compartment, between the superficial layer and the pretracheal fascia, contains the anterior belly of the omo-hyoid, the sterno-hyoid, and sterno-thyroid muscles. The middle or visceral compartment, between the pretracheal and prevertebral fasciæ, contains the thyroid gland, trachea, and esophagus. The posterior or muscular compartment, between the prevertebral fascia and the superficial layer, contains the prevertebral muscles, scaleni, levator anguli scapulæ, and the muscles of the back of the neck, excepting the trapezius.

Dr. Allan Burns first called the attention of the profession to the barrier at the upper opening of the chest, formed by the attachment of the deep cervical fascia to the sternum, the first rib, and the clavicle, supporting the soft parts and preventing them from yielding to the pressure of the atmosphere during inspiration. The internal jugular, subclavian, and innominate veins are so closely attached to the adjacent bones and muscles by the deep cervical fascia that they gape when divided, thus permitting air to enter. In operations on the neck, when these veins are exposed and division is necessary, it is best to ligate them before severing them.

Abscess.—In order to become familiar with the course pus pursues in the neck, a correct knowledge of the attachments of the deep cervical fascia is necessary. A collection of pus situated beneath the superficial layer of the deep fascia at the side of the neck may burrow into the axilla, and, vice versâ, one in the axilla may work its way into the neck; if situated beneath the layer of deep fascia (posterior process or prevertebral fascia) covering the scaleni muscles, and attached to the first rib as far forward as the anterior border of the anterior scalene muscle, it may burrow into the chest cavity, reaching the posterior mediastinum, or follow

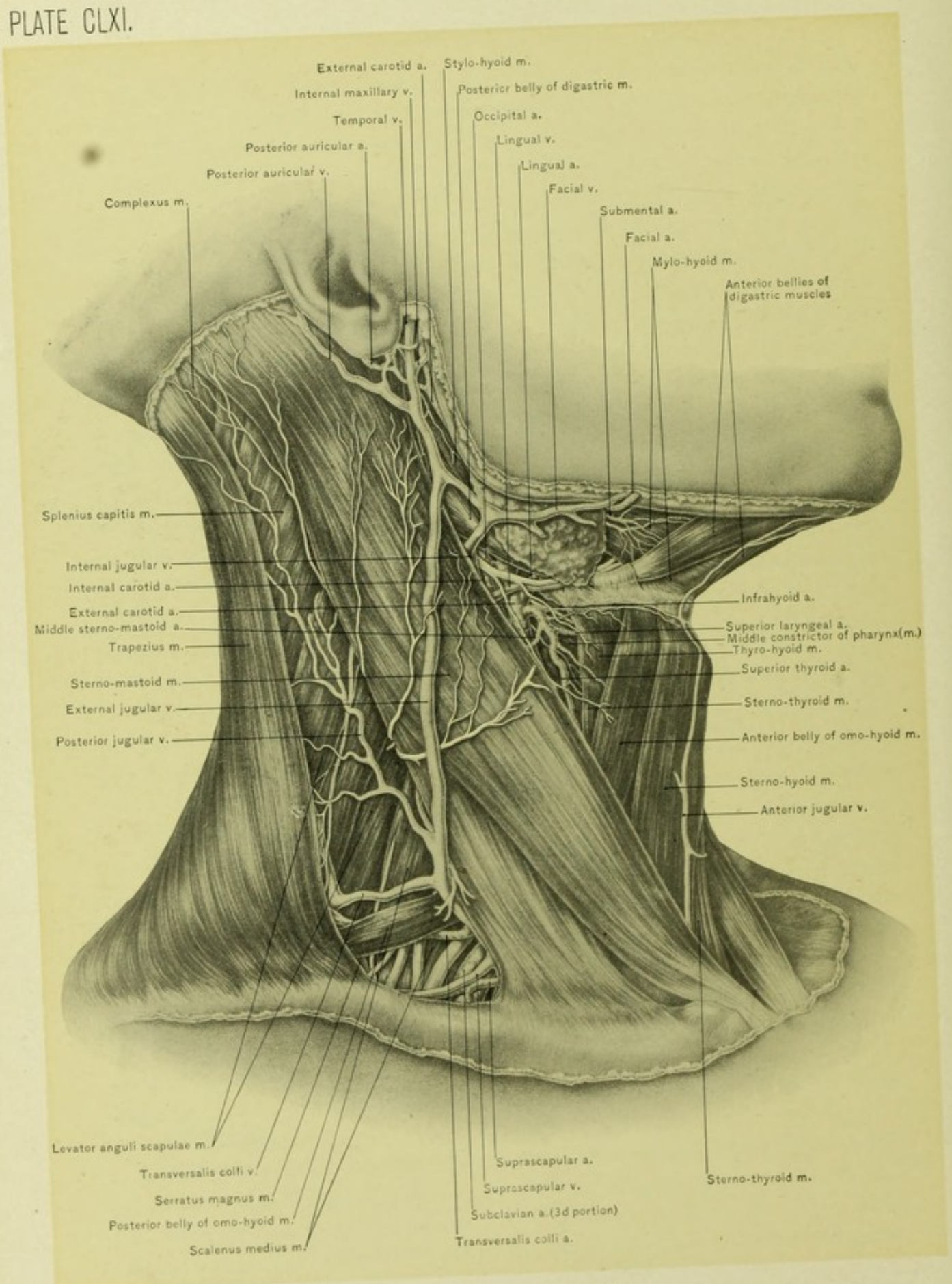
the sheath of the subclavian vessels into the arm-pit; if situated beneath the superficial layer of the deep fascia in the anterior portion of the neck, it may enter the chest, being guided into the anterior mediastinum by the pretracheal fascia; if it lie beneath the anterior process, or pretracheal fascia, it may extend into the posterior mediastinum. Abscesses of the neck have frequently burst into the esophagus or trachea, and even into the pleural sac; the great vessels at the side of the neck have in some instances been entered. "In one remarkable case, reported by Mr. Savory, not only was a considerable portion of the common carotid artery destroyed by the abscess, but a still larger portion of the internal jugular vein and a large part of the vagus nerve were also destroyed" (Treves). Mr. Jacobson (Hilton, on "Rest and Pain") states that "communication between abscesses and the deep vessels has usually taken place beneath two of the strongest fasciæ in the body—the deep cervical and the fascia lata." Prompt evacuation is indicated by the possibility that these abscesses may take one or more of the foregoing undesirable courses.

Dissection.—The superficial layer of the deep fascia should be removed by making incisions similar to those made for the removal of the skin and the superficial fascia, being careful not to destroy the superficial branches of the cervical plexus of nerves which pierce it. The removal of the superficial layer will expose its two processes and other underlying structures.

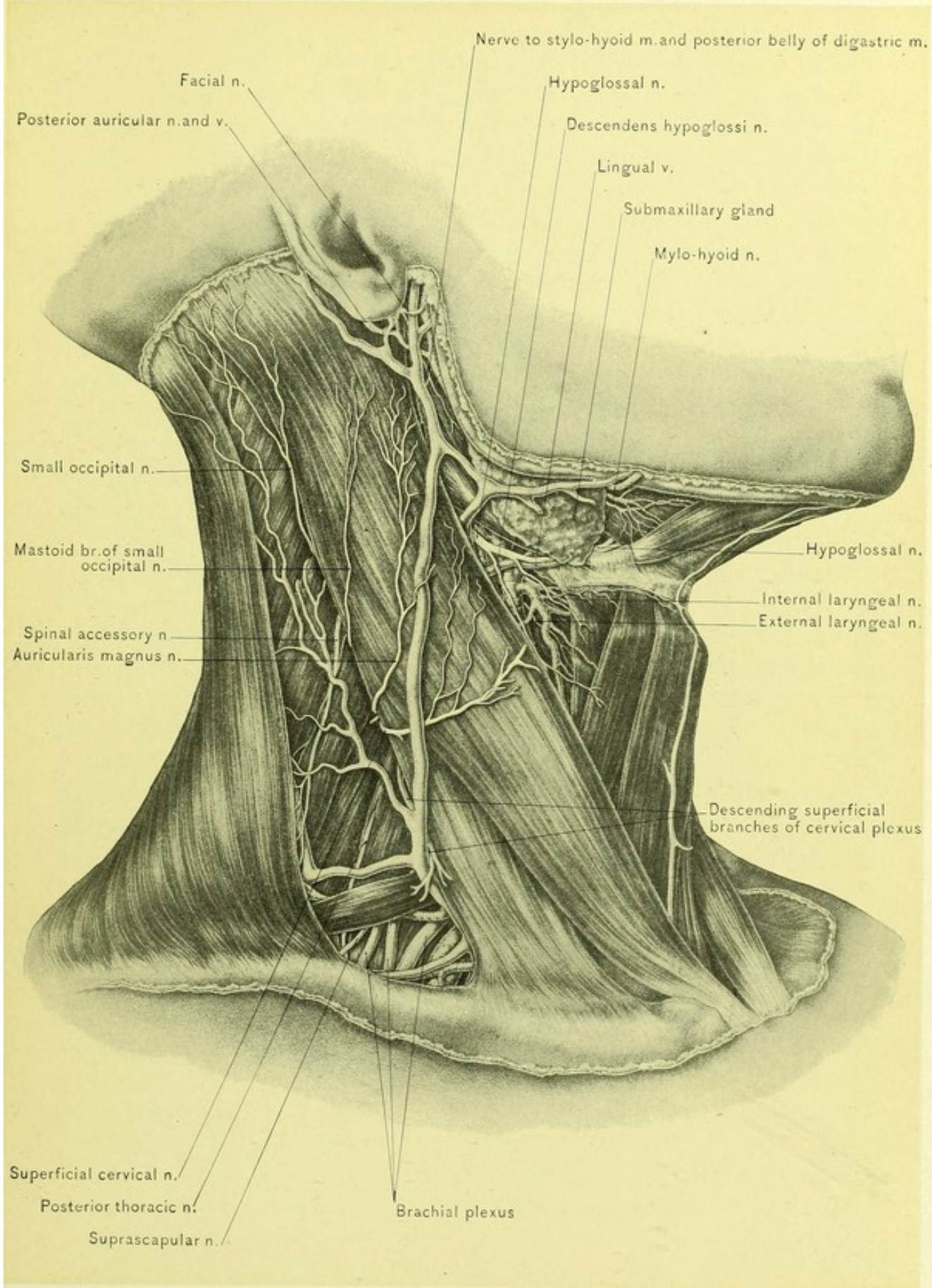
Cervical plexus.—Before taking up the description of the muscles of the neck and its dissection proper, the origins of the superficial branches of the cervical plexus of nerves should be studied. This plexus is formed by the communication of the anterior divisions of the upper four cervical nerves, all of which communicate with the sympathetic nerve. It lies under the sterno-mastoid muscle, opposite the upper four cervical vertebræ, and rests upon the levator anguli scapulæ and scalenus medius muscles. Its branches consist of a superficial and a deep set. The *superficial branches*, as previously described, are the auricularis magnus, the occipitalis minor, the superficial cervical, the supra-sternal, the supra-clavicular, and the supra-acromial, all running to the skin and subcutaneous structures. The *deep branches* are the phrenic, the communicantes hypoglossi, communicating, and muscular. The superficial branches alone concern us in this stage of the dissection. They emerge at the side of the neck from beneath the posterior border of the sterno-mastoid muscle, at the level of the upper border of the thyroid cartilage.

The **sterno-cleido-mastoid muscle,** the largest muscle of the neck and its most important landmark, arises by two heads: one, round and tendinous, from the front of the upper portion of the sternum; the other, flattened, partly muscular and partly tendinous, from the inner one-third of the upper surface

PLATE CLXI.



SUPERFICIAL STRUCTURES OF NECK.



SUPERFICIAL STRUCTURES OF NECK.

of the clavicle. These two heads unite at a variable distance from the clavicle. The muscle is inserted into the external surface of the mastoid process of the temporal bone by a strong, thick tendon, and into the outer two-thirds of the superior curved line of the occipital bone by a thin aponeurosis. The muscle is narrower in the middle than at either extremity. Its anterior border is the surgeon's *guide* in the ligation of the common, external, and internal carotid arteries, the superior thyroid, lingual, facial, and occipital arteries at their origin, and the inferior thyroid artery as it enters the thyroid gland; in exposing the spinal accessory nerve; upon the left side in the operation of esophagotomy; and in all other operations upon the front of the side of the neck. The posterior border of the muscle is a guide in the ligation of the subclavian and vertebral arteries; the inferior thyroid artery at its origin; in stretching the spinal accessory nerve, the superficial branches of the cervical plexus, and the cervical trunks of the brachial or axillary plexus; and in all other operations upon the posterior portion of the side of the neck.

Blood Supply.—From the superior, middle, and inferior sterno-mastoid arteries. The superior sterno-mastoid is a branch of the occipital artery, and enters the muscle with the spinal accessory nerve; the middle sterno-mastoid is a branch of the superior thyroid artery, and enters the middle one-third of the muscle, after crossing the sheath of the common carotid artery in the superior carotid triangle on a level with the thyroid cartilage; the inferior sterno-mastoid is a branch of the supra-scapular artery, and enters the lower one-third of the muscle. The muscle also receives a twig from the posterior auricular artery.

Nerve Supply.—From the spinal accessory and the anterior divisions of the second and third cervical nerves.

Action.—The combined action of the sterno-mastoid muscles is to draw the head forward, elevating the chin at the same time; when one muscle alone acts, it turns the face to the opposite side, cooperating with the opposite splenius muscle; it also draws the head toward the shoulder of the same side. If the head be fixed, these muscles will raise the sternum, as in forced respiration.

Torticollis.—Permanent contraction of one of the sterno-mastoid muscles constitutes torticollis (wryneck). The deep muscles of the neck—splenius capitis et colli, complexus, superior oblique, inferior oblique, and rectus capitis posticus major—may also be involved in this deformity, particularly in cases of long standing.

In true congenital wryneck, due possibly to faulty position of the fetus *in utero*, the sterno-mastoid muscle has, in some instances, been found to be abnormally short. Some cases of wryneck are doubtless due to laceration of the muscle during birth, with subsequent cicatricial contraction. Facial asymmetry

and deformities of the cervical portion of the spinal column may be associated with long-standing cases of torticollis. In spasmodic wryneck the sterno-cleido-mastoid muscle is at fault, through the spinal accessory nerve, though some of the muscles previously mentioned, as well as the trapezius muscle, may be involved; resection of the spinal accessory and branches of the posterior divisions of the cervical nerves has been performed in these cases. It should not be forgotten that irritation of some of the cervical nerves, as by inflamed lymph glands and caries of the cervical vertebræ, may cause a faulty position of the head which may be mistaken for torticollis due to other conditions.

TRIANGLES OF THE NECK.

The sterno-mastoid muscle, owing to its oblique position, divides each half of the neck into two triangles—the anterior and posterior common triangles. The **Anterior Common Triangle** is bounded above by the lower border of the body of the lower jaw and a line extending from the angle of the lower jaw to the mastoid process of the temporal bone; in front, by a line extending from the symphysis of the lower jaw to the middle of the supra-sternal notch, or by the median line of the neck; and behind, by the anterior border of the sterno-mastoid muscle; its apex is below—at the sternum. This triangle is subdivided into three smaller ones by the posterior belly of the digastric muscle and the anterior belly of the omo-hyoid muscle. The three triangles, from above downward, are the *submaxillary or digastric*, the *superior carotid*, and the *inferior carotid*. The **Posterior Common Triangle** is bounded in front by the posterior border of the sterno-mastoid muscle; behind, by the anterior border of the trapezius muscle; and below, by the clavicle; its apex is above—at the occiput. This triangle is subdivided into two smaller triangles by the posterior belly of the omo-hyoid muscle, the upper, the larger of the two, being known as the *occipital*, and the lower, the smaller, as the *subclavian*, triangle.

The author would here remind the reader that the boundaries of these triangles by muscular margins do not harmonize with the enumeration of their contents, many of which are overlapped by the boundary muscles, particularly the sterno-mastoid, and are, therefore, really outside the spaces to which they are thus inaccurately accredited. The most accurate dividing line between the anterior and posterior triangles would be the middle line of the sterno-mastoid muscle rather than its two borders.

Dissection.—Having mapped out the triangles into which the side of the neck is divided, the dissection of the individual triangles should next be made, commencing with the occipital, the largest. After reflecting the superficial layer

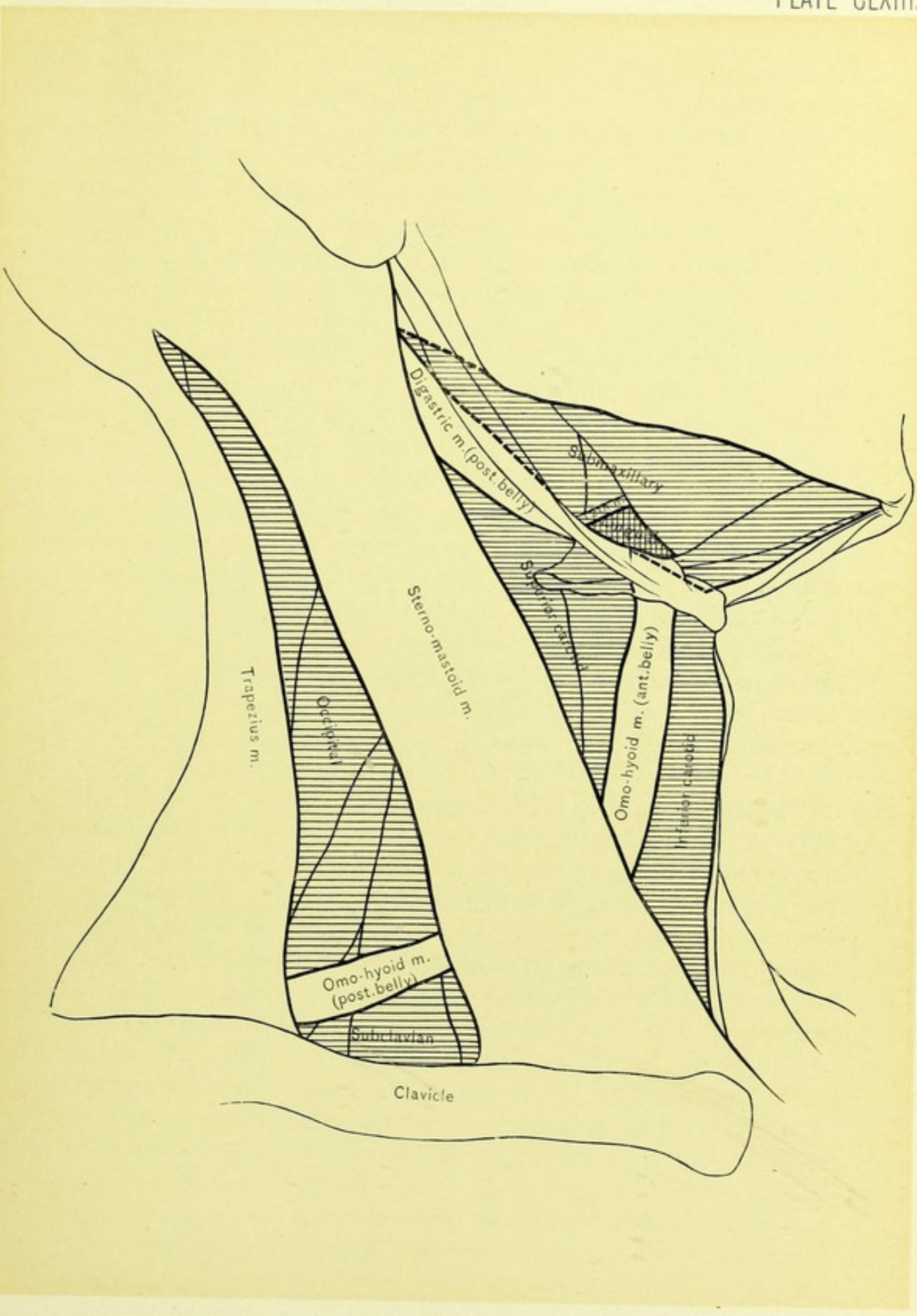


DIAGRAM OF TRIANGLES OF NECK.

of the deep cervical fascia which forms the roof of the occipital triangle, the fat and areolar tissue occupying the triangle should be dissected out, thus exposing its contents and the posterior process of the deep cervical fascia which covers the muscles forming its floor.

The occipital triangle.—The occipital triangle is bounded in front by the sterno-cleido-mastoid muscle; behind, by the trapezius muscle; below, by the posterior belly of the omo-hyoid muscle. Its *roof* is formed by the superficial layer of the deep cervical fascia, covered by the platysma myoides muscle, superficial fascia, and skin. When the sterno-mastoid and trapezius muscles do not meet at the apex of the triangle, a small portion of the occipital artery may be seen in the interval between the splenius and trapezius muscles. Crossing the triangle obliquely downward and backward from beneath the sterno-mastoid muscle are the spinal accessory nerve and the branches of the third and fourth cervical nerves, which enter the lower part of the trapezius muscle to supply it. Emerging from beneath the posterior border of the sterno-mastoid muscle are the superficial branches of the cervical plexus of nerves, which leave the triangle by piercing its roof. Occasionally the middle sterno-mastoid artery terminates in this triangle. Running along the posterior border of the sterno-mastoid muscle is a chain of lymphatic glands; this is known as the post-cervical chain, and is of special importance in the diagnosis of early secondary syphilis. Crossing the lower part of the triangle is the transversalis colli artery and its companion vein. The superficial cervical artery, one of the terminal branches of the transversalis colli, usually occupies the posterior inferior angle of this space; it runs upward, parallel with the anterior border of the trapezius muscle, but is, in some instances, concealed by the anterior border of the trapezius muscle. At the anterior inferior angle of the triangle the upper part of the brachial plexus may be seen. Branches of the third and fourth cervical nerves cross the floor of the triangle to supply the levator anguli scapulæ muscle.

The muscles forming the *floor* of the occipital triangle are, from above downward, the splenius capitis, the levator anguli scapulæ, the scalenus medius, and the scalenus posticus muscle, which can not be seen, however, until the posterior process of the deep cervical fascia is removed.

The **spinal accessory nerve.**—This nerve is the most important of the contents of the occipital triangle. It is the eleventh cranial nerve, and consists of two parts—the accessory, from the medulla oblongata, and the spinal, from the cervical portion of the spinal cord as low as the sixth or seventh cervical nerve. The spinal portion passes upward through the spinal canal between the ligamentum denticulatum and the posterior roots of the spinal nerves, and enters the cranial cavity through the foramen magnum to join the accessory portion. The two por-

tions emerge from the cranial cavity together through the jugular foramen, just external to which the accessory portion joins the ganglion of the root of the pneumogastric nerve. The spinal portion then passes successively behind the internal jugular vein, the posterior belly of the digastric, and the stylo-hyoid muscle, to enter the upper part of the sterno-mastoid muscle, entering its under surface midway between its two borders and one inch below the tip of the mastoid process. It leaves the muscle at the middle of the posterior border. Within the sterno-mastoid muscle it is joined by a branch of the second cervical nerve. The superior sterno-mastoid artery accompanies the nerve into the muscle, which it supplies. Having pierced the sterno-mastoid muscle, it crosses the occipital triangle obliquely downward and backward to enter and supply the trapezius muscle.

For the relief of spasmodic torticollis, *resection* of a portion of the spinal accessory nerve may be performed. The spinal accessory nerve may be exposed at one of three points—just before it enters the sterno-mastoid muscle, in the substance of the muscle, or at the posterior border of the muscle. Of these methods, the first is the best. To expose the nerve before it enters the muscle, the head and neck should be well extended, and an incision made along the anterior border of the upper one-third of the muscle, dividing skin, superficial fascia, some fibers of the platysma myoides muscle, and the superficial layer of the deep fascia, avoiding, if possible, the external jugular vein. Displace the sterno-mastoid muscle outward, when the nerve will be found beneath the prevertebral fascia and passing from beneath the sheath of the internal jugular vein, to enter the muscle about an inch below the tip of the mastoid process. The prominent transverse process of the atlas lies above the nerve, and serves as a deep guide in locating it.

To expose the nerve in the substance of the sterno-mastoid muscle an incision should be made in the middle line of the muscle. The muscle fibers are separated and the nerve exposed as it passes through the deeper portion just above the level of the thyroid cartilage. The skin, superficial fascia, fibers of the platysma myoides muscle, superficial layer of the deep fascia, the sterno-mastoid muscle, and the superior and middle sterno-mastoid arteries will be cut. The external jugular vein should, if possible, be avoided.

To expose the nerve along the posterior border of the muscle carry an incision along the middle one-third of that border. The skin, superficial fascia, fibers of the platysma myoides muscle, and the superficial layer of the deep fascia will be divided. The occipitalis minor nerve will be seen running upward along the posterior border of the sterno-mastoid muscle. Trace this nerve downward, and locate the spinal accessory nerve as it emerges from the posterior border of the sterno-mastoid muscle on a level with the upper border of the thyroid cartilage.

The **middle sterno-mastoid artery.**—The middle sterno-mastoid artery will

at times be of considerable size and extend well into, if not across, the occipital triangle, supplying the lymphatic glands and connective tissue contained therein. When, on opening an abscess in this triangle, more than the usual amount of bleeding follows, the probability is that an anomalously large middle sterno-mastoid artery has been severed. Under these circumstances the incision should be enlarged to sufficiently expose both ends of the bleeding vessel and permit their ligation. The author recalls a case in which this accident occurred, and the surgeon, believing that but a small subcutaneous vessel had been divided, relied on a compress, and the patient died from hemorrhage. The autopsy revealed a severed large middle sterno-mastoid artery.

The **transversalis colli artery** terminates in the lower part of this triangle, by dividing into the superficial cervical and the posterior scapular artery. The *superficial cervical artery* has been traced to the anterior border of the trapezius muscle, beneath which it anastomoses with the superficial branch of the princeps cervicis artery. The *posterior scapular*, occasionally a branch of the third part of the subclavian artery, passes beneath the levator anguli scapulæ muscle, then along the vertebral border of the scapula, running between the insertions of the serratus magnus and rhomboidei muscles to the inferior angle of the scapula, where it anastomoses with the subscapular artery. In its course it gives off branches to the adjacent muscles and anastomoses with the supra-scapular and dorsalis scapulæ arteries.

The subclavian or supra-clavicular triangle (trigonum omo-claviculare).—The subclavian triangle, the smaller of the two divisions of the posterior common triangle, is one of the most important triangles of the neck. It is bounded in front by the posterior border of the sterno-mastoid muscle; above, by the posterior belly of the omo-hyoid muscle; and below, by the clavicle. The base of the triangle, formed by the posterior border of the sterno-mastoid muscle, is directed forward. The *roof* of this triangle is formed of the superficial layer of the deep fascia, covered by the platysma myoides muscle, superficial fascia, and skin. The depth of this space is increased when the shoulder is raised and diminished when it is depressed. In all operations in this triangle the shoulder should be depressed, the contents of the triangle being thus brought nearer to the surface. Its size will depend on the extent of the attachment of the trapezius and sterno-mastoid muscles to the clavicle, and on the position of the omo-hyoid muscle.

Dissection.—The roof of the triangle having been reflected in removing the superficial layer of the deep fascia, some lymphatic glands, loose areolar tissue, and fat will be seen; a small portion of the external jugular vein is also visible; the termination of the transversalis colli and supra-scapular veins, the jugulo-cephalic vein, when present, and some additional veins from the muscles, the

layer of deep fascia (posterior process) covering the deeper structures,—namely, the scaleni muscles, the phrenic nerve, the cervical trunks of the axillary or brachial plexus of nerves,—and the subclavian, supra-scapular, and transversalis colli vessels will be seen. Remove the posterior process of the deep fascia from the triangle and study these deeper structures.

Contents of the Subclavian Triangle.—Crossing the lower part of the triangle beneath the clavicle are the *supra-scapular artery and vein;* these vessels pass in front of the third portion of the subclavian artery (the point of election), and may be the source of severe hemorrhage if divided when ligating the artery. The relation of the supra-scapular to the subclavian artery at its point of election is the same as that held by the middle sterno-mastoid artery to the common carotid artery at its point of election. Crossing the upper angle of the triangle are the *transversalis colli artery and vein.* Entering the triangle behind the posterior border of the lower part of the sterno-mastoid muscle is the *external jugular vein,* which passes in front of the subclavian artery to reach the subclavian vein. The external jugular vein is here joined by the supra-scapular and transversalis colli veins, and at times by a small branch (jugulo-cephalic) which passes over the clavicle, connecting the cephalic with the external jugular vein. The supra-scapular, transversalis colli, jugulo-cephalic, posterior external jugular, and some smaller veins at times form a plexus in front of the subclavian artery. This plexus of veins, especially when distended, renders operations in this space difficult. Emerging from beneath the posterior border of the sterno-mastoid and scalenus anticus muscles is the third portion of the *subclavian artery,* which crosses the triangle obliquely downward and outward. The subclavian artery rises in the neck, about three-fourths of an inch above the clavicle. In nearly every instance it runs behind the scalenus anticus muscle, but it may pass in front of that muscle or between its fibers. Normally, the third part of the subclavian artery does not give off any branches; the posterior scapular, however, one of the terminal branches of the transversalis colli artery, often arises from this portion of the vessel; the transversalis colli artery itself, or the supra-scapular artery, may arise from the third portion of the subclavian artery. The *subclavian vein* occupies a position below and anterior to the artery, not being visible frequently in a dissection of the subclavian triangle. It lies upon the first rib, in front of the anterior scalene muscle, and behind the clavicle. Passing downward over the anterior scalene muscle, beneath the posterior process of the deep fascia, is the *phrenic nerve,* which enters the chest through its upper opening, and between the subclavian artery and vein. Running through the upper and outer part of the triangle, above and external to the subclavian artery, are the three cervical trunks of the *axillary or brachial plexus* of nerves, which emerge at the side of the neck from between the anterior and middle scalene muscles. In the opera-

tion of ligation of the third portion of the subclavian artery, the upper trunk of the plexus may be mistaken for the artery, and the ligature passed around it. This trunk is, therefore, a very useful guide in locating the artery, and should always be kept in mind. A few lymphatic glands, which are continuous with the axillary lymphatics, are found in this space. These glands should always be removed in the radical operation for removal of carcinoma of the mammary gland. The triangle is also crossed by the supra-scapular and posterior thoracic nerves and the nerve to the subclavius muscle.

The *floor of the triangle* is formed by the scalenus medius and posticus muscles, the first rib, and the upper digitation of the serratus magnus muscle.

The inferior carotid triangle is bounded in front by the median line of the neck; behind, by the anterior border of the sterno-cleido-mastoid muscle; and above, by the anterior belly of the omo-hyoid muscle. The *roof* is formed by the skin, the superficial fascia, which contains the platysma myoides muscle, and the descending branch of the superficial cervical nerve, and by the superficial layer of the deep fascia. The outer margins of the sterno-hyoid and sterno-thyroid, and the anterior margin of the sterno-mastoid muscle cover the more important contents of the triangle, and should be drawn aside before dissecting the deeper structures.

Contents of the Triangle.—The common carotid artery (not strictly in the triangle, as the vessels lie under the margin of the sterno-mastoid muscle, but so closely related to the contents of the triangle that mention of it here is proper), the internal jugular vein, and the pneumogastric nerve, all three inclosed in a common sheath, in front of which are filaments of nerves derived from the loop of communication between the descendens hypoglossi, a branch of the hypo-glossal, and the communicantes hypoglossi nerves, which are deep branches of the cervical plexus; behind the sheath of the vessels are the sympathetic nerve and its cardiac branches. Upon the inner side of the sheath of the vessels are the lateral lobe of the thyroid gland, the trachea, the larynx, the esophagus, the inferior or recurrent laryngeal nerve (motor nerve of the larynx), which occupies the groove between the trachea and the esophagus, and the terminal portion of the deep chain of cervical lymphatic glands. To the outer side of the sheath of the vessels, running over the scalenus anticus muscle, is the phrenic nerve. The inferior thyroid artery, a branch of the thyroid axis, passes upward and inward through this space to the outer side of and then behind the sheath of the vessels. Situated deeply in the interval between the longus colli and the scalenus anticus muscle, and behind the sheath of the vessels, are the vertebral artery and its accompanying vein. In this triangle the relation between the internal jugular vein and the common carotid artery differs upon the two sides of the neck; upon the right side the vein

is a little to the outer side of the artery, the two vessels being in the lower part of the triangle, separated by a narrow interval, while on the left side it lies closer to the artery and somewhat overlaps it.

The *floor of the triangle* is formed by the longus colli and scalenus anticus muscles.

The superior carotid triangle is bounded above by the posterior belly of the digastric muscle; behind, by the anterior border of the sterno-mastoid muscle; and below, by the anterior belly of the omo-hyoid muscle; its apex is directed toward the median line of the neck. Its *roof* is formed by the skin, the superficial fascia, the platysma myoides muscle, and the superficial layer of the deep fascia.

Contents of the Superior Carotid Triangle.—These are: The common carotid artery and its terminal divisions,—the external and the internal carotid,—the internal jugular vein, and the pneumogastric nerve; these are all inclosed in a common sheath, the vein lying to the outer side of the artery and the nerve between, and on a plane posterior to both, resembling the ramrod in a double-barreled gun. The common carotid artery usually divides into the external and internal carotid arteries, on a level with the upper border of the thyroid cartilage; division may, however, take place below or above this point. In this triangle the external carotid artery gives off the superior thyroid, lingual, facial, occipital, and the ascending pharyngeal artery, all of which, excepting the occipital, are accompanied by their corresponding veins on their way to empty into the internal jugular vein. Passing downward in front of the carotid sheath is the descendens hypoglossi nerve, and behind the sheath, the sympathetic nerve. To the outer side of the sheath, above, is the spinal accessory nerve, which pierces the sterno-mastoid muscle; to the inner side of the sheath is the superior laryngeal nerve, a branch of the pneumogastric, accompanied by the superior laryngeal artery, a branch of the superior thyroid artery. Both the superior laryngeal artery and the internal laryngeal branch of the superior laryngeal nerve enter the larynx through the thyro-hyoid membrane. To the inner side of the sheath of the vessels, and a little lower, the superior thyroid artery and the external laryngeal nerve, a branch of the superior laryngeal nerve, are seen passing beneath the sterno-thyroid muscle. The hypoglossal nerve is seen in the upper part of the triangle, curving around the occipital artery at its origin from the external carotid, and crossing over the external and internal carotid arteries. Upon the inner side of the triangle are the upper part of the larynx and the lower portion of the pharynx. In the deep part of the triangle, to the inner side of the sheath of the vessels, are seen the pharynx, the esophagus, and the deep chain of the cervical lymphatic glands, the terminal portion of which has been observed when dissecting the inferior carotid triangle.

The superior carotid is the *triangle of election* for the ligation of the common carotid artery, the artery being more superficial and accessible here. Crossing the sheath of the vessels in this triangle is the middle sterno-mastoid, a small branch of the superior thyroid artery, which is severed in the ligation of the common carotid artery in this triangle.

The *floor of the triangle* is formed by the thyro-hyoid muscle, the hyo-glossus muscle, and the middle and inferior constrictor muscles of the pharynx.

The **submaxillary or digastric triangle,** the uppermost of the three anterior triangles, is bounded above by the lower border of the body of the lower jaw, and a line drawn from the angle of the lower jaw to the mastoid process of the temporal bone; below, by the posterior belly of the digastric and the stylo-hyoid muscle, and the line of these muscles extended to the median line of the neck; and, in front, by the middle line of the neck. Its *roof* is formed by the skin, the superficial fascia, the platysma myoides muscle, and the superficial layer of the deep fascia. The portion of the deep cervical fascia helping to form the roof of this triangle is very strong.

Contents of the Submaxillary Triangle.—The stylo-maxillary ligament, a process of the deep cervical fascia which extends from the styloid process of the temporal bone to the angle of the lower jaw and separates the submaxillary and parotid salivary glands, divides the submaxillary or digastric triangle into two portions, an anterior and a posterior. The posterior portion contains a part of the external carotid artery, embedded in the substance of the parotid gland, the internal carotid artery, the internal jugular vein, the pneumogastric, glosso-pharyngeal, hypo-glossal, and sympathetic nerves, the origins of the stylo-glossus and stylo-pharyngeus muscles, and the stylo-hyoid ligament. The last three of these structures, with the glosso-pharyngeal nerve, pass into the anterior part of the triangle between the internal and external carotid arteries. In addition to the terminal portion of the stylo-pharyngeus and stylo-glossus muscles the anterior portion contains the stylo-hyoid ligament and the glosso-pharyngeal nerve, which pass from the posterior portion, the submaxillary gland, the facial artery and vein, the ascending palatine, tonsillar, submaxillary, and submental branches of the facial artery, all of which arise within the triangle, the hypo-glossal nerve, the mylo-hyoid nerve, the mylo-hyoid artery, and lymphatic glands. A chain of lymphatic glands, ten to fifteen in number, is found below the body of the lower jaw. These glands belong to the superficial cervical lymphatics, and are known as the *submaxillary lymphatic glands.* In malignant growths of the lip, lower jaw, tongue, or oral and pharyngeal mucous membrane, this chain of glands will soon become infected and should always be removed, whether enlarged or not. In the operation for the removal of a malignant growth involving the areas which these glands

drain, the first step should consist in the removal of the submaxillary lymphatic glands of both sides of the neck, and, in some instances, of the submaxillary salivary gland; the final step consists of the removal of the growth. Tuberculosis of these glands is a not uncommon condition, because of the large area from which they receive lymph; infection from inflammatory affections of the pharyngeal, nasal, and oral mucous membranes, as well as from carious teeth, is very frequently the cause of disease of these glands. An extensive cervical cellulitis, known as *Ludwig's angina*, may originate from septic processes in the submaxillary lymphatic glands.

The *floor of the submaxillary triangle* is formed by the mylo-hyoid muscle, the anterior belly of the digastric, the hyo-glossus, the superior constrictor, and a small portion of the middle constrictor muscle of the pharynx.

Dissection.—The roof of the triangle having been reflected in removing the superficial layer of the deep cervical fascia, the submaxillary salivary gland, with the exception of its upper portion, which is hidden by the body of the lower jaw, will now be seen. The gland is surrounded by a fibrous capsule, which is derived from the superficial layer of the deep fascia. Displace the submaxillary gland upward upon the face, holding it there with hooks while further dissection of the triangle is made. In displacing the gland avoid severing the facial vein, which passes over it, and the facial artery, which passes through the groove on its deep surfaces.

The lingual triangle.—The portion of the submaxillary or digastric triangle, through which the lingual artery runs, is frequently spoken of as the lingual triangle. In relation with the triangle are the submaxillary gland, the posterior belly and the tendon of the digastric muscle, the hypo-glossal nerve, the hyo-glossus muscle, and the middle constrictor muscle of the pharynx. This subdivision of the submaxillary triangle is bounded above by the hypo-glossal nerve, posteriorly by the posterior belly of the digastric muscle, and anteriorly by the mylo-hyoid muscle; its *roof* is formed by the submaxillary gland, and its *floor* by the hyo-glossus and middle constrictor muscle of the pharynx. In ligating the lingual artery an incision is carried above and parallel with the greater cornu of the hyoid bone; the skin, the superficial fascia, the platysma myoides muscle, and the superficial layer of the deep fascia are divided, and the submaxillary gland is exposed. The gland is lifted upward, when the artery will be found beneath the hyo-glossus muscle and beneath the interval between the hypo-glossal nerve and the tendon of the digastric muscle. In making the incision through the hyo-glossus muscle care must be observed to avoid wounding the middle constrictor muscle, division of which would open the pharynx. It is not necessary to cut the hyo-glossus, as the artery is readily secured before it passes beneath that muscle without endangering the pharynx.

DISSECTION.—Divide the sterno-mastoid muscle at about its middle, and reflect the two portions. This exposes the descendens hypoglossi nerve, which lies upon the sheath of the vessels, the communicantes hypoglossi nerves, the ansa hypoglossi, the tendon of the omo-hyoid muscle, the sheath of the vessels, the spinal accessory nerve, the phrenic nerve, the cervical plexus, the anterior scalene muscle, and a portion of the subclavian vessels and some of their branches. The spinal accessory and phrenic nerves, the cervical plexus, the anterior scalene muscle, and the subclavian vessels are covered by the posterior portion of the two processes of the deep cervical fascia (prevertebral), overlaid by some areolar and fatty tissue. Remove the fat and areolar tissue with the layer of fascia (prevertebral) covering the structures just named, inferior thyroid, and the vertebral supra-scapular, transversalis colli, and vertebral arteries.

THE CERVICAL PLEXUS OF NERVES.

The cervical plexus is formed by the anterior branches of the upper four cervical nerves. It is situated in the upper part of the neck, beneath the sterno-mastoid muscle, and rests upon the scalenus medius and levator anguli scapulæ muscles. It differs from the axillary or brachial plexus in resembling a network rather than a bundle of cords. Each nerve, excepting the first, divides into an ascending and a descending branch; these unite with similar parts of the contiguous nerves, thus forming a plexus. The branches of the plexus are divided into a superficial and a deep set; the *superficial set* of branches has been described with the superficial fascia of the neck. The *deep set* of branches is, for convenience, divided into an internal and an external series. The internal series includes the phrenic, communicantes hypoglossi, muscular, and communicating branches; the external series includes muscular and communicating branches.

The **phrenic nerve,** the internal respiratory nerve of Bell, supplies the diaphragm. It arises from the third and fourth cervical nerves, and receives a communicating branch from the fifth. It passes downward and inward over the anterior surface of the anterior scalene muscle, beneath the omo-hyoid muscle, the transversalis colli and supra-scapular arteries, and the thoracic duct (left side), and enters the upper opening of the chest behind the subclavian vein, and in front of the subclavian artery. It then crosses in front of the internal mammary artery. from without inward, and the root of the lung, and passes through the middle mediastinum between the mediastinal layer of the pleura and the pericardium, to reach the diaphragm, which it pierces for final distribution upon its lower surface. At the lower part of the neck it is joined by a filament of the sympathetic nerve, and at times by a branch from the nerve to the subclavius muscle. In the chest it

is accompanied by the arteria comes nervi phrenici, a branch of the internal mammary artery. The origin of the phrenic nerve is mainly from the fourth cervical segment of the spinal cord, which is situated behind the upper part of the body of the fourth cervical vertebra, and the fact that this nerve is the one which innervates the diaphragm, explains the fatality due to injury of the spinal cord through fractures and dislocations of the upper cervical vertebræ.

The **communicantes hypoglossi** (communicantes noni) arise from the second and third cervical nerves, pass downward to the outer side of the internal jugular vein, then cross in front of the vein, and join the descendens hypoglossi, a branch of the hypo-glossal nerve, in front of the sheath of the blood vessels, forming the loop known as the *ansa hypoglossi.* The descendens and communicantes hypoglossi supply the depressor muscles of the hyoid bone and larynx—namely, the sterno-hyoid, sterno-thyroid, and omo-hyoid muscles. This loop (ansa) may be behind the internal jugular vein, and within or outside the sheath of the vessels.

The **muscular branches** of the internal series arise from the first, second, third, and fourth cervical nerves; they supply the rectus capitis anticus major and minor, rectus lateralis, and longus colli muscles.

The **communicating branches** of the internal series connect the cervical plexus with the sympathetic, pneumogastric, and hypo-glossal nerves.

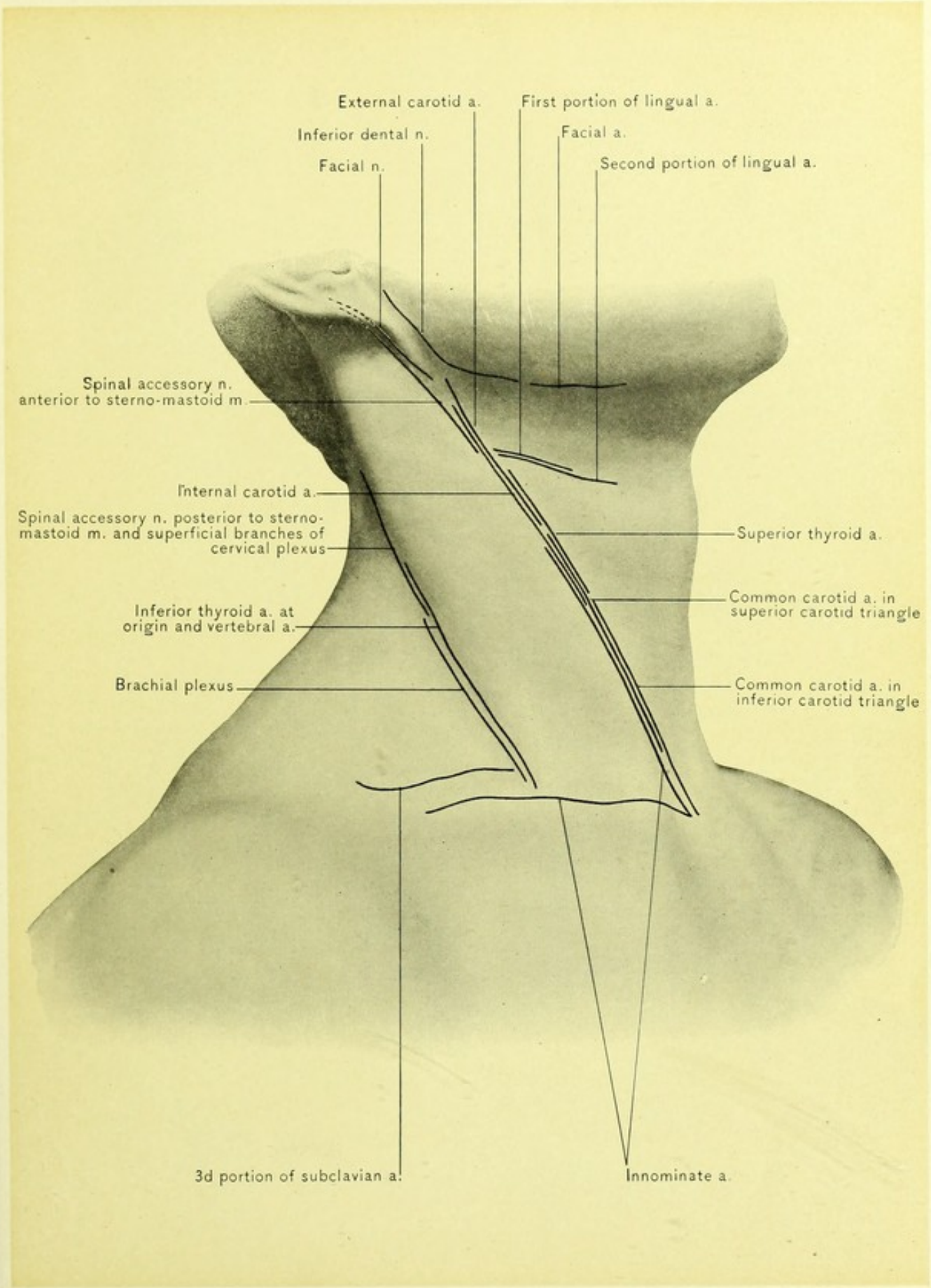
The **muscular branches** of the external series supply the sterno-mastoid, the trapezius, the levator anguli scapulæ, and the scalenus medius muscle; the branch to the sterno-mastoid muscle arises from the second cervical nerve; the branches to the levator anguli scapulæ, trapezius, and scalenus medius muscles from the third and fourth cervical nerves.

The **communicating branches** of the external series connect the cervical plexus with the spinal accessory nerve in the sterno-mastoid muscle, in the occipital triangle, and lastly beneath the trapezius muscle, forming the **subtrapezial plexus.**

Pain in one or more of the areas supplied by the various sensory branches of the cervical nerves may be caused by caries of the cervical vertebræ. Irritation of these nerves produces pain or spasm of the muscles in the regions supplied by the posterior branches of the nerves, as well as in those supplied by the cervical and brachial plexuses.

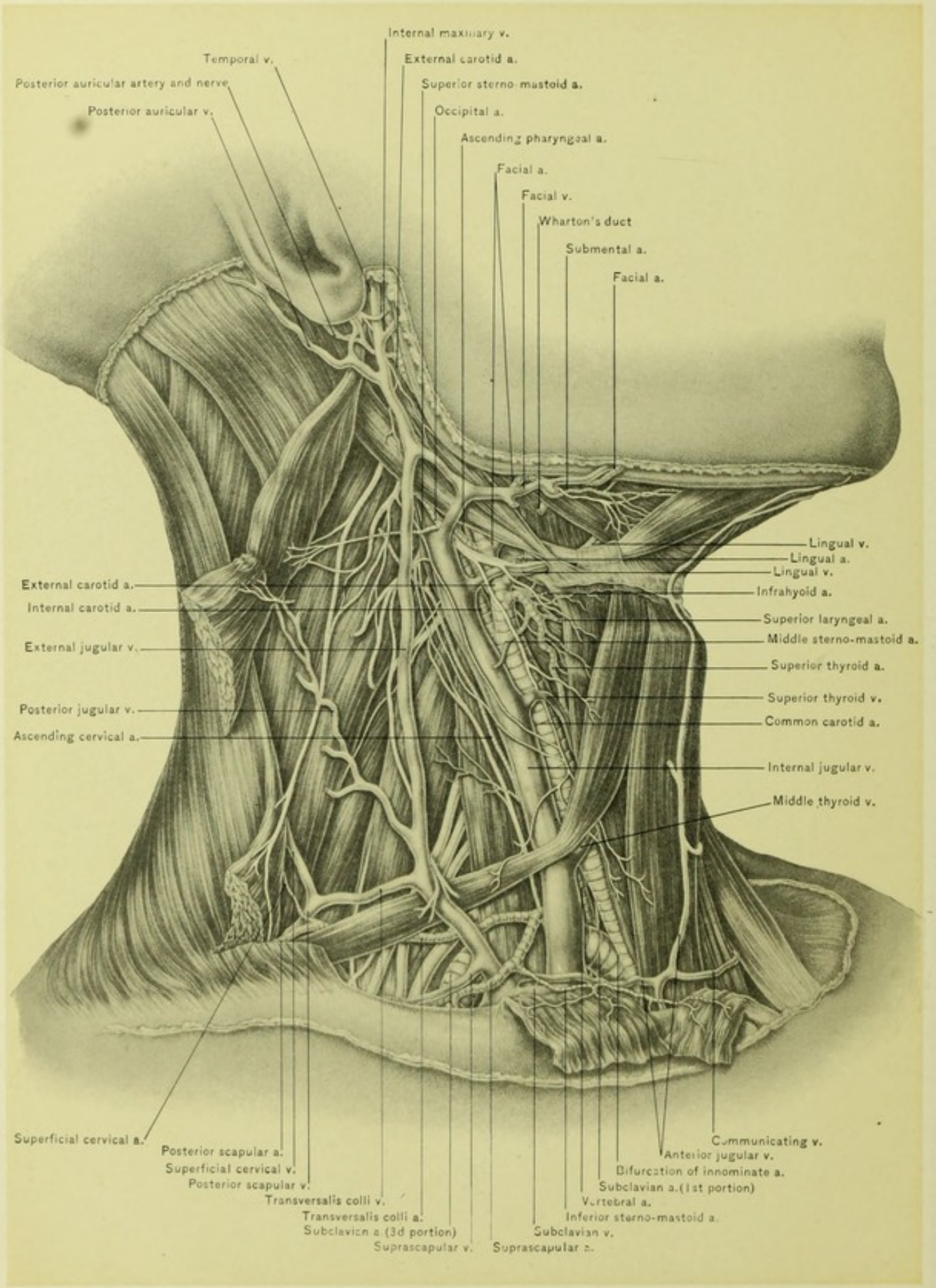
Next examine the carotid sheath and the structures in relation with it.

The **Carotid Sheath** is formed by the division of the superficial layer of the deep cervical fascia which passes beneath the sterno-mastoid muscle, by the pre-vertebral and pretracheal fasciæ. It is divided by septa into three compartments:

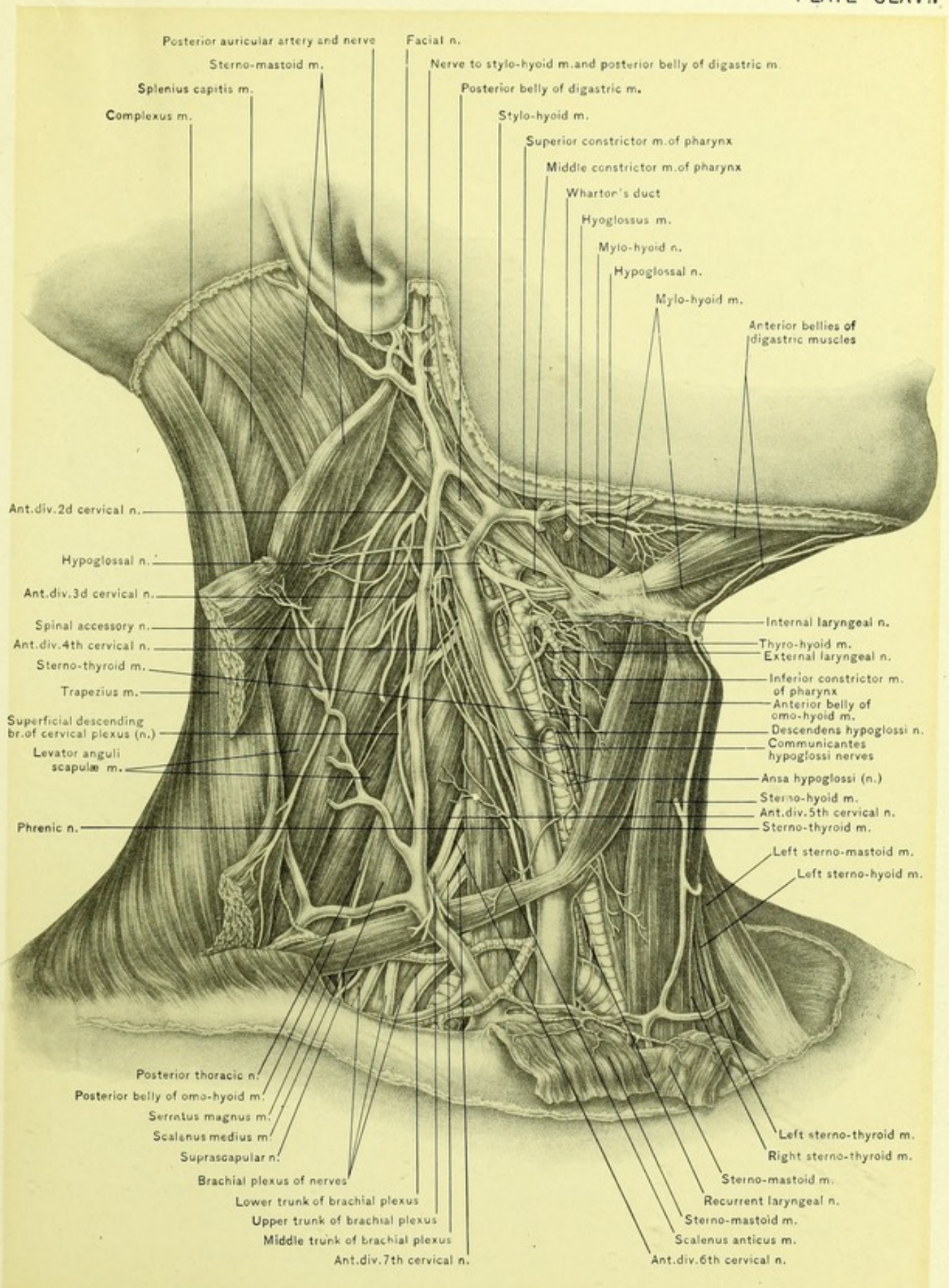


INCISIONS FOR DISSECTION AND LINES FOR ARTERIES, VEINS, AND NERVES.

PLATE CLXV.



VESSELS AND NERVES OF NECK.



VESSELS AND NERVES OF NECK.

the inner contains the common carotid artery, the outer the internal jugular vein, and the posterior the pneumogastric nerve.

The **descendens hypoglossi nerve** (descendens noni) is usually seen lying in front of the carotid sheath, but occasionally it lies within the anterior wall of the sheath. It is given off from the hypo-glossal nerve as the latter winds around the occipital artery. It is not a true branch of the hypo-glossal nerve, its fibers originally arising from the cervical plexus and running with the trunk of the hypo-glossal nerve for a short distance. It communicates with the communicantes hypoglossi, deep branches of the cervical plexus, thus forming a loop known as the *ansa hypoglossi*, which supplies the sterno-hyoid, sterno-thyroid, and both bellies of the omo-hyoid muscle.

Lymphatic glands.—In relation with the outer wall of the sheath of the vessels, observe the deep chain of lymphatic glands; these glands are in communication with the superficial chain, and therefore in enlargement of the latter the deep chain is more or less involved. Every surgeon who has had experience in the removal of glandular tumors of the neck appreciates this fact when forced to carry the dissection to the extent of exposing the carotid sheath for some distance if he would remove all enlarged glands. In cases where it is not possible to make a good exposure and dissect with safety around the vessels by simply displacing the sterno-mastoid muscle, it will be necessary to divide the muscle. In making a difficult dissection in a region rich in important structures success is obtained only by having a good exposure, which necessitates a large wound.

Dissection.—Remove the deep chain of lymphatic glands together with the fat and connective tissue around them, and lay open the sheath, when the carotid artery, the internal jugular vein, and the pneumogastric nerve will be brought into view. The internal jugular vein lies to the outer side of the common carotid artery, while the pneumogastric nerve lies between the vein and artery in a plane posterior to both.

The **internal jugular vein** is the continuation of the lateral sinus, and begins at the jugular foramen, where that sinus is joined by the inferior petrosal sinus. The vein is somewhat dilated at it origin, this enlargement constituting the so-called *bulb* or *sinus*, which lies in the jugular fossa. At the jugular foramen the vein lies behind and external to the glosso-pharyngeal, pneumogastric, and spinal accessory nerves. It passes down the side of the neck, at first beneath and external to the internal carotid artery, then on the outer side of the internal carotid, and, finally, on the outer side of the common carotid artery. It terminates by joining the subclavian vein just external to the upper margin of the sterno-clavicular articulation to form the innominate vein. It occupies the outer compartment of the carotid sheath, and is separated from the common carotid artery

and pneumogastric nerve by septa. At the lower part of the neck the internal jugular veins observe a slightly different course. At its termination the right internal jugular vein leaves the right common carotid artery to join the subclavian vein, forming a triangular interval between the artery and vein, while the left internal jugular vein turns forward to join the subclavian vein, and overlaps the left common carotid artery at the root of the neck. The internal jugular vein has a pair of valves about three-fourths of an inch from its termination. Opposite the angle of the lower jaw a communicating branch from the external jugular vein and some pharyngeal veins empty into it. Near the level of the greater cornu of the hyoid bone it receives the facial and lingual veins; lower, the superior thyroid vein; and opposite the cricoid cartilage, the middle thyroid vein.

The common carotid artery.—The right and left common carotid arteries are dissimilar in origin, but occupy similar positions in the neck (for this reason but one artery will be described). The right common carotid arises from the innominate artery behind the upper margin of the right sterno-clavicular articulation; the left common carotid arises from the highest part of the transverse portion of the arch of the aorta. As the left common carotid artery arises within the chest, it is the longer of the two vessels; it may be divided into a thoracic and a cervical portion. The thoracic portion of the left common carotid artery will be described with the chest.

The *course* of the common carotid, external carotid, and internal carotid arteries when the face is turned slightly to the opposite side, is represented by a line drawn from the sterno-clavicular articulation to a point midway between the angle of the lower jaw and the mastoid process of the temporal bone. That portion of the line below the level of the greater cornu of the hyoid bone indicates the course of the common carotid artery, and that part above the hyoid bone indicates the position of the internal carotid and external carotid arteries. The external carotid deviates slightly from this line toward the angle of the lower jaw.

At the lower part of the neck the common carotid artery is situated deeply beneath the sternal origin of the sterno-cleido-mastoid, the sterno-hyoid, and the sterno-thyroid muscle, being separated from its fellow by the trachea, which is about an inch in width. Thence it ascends in the inner compartment of the sheath of the vessels, beneath the anterior border of the sterno-cleido-mastoid muscle, to terminate opposite the upper border of the thyroid cartilage by bifurcating into the external and internal carotid arteries. As the artery ascends it diverges from the median line, on account of the interposition of the lateral lobe of the thyroid gland between it and the trachea, and as a result of the width of the larynx. It is covered by the skin, superficial fascia, platysma myoides muscle, superficial layer of the deep fascia, the anterior border of the sterno-mastoid mus-

cle, and the anterior wall of the carotid sheath; in addition to these, at the lower part of the neck are the sterno-hyoid and sterno-thyroid muscles, the thyroid gland, which slightly overlaps it, the omo-hyoid muscle and the anterior jugular vein, which cross it. The descendens hypoglossi nerve and ansa hypoglossi also lie in front of it, and the middle sterno-mastoid artery and the superior and middle thyroid veins cross it. Behind it are the rectus capitis anticus major and the longus colli muscle, the pneumogastric, sympathetic, and cardiac nerves, the recurrent laryngeal nerve, at the lower part of the neck, and the inferior thyroid artery crossing behind it at the level of the cricoid cartilage. To the inner side of the artery are the trachea and esophagus, the recurrent laryngeal nerve lying between them, the lateral lobe of the thyroid gland, the terminal portion of the inferior thyroid artery, the larynx, the pharynx, and the superior thyroid artery. To the outer side of the artery are the internal jugular vein and the pneumogastric nerve.

The common carotid artery seldom gives off branches, but may, when the bifurcation is higher than usual, give off the superior thyroid artery. The bifurcation of the artery may occur higher or lower than the upper border of the thyroid cartilage, and is not infrequently situated opposite the greater cornu of the hyoid bone.

Aneurysm of the common carotid artery most frequently develops near its bifurcation. Pressure upon the internal jugular vein by an aneurysm of the common carotid artery produces cyanosis or duskiness of the face and scalp, headache, and puffiness or edema of the face; pressure upon the sympathetic cord causes dilatation of the pupil, and, later, contraction of the pupil; pressure upon the superior laryngeal nerve causes cough, and spasm or paralysis of one crico-thyroid muscle; and pressure upon the recurrent laryngeal nerve, spasm or paralysis of the muscles of one side of the larynx, hoarseness, and difficulty in phonation. These aneurysms at the side of the neck produce a pulsating swelling which resembles that seen in enlargement of one lateral lobe of the thyroid gland. As the thyroid gland adheres to the trachea, enlargements or tumors of that organ move upward and downward with the larynx and trachea during deglutition, whereas an aneurysm of the common carotid artery remains stationary.

Ligation of the common carotid artery.—In wounds or aneurysm of this artery or one of its branches, it may require a ligature. It is tied, preferably, in the superior carotid triangle, opposite the cricoid cartilage and immediately above the point where the omo-hyoid muscle crosses its sheath. The incision is made along the anterior border of the sterno-mastoid muscle, cutting through the skin, superficial fascia, platysma myoides muscle, and superficial layer of the deep fascia; the sterno-mastoid muscle is then displaced outward, and the sheath with the descendens hypoglossi nerve upon it exposed. As the internal jugular vein slightly

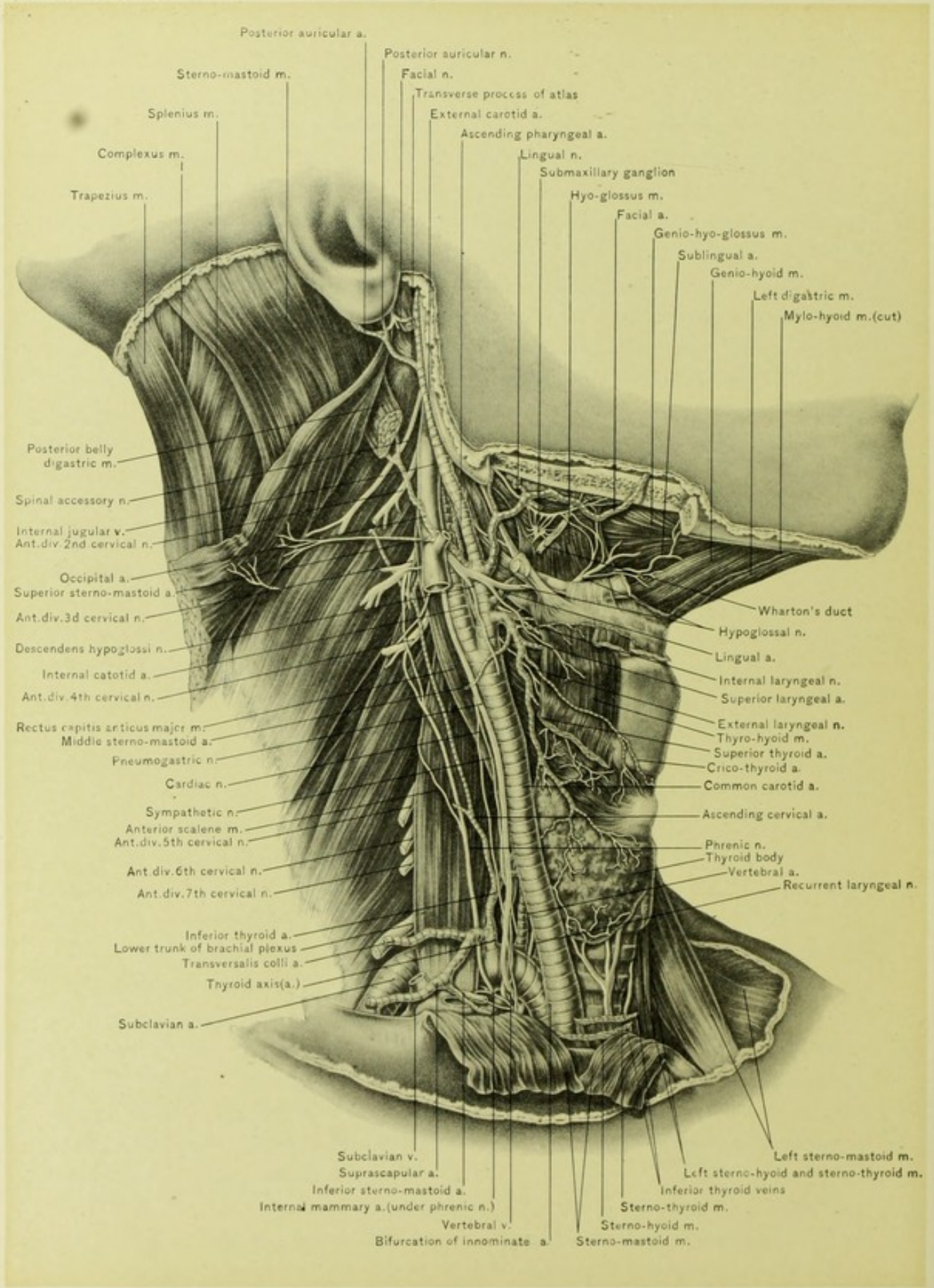
overlaps the outer side of the artery, a small incision should be made in the inner side of the sheath, and the needle passed from without inward, avoiding the internal jugular vein and the pneumogastric nerve. The opening in the sheath should be small, so that the vasa vasorum and the nutrition of the vessel will not be unnecessarily disturbed. In exposing the carotid sheath, the superior or middle thyroid vein and the middle sterno-mastoid artery may be severed. In the inferior carotid triangle the artery is ligatured with more difficulty and danger, because it is deeper and covered by three layers of muscles: the sterno-thyroid, sterno-hyoid, and sterno-mastoid; and, on the left side, the internal jugular vein turns forward in front of the artery at the root of the neck to join the subclavian vein.

Intercarotid body or ganglion.—This small, oval, reddish-brown body is situated in the interval between the external and internal carotid arteries, behind the bifurcation of the common carotid artery. It receives filaments from the sympathetic nerve, and resembles the coccygeal body or Luschka's gland.

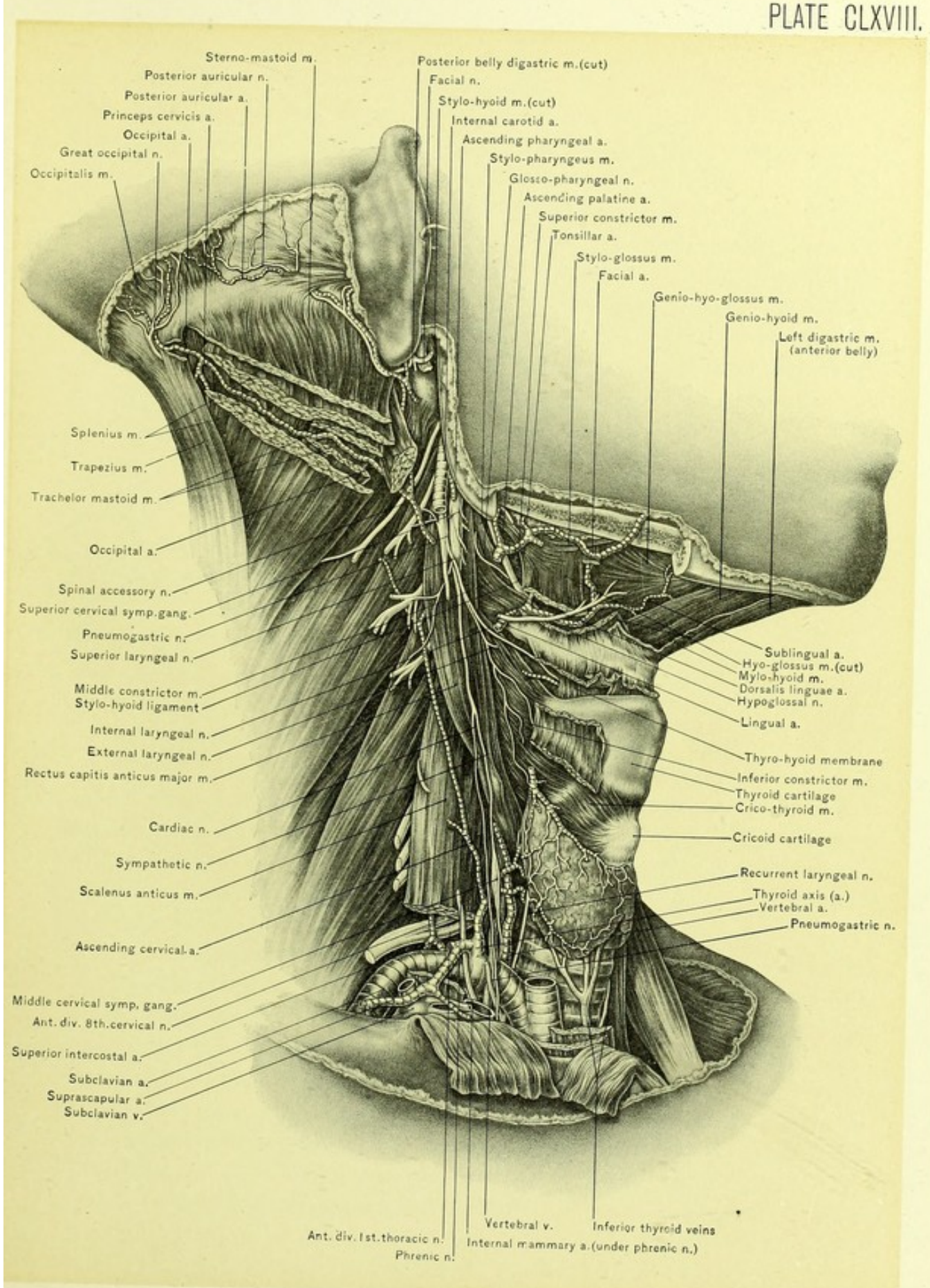
The Pneumogastric or Vagus Nerve.—The pneumogastric nerve, the tenth and longest of the cranial nerves, has an extensive area of distribution. It supplies branches to the dura mater, external ear, pharynx, larynx, esophagus, trachea, bronchi, lungs, stomach, spleen, liver, and to the sympathetic system of nerves in the cervical, thoracic, and abdominal regions. It leaves the cranial cavity at the jugular foramen, inclosed within the same sheath of the dura mater as the spinal accessory nerve. It runs downward between the internal jugular vein and the internal carotid artery, passing next between the internal jugular vein and the common carotid artery, lying behind and between them in the posterior compartment of their sheath. It enters the chest at its superior opening. On the right side it passes between the first portion of the subclavian artery and the subclavian vein, while on the left side it runs between the first portion of the subclavian artery and the common carotid artery, beneath the left innominate vein. Its course in the chest will be included in the description of that part of the body. The pneumogastric nerve, owing to its position between the internal jugular vein and the internal carotid artery, is closely associated with the glosso-pharyngeal, spinal accessory, and hypo-glossal nerves. These nerves accompany the internal carotid artery but a short distance, the glosso-pharyngeal nerve curving forward between the external and internal carotid arteries, the spinal accessory nerve turning backward beneath the internal jugular vein, and the hypo-glossal nerve curving forward over the internal and external carotid arteries and the root of the occipital artery.

There are two ganglia on the pneumogastric nerve: the *ganglion of the root*, and the *ganglion of the trunk*. The ganglion of the root is a small, rounded swelling seen upon the nerve as it lies in the jugular foramen. The ganglion of the trunk

PLATE CLXVII.



DEEP STRUCTURES OF NECK,—CAROTID ARTERIES AND PNEUMOGASTRIC NERVE.



SYMPATHETIC NERVE AND LARYNGEAL NERVES.

is a long, fusiform enlargement, situated upon the nerve about one-half of an inch below the jugular foramen. It is closely associated with the hypo-glossal nerve, which winds around its outer side; below this ganglion the vagus receives some fibers from the accessory portion of the spinal accessory nerve.

Branches of the Pneumogastric Nerve.—These may be classified as *communicating branches* and *branches of distribution.* The communicating branches connect it with the facial, glosso-pharyngeal, spinal accessory, hypo-glossal, sympathetic, and first two cervical nerves. The branches of distribution are: in the jugular foramen, the meningeal and the auricular nerve; in the neck, the pharyngeal, superior laryngeal, recurrent laryngeal, and cervical cardiac nerves; in the chest, the thoracic cardiac, anterior and posterior pulmonary, and esophageal nerves; in the abdomen, gastric branches.

The **meningeal or recurrent branch** is a small twig which runs upward from the ganglion of the root, through the jugular foramen, to the dura mater near the lateral sinus.

The **auricular (Arnold's) nerve** has its origin from the ganglion of the root of the vagus, receives a branch from the petrous ganglion of the glosso-pharyngeal nerve, and passes over the bulb of the internal jugular vein to reach an aperture in the outer wall of the jugular fossa. It next passes through the temporal bone near the facial canal, communicating with the facial nerve, and emerging from the bone between the mastoid process and the external auditory meatus. Turning outward, it supplies the back of the pinna and part of the external auditory canal, one of its branches communicating with the posterior auricular branch of the facial nerve. Irritation of this nerve by a foreign body in the external auditory meatus may induce cough, which is not relieved until the foreign body is removed. This *ear cough* is explained by reference of the irritation to the mucous membrane of the larynx through the auricular and superior laryngeal branches of the pneumogastric nerve.

The **pharyngeal branch,** the chief motor nerve of the pharynx, arises from the ganglion of the trunk and receives part of the accessory portion of the spinal accessory nerve. It runs behind or in front of the internal carotid artery to the back of the pharynx, to the upper border of the middle constrictor muscle, where it assists in forming the *pharyngeal plexus.* This plexus is formed by branches of the glosso-pharyngeal nerve, pneumogastric nerve, and superior cervical sympathetic ganglion. The pharyngeal muscles and mucous membrane and the azygos uvulæ and levator palati muscles are supplied by filaments from this plexus.

The **superior laryngeal nerve** is the sensory nerve of the larynx. It arises from the ganglion of the trunk of the pneumogastric nerve, curving downward and forward behind the internal and external carotid arteries, and dividing

into the external and internal laryngeal branches. The *internal branch*, together with the superior laryngeal artery, enters the larynx through the thyro-hyoid membrane, supplying the laryngeal mucous membrane and the arytenoid muscle, and communicating with the recurrent laryngeal nerve. Irritation of this branch, as by a crumb of bread or a drop of water entering the larynx, causes a momentary cessation of respiration, cough, and expulsion of the intruding substance. The *external branch*, which is smaller than the internal, descends along the side of the pharynx under the sterno-thyroid muscle; it supplies the crico-thyroid muscle and crico-thyroid membrane, the inferior constrictor muscle of the pharynx, and the thyroid gland; it also sends filaments to the pharyngeal plexus, and gives off, behind the common carotid artery, a branch to the superior cardiac nerve of the sympathetic.

Paralysis of the superior laryngeal nerve may be due to pressure of an aneurysm of the external or the internal carotid artery, or to enlarged lymphatic glands or tumors. The external laryngeal division may also be compressed by aneurysm of the upper part of the common carotid artery. Anesthesia of the laryngeal mucous membrane would permit foreign bodies to enter the larynx, and cause inflammation or obstruction. The vocal cords can not be stretched, owing to paralysis of the crico-thyroid muscle, and the voice is, in consequence, hoarse and of low pitch.

Irritation of the superior laryngeal nerve, as by aneurysm of the internal or external carotid artery, or by an enlarged thyroid gland or lymphatic glands, causes peculiar, ringing cough, without expectoration.

The **recurrent or inferior laryngeal nerves** are the motor nerves of the larynx, supplying all of the intrinsic muscles of that organ except the crico-thyroid muscles, these being supplied by the external laryngeal branches of the superior laryngeal nerves. The *right recurrent laryngeal nerve* is shorter than the left, arising from the pneumogastric nerve as it crosses the first portion of the right subclavian artery. It then winds behind the first portion of the right subclavian artery, ascending obliquely inward in front of the apex of the right pleural sac, and behind the root of the right common carotid artery and the terminal portion of the inferior thyroid artery to reach the groove between the trachea and esophagus. While in this groove it passes behind and internal to the right lateral lobe of the thyroid body, and leaves the groove to reach the intrinsic muscles of the larynx by passing behind the inferior cornu of the thyroid cartilage.

Pressure upon this nerve may be caused by aneurysm of the first portion of the right subclavian artery or lowermost portion of the right common carotid artery, by enlargement of the thyroid body, cicatrices of the apex of the right pleura, as in phthisis, or by malignant disease of the esophagus.

The *left recurrent laryngeal nerve* arises from the pneumogastric nerve in front of the transverse portion of the arch of the aorta, and winds behind that portion of the arch below and to the left side of the obliterated ductus arteriosus. It next ascends behind the root of the left common carotid artery to the groove between the trachea and esophagus, continuing upward to the larynx, and passing behind and internal to the left lateral lobe of the thyroid body, in a course similar to that of the right recurrent laryngeal nerve. Both nerves communicate with the superior laryngeal nerve of the same side, and with the sympathetic nerve.

Pressure upon the left recurrent laryngeal nerve may be produced by aneurysm of the arch of the aorta or of the lowermost portion of the left common carotid artery, by tumors of the posterior mediastinum, enlargement of the thyroid body, or by malignant disease of the esophagus. Moderate pressure causes spasm of the muscles of the same side of the larynx, dyspnea, and change of voice. Greater pressure causes paralysis and alteration of the voice. Both nerves may be involved in labio-glosso-pharyngeal paralysis or disseminated sclerosis of the pons, medulla oblongata, and spinal cord, or by pressure from an enlarged thyroid body, or carcinoma of the esophagus. When both nerves are paralyzed the vocal cords are immovable, phonation is imperfect, and the rima glottidis is in the relaxed attitude assumed in quiet breathing.

The **cervical cardiac branches of the pneumogastric nerve** are given off in the upper and lower part of the neck. The *superior cervical cardiac branches* join the cardiac branches of the sympathetic and terminate in the deep cardiac plexus. The *left inferior cervical cardiac branch* passes between the pleura and the left side of the transverse portion of the aortic arch, entering the superficial cardiac plexus with the left superior cervical cardiac branch of the sympathetic nerve. The *right inferior cervical cardiac branch* passes on the trachea to the deep cardiac plexus.

The **thoracic and abdominal branches of the pneumogastric nerve** are described with the thorax and abdomen.

The Sympathetic.—The sympathetic nervous system consists of a series of ganglia, one ganglion being joined to the other by connecting nerve cords; it is also composed of gangliated plexuses, visceral ganglia, and many nerve fibers. Some of the ganglia—as, for instance, the cardiac ganglia—possess automatic action. The nerve fibers of the sympathetic system are chiefly non-medullated.

The cervical portion of the sympathetic nerve is situated behind the carotid sheath or in its posterior wall, and lies beneath the prevertebral fascia, where it rests upon the rectus capitis anticus major and the longus colli muscle. Three cervical ganglia—the superior, middle, and inferior—lie in each side of the neck.

The **superior cervical ganglion,** the largest of the three, is a long, fusiform body situated opposite the transverse processes of the second and third cervical vertebræ, behind the sheath of the great vessels. It is formed probably by the fusion of four ganglia, as it communicates with four spinal nerves. It gives off an ascending and a descending branch, branches to cranial and cervical nerves, branches which follow the external carotid artery and its branches, pharyngeal branches, laryngeal branches, and the superior cardiac nerve.

The *ascending branch* passes upward through the carotid canal, with the internal carotid artery. It divides into an external and an internal branch. Its external branch forms the carotid plexus, while its internal branch forms the cavernous plexus.

The *descending branch* passes downward to the middle cervical ganglion.

The *branches to the cranial nerves* communicate with the ganglia of the root and trunk of the pneumogastric nerve, the petrous ganglion of the glosso-pharyngeal nerve, and the hypo-glossal nerve. No branches pass to the spinal accessory nerve. The branches to the spinal nerves pass outward over the rectus capitis anticus major muscle to join the upper four cervical nerves.

The branches which ramify upon the external carotid artery and its branches (*nervi molles*) proceed from the upper part of the ganglion. The nervi molles upon the external carotid artery supply branches to the intercarotid body; the nervi molles of the facial artery, branches to the submaxillary ganglion (the sympathetic root); those upon the middle meningeal artery, the sympathetic root to the otic ganglion, and the external *superficial petrosal nerve,* which is the sympathetic root of the geniculate ganglion of the facial nerve.

The *pharyngeal branches* pass inward behind the internal and external carotid arteries, and assists in forming the pharyngeal plexus.

The *laryngeal branches* join the superior laryngeal nerve.

The *superior cervical sympathetic cardiac nerve* arises from the lower part of the superior cervical sympathetic ganglion, or from the cord which runs to the middle cervical ganglion. It runs downward behind the carotid sheath, communicating with the superior cardiac branch of the pneumogastric, the external laryngeal, and the recurrent laryngeal nerve. In the chest the two nerves take different courses. The right superior cervical sympathetic cardiac nerve passes in front of or behind the first portion of the subclavian artery, following the innominate artery, and terminating in the deep cardiac plexus. On the left side the nerve passes between the left common carotid and the left subclavian artery, and over the left side of the arch of the aorta, to the left of the left pneumogastric nerve, terminating in the superficial cardiac plexus.

The **middle cervical or thyroid ganglion,** the smallest of the three ganglia,

appears as a swelling upon the sympathetic cord. It may, however, be absent. It rests upon or beneath the inferior thyroid artery, opposite the transverse process of the sixth cervical vertebra, and is formed probably by the fusion of two ganglia, as it communicates with two spinal nerves. It gives off communicating branches to the superior and inferior cervical ganglia, and to the fifth and sixth cervical nerves, thyroid branches, and the middle cardiac nerve.

The *communicating branch to the superior ganglion* is the cord of the sympathetic nerve.

The *communicating branches to the inferior ganglion* are the main sympathetic cord, which passes behind the first portion of the subclavian artery, and one or two nerves which form a loop (*ansa Vieussenii*) in front of and below the artery.

The *thyroid branches* accompany the inferior thyroid artery to the thyroid body.

The *middle cardiac nerve*, the largest of the three cervical sympathetic cardiac nerves, arises from the middle ganglion or the sympathetic cord just below it. It communicates with the superior cardiac and the recurrent laryngeal nerve, and passes in front of or behind the first portion of the subclavian artery, entering the deep cardiac plexus.

The **inferior cervical ganglion** is intermediate in size between the middle and superior ganglia. It is deeply situated between the transverse process of the seventh cervical vertebra and the neck of the first rib, and lies to the inner side of the superior intercostal artery, behind the vertebral artery. It is formed probably by the fusion of two ganglia, as it communicates with two spinal nerves, the seventh and eighth cervical. It is joined to the first thoracic ganglion by two large nerves, and may be fused with that ganglion. The sympathetic cord and the ansa Vieussenii connect it with the middle cervical ganglion. It gives off the inferior cardiac nerve and branches which form a plexus on the vertebral artery.

The *inferior cervical sympathetic cardiac nerve* arises from the inferior cervical ganglion, or occasionally from the first thoracic ganglion. It passes behind the subclavian artery, communicating with the recurrent laryngeal and the middle cardiac nerve, and descending upon the trachea to enter the deep cardiac plexus.

The branches forming a plexus (*vertebral plexus*) upon the vertebral artery accompany that vessel into the cranial cavity, after which they follow the basilar and cerebral arteries. It is through this plexus of nerves that contraction of the pupil of the same side results after ligation of the vertebral artery.

The **External Carotid Artery,** so called because it supplies the tissues on the outside of the cranium, is the smaller of the two terminal divisions of the common carotid artery. It arises opposite the upper border of the thyroid cartilage,

ascends, and enters the parotid gland, where it lies beneath the temporo-maxillary vein and facial nerve. Opposite the neck of the lower jaw it divides into its two terminal branches, the temporal and internal maxillary arteries. At first it lies to the inner side of the internal carotid artery, but later becomes superficial to that vessel.

Relations.—It is covered by the skin, superficial fascia, platysma myoides muscle, superficial layer of the deep cervical fascia, anterior border of the sterno-mastoid muscle, and a portion of the parotid gland, the temporo-maxillary vein, and the facial nerve. It is crossed by the hypo-glossal nerve, the facial and lingual veins, the posterior belly of the digastric muscle and the stylo-hyoid muscle, and enters the parotid gland. Along the inner side of the vessel, from below upward, are the wall of the pharynx, the hyoid bone, the ramus of the lower jaw, and the stylo-maxillary ligament, from which it is separated by a portion of the parotid gland. Beneath it, near its origin, is the superior laryngeal nerve; higher in the neck the stylo-glossus and stylo-pharyngeus muscles, the stylo-hyoid ligament, the glosso-pharyngeal nerve, the pharyngeal branch of the pneumogastric nerve, and part of the parotid gland separate it from the internal carotid artery. On its outer side, at its origin, is the internal carotid artery. The external carotid artery differs from most of the arteries in not having a companion vein, but a vein formed by the union of the temporal and internal maxillary veins does occasionally accompany it.

A *line* line drawn from the junction of the sternum with the clavicle, to a point midway between the angle of the lower jaw and the mastoid process represents the course of the common and external carotid arteries.

Branches of the External Carotid Artery.—These are the superior thyroid, lingual, facial, occipital, posterior auricular, ascending pharyngeal, superficial temporal, and internal maxillary arteries. They may be divided into four sets: an anterior, a posterior, an ascending, and a terminal. The anterior set comprises the superior thyroid, lingual, and facial; the posterior, the occipital, and posterior auricular; the ascending, the ascending pharyngeal; and the terminal, the superficial temporal, and internal maxillary.

The **superior thyroid artery,** the first branch given off from the external carotid, arises just below the greater cornu of the hyoid bone. Throughout the greater part of its course it occupies the superior carotid triangle. It passes forward and then downward and inward behind the omo-hyoid, sterno-thyroid, and sterno-hyoid muscles to the upper and front part of the thyroid body, in which it terminates. Its branches are the hyoid, middle sterno-mastoid, superior laryngeal, and crico-thyroid arteries.

The *hyoid (infra-hyoid) artery* is very small. It runs inward along the lower

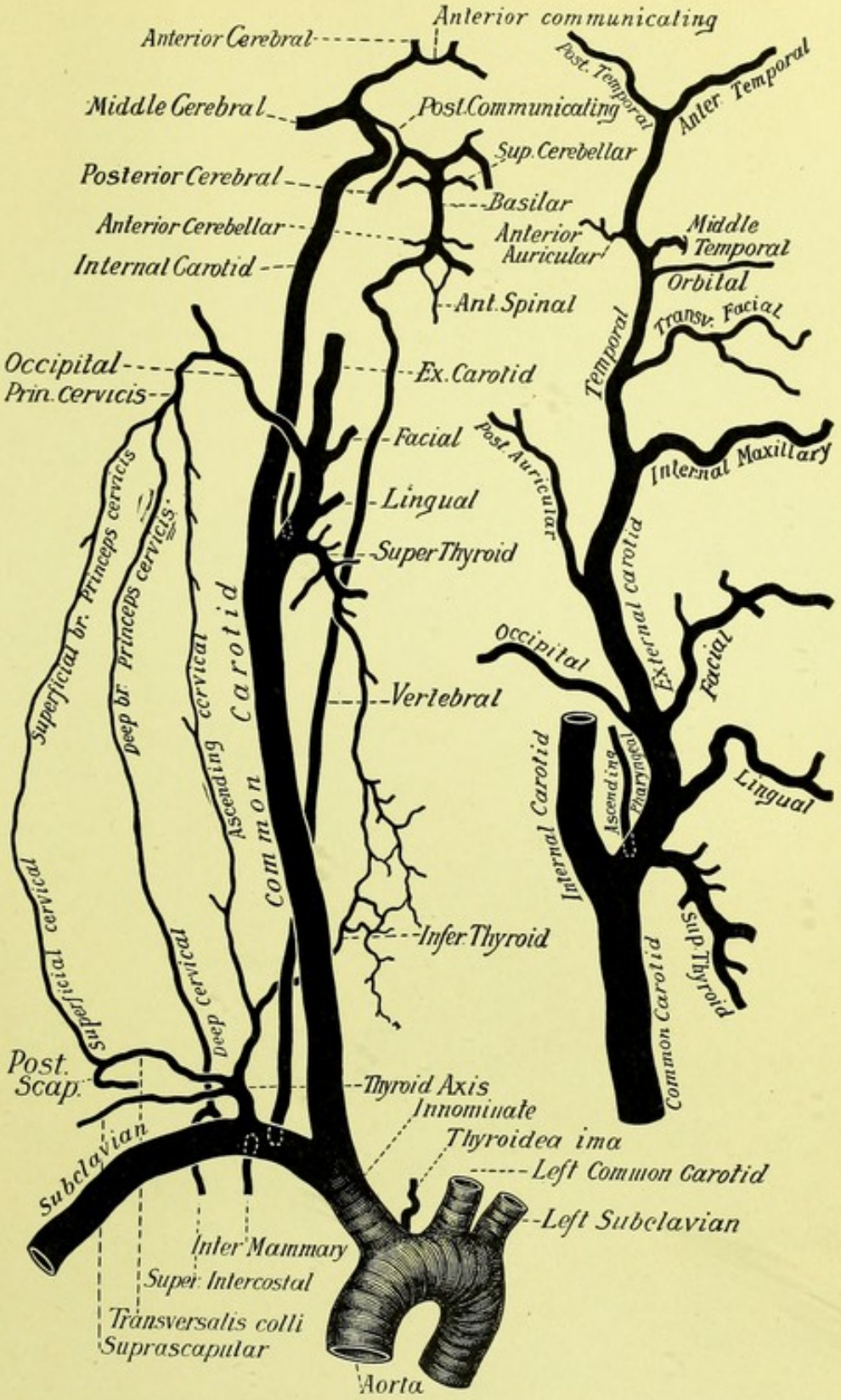
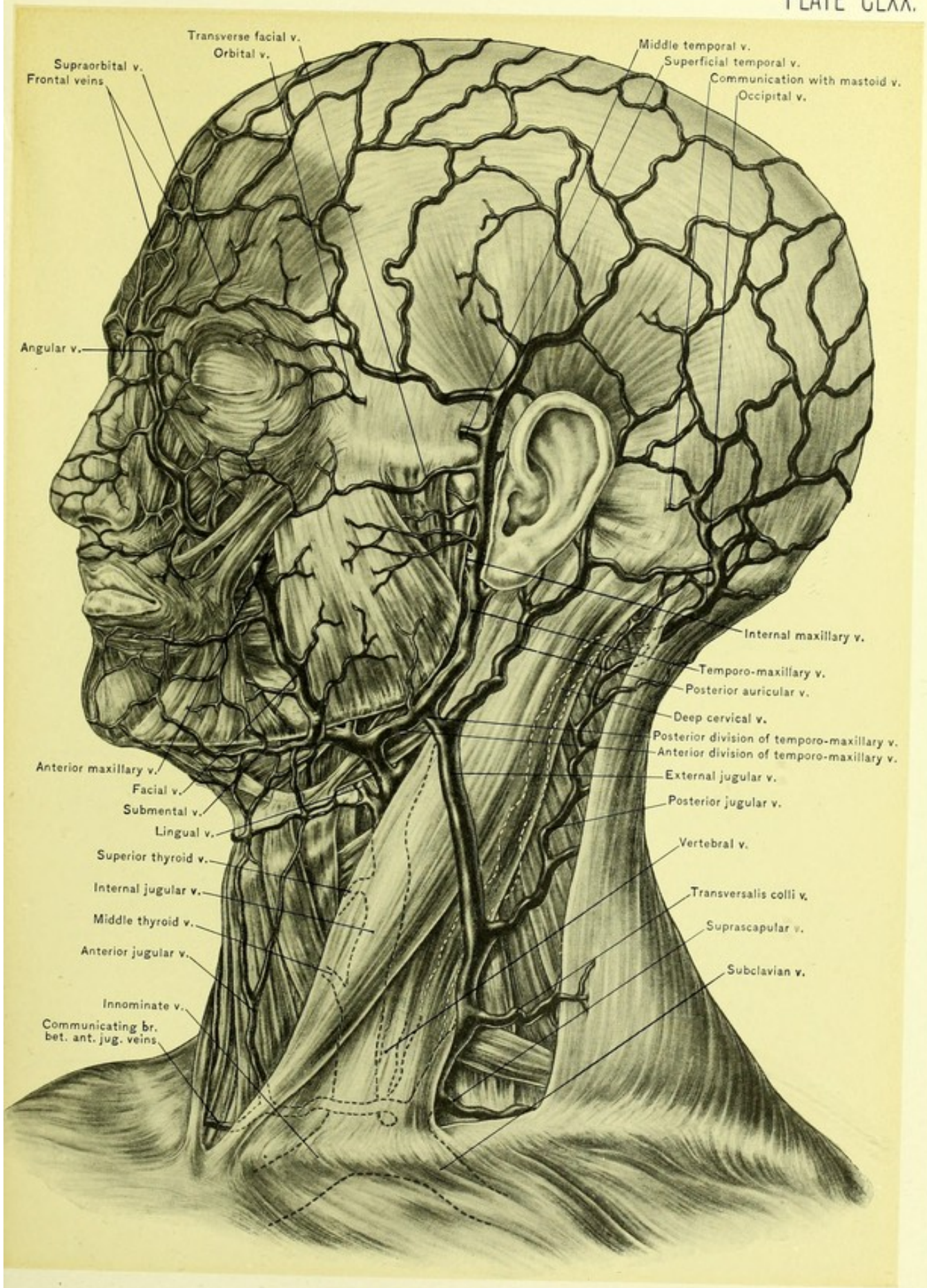


DIAGRAM OF SUBCLAVIAN AND CAROTID ARTERIES AND THEIR BRANCHES.



VEINS OF HEAD AND NECK.

border of the hyoid bone, beneath the thyro-hyoid muscle, supplying the infra-hyoid bursa and the thyro-hyoid muscle, and communicates with the infra-hyoid artery of the opposite side and with the supra-hyoid branch of the lingual artery.

The *middle sterno-mastoid artery* passes downward and outward over the sheath of the common carotid artery in the superior carotid triangle, the triangle of election; it is chiefly distributed to the middle portion of the sterno-mastoid muscle, supplying also the thyro-hyoid, sterno-thyroid, sterno-hyoid, omo-hyoid, and platysma myoides muscles, and the overlying skin. The author has observed cases in which this vessel was unusually large, running into the occipital triangle, and giving rise to fatal hemorrhage following the opening of an abscess.

The *superior laryngeal artery*, larger than either of the two preceding branches, is accompanied by the internal branch of the superior laryngeal nerve; it passes beneath the thyro-hyoid muscle and pierces the thyro-hyoid membrane, supplying the muscles and mucous membrane of the larynx, and anastomosing with the superior laryngeal artery of the opposite side and the inferior laryngeal branch of the inferior thyroid artery. At times it enters the larynx through a foramen in the thyroid cartilage.

The *crico-thyroid artery* runs across the crico-thyroid membrane, just below the lower border of the thyroid cartilage, and is continuous with the crico-thyroid artery of the opposite side. A small branch usually passes through the crico-thyroid membrane to the interior of the larynx. The operation of laryngotomy is performed by carrying a transverse incision through the crico-thyroid membrane, close to the cricoid cartilage, and it is therefore important to keep in mind the relation which the crico-thyroid artery bears to the membrane, and the necessity, when time is at command, for exposing the membrane by careful dissection.

The **superior thyroid vein,** the accompanying vessel of the superior thyroid artery, crosses the terminal part of the common carotid artery, and empties into the internal jugular vein; it may, at times, enter the facial or lingual vein. It emerges from the upper part of the lateral lobe of the thyroid body, accompanying the superior thyroid artery for a short distance, and then crossing the common carotid artery to empty into the internal jugular vein. A branch of the vein, or one which arises separately in the thyroid body, usually passes upward and anterior to the common carotid and the external carotid artery, and empties into the lingual vein.

The **lingual artery,** the second branch of the external carotid, arises opposite the greater cornu of the hyoid bone between the superior thyroid and facial arteries, occasionally arising as a common trunk with the latter. It consists of three portions: the *first* or oblique, which lies between its origin and the outer border of the hyo-glossus muscle; the *second* or horizontal portion, beneath the hyo-glossus

muscle and parallel with the greater cornu of the hyoid bone; and the *third* or ascending portion, between the hyo-glossus and the genio-hyo-glossus muscle. The *first* or oblique portion lies in the superior carotid triangle, and runs upward and inward to the upper border of the greater cornu of the hyoid bone, resting upon the middle constrictor muscle of the pharynx and the internal laryngeal branch of the superior laryngeal nerve. Thence it passes beneath the hyo-glossus, the posterior belly of the digastric, and the stylo-hyoid muscle, emerging from the superior carotid triangle and entering the submaxillary triangle. This portion of the vessel is crossed by the hypo-glossal nerve and lingual vein, and gives off the supra-hyoid branch. The *second* or horizontal portion runs beneath the hyo-glossus muscle. (See description of submaxillary triangle.) The *third* or ascending portion runs beneath the anterior border of the hyo-glossus on the outer aspect of the genio-hyo-glossus muscle, and runs forward to the tip of the tongue, terminating as the *ranine artery;* the terminal portion of the lingual artery is separated from the cavity of the mouth by the mucous membrane which lines it. (See description of submaxillary triangle.)

The *lingual vein* is seen crossing the first portion of the lingual artery with the hypo-glossal nerve. It runs over the external carotid artery and opposite the greater cornu of the hyoid bone empties into the internal jugular vein separately, or by a common trunk with the facial vein and a branch of the superior thyroid vein. These veins and their common trunk may cause some difficulty in ligation of the common carotid or first portion of the lingual artery.

The **facial artery** (external maxillary) arises from the external carotid above the lingual artery, passes upward beneath the posterior belly of the digastric and the stylo-hyoid muscle and the submaxillary gland, being embedded in a groove on the under surface of the latter; it then curves upward over the body of the lower jaw, reaching the face at the anterior inferior angle of the masseter muscle, where the artery can be compressed and its pulsations readily felt. It consists of two portions, a cervical and a facial.

The BRANCHES given off from the cervical portion of the facial artery are the ascending or inferior palatine, the tonsillar, the submaxillary, the submental, and the muscular.

The *ascending or inferior palatine artery* occasionally arises separately from the external carotid artery. It ascends between the internal and external carotid arteries, then runs between the stylo-glossus and stylo-pharyngeus muscles, and finally between the internal pterygoid muscle and the superior constrictor muscle of the pharynx. Reaching the levator palati muscle, it divides into two branches: one, the palatine, follows the course of the levator palati muscle to supply the soft palate, and anastomoses with the ascending palatine artery of the opposite side, the

descending palatine branch of the internal maxillary artery, and the ascending pharyngeal artery; the other branch, the tonsillar, perforates the superior constrictor muscle of the pharynx, and supplies the tonsil and the Eustachian tube, anastomoses with the tonsillar branches of the ascending pharyngeal and facial arteries, and with the descending or posterior palatine branch of the internal maxillary artery.

The *tonsillar artery*, smaller than the ascending palatine artery, passes upward between the internal pterygoid and the stylo-glossus muscle. It perforates the superior constrictor muscle of the pharynx opposite the tonsil, and supplies branches to the tonsil and root of the tongue. It anastomoses with the tonsillar branch of the ascending palatine and the other tonsillar arteries.

The *glandular* (*submaxillary*) *branches*, three or four in number, supply the submaxillary gland, and are derived from the portion of the artery in contact with the gland; some twigs usually run to Wharton's duct.

The *submental artery* is the largest of the branches given off from the cervical portion of the facial artery. It arises from this vessel, beneath the submaxillary gland. It next runs forward upon the mylo-hyoid muscle, under the lower border of the lower jaw, and beneath the anterior belly of the digastric muscle, to the symphysis of the lower jaw, where it divides into a superficial and a deep branch. The superficial branch winds over the lower jaw and runs in the superficial fascia of the chin, anastomosing with the inferior labial artery. The deep branch runs beneath the depressor labii inferioris muscle, and anastomoses with the inferior labial and mental arteries. Its branches are *muscular*, which supply the adjacent muscles; *perforating*, which pierce the mylo-hyoid muscle to anastomose with the sublingual artery; and *cutaneous*, to the overlying skin.

The *muscular branches* supply the posterior belly of the digastric, the stylo-hyoid, the stylo-glossus, the mylo-hyoid, and the internal pterygoid muscle.

The **facial vein** leaves the face at the anterior inferior angle of the masseter muscle. It passes over the submaxillary gland, the stylo-hyoid and posterior belly of the digastric muscle, which separate it from the facial artery. It receives the anterior division of the temporo-maxillary vein, crosses the external carotid artery, and empties into the internal jugular vein opposite the greater cornu of the hyoid bone. It may be injured in opening abscesses situated where it passes over the submaxillary gland.

The **occipital artery,** quite a large vessel, is one of the posterior branches of the external carotid artery. It arises opposite the facial artery, near the lower border of the posterior belly of the digastric muscle, along which it runs to the interval between the mastoid process of the temporal bone and the transverse

process of the atlas, to reach the groove on the under surface of the mastoid portion of the temporal bone. At its origin it is crossed by the hypo-glossal nerve. On its way to the mastoid process it crosses the internal carotid artery, the internal jugular vein, the pneumogastric, hypo-glossal, and spinal accessory nerves, and passes beneath the lower portion of the parotid gland. It runs horizontally backward through the occipital groove of the temporal bone, covered by all the muscles attached to the mastoid process,—the sterno-mastoid, splenius capitis, trachelo-mastoid, and posterior belly of the digastric muscle,—and lies upon the superior oblique and complexus muscles. Reaching the back of the head, the artery pierces the trapezius muscle close to the superior curved line of the occipital bone, ascends, and divides into branches, as described under the Dissection of the Scalp. As it pierces the trapezius muscle and ramifies in the superficial fascia of the scalp, it is accompanied by the great occipital nerve. This vessel is conveniently divided by the sterno-mastoid muscle into three parts,—a first, a second, and a third portion,—situated respectively internal to, beneath, and external to that muscle. The *first portion* is covered only by skin and fasciæ, except where it is overlapped by the posterior belly of the digastric muscle, the parotid gland, and the temporo-maxillary vein. It is crossed by the hypo-glossal nerve. Behind it successively lie the internal carotid artery, the hypo-glossal and the pneumogastric nerve, the internal jugular vein, and the spinal accessory nerve. The first portion of the artery is the *place of election* for ligation. An *incision* is carried along the anterior border of the upper part of the sterno-mastoid muscle while the neck is well extended. The skin, superficial fascia, platysma myoides muscle, and the superficial layer of the deep fascia are divided, and the artery is seen running parallel with or beneath the lower border of the digastric muscle. The hypo-glossal nerve will be seen curving around the artery at its origin. The *second portion* dips deeply under the digastric muscle between the mastoid process of the temporal bone and the transverse process of the atlas, being covered, as previously stated, by the muscles attached to the mastoid process, and lying successively against the rectus capitis lateralis, which separates it from the vertebral artery, the mastoid portion of the temporal bone while passing through the occipital groove, and finally against the insertion of the superior oblique muscle. The *third portion* emerges from beneath the posterior border of the sterno-mastoid and splenius muscles, lying upon the complexus in the triangular interval between the sterno-mastoid and the trapezius, and piercing the trapezius muscle about midway between the mastoid process and the external occipital protuberance, to become subcutaneous and pass upward in the superficial fascia of the scalp. It is accompanied by the great occipital nerve.

The Branches given off from the occipital artery are the muscular, superior

sterno-mastoid, auricular, posterior meningeal, mastoid, princeps cervicis, communicating, and terminal.

The *muscular branches* supply the digastric, stylo-hyoid, splenius, trachelo-mastoid, trapezius, recti, superior and inferior oblique, and the occipitalis muscles.

The *superior sterno-mastoid artery* enters the sterno-mastoid muscle with the spinal accessory nerve. It arises from the first portion of the occipital artery, and passes downward and backward over the hypo-glossal nerve to enter the sterno-mastoid muscle.

The *auricular branch* supplies the back of the pinna. At times it is large and takes the place of the posterior auricular artery; it may send a branch to the dura mater through the mastoid foramen.

The *posterior meningeal branches* ascend along the internal jugular vein, and enter the cranial cavity through the jugular foramen to supply the dura mater of the posterior cranial fossa.

The *mastoid branch* is a small vessel which traverses the mastoid foramen to supply the diploë, the walls of the lateral sinus, the dura mater, and the mastoid air cells.

The *princeps cervicis artery* is the largest branch of the occipital artery. It runs down the back of the neck between the splenius and the complexus muscle, and divides into a superficial and a deep branch. The *superficial branch* pierces the splenius and runs between it and the trapezius, supplying these muscles and anastomosing with the superficial cervical artery, one of the terminal branches of the transversalis colli; the *deep branch* descends between the complexus and semi-spinalis colli, supplies these muscles, and anastomoses with branches of the vertebral and with the deep cervical branch of the superior intercostal artery. The anastomoses between the occipital, vertebral, and superior intercostal arteries play an important part in the formation of the collateral circulation after ligation of the common carotid or the subclavian artery.

Communicating branches run between the recti and the superior and inferior oblique muscles to anastomose with branches of the vertebral artery.

The *terminal branches* pass laterally and mesially upward in the superficial fascia of the occipital region of the scalp to supply the scalp and pericranium, and are known as external and internal. They anastomose with the occipital artery of the opposite side, the posterior auricular and the superficial temporal artery.

The **occipital vein** accompanies the third portion of the occipital artery; it communicates with the lateral sinus through the mastoid foramen, and with the diploic veins, piercing the trapezius muscle with the occipital artery. It enters the occipital triangle and terminates in the deep cervical vein, or it may bifurcate, one subdivision emptying into the posterior jugular vein, and the other

into the deep cervical vein. The *deep cervical vein* accompanies the deep branch of the princeps cervicis artery, then the profunda cervicis, passes between the transverse process of the seventh cervical vertebra and the neck of the first rib, and empties into the innominate or vertebral vein.

The **posterior auricular artery,** the remaining posterior branch of the external carotid, is smaller than the occipital artery, and arises just above the posterior belly of the digastric muscle. It ascends obliquely upward and backward in the parotid gland, to the furrow between the pinna of the ear and the mastoid process of the temporal bone, passing below the facial nerve and over the spinal accessory nerve. Immediately above the mastoid process it divides into two branches—an anterior, which passes forward and anastomoses with the posterior division of the temporal artery, and a posterior, which anastomoses with the occipital artery.

The BRANCHES of the posterior auricular artery are the parotid, muscular, stylo-mastoid, auricular, and mastoid.

The *parotid branches* supply the lower end of the parotid gland, anastomosing with other arteries distributed to the gland.

The *muscular branches* supply the digastric, stylo-hyoid, sterno-mastoid, and retrahens aurem muscles.

The *stylo-mastoid branch* enters the stylo-mastoid foramen of the temporal bone, and supplies the tympanum, the mastoid cells, and the semicircular canals. In the fetus a branch of the stylo-mastoid artery forms, with the tympanic branch from the internal maxillary artery, a vascular circle around the circumference of the tympanic membrane; from this circle smaller vessels are given off, which ramify upon the membrane. From the aqueduct of Fallopius it sends branches to the external auditory meatus (*meatal*); to the mastoid cells and mastoid antrum (*mastoid*); to the stapedius muscle (*stapedic*); to the tympanum, forming the anastomotic circle in the fetus (*tympanic*); to the vestibule and semicircular canals (*vestibular*); and a final twig (*terminal*), which accompanies the great superficial petrosal nerve through the hiatus Fallopii and anastomoses with the petrosal branch of the middle meningeal artery.

The *auricular branch* (anterior terminal) supplies the back part of the auricle, and anastomoses with the posterior temporal and auricular branch of the superficial temporal artery; some of its branches perforate the cartilage of the pinna to supply its anterior surface.

The *mastoid branch* (occipital branch) crosses the insertion of the sterno-mastoid muscle, supplies the structures over the mastoid process, and anastomoses with the occipital artery.

The **posterior auricular vein,** which is of considerable size, accompanies the

terminal portion of the posterior auricular artery and joins the posterior division of the temporo-maxillary vein to form the external jugular vein.

The posterior auricular nerve.—Running close to the posterior auricular artery is the posterior auricular nerve, the first branch given off from the facial after its exit from the stylo-mastoid foramen. It ascends in front of the mastoid process, where it communicates with the great auricular nerve and the auricular branch of the pneumogastric nerve. Between the mastoid process and the external auditory meatus it divides into two branches: an anterior, which supplies the retrahens aurem and the small muscles on the back of the pinna, and a posterior occipital, the larger, which passes along the superior curved line of the occipital bone, supplying the occipitalis muscle and communicating with the small occipital nerve.

The **ascending pharyngeal artery,** a long, slender branch, the smallest given off from the external carotid artery, arises from the back part of that artery, about one-half of an inch above the bifurcation of the common carotid artery. At times, however, it arises from the common carotid artery. It is situated deep in the neck, in relation with the internal carotid artery, and lies upon the rectus capitis anticus major muscle. It ascends between the internal carotid artery and the side of the pharynx, and beneath the stylo-pharyngeus muscle and the glosso-pharyngeal nerve, to the base of the skull: here it enters the pharynx above the superior constrictor muscle, to end in the soft palate. It gives off prevertebral, pharyngeal, meningeal, palatine, and tympanic branches.

The *prevertebral branches* are small vessels which pass outward to supply the rectus capitis anticus major and minor muscles, the sympathetic, pneumogastric, and hypo-glossal nerves, and the deep cervical chain of lymphatic glands. They anastomose with the ascending cervical artery.

The *pharyngeal branches,* three or four in number, supply the upper and middle constrictor muscles, the mucous membrane of the pharynx, and the stylo-pharyngeus muscle. The largest of these branches, the *palatine,* enters the pharynx above the superior constrictor muscle, and terminates in the soft palate, the Eustachian tube, and the tonsil; it takes the place of the ascending palatine branch of the facial artery when this vessel is small.

The *meningeal branches,* three in number, enter the cranial cavity through the jugular foramen, in company with the internal jugular vein, through the anterior condyloid and middle lacerated foramina, to supply the dura mater.

The *tympanic branch* traverses the tympanic canaliculus, together with the tympanic branch of the glosso-pharyngeal nerve, enters the tympanum, anastomoses with the other tympanic arteries, and supplies the adjacent structures.

The **descending pharyngeal vein** arises in a minute plexus at the back part

and side of the pharynx. After receiving meningeal branches, the veins from the soft palate and Eustachian tube, and the Vidian vein, it terminates in the internal jugular vein. It occasionally empties into the facial vein.

Internal maxillary and temporal arteries.—The description of the internal maxillary artery is given under the Dissection of the Pterygo-maxillary Region. The temporal artery is described under the Dissection of the Face.

The **Submaxillary Triangle** (continued).—

The **digastric muscle** consists of two muscular bellies, an anterior and a posterior, united by an intervening tendon. The posterior belly, the larger of the two, arises from the digastric groove, which lies to the inner side of the base of the mastoid process of the temporal bone; the anterior belly, the shorter of the two, arises from the depression on the deep surface of the lower jaw at the side of the symphysis. The fibers of the posterior belly are directed downward, forward, and inward; those of the anterior, downward and backward to the intervening tendon, which pierces the stylo-hyoid muscle, and is connected to the side of the body of the hyoid bone by a process of the deep cervical fascia lined with a synovial membrane. A broad aponeurotic expansion—the *supra-hyoid aponeurosis*—is given off on each side from the tendon of the digastric muscle, and is attached to the body and greater cornu of the hyoid bone and to aponeurotic expansion of the opposite side, so that the interval between the anterior bellies of the digastric muscles is occupied by this expansion. The posterior belly passes over the sheath of the carotid vessels, the hypo-glossal and spinal accessory nerves, and beneath the sterno-mastoid and trachelo-mastoid muscles. The occipital artery passes upward and backward along the lower border of the posterior belly. The anterior belly may be absent and the posterior belly may be double. At times accessory slips join the posterior belly from the styloid process or pharynx.

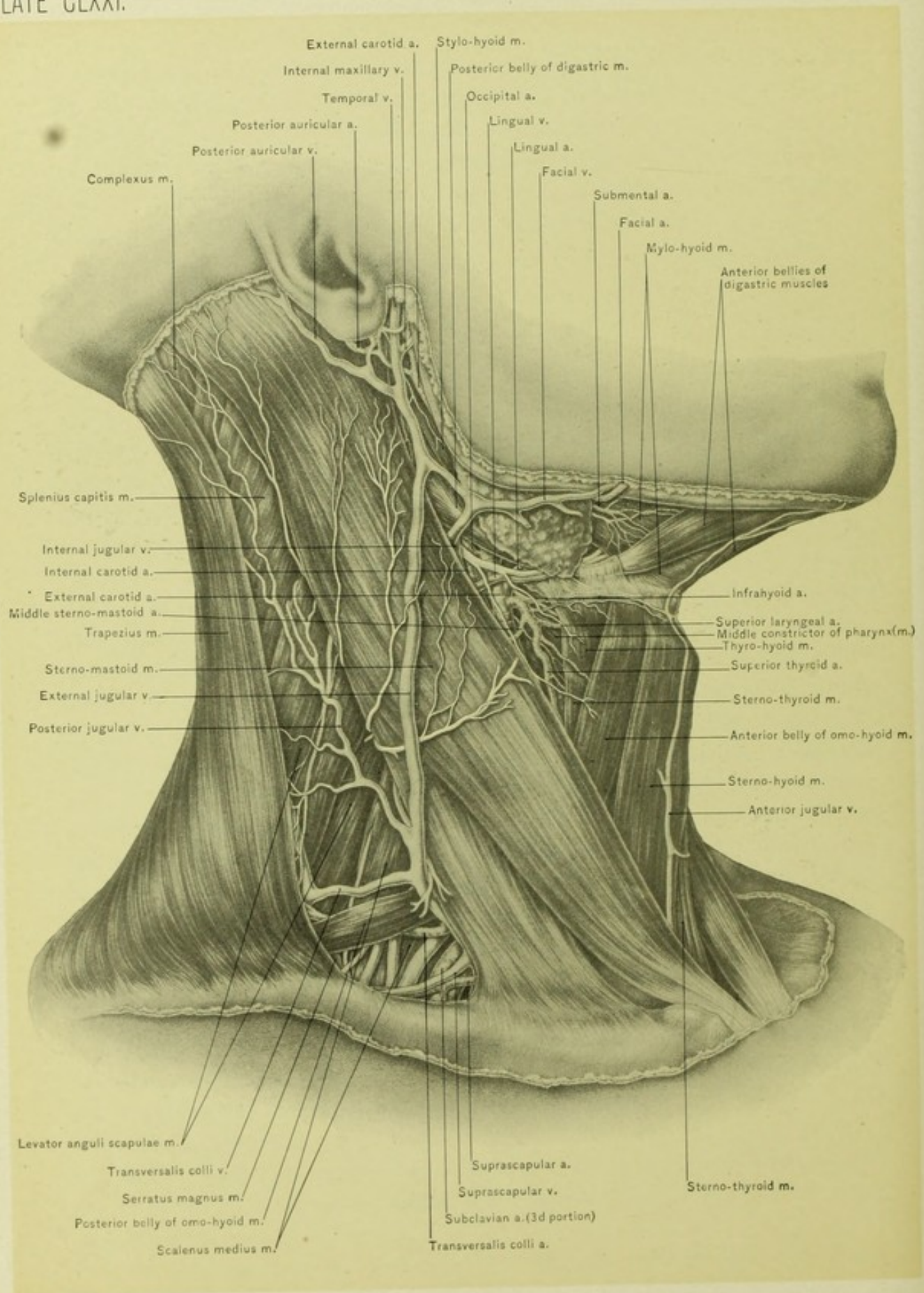
Nerve Supply.—The posterior belly of the digastric muscle is supplied by a branch from the facial nerve; the anterior belly, by the mylo-hyoid, a branch of the inferior dental nerve.

Blood Supply.—From muscular branches of the facial, occipital, and posterior auricular arteries.

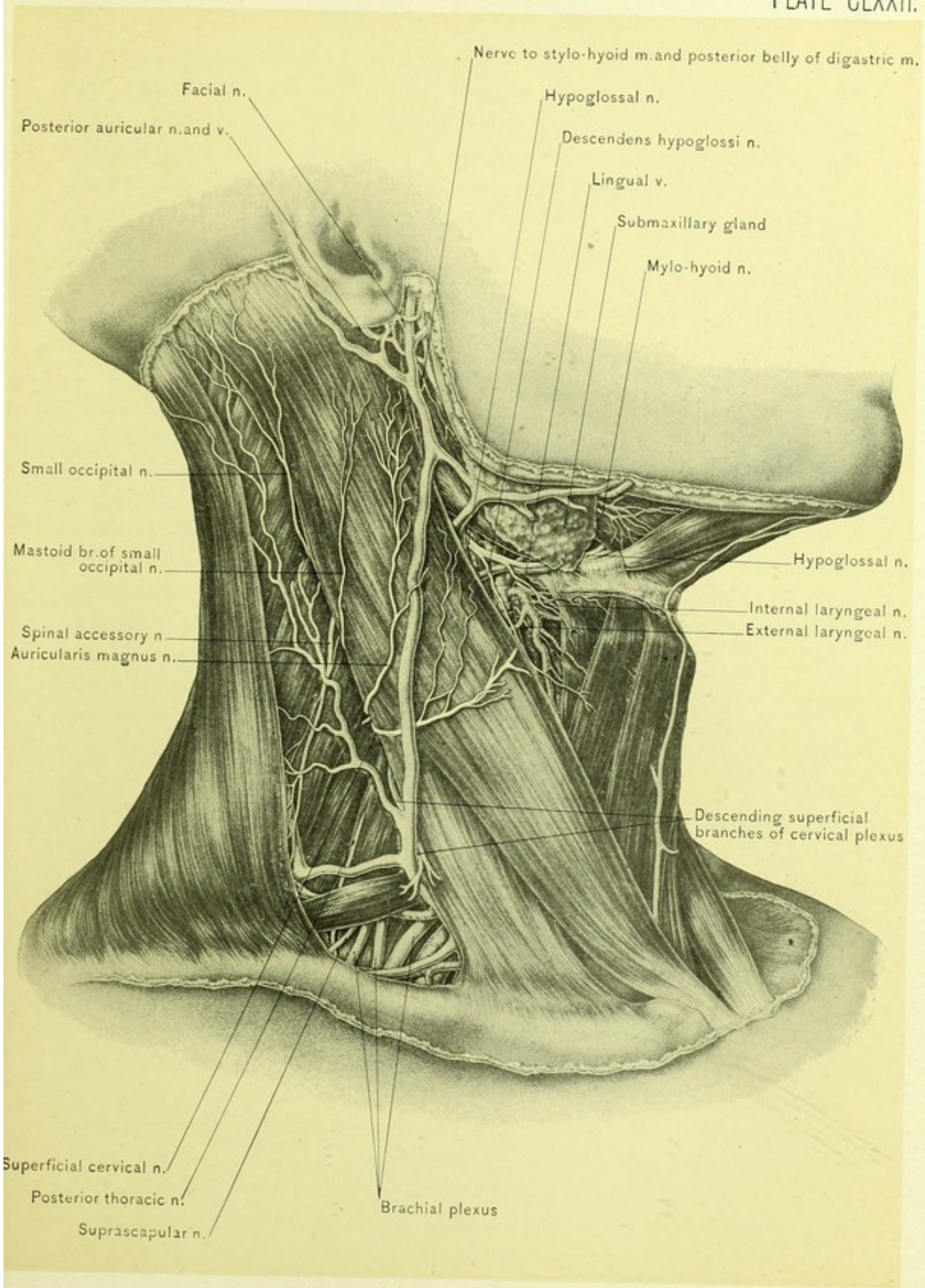
Action.—It depresses the lower jaw and assists in opening the mouth. If the lower jaw be fixed, the two bellies acting together would raise the hyoid bone, as in deglutition.

The **stylo-hyoid muscle** is slender, has about the same position as the poste-

PLATE CLXXI.



SUPERFICIAL STRUCTURES OF NECK.



SUPERFICIAL STRUCTURES OF NECK.

rior belly of the digastric, and lies in contact with the upper border of the posterior belly of the digastric muscle. It arises from the middle of the outer surface of the styloid process of the temporal bone, whence it passes downward and forward to be inserted into the outer surface of the hyoid bone where the greater cornu joins the body. It lies above the posterior belly of the digastric muscle, and is pierced near its insertion by the tendon of the digastric. In some cadavers the stylo-hyoid muscle is absent.

Nerve Supply.—From the facial nerve.

Blood Supply.—From the muscular twigs of the facial, occipital, and posterior auricular arteries.

Action.—It raises and draws the hyoid bone backward, thus preventing the return of food into the pharynx during deglutition.

The **submaxillary gland,** one of the three salivary glands, is situated in the submaxillary triangle and extends upward under the body of the lower jaw as far as the attachment of the mylo-hyoid muscle. It weighs about two drams. It consists of a larger superficial portion and a smaller deep portion. The superficial portion of the gland is covered by the skin, superficial fascia, platysma myoides muscle, infra-maxillary branches of the facial nerve, superficial layer of the deep fascia, facial vein, some lymphatic glands, and the body of the lower jaw; it rests upon the mylo-hyoid, hyo-glossus, and stylo-glossus muscles, the facial artery, submental artery, mylo-hyoid artery and nerve, and the hypo-glossal nerve and lingual vein; in front of it lies the anterior belly of the digastric muscle; behind it is the stylo-maxillary ligament, which separates it from the parotid gland. Its deep surface contains a groove for the facial artery. The deep portion and duct of the gland (Wharton's duct), which dip under the posterior border of the mylo-hyoid muscle, will be described.

Blood Supply.—From branches of the facial and lingual arteries.

Nerve Supply.—From branches of the submaxillary ganglion, through which it receives filaments from the gustatory and chorda tympani nerves. It also receives branches from the mylo-hyoid nerve and from the sympathetic plexus around the facial artery.

Dissection.—Reflect the submaxillary gland upward without dividing the facial vein, which runs over the gland, or the facial and submental arteries, which are beneath it. The submaxillary branches of the facial artery which supply the gland must be divided. This exposes a portion of the facial artery and its infra-maxillary branches, the mylo-hyoid artery and nerve, a part of the hypo-glossal nerve and lingual vein, the mylo-hyoid, hyo-glossus, and stylo-glossus muscles.

The cervical portion of the facial artery and its submaxillary, submental, ascending palatine, and tonsillar branches have been described.

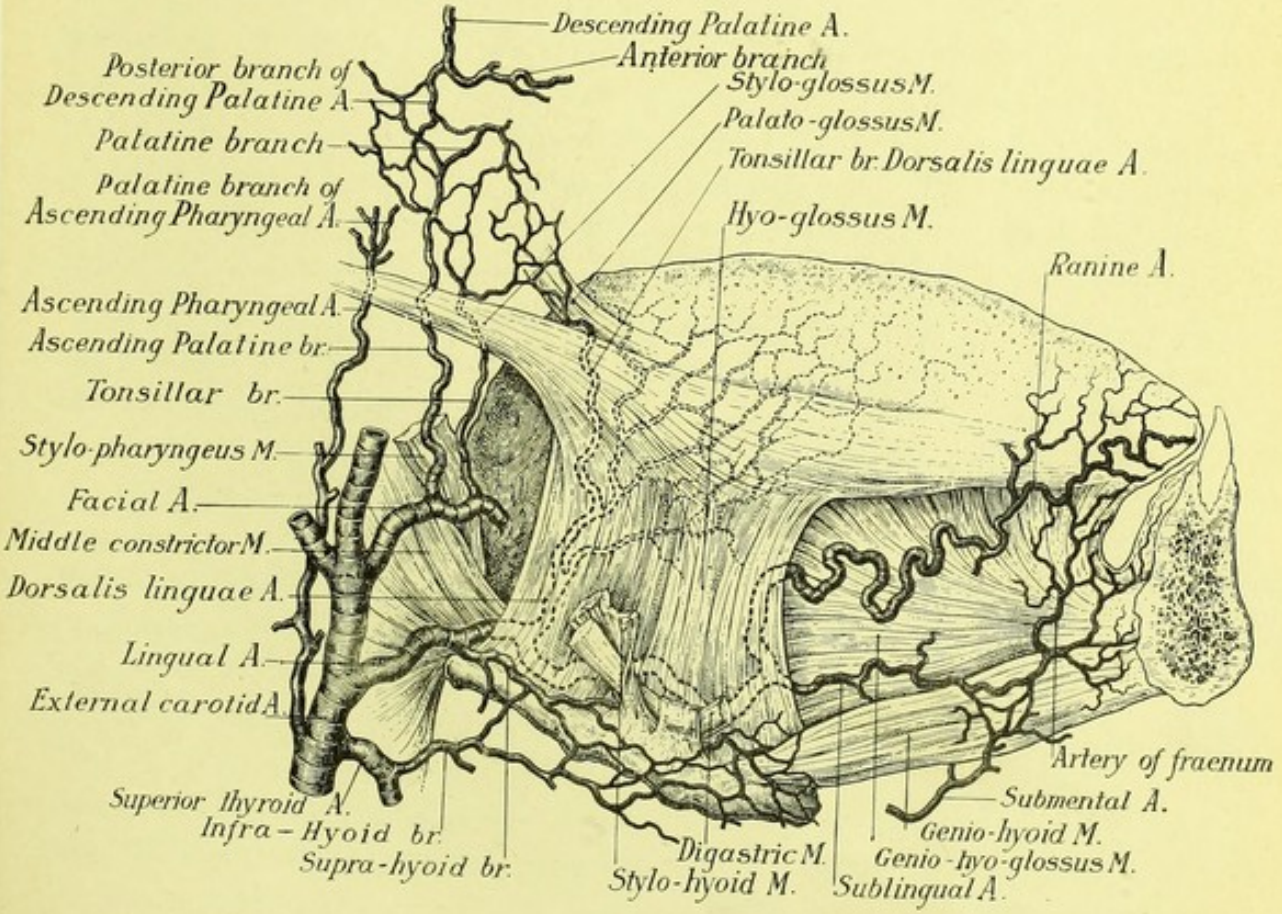
The **mylo-hyoid nerve,** a branch of the inferior dental nerve, may be seen emerging from between the lower jaw and the internal pterygoid muscle. It runs forward with the submental artery upon the mylo-hyoid muscle, to terminate in the anterior belly of the digastric muscle, supplying the mylo-hyoid and the anterior belly of the digastric muscle.

The **mylo-hyoid artery** accompanies the mylo-hyoid nerve between the internal pterygoid muscle and lower jaw, and anastomoses with the submental and dorsalis linguæ arteries.

The **hypo-glossal nerve,** the motor nerve of the tongue, is the twelfth or last of the cranial nerves. It leaves the cranial cavity at the anterior condyloid foramen, and descends almost vertically toward the angle of the lower jaw, lying at first deeply beneath the internal jugular vein and internal carotid artery, and is intimately connected with the lower ganglion (ganglion of the trunk) of the pneumogastric nerve. It then passes forward between the internal jugular vein and the internal carotid artery, and beneath the posterior belly of the digastric muscle, at the lower border of which it becomes more superficial and enters the superior carotid triangle. It next passes over the internal carotid and curves around the occipital artery, at its origin from the external carotid artery; thence it continues forward over the external carotid and facial arteries, and near the greater cornu of the hyoid bone, over the superior laryngeal nerve, the middle constrictor muscle of the pharynx, and the hyo-glossus muscle, forming a loop the convexity of which is directed downward and outward. At the anterior border of the hyo-glossus muscle it communicates with the gustatory or lingual nerve. It passes beneath the tendon of the digastric, the stylo-hyoid, and the mylo-hyoid muscle. After running beneath the stylo-hyoid and the posterior part of the tendon of the digastric muscle, it lies in the submaxillary triangle upon the hyo-glossus muscle, and beneath the submaxillary gland. Here it forms the base of the lingual triangle, and lies above the lingual vein. It supplies all of the extrinsic muscles of the tongue, the thyro-hyoid, and through the descendens hypoglossi nerve assists in supplying the omo-hyoid, sterno-hyoid, and sterno-thyroid muscles. The branch to the thyro-hyoid muscle is given off near the tip of the greater cornu of the hyoid bone, and passes obliquely downward and forward to reach the superficial surface of that muscle.

Paralysis of one hypo-glossal nerve causes wasting and flabbiness of the corresponding half of the tongue; when the tongue is protruded, the tip of the organ is carried toward the paralyzed side.

Dissection.—In completing the dissection of the submaxillary triangle, the anterior belly of the digastric muscle should be detached from the lower jaw and displaced downward, when the mylo-hyoid, the muscle forming the greater part



ARTERIES OF TONGUE AND TONSIL.

of the floor of the triangle, as well as the greater part of the floor of the mouth, will be completely exposed.

The **mylo-hyoid** is a triangularly shaped muscle, with its base at the lower jaw and its apex at the hyoid bone; it unites along the middle line with the mylo-hyoid muscle of the opposite side. It is sometimes termed the diaphragm of the mouth, or the upper diaphragm. It arises from the mylo-hyoid ridge (internal oblique line) of the lower jaw, its origin extending from the symphysis as far backward as the last molar tooth. The posterior fibers are inserted into the body of the hyoid bone; the middle and anterior fibers into the median fibrous raphé, where they join the fibers of the opposite muscle. Its lower or cutaneous surface has the anterior belly of the digastric muscle, the supra-hyoid aponeurosis, the mylo-hyoid nerve and artery, the submental vessels, and the submaxillary glands in relation with it. The duct of the submaxillary gland winds around its free posterior border. In relation with its deep or buccal surface are the genio-hyoid muscle, part of the hyo-glossus and stylo-glossus muscles, the deep part of the submaxillary gland, Wharton's duct, the hypo-glossal and gustatory nerves, the submaxillary ganglion, the sublingual gland, the ranine and sublingual arteries, and the mucous membrane of the mouth.

Nerve Supply.—From the mylo-hyoid branch of the inferior dental nerve.

Blood Supply. From the submental branch of the facial artery.

Action.—When both muscles act conjointly from their point of origin they elevate the hyoid bone, the larynx, and the floor of the mouth, preparatory to swallowing; when acting from their hyoid attachment they assist in depressing the jaw and in opening the mouth.

Dissection.—Divide the facial vessels immediately below the lower jaw, and displace them upward with the superficial part of the submaxillary gland, leaving *in situ* the deep part of the gland which turns beneath the mylo-hyoid muscle and has the submaxillary ganglion in contact with it. Divide the small vessels and nerves on the cutaneous surface of the mylo-hyoid muscle, detaching it from the lower jaw and the mylo-hyoid muscle of the opposite side, and displace it downward. This exposes the structures in relation with the upper surface of the mylo-hyoid muscle.

The **genio-hyoid** is a slender muscle which arises from the lower of the two lateral (genial) tubercles on the inner aspect of the symphysis of the lower jaw, and is inserted into the middle of the front of the body of the hyoid bone. It is covered by the mylo-hyoid muscle, rests upon the genio-hyo-glossus muscle, and mesially against the genio-hyoid muscle of the opposite side.

Nerve Supply.—From the hypo-glossal nerve.

Blood Supply.—From the lingual artery.

Action.—It raises and advances the hyoid bone; when the mouth is closed, acting in the reverse direction, it assists in depressing the lower jaw and in opening the mouth. It may be inseparable from the genio-hyoid muscle of the other side.

Dissection.—The lower jaw should be sawed through at two points—viz., immediately in advance of the angle and at the symphysis; the intervening portion, carrying with it the mucous membrane of the mouth, should be displaced upward, and fastened with hooks or with a stitch. The tongue should next be drawn out of the mouth, with its tip fastened to the nose, and the hyoid bone drawn downward and also fixed by means of hooks, thus putting the muscular fibers of the tongue on the stretch. All the fat and connective tissue having been removed, the following structures should be carefully examined: The hyo-glossus, stylo-glossus, and genio-hyo-glossus muscles, the lingual vein, the hypo-glossal nerve, the gustatory or lingual nerve, the submaxillary ganglion, Wharton's duct, the deep portion of the submaxillary gland, the sublingual gland, the ranine and sublingual arteries.

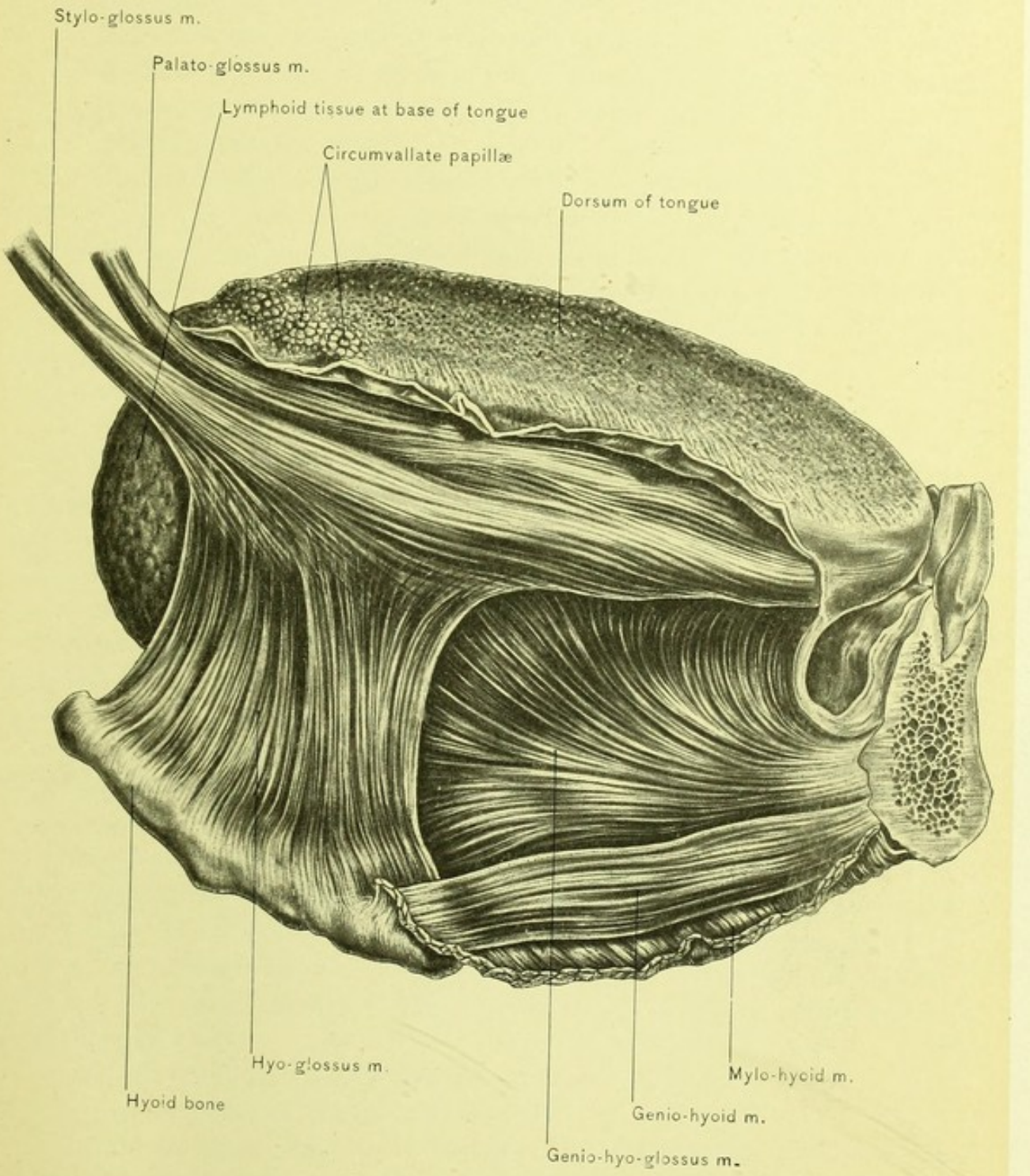
The **hyo-glossus** is a thin, flat, square-shaped muscle, arising from the side of the body of the hyoid bone and from its greater and lesser cornua. It is inserted into the posterior half of the side of the tongue between the stylo-glossus and lingualis muscles. Its fibers ascend almost perpendicularly from their origin to their insertion, and mingle with the fibers of the palato-glossus and stylo-glossus muscles. The fibers arising from the body of the hyoid bone, termed the *basio-glossus*, pass upward and backward, and overlap those which arise from the greater cornu, termed the *kerato-glossus*, which are directed obliquely forward. Those fibers which arise from the lesser cornu are termed the *chondro-glossus*, and are separated from the remainder of the muscle by a few fibers of the genio-hyo-glossus muscle; they are covered by the fibers arising from the body of the hyoid bone.

Nerve Supply.—From the hypo-glossal nerve.

Blood Supply.—From the lingual artery.

Action.—It draws the side of the tongue downward, and when the tongue is protruded it draws it back into the mouth.

Relations of the Hyo-glossus Muscle.—Upon the outer surface of the muscle are the hypo-glossal nerve and the small branch which ascends to the stylo-glossus muscle, the gustatory or lingual nerve, the loop of communication between the gustatory and hyo-glossal nerves, the submaxillary ganglion, the submaxillary gland, Wharton's duct, the hyoid branch of the lingual artery, the lingual vein, the sublingual gland, the posterior belly of the digastric, the stylo-hyoid, stylo-glossus, and myo-hyoid muscles. Its deep surface is in contact with the genio-hyo-glossus, lingualis, middle constrictor muscle of the pharynx, part of the origin of the superior constrictor muscle, the lingual artery, the glosso-pharyngeal nerve, and the



EXTRINSIC MUSCLES OF TONGUE.

stylo-hyoid ligament. At the posterior border of the hyo-glossus muscle may be seen the lingual artery, the glosso-pharyngeal nerve, and the stylo-hyoid ligament passing beneath the muscle. At the anterior border may be seen the loop of communication between the gustatory and hypo-glossal nerves, the branches of which can be traced to the under surface of the tongue; and the ranine artery, emerging from beneath the anterior border of the hyo-glossus muscle.

The **stylo-glossus muscle**—the smallest of the three muscles which arise from the styloid process—has its origin from the front and outer side of that process near its apex and from the stylo-maxillary ligament. Its fibers pass downward and forward, and then run almost horizontally to be inserted along the side of the tongue, superficial to the hyo-glossus muscle and as far forward as the tip of that organ; they blend with the fibers of the lingualis muscle. Beneath the lower jaw the stylo-glossus muscle is crossed by the gustatory or lingual nerve.

Nerve Supply.—From the hypo-glossal nerve.

Blood Supply.—From the muscular branches of the facial artery.

Action.—When both muscles act together they raise the back of the tongue toward the roof of the mouth. When the tongue is protruded, they draw it back into the mouth. They also draw the sides of the tongue upward, thus helping to make it transversely concave.

The **genio-hyo-glossus muscle,** the largest of the muscles of the tongue, is triangular in shape, with its apex attached to the lower jaw, and its base to the tongue and the hyoid bone. It arises from the upper genial tubercle on the inner aspect of the symphysis of the lower jaw, immediately above the genio-hyoid muscle. The fibers diverge from their origin, the inferior fibers passing downward to be inserted into the body of the hyoid bone, the middle fibers into the side of the pharynx, and the superior fibers into the tongue from the root to the tip. In relation with the external surface of the muscle are the stylo-glossus, hyo-glossus, and lingualis muscles, the lingual artery, the hypo-glossal and gustatory nerves, the sublingual gland, and the submaxillary or Wharton's duct. It is separated from the genio-hyo-glossus muscle of the opposite side by the fibrous septum,—the *septum linguæ*,—which extends through the middle of the tongue. Below it is the genio-hyoid muscle.

Nerve Supply.—From the hypo-glossal nerve.

Blood Supply.—From the lingual artery.

Action.—By the simultaneous action of all the fibers of the muscle attached to the tongue that organ is depressed and its upper surface grooved. The fibers inserted near the base of the tongue protrude it, while those attached near the tip retract it after it has been protruded. The inferior fibers aid the genio-hyoid and anterior belly of the digastric muscle in pulling the hyoid bone upward and

forward; acting from below, they tend to depress the chin. Contraction of this muscle in epileptic convulsions causes the tongue to protrude from the mouth, and it may thus be bitten. In certain fractures of the lower jaw, as well as in some operations about the tongue and floor of the mouth in which the origin of this muscle is detached, the tongue has a tendency to fall backward over the superior aperture of the larynx, and respiration may be embarrassed. During anesthetization the base of the tongue at times falls backward, and breathing becomes labored; by carrying the angles of the lower jaw forward, the genio-hyo-glossus muscles are made to pull the tongue forward, and thus to relieve the difficulty. If the genio-hyo-glossus muscle of one side is paralyzed and the patient is asked to protrude the tongue, the sound muscle pulls its own side of the base of the tongue forward, whereas the other side is not acted upon; the tip of the organ will consequently protrude toward the paralyzed side.

The **lingual vein** arises near the tip of the tongue, where it is also known as the ranine vein. It receives a branch of the superior thyroid vein and the venæ comites of the lingual artery, the tributaries of which correspond to the branches of the lingual artery. It accompanies the hypo-glossal nerve over the outer surface of the hyo-glossus muscle, which separates it from the lingual artery. It passes beneath the stylo-hyoid and posterior belly of the digastric muscle, and empties into the internal jugular or facial vein. When the lingual vein empties into the internal jugular vein, it crosses the external carotid artery at about the level of the greater cornu of the hyoid bone.

The hypo-glossal nerve.—Its course as far as the point where it passes beneath the posterior border of the mylo-hyoid muscle has been described. In the submaxillary triangle it lies on the hyo-glossus muscle, accompanied by the lingual vein, and communicates with the gustatory or lingual nerve at the anterior border of that muscle, from which point it continues forward to the tip of the tongue in the substance of the genio-hyo-glossus muscle.

The **gustatory or lingual nerve** is a branch of the inferior maxillary division of the fifth nerve, and for some little distance from its origin it lies in the pterygo-maxillary region. This portion of the nerve has been described under the Dissection of the Pterygo-maxillary Region. Passing between the ramus of the lower jaw and the internal pterygoid muscle it leaves the pterygo-maxillary region, inclines forward along the side of the tongue, and runs upon the superior constrictor muscle of the pharynx and between the stylo-glossus muscle and the deep portion of the submaxillary gland. It next crosses the upper part of the hyo-glossus muscle and Wharton's duct, whence it passes between the mylo-hyoid muscle and the mucous membrane of the floor of the mouth along the side of the tongue to its tip. Two or more branches connect the gustatory nerve with the submaxillary

ganglion near the root of the tongue, while near the anterior border of the hyo-glossus muscle it forms a loop with the hypo-glossal nerve.

It supplies the mucous membrane of the mouth, the lower gums, and the sublingual and submaxillary glands, and gives off branches which ascend through the muscular substance of the tongue to the filiform and fungiform papillæ. The branches to the sublingual and submaxillary glands contain secreto-motor fibers, which, when stimulated, increase the secretion of these glands. The lingual is the common sensory nerve of the tongue, and contains taste fibers for the anterior two-thirds of that organ.

The **submaxillary ganglion** is small, and is situated upon the hyo-glossus muscle, between the gustatory nerve and the deep portion of the submaxillary gland and beneath the posterior border of the mylo-hyoid muscle. Like the other ganglia of the head, it is connected with the branches of the trifacial nerve and receives filaments of communication of three kinds—viz., motor, sensory, and sympathetic. Its motor root arises from the facial nerve through the chorda tympani; the sensory branches are derived from the gustatory or lingual nerve; its connection with the sympathetic nerve is through a branch which comes from the nervi molles around the facial artery. Its branches of distribution, five or six in number, supply the mucous membrane of the floor of the mouth, and the submaxillary gland and its duct.

Wharton's duct, the duct of the submaxillary gland, is about two inches long, and has its origin in the deep portion of the gland. It winds around the posterior or free border of the mylo-hyoid muscle, then lies on the hyo-glossus muscle, between the hypo-glossal and gustatory nerves, under cover of the mylo-hyoid muscle; thence it passes forward over the genio-hyo-glossus muscle, and beneath the gustatory nerve and sublingual gland, terminating in a constricted opening, situated on a small papilla in the floor of the mouth at the side of the lingual frenum. Near its termination it is joined by one of the ducts of the sublingual gland—the duct of Bartholin.

The submaxillary gland.—The deep portion of the submaxillary gland turns forward around the posterior or free border of the mylo-hyoid muscle, lying between it and the hyo-glossus muscle.

The **sublingual gland,** the smallest of the three salivary glands, lies upon the mylo-hyoid muscle beneath the mucous membrane of the floor of the mouth at the side of the lingual frenum, where it produces an oblong prominence. It is in contact, on its inner side, with the hyo-glossus, genio-hyo-glossus, and stylo-glossus muscles, the gustatory nerve, and the duct of the submaxillary gland. On its outer side it is in relation with the sublingual fossa in the body of the lower jaw and with the mylo-hyoid muscle; behind, with the deep portion of the submaxil-

lary gland, touching the other sublingual gland in the mesial plane. It measures about one and one-half inches in its long diameter, and weighs about one dram. Its ducts—*ducti Rivini*—are from ten to twenty in number, and open separately on the ridge at each side of the lingual frenum, with the exception of two or more which join to form the *duct of Bartholin*, which opens either near or into Wharton's duct.

Blood Supply.—From the lingual and submental arteries.

Nerve Supply.—From the gustatory, chorda tympani, and sympathetic nerves.

Obstruction of the salivary ducts.—The duct of the submaxillary gland may become obstructed by a calculus, and give rise to a hard and painful swelling over the site of the duct, perceptible through the submaxillary triangle and through the floor of the mouth. Obstruction and dilatation of one of the several ducts opening at the side of the lingual frenum will occasion a cystic swelling known as *ranula;* this condition may also be due to an obstructed mucous follicle.

Dissection.—Detach the hyo-glossus muscle from the hyoid bone and lift it up, when the structures in relation with the deep surface may be seen; these are the horizontal portion, and the commencement of the ascending portion, of the lingual artery, part of the genio-hyo-glossus muscle, the lingualis muscle, the origin of the middle constrictor muscle of the pharynx, the glosso-pharyngeal nerve, and the stylo-hyoid ligament.

The **horizontal or second portion of the lingual artery** rests upon the middle constrictor of the pharynx and the genio-hyo-glossus muscle, below the level of the glosso-pharyngeal nerve, and is covered by the tendon of the digastric, the stylo-hyoid, and the hyo-glossus muscle. From this portion the *dorsalis linguæ artery* is given off, which ascends to the base of the tongue to supply the mucous membrane back of the circumvallate papillæ, the tonsil, and the soft palate. It anastomoses with the dorsalis linguæ of the opposite side, but this anastomosis is so fine that but slight bleeding follows severance of the tongue accurately in the median line.

The **ascending or third portion of the lingual artery** commences beneath the hyo-glossus muscle. It rests upon the genio-hyo-glossus, and passes tortuously between the genio-hyo-glossus and the lingualis muscle to the tip of the tongue, being covered only by the mucous membrane of the under surface of this organ. This portion gives off the sublingual artery and continues as the ranine.

The **ranine artery,** the continuation of the lingual artery, passes to the tip of the tongue along the outer side of the genio-hyo-glossus muscle, running between it and the lingualis muscle, and is accompanied by the ranine vein and the terminal portion of the gustatory nerve. Near the tip of the tongue it anastomoses

with the ranine artery of the opposite side, and on its way supplies the adjacent muscles and mucous membrane.

The **sublingual artery,** smaller than the ranine, arises near the anterior border of the hyo-glossus muscle, and runs outward and forward over the oral surface of the mylo-hyoid muscle to reach the sublingual gland. It supplies the sublingual gland, the mylo-hyoid muscle, the mucous membrane of the floor of the mouth, and the gums. It anastomoses with the opposite sublingual artery, and with the submental branch of the facial artery, after having perforated the mylo-hyoid muscle.

The **artery of the frenum** is usually a branch of the sublingual artery. It is sometimes wounded in operating for "tongue tie." The best way to divide the lingual frenum so as to avoid wounding the vessel is to place the child upon its back in the mother's lap, and, with the head held tightly between the knees of the operator, to engage the frenum in the slot of a grooved director, by means of which the point of the tongue can be held up. The frenum is thus made tense, and at its attachment to the lower jaw is then simply nicked with a pair of blunt scissors, after which any additional separation which may be required can be done with the finger nail.

The **stylo-pharyngeus muscle,** long and slender, arises from the inner side of the base of the styloid process, and is the longest of the three muscles arising therefrom. It passes downward and forward, and disappears between the middle and superior constrictor muscles of the pharynx. Some of its fibers join the palato-pharyngeus muscle, to be inserted into the posterior border of the thyroid cartilage. The remaining fibers become connected with the fibers of the constrictor muscles of the pharynx. Running along its outer side is the glosso-pharyngeal nerve. In order to reach the tongue, to which it is partly distributed, the nerve passes over the muscle, supplying it with twigs.

The **stylo-hyoid ligament** is a fibrous cord which passes from the tip of the styloid process to the lesser cornu of the hyoid bone. It may be seen lying near the anterior border of the stylo-pharyngeus muscle, and passing beneath the hyo-glossus muscle to the lesser cornu of the hyoid bone. It is the continuation of the styloid process; it may contain nodules of cartilage, and may be largely ossified, forming an unusually long styloid process.

Dissection.—Cut off the styloid process at its base, and reflect it downward with the attached muscles and the stylo-hyoid ligament.

The glosso-pharyngeal nerve.—Running along the posterior border of the stylo-pharyngeus muscle, and crossing in front of it, is the glosso-pharyngeal nerve. It curves upon the side of the neck, the convexity being directed downward and backward; it resembles in this respect the hypo-glossal and superior laryngeal

nerves. The principal landmark for finding this nerve is the stylo-pharyngeus muscle, around which it curves. Beyond the stylo-pharyngeus muscle the glosso-pharyngeal nerve lies on the middle constrictor muscle of the pharynx. The terminal portion of the nerve lies beneath the hyo-glossus muscle, where it divides into two terminal lingual branches, one supplying the mucous membrane covering the posterior third of the dorsum of the tongue, and the other the mucous membrane of the side of the tongue, inosculating with the lingual nerve. The glosso-pharyngeal is a nerve of motion, sensation, and special sense (taste): of *motion*, to the muscles of the pharynx; of *sensation*, to the mucous membrane of the fauces, tonsil, and pharynx; and of *taste*, to the base of the tongue and the fauces.

It leaves the cranial cavity by way of the middle compartment of the jugular foramen, clothed by a separate sheath of the dura mater, and lying in advance of, and a little internal to, the pneumogastric and spinal accessory nerves. Having made its exit from the foramen, it descends between the internal jugular vein and the internal carotid artery, crosses over the latter vessel obliquely, and passes beneath the styloid process and the muscles arising therefrom, to reach the posterior border of the stylo-pharyngeus muscle, as previously described.

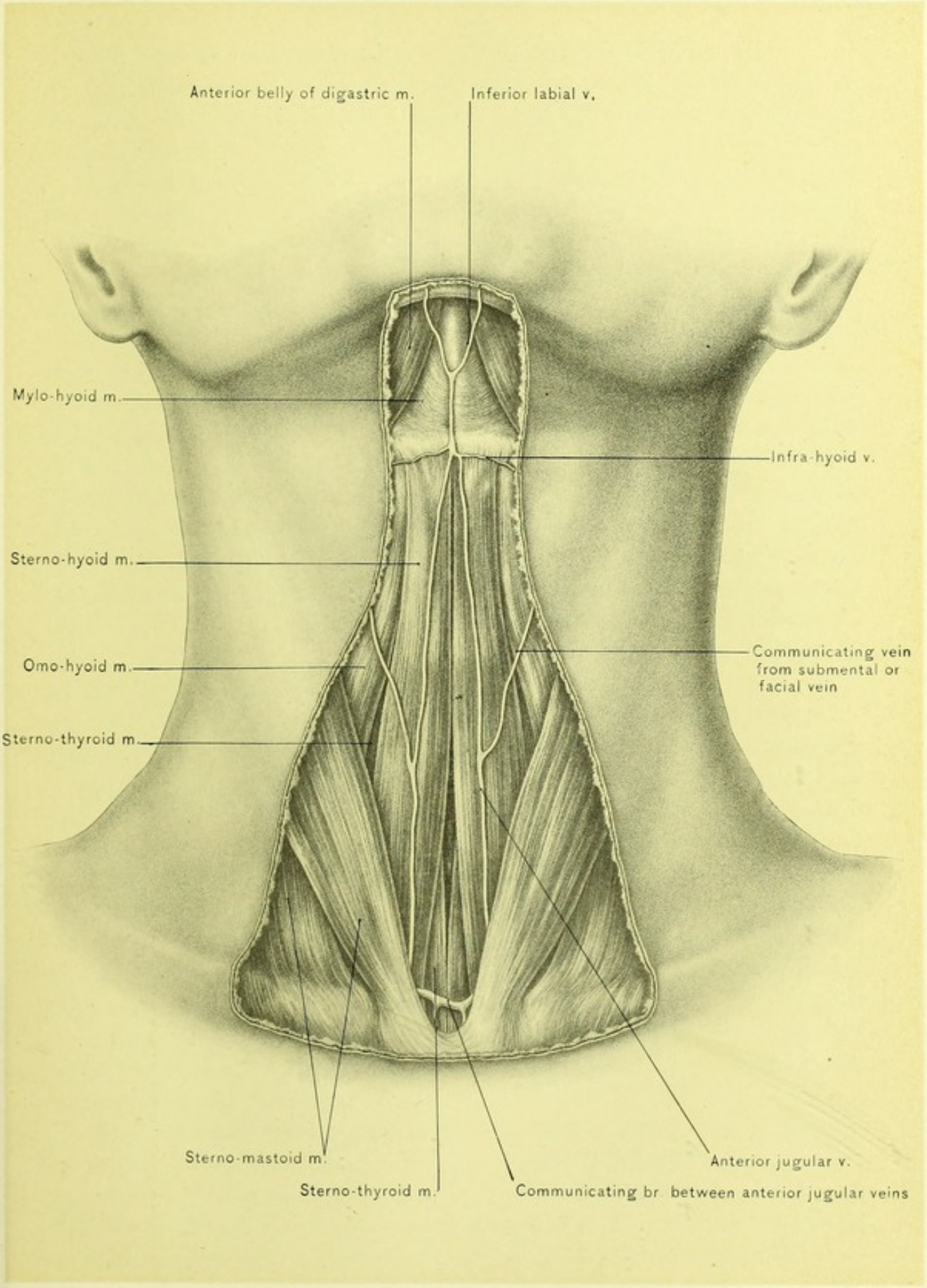
Upon the trunk of the nerve in the jugular foramen are two ganglia: an upper, the *jugular*, and a lower, the *petrous*. The former is inconstant, and both are considered analogous to the ganglia on the posterior roots of the spinal nerves. At the petrous ganglion (ganglion of Andersch), the glosso-pharyngeal nerve is connected with the pneumogastric and sympathetic nerves by communicating branches. The branches of the glosso-pharyngeal nerve, other than the terminal lingual and the communicating, are the meningeal, tympanic, carotid, pharyngeal, muscular, and tonsillar.

The *meningeal branches* arise within the cranial cavity, and are distributed to the pia mater and arachnoid.

The *tympanic branch* (*Jacobson's nerve*) arises from the petrous ganglion, and passes to the inner wall of the tympanum through a bony canal (the tympanic canaliculus) the orifice of which is situated upon the ridge of bone between the carotid canal and the jugular fossa. It ramifies upon the promontory of the tympanum, forming the tympanic plexus, which supplies branches to the round and oval windows, and to the Eustachian tube, and communicates with the carotid plexus and with the great and small superficial petrosal nerves.

The *carotid branches* surround the cervical portion of the internal carotid artery, and communicate with the pneumogastric and sympathetic nerves.

The *pharyngeal branches*, three or four in number, join branches from the pneumogastric, superior laryngeal, and sympathetic nerves, and from the *pharyngeal plexus*, which supplies the pharynx.



SUPERFICIAL STRUCTURES NEAR MEDIAN LINE OF NECK.

The *muscular branch* supplies the stylo-pharyngeus muscle.

The *tonsillar branches* arise under the hyo-glossus muscle, and are distributed to and around the tonsils, forming a plexus from which branches to the fauces and soft palate are derived.

The *communicating branches* arise from the petrous ganglion, as stated, and run to the superior cervical ganglion; to the auricular branch of the pneumogastric, forming a loop; an inconstant branch to the ganglion of the root of the pneumogastric nerve; and one from the nerve just below the ganglion, to join the lingual branch of the facial nerve.

The *lingual branches* proceed from the end of the glosso-pharyngeal nerve, and are, therefore, its terminal filaments. They are distributed mainly to the circumvallate papillæ, while some filaments supply the follicular glands of the tongue and the front of the epiglottis. Others inosculate around the foramen cæcum with those of the same nerve of the opposite side.

The **Internal Carotid Artery,** the larger of the two terminal divisions of the common carotid, ascends perpendicularly by the side of the pharynx to the base of the skull, where it enters the carotid canal, in the petrous portion of the temporal bone. It lies at first on the outer side of the external carotid artery, and then behind it. At its origin it is more superficial than elsewhere, and lies in the superior carotid triangle; but as it ascends it lies more deeply, passing beneath the parotid gland, the posterior belly of the digastric muscle, styloid process, stylo-pharyngeus and stylo-hyoid muscles. It is crossed by the hypo-glossal and glosso-pharyngeal nerves, and the occipital and posterior auricular arteries. Externally it is in close relation with the internal jugular vein and the pneumogastric nerve, and near the base of the skull with the glosso-pharyngeal, hypo-glossal, and spinal accessory nerves; behind, with the rectus capitis anticus major muscle, the superior ganglion of the sympathetic nerve, and the superior laryngeal nerve; internally, with the pharynx, the tonsil, and the ascending pharyngeal artery; in front it is covered by the skin, fasciæ, parotid gland, and the structures which pass between it and the external carotid artery—the stylo-glossus and stylo-pharyngeus muscles, the glosso-pharyngeal nerve, and the stylo-hyoid ligament.

Dissection.—The deep fascia upon each side of the median line of the neck having been removed, the anterior belly of the omo-hyoid, the sterno-hyoid, sterno-thyroid, and thyro-hyoid muscles will be exposed.

The **omo-hyoid muscle** consists of two bellies, an anterior and a posterior, connected by an intervening tendon. The anterior belly, which is exposed in this dissection, commences at the tendon intervening between the two bellies of the muscle beneath the sterno-mastoid muscle and in front of the carotid sheath, on a level with the cricoid cartilage. It passes upward along the outer border of

the sterno-hyoid and over the sterno-thyroid and thyro-hyoid muscles, to be inserted into the lower border of the body of the hyoid bone external to the sterno-hyoid muscle. It lies beneath the superficial layer of the deep fascia and sterno-mastoid muscle, and in front of the thyro-hyoid and sterno-thyroid muscles and the carotid sheath. It may be absent or double, or may blend with the adjacent sterno-hyoid muscle; occasionally it receives an accessory slip from the manubrium sterni, or sends one to the lower jaw.

The posterior belly of the muscle has already been seen crossing the posterior triangle just above the clavicle, and dividing it into the occipital and subclavian triangles. It arises from the upper border of the scapula, behind the supra-scapular notch, and from the transverse ligament, and may have an additional origin from the upper surface of the middle third of the clavicle. It terminates in the tendon of the omo-hyoid muscle which crosses the carotid sheath. It is covered by the superficial layer of the deep fascia, trapezius muscle, clavicle, subclavius muscle, sterno-mastoid muscle, external jugular vein, and the descending superficial branches of the cervical plexus of nerves. It passes over the first digitation of the serratus magnus muscle and third part of the subclavian artery, the transversalis colli and supra-scapular arteries, the supra-scapular nerve, the cervical trunks of the brachial plexus, the scaleni muscles, the prevertebral fascia, and the carotid sheath. The intervening tendon is bound down by a process of the deep fascia, attached to the clavicle and first rib.

Action.—It draws the hyoid bone downward and assists in making tense the lower portion of the deep cervical fascia, thus diminishing the atmospheric pressure upon the large veins at the root of the neck and favoring the return circulation.

Nerve Supply.—It is supplied by the descendens hypoglossi and the communicantes hypoglossi nerves.

The **sterno-hyoid muscle** arises from the posterior surface of the upper part of the manubrium sterni, the posterior sterno-clavicular ligament, and the posterior surface of the inner extremity of the clavicle. Its fibers pass upward and inward to be inserted into the lower border of the body of the hyoid bone. It has, at times, a tendinous intersection in its lower part. It lies beneath the skin and fasciæ, anterior jugular vein, sterno-mastoid muscle, sterno-clavicular joint, and the manubrium sterni; in front of the sterno-thyroid, thyro-hyoid, and crico-thyroid muscles, the thyroid and cricoid cartilages, the thyro-hyoid and crico-thyroid membranes, the pretracheal fascia, trachea, isthmus of the thyroid body, and inferior thyroid veins.

Nerve Supply.—From the loop between the descendens and communicantes hypoglossi nerves.

Blood Supply.—From branches of the superior thyroid artery.

Action.—It draws the hyoid bone downward, as after swallowing. In labored respiration it will act as an elevator of the sternum, being an accessory muscle of respiration.

The **sterno-thyroid muscle** is wider and shorter than the sterno-hyoid muscle, beneath which it lies. It arises from the posterior surface of the upper part of the manubrium sterni and the cartilage of the first rib, below, and internal to the sterno-hyoid muscle. Its fibers pass upward and outward, and are inserted into the oblique line on the side of the thyroid cartilage, where it is continuous with the thyro-hyoid muscle. In the inferior carotid triangle the outer border of the muscle partly overlaps the sheath of the common carotid artery. It lies beneath the skin and fasciæ, the manubrium sterni, anterior jugular vein, sterno-mastoid, sterno-hyoid, and anterior belly of the omo-hyoid muscle, and in front of the thyroid and cricoid cartilages, the crico-thyroid muscle, the inferior constrictor muscle of the pharynx, thyroid gland, inferior thyroid veins, pretracheal fascia, trachea, common carotid artery, and left innominate vein. This muscle may be absent or double.

Nerve Supply.—From the ansa hypoglossi.

Action.—It draws the thyroid cartilage downward, as after swallowing, and assists the crico-thyroid muscle in making tense the vocal cords, by drawing the thyroid cartilage downward and forward. It is an accessory muscle of respiration.

The *interspace* between the internal borders of the sterno-hyoid muscles is wider at the sternum than at the hyoid bone, while the interspace between the inner margins of the sterno-thyroid muscles is wider above than at the sternum ; a lozenge-shaped intermuscular space is thus formed.

The **thyro-hyoid muscle,** apparently an extension of the sterno-thyroid muscle, arises from the oblique line on the side of the thyroid cartilage. Its fibers ascend and are inserted into the lower border of the body and the inner half of the greater cornu of the hyoid bone. The sterno-mastoid, sterno-hyoid, and the anterior belly of the omo-hyoid muscle pass over the outer surface of the thyro-hyoid muscle ; the superior laryngeal vessels and nerve, the thyro-hyoid membrane, bursa, and the thyroid cartilage lie beneath it.

Nerve Supply.—From the hypo-glossal nerve.

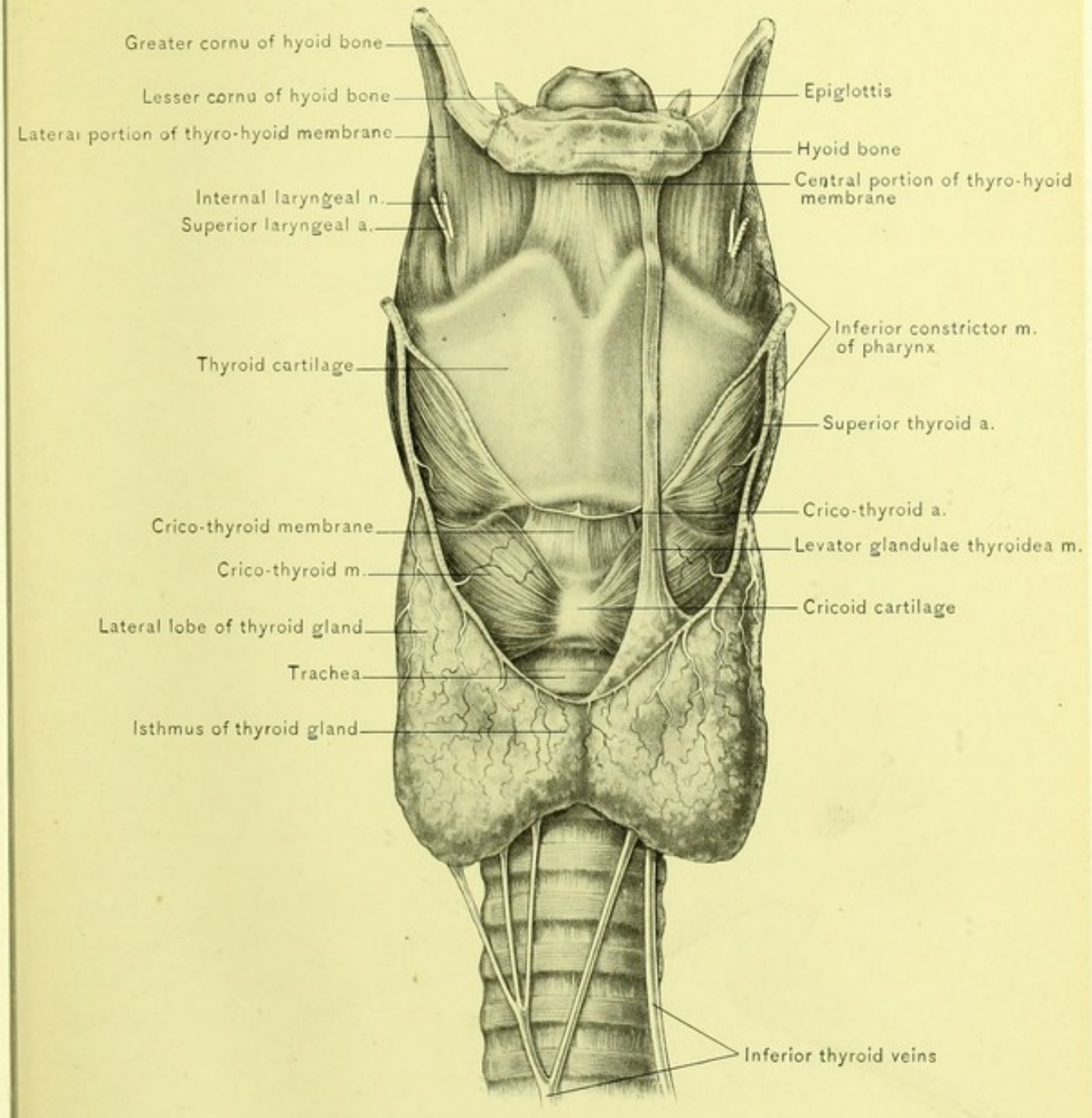
Blood Supply.—From the hyoid, the sterno-mastoid, and the crico-thyroid branches of the superior thyroid artery, and the hyoid branch of the lingual artery.

Action.—It raises the thyroid cartilage toward the hyoid bone preparatory to swallowing, and in conjunction with the sterno-thyroid muscle it depresses the hyoid bone and larynx.

Dissection.—Divide the sterno-hyoid and sterno-thyroid muscles at their

middle, and reflect them upward and downward. This exposes, from above downward, the thyro-hyoid membrane, pierced upon each side by the internal branch of the superior laryngeal nerve and the superior laryngeal artery; the thyroid cartilage; the crico-thyroid membrane, upon which are the crico-thyroid arteries; the cricoid cartilage, partly concealed by the crico-thyroid muscles; the first, and at times the second, ring of the trachea; the thyroid gland, its middle portion, or isthmus connecting the two lateral lobes; the trachea, covered by a plexus of veins formed by the anastomoses of the inferior thyroid veins; the middle thyroid artery, when present, and the pretracheal fascia.

The **Thyroid Gland or Body,** a ductless and very vascular structure, is situated on the front and sides of the upper part of the trachea, and the sides of the lower part of the larynx. It consists of two lateral lobes and a middle lobe, or isthmus, and weighs from one to two ounces. Each lateral lobe is about two inches in length, one and one-fourth inches in breadth, and three-fourths of an inch in thickness. Each lateral lobe is pyriform or cone-shaped, the apex directed upward; it extends from the fifth or sixth ring of the trachea to the middle of the side of the thyroid cartilage. It is convex anteriorly, and is situated between the trachea and the sheath of the common carotid artery, and is covered anteriorly by the sterno-hyoid, the sterno-thyroid, and the anterior belly of the omo-hyoid muscle. Its deep surfaces is concave, and in contact with the trachea, larynx, pharynx, esophagus, inferior thyroid artery, and recurrent laryngeal nerve. From its upper part, and most commonly from the left lobe, a conic piece, called the *pyramid*, at times ascends toward the hyoid bone, to which it is attached by a fibrous band in front of the thyro-hyoid membrane; this part is at times attached to the hyoid bone by a slip of muscle, the *levator glandulæ thyroideæ of Soemmering.* The middle lobe, or isthmus, is about one-half of an inch in depth, and rests upon the second and third rings of the trachea. The isthmus varies much in its dimensions, and is sometimes absent. There is a space between the upper border of the middle lobe, or isthmus, and the cricoid cartilage, where the trachea is not covered by the gland; this portion of the trachea is opened in the high operation of tracheotomy. To perform this operation when the space is covered by the middle lobe, it is necessary either to displace the lobe downward or pass two ligatures around it and divide it between them. In some instances, however, the width of the middle lobe, or isthmus, is so great that it covers the trachea almost to the sternum. The low operation of tracheotomy is performed below the isthmus of the gland. That this operation is the more difficult of the two will be seen at a glance in the dissected neck; this is due to the increasing depth of the trachea as it approaches the sternum, and the presence of the thyroid plexus of veins in front of this part of the trachea. An abnormally high position of the large vessels at the root of the neck



THYROID BODY.

would add to the difficulty and danger of the low operation. The thyroid gland is closely attached by areolar tissue to the sides of the trachea and the cricoid and thyroid cartilages. During deglutition it rises and falls with the larynx—a fact of the utmost value in the differential diagnosis between cervical tumors and enlargement of this gland. It varies in size in different individuals and at different periods of life, being relatively larger in children and in females. It often enlarges during menstruation, owing to increased distention of the blood vessels. The right lobe is larger than the left. In old age the gland decreases in size, becomes firmer, and at times contains calcareous substances. When enlarged, it may displace and compress the trachea, especially if the enlargement take place rapidly, the body of the gland being held down by the sterno-thyroid and omo-hyoid muscles; or it may displace the great vessels of the neck laterally, so that the common carotid artery may be felt pulsating at the outer border of the sterno-mastoid muscle. Venous engorgement may also ensue, and the recurrent laryngeal nerve may suffer from the pressure of an enlarged thyroid gland. Bonnett has practised subcutaneous section of the muscles in some cases of dyspnea caused by a rapidly growing bronchocele (enlarged thyroid gland). Sir Duncan Gibb, on the other hand, because of the fact that the isthmus, or middle lobe, binds together the enlarging lateral lobes of a bronchocele, proposed to divide the isthmus in cases where dyspnea resulted. He performed this operation several times, great relief to the patient ensuing. As the lateral borders of the thyroid gland are in contact with the sheath of the common carotid artery, it follows that the gland, when enlarged, may readily receive transmitted pulsations from that vessel. An error is occasionally made by mistaking a pulsating goiter for aneurysm of the common carotid artery.

The median lobe of the thyroid gland is developed as a downgrowth of the epithelium from the posterior part of the tongue; the site from which this starts is indicated in the adult by the foramen cæcum of the tongue. The canal thus formed is known as the *thyro-glossal duct*, or *canal of His*. Its walls normally disappear, but remains of them are frequently found in the pyramidal process of the thyroid gland. Accessory thyroid glands, occurring near the median line of the neck, in the vicinity of the hyoid bone, and elsewhere in the neck, are regarded as being formed by division of the pyramidal process. Furthermore, certain cystic tumors at the base of the tongue and in the median line of the neck, as well as the rare cases of median cervical fistula, result from incomplete obliteration of the thyro-glossal duct.

The deep surface of the thyroid gland being in relation with the lower part of the pharynx and the upper part of the esophagus, the difficulty in swallowing often observed in bronchocele is explained by the direct pressure, and the interference

with the movements of the larynx. Enlargement of the left lobe of the gland is more likely to occasion difficulty in swallowing than a similar condition on the right side, owing to the inclination of the esophagus toward the left. In a case mentioned by Allan Burns, the isthmus was located between the trachea and the esophagus. It is very evident that enlargement of this portion of the gland holding such abnormal relation would occasion great difficulty in swallowing. The author has seen a case of goiter in which the esophagus was so nearly occluded that the patient, an old woman, was no longer able to swallow liquids. Atrophy of the thyroid gland, or its destruction by disease, is apt to be followed by the condition known as myxedema. Absence of the thyroid gland in children causes cretinism and idiocy.

The **arteries of the thyroid gland**—two on each side—are the superior and inferior thyroid. The superior thyroid, a branch of the external carotid artery, ramifies chiefly upon the anterior aspect of the gland, while the inferior thyroid, a branch of the thyroid axis, enters the under and inner surface of the lateral lobe of the gland. A very free anastomosis is established between these vessels, which form a complete network around the acini in the substance of the gland. Occasionally there is a middle thyroid artery (thyroideæ ima), a branch of the innominate artery or arch of the aorta, which ascends in front of the trachea and enters the isthmus of the gland.

The thyroid gland is surrounded by a thin, dense, fibrous capsule, which is derived from the pretracheal fascia and sends processes into the interior which separate the substance into lobules of varying form and size. The vesicles composing these lobules are lined by a single layer of columnar epithelium and contain a colloid substance. Increase of this colloid substance constitutes a form of goiter.

The **nerves of the thyroid gland** are derived from the middle and lower cervical sympathetic ganglia, and accompany the inferior thyroid artery.

The **thyroid veins,** three on each side, are the superior, the middle, and the inferior thyroid. The superior and middle thyroid veins cross in front of the common carotid artery, emptying into the internal jugular vein. The inferior thyroid veins descend on the trachea, form a plexus in front of the pretracheal fascia, and behind the sterno-thyroid muscles, and empty into the left innominate vein. The numerous and large lymphatics pass to the lymph trunks at the root of the neck. In some cases these lymphatics have been found to contain colloid substance, giving rise to the supposition that they act as ducts of the gland.

Thyroidectomy.—In the operation of removal of half of the thyroid gland in either bilateral or unilateral goiter (bronchocele) the incision may be made parallel with the anterior border of the sterno-mastoid muscle, or a transverse curved incision, concave upward, may be carried over the most prominent portion

of the tumor. The gland being exposed, the superior and inferior thyroid arteries should be carefully freed, and then secured and divided between ligatures. In exposing the inferior thyroid artery preparatory to severing it, and in freeing the lower end of the lateral lobe of the gland behind, care must be exercised to avoid injuring the recurrent laryngeal nerve. After attempts to cure a unilateral goiter by the injection of tincture of iodin or by electro-puncture have failed, the inflammation consequent upon either form of treatment may result in binding the gland tightly to the carotid sheath, or perhaps to the wall of the internal jugular vein. Under these circumstances dissecting it loose, in attempted removal of the goiter, will be attended by risk of tearing the vein. Where much periglandular inflammation has occurred, the recurrent laryngeal nerve may be involved in the deposit of exudate, this condition giving rise to aphonia, which is likely to be permanent whether the goiter be removed or not.

The **recurrent laryngeal nerve,** which has been described with the pneumogastric nerve, should now be observed passing upward in the groove between the trachea and esophagus and behind and internal to the lateral lobe of the thyroid gland to enter the larynx.

The Subclavian Artery.—The origin, course, and relations of the subclavian arteries differ upon the two sides. The right subclavian is a branch of the innominate artery, and the left of the arch of the aorta. The anterior scalene muscle passes in front of the subclavian artery and divides it into three portions. The *first portion* is situated between its origin and the inner border of the anterior scalene muscle, the *second portion* behind the muscle, and the *third portion* between the outer border of the muscle and the lower border of the first rib. The first portion of the artery is the one which differs in course and relations on the two sides; it will, therefore, be described separately.

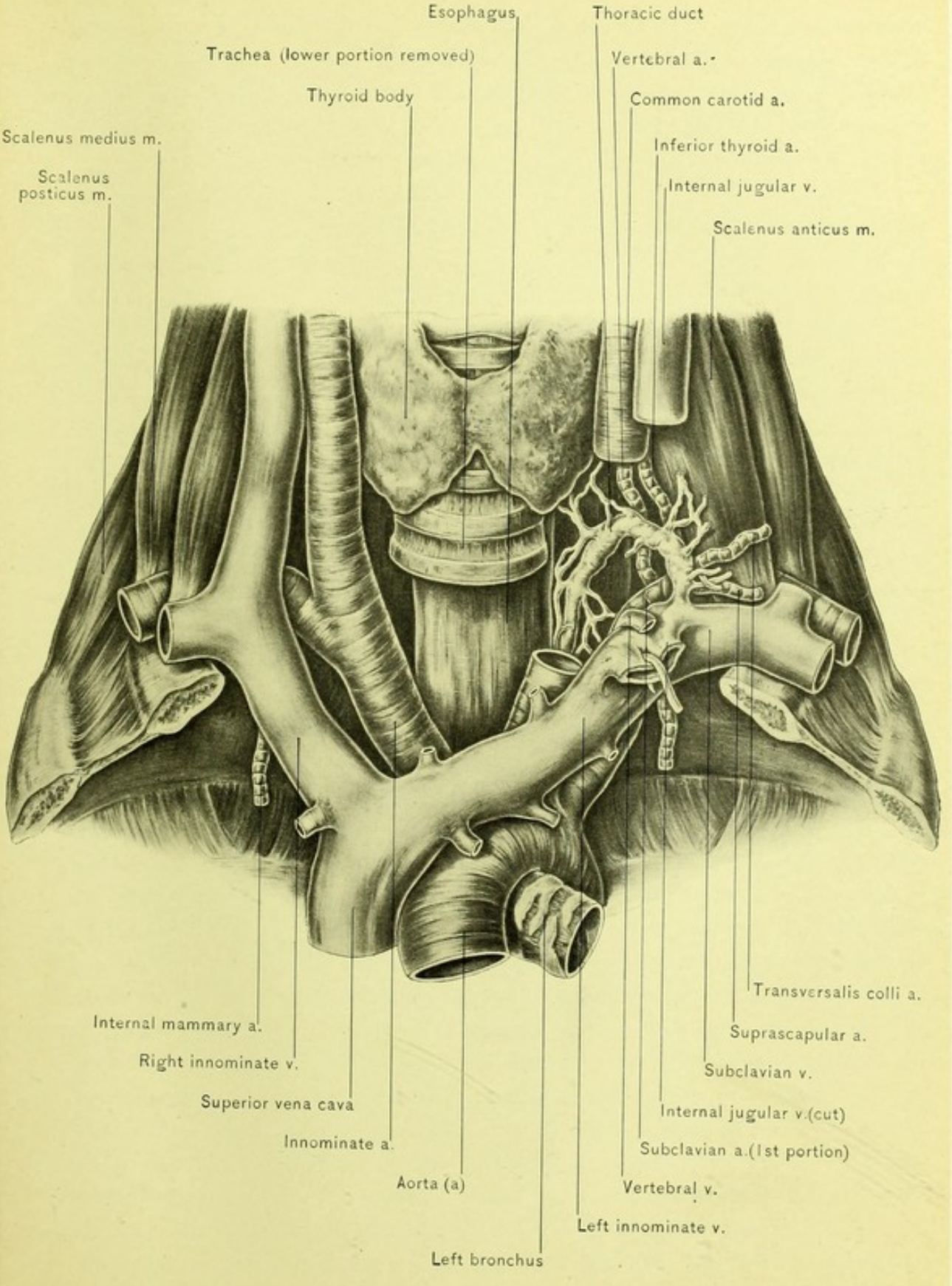
The **right subclavian artery** is the shorter of the two. It arises as one of the two terminal divisions of the innominate artery behind the upper border of the right sterno-clavicular articulation. The first portion of the artery lies deep in the neck, and ascends upward and outward to the inner border of the anterior scalene muscle. It is covered in front by the skin, the superficial fascia, the platysma myoides muscle, the superficial layer of the deep fascia, the sternal end of the clavicle, the sterno-mastoid muscle, the anterior jugular vein, the sterno-hyoid and sterno-thyroid muscles, and the posterior process of the deep fascia (prevertebral fascia) continued forward from in front of the scaleni muscles. It is crossed by the internal jugular and vertebral veins, the pneumogastric nerve, the superior cardiac nerves and a loop of the sympathetic nerve (ansa Vieussenii), and the phrenic nerve. Below the artery are the pleura, the recurrent laryngeal nerve,

and the subclavian vein; behind it are the recurrent laryngeal nerve, the cord of the sympathetic nerve with its middle and inferior cardiac branches, the longus colli muscle, the transverse process of the seventh cervical or first thoracic vertebra, from which it is separated by a small quantity of cellular tissue and fat, and the apex of the lung, covered with pleura.

The **left subclavian,** the longer of the two arteries, arises from the transverse portion of the arch of the aorta opposite the third thoracic vertebra. Its first portion ascends almost vertically to the inner margin of the first rib and the inner border of the insertion of the anterior scalene muscle. Only the relations of the cervical part of this portion of the artery will be described here. The cervical part of the first portion is covered by the skin, the superficial fascia, the platysma myoides muscle, the superficial layer of the deep fascia, the sterno-mastoid muscle, the anterior jugular vein, the sterno-hyoid and sterno-thyroid muscles, the posterior process of the deep fascia, continued forward from in front of the scaleni muscles, the sternal end of the clavicle, the left internal jugular vein, the vertebral and subclavian veins, the apex of the left lung and its pleura, the phrenic nerve, and the cardiac branches of the sympathetic nerve, which lie parallel with the artery, the left common carotid artery, and the thoracic duct. On its outer side are the apex of the lung and pleura; on its inner side are the trachea, the recurrent laryngeal nerve, the esophagus, and the thoracic duct; behind it are the pleura and the apex of the left lung, while behind and internal to it are the thoracic duct, the esophagus, the inferior cervical ganglion of the sympathetic nerve, the sympathetic cord, the longus colli muscle, and the spinal column.

Differences Between the Right and Left Subclavian Arteries in Their First Portion.—The first portion of the left subclavian artery differs from the first portion of the right in the following respects: The left subclavian arises directly from the arch of the aorta, while the right arises from the innominate artery; it lies deeper, is longer and more vertical; it is in relation with the esophagus and the thoracic duct, while the right is not; it is crossed by the left innominate or brachio-cephalic vein, the phrenic and pneumogastric nerves, and the cardiac branches of the sympathetic nerve running almost parallel with it; on the right side the phrenic and pneumogastric nerves and some of the cardiac branches of the sympathetic nerve pass in front of the right subclavian artery, at nearly a right angle. The left subclavian artery is not in so close a relation with the recurrent laryngeal nerve as is the right subclavian, the nerve winding around below the latter. In the following description of the course of the thoracic duct it will be seen to be in relation with the first portion of the left subclavian artery at two points; it holds, of course, no relation to the right subclavian artery.

The **thoracic duct** passes upward and out of the chest to the left of the


Esophagus
Thoracic duct
Trachea (lower portion removed)
Vertebral a.
Thyroid body
Common carotid a.
Scalenus medius m.
Inferior thyroid a.
Scalenus posticus m.
Internal jugular v.
Scalenus anticus m.
Transversalis colli a.
Internal mammary a.
Suprascapular a.
Right innominate v.
Subclavian v.
Superior vena cava
Internal jugular v.(cut)
Innominate a.
Subclavian a.(1st portion)
Aorta (a)
Vertebral v.
Left innominate v.
Left bronchus

esophagus and behind the first portion of the subclavian artery and the apex of the left lung. Behind the left internal jugular vein and common carotid artery, and opposite the seventh cervical vertebra, the duct forms an arch above the subclavian artery and anterior to the vertebral artery and vein, and descends in front of the anterior scalene muscle to empty into the left subclavian vein at its junction with the internal jugular vein.

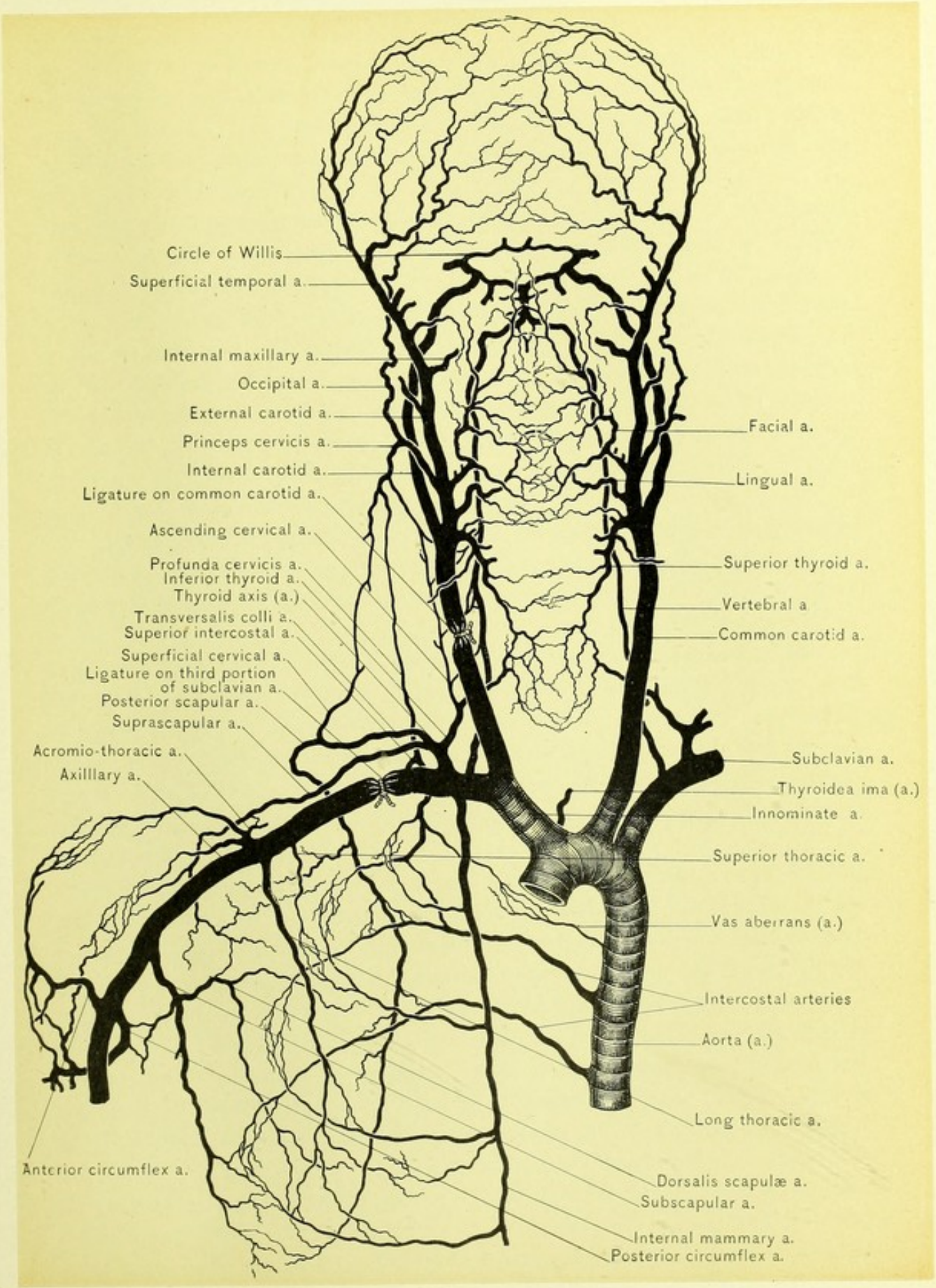
The Second Portion of the Subclavian Artery.—The relations of the subclavian artery in its second and third portions are alike on its two sides. In its second portion the artery lies behind the scalenus anticus and in front of the scalenus medius muscle ; at this point it rises highest above the clavicle, usually about three-fourths of an inch. It is covered by the skin, the superficial fascia, the platysma myoides muscle, the superficial layer of the deep fascia, the clavicular origin of the sterno-mastoid muscle, the posterior process of the deep fascia, the phrenic nerve, and the anterior scalene muscle, the latter separating it from the subclavian vein. Above it lies the lower of the three cervical trunks of the axillary or brachial plexus of nerves. Behind it are the middle scalene muscle and the apex of the lung and pleura. Below it lies the pleura, while below and in front of it is the subclavian vein. This portion gives off but one branch, the superior intercostal artery.

The Third Portion of the Subclavian Artery.—In the third part of its course the artery passes downward and outward from the external margin of the anterior scalene muscle to the lower border of the first rib, occupying the subclavian triangle, where it is nearer the surface than in either the first or second portion of its course. It is covered by the skin, the superficial fascia, the platysma myoides muscle, the superficial layer and the posterior of the two processes of the deep fascia, and near its termination by the clavicle and subclavius muscle. Running in front of this portion are the supra-scapular artery and vein, while crossing it are the clavicular branches of the cervical plexus, the nerve to the subclavius muscle, and the external jugular vein. The transversalis colli, supra-scapular, posterior jugular, and jugulo-cephalic veins, which frequently form a plexus in front of the artery, and should be borne in mind in ligating the third portion of the subclavian artery, empty into the external jugular vein. The relation between the supra-scapular artery and the third portion of the subclavian artery at its point of election can be compared, surgically, to the relation held between the middle sterno-mastoid and the common carotid artery at its point of election. The anatomic difference is, however, that the middle sterno-mastoid artery passes across the sheath of the common carotid, and is frequently severed in the ligation of the latter, while the supra-scapular passes in front of, and almost parallel with, the subclavian artery, and can be displaced when the main vessel is ligatured. The subclavian

vein lies below the artery, and on a plane anterior to it. Above and to the outer side of this portion of the artery are the three cervical trunks of the axillary or brachial plexus of nerves and the omo-hyoid muscle. The upper trunk runs so close to and so nearly parallel with the artery that it may be mistaken for it and tied, the surgeon being misled by the pulsation communicated to the nerve. Behind the artery are the middle scalene muscle and the lower cervical trunk of the brachial plexus. Below this portion of the artery is the first rib. The third portion of the subclavian artery, as a rule, gives off no branches, but occasionally gives origin to the posterior scapular artery.

Variations of the subclavian artery.—The right subclavian artery may arise as a separate trunk from the arch of the aorta. It may pass in front of or through the fibers of the anterior scalene muscle, and ascend as high as one and one-half inches above the clavicle. In some cases the subclavian vein passes with the artery behind the anterior scalene muscle.

Ligation of the third portion of the subclavian artery.—The third portion is the point of election for ligation of the subclavian artery; in this portion it is most superficial, is covered by fewer important structures, and, as a rule, gives off no branches; the posterior scapular artery occasionally arises from it. When performing this ligation the patient should be placed in the supine position, with a pillow beneath the upper part of the back, and the shoulder depressed. The incision is made parallel with the upper border of the clavicle, should be three or four inches in length, and commence at the outer border of the clavicular origin of the sterno-mastoid muscle. The vessel is brought nearer the surface by carrying the arm to the side and depressing the shoulder, thus diminishing the depth of the triangle through which the artery passes. The relation of the supra-scapular vessels to the third portion of the subclavian artery is so changed when the arm is well drawn down that it is not endangered in the ligation. The following structures are divided: the skin, the superficial fascia, the platysma myoides muscle, some of the clavicular branches of the cervical plexus of nerves, the superficial layer of the deep fascia, and the posterior of its two processes (prevertebral fascia). The external jugular vein, with the veins emptying into it, which frequently form a plexus above and in front of the subclavian artery between the two layers of the deep fascia (superficial and prevertebral), should be pushed aside; if this is not feasible, they may be tied and severed between ligatures. The posterior belly of the omo-hyoid muscle should next be exposed by dividing the connective tissue at the bottom of the wound; the operator then searches for the upper cervical trunk of the axillary or brachial plexus of nerves and the outer border of the anterior scalene muscle, along which the finger is passed until the tubercle on the first rib is reached, provided the vessel is not felt pulsating before the finger reaches



COLLATERAL CIRCULATION AFTER LIGATION OF SUBCLAVIAN ARTERY.

the rib. If the pulsations of the artery be felt, its sheath should be opened and the aneurysm needle, carrying the ligature, passed from before backward, away from the vein, and then from below upward, care being taken to avoid including the lower of the three cervical trunks of the axillary or brachial plexus, which runs behind and nearly parallel with the third portion of the subclavian artery. In very muscular subjects, in addition to the above structures, it may be necessary to divide a portion of the clavicular head of the sterno-mastoid and the anterior border of the trapezius muscle.

After this ligation the *collateral circulation* is carried on by the anastomosis of the supra-scapular and posterior scapular arteries with the dorsalis scapulæ and the terminal portion of the subscapular artery, the supra-scapular above, with the acromio-thoracic and posterior circumflex arteries below, and by the anastomosis of the superior thoracic, thoracic branches of the acromio-thoracic, the long thoracic, and the subscapular artery, with the aortic intercostal arteries, the internal mammary, and the superior intercostal artery.

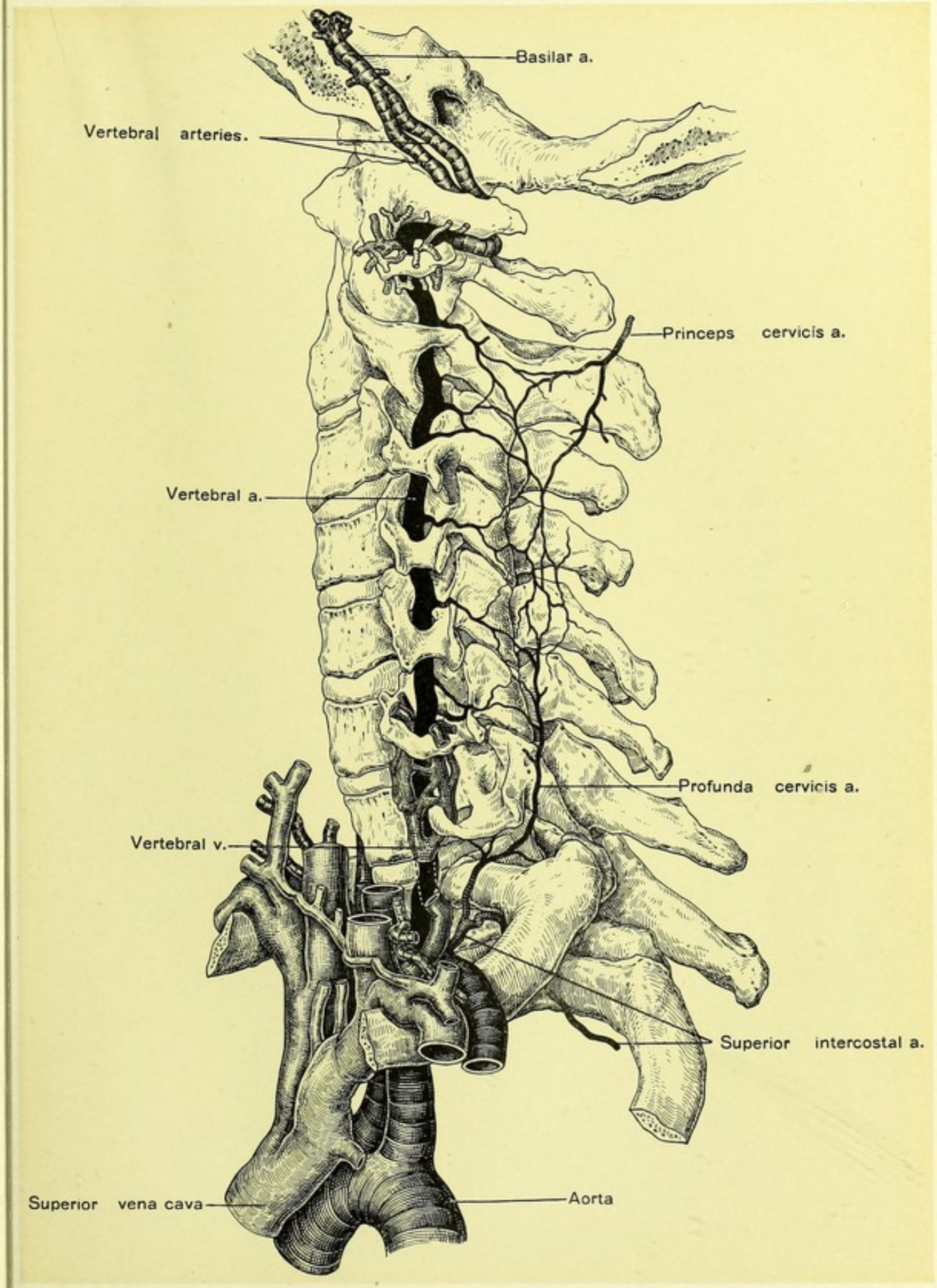
Ligation of the second portion of the subclavian artery is very rarely performed. The vessel is exposed by an incision along the clavicle, as in the foregoing ligation; in addition, the clavicular head of the sterno-mastoid muscle is divided, the connective tissue is cleared away, and any veins which may be found overlying the prevertebral fascia covering the anterior scalene muscle are tied. The prevertebral fascia is divided, the phrenic nerve carried inward, and the anterior scalene muscle severed near its attachment to the first rib, care being taken not to injure the anterior jugular, external jugular, internal jugular, and subclavian veins or the pleura. The needle should be carried from before backward and below upward to avoid injuring the vein, as in ligating the third portion of the artery.

Ligation of the first portion of the subclavian artery is the most difficult of the three ligations, especially of the left subclavian artery. This portion of the vessel lies deeper than the other two portions, is surrounded more intimately by important structures, and gives off three branches. (See description of the relations of the first portion.) To expose this portion of the vessel on the right side make a triangular flap, like that made in tying the innominate artery, by carrying an incision along the inner border of the sterno-mastoid muscle and one along the upper border of the clavicle. The skin, superficial fascia, platysma myoides muscle, superficial layer of the deep fascia, and the anterior jugular vein are divided. The sternal head of the sterno-mastoid muscle, and, if necessary, the clavicular head, as well as the sterno-hyoid and sterno-thyroid muscles at their origin, are divided. The inferior thyroid veins, now seen at the bottom of the wound, should be held aside or divided between ligatures, and the root of the com-

mon carotid artery exposed; this artery is then followed downward to the innominate, thus reaching the first part of the subclavian artery. To expose the first portion of the left subclavian artery a flap similar to that described in exposing the same portion of the right should be made. The sterno-mastoid, the sterno-hyoid, and the sterno-thyroid muscle are divided, and the apex of the left lung, with the structures running parallel to and in front of the artery (see description of the relations of the first portion of the left subclavian artery), should be drawn forward, the vertebral and internal jugular veins avoided, and the aneurysm needle passed from below upward. In carrying the needle behind the artery, unless great care be exercised, the thoracic duct and pleura may be wounded.

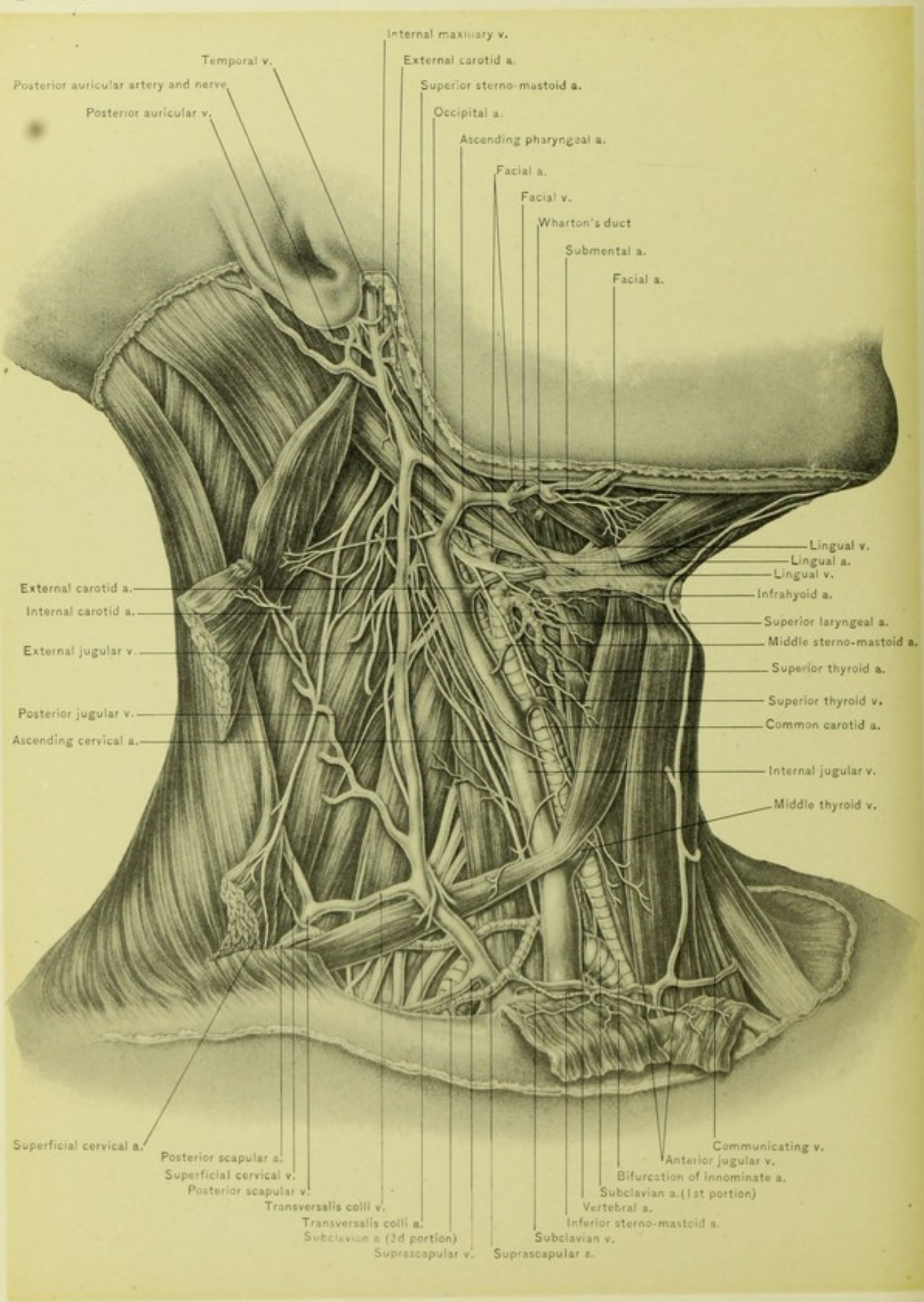
Branches of the Subclavian Artery.—These consist of the vertebral, the thyroid axis, the internal mammary, and the superior intercostal artery. The first three branches arise from the first portion of the artery; the fourth branch arises from the second portion. In the majority of cases the third portion gives off no branches, but the posterior scapular artery frequently arises from it.

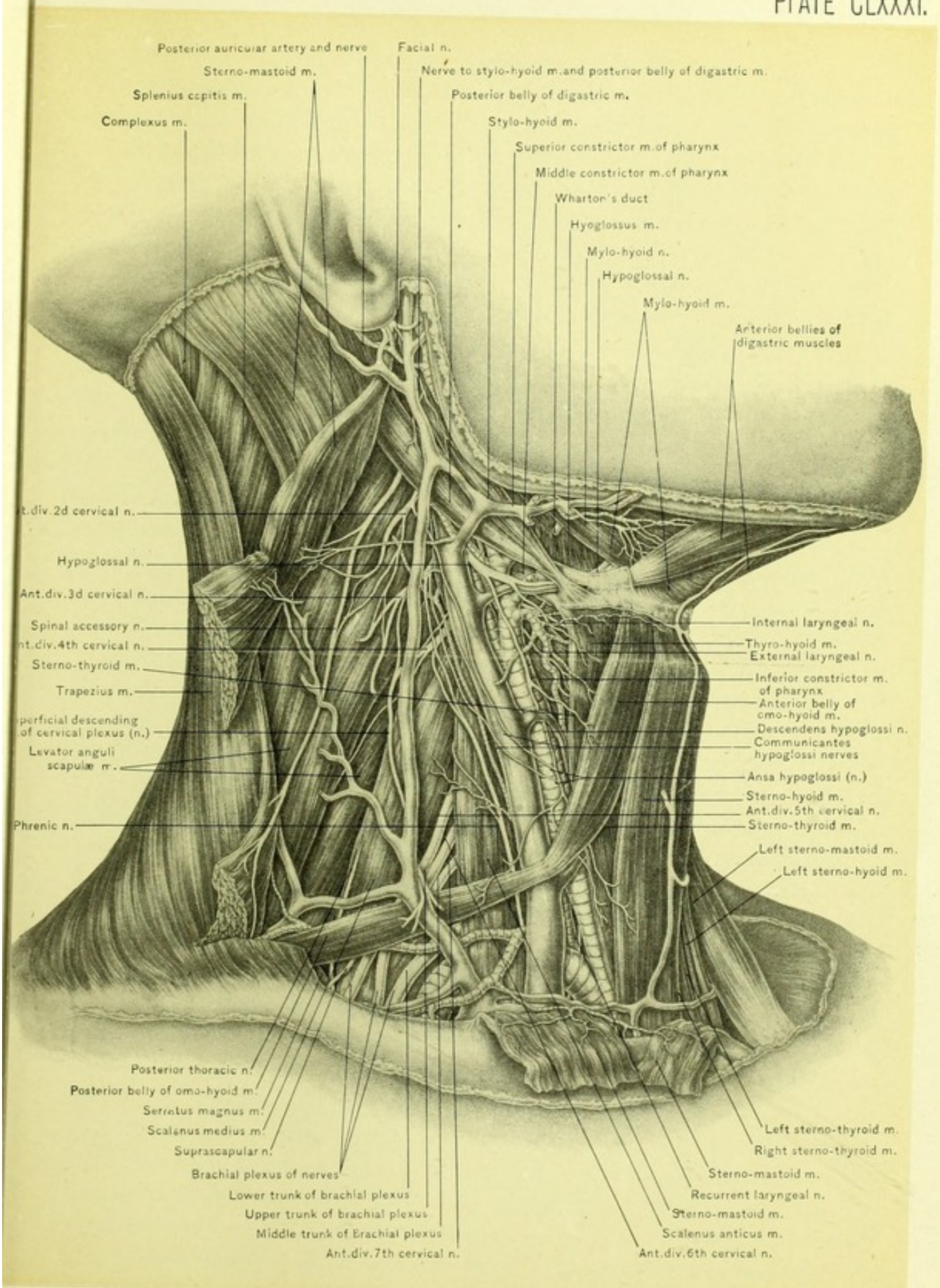
The **vertebral artery,** the first and largest branch, arises from the upper and back part of the first portion of the subclavian artery. It ascends in the interval between the scalenus anticus and longus colli muscles, entering the foramen in the transverse process of the sixth cervical vertebra, just below the level of the lower border of the cricoid cartilage. It continues upward through the foramina in the transverse processes of the remaining cervical vertebræ to the skull. Having passed through the foramen in the transverse process of the axis, it makes an S-shaped curve upward and outward, which prevents its being stretched when the head is rotated. It then passes through the foramen in the transverse process of the atlas, curving backward behind the articular process in a deep groove on the upper surface of the posterior arch of the atlas. Here it lies in the suboccipital triangle, and pierces the posterior occipito-atloid ligament and dura mater of the spinal cord to traverse the foramen magnum and become intra-cranial. It unites with the vertebral artery of the opposite side near the lower border of the pons Varolii to form the basilar artery. The first or *cervical portion* of the vertebral artery lies behind the internal jugular vein, the inferior thyroid artery, and the vertebral vein, while near the transverse process of the sixth cervical vertebra it lies between the scalenus anticus and longus colli muscles; the thoracic duct lies in front of the left vertebral artery. The second or *vertebral portion* lies within the canal formed by the foramina of the transverse processes of the upper six cervical vertebræ, and is accompanied by the vertebral veins and the vertebral plexus of nerves derived from the inferior cervical sympathetic ganglion; it lies between the vertebral vein in front, and the cervical nerves, which pass out of the spinal canal through the intervertebral foramina, behind. It is in contact with the



VERTEBRAL ARTERY IN TRANSVERSE PROCESSES.

PLATE CLXXX.


Internal maxillary v.
Temporal v.
External carotid a.
Posterior auricular artery and nerve
Superior sterno-mastoid a.
Posterior auricular v.
Occipital a.
Ascending pharyngeal a.
Facial a.
Facial v.
Wharton's duct
Submental a.
Facial a.
Lingual v.
Lingual a.
Lingual v.
External carotid a.
Infrahyoid a.
Internal carotid a.
Superior laryngeal a.
External jugular v.
Middle sterno-mastoid a.
Superior thyroid a.
Superior thyroid v.
Posterior jugular v.
Common carotid a.
Ascending cervical a.
Internal jugular v.
Middle thyroid v.
Superficial cervical a.
Communicating v.
Posterior scapular a.
Anterior jugular v.
Superficial cervical v.
Bifurcation of innominate a.
Posterior scapular v.
Subclavian a. (1st portion)
Transversalis colli v.
Vertebral a.
Transversalis colli a.
Inferior sterno-mastoid a.
Subclavian a (3d portion)
Subclavian v.
Suprascapular v.
Suprascapular a.


Posterior auricular artery and nerve
Facial n.
Sterno-mastoid m.
Nerve to stylo-hyoid m. and posterior belly of digastric m.
Splenius capitis m.
Posterior belly of digastric m.
Complexus m.
Stylo-hyoid m.
Superior constrictor m. of pharynx
Middle constrictor m. of pharynx
Wharton's duct
Hyoglossus m.
Mylo-hyoid n.
Hypoglossal n.
Mylo-hyoid m.
Anterior bellies of digastric muscles
t. div. 2d cervical n.
Hypoglossal n.
Ant. div. 3d cervical n.
Spinal accessory n.
nt. div. 4th cervical n.
Sterno-thyroid m.
Trapezius m.
perficial descending of cervical plexus (n.)
Levator anguli scapulæ m.
Phrenic n.
Internal laryngeal n.
Thyro-hyoid m.
External laryngeal n.
Inferior constrictor m. of pharynx
Anterior belly of omo-hyoid m.
Descendens hypoglossi n.
Communicantes hypoglossi nerves
Ansa hypoglossi (n.)
Sterno-hyoid m.
Ant. div. 5th cervical n.
Sterno-thyroid m.
Left sterno-mastoid m.
Left sterno-hyoid m.
Posterior thoracic n.
Posterior belly of omo-hyoid m.
Serratus magnus m.
Scalenus medius m.
Suprascapular n.
Brachial plexus of nerves
Lower trunk of brachial plexus
Upper trunk of brachial plexus
Middle trunk of Brachial plexus
Ant. div. 7th cervical n.
Left sterno-thyroid m.
Right sterno-thyroid m.
Sterno-mastoid m.
Recurrent laryngeal n.
Sterno-mastoid m.
Scalenus anticus m.
Ant. div. 6th cervical n.

intertransverse muscles. Its third or *occipital portion* lies in the groove on the posterior arch of the atlas, where it rests upon the suboccipital nerve, and is within the suboccipital triangle formed by the rectus capitis posticus major muscle upon the inner side, the obliquus capitis superior above and the obliquus capitis inferior muscle below; it is covered by the complexus muscle. The relation which the fourth or *intra-cranial portion* holds within the cranial cavity is described under the Dissection of the Brain.

The Branches of the Vertebral Artery.—These consist of two sets: those given off in the neck and those given off within the cranial cavity. The branches given off in the neck are the lateral spinal and the muscular.

The *lateral spinal arteries* pass through the intervertebral foramina, and each divides into two branches for the supply of the spinal cord, its membranes, and the bodies of the vertebræ.

The *muscular branches* are given off immediately before the vertebral artery pierces the occipito-atloid ligament; they supply the deep muscles of the neck, and anastomose with the ascending cervical, occipital, and deep cervical arteries.

The *vertebral vein* is formed in the suboccipital triangle from a plexus of veins composed of numerous small branches from the deep muscles. It enters the foramen in the transverse process of the atlas, and forms a plexus around the vertebral artery. At the lower part of the neck the plexus unites to form the vertebral vein, which emerges at the foramen in the transverse process of the sixth cervical vertebra, whence it passes downward in front of the vertebral artery and behind the internal jugular vein and terminates in the innominate vein near its origin, passing in front of the first portion of the subclavian artery. Its orifice is guarded by a pair of valves. It receives as tributaries the veins from the neighboring muscles; the dorsi spinalis veins, the veins from the spinal canal (the meningo-rachidian veins), the deep cervical, and, at times, the first pair of intercostal veins. In cases where the posterior condyloid foramen is present, the vertebral vein communicates with the lateral sinus by a branch which passes through the foramen.

Ligation of the vertebral artery is performed through an incision carried along the lower part of the posterior border of the sterno-mastoid muscle, which corresponds to the outer border of the anterior scalene muscle. The skin, superficial fascia, platysma myoides muscle, and the superficial layer of the deep fascia are divided, the external jugular vein being displaced outward. The sterno-mastoid muscle is drawn toward the median line, and the connective tissue divided or pushed aside with the handle of the scalpel, thus exposing the prevertebral fascia or posterior process of the deep cervical fascia which covers the anterior scalene muscle and the phrenic nerve. The posterior process of the deep

cervical fascia (prevertebral fascia) is divided on a line with the inner border of the anterior scalene muscle; the vertebral artery with its companion vein, which partly covers it, will be found occupying the interval between the anterior scalene and the longus colli muscle. The inferior thyroid artery, which lies in front of the vertebral artery, must not be mistaken for it. The dissection necessary to expose the vessel must be done cautiously, otherwise there is danger of wounding the phrenic nerve and the internal jugular vein, or of opening the pleural sac. The inexperienced operator may be led to believe he has opened the pleural sac, by the crackling sound occasioned by air infiltrating the connective tissue occupying this position. The vertebral vein must be slightly displaced before passing the aneurysm needle, which should be carried from without inward to avoid injuring the vertebral vein, the internal jugular vein being protected with the tip of the finger. On the left side the thoracic duct should be avoided. Contraction of the pupil of the eye of the corresponding side, caused by the disturbance of the sympathetic filaments in relation with the artery, is evidence that the ligature has included the vertebral artery. The author has found this a reliable sign. The carotid tubercle, which is at the upper extremity of the groove between the scalenus anticus and longus colli muscles, is the deep guide to the artery.

The **thyroid axis,** a short thick trunk, arises from the subclavian artery near the inner border of the anterior scalene muscle. It lies beneath the internal jugular vein and prevertebral fascia and between the phrenic nerve and vertebral vein, and divides into three BRANCHES: the inferior thyroid, supra-scapular, and transversalis colli arteries.

The **inferior thyroid artery,** the largest branch of the thyroid axis, passes obliquely upward and inward behind the internal jugular vein, and in front of the vertebral artery and inward behind the sheath of the common carotid artery and the sympathetic nerve to the deep surface of the lateral lobe of the thyroid gland, which gland it supplies and within which it anastomoses with the superior thyroid artery and the inferior thyroid artery of the opposite side. It turns inward just below the carotid tubercle (anterior tubercle of the sixth cervical transverse process), and crosses behind the sheath of the vessels at about the level of the tendon of the omo-hyoid muscle. The middle cervical or thyroid ganglion of the sympathetic nerve rests upon the inferior thyroid artery. It gives off the following BRANCHES: ascending cervical, laryngeal, tracheal, esophageal, and muscular.

The *ascending cervical artery* arises from the inferior thyroid behind the internal jugular vein, and runs up the neck close to the tips of the transverse processes of the cervical vertebræ in the groove between the anterior scalene and the rectus capitis anticus major muscle, and to the inner side of the phrenic nerve.

Its branches to the muscles of the neck communicate with the muscular branches of the vertebral artery, while others enter the intervertebral foramina to reach the bodies of the vertebræ and the spinal cord and its meninges. It anastomoses with the veretebral, ascending pharyngeal, and branches of the occipital artery. It sends a branch to the phrenic nerve.

The *inferior laryngeal artery* accompanies the recurrent laryngeal nerve, supplies the muscles and mucous membrane of the larynx, and anastomoses with the superior laryngeal artery.

The *tracheal branches* ramify upon the trachea, the lower ones anastomosing with the bronchial arteries.

The *esophageal branches* supply the esophagus. One of these is often large, runs parallel with the continuation of the inferior thyroid artery, and may be mistaken for it.

The *muscular branches* supply the muscles of the lower anterior part of the neck.

The inferior thyroid artery is not accompanied by the corresponding **vein,** which lies at the side of the median line of the neck. (See Dissection of Front of Neck.)

Ligation of the inferior thyroid artery.—This is performed either where the artery lies between the internal jugular vein and the inner border of the anterior scalene muscle, or to the inner side of the carotid sheath as it passes to the deep surface of the lateral lobe of the thyroid gland just below the level of the cricoid cartilage. To secure the inferior thyroid artery along the inner border of the anterior scalene muscle make an incision similar to that made in ligation of the vertebral artery, carrying the aneurysm needle from within outward away from the vertebral vein. To secure the inferior thyroid artery on the inner side of the carotid sheath make an incision along the anterior border of the sterno-mastoid muscle.

The **supra-scapular artery** (transversalis humeri), smaller than the transversalis colli artery, coarses outward across the lower part of the neck. It first passes beneath the sterno-mastoid muscle and over the phrenic nerve and lower part of the anterior scalene muscle; then it runs behind the clavicle and subclavius muscle, crosses the third part of the subclavian artery, and passes beneath the posterior belly of the omo-hyoid and the anterior border of the trapezius muscle, to the superior border of the scapula, where it passes over the transverse ligament of that bone to reach the supra-spinous fossa. The supra-scapular nerve, which joins the artery just before it dips under the omo-hyoid muscle, passes beneath the transverse ligament, and through the supra-scapular notch. In the supra-spinous fossa the artery lies close to the bone, and supplies the supra-spinatus muscle; at

the neck of the scapula it turns around the base of the spine to the infra-spinous fossa, where it anastomoses with the dorsalis scapulæ, a branch of the subscapular artery, and with the posterior scapular artery. The chief Branches of the supra-scapular artery are the inferior sterno-mastoid, supra-acromial, and articular. Other branches supply the subclavius muscle, the skin over the manubrium sterni (supra-sternal), and the clavicle.

The *inferior sterno-mastoid artery* supplies the clavicular portion of the sterno-mastoid muscle, behind which it is given off.

The *supra-acromial branch* pierces the trapezius muscle, passes over the acromion process, and anastomoses with the acromio-thoracic and posterior circumflex arteries.

The *articular branches* supply the acromio-clavicular joint and the shoulder-joint.

The **transversalis colli artery,** or transverse cervical, usually larger than the supra-scapular artery, passes outward across the side of the neck, higher than the supra-scapular, over the scalene muscles and phrenic nerve, and over or between the cervical trunks of the axillary or brachial plexus to the anterior border of the trapezius, beneath which, and at the outer border of the levator anguli scapulæ muscle, it divides into its two terminal branches, the superficial cervical and the posterior scapular.

The *superficial cervical artery* passes upward beneath the anterior border of the trapezius and over the levator anguli scapulæ and splenius muscles. It supplies these muscles and the posterior chain of lymphatic glands in the neck, and anastomoses with the superficial branch of the arteria princeps cervicis, which descends from the occipital artery between the splenius and complexus muscles.

The *posterior scapular artery*, the larger of the two terminal branches, passes beneath the trapezius and the levator anguli scapulæ muscle to the superior angle of the scapula, whence it descends along the vertebral border or base of the scapula to the inferior angle. It runs between the insertions of the serratus magnus muscle in front and the rhomboidei and levator anguli scapulæ muscles behind, which, with the latissimus dorsi and trapezius, it supplies. It anastomoses with the supra-scapular and subscapular arteries, and with the posterior branches of the intercostal arteries. It frequently arises from the third portion of the subclavian artery, and in such cases the superficial cervical artery usually arises from the thyroid axis.

The **veins** corresponding to the branches of the thyroid axis empty into the external jugular vein, except the inferior thyroid vein, which goes to the innominate vein.

The **Internal Mammary Artery** arises from the lower margin of the first

part of the subclavian artery opposite the thyroid axis. It passes downward beneath the clavicle, the subclavius muscle, and the subclavian vein, and enters the chest between the cartilage of the first rib and the pleura. At its origin it is crossed from without inward by the phrenic nerve. Its further course is described under the Dissection of the Thorax. The accompanying **veins** of the internal mammary artery, two in number, unite to form a common trunk which empties into the innominate vein.

The **Superior Intercostal Artery** arises from the upper margin of the second portion of the subclavian artery, and occasionally arises from the first portion upon the left side. It arches backward and a little upward over the pleura, and then descends behind it, giving off the profunda cervicis artery; it then passes in front of the neck of the first, and sometimes of the second, rib, giving off the arteries of the first, and at times of the second, intercostal space, and a posterior branch, which is distributed to the muscles of the back and to the spinal cord and its membranes. In front of the neck of the first rib it lies between the first thoracic sympathetic ganglion on the inner side, and the anterior branch of the first thoracic nerve on the outer side. Its BRANCHES are the deep cervical, the first intercostal, and the arteria aberrans.

The **deep cervical artery** (profunda cervicis) passes backward between the seventh and eighth cervical nerves, and then between the transverse process of the last cervical vertebra and the neck of the first rib, internal to the middle and posterior scalene muscles; thence it passes up the back of the neck between the complexus and semi-spinalis colli muscles, which it supplies, and anastomoses with the arteria princeps cervicis and branches of the ascending cervical and vertebral arteries.

The **deep cervical vein** begins in the suboccipital triangle, usually receives the occipital vein, accompanies the arteria princeps cervicis, and then the profunda cervicis artery, and empties into the vertebral or innominate vein.

The **first intercostal artery** has a distribution in the first intercostal space corresponding with that of the arteries in the other intercostal spaces.

The **arteria aberrans,** inconstant, arises from the inner side of the right superior intercostal artery, and passes downward behind the esophagus, supplying adjacent structures and sometimes joining a small ascending branch of the aorta, opposite the third thoracic vertebra.

The *anastomosis* between the superior intercostal and the occipital artery performs an important part in the development of the collateral circulation after ligation of the common carotid artery.

The **veins** which correspond to the superior intercostal arteries are the right

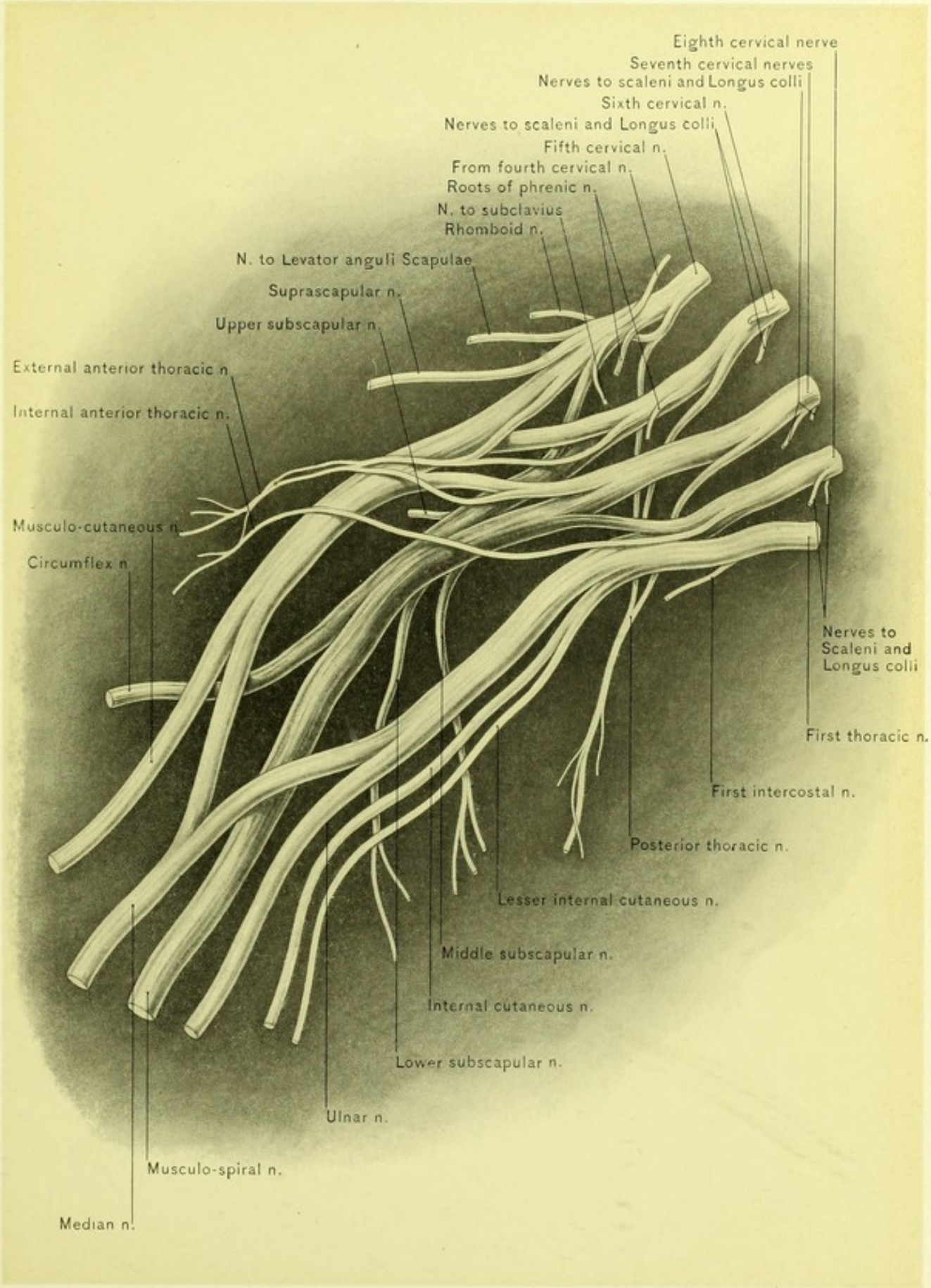
and left superior intercostal veins. The left superior intercostal vein empties into the left innominate vein, and the right into the vena azygos major or the right innominate vein.

The Axillary or Brachial Plexus.—The axillary or brachial plexus of nerves will be seen at the side of the neck, emerging from between the anterior and middle scalene muscles; it is formed by the union of the anterior branches of the lower four cervical nerves and by the greater portion of the anterior branch of the first thoracic nerve. A small branch from the anterior division of the fourth cervical and another from the second thoracic nerve usually enter the plexus. These branches form the cords of the plexus, from which are given off the branches that supply the upper extremity. The nerves in the neck are arranged as follows: the anterior branches of the fifth and sixth cervical nerves unite beyond the outer border of the anterior scalene muscle to form an upper trunk; the anterior branch of the seventh cervical nerve remains distinct as the middle trunk; the anterior branches of the eighth cervical and first thoracic nerves unite between the scalenus anticus and scalenus medius muscles to form the lower trunk. The upper and middle trunks run above and parallel with the subclavian artery, but on a posterior plane, while the lower trunk passes behind the artery. The three trunks accompany the artery between the clavicle and first rib on their way to the axilla. These three trunks separate into anterior and posterior divisions, the anterior divisions of the upper and middle trunks forming the outer cord, that of the lower trunk continuing as the inner cord, and all the posterior divisions uniting to form the posterior cord. (For a description of the plexus within the axilla see Dissection of Axilla.)

The **branches of the axillary or brachial plexus** are divided into two sets: those given off above the clavicle and those arising below that bone. The branches arising above the clavicle are the nerves to the subclavius, rhomboidei, scaleni, and longus colli muscles, the posterior or long thoracic nerve (the external respiratory nerve of Bell), communicating, and supra-scapular nerves.

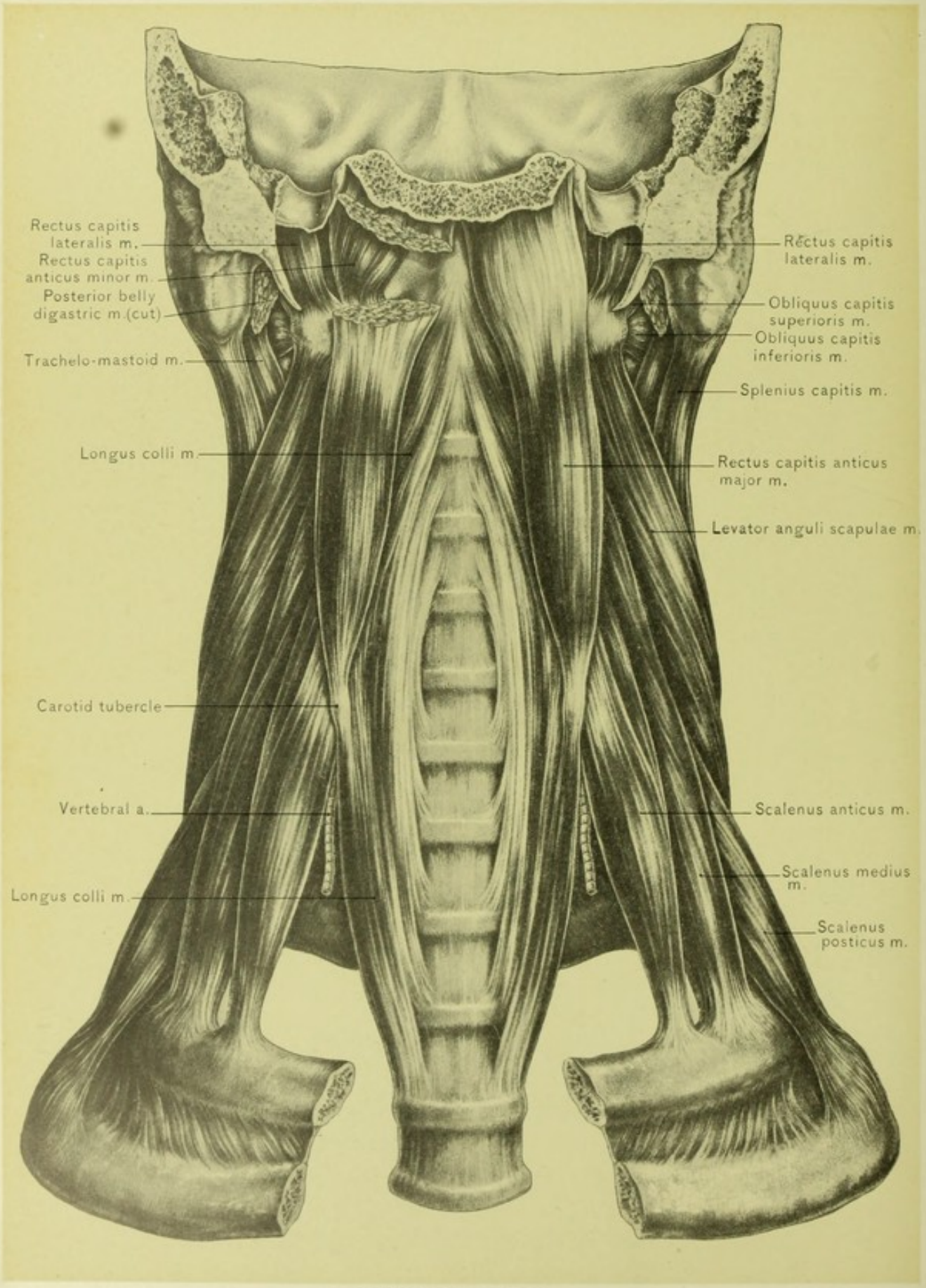
The **nerve to the subclavius muscle** arises from the trunk formed by the fifth and sixth cervical nerves, and passes downward over the third portion of the subclavian artery to the under surface of the subclavius muscle. It is frequently connected with the phrenic nerve at the lower part of the neck by a filament which passes in front of the subclavian vein.

The **nerve to the rhomboidei muscles** arises from the fifth cervical nerve,



AXILLARY OF BRACHIAL PLEXUS OF NERVES.

PLATE CLXXXIII.



PREVERTEBRAL MUSCLES.

pierces the middle scalene muscle, and passes backward beneath the levator anguli scapulæ muscle to the under surface of the rhomboidei muscles, which, with the levator anguli scapulæ muscle, it supplies. It accompanies the posterior scapular artery.

The **nerves to the scaleni and longus colli muscles** arise from the lower three cervical nerves near the intervertebral foramina.

The **posterior or long thoracic nerve** (external respiratory nerve of Bell) arises within the substance of the scalenus medius muscle from the fifth, sixth, and seventh cervical nerves. The first two roots pierce the scalenus medius muscle below the nerve to the rhomboidei muscles, and the last root passes in front of the scalenus medius muscle. The long thoracic nerve passes downward behind the trunks of the axillary plexus and the subclavian vessels, and enters the axilla by way of the apex. Here it lies upon the serratus magnus muscle, which it supplies.

Communicating.—Usually a branch from the fifth cervical nerve joins the phrenic nerve on the anterior scalene muscle.

The **supra-scapular nerve,** the largest of the branches given off above the clavicle, arises from the upper cervical trunk near the nerve to the subclavius muscle. It passes downward and outward beneath the trapezius and the posterior belly of the omo-hyoid muscle to the upper border of the scapula, where it is in relation with the supra-scapular artery. It passes through the supra-scapular notch, being separated from the artery by the transverse ligament, and enters the supra-spinous fossa. It supplies the supra-spinatus muscle, winds around the base of the spine of the scapula, and sends articular branches to the shoulder-joint, after which it terminates in the infra-spinatus muscle.

The scalene muscles.—The scalene muscles are three in number: the anterior, the middle, and the posterior.

The **anterior scalene muscle** arises from the anterior tubercles of the transverse processes of the third, fourth, fifth, and sixth cervical vertebræ, and is inserted into the tubercle on the inner border and upper surface of the first rib in front of the groove for the subclavian artery. It is most deeply situated below. In relation with its anterior surface are the phrenic and pneumogastric nerves, the transversalis colli, supra-scapular, and ascending cervical arteries, the internal jugular and subclavian veins, the subclavius and omo-hyoid muscles, and the clavicular head of the sterno-mastoid muscle. On the left side the thoracic duct crosses in front of the muscle. Along the inner border of the muscle, above, lies the rectus capitis anticus major muscle; the vertebral artery and vein, the inferior thyroid artery and sympathetic nerves, which separate it from the longus colli muscle, lie along the inner side of the lower part of the muscle.

Behind the anterior scalene muscle are the pleura, the subclavian and superior intercostal arteries, the nerves forming the axillary plexus of nerves, and the middle scalene muscle.

Nerve Supply.—From the anterior primary branches of the fourth, fifth, and sixth cervical nerves.

Action.—The anterior scalene muscle, when acting from its points of origin, will raise the first rib; but if the rib be fixed, the muscle acting from below will flex the lower cervical vertebræ, at the same time slightly rotating these vertebræ.

The **middle scalene muscle,** the largest, as well as the longest, of the three scalene muscles, arises from the posterior tubercles of the transverse processes of the lower six cervical vertebræ, and is inserted into the upper surface of the first rib, behind the groove for the subclavian artery. It is separated from the anterior scalene muscle by the subclavian artery and the nerves forming the axillary plexus. Passing through its substance is the posterior or long thoracic nerve (the external respiratory nerve of Bell). It is in relation, in front, with the cervical and brachial plexuses of nerves, the subclavian artery, the anterior scalene, omo-hyoid, and sterno-mastoid muscles, and the clavicle; along its outer border, with the levator anguli scapulæ and posterior scalene muscles; behind, with a part of the posterior scalene and the deep lateral muscles of the back of the neck.

Nerve Supply.—From the posterior primary branches of the cervical nerves.

Action.—When acting from above, the middle scalene muscle elevates the first rib; with the rib fixed, it laterally flexes the cervical portion of the spinal column.

The **posterior scalene muscle,** the smallest and deepest of the three scaleni, arises from the posterior tubercles of the transverse processes of the lower two or three cervical vertebræ, and is inserted into the outer surface of the second rib behind the origin of the serratus magnus muscle. It is sometimes blended with the middle scalene muscle.

Nerve Supply.—From the lower three cervical nerves.

Action.—It produces lateral cervical flexion when acting from below, and raises the second rib when acting from above.

The scaleni are accessory muscles of respiration; this can be demonstrated by placing the fingers over them while taking a full breath, when they will be felt contracting.

The scalene tubercle, or the tubercle on the first rib, to which the anterior scalene muscle is attached, is an important guide in locating the outer edge of the muscle and the third portion of the subclavian artery. Immediately to the outer side of the tubercle the subclavian artery can be compressed against the first rib. The position of the phrenic nerve on the anterior scalene muscle, and the relation which the clavicular head of the sterno-mastoid muscle holds to the

phrenic nerve and anterior scalene muscle must be borne in mind in operations upon the lower part of the side of the neck.

To *faradize the diaphragm* in suspended respiration, one pole of the battery should be placed over the anterior scalene muscle to stimulate the phrenic nerve. The head should be turned to the opposite side, so that the posterior border of the sterno-mastoid muscle will not extend so far beyond the phrenic nerve. The author doubts if this procedure is of any value.

DISSECTION.—Divide the trachea, esophagus, common carotid artery, internal jugular vein, the pneumogastric, sympathetic, and recurrent laryngeal nerves at the lower part of the neck. Separate these structures from the prevertebral muscles with the fingers. In order to study the prevertebral muscles and the pharynx, it is necessary to divide the skull so as to leave its posterior portion attached to the prevertebral muscles and its anterior portion attached to the pharynx. Draw the pharynx well forward; while an assistant holds a weight or block against the upper surface of the basilar process of the occipital bone, divide that process between the attachments of the pharynx and the rectus capitis anticus major muscle with a chisel and a mallet. The chisel should be directed upward and backward. Next saw through the sides of the skull, so as to leave the jugular foramina and carotid canals in the anterior segment. With a chisel separate the petrous portion of the temporal bone from the basilar process. The two portions of the skull can now be separated with a knife; the two segments can also be separated by sawing from above downward just in front of the foramen magnum. The anterior portion of the skull, with the pharynx and larynx, should be kept moist while the prevertebral muscles are dissected.

DISSECTION.—The remainder of the prevertebral fascia should now be removed.

The **prevertebral muscles** are the longus colli, rectus capitis anticus major, rectus capitis anticus minor, and rectus capitis lateralis.

The **longus colli muscle** consists of three sets of fibers: a longitudinal, a superior oblique, and an inferior oblique set. The *longitudinal set* arises from the bodies of the first, second, and third thoracic, and of the sixth and seventh cervical vertebræ, and passes upward to be inserted into the bodies of the second, third, and fourth cervical vertebræ. The *superior oblique set* arises from the anterior tubercles of the transverse processes of the third, fourth, and fifth cervical vertebræ, and passes upward and inward to be inserted into the anterior tubercle of the atlas. The *inferior oblique set* arises from the bodies of the first, second, and third thoracic vertebræ, and passes upward and outward to be inserted into the anterior tubercles of the transverse processes of the fifth and sixth cervical vertebræ.

Lying in front of the longus colli muscle are the prevertebral fascia, the pharynx, the esophagus, the sympathetic nerve, the inferior thyroid artery, the

recurrent laryngeal nerve, and the carotid sheath, containing the pneumogastric nerve, common carotid artery, and internal jugular vein. Behind the muscle are the cervical and upper thoracic vertebræ and the vertebral artery. Below, the vertebral artery lies along the outer border of the muscle, in the groove between it and the scalenus anticus muscle.

Nerve Supply.—From the anterior branches of the lower cervical nerves.

Action.—It flexes the cervical portion of the spinal column, slightly flexes it laterally, and rotates it.

The **rectus capitis anticus major muscle** arises from the anterior tubercles of the third, fourth, fifth, and sixth cervical vertebræ by four tendinous slips; these slips pass upward and inward to the belly of the muscle, which is inserted into the basilar process of the occipital bone by a short tendon.

In front of the muscle are the prevertebral fascia, the common and internal carotid arteries, the internal jugular vein, the pneumogastric and sympathetic nerves, and a portion of the pharynx. Behind it are the rectus capitis anticus minor and part of the longus colli muscle, and the upper cervical vertebræ.

Nerve Supply.—From the first and second cervical nerves.

Action.—It flexes the head and rotates the face to the same side.

Dissection.—Divide the rectus capitis anticus major muscle near the basilar process and reflect it downward to expose the rectus capitis anticus minor muscle.

The **rectus capitis anticus minor muscle** arises from the anterior part of the lateral mass and the root of the transverse process of the atlas. Its fibers pass upward and inward to be inserted into the basilar process of the occipital bone, between the foramen magnum and the insertion of the rectus capitis anticus major muscle, which lies in front of it. Behind it is the occipito-atlantal joint.

Nerve Supply.—From the first cervical nerve.

Action.—It flexes the head.

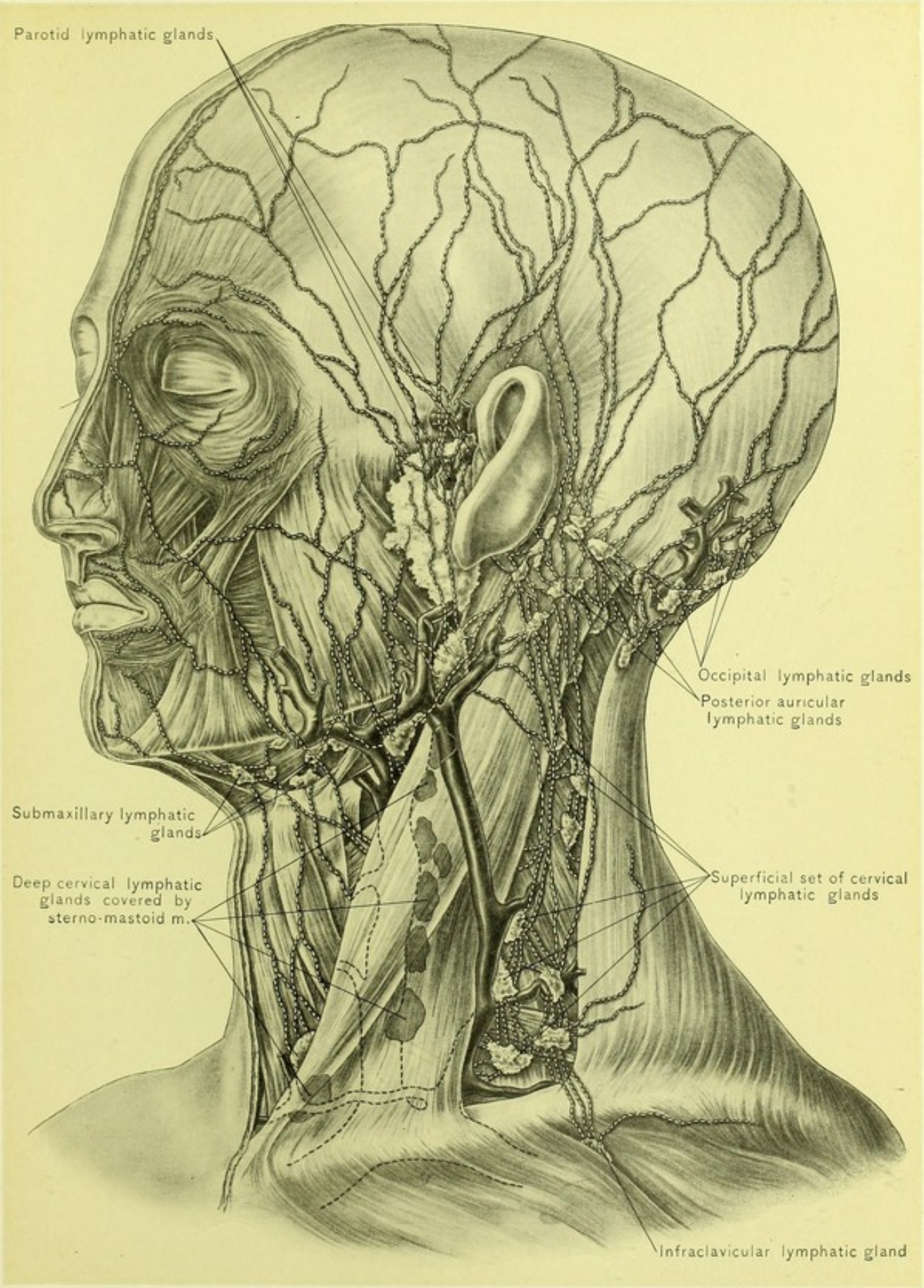
The **rectus capitis lateralis muscle** is seen to the outer side of, and slightly posterior to, the rectus capitis anticus minor muscle. It arises from the upper surface of the transverse process of the atlas, and is inserted into the jugular process of the occipital bone.

In front of it are the internal jugular vein and the anterior branch of the first cervical nerve, and behind it are the trachelo-mastoid muscle and the vertebral artery. The occipital artery lies on its outer side.

Nerve Supply.—From the anterior branch of the first cervical nerve.

Action.—It flexes the head laterally.

There are three **bursæ** in the neck: one in front of the upper part of the thyroid cartilage, or *pomum Adami;* another between the upper margin of the thyroid cartilage and the posterior surface of the hyoid bone; a third is also situ-



LYMPHATIC GLANDS AND LYMPHATIC VESSELS.

ated near the median line, between the genio-hyoid and genio-hyo-glossus muscles. These bursæ may become enlarged; that beneath the genio-hyoid muscle, when distended, may simulate a ranula. Like goiters and cysts of the thyroid gland, they move with the larynx in deglutition, differing in this respect from sebaceous and dermoid cysts, aneurysms of the carotid arteries, and growths of the lymphatic glands.

LYMPHATIC GLANDS OF THE NECK.

The lymphatic glands of the neck are classified as superficial and deep.

The **Superficial Lymphatic Glands** of the neck are most numerous along the course of the external jugular vein and posterior jugular vein. This set, the **superficial cervical chain,** is composed of from four to six glands, and lies beneath the superficial layer of the deep cervical fascia in the posterior triangle. The glands of this set are most numerous at the lower part of this triangle. Other small superficial lymphatic glands are seen in the median line of the neck: one below the symphysis of the lower jaw, two above the body of the hyoid bone, one near the cricoid cartilage, one above the sternum, and some resting upon the trapezius muscle. The superficial cervical chain receives the efferent vessels from the suboccipital and posterior auricular lymphatic glands and some from the parotid and submaxillary lymphatic glands, and the lymphatic vessels from the external ear and skin of the neck. Their efferent vessels empty into the inferior deep cervical glands. The lowest of the superficial cervical lymphatic glands also receive lymphatic vessels from the infraclavicular glands which are situated in the upper part of the delto-pectoral sulcus. In secondary syphilis the superficial cervical lymphatic glands along the posterior border of the sterno-mastoid muscle are enlarged early and can readily be felt.

The **Deep Lymphatic Glands** of the neck number from twenty to thirty, and are situated along the internal jugular and subclavian veins. They are divided into a superior and an inferior set. The **superior set** is situated along the internal jugular vein, between the base of the skull and the bifurcation of the common carotid artery. These glands receive the efferent vessels from the internal maxillary lymphatic glands, and some from the submaxillary lymphatic glands, the lymphatic vessels from the cranial cavity, the deep muscles of the upper part of the neck, the posterior part of the tongue, the middle portion of the pharynx, the upper part of the larynx, and the upper part of the thyroid body. Their efferent vessels empty into the glands of the inferior set. The **inferior set** is situated along the internal jugular vein, below the bifurcation of the common carotid artery, and extends outward into the subclavian triangle along the subclavian vein. These glands receive the efferent vessels from the superior deep cervical

and the superficial cervical glands; the lymphatic vessels from the lower part of the thyroid body, lower part of the larynx, lower part of the pharynx, upper part of the trachea and esophagus, and lower part of the neck; and some of the lymphatic vessels from the axillary and infra-clavicular glands. Their efferent vessels unite to form the jugular lymphatic trunk, which empties into the right lymphatic duct on the right side, and into the thoracic duct on the left side.

The deep cervical lymphatic glands are more important surgically than the superficial glands. These deep glands hold so close a relation to the great vessels of the neck that an attempt to remove them when they are much enlarged may lead the operator into dangerous locations.

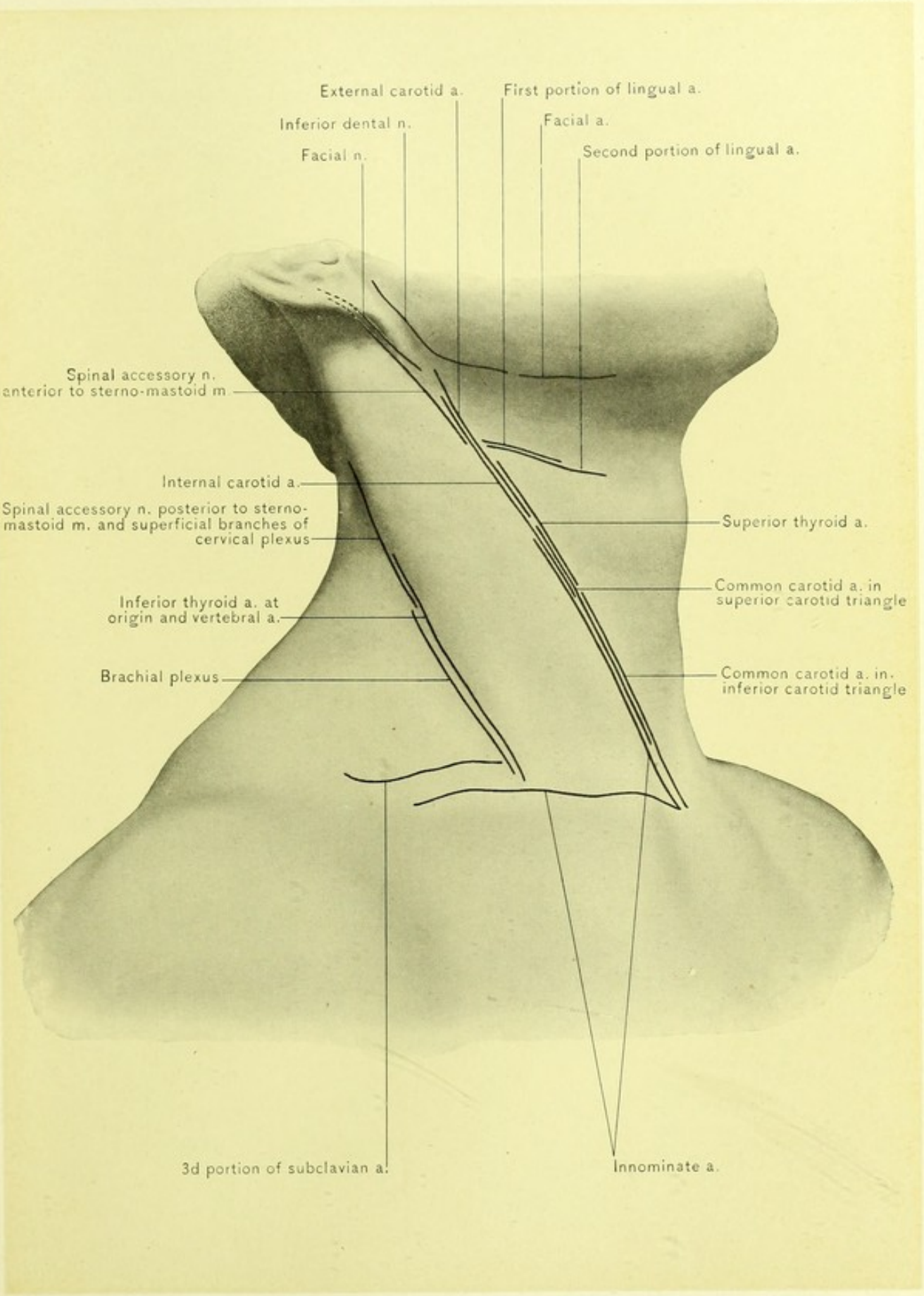
In the most radical operation for excision of the mammary gland for carcinoma the lymphatic glands in the subclavian triangle are removed so that there will be less likelihood of recurrence of the disease.

The *right lymphatic duct* is a short trunk about one-half of an inch in length. It receives the lymphatic vessels from the right side of the neck, right upper extremity, right side of the thorax, and upper surface of the liver. It empties into the subclavian vein or the internal jugular vein at the junction of these veins. Its orifice is guarded by a double valve.

The *thoracic duct*, which is described with the contents of the thorax, receives the lymphatic vessels from about three-fourths of the body—from the left side of the head, neck, and thorax, left upper extremity, abdomen, and lower extremities. It is found only on the left side in the neck. It emerges from the upper opening of the thorax behind and internal to the apex of the left pleural sac, curves forward and outward above the first portion of the left subclavian artery and in front of the left vertebral artery, and empties into the left subclavian vein or the left internal jugular vein near the angle of junction of these veins. The thoracic duct near its termination may subdivide into two or more ducts, and it rarely empties into the right subclavian vein.

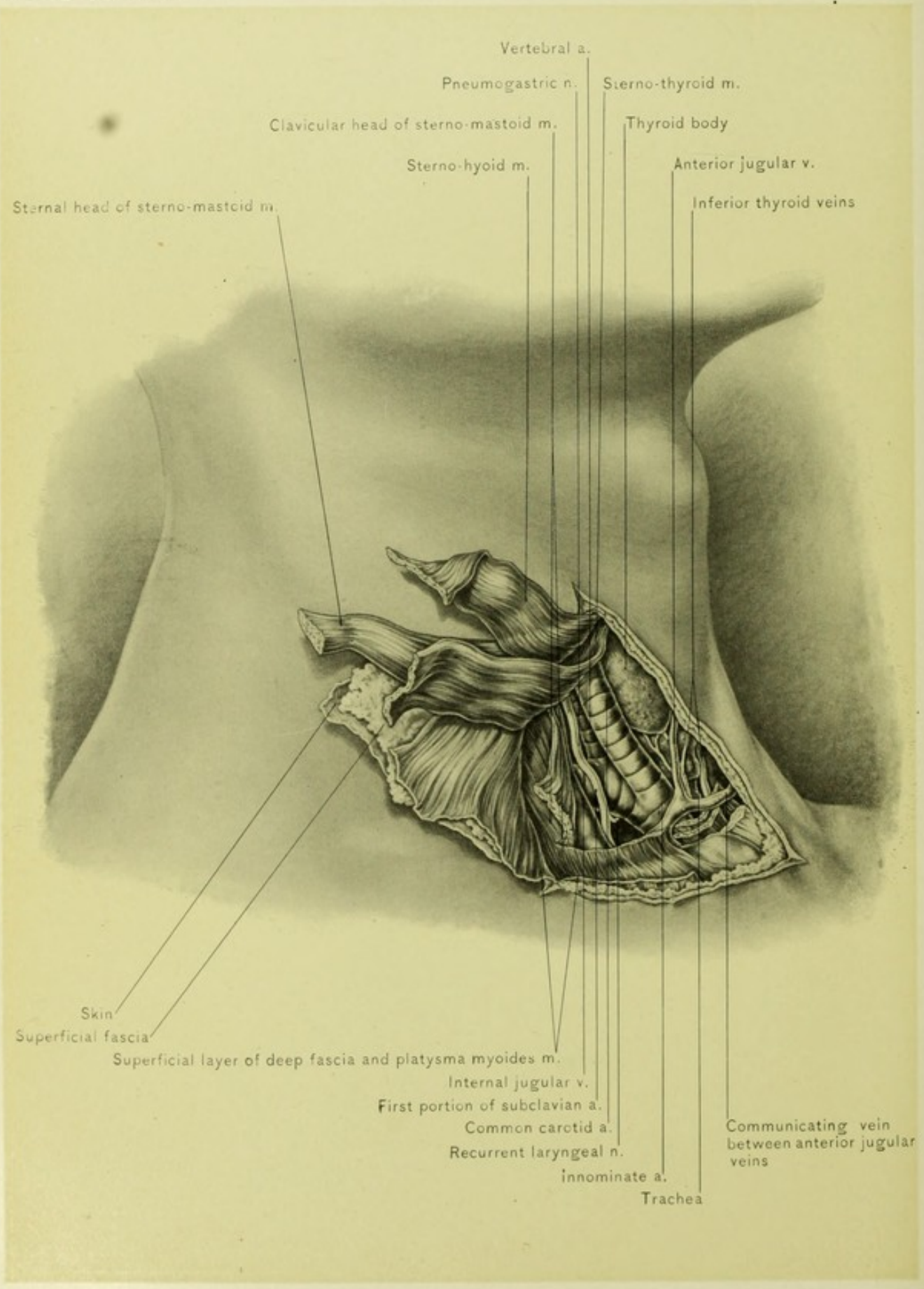
LIGATION OF ARTERIES OF HEAD AND NECK.

The **innominate artery** has been ligatured twenty-four times, with but two recoveries (Ashhurst). The operation is, for this reason, rarely performed. Ligation was indicated in these cases by aneurysms of the right subclavian or common carotid artery. Death was caused by secondary hemorrhage occurring on the distal side of the ligature. To avoid this sequel, ligatures should be placed at the same time upon the common carotid and vertebral arteries and not upon the



LINES OF INCISIONS FOR OPERATIONS ON NERVES AND ARTERIES OF HEAD AND NECK.

PLATE CLXXXVI.



EXPOSURE OF INNOMINATE ARTERY.

innominate artery. In front of the innominate artery are the sternum, right sterno-clavicular joint, sterno-hyoid and sterno-thyroid muscles, and the remains of the thymus gland. The left innominate vein crosses it at its origin, and the right inferior thyroid vein descends obliquely over its lower and inner part. Behind it are the trachea and right pleura. To its right side are the right innominate vein, right pneumogastric nerve, and pleura. To its left side are the inferior thyroid veins, left common carotid artery, remains of the thymus gland, and, at its upper end, the trachea. The innominate artery divides most frequently at the upper border of the right sterno-clavicular articulation; it occasionally divides lower, but seldom higher. Its depth and relation to important and delicate structures render the operation of ligation a difficult one. The incision should be carried along the anterior border of the right sterno-mastoid muscle to the upper margin of the sternum, and thence along the right clavicle. An angular incision is thus made, each part of which should be about three inches in length. The superficial incision divides the skin, superficial fascia, platysma myoides muscle, and supra-sternal and supra-clavicular branches of the cervical plexus. The triangular flap of skin, superficial fascia, and platysma myoides muscle should next be turned upward. The superficial layer of the deep fascia, sterno-hyoid, sterno-thyroid, and inner part of the sterno-mastoid muscle are next divided. The anterior jugular vein, which may require division between ligatures, runs transversely under the lower end of the sterno-mastoid muscle. The sheath of the common carotid artery should be opened and the artery traced downward to the innominate artery. The aneurysm needle, directed slightly downward, should be carefully passed around the artery, from without inward. In doing this, the dangers to be guarded against are punctures of the innominate vein and pleura.

Collateral Circulation.—The collateral circulation is established by the following anastomoses:

Proximal.		Distal.
Aortic intercostal arteries	with	Superior intercostal artery. Internal mammary artery. Superior thoracic artery. Long thoracic artery. Subscapular artery. Posterior scapular artery.
Phrenic artery Deep epigastric artery	with	Internal mammary artery.
Thyroidea ima artery	with	Superior thyroid artery. Inferior thyroid artery.

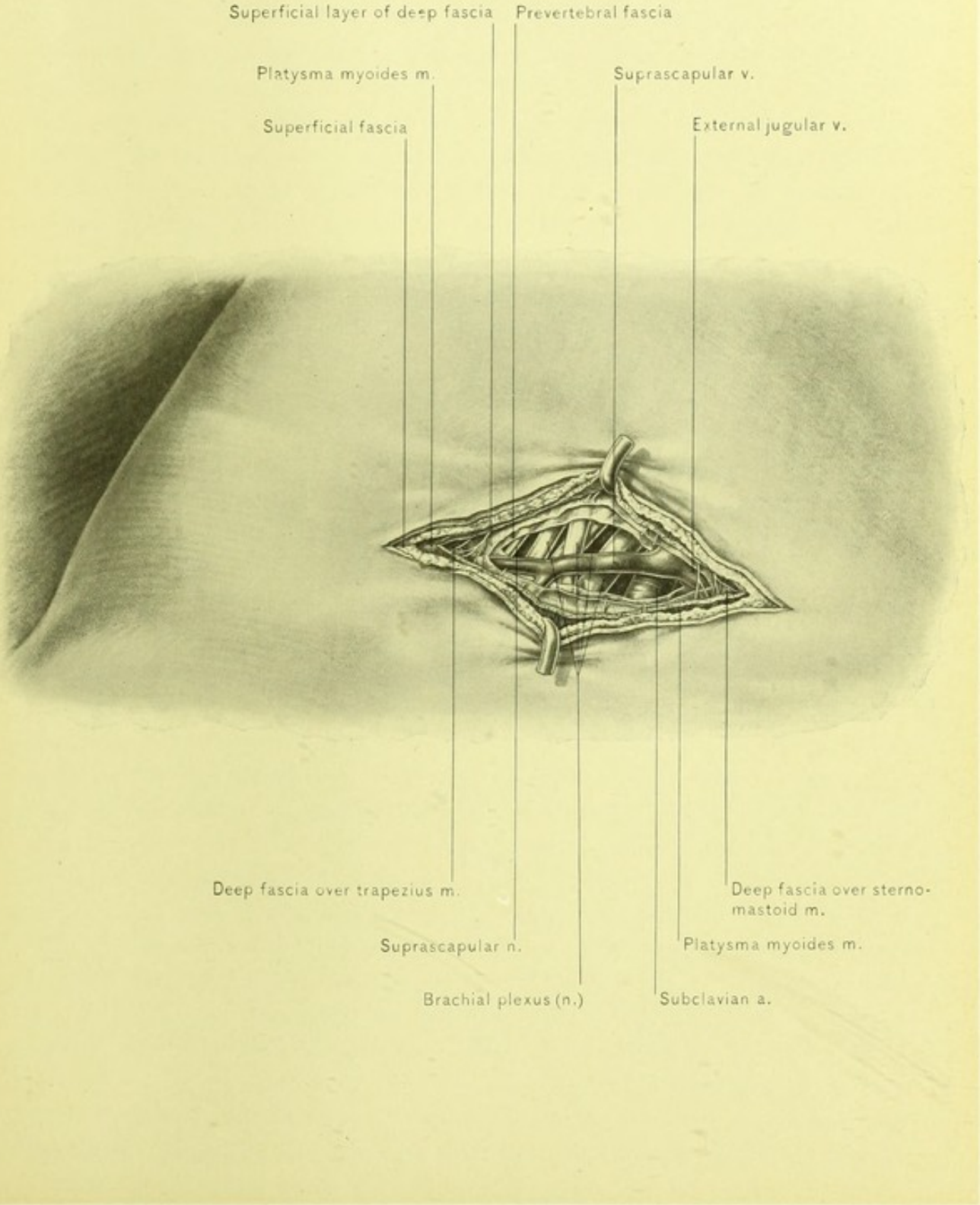
Arteries of one side of the head and neck anastomose with corresponding arteries of the opposite side, as the two external carotid, two internal carotid, two vertebral, two inferior thyroid arteries, etc.

Irregular Forms.—The innominate artery may bifurcate higher or lower than the upper margin of the right sterno-clavicular articulation; it may give off the thyroidea ima, vertebral, or internal mammary artery, a thymic, tracheal, bronchial, or pericardiac branch, and it may arise as the third branch of the transverse portion of the arch of the aorta. When the innominate artery bifurcates at an unusually high level, it may be tied more readily, and may overlie the trachea for an inch above the sternum and be endangered in the low operation for tracheotomy; if it divide at a lower level, it is tied with greater difficulty. When the innominate artery is the last branch of the transverse portion of the arch of the aorta, it may pass behind the trachea and esophagus. An innominate artery rarely exists on the left side, or the innominate artery may be absent and the right common carotid and the right subclavian artery may arise from the arch of the aorta.

Guides.—The guides to the innominate artery are the right sterno-clavicular articulation, the right common carotid artery, and the angle between the roots of the right common carotid and the right subclavian artery.

The **subclavian artery** is usually tied at its third portion, which is to the outer side of the anterior scalene muscle, and is the place of election. Ligature of the *first portion* of the artery is attended by great risk, this portion being deeply placed, and having closely associated with it the pneumogastric and sympathetic nerves and their cardiac branches; the pleura is behind and the commencement of the innominate vein or the termination of the internal jugular vein in front of the first portion. The *second portion* is seldom tied, the artery being here covered by the anterior scalene muscle, which underlies the phrenic nerve; this portion is closely related to the pleura.

The *third portion* of the subclavian artery is more accessible, being more superficial, and not so closely associated with important structures. It is ligatured for aneurysm of the arch of the aorta, the innominate, and the axillary artery; also previous to excision of the scapula, amputation at the shoulder-joint, and removal of large growths from the axilla. It is covered by the skin, superficial fascia, platysma myoides muscle, supra-clavicular branches of the cervical plexus, superficial layer of the deep cervical fascia, areolar tissue and fat, which here contains the terminations of the external jugular vein and supra-scapular vein, and, at times, the posterior external jugular, transversalis colli, and jugulo-cephalic veins. When all of these veins are present in this location, they form a plexus over the artery and increase the difficulty of reaching the vessel. The third



EXPOSURE OF THIRD PORTION OF SUBCLAVIAN ARTERY.

portion of the artery is also covered by the prevertebral fascia or posterior process of the deep cervical fascia, and is crossed by the nerve to the subclavius muscle. The supra-scapular artery and vein cross this portion of the artery from within outward, and usually lie near the level of the upper border of the clavicle. In this respect the supra-scapular artery bears the same relation to the subclavian artery at the point of election as the middle sterno-mastoid artery does to the common carotid artery at its point of election. Behind this part of the artery are the middle scalene muscle, the first rib, and the lower cervical trunk of the brachial plexus, which is formed by the eighth cervical and the first thoracic nerve. Above it are the upper and middle trunks of the brachial plexus and the posterior belly of the omo-hyoid muscle. The upper cervical trunk of the brachial plexus, which lies just above the artery and in an anterior plane, may be mistaken for the subclavian artery. Below, it rests against the upper surface of the first rib. The subclavian vein lies below the subclavian artery, but on an anterior plane, and is usually behind the clavicle.

In ligating the third portion of the subclavian artery the upper part of the thorax should be elevated by placing a pillow beneath the shoulders; the neck should be extended, and the head turned toward the opposite side. The shoulder is next depressed, to make the subclavian triangle shallow, and to bring the artery nearer to the surface. The skin should be drawn downward over the clavicle, and a transverse incision, three inches long, should be carried along that bone, so that when the skin is allowed to retract, the incision will be about one-half of an inch above the clavicle. This method of dividing the skin obviates the danger of injuring the external jugular vein, which crosses the artery close to or under the posterior border of the sterno-mastoid muscle. The incision should extend from the trapezius to the sterno-mastoid muscle. It divides the skin, superficial fascia, platysma myoides muscle, supra-clavicular branches of the cervical plexus, some small arteries, and the jugulo-cephalic vein, if present. The superficial layer of the deep fascia is next divided. If a plexus of veins be present, the veins should be divided between ligatures, and the posterior process of the deep fascia (prevertebral fascia) carefully incised. The posterior belly of the omo-hyoid muscle is located, and the posterior border of the anterior scalene muscle is found, and traced downward to the scalene tubercle of the first rib. The artery may be felt pulsating just external to the tubercle, and is exposed, together with the cervical trunks of the brachial plexus, by a slight dissection. The sheath of the artery being opened, the aneurysm needle is passed around the artery from before backward and below upward, to avoid the subclavian vein, which lies below, but in an anterior plane. The needle should be held close to the artery, to avoid inclusion of the lowest trunk of the brachial plexus, which lies behind the artery.

The transversalis colli artery is rarely seen, owing to its high position, while the supra-scapular artery crosses the subclavian artery just behind the clavicle. If either artery is seen, it should be displaced, and not divided; if the external jugular vein causes much difficulty, it should be divided between ligatures. In very muscular subjects it may be necessary to cut through the posterior part of the clavicular origin of the sterno-mastoid muscle. The variations in the position of this portion of the artery should be borne in mind. It usually emerges from beneath the anterior scalene muscle, about one-half of an inch above the clavicle, and descends abruptly; it may, however, lie almost entirely under the clavicle, or it may ascend as high as one and one-half inches above the clavicle. It occasionally gives origin to the posterior scapular artery. That the ligature has been applied to the subclavian artery instead of to a trunk of the brachial plexus is proved by the absence of the pulse beyond the ligature.

The Collateral Circulation is established by the anastomoses of the—

Above.		Below.
Supra-scapular and Posterior scapular arteries	with	Acromio-thoracic, posterior circumflex, and subscapular arteries.
Internal mammary artery Superior intercostal artery Aortic intercostal artery	with	Superior thoracic, long thoracic, and subscapular arteries.

Irregular Forms.—The *right subclavian artery* arises at times higher or lower than normally, or may spring directly from the transverse portion of the arch of the aorta as the first, second, third, or fourth branch. When it is the first branch, the first portion takes the course of the innominate artery and is more deeply situated than normally; when it is the second or third branch, it usually passes under the common carotid artery; and when it is the fourth branch, it may pass under the trachea and esophagus, or between the trachea and esophagus, and has been seen arising from the descending portion of the aorta as low as the fourth thoracic vertebra. The *left subclavian artery* may arise from a short trunk common to it and the left common carotid artery. On each side the subclavian artery may pass in front of or pierce the scalenus anticus muscle; the subclavian vein may accompany the second portion of the subclavian artery through or under the scalenus anticus muscle. The second portion may lie under the clavicle, or may rise one and one-half inches above the clavicle. The third portion of the subclavian artery frequently gives origin to the posterior scapular artery, and occasionally to the supra-scapular artery, and in muscular persons may be covered by the sterno-mastoid and trapezius muscles. A clavicular origin of the posterior belly of the omo-hyoid muscle may lie in front of this portion, and this belly of the

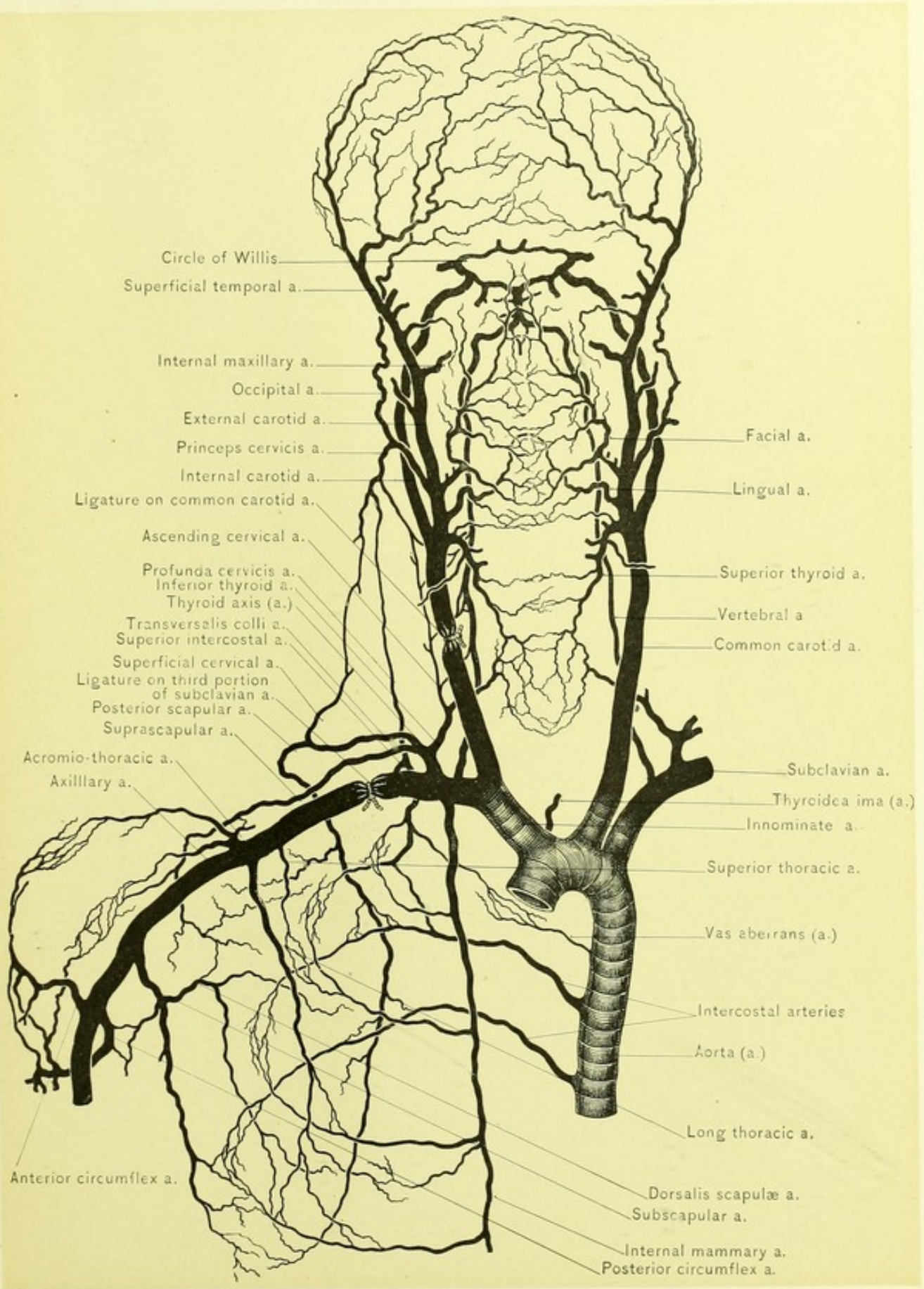
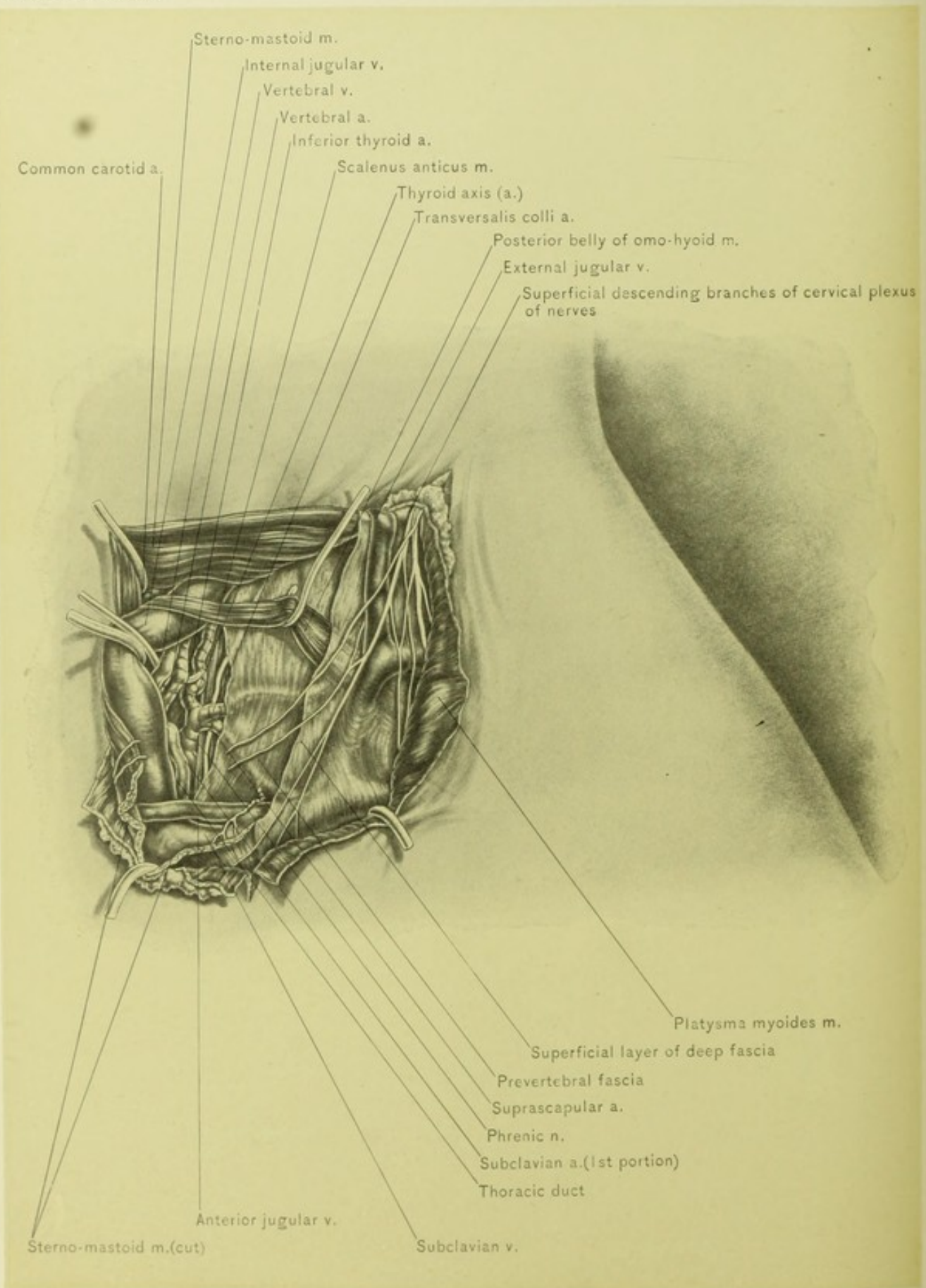


DIAGRAM OF COLLATERAL CIRCULATION.

PLATE CLXXXIX.



EXPOSURE OF VERTEBRAL ARTERY AND INFERIOR THYROID ARTERY AT ORIGIN—LEFT SIDE OF NECK.

omo-hyoid may lie close to the clavicle in front of the subclavian artery. The external jugular vein may cross the artery at some distance external to the posterior border of the sterno-mastoid muscle.

GUIDES.—The guides to the third portion of the subclavian artery (the place of election) are the most prominent part of the clavicle behind which it lies, the posterior border of the sterno-mastoid muscle, the outer border of the insertion of the scalenus anticus muscle into the scalene tubercle of the first rib, and the pulsations of the artery.

The **vertebral artery** may be ligatured for wounds, traumatic aneurysm, and aneurysm of the innominate artery and arch of the aorta. Its only accessible portion is deeply situated in the lower part of the neck, where it lies in the groove between the scalenus anticus and longus colli muscles. This portion of the artery is in relation, in front, with the vertebral and internal jugular veins, and is crossed on both sides by the inferior thyroid artery and by the thoracic duct on the left side. The vertebral vein crosses in front of the artery just below the transverse process of the sixth cervical vertebra; it then lies in front and to the outer side of the artery as it passes downward to the innominate vein. The relation of this vein to the artery is variable, as the vein may be found on either side of the artery. Behind the artery are the sympathetic nerve cord, the inferior cervical sympathetic ganglion, and the transverse process of the seventh cervical vertebra. To its inner side is the longus colli muscle, and to its outer side the anterior scalene muscle. It is surrounded by the vertebral sympathetic plexus.

In the operation for ligation of the vertebral artery the patient lies in the same position as in ligature of the third portion of the subclavian artery—*i. e.*, with the shoulder elevated, the neck extended, and the face turned to the opposite side. The incision should commence at the clavicle, and be carried for three inches upward along the posterior border of the sterno-mastoid muscle.

Care is required here to avoid injuring the external jugular vein, which runs under the platysma myoides muscle obliquely across the sterno-mastoid muscle to its posterior border, then along that border, piercing the superficial layer of the deep fascia one-half of an inch above the clavicle. The incision divides the skin, superficial fascia, platysma myoides muscle, and descending branches of the cervical plexus. The external jugular vein is exposed and drawn outward, and the superficial layer of the deep fascia divided. It may be necessary to sever part of the clavicular head of the sterno-mastoid muscle at its origin. The anterior scalene muscle is located, and the surgeon carries his finger inward through the interval between the prevertebral fascia and the superficial layer of the deep fascia. The positions of the internal jugular vein, common carotid artery, and transverse process of the sixth cervical vertebra are ascertained. The anterior

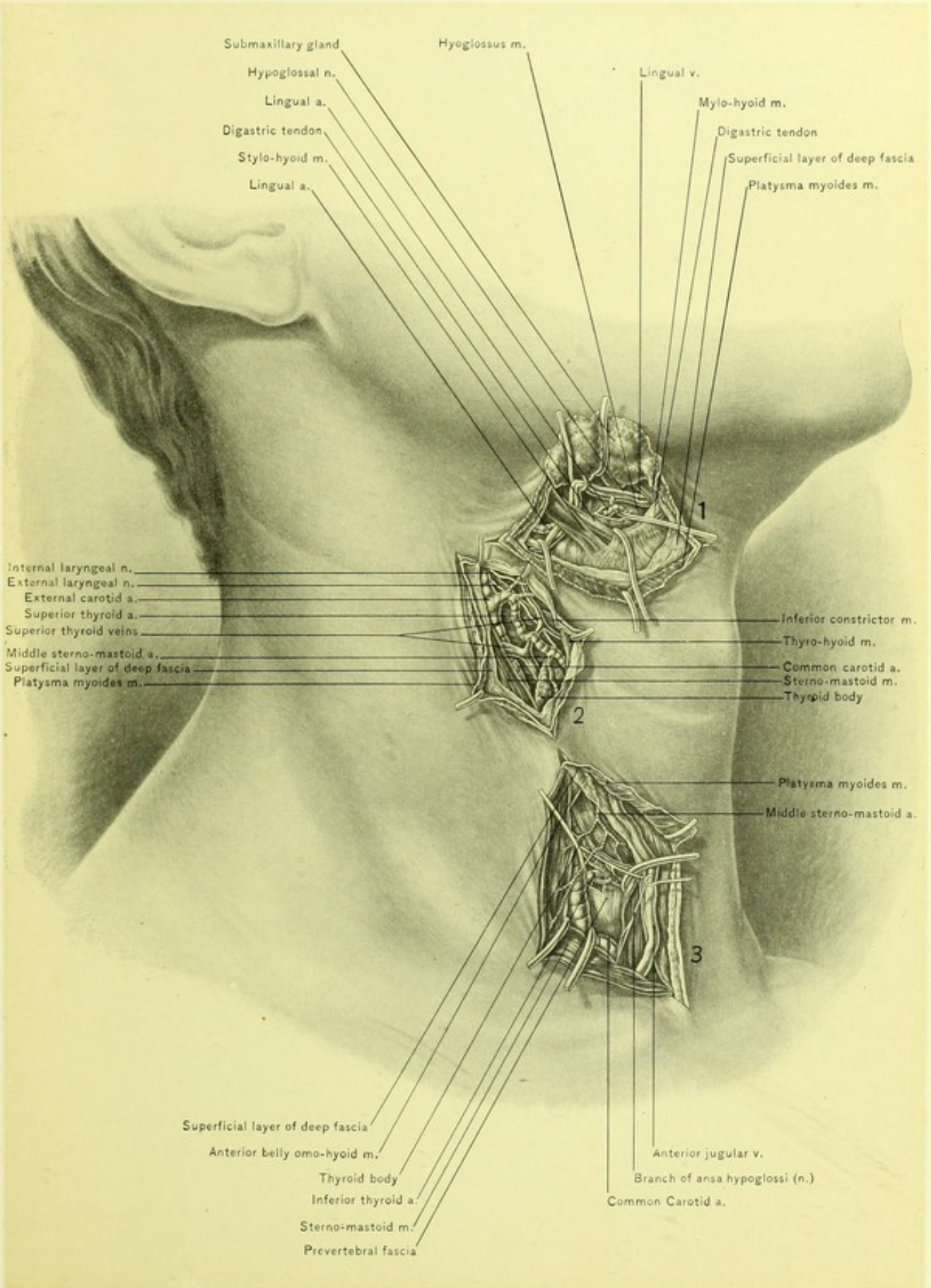
tubercle of the transverse process of the sixth cervical vertebra (carotid tubercle) is the guide to the vertebral artery, for the reason that it is usually the first transverse process which is entered by the artery. Just below this tubercle the groove between the scalenus anticus and longus colli muscles can be felt, and the prevertebral fascia is divided along the inner border of the scalenus anticus muscle. Along the inner border of the scalenus anticus muscle the inferior thyroid artery can be recognized by its pulsations; the vertebral artery is detected in the same manner, deep in the groove previously mentioned. The vertebral vein and inferior thyroid artery should then be drawn outward, and the needle be passed from without inward. Care is necessary to avoid injuring the internal jugular vein, inferior thyroid artery, vertebral vein, pleura, the right lymphatic duct, and, on the left side, the thoracic duct. The phrenic nerve is not endangered, because it lies beneath the prevertebral fascia on the scalenus anticus muscle. Immediately after the artery is tied contraction of the pupil of the same side occurs, due to disturbance of the vertebral plexus of the sympathetic nerve. This condition is evidence that the inferior thyroid artery or its ascending cervical branch has not been ligatured instead of the vertebral artery.

Irregular Forms.—The left vertebral artery may arise from the subclavian artery at a point unusually near either to the origin or the termination of the first portion of the left subclavian artery. It may arise from the arch of the aorta or the left common carotid artery.

The right vertebral artery occasionally arises nearer to the bifurcation of the innominate artery or to the inner margin of the scalenus anticus muscle. When the right subclavian artery arises from the aortic arch, the right vertebral artery may arise from the right common carotid artery or from the arch of the aorta. When it arises from the left side of the aortic arch, it may pass behind the esophagus.

Either vertebral artery may arise from the subclavian as two branches, which later unite, or the vertebral artery may divide while passing upward in the transverse processes, one branch entering the spinal canal with the second cervical nerve, and the other pursuing the normal course of the vertebral artery. On each side the vertebral artery frequently enters the passageway in the cervical transverse processes, at some other than at the sixth cervical transverse process. It may first enter any of the cervical transverse processes from the second to the seventh inclusive. When the artery first enters the seventh cervical transverse process its ligation is difficult, and when it enters above the sixth, the artery lies nearer to the esophagus than normally. The vertebral artery rarely gives origin to the inferior thyroid, superior intercostal, profunda cervicis, or occipital artery. One vertebral artery may be larger than the artery of the opposite side.

Guides.—The guides to the vertebral artery are the posterior border of the



LIGATION OF (1) FIRST AND SECOND PORTIONS OF LINGUAL ARTERY; (2) SUPERIOR THYROID ARTERY; (3) INFERIOR THYROID ARTERY.

sterno-mastoid muscle and the carotid tubercle or anterior tubercle of the sixth cervical transverse process, which lies at the upper extremity of the groove between the scalenus anticus and longus colli muscles.

The **inferior thyroid artery** may be ligatured to arrest the growth of the thyroid body in goiter, and for wounds of this body. It is more commonly ligatured in the removal of one-half of the thyroid body (thyroidectomy). It may be tied near its origin, where it lies along the inner border of the anterior scalene muscle,—*i. e.*, between that muscle and the internal jugular vein, or to the inner side of the carotid sheath as it enters the thyroid gland. It is seldom ligatured near its origin, where it may be secured through an incision similar to that made in ligature of the vertebral artery. To reach it just before it enters the thyroid body, where it lies on or slightly below the level of the cricoid cartilage of the larynx, the shoulders should be elevated and the neck extended, and an incision three inches long be made along the lower portion of the anterior border of the sterno-mastoid muscle. The skin, superficial fascia, and platysma myoides muscle are divided, avoiding the anterior external jugular vein; the superficial layer of the deep fascia is also divided. The sterno-mastoid muscle and carotid sheath with its contents should be drawn outward, and the sterno-hyoid and sterno-thyroid muscles and thyroid body drawn inward. Locate the carotid tubercle behind the carotid sheath, and the artery will be felt pulsating just below and internal to it. Next divide the prevertebral fascia. The artery should then be tied near the carotid sheath, thus avoiding injury of the recurrent laryngeal nerve; this nerve, however, is not in much danger, as in this location it lies behind and internal to the lateral lobe of the thyroid body. The inferior thyroid artery frequently divides behind the carotid sheath into two terminal branches of about equal size, which are separated by an interval of about one-fourth of an inch.

Irregularities.—The inferior thyroid artery occasionally arises directly from the first portion of the subclavian artery; it may, however, arise from the third portion near the outer border of the scalenus anticus muscle, or from the vertebral or common carotid artery. It may subdivide before it reaches the thyroid body, or it may arise as two separate arteries, one branch of it passing in front of and the other behind the carotid sheath. The artery may be small or absent.

The **common carotid artery** is tied for aneurysm or wounds of the internal or external carotid artery or their branches, to check malignant growths, and preparatory to the removal of tumors. It may be tied in any part of its course in the neck, which is indicated by a line drawn from the sterno-clavicular articulation to a point midway between the angle of the lower jaw and the mastoid process of the temporal bone, the portion of this line below the level of the upper border of the thyroid cartilage indicating the course of the common carotid artery. On the

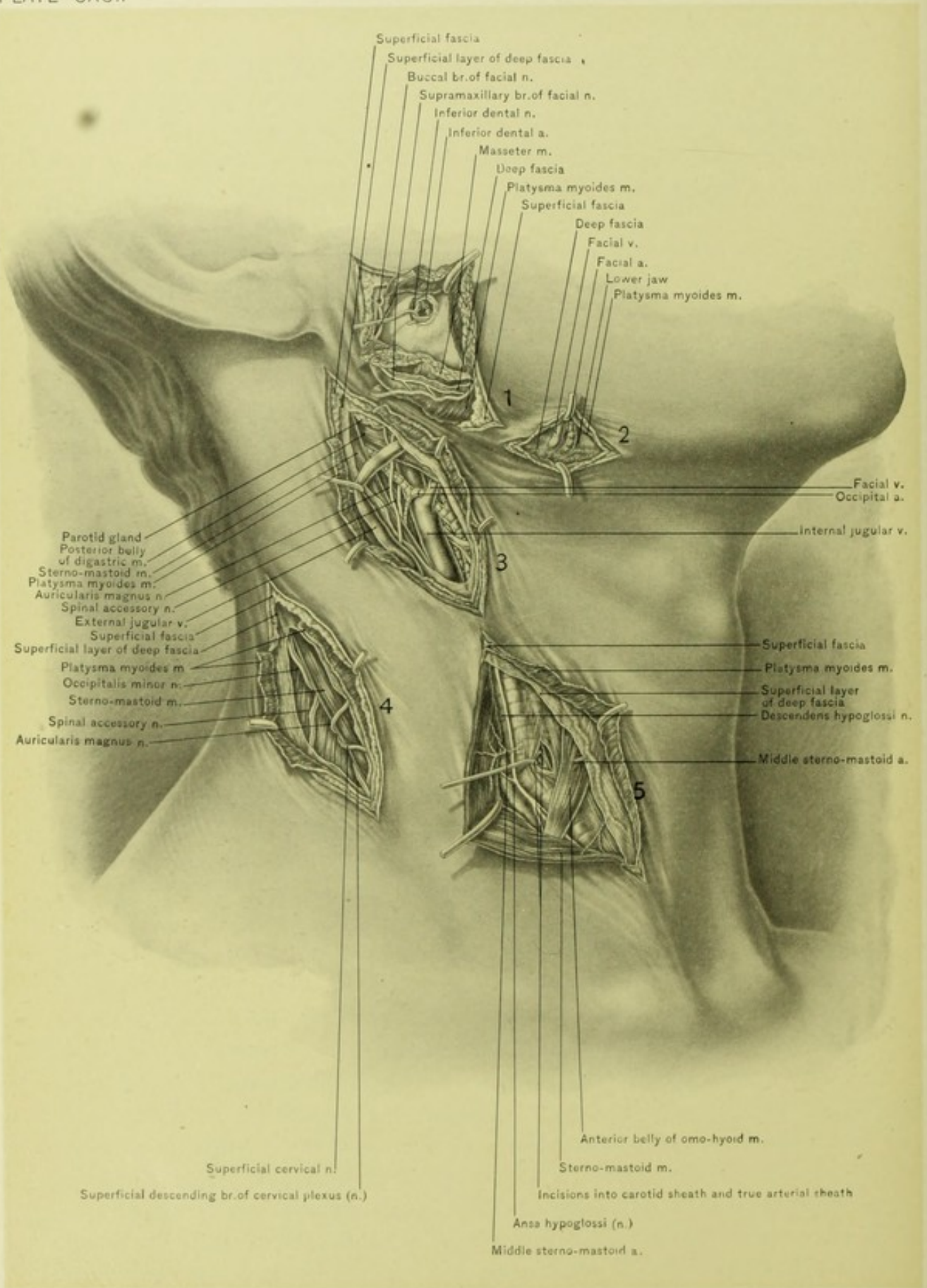
right side the common carotid artery arises as one of the two terminal branches of the innominate artery, which divides behind the upper border of the right sterno-clavicular articulation; on the left side, however, it arises within the chest from the arch of the aorta. On both sides the common carotid artery terminates opposite the upper border of the thyroid cartilage, where it divides into the external and internal carotid arteries.

In front of the artery are the skin, superficial fascia, platysma myoides muscle, superficial layer of the deep fascia, inner border of the sterno-mastoid muscle, anterior jugular vein, sterno-hyoid muscle, sterno-thyroid muscle, lateral lobe of the thyroid gland, superior and middle thyroid veins, middle sterno-mastoid artery, omo-hyoid muscle, descendens hypoglossi nerve, ansa hypoglossi, and anterior wall of the sheath. To its outer side are the internal jugular vein and the pneumogastric nerve. On the right side the internal jugular vein at the root of the neck passes outward away from the artery, while on the left side it overlaps the artery and curves forward to empty into the left innominate vein. Behind and to its outer side is the pneumogastric nerve, and behind it are the posterior wall of its sheath, the sympathetic nerve, inferior thyroid artery, recurrent laryngeal nerve, and the longus colli and rectus capitis anticus major muscles. To its inner side are the inner wall of its sheath, the trachea, esophagus, recurrent laryngeal nerve, lateral lobe of the thyroid gland, cricoid cartilage, thyroid cartilage, pharynx, superior thyroid artery, and external laryngeal branch of the superior laryngeal nerve.

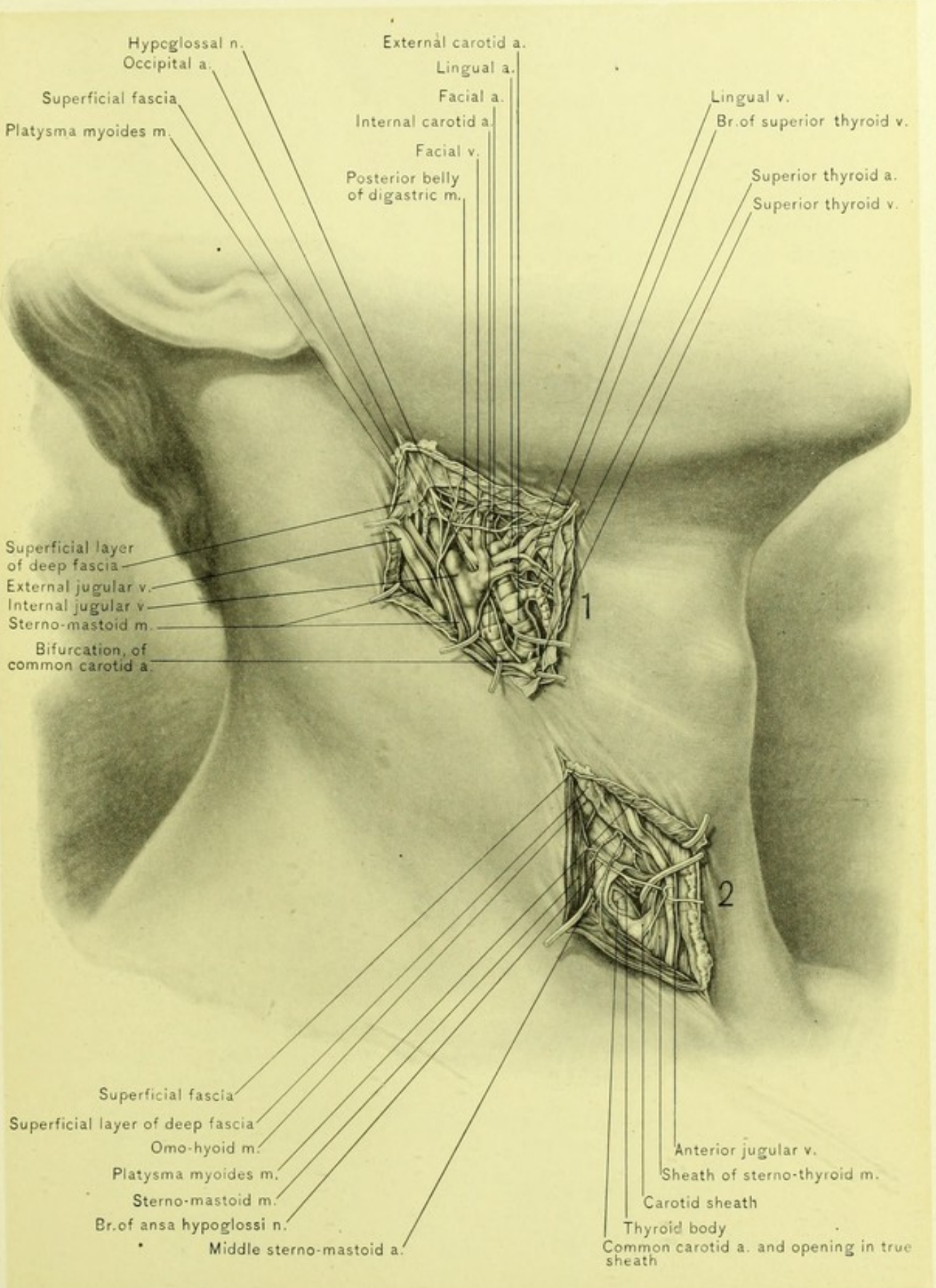
It is usually tied in the superior carotid triangle,—above the anterior belly of the omo-hyoid muscle,—where it is more superficial. In the inferior carotid triangle—below the anterior belly of the omo-hyoid muscle—the artery is deeper, being in this location covered by additional structures, the sterno-hyoid and sterno-thyroid muscles, and overlapped by the lateral lobe of the thyroid gland. The omo-hyoid muscle crosses the artery at the level of the cricoid cartilage, the middle thyroid vein crosses just above that muscle, and the superior thyroid vein and middle sterno-mastoid artery cross the artery higher in the superior carotid triangle.

In the operation through the *superior carotid triangle* the patient should rest upon the back, with the shoulders elevated, the neck extended, and the face turned slightly to the opposite side. The superficial veins should be located, especially the vein which connects the submental veins with the anterior jugular vein and runs beneath the platysma myoides muscle parallel to and along the inner side of the anterior border of the sterno-mastoid muscle. An incision three inches long should be made in the line of the artery, so that the center of the incision will be on a level with the cricoid cartilage. Skin, superficial fascia, platysma myoides muscle, superficial vessels and nerves, and the superficial layer of the deep fascia are divided, the communicating branch between the anterior jugular and sub-

PLATE CXCI.



EXPOSURE OF (1) INFERIOR DENTAL NERVE; (2) FACIAL ARTERY; (3, 4) SPINAL ACCESSORY NERVE AND SUPERFICIAL BRANCHES OF CERVICAL PLEXUS; AND (5) COMMON CAROTID ARTERY IN SUPERIOR CAROTID TRIANGLE.



(1) EXPOSURE OF EXTERNAL CAROTID AND INTERNAL CAROTID, AND OF THE SUPERIOR THYROID, LINGUAL, FACIAL, AND OCCIPITAL AT THEIR ORIGIN; AND (2) EXPOSURE OF COMMON CAROTID IN INFERIOR CAROTID TRIANGLE.

mental veins being avoided. The sterno-mastoid muscle should be displaced outward and the omo-hyoid muscle downward, and the pulsations of the artery are felt. The middle sterno-mastoid artery and the superior and middle thyroid veins should be avoided, if possible, and the internal jugular vein and descendens hypoglossi nerve should be avoided by opening the inner wall of the carotid sheath. By holding up first one edge of the opening in the sheath and then the other, the sheath can be gently separated from the artery with an aneurysm needle. The needle should be passed from without inward, threaded, and withdrawn.

To tie the common carotid artery in the *inferior carotid triangle*, the patient should be placed in the same position as for the higher ligation. The incision, which is about three inches in length, should be made along the anterior border of the sterno-mastoid muscle, beginning at the level of the cricoid cartilage, and extending almost to the sterno-clavicular articulation. Skin, superficial fascia, platysma myoides muscle, and superficial vessels and nerves are divided. The anterior jugular vein and the vein which connects it with the facial or submental vein should be avoided. The superficial layer of the deep fascia is divided, and the sterno-mastoid muscle drawn outward, the sterno-hyoid and sterno-thyroid muscles inward. The sheath is opened on the inner side, and the needle passed from without inward. The structures which are to be avoided in the operation are the anterior jugular vein; its tributary, which runs beneath the platysma myoides muscle parallel with the anterior border of the sterno-mastoid muscle; the nerves from the ansa hypoglossi to the sterno-hyoid and sterno-thyroid muscles, the internal jugular vein, the inferior thyroid veins, the inferior thyroid artery, and the recurrent laryngeal nerve. On the left side the internal jugular vein overlaps the artery at the lower part of the neck and renders the operation more difficult.

Collateral Circulation.—The collateral circulation, after ligation of the common carotid artery, is established by the anastomoses of the following arteries:

Proximal Side.		Distal Side.
Branches of the external carotid artery of the opposite side	with	Branches of the external carotid artery of the same side.
Vertebral artery of same side and opposite internal carotid artery and vertebral artery	with	Internal carotid artery of the same side through circle of Willis.
Inferior thyroid artery, thyroidea ima artery (if present)	with	Superior thyroid artery.
Ascending cervical artery Superficial cervical artery Deep cervical artery	with	Princeps cervicis artery.
Ascending cervical artery	with	Ascending pharyngeal artery.
Vertebral artery	with	Occipital artery.

The tissues supplied by the external carotid artery are chiefly nourished through the anastomoses between the opposite branches of the two external carotid arteries, and the portion of the brain previously nourished by the internal carotid artery receives its blood supply through the two vertebral arteries and the opposite internal carotid artery.

Irregularities.—The *right common carotid artery*, when the innominate artery is absent, may arise from the arch of the aorta separately or from a trunk common to the two common carotid arteries. When it arises from a trunk common to it and the left common carotid artery, it may cross in front of the trachea above the sternum. Owing to the variability in the level at which the innominate artery bifurcates, the right common carotid artery may arise higher or lower than the upper margin of the right sterno-clavicular joint; its origin is more frequently below that level than above it.

The *left common carotid artery* varies chiefly in its origin from the arch of the aorta. Its place of origin may extend into that of the innominate artery. When the right common carotid artery arises from the arch of the aorta, the two carotid arteries may arise from a common trunk. The left common carotid artery occasionally arises from a left innominate artery.

Either of the common carotid arteries may bifurcate higher or lower than the upper border of the thyroid cartilage. The artery may bifurcate above the level of the hyoid bone, giving off some of the branches which should arise from the external carotid artery. It may not bifurcate, the external carotid or internal carotid artery being absent. The point of bifurcation may be as low as the root of the neck. The common carotid artery may be absent, the external carotid and internal carotid arteries arising from the innominate artery or the arch of the aorta.

The common carotid artery may give origin to the thyroidea ima, vertebral, inferior thyroid, or some of the branches of the external carotid artery. The pneumogastric nerve may lie in front of the common carotid artery.

The **external carotid artery** is ligatured after injury to this vessel or its branches, to check malignant growths, in cirsoid aneurysm of its branches, before removal of the parotid gland, and in various other conditions. The artery is usually tied between the points of origin of the lingual and superior thyroid arteries and in the superior carotid triangle, as it is more superficial here, and the distance from the bifurcation of the common carotid artery is sufficient to favor the formation of a clot. Its course is represented by that portion of the line of the common carotid artery which is above the level of the upper border of the thyroid cartilage. In the superior carotid triangle below the posterior belly of the digastric muscle the external carotid artery is covered by skin, super-

ficial fascia, platysma myoides muscle, superficial layer of the deep fascia, anterior border of the sterno-mastoid muscle, and the sheath of the vessels; it is crossed by the hypo-glossal nerve and lingual and facial veins. Higher in its course it is crossed by the stylo-hyoid and posterior belly of the digastric muscle, and enters the parotid gland. To its inner side are the hyoid bone, the pharynx, the superior laryngeal and glosso-pharyngeal nerves, part of the parotid gland, and the ramus of the lower jaw. To its outer side, at its origin, is the internal carotid artery. Behind it are the internal carotid artery, from which it is separated above by the stylo-glossus and stylo-pharyngeus muscles, the glosso-pharyngeal nerve, the pharyngeal branch of the pneumogastric nerve, the stylo-hyoid ligament, and part of the parotid gland. The superior laryngeal nerve is also behind the artery.

The position of the patient should be the same as in ligature of the common carotid artery, the shoulders being elevated, the neck extended, and the face turned slightly to the opposite side. The incision should extend from the angle of the lower jaw downward along the anterior border of the sterno-mastoid muscle for about two and one-half inches, so that the greater cornu of the hyoid bone will be just above the center of the incision. The skin, superficial fascia, platysma myoides muscle, some cutaneous vessels and nerves, and the superficial layer of the deep fascia are divided. The sterno-mastoid muscle is drawn outward, and the greater cornu of the hyoid bone, the hypo-glossal nerve, and lingual and facial veins located. The sheath is opened, and the needle is passed from without inward. The needle should be kept close to the artery, thus avoiding the superior laryngeal nerve, which passes beneath the artery.

Collateral Circulation.—The collateral circulation, after ligature of the external carotid artery, is established by the anastomoses between the branches of this artery and the corresponding branches of the opposite external carotid artery.

Irregularities.—The external carotid artery may be absent, the branches of that artery arising from the common carotid artery, which continues upward as the internal carotid artery. It may be a short trunk or arise at a higher or lower level than normally. Two or more of its branches—as the superior thyroid, lingual and facial arteries—may arise from it by a common trunk. Some of its lower branches may arise from the common carotid artery. Occasionally it gives origin to additional branches—viz., the superior laryngeal and middle sterno-mastoid branches of the superior thyroid artery, the ascending palatine and tonsillar branches of the facial artery, the superior sterno-mastoid branch of the occipital artery, and the transverse facial branch of the superficial temporal artery.

The **superior thyroid artery** is tied preparatory to removal of one-half of the thyroid body, and may be ligatured to arrest the growth of a goiter. It arises from the external carotid artery just below the greater cornu of the hyoid bone, and runs

forward and then downward and forward along the inner side of the carotid sheath. Its upper portion is superficial, its lower portion being more deeply situated between the larynx and the carotid sheath. The superior laryngeal nerve lies beneath the upper portion of the artery, and its external laryngeal branch runs parallel with the lower part of the vessel. The artery may be tied near its origin and above its hyoid branch, but is preferably ligatured between the origins of the superior laryngeal and middle sterno-mastoid branches.

The patient is placed in the same position as for ligature of the external carotid artery, and an incision two inches long should be made along the anterior border of the sterno-mastoid muscle. The center of the incision should be on a level with the upper border of the thyroid cartilage. Skin, superficial fascia, platysma myoides muscle, and superficial layer of the deep fascia are divided. The sterno-mastoid muscle is drawn outward, and the superior thyroid artery seen running downward along the inner side of the carotid sheath. The artery should be traced from its origin and tied above the origin of the middle sterno-mastoid artery, avoiding the superior thyroid vein. The vein which connects the facial or submental vein with the anterior jugular vein and runs beneath the platysma myoides muscle parallel with the anterior margin of the sterno-mastoid muscle should also be avoided. The needle is preferably passed away from the superior thyroid vein, which usually runs on the lower side of the artery and may form a plexus.

Irregularities of the superior thyroid artery and of the other branches of the external carotid artery are not of much surgical importance. The superior thyroid artery may be double, or it may be unusually small, the other thyroid arteries being larger than normal. It may arise from the common carotid artery or a trunk common to it and the lingual artery, or a trunk common to the superior thyroid, lingual, and facial arteries. The hyoid, superior laryngeal, and middle sterno-mastoid branches may arise from the external carotid artery. The superior laryngeal artery may be unusually large, occasionally passing through a foramen in the thyroid cartilage, or it may pass along the thyroid cartilage and turn inward under the lower margin of that cartilage. The crico-thyroid artery may be unusually large, and may send a branch downward over the crico-thyroid membrane to the isthmus of the thyroid body. Such an abnormal branch would be divided in laryngotomy and perhaps in high tracheotomy. For this reason it is advisable to thoroughly expose the crico-thyroid membrane before incising it, as the entrance of blood into the larynx might cause broncho-pneumonia.

The **lingual artery** is most frequently ligatured preparatory to removal of the tongue. It is also tied to control hemorrhage from it or its branches in injuries and advanced carcinoma of the tongue, to check the growth of advanced carcinoma of the tongue, and in macroglossia. It arises from the external carotid

artery, opposite the greater cornu of the hyoid bone, and its course, as elsewhere described, is divided into three portions:

The *first portion* extends from the origin of the artery to the outer border of the hyo-glossus muscle. It ascends to reach the upper border of the greater cornu of the hyoid bone, and then runs just above and parallel with that cornu. This is the most superficial portion of the artery. It is covered by skin, superficial fascia, platysma myoides muscle, and superficial layer of the deep fascia, and is crossed by the hypo-glossal nerve, lingual vein, and digastric and stylo-hyoid muscles. This portion of the vessel rests upon the middle constrictor muscle of the pharynx and the superior laryngeal nerve.

The *second portion* runs along the upper border of the hyoid bone beneath the hyo-glossus muscle, lingual vein, hypo-glossal nerve, digastric and stylo-hyoid muscles, submaxillary gland, superficial layer of the deep fascia, platysma myoides muscle, and superficial fascia and skin.

It rests here upon the middle constrictor muscles of the pharynx and the genio-hyo-glossus muscle. This portion is the point of election in ligation of the artery.

The *third portion* ascends between the hyo-glossus and genio-hyo-glossus muscles, pierces the latter muscle, and runs between it and the lingualis muscle in the under surface of the tongue as far as the tip of that organ.

To ligature the lingual artery in its second portion, or point of election, the patient should be placed in the same position as for ligature of the common and external carotid arteries, and the lower jaw drawn upward. The incision extends from the anterior border of the sterno-mastoid muscle forward along the upper border of the greater cornu of the hyoid bone. The skin, superficial fascia, platysma myoides muscle, branches of the facial and anterior jugular veins, and the superficial layer of the deep fascia are divided. The submaxillary gland is displaced and held well upward on the lower jaw, and the process of deep fascia beneath the gland divided. The tendon and bellies of the digastric muscle, the stylo-hyoid muscle, the hypo-glossal nerve, the lingual vein (which is just below the nerve), the mylo-hyoid and the hyo-glossus muscle, will be exposed. The stylo-hyoid muscle and the tendon of the digastric muscle are drawn downward, the lingual vein and hypo-glossal nerve upward, and an incision one-half of an inch long should be carefully made through the hyo-glossus muscle just above the hyoid bone. If the incision through the hyo-glossus muscle is accurately made, the artery will project into the wound. The aneurysm needle is passed around the artery, and may include the venæ comites. The submaxillary gland should not be injured, as this accident would probably give rise to a salivary fistula. To avoid the danger of opening the pharynx when incising the hyo-

glossus muscle care is required. Instead of dividing the hyo-glossus muscle, the artery may be ligatured immediately before it passes under the outer border of that muscle.

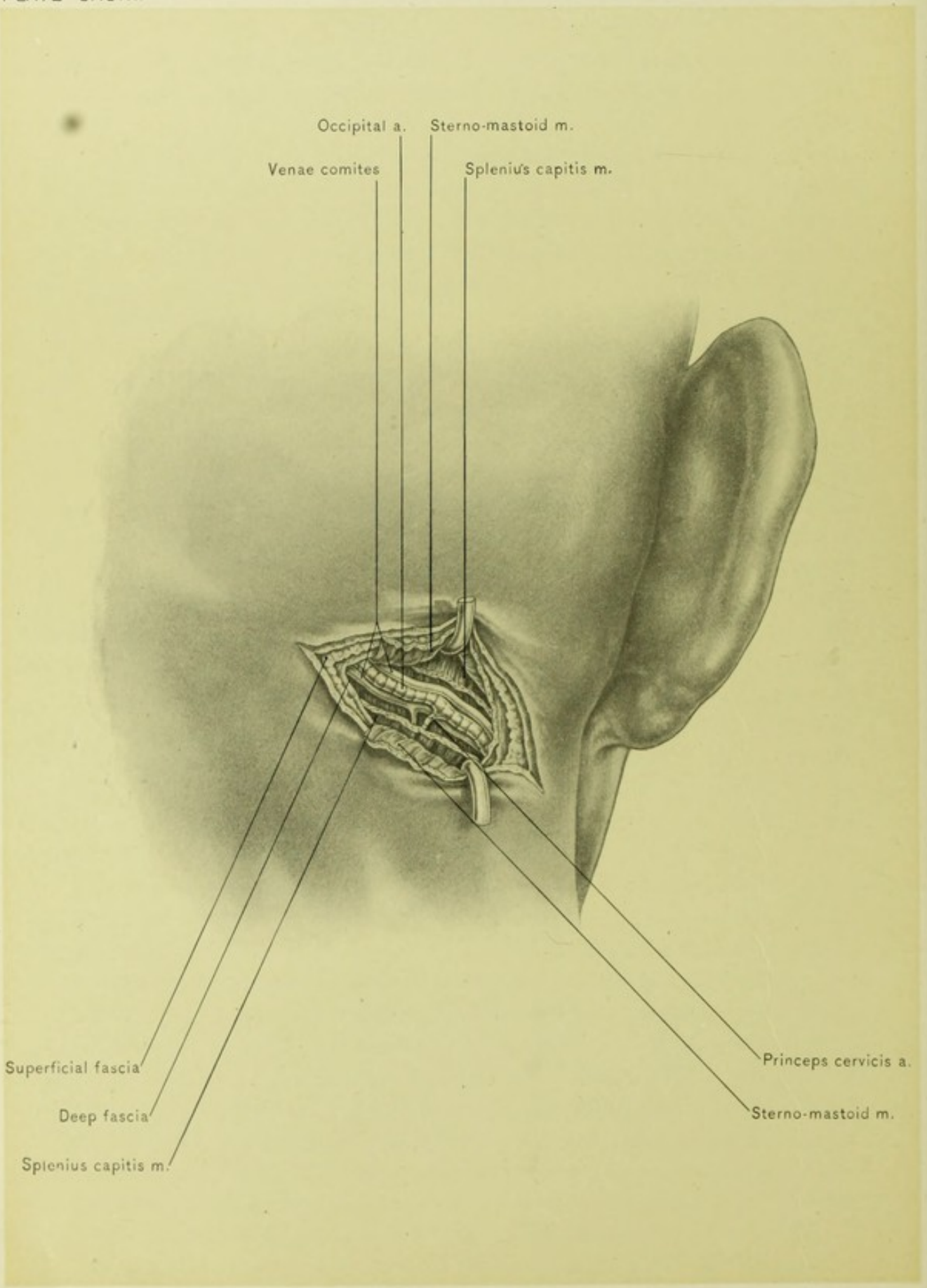
The *first portion* of the lingual artery is reached through an incision one inch long, carried from the sterno-mastoid muscle forward along the upper border of the greater cornu of the hyoid bone. The position of the patient should be the same as that for the foregoing operation. Skin, superficial fascia, platysma myoides muscle, and superficial layer of the deep fascia are divided. The submaxillary gland is displaced upward, and the process of deep fascia beneath the gland divided. The lingual vein and hypo-glossal nerve are exposed and drawn upward, and the artery secured as it passes under the posterior margin of the hyo-glossus muscle. This operation is more difficult than ligature of the second portion of the vessel; this is due to the fact that the lingual vein, hypo-glossal nerve, stylo-hyoid muscle, and posterior belly of the digastric muscle lie in front of the artery. This portion of the artery may be secured at its origin through an incision two inches long, made along the anterior border of the sterno-mastoid muscle. The center of the incision should be opposite the greater cornu of the hyoid bone. The location of the external carotid artery is ascertained, as described under ligature of that vessel, and the origin of the lingual artery located opposite the greater cornu of the hyoid bone. The hypo-glossal nerve and lingual and facial veins must be avoided.

Irregularities.—The most common irregularities of the lingual artery are the following: It may arise from a trunk common to it and the facial artery, or from a trunk common to the superior thyroid, lingual, and facial arteries. It may pierce the hyo-glossus muscle. Occasionally it is given off as a branch of the facial or internal maxillary artery. Its sublingual branch may arise from the facial artery, and the hyoid branch may be absent.

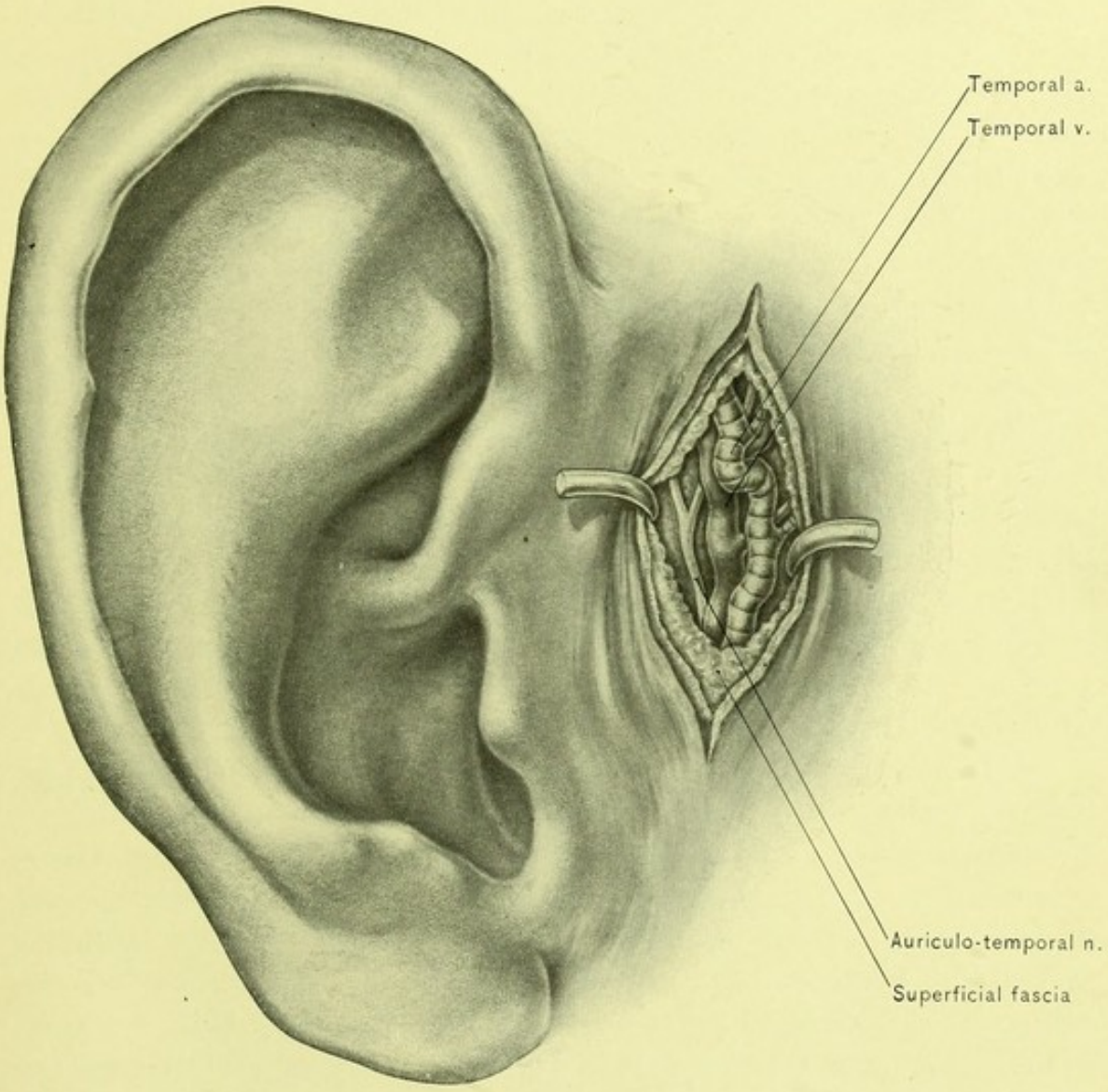
The **facial artery** may be secured at its origin or as it passes over the lower border of the lower jaw at the anterior inferior angle of the masseter muscle. To ligature the facial artery at its origin, which is just above that of the lingual artery, an incision should be made similar to that for ligation of the external carotid artery, except that the center of the incision should be just above the greater cornu of the hyoid bone. The facial and lingual veins, anterior division of the temporo-maxillary vein, and hypo-glossal nerve should be avoided. To tie the artery as it turns over the lower border of the lower jaw, an incision one inch long should be made below and parallel with this border of the jaw, so that the resulting scar will not be prominent. The skin, superficial fascia, platysma myoides muscle, and superficial layer of the deep fascia are divided. As the facial vein is behind the artery, the needle should be passed from behind forward.

Irregularity.—The irregularity of the facial artery which is of importance

PLATE CXCIII.



EXPOSURE OF OCCIPITAL ARTERY FOR LIGATION.



EXPOSURE OF AURICULO-TEMPORAL NERVE AND TEMPORAL ARTERY.

is the following: It may terminate as the submental artery, its area of distribution in the face being supplied by the nasal branch of the ophthalmic, the transverse facial, or the internal maxillary artery.

The **occipital artery** is ligatured for cirsoid aneurysm. It may be tied at its origin, or as it passes through the occipital region. To tie it at its origin the shoulders should be elevated, the neck well extended, and an incision made along the upper part of the anterior border of the sterno-mastoid muscle. The origin of the artery will be found by tracing backward over the external carotid artery the hypo-glossal nerve, which winds from behind forward over that portion of the vessel. In the occipital region the artery may be secured through an incision carried obliquely backward and slightly upward from the tip of the mastoid process. The structures divided in the occipital region are the skin, superficial fascia, superficial nerves and vessels, superficial layer of the deep fascia, a portion of the sterno-mastoid muscle, posterior process of the deep fascia (prevertebral fascia), and the splenius capitis muscle. The artery may be readily found in this region, at a point midway between the mastoid process and the external occipital protuberance.

Irregularities.—The irregularities of the occipital artery which are of importance are the following: It may arise from the internal carotid artery or the ascending cervical branch of the inferior thyroid artery; it may cross over, instead of under, the upper portion of the sterno-mastoid muscle; it may give origin to the posterior auricular or ascending pharyngeal artery.

Irregularities of the ascending pharyngeal, posterior auricular, superficial temporal, and internal maxillary arteries are not of much surgical importance.

The **superficial temporal artery,** like the occipital, is ligatured in injuries and cirsoid aneurysm. The artery usually bifurcates into the anterior and posterior temporal one and one-half to two inches above the zygoma, but it frequently divides at a lower level. The artery may be felt pulsating just in front of the pinna of the ear, where it crosses the posterior root of the zygoma; this is the point at which it should be tied. The incision should be vertical, about one inch in length, and be made over the vessel in front of the pinna. The structures divided are the skin, superficial fascia, and deep fascia. The superficial temporal vein lies behind the artery and overlaps it, and the auriculo-temporal nerve emerges from beneath the artery and vein, and then runs behind the vein. The temporal branches of the facial nerve cross the artery and vein in the parotid gland. The needle should be passed from behind forward.

The **internal carotid artery** is rarely ligatured, but may be tied after injury of the vessel and for traumatic aneurysm. The line for this vessel is the same as that for the common carotid artery. Its only accessible and superficial portion

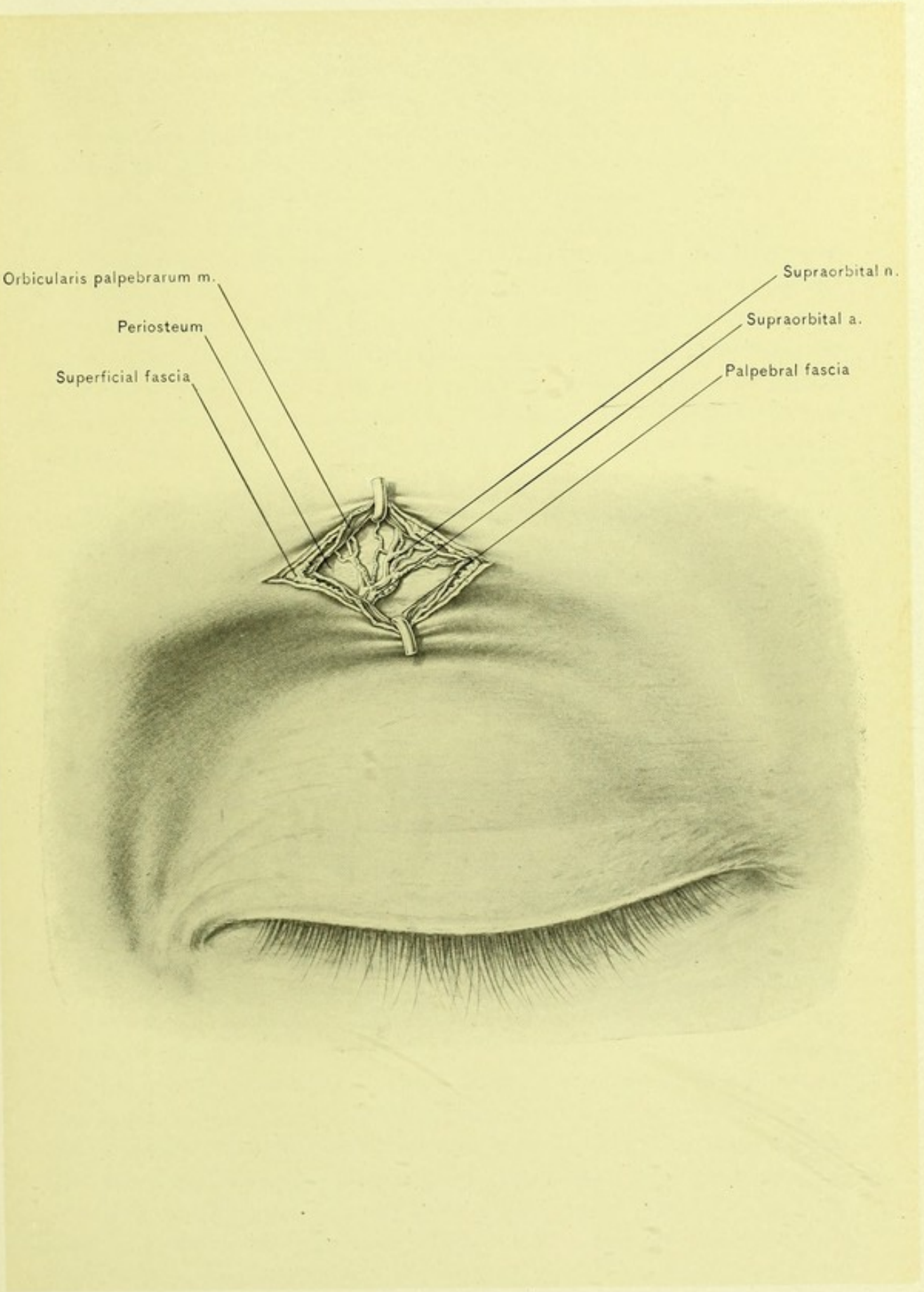
is at its origin, and is about one inch in length. The internal carotid artery begins at the bifurcation of the common carotid artery, which is opposite the upper border of the thyroid cartilage. At first it lies external to and on the same plane as the external carotid artery, but it gradually passes beneath the latter vessel. In front of it in this location are the skin, superficial fascia, platysma myoides muscle, superficial layer of the deep fascia, anterior border of the sterno-mastoid muscle, and the wall of the carotid sheath; behind it are the pneumogastric nerve, prevertebral fascia, superior sympathetic ganglion, and rectus capitis anticus major muscle; to the outer side are the pneumogastric nerve and internal jugular vein; and to the inner side are the external carotid artery, ascending pharyngeal artery, and pharynx. The patient should be placed in the same position as for ligature of the common carotid artery. An incision three inches long is made over the anterior border of the sterno-mastoid muscle, the center of the incision being slightly above the level of the upper border of the thyroid cartilage. Skin, superficial fascia, platysma myoides muscle, and superficial layer of the deep fascia are divided. The sterno-mastoid muscle is drawn outward, the posterior belly of the digastric muscle upward, the external carotid artery inward, and the internal carotid artery outward. The anterior wall of the sheath of the artery should be carefully opened, and the needle passed from without inward, away from the internal jugular vein and pneumogastric nerve. In many cases the facial and lingual veins cross the internal carotid artery to empty into the internal jugular vein.

Collateral Circulation.—The collateral circulation is established by the anastomosis of the vertebral arteries and opposite internal carotid with the ligatured artery through the circle of Willis.

Irregularities.—The irregularities of the internal carotid artery which are of importance are the following: It may arise from the arch of the aorta or the innominate artery; its cervical portion may be tortuous; it may give origin to the occipital artery.

OPERATIONS UPON NERVES OF HEAD AND NECK.

The **supra-orbital nerve** is exposed at the supra-orbital notch or foramen, which is located at the junction of the middle one-third with the inner one-third of the supra-orbital margin. The eyelid is drawn downward and the eyebrow held steady while a transverse incision is made along the supra-orbital margin. The incision is one-half to three-fourths of an inch in length and divides skin, superficial fascia, and orbicularis palpebrarum muscle. The nerve is now



EXPOSURE OF SUPRAORBITAL ARTERY AND NERVE.

exposed, the supra-orbital vessels being on its outer side. The palpebral fascia is divided, the orbital fat depressed, and the nerve traced into the orbit as far as possible, so that the frontal nerve may be reached and divided just before it bifurcates into the supra-orbital and supra-trochlear nerves. About an inch of the supra-orbital nerve is resected. The supra-orbital vessels may be injured. The supra-orbital artery may be ligated through the same incision.

The **infra-orbital nerve** may be resected through an incision three-fourths of an inch long, made about one-fourth to three-eighths of an inch below, and parallel with, the infra-orbital margin, so that its center will lie over the infra-orbital foramen, which is situated in a line drawn from the supra-orbital notch to the second bicuspid tooth of the upper jaw, and between one-fourth and three-eighths of an inch below the infra-orbital margin. The skin, superficial fascia, orbicularis palpebrarum muscle, and levator labii superioris muscle are divided, the nerve is drawn out of the foramen, and as much as possible resected.

The **superior maxillary nerve** is resected in the spheno-maxillary fossa by way of the antrum of Highmore, or through an incision at the side of the face. These operations are described in volume I, page 563.

The **Gasserian ganglion** is removed through an osteo-plastic resection of the temporal region, or by way of the pterygo-maxillary region. (See Vol. I, page 595.)

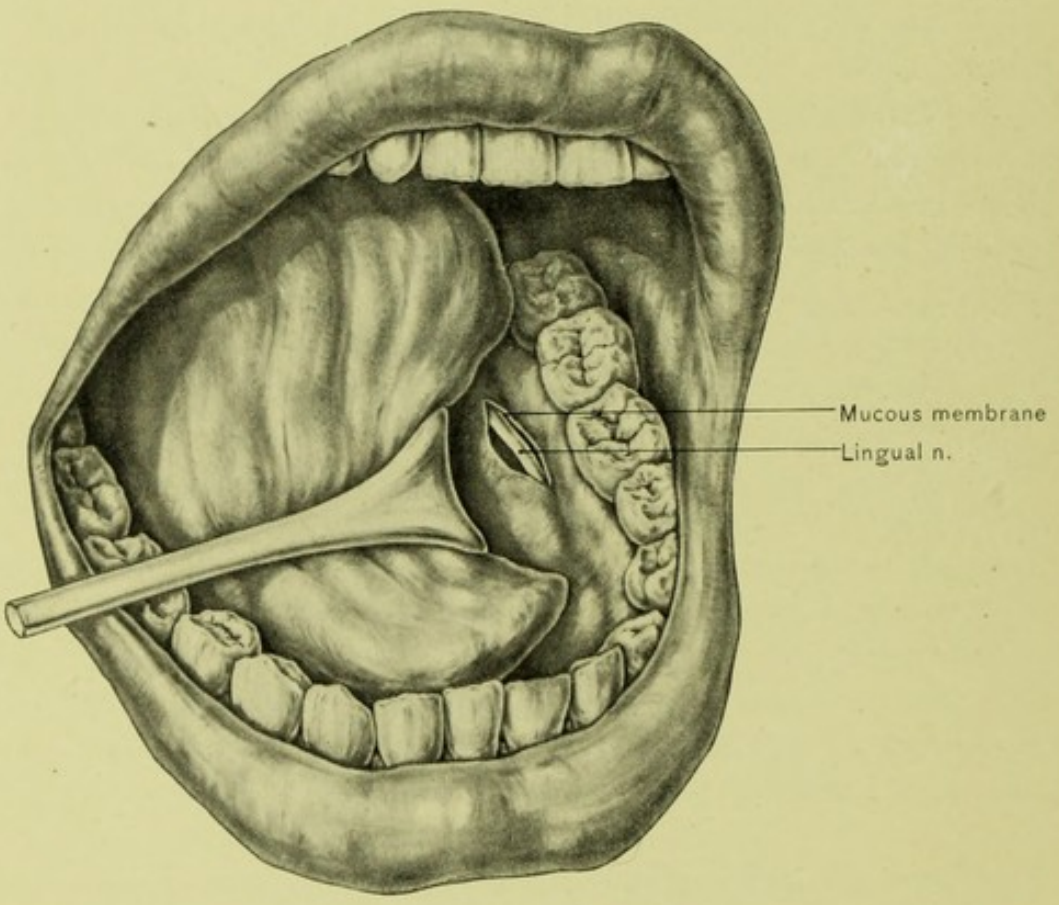
The **inferior maxillary nerve** is exposed at its exit from the foramen ovale. The reflected flap is square, its attached margin being below. Two vertical incisions are made, parallel with the margins of the ramus of the lower jaw, and extend from the level of the upper margin of the zygoma to half way down the ramus; the upper extremities of the incisions are connected by a transverse incision. The skin and superficial fascia are divided, the zygoma is sawed at each end, the temporal fascia and the masseteric fascia are divided, the zygoma and the masseter muscle are displaced downward, and the masseteric vessels and nerve are severed. Care is required to avoid injuring Stenson's duct and some of the large branches of the facial nerve which are at the attached margin of the flap. The coronoid process of the lower jaw is divided and reflected upward with the temporal muscle; and the upper head of the external pterygoid muscle is separated from the pterygoid ridge of the sphenoid bone and displaced downward. The nerve can then be exposed at the foramen ovale and divided with scissors. The small meningeal artery is necessarily divided with the nerve. The foramen ovale is situated about one-fourth of an inch in front of the spine of the sphenoid bone, just behind the base of the external pterygoid plate, and in a transverse line passing through the eminentia articularis of the temporal bone. This operation is hardly justifiable on account of the number of important tissues injured, the resulting paralysis of the muscles of mastication and of the mylo-hyoid muscle

and anterior belly of the digastric muscle, the partial loss of power in moving the lower jaw, and the dangers of infection and suppuration in so inaccessible a region as the pterygo-maxillary space.

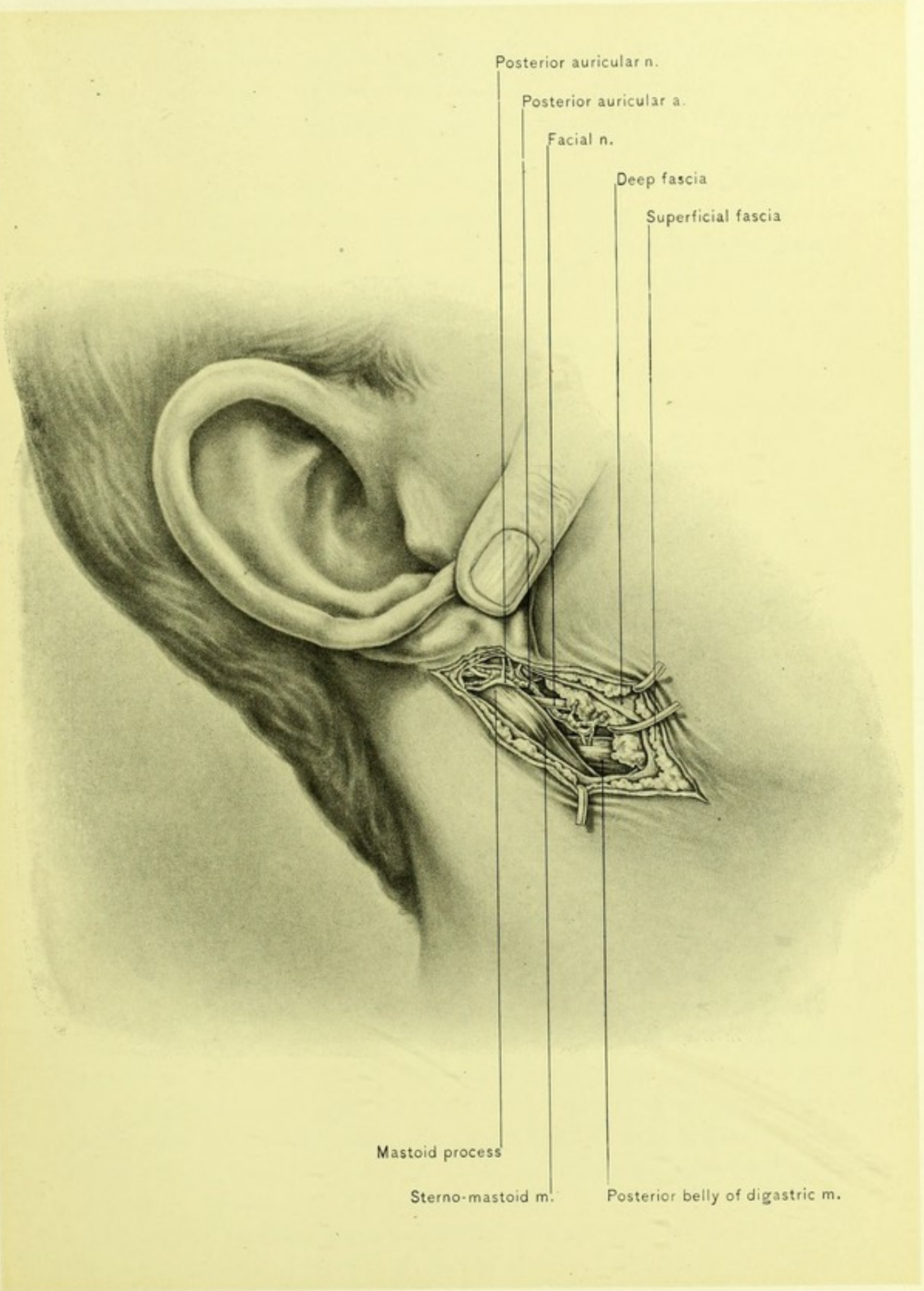
The **inferior dental nerve** may be resected at the mental foramen, in the inferior dental canal, or before it enters that canal. It is preferably resected before it enters the inferior dental canal, in order that all the dental and gingival fibers of the nerve can be included. This portion of the nerve can be reached by an incision through the cheek or through the mucous membrane of the mouth. The external incision is preferable because asepsis is an impossibility in wounds of the mouth, the external method is more easily performed, and the incision can be so located that the scar will not be prominent. The incision in the external method is angular and made along the posterior border of the ramus to the angle of the lower jaw, and thence forward along the lower border of the lower jaw, each limb of the incision being about one inch in length. Only the skin and superficial fascia are divided in the first stage of the operation. Next divide the masseteric fascia and the platysma myoides muscle, exercising care to avoid injuring the buccal and supra-maxillary branches of the facial nerve and the parotid gland. The lower limb of the incision should not extend far enough forward to divide the facial artery or vein. The lower portion of the masseter muscle is separated from the ramus of the lower jaw with the periosteal elevator and the knife, and displaced upward. A small trephine is applied to the ramus midway between its anterior and posterior borders, and just above the level of the alveolar margin of the lower jaw. The trephine first divides the upper and thinner portion of the circle of bone; the remainder of the incision through the bone must be completed with the chisel and elevator, so that the inferior dental vessels will not be injured. The inferior dental vessels and nerve are detected lying upon the internal lateral ligament of the lower jaw. The nerve is separated from the vessels, drawn out with a blunt hook, and as much of it as possible resected.

In *neurectomy of the inferior dental nerve* through the mouth, the upper teeth are widely separated from the lower with a gag, and a vertical incision about an inch long is made through the mucous membrane along the inner margin of the anterior border of the ramus of the lower jaw. The anterior margin of the ramus is exposed, and the mucous membrane is separated from the ramus with a small periosteal elevator. The lingual nerve is seen, the separation is extended a short distance further backward, and the spine of bone (spine of Spix) just below the inferior dental foramen is located with the finger. This spine gives attachment to the internal lateral ligament of the lower jaw; this ligament hides from view the inferior dental vessels and nerve which lie between it and the ramus of the lower jaw. The internal lateral ligament is cautiously divided with long, slender scis-

PLATE CXCVI.



EXPOSURE OF LINGUAL NERVE.



EXPOSURE OF FACIAL NERVE.

sors, and the inferior dental vessels and nerve are exposed at their entrance into the inferior dental canal. The nerve and vessels are gently drawn forward with a small blunt hook and traced upward for about a half inch above their point of entrance into the inferior dental canal. Here the nerve and vessels are not in so close contact and can be separated. The nerve is isolated from the vessels, and about one-fourth or one-half of an inch removed, the upper end of the segment being divided first because of the fact that the upper part of the nerve retracts after being divided. If the nerve and vessels are traced too high, the internal maxillary artery is endangered. The wound in the mucous membrane is not closed.

The **lingual (gustatory) nerve** is divided or a portion of it excised for painful conditions of the tongue, as advanced cancer of that organ. The nerve may be exposed by merely cutting through the mucous membrane of the floor of the mouth near the side of the tongue, and opposite the second molar tooth. The nerve may also be exposed by dividing the mucous membrane about one-half of an inch below and behind the last molar tooth, where the nerve can readily be felt.

The **auriculo-temporal nerve** is exposed where it first lies in relation with the superficial temporal vessels over the posterior root of the zygoma and in front of the pinna of the ear. The incision is the same as that made for ligation of the superficial temporal artery. The nerve is found just to the outer side of the superficial temporal vessels.

The **facial nerve** is stretched for twitching of the muscles of expression, associated with more or less pain (*tic convulsif*). The nerve is secured near the stylo-mastoid foramen, as it lies superficial to the styloid process and above the posterior belly of the digastric muscle.

In this location the trunk of the nerve is found before it gives off the stylo-hyoid and digastric branches, and before it bifurcates into its two divisions. The posterior auricular nerve arises from it close to the stylo-mastoid foramen. The incision begins behind the pinna of the ear, opposite the external auditory meatus, and is carried behind the lobule of the ear downward and forward to the angle of the lower jaw. A transverse incision may also be made behind the lobule. The skin, superficial fascia, superficial layer of the deep fascia, and branches of the auricularis magnus nerve are divided. The flaps which have been made are now dissected from the parotid gland, sterno-mastoid muscle, and mastoid process, the posterior auricular nerve, vein, and artery being avoided. The parotid gland is separated from the mastoid process, and the trunk of the nerve is found above the posterior belly of the digastric muscle, lying upon the styloid process. The nerve is stretched by lifting it with a blunt hook.

The **spinal accessory nerve** is stretched or divided for spasmodic wryneck. Division or excision of a portion of the nerve offers better results. The nerve is

secured at the anterior or at the posterior border of the sterno-mastoid muscle. When it is exposed behind the sterno-mastoid muscle, it should be traced upward and divided above its sterno-mastoid branches. In its course downward from the jugular foramen the nerve runs beneath the internal jugular vein, the occipital artery and posterior belly of the digastric muscle, and enters the under surface of the sterno-mastoid muscle about midway between its two borders and about two inches from the tip of the mastoid process. It emerges from the muscle at about the middle of its posterior border. Between the posterior belly of the digastric muscle and the point where it enters the sterno-mastoid muscle it is accompanied by the superior sterno-mastoid artery.

Before exposing the nerve at the anterior border of the sterno-mastoid muscle the patient is placed on his back, with the shoulders raised and the neck extended. The incision begins at the anterior border of the mastoid process, and is carried downward for two and one-half or three inches along the anterior margin of the sterno-mastoid muscle. The skin, superficial fascia, platysma myoides muscle, a branch of the auricularis magnus nerve, and the deep fascia are divided, the external jugular vein being avoided. The sterno-mastoid muscle is drawn outward, and the nerve, with its accompanying sterno-mastoid artery, can be felt just below the prominent transverse process of the atlas, lying upon the levator anguli scapulæ muscle.

Before exposing the spinal accessory nerve at the posterior border of the sterno-mastoid muscle the shoulders are elevated, the face is turned to the opposite side, and the neck is flexed laterally toward the opposite shoulder. The incision is made along the posterior border of the sterno-mastoid muscle, is two inches in length, and its center is at the middle of that border of the muscle. The skin, superficial fascia, platysma myoides muscle, and the superficial layer of the deep fascia are divided. The small occipital nerve is easily found as it runs along the upper one-half of the posterior border of the sterno-mastoid muscle. This nerve is traced downward to the spinal accessory nerve, with which it forms a loop. The spinal accessory nerve is then traced beneath or through the deeper portion of the sterno-mastoid muscle and divided.

The **superficial branches of the cervical plexus** may be exposed through the same incision as that made at the posterior border of the sterno-mastoid muscle for the spinal accessory nerve. The *auricularis magnus nerve* runs from the middle of the posterior border of the sterno-mastoid muscle toward the pinna. The *occipitalis minor nerve* lies between the superficial layer of the deep fascia and its posterior process (prevertebral fascia), and just behind the upper one-half of the posterior margin of the sterno-mastoid muscle. The *superficial cervical nerve* emerges from under the sterno-mastoid muscle at the middle of its posterior

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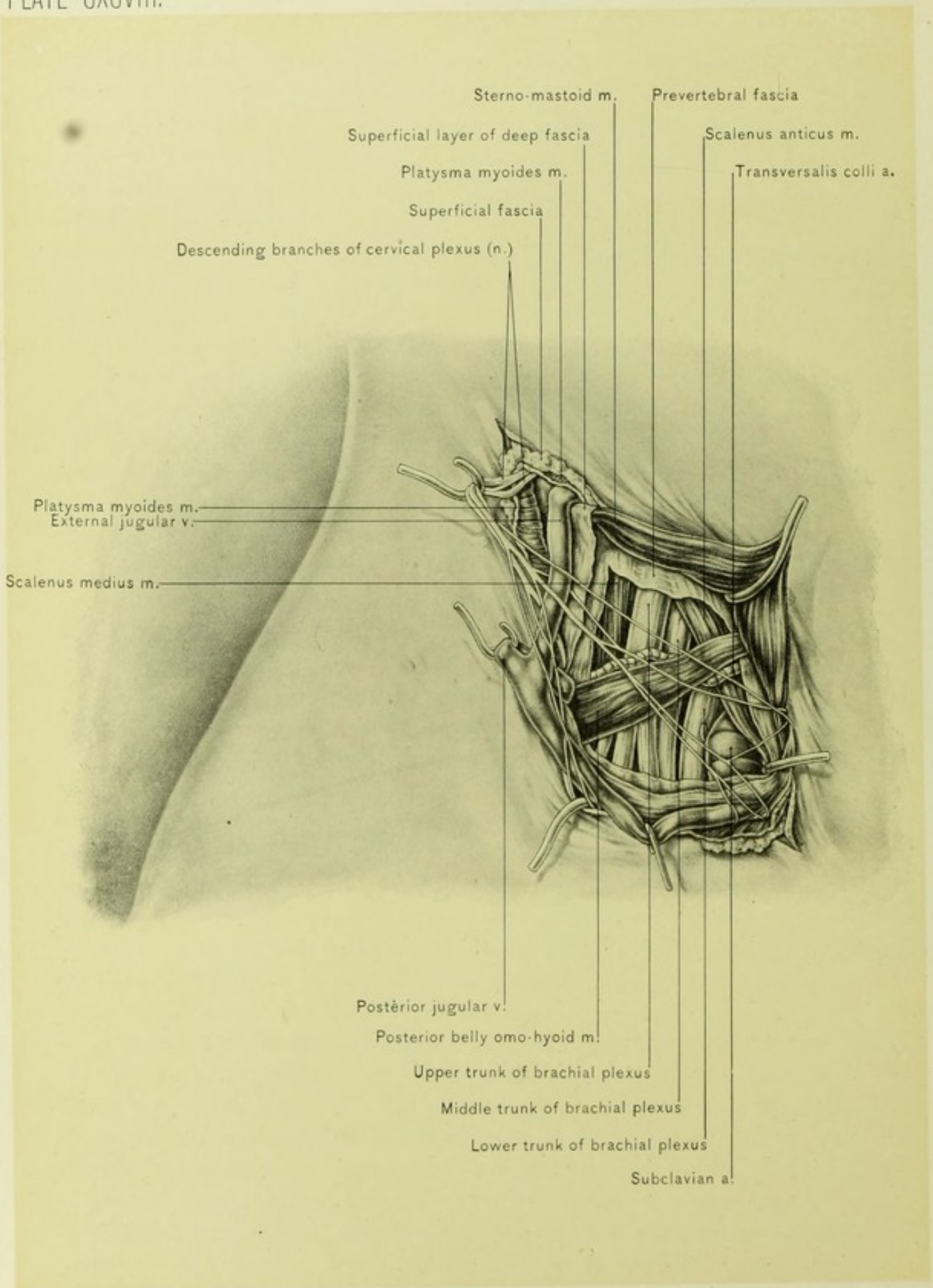
PLATE CXCVIII.



EXPOSURE OF BRACHIAL PLEXUS OF NERVES.

border, turns downward along that margin for a short distance, and then runs transversely forward. The *descending superficial branch of the cervical plexus*, which divides into the supra-sternal, supra-clavicular, and supra-acromial nerves, is found running along the posterior border of the sterno-mastoid muscle just below the middle of that margin, and usually passes between the sterno-mastoid muscle and the external jugular vein.

The **brachial plexus** may be stretched in the neck external to the scalenus anticus muscle. It emerges from between the scalenus anticus and scalenus medius muscles, and converges toward the apex of the axilla. The patient is placed on the back, with the shoulders elevated, the neck extended, and the face turned to the opposite side. The incision begins about one-half of an inch above the middle of the clavicle. It is carried directly upward for about three inches, and parallel with the posterior margin of the sterno-mastoid muscle. The skin, superficial fascia, and platysma myoides muscle are divided. The external jugular vein, which lies to the inner side of the incision, should be located, and it may be necessary to divide the posterior external jugular or transverse cervical and supra-scapular veins between ligatures. The superficial layer of the deep fascia is next divided. The posterior belly of the omo-hyoid muscle is drawn upward, the transversalis colli artery and the cords of the plexus and the position of the outer border of the scalenus anticus muscle are located with the finger. The posterior process of the deep fascia (prevertebral fascia) is divided a short distance external to the scalenus anticus muscle, avoiding the nerve to the subclavius muscle, which runs along the outer border of the scalenus anticus muscle, and the transversalis colli artery, which runs across the upper part of the plexus. The prevertebral fascia is reflected outward. The upper and middle cervical trunks of the plexus are found above the subclavian artery, whereas the lower trunk is overlapped by the upper margin of that artery.

THE MOUTH.

The student should now examine the mouth, the pharynx, the larynx, and the nose. These are attached to the anterior portion of the skull which has been divided previous to the dissection of the prevertebral muscles.

The **mouth** is situated at the commencement of the alimentary canal. It contains the organs of mastication, those of the sense of taste, some of the organs of speech, and it acts as a resonating cavity. The buccal cavity (cavity of the

mouth) is divided into two parts by the teeth and alveolar processes—viz., the vestibule and the mouth proper.

The **Vestibule** is situated between the lips and cheeks externally, and the teeth and gums internally. The walls of the vestibule, except when it is distended, are in contact. In front it opens upon the face at the buccal orifice, and behind the last molar teeth it communicates with the mouth proper, even when the teeth are in contact, so that in tetanus or during treatment of fractures of the lower jaw a patient may be fed liquids through a tube passed from the back part of the vestibule into the mouth proper. Under these circumstances a preferable method of feeding may be through a catheter introduced through the nose.

The **Lips** are composed of the skin, superficial fascia, orbicularis oris muscle and the muscles inserted around it, areolar tissue, and mucous membrane. The first three layers of the lips—skin, superficial fascia, and muscular tissue—have been described with the face. The margins of the lips are covered with dry, red mucous membrane, which is continuous with the skin, and contains numerous vascular papillæ and touch corpuscles. Internally, the mucous membrane is reflected from the upper and lower lips upon the gums, and in the median line forms two folds—the frænum labii superioris and frænum labii inferioris. Along the line of junction of the skin and mucous membrane "fever blister," or herpes labialis, is very common. Through cicatricial contraction after burns of the lips and cheeks the buccal orifice may be much distorted. The deformity can be lessened, if not corrected, by plastic operation. The areolar tissue, or submucous layer, contains the coronary vessels, branches of the infra-orbital and mental nerves, and the labial glands. The coronary vessels completely encircle the buccal orifice near the free margin of the lips, lying immediately superficial to the mucous membrane in the submucous layer.

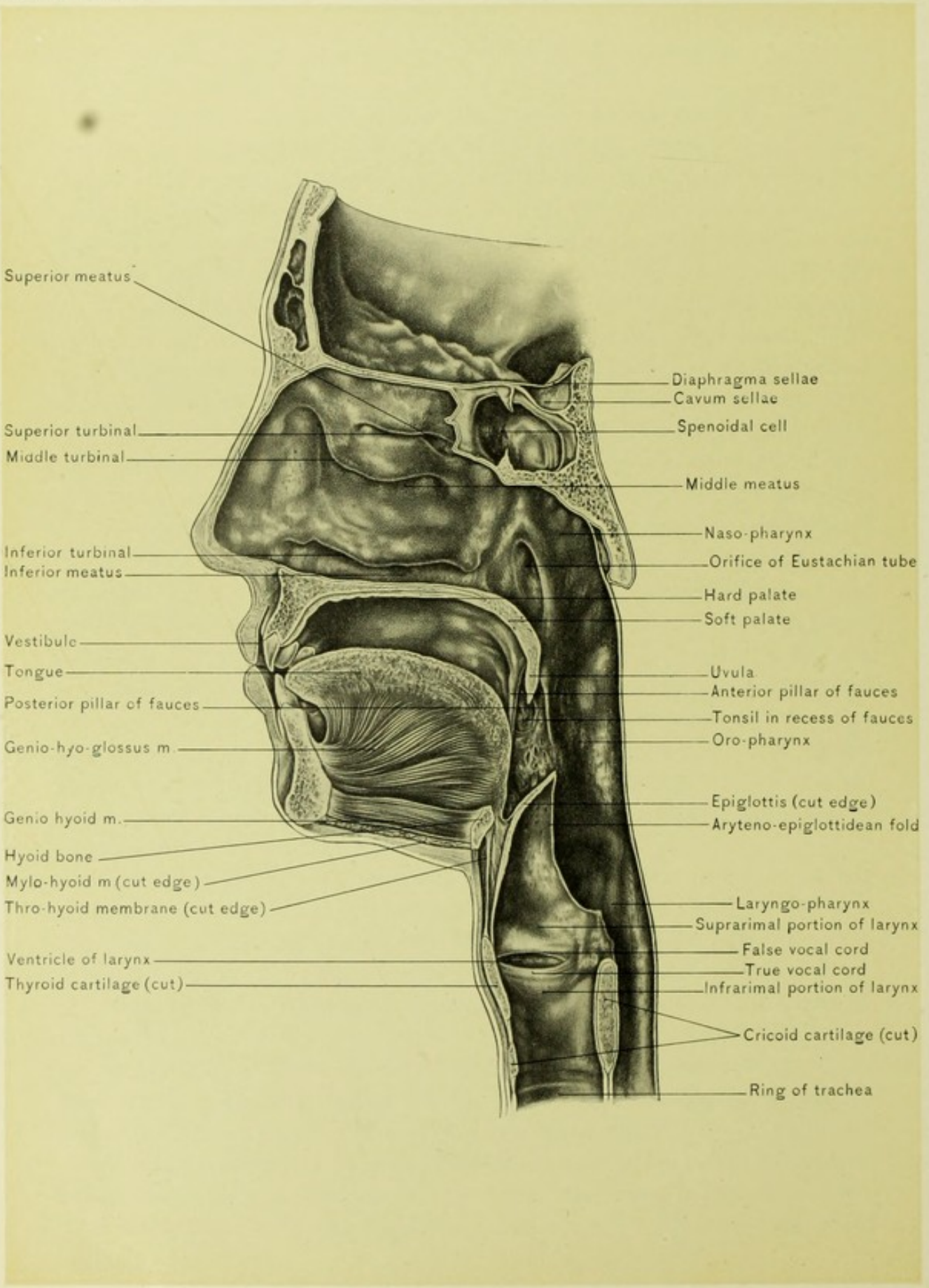
The **labial glands** are situated around the orifice of the mouth, in the submucous layer of the lips. They are small lobulated bodies, about the size of a small pea, and their ducts open into the mouth. They secrete a mucous fluid. When the ducts of these glands become occluded, mucous retention cysts develop.

Between the lips is the **buccal orifice,** which extends between the **angles of the mouth.**

In harelip operations and after excision of a large segment of the lip in removing an epithelioma, the mobility and elasticity of the lips, particularly of the lower lip, allow approximation of the edges of the wound.

The **lymphatics** from the median portion of the lower lip pass to a lymphatic gland situated just above the body of the hyoid bone; those from the lateral portions pass to the submaxillary lymphatic glands, into which the lymphatics of the upper lip also empty.

PLATE CXCIX.



VERTICAL SECTION OF MOUTH, PHARYNX, LARYNX, AND NOSE.

The operation which is frequently performed upon the upper lip is for correction of **harelip** which occurs upon one side, opposite the interval between the canine and lateral incisor teeth and not in the median line, because the central portion of the lip with the premaxillary bone is formed by the fronto-nasal process of the fetus, whereas each lateral portion of the upper lip develops from the maxillary process of the superior visceral arch. The lower lip is rarely operated upon except for extirpation of epitheliomata. These operations leave a V-shaped wound, which is closed by pins or sutures. The arteries divided are the superior coronary or inferior coronary arteries. During the operation hemorrhage may be checked by an assistant grasping the lip at the angles of the mouth, between the thumbs and index fingers. In closing the wound the arteries are occluded by pressure of one of the pins or sutures. The pin or suture is carried through the tissues of the lip to the mucous membrane and under the artery, then under the artery at the opposite side of the wound, and outward through the tissues of the lip. The lower lip is occasionally the site of nevus or hypertrophy. Neurotic edema of the lower lip, a condition seldom seen, and for which operation is of no avail, must not be mistaken for hypertrophy of the lower lip.

The **Cheeks** are composed of five layers: the skin, the superficial fascia (which contains the facial vessels and some branches of the facial and trifacial nerves), the bucco-pharyngeal fascia, the buccinator muscle, the submucous areolar tissues, and the mucous membrane.

The **bucco-pharyngeal fascia** covers the buccinator muscle, and is continued backward over the constrictor muscles of the pharynx. The submucous areolar tissue contains the **buccal glands,** which resemble the labial glands. Two or three glands larger than the others are situated between the buccinator muscle and its fascial covering. They are called **molar glands,** and their ducts open into the vestibule of the mouth opposite the last molar tooth. Opposite the crown of the second molar tooth of the upper jaw is the papilla, which marks the orifice of Stenson's duct.

The **Mouth Proper** is bounded in front and at the sides by the teeth and gums. Its roof is formed by the hard and the soft palate, and its floor by the mucous membrane of the mouth, a large portion of the tongue, and the mylo-hyoid and genio-hyoid muscles. Behind, it opens into the pharynx at the **isthmus of the fauces.** When the mouth is closed, the tongue lies in contact with the palate and almost fills the mouth proper.

The **Teeth** in the human subject appear as two sets: The *first or temporary set* is present in children, and numbers ten in each jaw—viz., four incisors, two canines, and four molars. The central incisors are the first to pierce the gum, and make their appearance at the seventh month. The lateral incisors soon follow, the last

of the set to appear being the posterior molars, the eruption of which should occur in the third year or the latter half of the second year. The *second or permanent set* are sixteen in number in each jaw—viz., four incisors, two canines, four bicuspids or premolars, and six molars. The first molars appear in the seventh year; the middle incisors and then the lateral incisors soon follow. The third molars, or wisdom teeth, are the last to pierce the gums, usually at the seventeenth or eighteenth year. When a child is affected by congenital syphilis, faulty nutrition affects the development of the permanent teeth, so that they are not perfectly formed. These syphilitic teeth are uneven, and have a contracted and a crescentically notched cutting edge. The central incisors are the most typical, and are the "test teeth of Hutchinson."

When the mouth is wide open, a ridge produced by the pterygo-maxillary ligament may be seen ascending from just behind the last molar tooth to the hamular process of the internal pterygoid plate of the sphenoid bone. The hamular process may be felt as a resisting prominence a short distance behind and slightly internal to the upper last molar tooth. It is the guide in division of the tensor palati and levator palati muscles.

The **Gums** cover the alveolar processes of the jaws and firmly surround the necks of the teeth. They are composed of dense vascular connective tissue, covered by mucous membrane. The periosteum of the alveolar processes is continued into the alveoli, forming the lining membrane of these cavities. Pus at the root of a tooth may work its way into the gum, producing a "gum boil."

In chronic lead poisoning a blue line appears upon the dental margin of the gums, and is produced by lead sulphid, which is formed by chemic combination between lead in the tissues and hydrogen sulphid derived from decomposing food.

Swelling of the gums and tenderness of the teeth during the administration of mercury indicate that the physiologic limit for that remedy has been reached, and that the dose should be decreased or the drug temporarily withdrawn.

The swollen and readily bleeding gums in scurvy assist in the diagnosis of that disease.

The **Hard Palate** is composed of the palate or horizontal processes of the superior maxillary and palate bones, clothed on their inferior surface by a dense, tough muco-periosteum. In the operation for cleft palate the toughness and density of the muco-periosteum render its manipulation less difficult. The muco-periosteum contains a median raphe, which marks the line of junction of the two halves. When these two halves fail to unite, cleft palate results. This malformation is often associated with harelip.

Blood Supply.—The hard palate is supplied by the naso-palatine and posterior palatine vessels.

The posterior or descending palatine arteries furnish nearly all the nutrition of the hard palate, and lie in the muco-periosteum near the alveolar processes. The incision into the muco-periosteum in the operation for cleft of the hard palate should be made near and parallel with the alveolar processes, so that the descending palatine arteries need not be divided and may be retained in the flaps to provide for their nutrition. In dissecting up the flaps the operator should follow the bone closely, as these arteries run nearer to the bone than to the free surface of the muco-periosteum. Bleeding from the posterior palatine artery may be checked by plugging the posterior palatine canal, which can be located to the inner side of the last molar tooth with a sharp probe.

NERVE SUPPLY.—From the naso-palatine and great or anterior palatine nerves.

Cleft palate, as previously stated, occurs only in the median line. The cleft may affect only the uvula and soft palate, or it may extend forward through the hard palate to the anterior palatine foramen. If the cleft extend forward beyond this foramen, it leaves the median line and follows the line of the suture at the side of the premaxillary bone, the anterior extremity of the cleft being between the lateral incisor and the canine tooth. If the cleft follow one suture, single harelip is usually present, and if it traverse both sutures, double harelip usually exists and the premaxillary bone is suspended by the vomer. In the operation for the correction of double harelip with projection of the premaxillary bone, the author advises that the attachments of this bone be loosened and the bone be pushed back in place and not removed.

The **Soft Palate** is described with the pharynx.

The **Mucous Membrane** in the floor of the mouth covers the tongue, a small area on each side of that organ, and the triangular area beneath its tip or free end. In the median line, as the mucous membrane is reflected upon the under surface of the tongue, it forms a fold—the **frænum linguæ.** In some infants the frænum linguæ is so short that it interferes with sucking, and later prevents distinct articulation. To relieve these cases it is necessary to divide the frenum by snipping its free margin with blunt scissors close to the floor of the mouth and then tearing it. This method is adopted to avoid division of the artery of the frenum, with consequent annoying hemorrhage. On each side of the frenum are the small papillæ, which contain the orifices of Wharton's ducts. The rounded elevation on each side of the lingual frenum is produced by the sublingual glands, which lie immediately beneath the mucous membrane. The orifices of the ducts of Rivini are situated upon these elevations. In the floor of the mouth, opposite the second molar tooth, the lingual nerve may be felt and divided to relieve pain in the tongue ; when the tongue is drawn out of the mouth

and toward the opposite side, a ridge in the mucous membrane of the floor of the mouth, produced by this nerve, is seen extending forward from the inner side of the last molar tooth.

A cystic tumor in the floor of the mouth due to occlusion of the orifice of Wharton's duct, one of the ducts of Rivini, or the duct of a mucous follicle, is called a *ranula*.

The *sublingual bursa*, according to Tillaux, is found immediately beneath the mucous membrane of the anterior part of the floor of the mouth, where the mucous membrane is reflected upon the posterior surface of the lower jaw. This bursa is affected in acute ranula.

The **Tongue** is a freely movable, muscular organ, covered with mucous membrane. It contains the organs of the special sense of taste, and is an important accessory in the functions of mastication, deglutition, and speech.

The mucous membrane covers all the free surface of the tongue—*i. e.*, the dorsum, sides, and less than the anterior one-third of the under surface of the organ.

The tongue has a tip, a base, a dorsum, and two sides.

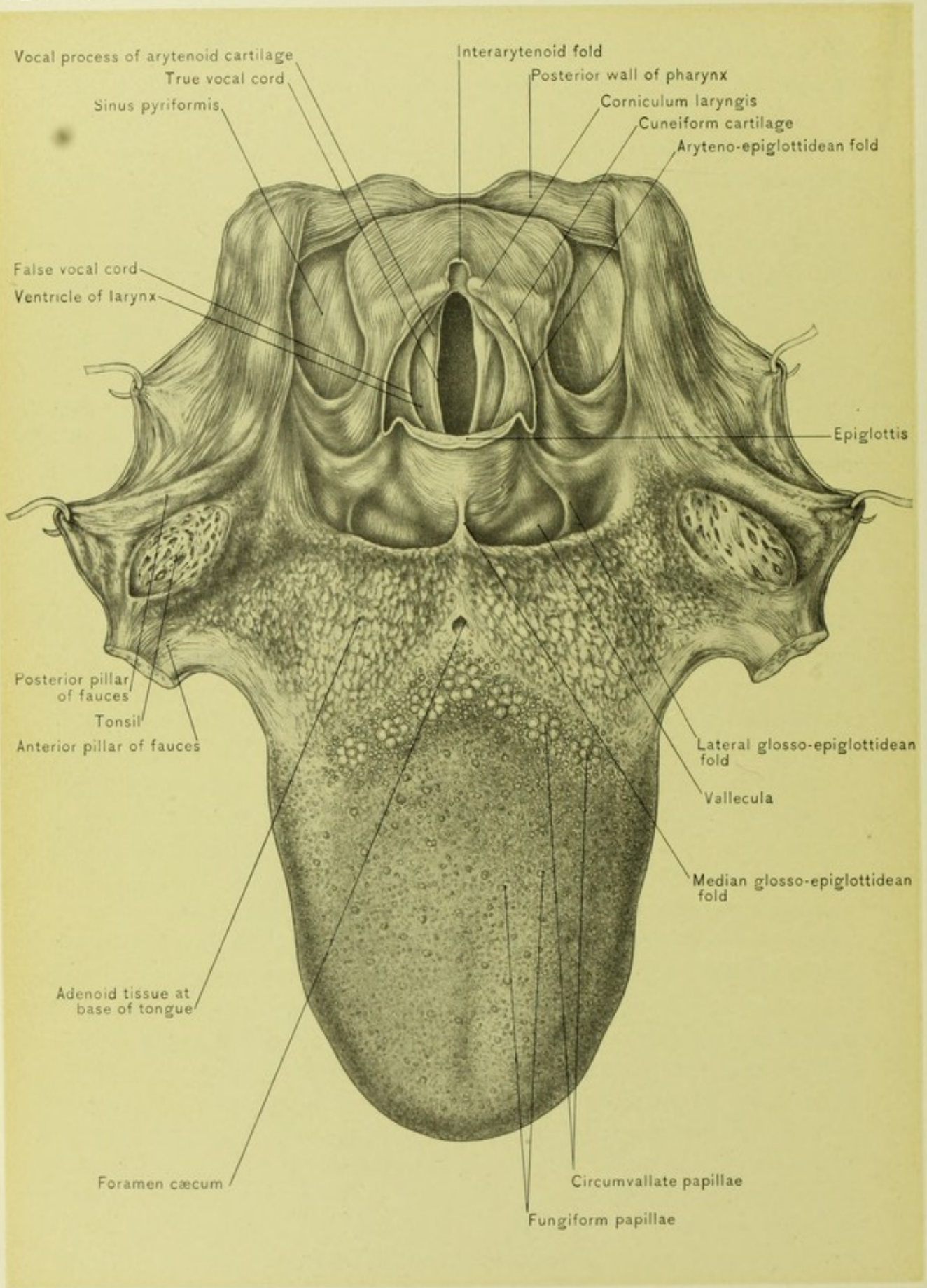
The **tip or apex of the tongue** is its most movable portion, and is covered on both its upper and lower surface by mucous membrane. Its range of motion is influenced by the length of the frænum linguæ. A short frenum causes tongue-tie, and a long one allows swallowing of the tongue.

The **base or root of the tongue** is its least movable portion. It is attached to the hyoid bone by muscular tissue and by a fibrous membrane (*hypo-glossal membrane*); to the anterior portion of the lower jaw, at the side of the symphysis, by the genio-hyo-glossus muscle; and to the epiglottis, by the three glosso-epiglottidean folds of mucous membrane.

The **median glosso-epiglottidean fold** is sharply outlined, and has been called the **frænum epiglottidis.** The **lateral glosso-epiglottidean folds** are rounded and indistinct. Between the median and the lateral folds are the **glosso-epiglottidean pouches or valleculæ,** in which small foreign bodies may lodge and cause much discomfort.

The **dorsum of the tongue** is convex and grooved in the median line, forming a raphe from which a septum dips down between the muscles of the two sides. The raphe terminates behind at the **foramen cæcum,** which is the orifice of the obliterated thyro-glossal duct. In the fetus the **thyro-glossal duct** extends from the middle lobe of the thyroid gland to the tongue. It can seldom be traced in the adult. The posterior one-third of the dorsum of the tongue dips downward in front of the pharynx almost to the level of the hyoid bone, and overhangs the epiglottis. It presents no papillæ, but has a somewhat uneven surface, produced

PLATE CC.



SUPERIOR APERTURE OF LARYNX AND DORSUM OF TONGUE.

by the irregular collection of lymphoid tissue, known as the *lingual tonsil.* When the lingual tonsil is much enlarged, it may depress the epiglottis and cause difficult respiration. On the anterior two-thirds of the dorsum of the tongue the mucous membrane contains numerous papillæ, which are of three varieties: filiform, fungiform, and circumvallate.

The **filiform papillæ** are the smallest and most numerous. They are long, slender, conic, and branched at their free ends. Fur on the tongue, or coated tongue, is due to increase in the thickness of the epithelium upon these papillæ. Fur on the tongue is present in indigestion, constipation, high fever, contagious and infectious diseases, when large abscesses are present, or in the various forms of ptomain poisoning.

The **fungiform papillæ** are more numerous than the circumvallate papillæ. They resemble small knobs, and are the red spots best observed on the sides and anterior portion of the dorsum of the tongue.

The **circumvallate papillæ,** numbering from eight to twelve, are situated at the junction of the posterior with the middle one-third of the dorsum of the tongue. They form a letter V, its apex being directed backward toward the foramen cæcum. They are surrounded by an elevated margin or *vallum,* so that the papiliæ rest in pits. They contain the special taste organs.

On the **sides of the tongue** the mucous membrane is smooth, except at the posterior part, just in front of the attachment of the anterior pillars of the fauces, where there are several parallel folds, known as the papillæ foliata. The **papillæ foliata** are best developed in some of the lower animals, and contain taste organs.

The **under surface of the tongue,** behind, receives the insertion of its extrinsic muscles, but in front it is free and covered by smooth, thin mucous membrane, through which the commencement of the lingual vein can be seen on each side of the median line. These veins are so superficial that they may be injured in division of the lingual frenum for tongue-tie.

The **glands of the tongue** are found in the mucous membrane of the posterior third of the dorsum and at the sides of the organ. They are most numerous around the circumvallate papillæ. Those in relation with the taste buds secrete a serous, and the others a mucous, fluid. Embedded in the substance of the lower surface of the tongue, near the tip of the organ, is a collection of mucous glands, about the size of a pea; this is the so-called gland of Nuhn or Blandin; occlusion of the duct of these glands may cause the formation of a retention cyst.

Dissection.—To study the arrangement of the muscles of the tongue it is necessary to remove the mucous membrane from one side of it.

The **muscles of the tongue** compose the greater part of its mass, and are divided into an extrinsic and an intrinsic group. The *extrinsic muscles* are the

stylo-glossus, hyo-glossus, a small portion of the superior constrictor muscle of the pharynx, palato-glossus, and genio-hyo-glossus.

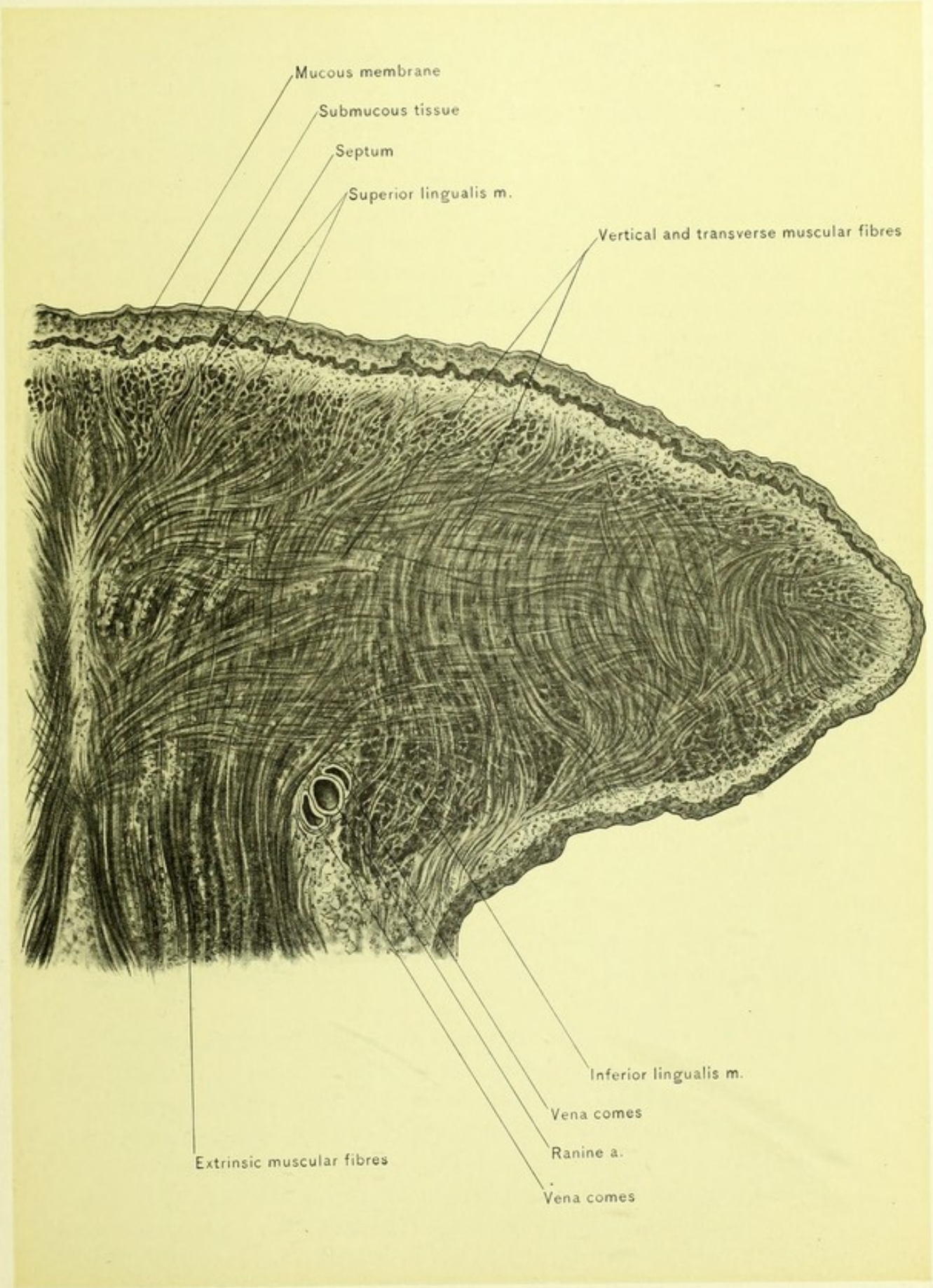
The stylo-glossus muscle runs along the side of the tongue to its tip. The hyo-glossus muscle is inserted internal to the stylo-glossus muscle. The superior constrictor muscle of the pharynx is seen arising from the side of the base of the tongue. The palato-glossus muscle is continuous with the transverse fibers of the intrinsic muscular tissue of the tongue. The genio-hyo-glossus muscle is next to the median line, and is separated from the genio-hyo-glossus of the opposite side by the septum linguæ and hypo-glossal membrane.

The *intrinsic or lingualis muscle* contains longitudinal, transverse, and vertical fibers. The longitudinal fibers are composed of two separate bundles on each side, a superior and an inferior. The *superior lingualis muscle* lies beneath the mucous membrane of the dorsum, and extends from the base to the apex of the tongue. It is separated from the superior lingualis of the opposite side by the septum linguæ. The *inferior lingualis muscle* is found on the under surface of the tongue, beneath the transverse fibers. It is attached behind to the hyoid bone, and extends from the base of the tongue to its apex. Behind, it lies between the hyo-glossus and the genio-hyo-glossus muscle, and in front, between the stylo-glossus and the genio-hyo-glossus muscle. The *transverse fibers* form a thick layer beneath the superior lingualis muscle, and extend from the septum linguæ to the side of the tongue. The *vertical fibers* decussate with the transverse fibers, and pass in curved lines from the dorsum to the inferior aspect of the tongue. As the tongue is almost entirely composed of muscular tissue and contains little areolar tissue, it does not become much swollen when inflamed.

Many of the muscular fibers of the tongue are attached to the mucous membrane; hence, when the mucosa is destroyed, as in ulcerative processes, the surface of the ulcer presents an uneven, ragged appearance, due, in part, to retraction of the muscular fibers.

The **septum linguæ** is a fibrous membrane which extends vertically downward from the median raphe between the halves of the tongue, and separates the two lingualis and the two genio-hyo-glossus muscles. Its lower portion is strong, attaches the base of the tongue to the hyoid bone, and is called the **hypo-glossal membrane.**

Paralysis and **atrophy of one-half of the tongue** may be produced by a central lesion of the hypo-glossal nerve, as by a hemorrhage affecting the center of that nerve in the medulla oblongata, or by a peripheral lesion, as disease or fracture of the occipital bone at the anterior condyloid foramen or by pressure from an aneurysm of the external carotid or internal carotid artery.



TRANSVERSE SECTION OF ONE-HALF OF TONGUE.

Macroglossia, or congenitally large tongue, is usually due to increased development of the lymphoid tissue of the tongue.

Blood Supply.—The nutrition of the tongue is derived from the lingual, facial, and ascending pharyngeal arteries.

Nerve Supply.—From the glosso-pharyngeal, hypo-glossal, lingual, and chorda tympani nerves. The glosso-pharyngeal is the nerve of the special sense of taste, and supplies special sensory and common sensory fibers to the mucous membrane at the posterior third of the tongue, and to the circumvallate papillæ. The hypo-glossal is the motor nerve, and supplies the extrinsic muscles and the lingualis muscle, the latter being also supplied by the chorda tympani nerve. The lingual, or gustatory, is the common sensory nerve of the tongue, and supplies the front and sides of that organ. Small branches of the superior laryngeal nerve are distributed to the base of the tongue in the region of the epiglottis.

Irritation of the lingual nerve, as by an ulcer or a carcinoma of the tongue, may cause reflected disturbance in the tissues supplied by other branches of the inferior maxillary nerve—through the auriculo-temporal nerve, pain in the pinna, external auditory meatus, and temporal region; through the inferior dental nerve, pain in the lower teeth, lower gums, and chin; and through the motor branches of the inferior maxillary nerve, spasm of the muscles of mastication, excepting the buccinator muscle.

In **profound anesthesia** relaxation of the tissues allows the tongue to fall backward, depress the epiglottis, and obstruct respiration. To relieve this condition the anesthetizer carries the lower jaw forward by placing his fingers behind the angles of that bone. This procedure makes tension upon the genio-hyo-glossus, genio-hyoid, and mylo-hyoid muscles, the hypo-glossal membrane, the glosso-epiglottidean folds, and the hyo-epiglottidean ligament; draws the tongue, epiglottis, and hyoid bone forward; and opens the superior aperture of the larynx.

The **lymphatic vessels of the lips** pass with the superficial lymphatic vessels of the front of the face into the submaxillary and superior deep cervical lymphatic glands.

The **lymphatics of the roof of the mouth and deeper portion of the cheek** terminate in the internal maxillary lymphatic glands.

The **lymphatics of the floor of the mouth and anterior part of the tongue** pierce the mylo-hyoid muscle and join the submaxillary lymphatic glands.

The **lymphatics of the tongue,** excepting those of the most anterior portion, accompany the lingual vein, pass through the lingual lymphatic glands on the hyo-glossus muscle, and terminate in the superior deep cervical glands.

In **excision of the tongue** for carcinoma it is advisable to remove the superior

deep cervical, submaxillary, and lingual lymphatic glands, so that the involved glands may not be the source of a secondary growth. Occasionally the submaxillary salivary gland, which contains two or more lymphatic glands, should also be removed.

The **isthmus of the fauces** is the large orifice of communication between the mouth and the pharynx. It is bounded above by the soft palate, below by the base of the tongue, and on each side by the pillars of the fauces.

The under surface of the **Soft Palate,** which is seen through the mouth, is concave, and its mucous membrane is continuous with that of the hard palate. It presents a median raphe which marks the line of union of the halves.

The **Uvula** is the conic process which is suspended in the isthmus of the fauces from the middle of the free border of the soft palate.

The **pillars of the fauces,** or **pillars of the soft palate,** are ridges in the mucous membrane which extend outward and downward from the uvula. There are two pillars on each side—an anterior and a posterior pillar. The anterior pillars extend downward, outward, and forward to the sides of the base of the tongue. They contain the palato-glossus muscles. The posterior pillars are directed downward, outward, and backward, and fade away upon the lateral wall of the pharynx. They are produced by the palato-pharyngeus muscles. A triangular depression exists on each side between the anterior and the posterior pillar, and is termed the **recess of the fauces,** or **tonsillar recess.**

The **Tonsils** are two oblong rounded bodies, situated in the recesses of the fauces. They vary in size in different individuals, but should not project beyond the anterior pillars of the fauces. The internal surface of the tonsil is covered by the oral mucous membrane, and presents from ten to fifteen puncture-like orifices, which lead into recesses called *crypts.* The crypts are lined by extensions of the oral mucous membrane. The tonsils are compound follicular glands —*i. e.*, they contain a number of aggregations of lymphoid tissue similar to that of the solitary glands of the intestines. They are enveloped by a fibrous capsule. The secretion of the tonsil is derived from the mucous glands in the mucous membrane lining the crypts, and contains numerous epithelial and lymphoid cells.

Inspissation of the mucous secretion in the crypts of the hypertrophied tonsils gives rise to the formation of cheesy plugs, which contain decomposing epithelium, emit a foul odor, and produce fetid breath.

It is quite probable that germs in the stagnant secretion in the crypts of the tonsils enter the lymphatic vessels, and cause many of the cases of inflammation and tuberculosis of the deep cervical chain of lymphatic glands.

Blood Supply.—From the ascending pharyngeal branch of the external

carotid, the tonsillar, and ascending palatine branches of the facial artery, the dorsalis linguæ branch of the lingual artery, and the descending palatine branch of the internal maxillary artery.

NERVE SUPPLY.—From the glosso-pharyngeal nerve and branches of Meckel's ganglion.

The **veins** of the tonsils empty into the tonsillar plexus, which lies on the outer surface of the gland and is drained by the pharyngeal veins.

The **lymphatics** of the tonsil, which are numerous, empty into the lymphatic glands near the angle of the lower jaw, and into the superior deep cervical lymphatic glands.

RELATIONS.—Externally, the tonsil is in relation with the superior constrictor muscle of the pharynx and the pharyngeal aponeurosis, which separate it from the internal carotid and the ascending pharyngeal artery; internally, with the mucous membrane of the mouth and pharynx.

Tonsillitis.—The tonsils are frequently affected by inflammation. In follicular tonsillitis the crypts especially are involved, and their secretion is inspissated, forming yellowish-white plugs which resemble diphtheric false membrane, and give the throat the appearance of "ulcerated sore throat." In phlegmonous or purulent tonsillitis (quinsy), when the affection is bilateral, the tonsils may almost meet in the median line. These tonsillar abscesses should be incised with a bistoury, guarded to avoid injuring the tongue. The knife should be directed backward and inward, and the incision be made toward the median line to avoid injuring the internal carotid artery, which lies just external to the gland.

Hypertrophied tonsils can not be felt externally below the angles of the lower jaw, for the reason that the pharyngeal aponeurosis and the superior constrictor muscles of the pharynx prevent the tonsils from projecting outward. The masses present in these locations are enlarged lymphatic glands which receive lymphatic vessels from the tonsils. Hypertrophied tonsils project beyond the pillars of the fauces, and cause considerable annoyance through their interference with respiration and with the resonance of the voice. Hypertrophied tonsils should be amputated with a tonsillotome, or removed by dissection. Exaggerated prominence of the anterior pillars of the fauces may render these operations quite difficult. The relation which the tonsil bears to the internal carotid and ascending pharyngeal arteries should be borne in mind in either of these operations.

The ascending pharyngeal artery runs upon the external surface of the superior constrictor muscle of the pharynx, opposite the tonsil, and in operations upon the tonsil or in wounds of that organ is in more danger of being injured than is the internal carotid artery, which is placed further back.

Malignant growths of the tonsil are not infrequent, and are best removed through an incision made along the anterior border of the sterno-mastoid muscle and not through the mouth, because the involved lymphatic glands can not be satisfactorily reached by the latter route.

The **Bucco-pharyngeal Fascia** is a thin layer of deep fascia which covers the buccinator muscle and the constrictor muscle of the pharynx. It is continuous below with the delicate fibrous investment of the esophagus.

Dissection.—Stuff the pharynx and esophagus with cotton, and carefully remove the fascia covering the esophagus, trachea, and the constrictor muscles of the pharynx. The ascending pharyngeal artery, which is in relation with the superior constrictor muscle of the pharynx, and the recurrent laryngeal nerve, which lies in the groove between the esophagus and trachea, are the structures most likely to be destroyed.

The **Esophagus** is the narrow continuation of the pharynx. It begins at the lower, contracted end of the pharynx, opposite the sixth cervical vertebra and the lower border of the cricoid cartilage. It passes downward behind the trachea, to enter the posterior mediastinum of the chest. At its beginning it lies in the median line, but at the lower part of the neck it inclines to the left side. Its muscular coat is seen to be continuous with the inferior constrictor muscle of the pharynx.

Relations.—In front of the esophagus, in the neck, are the trachea, left recurrent laryngeal nerve, and the posterior surface of the left lobe of the thyroid gland. Behind it are the prevertebral fascia, the bodies of the vertebræ, and the longus coli muscles. On its right side are the right carotid sheath and its contents, the right recurrent laryngeal nerve, and the right lobe of the thyroid gland. On its left side are the left carotid sheath, the left common carotid and subclavian arteries, the left recurrent laryngeal nerve, the thoracic duct, and the left lobe of the thyroid gland.

The narrowest point in the esophagus is behind the lower border of the cricoid cartilage and in front of the sixth cervical vertebra. This is the point at which a large foreign body, such as a set of false teeth, would be likely to lodge. If a foreign body can not be withdrawn through the mouth or pushed into the stomach, it becomes necessary to perform an esophagotomy. This is done as follows: An incision is made along the anterior border of the left sterno-mastoid muscle, cutting skin, superficial fascia, platysma myoides muscle, some superficial vessels and nerves, superficial layer of the deep fascia, omo-hyoid muscle if necessary, pretracheal fascia, and esophagus. The carotid sheath and its contents must be displaced outward; the trachea, thyroid gland, and sterno-thyroid and sterno-hyoid muscles should be displaced inward. The superior and middle thyroid veins must

be avoided or divided between ligatures, and the recurrent laryngeal nerve and inferior thyroid artery must not be injured.

The thoracic portion of the esophagus will be described with the chest.

THE PHARYNX.

The **pharynx,** the second portion of the alimentary tract, is situated behind the nasal cavities, the mouth, and the larynx ; it is subdivided into the naso-pharynx, oro-pharynx, and laryngo-pharynx, and is a conic, musculo-membranous tube. The **naso-pharynx** and **oro-pharynx** bridge the gap in the respiratory tract between the larynx and nasal cavities, and assist in giving resonance to the voice; the **oro-pharynx** and **laryngo-pharynx** connect the mouth with the esophagus, and carry the food from the former to the latter. The pharynx is about four and one-half inches in length, and extends from the base of the skull to the upper border of the sixth cervical vertebra, opposite the lower border of the cricoid cartilage, where it becomes the esophagus. The base of the cone is in contact with the under surface of the body of the sphenoid bone and the basilar process of the occipital bone, and its apex blends with the esophagus. The pharynx is compressed from before backward, the transverse diameter being greater than the antero-posterior. Its widest point is opposite the greater cornua of the hyoid bone, where it is about two inches in width ; its narrowest point is at its junction with the esophagus, opposite the lower border of the cricoid cartilage, where it is about three-fourths of an inch wide.

Although, owing to the dilatability of the pharynx, large foreign bodies may be retained in it for a long time without producing much discomfort, they more frequently give rise to alarming symptoms. They usually lodge at the lower end, which is the narrowest portion of that canal. Here they lie behind the larynx, causing dyspnea and obstructing deglutition. In attempting removal of these bodies it is important to remember that the pharyngo-esophageal junction is about six inches from the teeth.

Foreign bodies in the pharynx may cause suffocation by occlusion of the superior aperture of the larynx, or by producing spasm of the muscles of the larynx. In either condition sudden death may occur during eating. As the mass of food can be reached if it rests upon the superior aperture of the larynx, the proper course of procedure is to remove it with the finger used as a hook.

The pharynx has a muscular, a fibrous, and a mucous coat.

The **Muscular Coat of the Pharynx** is composed of three muscles—viz., the

inferior, middle, and superior constrictor muscles,—with a few fibers from the stylo-pharyngeus and palato-pharyngeus muscles.

The **constrictor muscles of the pharynx** are flat, and are inserted into the median raphe on the posterior aspect of the organ. This raphe is formed by the interlacing, tendinous fibers of the muscles of the opposite sides, and extends downward from the pharyngeal spine on the basilar process of the occipital bone. The constrictor muscles are arranged so that the inferior overlaps the middle, and the middle overlaps the superior.

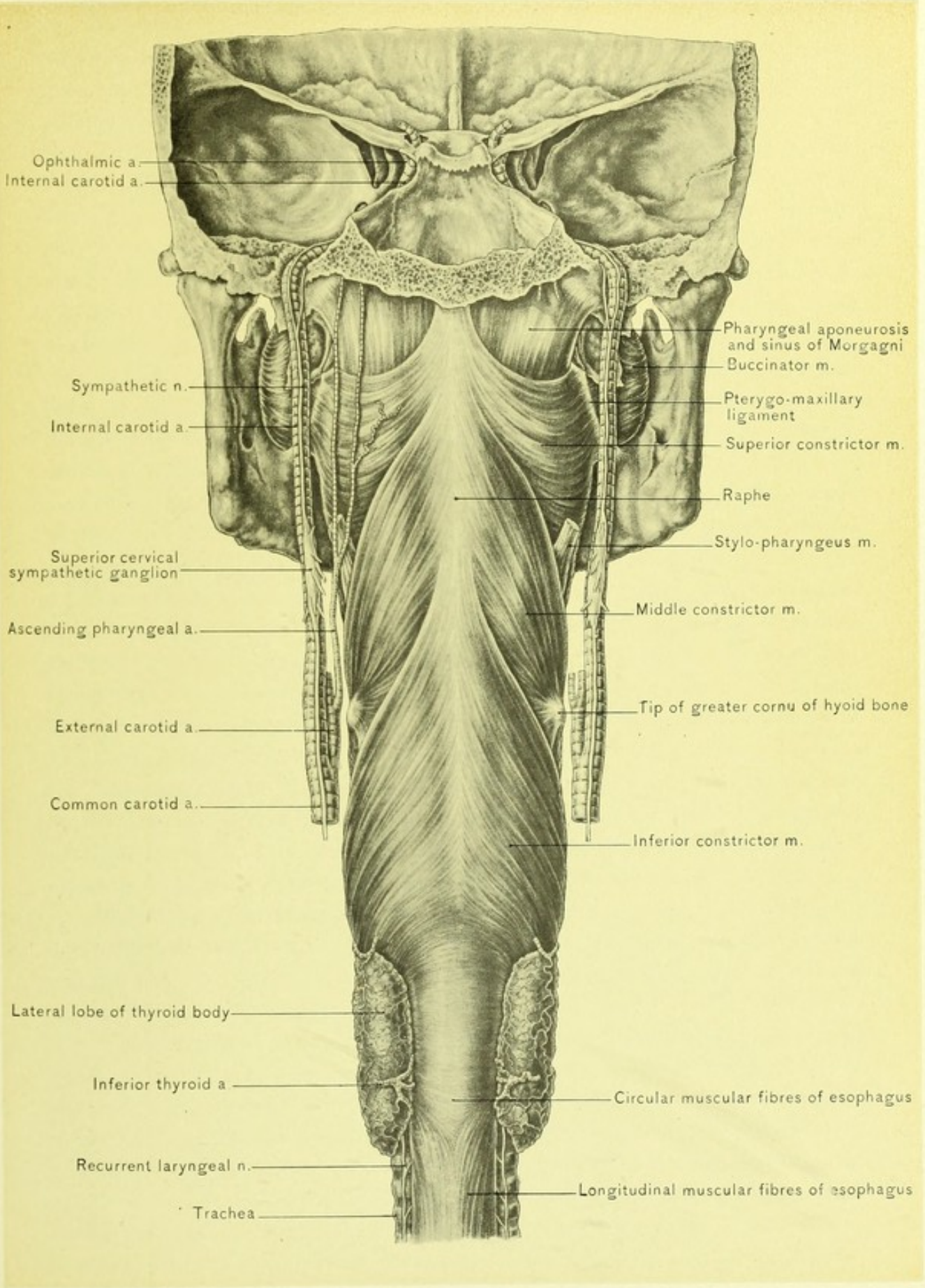
The *inferior constrictor muscle of the pharynx* arises from the posterior part of the side of the cricoid cartilage behind the crico-thyroid muscle, from the inferior cornu, the oblique line, and the superior border of the ala of the thyroid cartilage. Its fibers diverge as they pass backward around the pharynx, to be inserted into the median raphe. The lower fibers are almost horizontal, and are continuous with the muscular coat of the esophagus. The upper fibers ascend obliquely over the lower portion of the middle constrictor muscle, to be inserted into the raphe higher up. Passing beneath or through the lower border of the inferior constrictor muscle at its origin are the recurrent laryngeal nerve and the inferior laryngeal branch of the inferior thyroid artery on their way to the larynx.

The *middle constrictor muscle of the pharynx* has a narrow origin from the stylo-hyoid ligament, the lesser cornu of the hyoid bone, and the entire length of the upper surface of the greater cornu of the hyoid bone. Its fibers diverge as they pass to the back of the pharynx, to reach the median raphe. The lower fibers are almost horizontal, and pass beneath the upper part of the inferior constrictor muscle. The upper fibers pass obliquely upward over the lower part of the superior constrictor muscle, to reach the raphe near the base of the skull. Some of its tendinous fibers continue upward to the pharyngeal spine on the basilar process of the occipital bone.

In the interval between the origins of the middle and inferior constrictor muscles, the *internal laryngeal branch of the superior laryngeal nerve* and the *superior laryngeal artery* pierce the thyro-hyoid membrane. Near the upper margin of the middle constrictor muscle runs the glosso-pharyngeal nerve, and passing beneath that margin is the stylo-pharyngeus muscle. Its origin is covered by the hyo-glossus muscle and the lingual artery, which lies between the hyo-glossus and the middle constrictor muscle.

Dissection.—To expose the origin of the superior constrictor muscle it is necessary to remove the internal pterygoid muscle. In removing the origin of that muscle from the pterygoid fossa preserve the tensor palati muscle, which lies between the internal pterygoid muscle and the internal pterygoid plate.

The *superior constrictor muscle* is a thin, pale, quadrilateral muscle. It arises



CONSTRICTOR MUSCLES OF PHARYNX.

from the lower one-third of the posterior border of the internal pterygoid plate, from the hamular process of that plate, the pterygo-maxillary ligament, the posterior part of the mylo-hyoid ridge of the lower jaw, and the side of the base of the tongue. Its fibers pass backward to be inserted into the median raphe. The lower fibers are overlapped by the middle constrictor muscle. The upper fibers curve upward, and have a tendinous attachment to the pharyngeal spine on the basilar process of the occipital bone. The upper margin is crescentic, and situated some distance from the base of the skull, leaving a semilunar interval—the sinus of Morgagni. The floor of the *sinus of Morgagni* is formed by the pharyngeal aponeurosis. The upper border of the superior constrictor muscle of the pharynx is in relation with the levator palati muscle and the Eustachian tube. The superior constrictor muscle with the pharyngeal aponeurosis separate the ascending pharyngeal and internal carotid arteries from the tonsil.

Nerve Supply.—The constrictor muscles of the pharynx derive their nerve supply from the pharyngeal plexus. The inferior constrictor muscle receives additional branches from the external and recurrent laryngeal nerves.

Tetanus often presents its first symptom as spasm of those muscles of mastication which elevate the lower jaw,—viz., the masseter, temporal and internal pterygoid muscles,—and of the constrictor muscles of the pharynx. Consequently, the patient can not open the mouth, and deglutition, or swallowing, is difficult or causes choking sensations. Spasm of the constrictor muscles of the pharynx and difficult deglutition are also prominent symptoms of hydrophobia.

The **Pharyngeal Plexus of Nerves** is found chiefly upon the middle constrictor muscle. It is formed by the pharyngeal branches of the pneumogastric, external laryngeal, and glosso-pharyngeal nerves, and of the superior cervical sympathetic ganglion. It supplies the muscular and other coats of the pharynx.

The **Pterygo-maxillary Ligament** is a fibrous raphe between the buccinator and superior constrictor muscles, and extends from the lower extremity of the internal pterygoid plate to the posterior end of the mylo-hyoid ridge or internal oblique line of the lower jaw.

The **Pharyngeal Aponeurosis,** the fibrous coat of the pharynx, is dense and strong where the muscular coat is absent,—viz., at the sinuses of Morgagni and in the triangular intervals between the origins of the constrictor muscles,—and becomes delicate and fades away below. It holds the pharynx open by means of its attachment to the basilar process of the occipital bone, the cartilages in the middle lacerated foramina, the apices of the petrous portions of the temporal bones, the posterior borders of the internal pterygoid plates, the greater cornua of the hyoid bone, and the posterior borders of the alæ of the thyroid cartilage.

The **Mucous Coat,** or mucous membrane, lining the pharynx is continuous with that of the Eustachian tubes, nasal cavities, mouth, larynx, and esophagus. It contains racemose mucous glands and scattered lymphoid follicles. Because of its vascularity, **inflammation of this membrane,** which is known as pharyngitis or sore throat, frequently occurs. Through the continuity of the mucous membrane of the nose and larynx the catarrhal process may extend to the mucous membrane of those cavities.

Dissection.—Divide the posterior wall of the pharynx in the median line, and detach it from the base of the skull as far as the lateral wall. Then turn the two flaps outward, to study the interior of the pharynx.

Beneath the petrous portion of the temporal bone the cavity of the pharynx extends outward, forming a pouch—the *pharyngeal recess.*

The **Pharyngeal Tonsil of Luschka** is a collection of lymphoid tissue in the posterior wall of the pharynx, near its junction with the roof.

The **Pharyngeal Bursa** is a small diverticulum in the posterior wall of the pharynx, below the occipital bone; it is most conspicuous in the fetus and in infants.

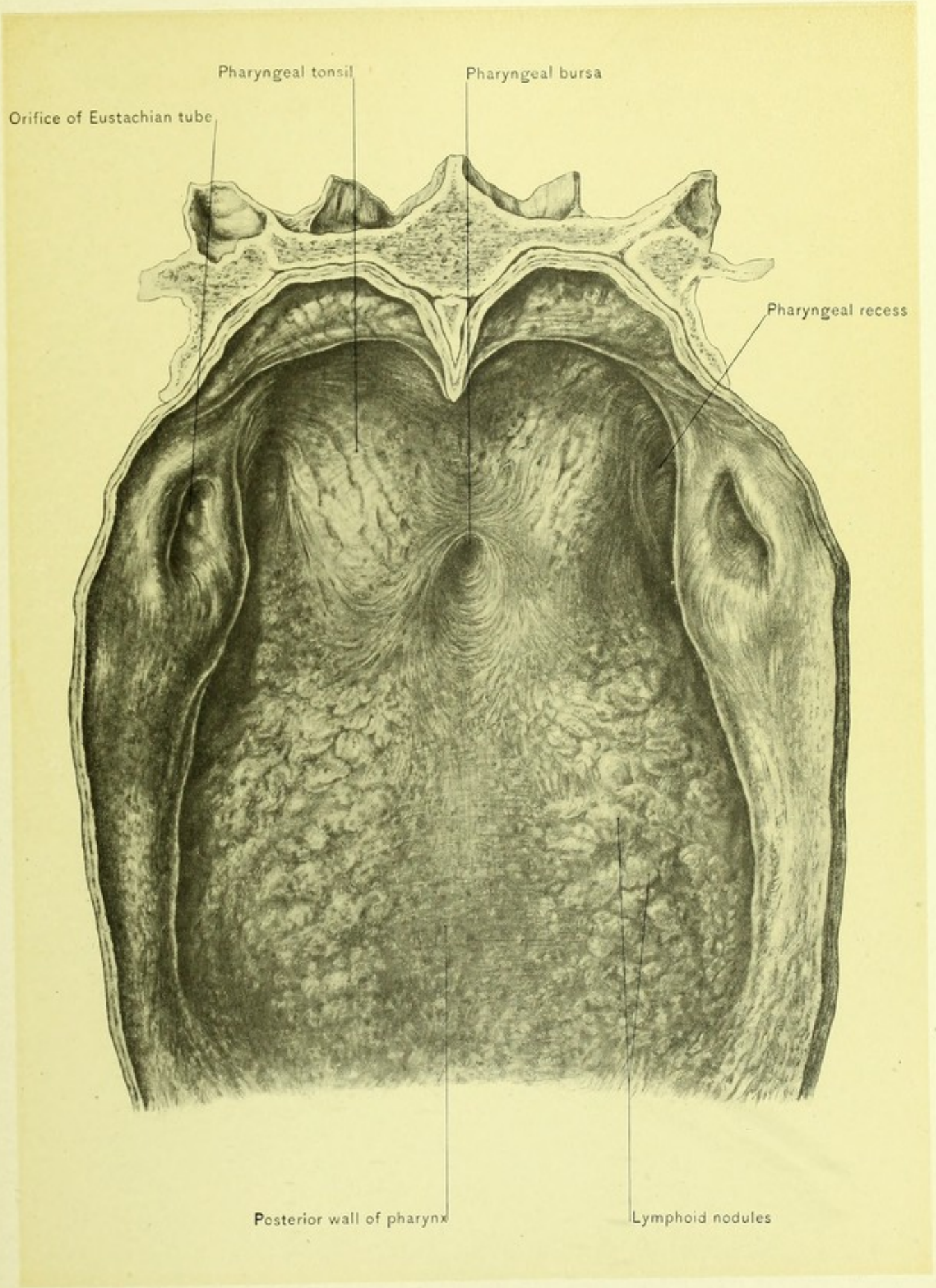
Hypertrophy of the Pharyngeal Tonsil is the source of adenoid growths in the naso-pharynx. Obstruction of the posterior nares, loss of nasal resonance in the voice, and mouth breathing result. Extension of the hypertrophic process into the Eustachian tubes causes obstruction of those tubes, tinnitus aurium, or peculiar sounds in the ears, and deafness.

Post-pharyngeal Abscess, usually resulting from caries of the upper cervical vertebræ or suppuration of the post-pharyngeal lymphatic gland, may bulge into the pharynx and cause difficulty in deglutition or respiration. Post-pharyngeal abscesses, and those arising in the pterygo-maxillary region and temporal fossa, may rupture into the pharynx.

There are seven **Openings** into the pharynx: The two posterior nares, two Eustachian tubes, mouth, larynx, and esophagus.

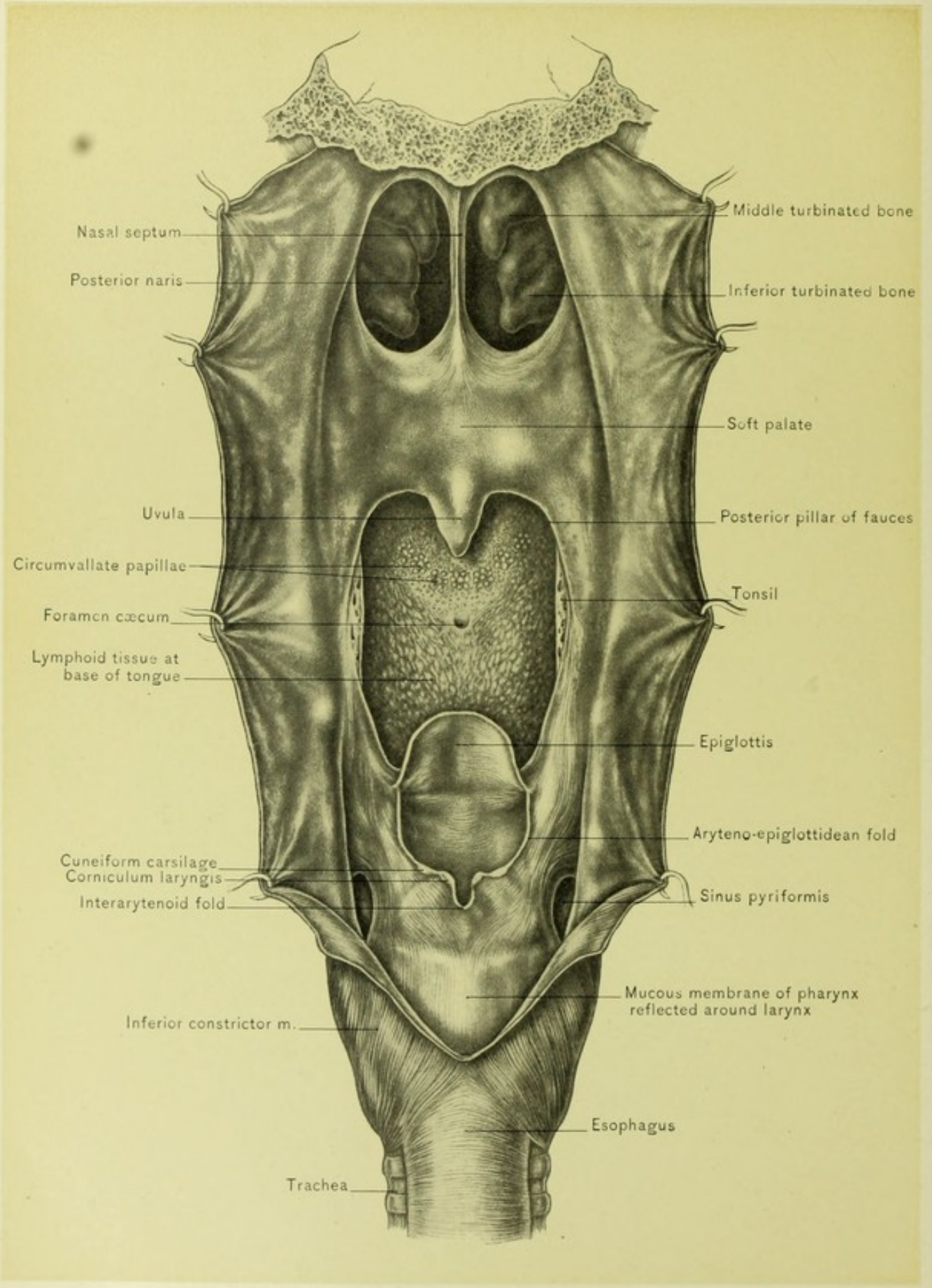
The two **posterior nares** (choanæ) are at the highest point of the anterior wall of the pharynx. They are separated from each other by the posterior margin of the septum of the nose. Through them can be seen the middle and inferior turbinated bones. When a mirror is placed immediately behind the soft palate, the superior turbinated bones can also be seen.

The trumpet-shaped orifices of the **Eustachian tubes** are in the lateral walls of the pharynx, at about the level of the inferior turbinated bones. It should be noticed that a Eustachian catheter carried through the inferior meatus to the posterior wall of the pharynx, rotated outward, and drawn forward along the lateral wall of the pharynx until it passes over the elevation at the posterior mar-



PHARYNGEAL TONSIL AND BURSA.

PLATE CCIV.



INTERIOR OF PHARYNX.

gin of the Eustachian orifice, will readily slip into the Eustachian tube when pushed backward again. From their orifices the Eustachian tubes are directed backward, outward, and slightly upward, opening into the tympanic cavity at its anterior wall. The inner portion of the Eustachian tube is cartilaginous on the upper and inner sides, and fibrous below. The outer portion of the Eustachian tube has bony walls, and begins in the receding angle between the squamous and petrous portions of the temporal bone.

The **isthmus of the fauces,** or posterior opening of the mouth, is situated immediately below the posterior nares and soft palate. Through the isthmus some of the structures of the mouth can be examined from behind. The pillars of the fauces, the tonsils, situated in the recesses of the fauces, and the base of the tongue are more satisfactorily seen through the isthmus of the fauces than through the buccal orifice. The base of the tongue holds a vertical position, and overhangs the epiglottis. Between the tongue and the epiglottis are the three glosso-epiglottidean folds and the two glosso-epiglottidean pouches.

The **superior aperture of the larynx** is situated below the base of the tongue. It is a large, triangular-shaped opening, its wider portion being directed forward. It slopes obliquely downward and backward from the upper extremity of the epiglottis. It is bounded in front by the epiglottis, behind by the interarytenoid fold of mucous membrane, and on each side by the aryteno-epiglottidean fold and the tips of the arytenoid cartilages. On each side of its posterior portion there is a deep depression, the *sinus pyriformis*, in which foreign bodies may lodge.

The **esophageal opening of the pharynx** is the narrowest portion of the pharynx, and is located behind the lower border of the cricoid cartilage.

Relations of the Pharynx.—In front of the pharynx are the posterior nares, the soft palate, the isthmus of the fauces, the base of the tongue, the hyoid bone, and the larynx. Behind it are the prevertebral fascia, the post-pharyngeal lymphatic gland, the rectus capitis anticus major and longus colli muscles, and the bodies of the upper vertebræ. Laterally, its upper portion is in relation with the Eustachian tube, the inferior maxillary nerve, the styloid process of the temporal bone, the muscles arising from that process, the internal pterygoid muscles, the parotid gland, the glosso-pharyngeal, pneumogastric, spinal accessory, hypo-glossal, and sympathetic nerves, ascending pharyngeal, and internal carotid arteries, and internal jugular vein ; its lower portion is in relation laterally with the carotid sheath and its contents, the lower part of the external carotid artery, the commencement of the superior thyroid, lingual, and facial arteries, the lateral lobe of the thyroid body, the sterno-thyroid muscle, and the deep cervical chain of lymphatic glands. Above the pharynx is that portion of the base of the skull formed by the body of

the sphenoid bone and the basilar process of the occipital bone. Below, it leads into the esophagus.

While studying the relations of the pharynx, it is well to observe some important facts associated therewith. The body of the sphenoid bone and the basilar process of the occipital bone and the upper three cervical vertebræ can be palpated with the finger inserted into the pharynx. The anterior arch of the atlas is in the same transverse plane as the hard palate; the body of the axis is in the same transverse plane as the cutting edges of the upper teeth; and the body of the third cervical vertebra is just below that of the axis. In *necrosis* of the body of the sphenoid bone, basilar process of the occipital bone, anterior arch of the atlas, and bodies of the upper cervical vertebræ, pus and pieces of bone may be discharged through the pharynx and mouth. *Sharp foreign bodies* which have perforated the wall of the pharynx may wound one of the carotid arteries or the internal jugular vein.

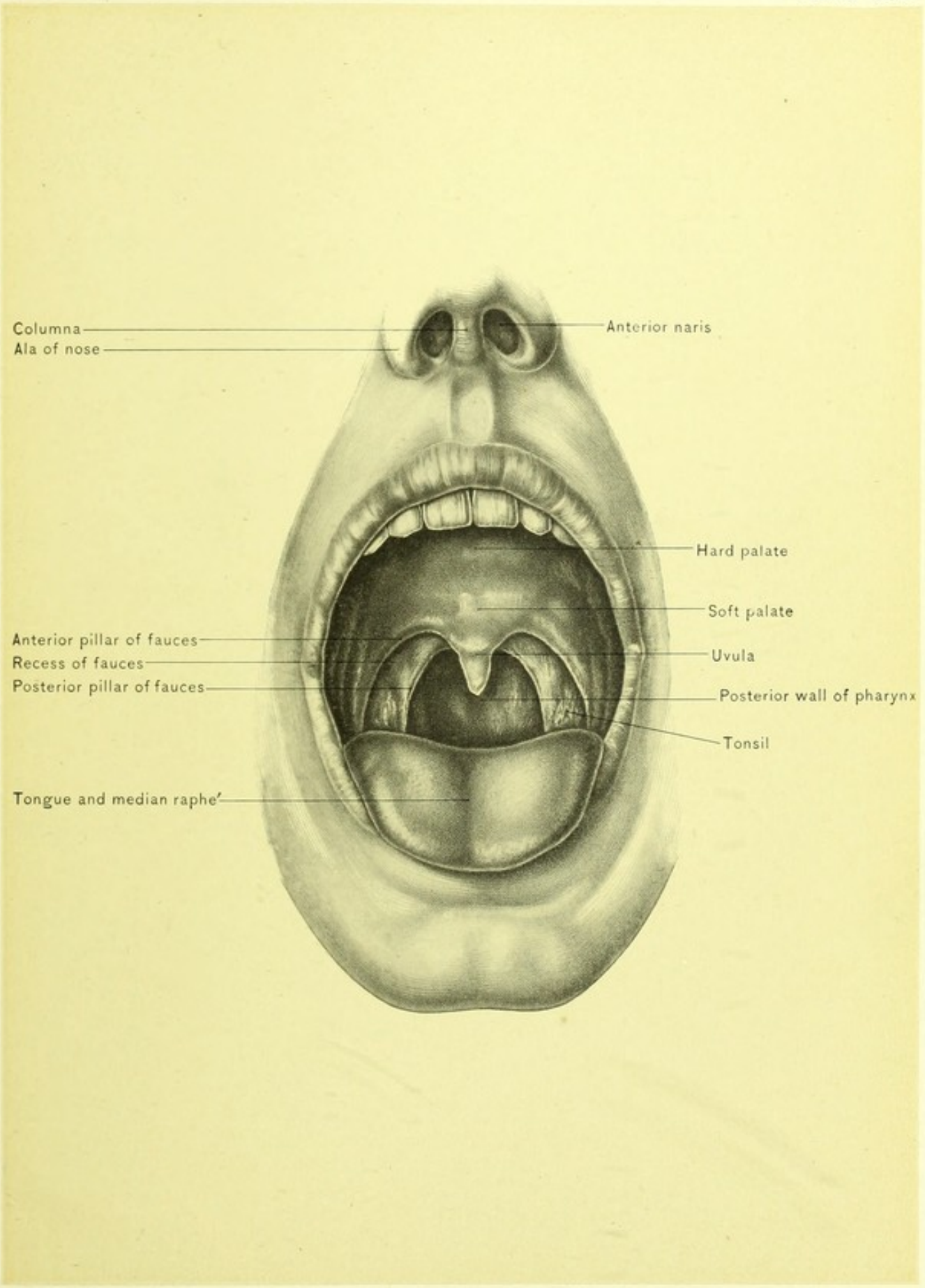
Blood Supply.—From the ascending pharyngeal artery, the tonsillar and ascending palatine branches of the facial artery, the superior laryngeal branch of the superior thyroid artery, and the inferior laryngeal branch of the inferior thyroid artery.

Nerve Supply.—From the pharyngeal plexus of nerves.

The **Veins of the Pharynx** are arranged as a plexus which is situated between the constrictor muscles and the prevertebral fascia. This plexus communicates above with the pterygoid plexus of veins, and empties into the terminal portion of the facial vein or into the internal jugular vein.

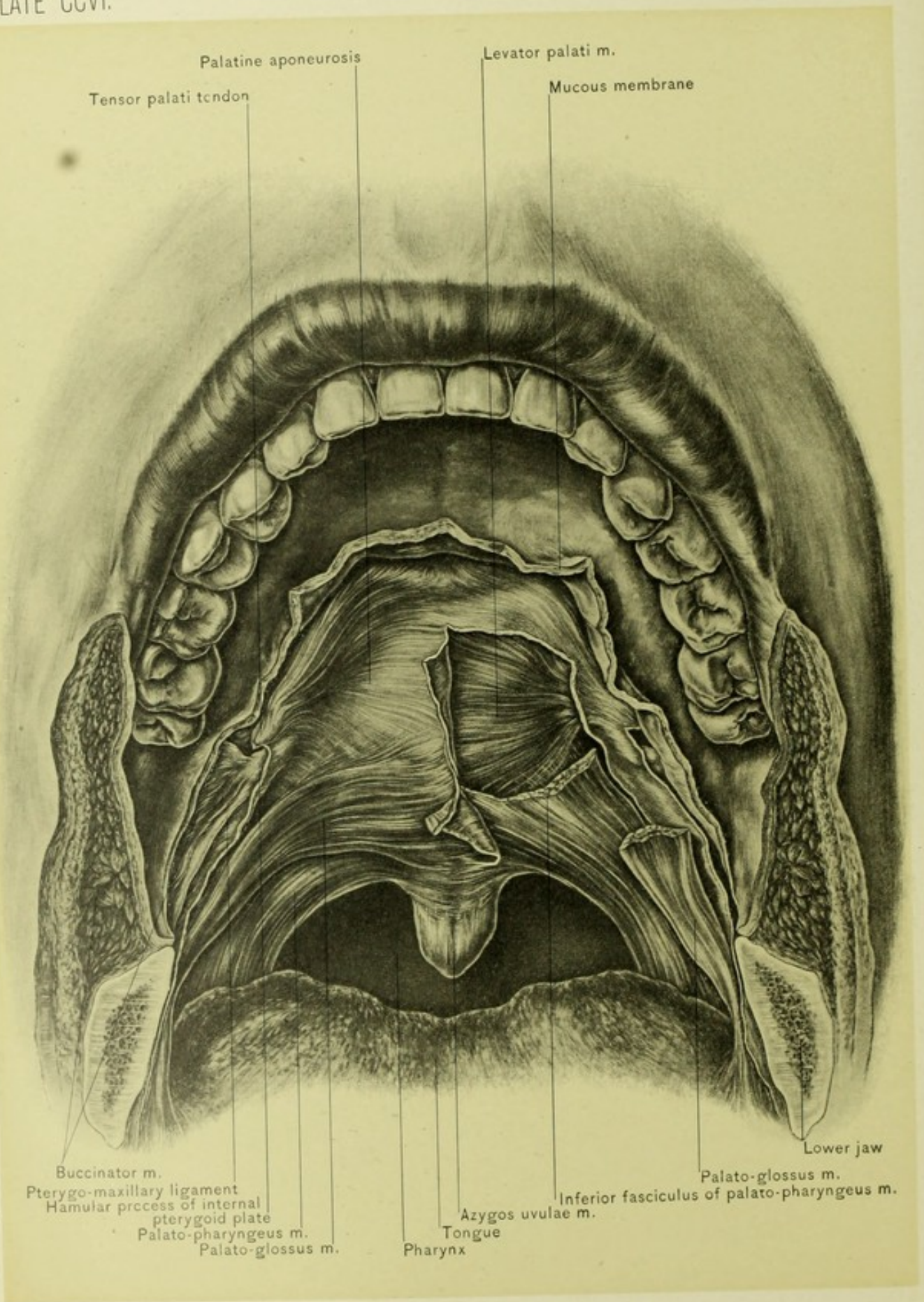
The **Lymphatic Vessels of the Upper Portion of the Pharynx** terminate in the post-pharyngeal gland; those of the middle portion, in the superior deep cervical glands; and those of the lower portion, in the inferior deep cervical lymphatic glands.

The **Soft Palate** is a musculo-membranous and freely movable curtain. Its anterior margin is attached to the posterior border of the hard palate; its posterior margin is free, and forms the upper boundary of the isthmus of the fauces. From the center of this curved margin the **uvula** is suspended. The lateral margins are attached to the side of the pharynx. Its upper surface is convex; its lower, concave. The mucous membrane on the upper surface is continuous with that of the floor of the nasal cavities, and the mucous membrane of its lower surface with that of the roof of the mouth. Between its two layers of mucous membrane are the two levatores palati, two tensores palati, the palato-pharyngeus, palato-glossus, and azygos uvulæ muscles, an aponeurosis, glandular tissue, vessels, and nerves. The under surface of the soft palate contains a prominence a short distance behind the last molar tooth. This elevation is produced by the hamular process of the in-

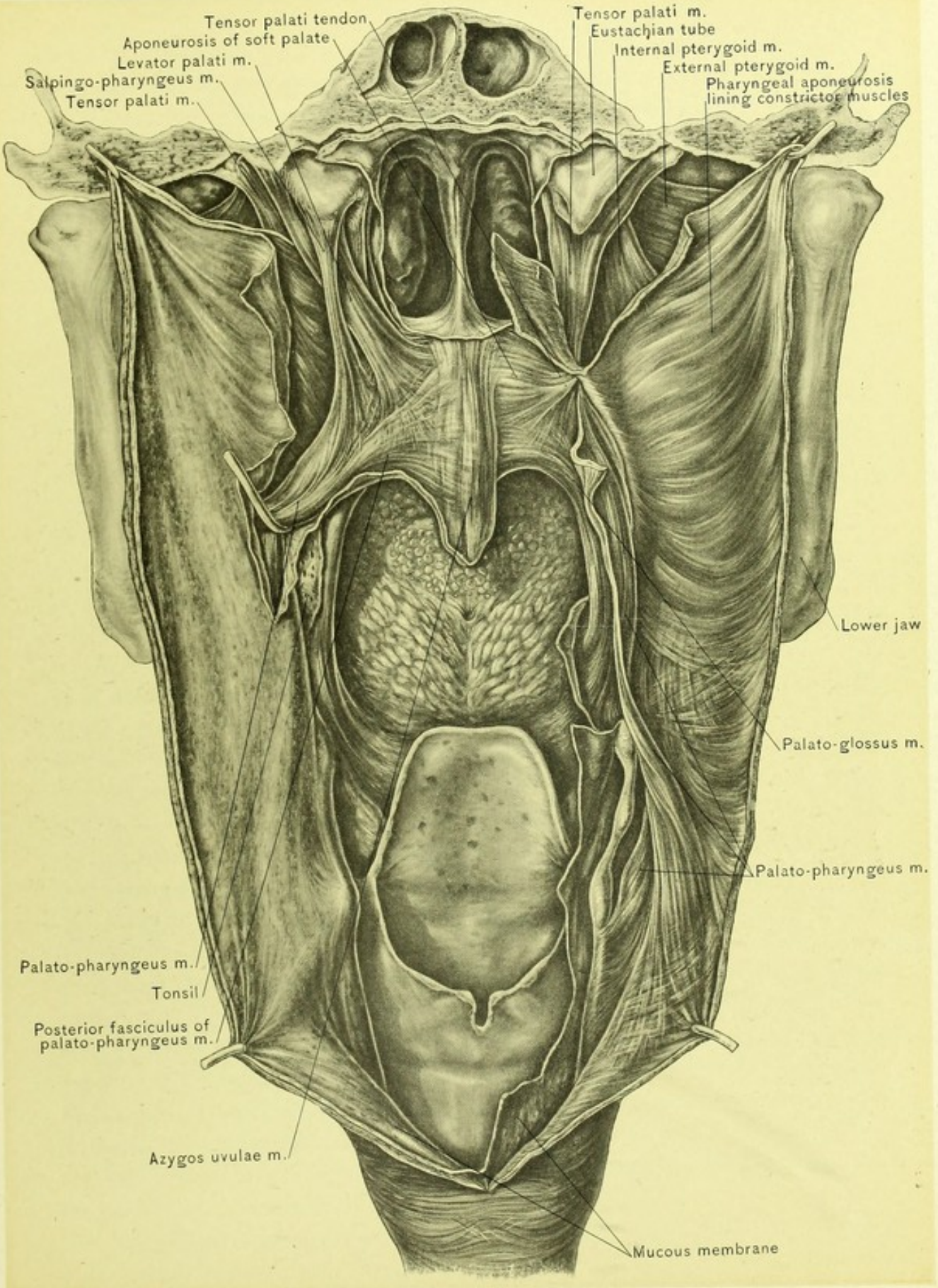


ANTERIOR VIEW OF MOUTH.

PLATE CCVI.



MUSCLES OF SOFT PALATE—ANTERIOR VIEW.



MUSCLES OF SOFT PALATE.

ternal pterygoid plate of the sphenoid bone, which is the guide in dividing the aponeuroses of the tensor palati and levator palati muscles.

Dissection.—Make the tissues tense by means of hooks, and reflect the mucous membrane from both surfaces of the soft palate and from the pillars of the fauces. Remove the mucous membrane and pharyngeal aponeurosis from the upper portion of the side of the pharynx, in order to fully expose the levatores and tensores palati muscles, which have been seen during the dissection of the superior constrictor muscle of the pharynx.

The **Levator Palati Muscle** arises from the under surface of the petrous portion of the temporal bone, in front of the carotid canal and from the under and inner surfaces of the cartilaginous portion of the Eustachian tube. It passes internal to the upper margin of the superior constrictor muscle of the pharynx, to reach the inner surface of that muscle, and is inserted into the palatine aponeurosis and into its fellow of the opposite side, in front of the azygos uvulæ muscle.

Action.—It elevates the soft palate and brings it into contact with the posterior wall of the pharynx, so as to separate the naso-pharynx from the oro-pharynx and prevent regurgitation of food from the oro-pharynx into the naso-pharynx and nasal cavities.

The **Tensor Palati Muscle** arises from the scaphoid fossa, which is situated behind the base of the internal pterygoid plate, from the spine of the sphenoid bone, and the outer side of the cartilaginous portion of the Eustachian tube. It is a flat muscle, which lies on the outer surface of the internal pterygoid plate and terminates in a tendon which winds around the hamular process of that plate. The tendon forms almost a right angle with the muscle, and is inserted into the palatine aponeurosis, with which it is continuous, and into the transverse ridge on the under surface of the horizontal plate of the palate bone. A bursa facilitates the movement of the tendon over the hamular process.

Action.—It renders the soft palate tense and opens the Eustachian tube during deglutition.

The **Palato-pharyngeus Muscle** is situated in the posterior pillar of the fauces. It arises from the soft palate by two slips, which are separated by the levator palati and azygos uvulæ muscles and are continuous with the corresponding slips of the opposite muscle, and also has an origin from the cartilage of the Eustachian tube (salpingo-pharyngeus). It passes to the side of the pharynx and joins the stylo-pharyngeus muscle, to be inserted into the posterior border of the thyroid cartilage below the base of the superior cornu, and by an expansion into the pharyngeal aponeurosis.

Action.—It elevates the pharynx and larynx and approximates the posterior pillars of the fauces.

The **Palato-glossus Muscle** is found in the anterior pillar of the fauces. It arises from the under surface of the palatine aponeurosis, and is partly continuous with the palato-glossus muscle of the opposite side in front of the azygos uvulæ muscle. It is inserted into the side of the tongue, and is partly continuous with the transverse muscular fibers of that organ.

Action.—It draws the side of the soft palate downward, and elevates the sides and back part of the tongue, thus constricting the isthmus of the fauces to prevent the morsel of food from being driven back into the mouth in deglutition.

The **Azygos Uvulæ Muscle** is a double muscle, and arises from the palatine aponeurosis and the posterior nasal spine on the horizontal plate of the palate bone, and is inserted into the mucous membrane of the uvula.

Action.—It elevates and shortens the uvula.

The **Palatine Aponeurosis** is a thin but dense fibrous membrane, which is attached to the posterior margin of the hard palate and gradually disappears as it approaches the posterior or free border of the soft palate. Laterally, it is continuous with the pharyngeal aponeurosis. It receives the tendinous expansion of the tensor palati muscle, and gives form to the soft palate.

The glandular tissue of the soft palate is most abundant in its upper surface, although there is some adenoid tissue in its under surface.

Blood Supply.—From the dorsalis linguæ and the ascending pharyngeal artery, the ascending palatine branch of the facial artery, and the posterior palatine branch of the internal maxillary artery.

The *veins* correspond to the arteries. The *lymphatics* empty into the glands at the angle of the jaw.

Nerve Supply.—From Meckel's ganglion, the glosso-pharyngeal nerve, the pharyngeal plexus of nerves, and the otic ganglion. The tensor palati muscle is supplied by a branch from the otic ganglion. The levator palati, palato-glossus, palato-pharyngeus, and azygos uvulæ muscles are probably supplied by branches from the pharyngeal plexus, which are derived from the spinal accessory nerve.

Clefts of the Soft Palate may exist independently of clefts of the hard palate. They are widened by the tensor palati, levator palati, palato-glossus, and palato-pharyngeus muscles. These clefts give rise to difficulty in deglutition, because they allow food to pass into the naso-pharynx and nose. Before closing the cleft, the aponeuroses of these muscles are divided to prevent them from causing tension upon the sutures. The aponeuroses of the tensor palati and levator palati muscles may be divided by one incision. A slender bistoury, with its cutting edge directed forward and upward, is inserted into the soft palate slightly in front of and close to the inner side of the hamular process of the internal pterygoid plate of the sphenoid bone, until it projects through the superior surface

of the soft palate. As the knife is pushed upward it cuts the tensor palati aponeurosis. The bistoury is then carried upward, forward, and inward, cutting the superior surface of the soft palate for a distance sufficient to allow severance of the levator palati aponeurosis. The palato-glossus and palato-pharyngeus muscles can be divided by a shallow incision across each of the pillars of the fauces. The attachment of the palatine aponeurosis to the posterior margin of the hard palate may also cause difficulty in approximating the freshened margins of the cleft, and should be divided as far as necessary. The success of the operation depends chiefly upon the relief of tension upon the sutures.

Paralysis of the Muscles of the Soft Palate and Pharynx may occur during convalescence from diphtheria. As a result, there is difficulty in swallowing and regurgitation of food through the nose.

THE LARYNX.

The **larynx** is a membrano-cartilaginous, box-like organ. It is the organ of voice, assists in protecting the respiratory tract from the entrance of foreign bodies during deglutition, and closes the respiratory tract, so that the chest can be made firm during great muscular effort. It is situated at the upper portion of the respiratory tract, above the trachea and in front of the lower portion of the pharynx. Anteriorly, it is covered by skin, superficial and deep fasciæ, two thin layers of muscular tissue, and, occasionally, a process of the middle lobe of the thyroid gland. The superficial stratum of muscular tissue is composed of the sterno-hyoid and omo-hyoid muscles; the deep stratum, of the sterno-thyroid and thyro-hyoid muscles. The great vessels lie on each side of the larynx in the groove between the larynx and the sterno-mastoid muscle. It is suspended from the skull by the stylo-hyoid ligament, the muscles attached to the superior surface of the hyoid bone, and the stylo-pharyngeus and palato-pharyngeus muscles, which are inserted into the posterior borders of the alæ of the thyroid cartilage. It is lined internally by mucous membrane which is continuous above with that lining the pharynx, and below with that of the trachea. It consists of three single cartilages and three pairs of cartilages united by membranes, ligaments, and muscles. The three single cartilages are the thyroid, cricoid, and epiglottis; the paired ones are the arytenoid, cornicula laryngis, and cuneiform. The larynx is larger in all its dimensions in the male than in the female.

The **Superior Aperture of the Larynx** inclines obliquely downward and backward. It is bounded in front by the epiglottis; behind, by the interarytenoid

fold of mucous membrane; and at the sides, by the aryteno-epiglottidean folds and the tips of the arytenoid cartilages.

The **aryteno-epiglottidean folds** extend from the sides of the epiglottis to the summits of the arytenoid cartilages. They are composed of two layers of mucous membrane, between which are a supporting layer of connective tissue; the corniculla laryngis, which rest upon the summits of the arytenoid cartilages; the cuneiform cartilages, which lie in front of the arytenoid cartilages; and the aryteno-epiglottidean muscles. In viewing the larynx from above, the corniculum laryngis and cuneiform cartilage appear as two small swellings in the aryteno-epiglottidean fold. In these folds there is much loose submucous tissue, which is the chief site of the swelling in edema of the larynx. This swelling may be so extensive as to interfere seriously with the entrance of air into the larynx, and laryngotomy, tracheotomy, or intubation may become necessary.

The **sinus pyriformis,** which is between the aryteno-epiglottidean fold and the ala of the thyroid cartilage, the **three glosso-epiglottidean** folds, and the **valleculæ,** between the epiglottis and the base of the tongue, have been previously described.

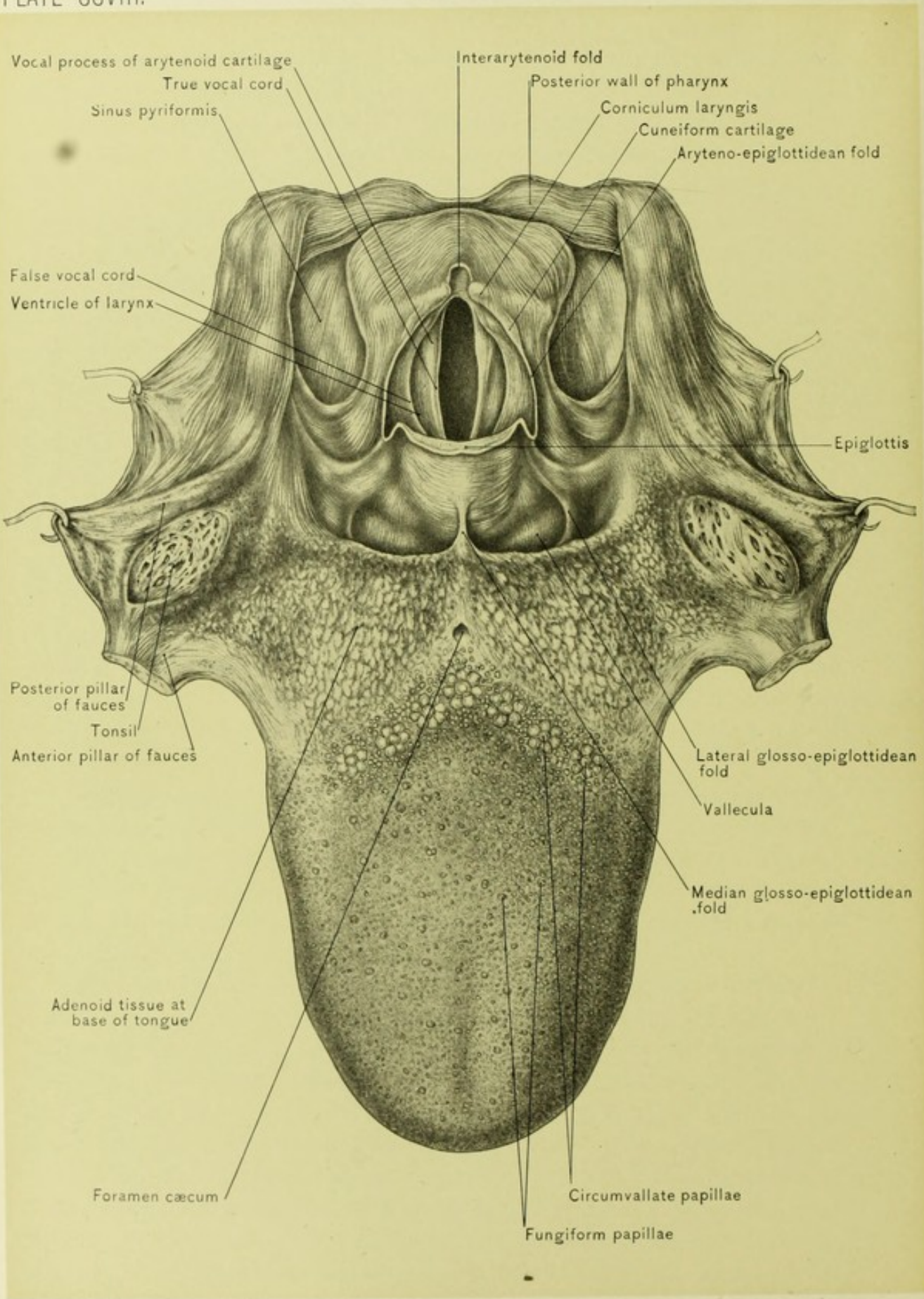
Two pairs of folds may be seen stretching across the cavity of the larynx. The upper pair is formed by the **false vocal cords,** and the lower pair by the **true cords,** which are more closely approximated. A depression—the **ventricle** of the larynx—exists between the true and false cords. The interval between the true vocal cords is the chink of the glottis, or **rima glottidis.** The true vocal cords divide the larynx into a supra-rimal and an infra-rimal portion.

The **Supra-rimal Portion** of the larynx extends from the superior aperture to the true vocal cords. It is wide and triangular above, and becomes narrow below.

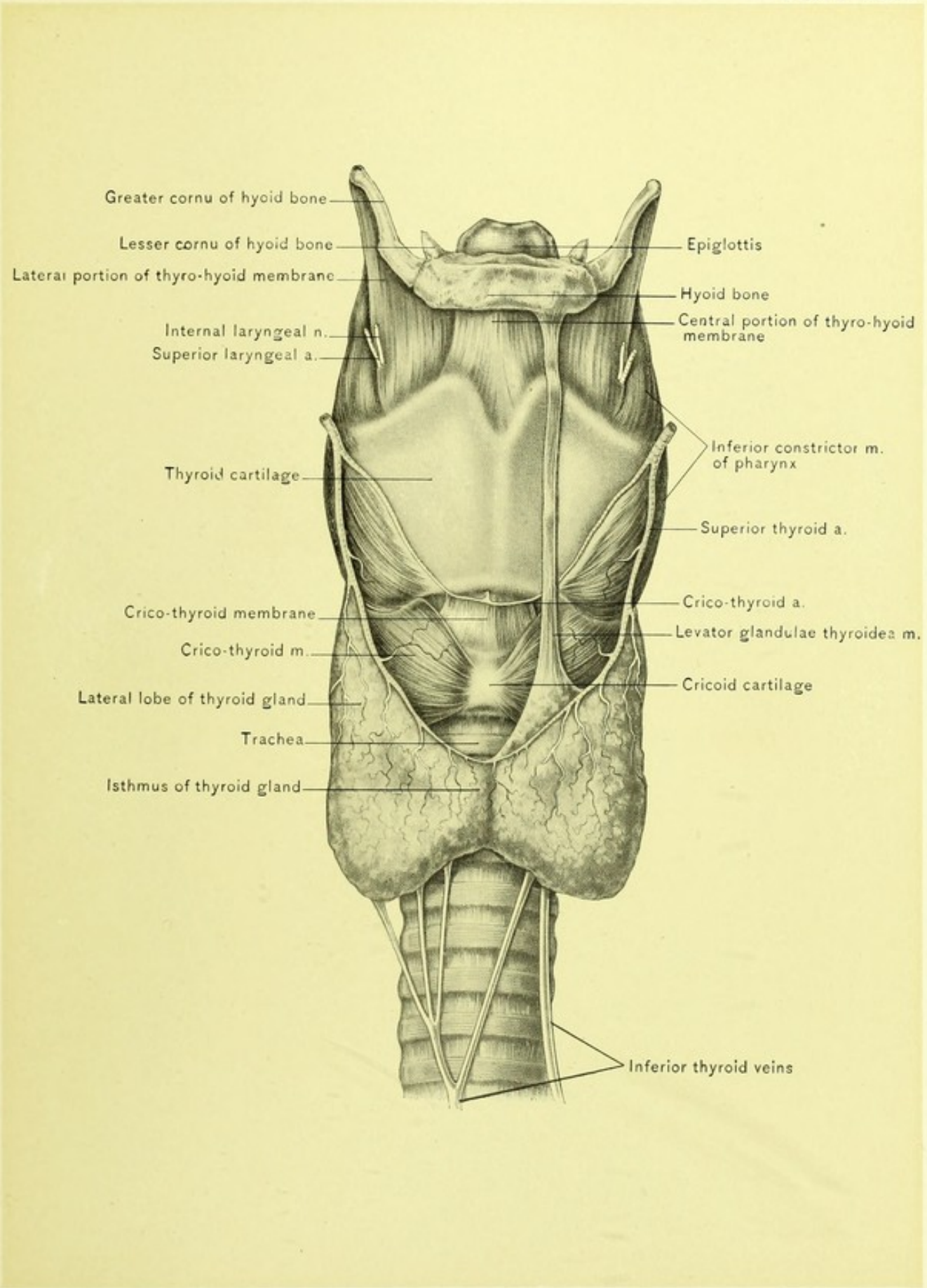
The **Infra-rimal Portion** is compressed laterally above, and becomes circular below, where it is surrounded by the cricoid cartilage and leads into the trachea. In laryngotomy the knife enters this portion of the larynx and is directed downward and backward to avoid the vocal cords.

Dissection.—Clean the anterior portion of the external surface of the larynx, entirely removing the attachments of the sterno-hyoid, omo-hyoid, and thyro-hyoid muscles from the hyoid bone, those of the thyro-hyoid and sterno-thyroid muscles from the thyroid cartilage, and the attachments of the inferior constrictor muscles of the pharynx from the thyroid and cricoid cartilages. Avoid injuring the superior laryngeal artery and the internal branch of the superior laryngeal nerve, which pierce the thyro-hyoid membrane; the external laryngeal nerve, which supplies the inferior constrictor and the crico-thyroid muscle; the crico-thyroid artery, which crosses the crico-thyroid membrane; and the recurrent laryngeal nerve and inferior laryngeal artery, which pass to the larynx behind

PLATE CCVIII.

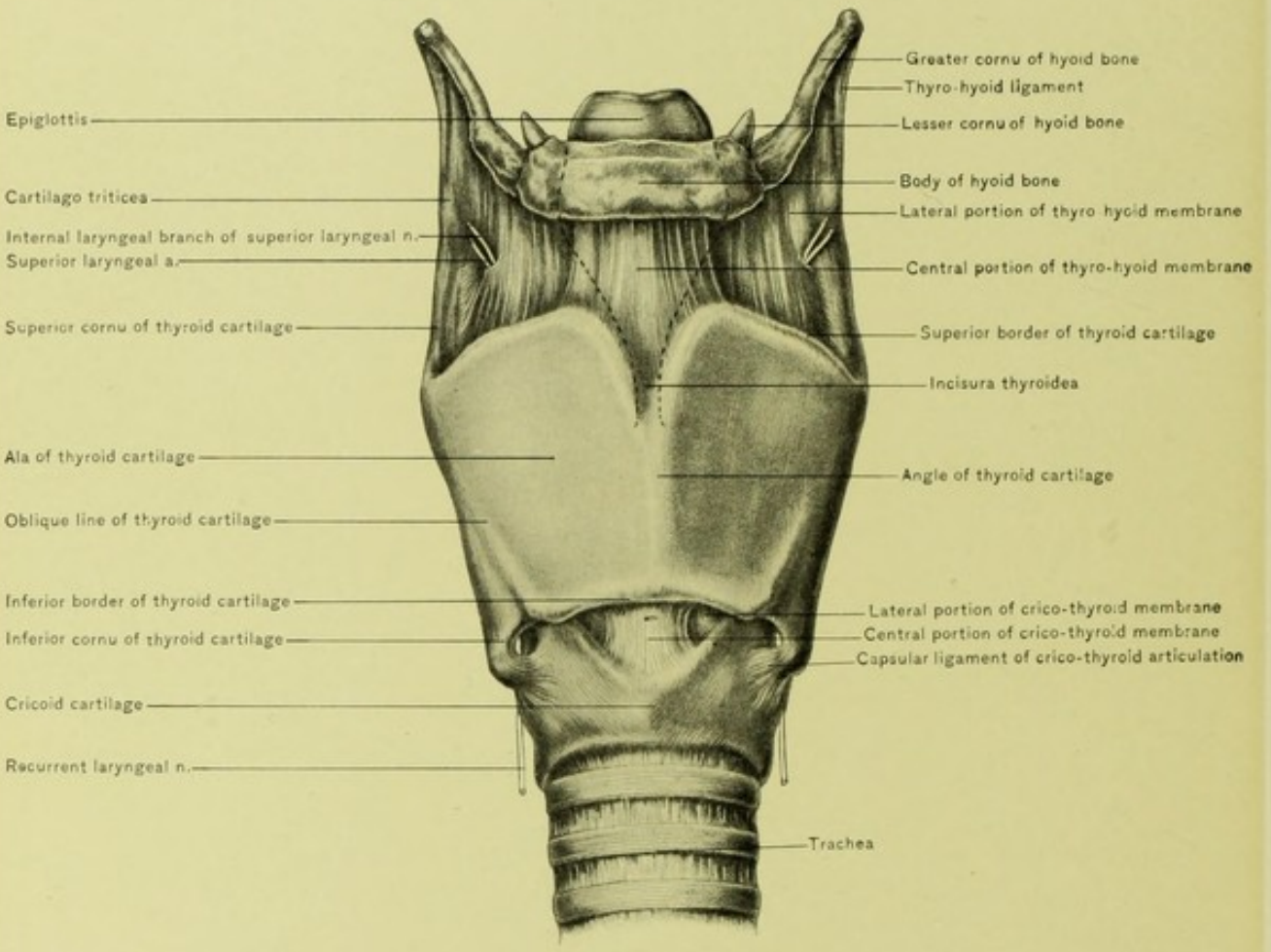


SUPERIOR APERTURE OF LARYNX.



LARYNX AND CRICO-THYROID MUSCLE.

PLATE CCX.



ANTERIOR VIEW OF LARYNX, INCLUDING CRICO-THYROID MEMBRANES.

the crico-thyroid articulation. This dissection more thoroughly exposes the thyro-hyoid membrane, thyroid cartilage, crico-thyroid muscles, crico-thyroid membrane, and cricoid cartilage.

The **Thyro-hyoid Membrane,** which is largely composed of elastic fibers, extends from the upper border of the thyroid cartilage to the posterior superior border of the hyoid bone. Its central portion is thick and strong, and its lateral portions are thin and pierced by the superior laryngeal arteries and internal laryngeal nerves on their way to the interior of the larynx. The *thyro-hyoid bursa* intervenes between the thyro-hyoid membrane and the posterior surface of the hyoid bone, and may be enlarged and produce a cystic tumor and swelling in the median line of the neck. Laterally, the thyro-hyoid membrane is continuous with the thyro-hyoid ligaments. Behind the thyro-hyoid membrane lies the epiglottis, from which it is separated by a small amount of loose areolar tissue.

The **Thyro-hyoid Ligaments** are elastic bands connecting the superior cornua of the thyroid cartilage with the tips of the greater cornua of the hyoid bone. They frequently contain a nodule of cartilage (*cartilago triticea*), which may be ossified.

The **thyroid and cricoid cartilages** will be described later.

The **Crico-thyroid Muscle** arises from the anterior portion of the side of the cricoid cartilage, and is inserted into the anterior border of the inferior cornu and the outer surface of the lower border of the ala of the thyroid cartilage. Its upper fibers pass obliquely upward and backward, and its lower fibers horizontally backward. At its insertion it blends with the origin of the inferior constrictor muscle of the pharynx. It rests upon the cricoid cartilage and lateral portion of the crico-thyroid membrane. In the interval between the two crico-thyroid muscles the central portion of the crico-thyroid membrane is seen.

Nerve Supply.—From the external laryngeal branch of the superior laryngeal nerve.

Action.—It depresses the anterior portion of the thyroid cartilage, thus making the vocal cords tense.

Dissection.—Remove the crico-thyroid muscle on one side, in order to more fully expose the crico-thyroid membrane.

The **Crico-thyroid Membrane** is chiefly composed of elastic fibers. It is divided into a central and two lateral portions, which are lined by the mucous membrane of the larynx. The **central portion** is thicker and stronger than the lateral portions, and extends from the middle of the upper border of the anterior portion of the cricoid cartilage to the corresponding portion of the lower border of the thyroid cartilage. Near the lower border of the thyroid cartilage it is crossed by the anastomosing crico-thyroid branches of the superior thyroid arteries, and is

pierced by one or two branches of the arch formed by the crico-thyroid arteries. It lies immediately beneath the interval between the two sterno-hyoid muscles and between the two sterno-thyroid muscles, and may be seen in the triangular interval between the inner margins of the crico-thyroid muscles. Laryngotomy is performed through the lower border of this portion of the membrane.

The **lateral portions** of the membrane are thin, and pass upward from the inner margin of the upper border of the cricoid cartilage to become continuous with the true vocal cords. The lateral portions of the crico-thyroid membrane are covered by the crico-thyroid, lateral crico-arytenoid, and thyro-arytenoid muscles.

Dissection.—Place the larynx, with the anterior aspect down, upon a board, and fasten it in that position with pins or tacks. Carefully remove the pharyngeal mucous membrane from its posterior aspect, preserving the recurrent laryngeal nerve and the inferior laryngeal artery, which is a branch of the inferior thyroid artery. Then remove the mucous membrane from the external surface of the aryteno-epiglottidean fold and the portion of the thyroid cartilage bounding the sinus pyriformis. Next cut through the crico-thyroid articulation on one side, and divide the ala of the thyroid cartilage about one-fourth of an inch to the same side of the angle of that cartilage. This dissection requires care to avoid injuring the underlying muscles, vocal cords, lateral portion of the crico-thyroid membrane, the superior laryngeal artery, the internal laryngeal nerve, and the terminal portion of the recurrent laryngeal nerve and inferior laryngeal artery.

The **Crico-arytenoideus Posticus Muscle** arises from the surface at the side of the posterior median ridge of the cricoid cartilage. It is inserted into the posterior portion of the external angle (muscular process) of the arytenoid cartilage. Its upper fibers pass transversely outward; its middle fibers, obliquely upward and outward, and its lower fibers, vertically upward.

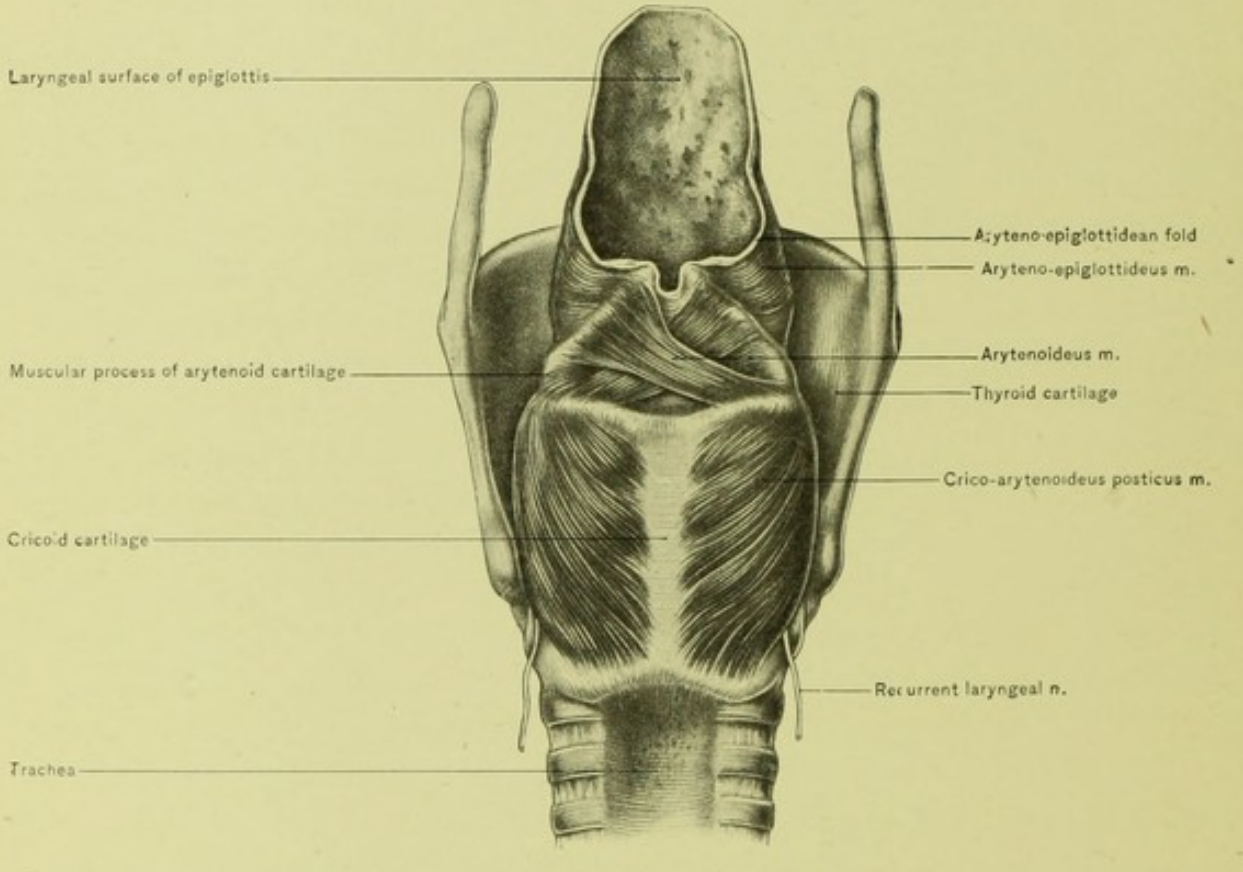
Nerve Supply.—From the recurrent laryngeal nerve.

Action.—It rotates the arytenoid cartilage, and opens the rima glottidis, and its vertical fibers produce the gliding motion of that cartilage.

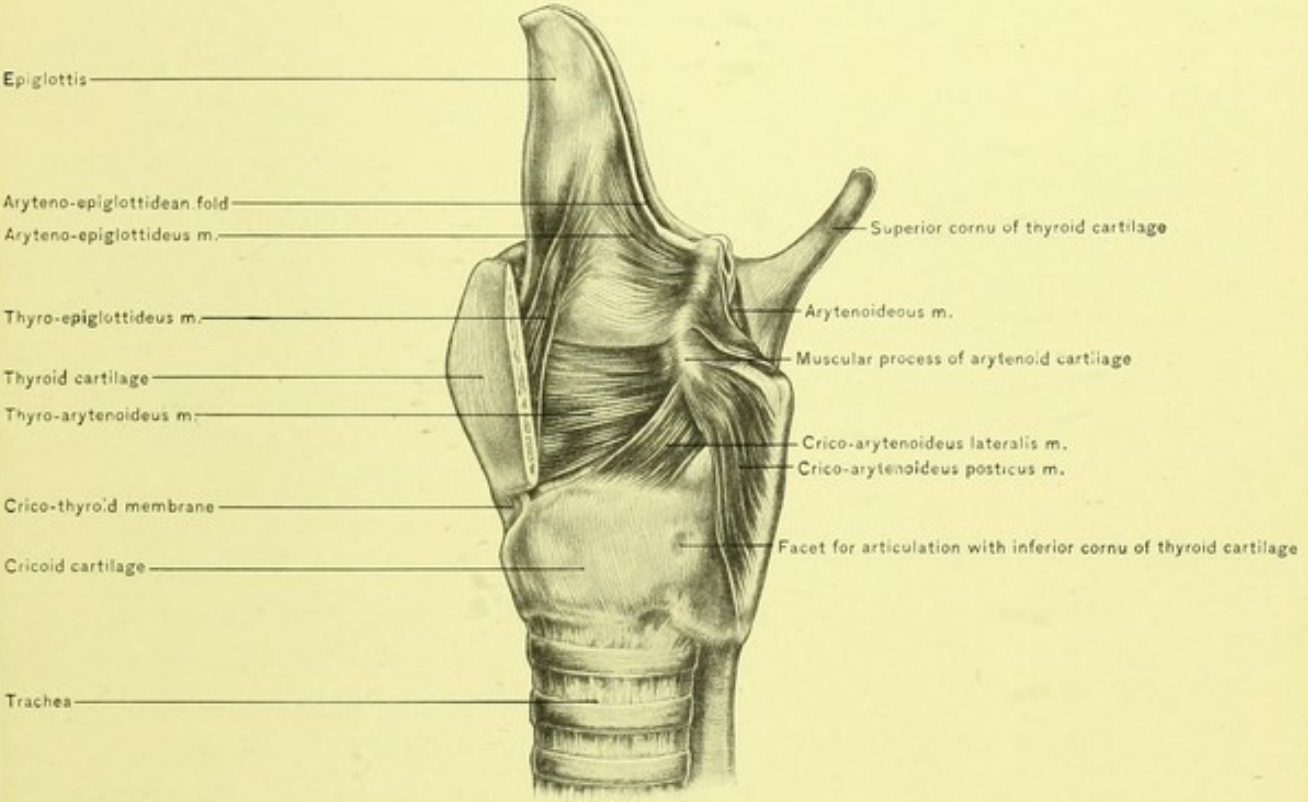
The **arytenoideus muscle** is a single muscle, situated between the arytenoid cartilages. It consists of superficial oblique fibers and a transverse portion. The oblique fibers arise from the external angle of one arytenoid cartilage, and pass upward and outward to the summit of the opposite arytenoid cartilage, crossing the oblique fibers from the other side in the form of the letter X. Some of these fibers pass around the apex of the arytenoid cartilage, and join the aryteno-epiglottideus muscle to form a sphincter for the superior aperture of the larynx. The transverse portion is thicker, and connects the posterior concave surfaces of the arytenoid cartilages.

Nerve Supply.—From the recurrent and superior laryngeal nerves.

PLATE CCXI.



MUSCLES OF LARYNX—POSTERIOR VIEW.



MUSCLES OF LARYNX—LATERAL VIEW.

Action.—The arytenoideus muscle draws the arytenoid cartilages together and approximates the vocal cords.

The **Crico-arytenoideus Lateralis Muscle** arises from the upper border of the cricoid cartilage, in front of the crico-arytenoid articulation. It is inserted into the anterior and inferior aspects of the external angle of the arytenoid cartilage. It is covered by the thyroid cartilage and the crico-thyroid muscle, and rests upon the lateral portion of the crico-thyroid membrane. Its upper border, near its termination, blends with the thyro-arytenoid muscle.

Nerve Supply.—From the recurrent laryngeal nerve.

Action.—It pulls the arytenoid cartilage forward, relaxing the vocal cords, and rotates that cartilage inward, approximating the cords and closing the rima glottidis.

The **Thyro-arytenoideus Muscle** is a quadrilateral band of muscular fibers which is divided into a superior and an inferior portion. The **superior portion** is broad and thin, and is situated above the level of the vocal cords, external to the ventricle of the larynx and the laryngeal pouch. It arises from the lower two-thirds of the inner surface of the ala, near the angle of the thyroid cartilage, and is inserted into the anterior surface and external angle of the arytenoid cartilage. The **inferior portion** is closely attached to the true vocal cord. It arises from the ala, near the angle of the thyroid cartilage, external to the attachment of the true vocal cord, and is inserted into the anterior angle (vocal process) and the adjacent portion of the anterior surface of the arytenoid cartilage. Some of its deeper fibers (*ary-vocalis* of Ludwig) are attached to the vocal cord at several points.

Nerve Supply.—From the recurrent laryngeal nerve.

Action.—The thyro-arytenoid muscles relax the true vocal cords by drawing the arytenoid cartilages forward, and approximate them by drawing the vocal processes downward and inward. The ary-vocalis can make a portion of the true cord tense while the remainder is relaxed.

The **Thyro-epiglottideus Muscle** is composed of a few of the uppermost fibers of the thyro-arytenoideus muscle, which turn upward, external to the laryngeal pouch, to be attached to the side of the epiglottis.

Nerve Supply.—From the recurrent laryngeal nerve.

Action.—It depresses the epiglottis.

The **Aryteno-epiglottideus Muscle** is situated in the aryteno-epiglottidean fold. It arises from the apex and anterior border of the arytenoid cartilage, above the false vocal cord. Its upper fibers are inserted into the mucous membrane at the margin of the aryteno-epiglottidean fold, and its lower fibers are inserted into the side of the epiglottis. It is joined by some of the fibers of the oblique portion of the arytenoideus muscle, which pass around the apex of the arytenoid cartilage.

Nerve Supply.—From the recurrent laryngeal nerve.

Action.—It pulls the epiglottis backward and compresses the laryngeal pouch, and with the assistance of the arytenoideus muscle acts as a sphincter of the superior aperture of the larynx.

The muscles just described—viz., the two crico-thyroidei, two crico-arytenoidei postici, one arytenoideus, two crico-arytenoidei laterales, two thyro-arytenoidei, two thyro-epiglottidei, and two aryteno-epiglottidei—are the **intrinsic muscles of the larynx.**

The **extrinsic muscles of the larynx**—viz., the sterno-thyroid, thyro-hyoid, stylo-pharyngei, and palato-pharyngei—have been described with the neck and pharynx. These muscles are assisted by all the muscles which elevate or depress the hyoid bone and larynx or hold the hyoid bone firm.

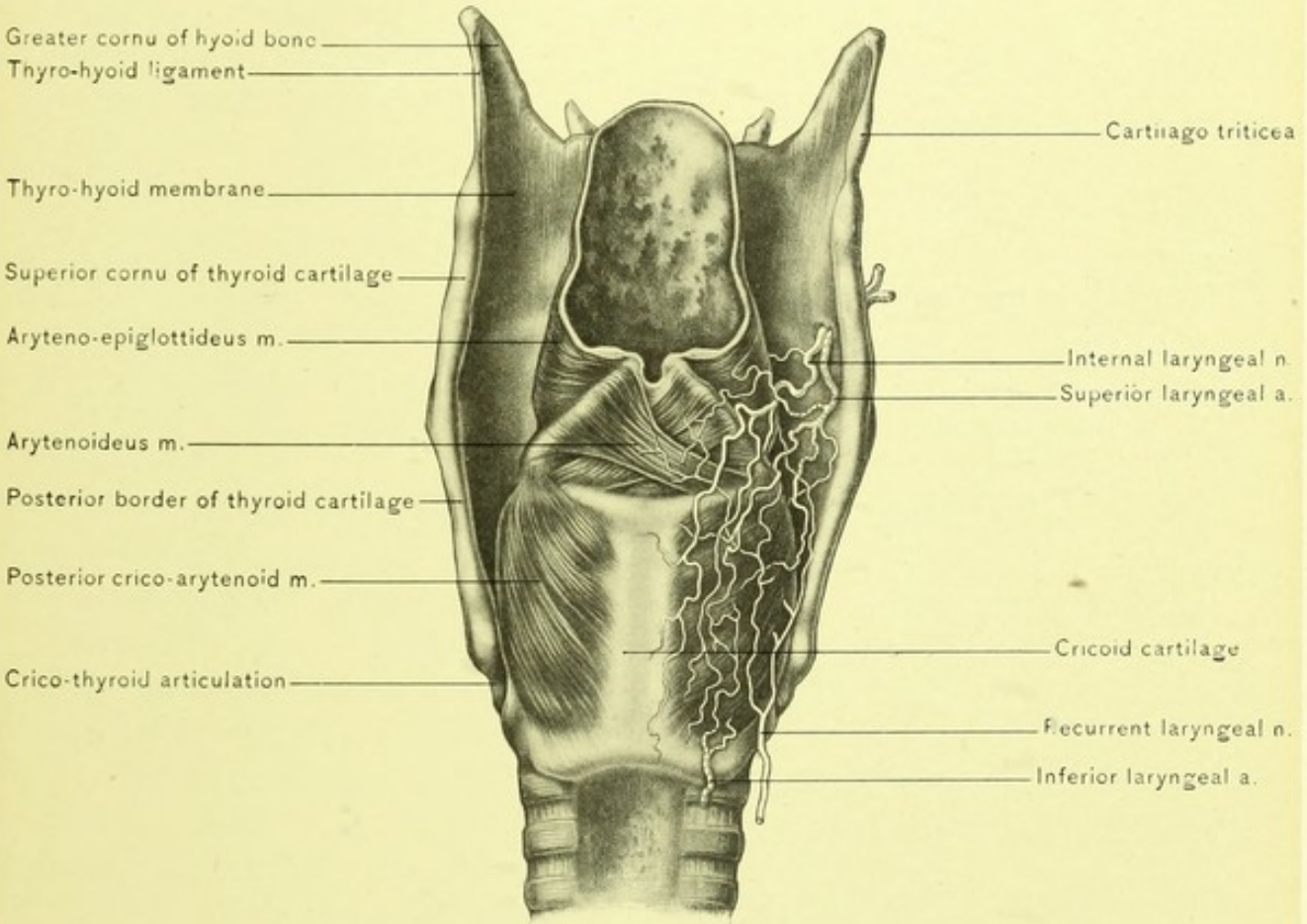
In **Laryngismus Stridulus,** or laryngeal asthma, there occurs spasm of the muscles of the larynx. This condition occurs most frequently in children, is usually due to reflected irritation, as after eating indigestible food, and may be caused by irritation of the nerve centers in the medulla oblongata. In adults it may be caused by pressure upon the recurrent laryngeal nerve by aneurysms, malignant growths of the esophagus or posterior mediastinal glands, or enlargement of the thyroid body. It may also be produced by irritation from foreign bodies in the larynx or lower part of the pharynx.

Nerve Supply of the Larynx.—From the superior laryngeal and recurrent laryngeal branches of the pneumogastric nerve.

The **Superior Laryngeal Nerve** divides into the external and internal laryngeal nerves. The **external laryngeal nerve** passes downward with the superior thyroid artery, and supplies the crico-thyroid muscle. The **internal laryngeal nerve** pierces the thyro-hyoid membrane with the superior laryngeal artery, passes downward and backward, ramifies upon the intrinsic muscles in the lateral wall of the larynx, and supplies the mucous membrane, sending a branch to the arytenoideus muscle. The internal laryngeal nerve is the *sensory nerve* of the larynx.

The **Recurrent Laryngeal Nerve** is the *motor nerve* of the larynx, and reaches it behind the crico-thyroid articulation, where it divides into an anterior and a posterior branch. The posterior branch supplies the arytenoideus muscle and the crico-arytenoideus posticus muscle, and communicates with the internal laryngeal branch of the superior laryngeal nerve; the anterior branch supplies all the other intrinsic muscles except the crico-thyroid muscle.

Paralysis of the Right Side of the Larynx may be caused by pressure upon the right recurrent laryngeal nerve, produced by aneurysm of the first portion of the right subclavian artery or lower portion of the right common carotid artery,



NERVES AND ARTERIES OF LARYNX.

enlargement of the thyroid body, malignant disease of the esophagus, and cicatrices at the apex of the right pleura, as in phthisis.

Paralysis of the Left Side of the Larynx may be caused by pressure upon the left recurrent laryngeal nerve, produced by aneurysm of the arch of the aorta and lower portion of the left common carotid artery, malignant disease of the esophagus, and enlargement of the thyroid body. The left side of the larynx is more frequently paralyzed than the right; this is explained by the longer course of the left recurrent laryngeal nerve, and by its relation with the arch of the aorta, which is more commonly affected by aneurysm than the first portion—the right subclavian artery. Moderate pressure upon one of the recurrent laryngeal nerves causes spasm of the muscles of one side of the larynx, dyspnea, and change of voice; greater pressure causes paralysis and change of voice. Both nerves may be paralyzed by a lesion of the medulla oblongata, as in labio-glosso-pharyngeal paralysis or disseminated sclerosis, or by pressure from a goiter or malignant growth of the esophagus. In bilateral paralysis the true vocal cords are immovable, and the rima glottidis is in the position assumed in quiet breathing.

Blood Supply of the Larynx.—From the superior laryngeal and inferior laryngeal arteries, and some twigs from the dorsalis linguæ artery, which supply the epiglottis.

The **Superior Laryngeal Artery** is a branch of the superior thyroid artery, and pierces the thyro-hyoid membrane with the internal laryngeal nerve. It runs downward and backward with that nerve to anastomose with the inferior laryngeal artery.

The **Inferior Laryngeal Artery** is derived from the inferior thyroid artery, and accompanies the terminal portion of the recurrent laryngeal nerve.

The Veins of the Larynx.—The superior laryngeal veins empty into the superior thyroid veins, and the inferior laryngeal veins into the inferior thyroid veins.

The **Lymphatic Vessels of the Larynx** terminate in the deep cervical chain of lymphatic glands. The lymphatics from the upper or supra-rimal portion of the larynx pass through the thyro-hyoid membrane with the superior laryngeal vessels, and join the superior set of deep cervical glands near the bifurcation of the common carotid artery. The lymphatics from the lower or infra-rimal portion of the larynx pierce the crico-thyroid membrane, join the prelaryngeal gland situated upon that membrane, and pass thence to some lateral laryngeal glands situated between the lower portion of the larynx and the lateral lobes of the thyroid body. The efferent vessels from the lateral or inferior laryngeal glands terminate in the inferior set of deep cervical glands.

Dissection.—Remove the muscles from one side of the larynx—viz., the

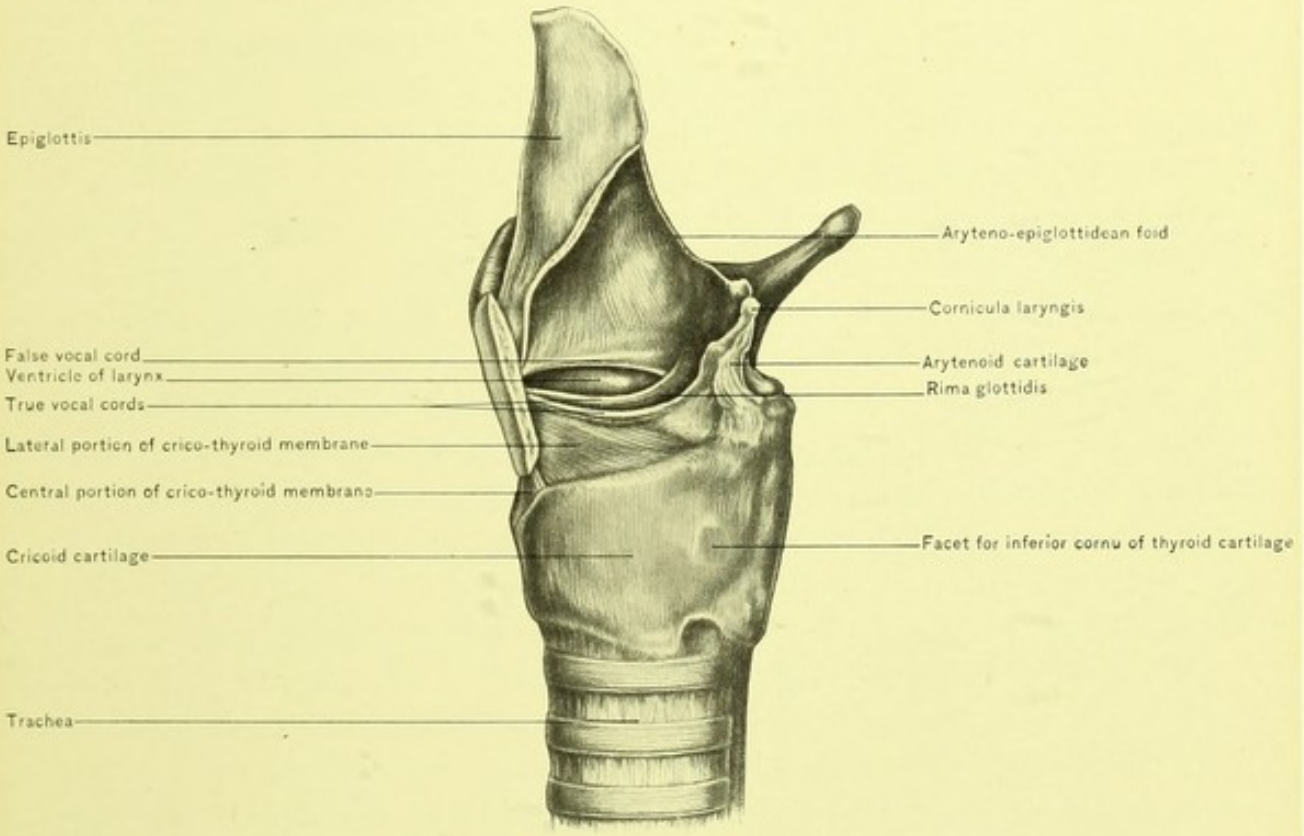
lateral crico-thyroid, thyro-arytenoid, thyro-epiglottideus, and aryteno-epiglottideus muscles. Next cut away the mucous membrane and connective tissue from the same side, from the upper border of the true vocal cord to the upper margin of the aryteno-epiglottidean fold, preserving intact the cuneiform cartilage which lies in that fold. The lateral portion of the crico-thyroid membrane, both true vocal cords, and one side of the interior of the larynx are exposed by this procedure.

The **True or Inferior Vocal Cords,** or inferior thyro-arytenoid ligaments, are two pearly white, fibro-elastic bands stretching between the anterior angles (vocal processes) of the arytenoid cartilages and the retiring angle of the thyroid cartilage on each side of the median line. They are continuous with the lateral portions of the crico-thyroid membrane, and on transverse section are prismatic in form. The free border is directed upward and inward, and vibrates to produce the voice. They are covered internally by a very thin layer of mucous membrane, through which they appear as white bands in laryngoscopic examination. They are longer in the adult male than in women and children.

The **Rima Glottidis,** or chink of the glottis, is bounded in its anterior portion on each side by the true vocal cords, and in its posterior portion on each side by the internal surfaces of the arytenoid cartilages. According to Krause, its length, in the male, varies from nineteen to twenty-five millimeters, and in the female, from fourteen to seventeen millimeters. The portion of the chink between the true cords is called the **glottis vocalis,** for it is closely related to phonation ; the portion between the bases of the arytenoid cartilages is called the **glottis respiratoria,** because it is closed in phonation, and affords additional space for passage of air in respiration. In ordinary respiration the rima glottidis is almost triangular in shape, but is more nearly of a lanceolate form, as there is a slight angle at the junction of the true cord with the arytenoid cartilage. The apex of the triangle or point of the lance is directed forward, and is situated at the retiring angle of the thyroid cartilage, the base lying between the arytenoid cartilages. During phonation the rima glottidis is closed, and air is forced through the narrow slit thus formed, causing vibration of the thin free borders of the true cords.

The **False or Superior Vocal Cords** are not concerned in phonation. They are two rounded folds of mucous membrane which cover two elastic bands, the **superior thyro-arytenoid ligaments.** Below they present a free, arched border, which bounds the ventricle of the larynx above. They are situated above the true cords upon each side of the larynx, but as they are more widely separated, the true cords are seen between them in a laryngoscopic examination. The space between them is called the **false glottis.**

The **Ventricles or Sinuses of the Larynx,** one on each side, are the depressions between the true and false cords. They permit free vibration of the true



LATERAL VIEW OF INTERIOR OF LARYNX.

cords. They partially undermine the false cords, and a probe or grooved director passed into one of them will enter a diverticulum which passes beneath the anterior portion of the false cord, and which usually projects upward as high as the upper border of the ala of the thyroid cartilage. This diverticulum is the **laryngeal pouch or sac.** The ventricles of the larynx may retain small foreign bodies which have entered the larynx. Through irritation these bodies may cause spasm of the muscles of the larynx and asphyxia.

The **Fossa Innominata** is a depression situated behind the margin of the epiglottis, on the lateral wall of the larynx, and between the aryteno-epiglottidean fold and the false vocal cord. It is indistinct except during phonation.

The **Mucous Membrane of the Larynx** is thin and closely adherent over the true cords, but is thicker, more vascular, and, excepting over the epiglottis, loosely adherent elsewhere. It is continuous above with the mucous membrane of the pharynx, and below with that of the trachea, so that an inflammation of the mucous membrane may spread, by continuity, from the pharynx to the larynx to the trachea. This course is frequently observed in diphtheria. Irritation of this membrane, as by a foreign body or mucus in laryngitis, causes cough, or spasm of the muscles of the larynx, as in croup or laryngismus stridulus.

Edema of the mucous membrane of the larynx or **edema of the glottis** is frequently associated with severe attacks of acute laryngitis, as after swallowing hot or irritating liquids or the inhalation of irritating vapors. Unless the submucous effusion of serum is allowed to escape by scarification, death may result from asphyxia. Intubation of the larynx, laryngotomy, or tracheotomy may be required to prevent suffocation. As the submucous tissue is more plentiful at the superior aperture of the larynx, and especially upon the epiglottis, the swelling is most extensive in this location.

The **Mucous Glands of the Larynx** are found in the mucous membrane of all portions of the larynx except over the true cords. They are especially numerous in the aryteno-epiglottidean folds, in front of the arytenoid cartilages, in the laryngeal sacs, and upon the posterior surface of the epiglottis, in which they are lodged in pits. These glands keep the larynx moist, and those in the laryngeal sacs are especially active in lubricating the true vocal cords during phonation. After long-continued speaking, especially if in the open air, these glands are unable to preserve the moist condition of the true vocal cords, and the voice becomes husky. These same conditions are likely to cause a determination of blood to the larynx and produce an acute laryngitis. When the ducts of these glands become occluded, cystic tumors appear in the mucous membrane of the larynx.

Dissection.—Clean the cartilages of the larynx, preserving the slender liga-

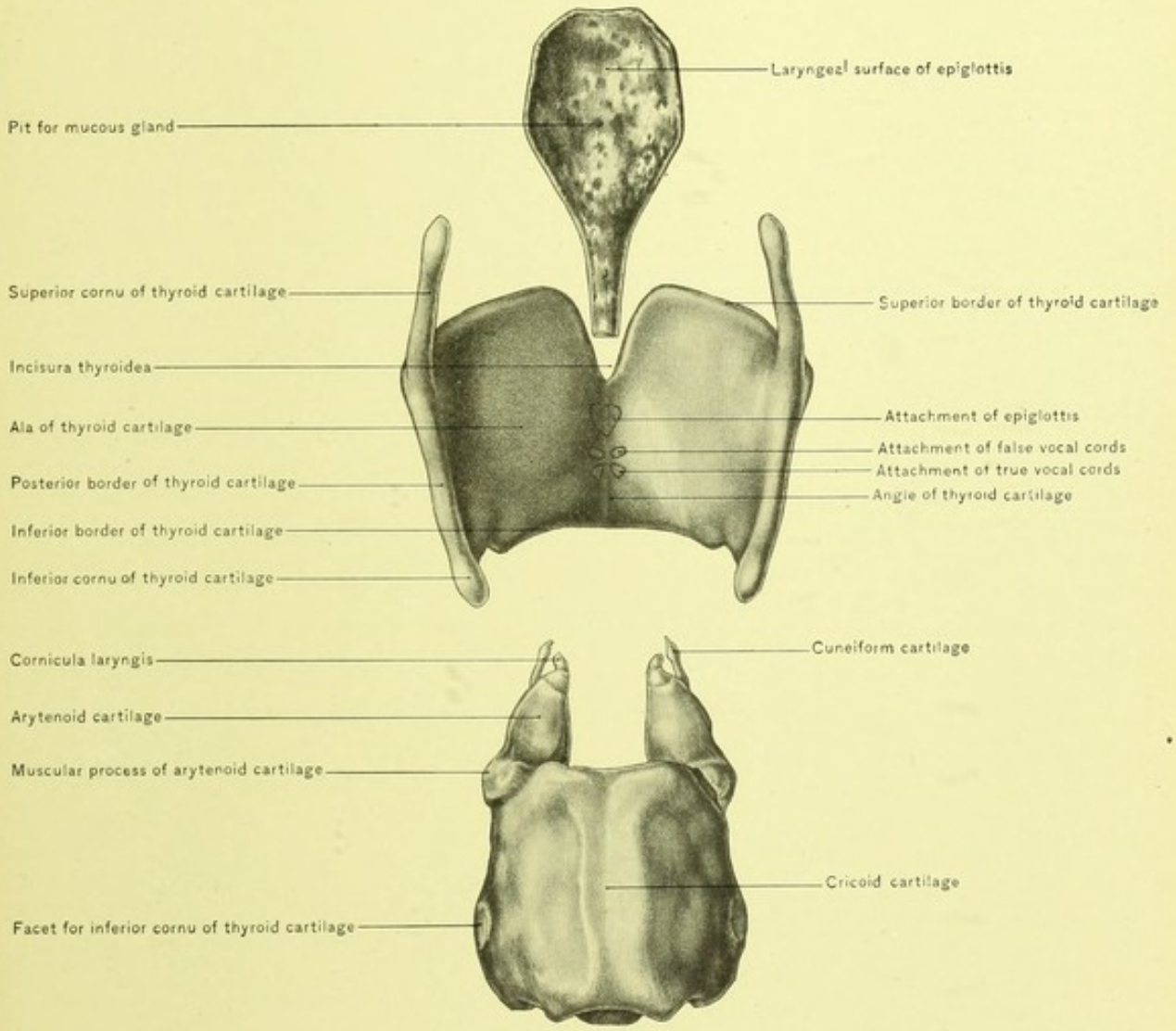
ment connecting the cornicula laryngis with the cricoid cartilage (*ligamentum jugale*), the superior thyro-arytenoid ligaments, which are located in the false cords, the inferior thyro-arytenoid ligaments or true vocal cords, and the glosso-epiglottidean and hyo-epiglottidean ligaments.

The **Cartilages of the Larynx** are nine in number—viz., the epiglottis, thyroid, and cricoid, which are unpaired, and two arytenoid, two cornicula laryngis, and two cuneiform cartilages.

The **epiglottis** is composed of yellow elastic cartilage. It is leaf-like in form, its stalk being directed downward and attached to the internal surface of the angle of the thyroid cartilage by an elastic band—the *thyro-epiglottidean ligament.* Its uppermost portion is free, and is situated behind the lowermost portion of the base of the tongue, the greater part of which holds a vertical position above it. Its *postero-inferior surface* is covered by mucous membrane. It is concave from side to side, looks toward the larynx, and contains numerous pits, which are occupied by mucous glands. About its center this surface projects backward and forms a low eminence, the cushion or *tubercle of the epiglottis.* Its *antero-superior surface,* except in its uppermost portion, is not covered by mucous membrane. It is convex from side to side and looks toward the thyro-hyoid membrane, hyoid bone, and a small portion of the base of the tongue. This surface is attached to the thyro-hyoid membrane by intervening fat and loose, cellular, elastic tissue, called the *periglottis.* It is attached to the hyoid bone by the *hyo-epiglottidean ligament* or hypoglossal membrane, which is composed of elastic tissue; and to the base of the tongue by the three *glosso-epiglottidean folds,* which contain three delicate elastic *glosso-epiglottidean ligaments.* The *lateral margins* are curved backward; and for nearly their whole extent are attached to the aryteno-epiglottidean folds. Into these margins the aryteno-epiglottidean and thyro-epiglottidean muscles are inserted. Its upper border is free and curls forward.

The epiglottis is the door which guards the superior aperture of the larynx. It lies in a vertical position during respiration and phonation, and, dropping backward, closes the superior aperture of the larynx during deglutition. It is drawn forward into the vertical position by muscles which are attached to the tongue and hyoid bone—*i. e.*, the genio-hyo-glossus, genio-hyoid, and mylo-hyoid muscles. The epiglottis is depressed by the aryteno-epiglottideus and thyro-epiglottideus muscles; they are small and have but slight power. Occlusion of the superior aperture of the larynx is produced by elevation of that organ; by this means the larynx approaches the base of the tongue, and the epiglottis is brought against the margins of the superior aperture of the larynx.

After the epiglottis has been destroyed by ulceration, food and liquids may enter the larynx during deglutition; to prevent such a disaster the patient should



CARTILAGES OF LARYNX.

be fed through a stomach tube; or he may successfully feed himself by leaning his body far forward and sucking liquid food through a tube. After a time the muscles of the larynx may act as a sphincter, thus preventing food from entering the larynx.

The **thyroid cartilage** is of the hyaline variety, and forms the greater part of the anterior and lateral walls of the larynx. It is composed of two wings, or alæ, connected in the median line, forming almost a right angle.

The *alæ* are irregularly quadrilateral in form. Their *upper borders*, where they meet in the median line, dip downward, leaving a deep thyroid notch or *incisura thyroidea*. Behind they terminate in the anterior margins of the superior cornua. Anterior to the superior cornua each ala presents a tubercle, which is placed at the upper end of the oblique line. To the upper border of the alæ is attached the thyro-hyoid membrane.

The *lower border of the cartilage* is not so sinuous as the upper border; it terminates, behind, in the anterior margins of the inferior cornua; and presents a tubercle, which is located at the lower end of the oblique line. It gives attachment to the central portion of the crico-thyroid membrane and to the crico-thyroid muscles.

The *posterior border* is continuous with the posterior borders of the superior and inferior cornua. It gives attachment to the stylo-pharyngeus and palato-pharyngeus muscles, and to the pharyngeal aponeurosis.

The *external surface of the ala* presents an oblique line, which inclines downward and slightly forward. The oblique line gives attachment to the sterno-thyroid and thyro-hyoid muscles. The surface behind the oblique line is covered by the inferior constrictor muscle of the pharynx, which arises just behind the line.

The *inner surface of the ala* is slightly concave. It is in relation with the mucous membrane of the sinus pyriformis, with the thyro-hyoid and lateral crico-arytenoid muscles, and with the lateral portion of the crico-thyroid membrane.

The *superior cornua* are longer than the inferior, and extend upward, inward, and backward. They are attached to the greater cornua of the hyoid bone by the thyro-hyoid ligaments.

The *inferior cornua* are short, and directed downward, forward, and inward. On their inner surfaces they have concave facets for articulation with the cricoid cartilage. They give attachment to the inferior constrictor and crico-thyroid muscles, and to the capsular ligaments of the crico-thyroid articulations.

The *angle* is at the line of junction of the alæ, is more prominent above, where it is called the *pomum Adami*, and lies beneath the interval between the sterno-hyoid muscles. Internally it gives attachment, on each side of the median line, to the true and the false vocal cords. For the purpose of making the interior

of the larynx accessible, the thyroid cartilage is sometimes split longitudinally, from the notch in the upper border to the lower border. In this operation it is important to divide the cartilage exactly in the median line, so as not to injure the attachments of the vocal cords. When the cartilage has been divided, the two halves are turned aside, thus exposing the interior of the larynx and enabling the operator to remove a small tumor or foreign body.

Fractures of the thyroid cartilage are rare, but are more common than in the other cartilages of the larynx. They are usually produced by external direct violence, as choking or throttling, and the line of fracture is usually in the median line, at the angle. There are pain, swelling, and tenderness in and around the larynx, with increased pain on swallowing, coughing, or talking. The moist crepitus which can be produced by forcibly moving a normal thyroid cartilage laterally must not be mistaken for that present as a result of fracture.

Ossification of the thyroid cartilage frequently occurs, and may commence at the age of twenty years.

The **cricoid cartilage** is the strongest of the cartilages of the larynx; it is a firm base which supports the other portions of the larynx, and rests upon the upper end of the trachea. It is hyaline in structure, completely encircles the lower portion of the cavity of the larynx, and, like a signet ring, is broader behind than in front.

Its *external surface* gives origin, in front, to the crico-thyroid muscle, and, at the side, to the inferior constrictor muscle of the pharynx. Where its lateral aspect joins the posterior there is a facet for articulation with the inferior cornu of the thyroid cartilage. The posterior portion of this surface presents a median ridge, which gives origin to the longitudinal muscular fibers of the esophagus, and a depression on each side of the ridge, which gives origin to the posterior crico-arytenoid muscles.

The *upper border* is horizontal for a short distance, but is soon directed obliquely downward and forward. Where the oblique portion begins there is a facet upon which the base of the arytenoid cartilage rests. The anterior and lateral portions of the upper border give attachment to the crico-thyroid membrane and the lateral crico-thyroid muscle.

The *inferior border* is horizontal. It is attached to the first ring of the trachea by fibrous membrane like that between the tracheal rings. The internal surface is covered by the mucous membrane of the larynx.

Ossification is not uncommon in the cricoid cartilage, but in the smaller cartilages of the larynx that stage of development is seldom attained.

The **cuneiform cartilages,** or cartilages of Wrisberg, should next be studied. They are two small conic masses of yellow elastic cartilage situated in the aryteno-

epiglottidean folds, just anterior to the cornicula laryngis. Sometimes they are long and club-shaped; occasionally they are absent.

The **cornicula laryngis,** or cartilages of Santorini, are two pyramidal masses of yellow elastic cartilage situated upon the summits of the arytenoid cartilages in the aryteno-epiglottidean folds. They are directed inward. There may be a joint between them and the arytenoid cartilages, or they may be directly continuous with those cartilages. Their summits are attached to the upper border of the posterior portion of the cricoid cartilage by the ligamentum jugale. The *ligamentum jugale* is Y-shaped, the stem of the Y being attached to the cricoid cartilage and the two limbs to the summits of the cornicula laryngis.

The cornicula laryngis and cuneiform cartilages, on laryngoscopic examination, appear as two whitish swellings in the posterior extremity of each aryteno-epiglottidean fold.

The **arytenoid cartilages** are two irregularly pyramidal bodies, which rest upon the upper border of the posterior portion of the cricoid cartilage. Their greater portion is composed of hyaline cartilage; the remainder, their apices, being yellow elastic cartilage. Each has an apex, a base, three sides, three borders, and three angles. The *apex* is directed upward, backward, and inward, and supports the corniculum laryngis. The *base* is concave, and presents on its inner side a facet for articulation with the cricoid cartilage. The three sides are an internal, a posterior, and an antero-external or anterior surface.

The *internal surface* is directed toward the corresponding surface of the opposite arytenoid cartilage, and is covered by mucous membrane.

The *posterior surface* is concave, and gives attachment to the arytenoideus muscle.

The *antero-external or anterior surface* is rough and irregular. It gives attachment to the thyro-arytenoideus muscle and the superior thyro-arytenoid ligament, which supports the mucous membrane of the false vocal cord.

The three borders are the internal, external, and anterior.

The *internal border* is directed inward and backward; the *external border* slopes downward and outward to the external angle; the *anterior border* slopes downward and forward to the anterior angle. The three angles are the internal, external, and anterior. The *internal angle* is situated at the postero-internal angle of the base. It gives attachment to the transverse or crico-arytenoid ligament. The *external angle* or muscular process is located at the external angle of the base. It gives attachment anteriorly to the lateral crico-arytenoid muscle, and posteriorly to the posterior crico-arytenoid muscle. The *anterior angle* or vocal process, situated at the anterior angle of the base, is long and pointed, and gives attachment to the true vocal cord or inferior thyro-arytenoid ligament.

The **hyaline cartilages of the larynx**—namely, the thyroid, cricoid, arytenoid, and cartilago triticea—frequently undergo ossification.

When any of the cartilages of the larynx are fractured, the patient should be placed on his back, prohibited from talking, and fed through the rectum; it may be necessary to practise intubation, laryngotomy, or tracheotomy.

The **Joints of the Larynx** are the crico-thyroid and crico-arytenoid.

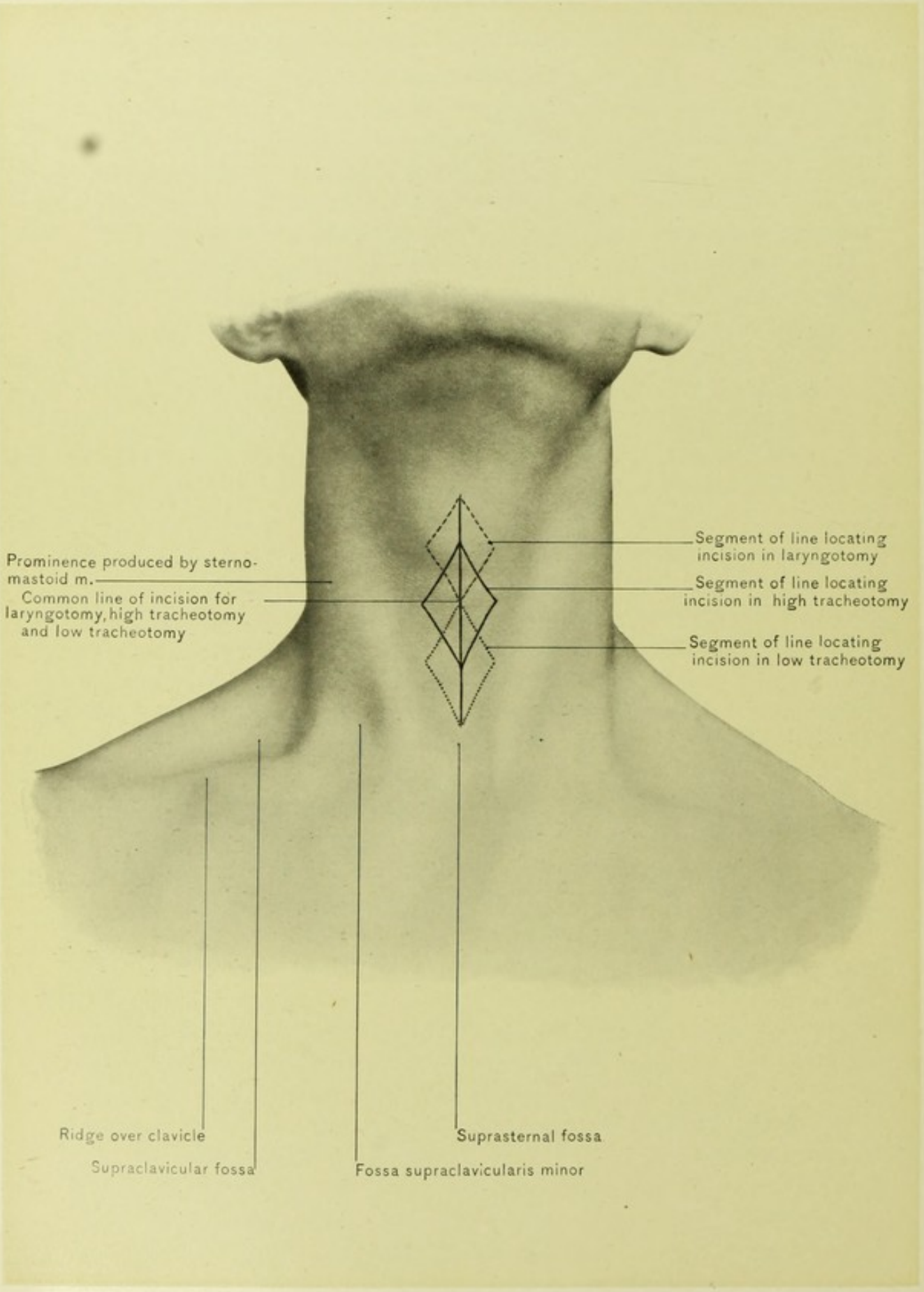
The **crico-thyroid joints** are formed by the articulation of the inferior cornua of the thyroid cartilage with the cricoid cartilage. They are lined by synovial membrane, and have capsular ligaments which are stronger posteriorly. Their movements are gliding of the cricoid cartilage upward and backward, and rotatory around a transverse axis.

The **crico-arytenoid joints** are formed by the articulation of the cricoid cartilage with the bases of the arytenoid cartilages. They have a capsular, a posterior crico-arytenoid, and a transverse or crico-arytenoid ligament; and each has a synovial membrane. The capsular ligament is loose and allows free movement. The posterior crico-arytenoid ligament arrests the forward movement of the arytenoid cartilage. The transverse or crico-arytenoid ligament connects the upper border of the cricoid cartilage with the internal angles of the arytenoid cartilages. The crico-arytenoid joints permit of the arytenoid cartilages gliding inward or outward or rotating around a vertical axis. These movements permit the vocal processes to rotate inward and the arytenoid cartilages to be drawn together, closing the rima glottidis, as in phonation; or they allow the vocal processes to rotate outward and the arytenoid cartilages to be separated, thus opening the rima glottidis as in respiration.

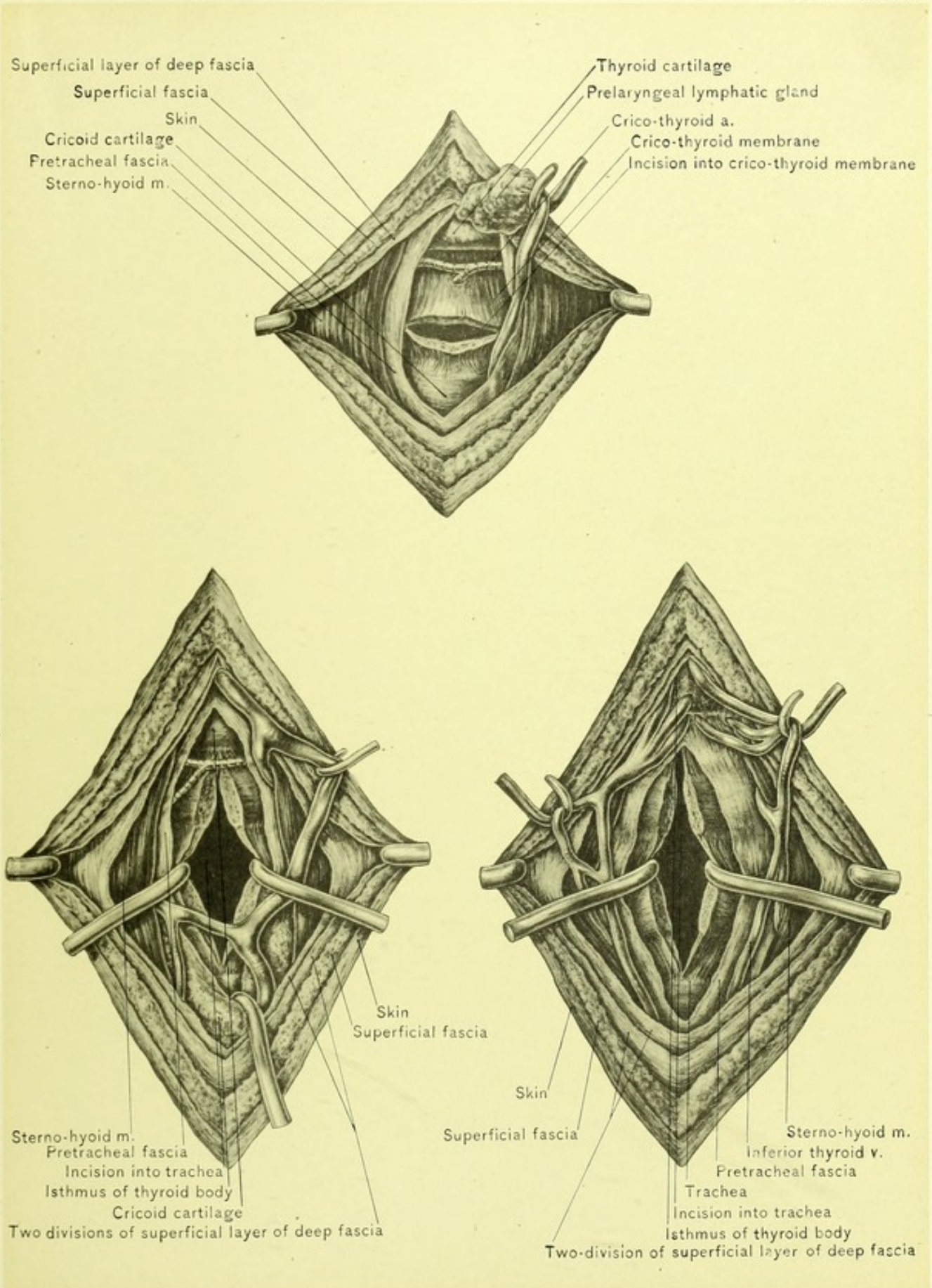
The **Ligaments of the Larynx** not associated with the joints are the thyro-hyoid and crico-thyroid membranes; the thyro-hyoid ligaments, which have been described; the superior thyro-arytenoid ligaments, described with the false vocal cords; and the inferior thyro-arytenoid ligaments, described as the true vocal cords.

In **Laryngoscopic Examination** the patient should sit at a higher level than the physician; his tongue should be drawn forward so that the base of that organ will not hang backward over the epiglottis and superior aperture of the larynx; his head should be thrown backward so that the reflection of the interior of the larynx, instead of the image of the base of the tongue, will be seen. When the mirror has been introduced into the oro-pharynx, its handle must usually be depressed. The epiglottis will be seen in its upper part; the arytenoid cartilages, cartilages of Santorini and Wrisberg, in its lower part; the false vocal cords, ventricles, and true vocal cords, on their corresponding sides; and the anterior wall of the trachea and, occasionally, its bifurcation may be seen. The true vocal cords

PLATE CCXVI.



SURFACE MARKS OF NECK AND LINES OF INCISIONS FOR LARYNGOTOMY AND TRACHEOTOMY.



LARYNGOTOMY.

HIGH TRACHEOTOMY.

LOW TRACHEOTOMY.

appear as white bands more nearly approximated than the false cords. In acute laryngitis the true vocal cords are of a pinkish color, and the remainder of the larynx is red and swollen. This swelling, or edema, of the glottis is produced by a serous infiltration into the submucous areolar tissue; and if present to a marked degree, is best treated by scarification; it may, however, necessitate intubation, laryngotomy, or tracheotomy.

The **Hyoid Bone** is an important adjunct to the larynx. It prevents collapse of the pharynx over the superior aperture of the larynx, and from it the larynx is suspended by the thyro-hyoid membrane and thyro-hyoid ligaments. The greater cornua of this bone are important guides. The tip of the greater cornu is opposite the origin of the lingual artery, just above the level of that of the superior thyroid artery, and just below the level of the origin of the facial artery. In the operation for ligation of the lingual artery in the lingual triangle the incision is made just above and parallel with the greater cornu of the hyoid bone. This bone is sometimes fractured by external violence, as in choking or throttling, and has been broken by muscular action. The body of the bone is rarely fractured, one of the greater cornua usually being fractured.

The Movements of the Larynx *en masse* are in but two directions—upward and downward. The most marked movements are performed during deglutition, prior to which the larynx, as well as the pharynx, is drawn upward. By this means closure of the superior aperture of the larynx is facilitated, and elevation of the pharynx aids the constrictor muscles of the pharynx to grasp the morsel of food. The larynx is elevated by the following muscles: The digastric, the stylo-hyoid, the mylo-hyoid, the genio-hyoid, the lower portion of the genio-hyo-glossus, the stylo-pharyngeus, and the palato-pharyngeus. It is depressed by the sterno-hyoid, the sterno-thyroid, and the omo-hyoid muscles.

Laryngotomy is performed through the crico-thyroid membrane. The shoulders are elevated by a pillow, the head and neck are extended, a firm support is placed under the neck, and the face is made to look directly forward so that the relations of the structures in the median line of the neck may not be distorted. The thyroid and cricoid cartilages and the crico-thyroid space are outlined, the larynx is gently steadied with the thumb and fingers of one hand, and an incision one and one-half inches long is made in the median line over the lower part of the thyroid cartilage, the crico-thyroid membrane, and the cricoid cartilage. The skin, the superficial fascia, and the superficial layer of the deep fascia are divided; the sterno-hyoid and sterno-thyroid muscles are separated from the corresponding muscles of the opposite side; the pretracheal fascia is divided; and the central portion of the crico-thyroid membrane is divided transversely along the upper border of the cricoid cartilage. By dividing the lowest portion of the membrane the

crico-thyroid arteries and the true vocal cords are avoided, and if the knife is directed downward and backward, the vocal cords are in less danger.

Excision of the Larynx is sometimes performed for removal of malignant disease of that organ; but the results of the operation are so discouraging that a palliative tracheotomy is usually preferred.

The **Trachea** is directly continuous with the lower portion of the larynx, so that the larynx appears to be the upper extremity of the trachea modified for the performance of certain special functions. The trachea varies between four and one-half and five inches in length and three-fourths of an inch and one inch in width. On transverse section it is shaped like a bar horseshoe, the indentation being posteriorly for the accommodation of the esophagus. The trachea is composed of cartilaginous rings, which are connected by fibrous membrane. The rings are horseshoe-shaped, with the open end posteriorly; this interval is filled by the fibro-elastic membrane, which yields to pressure of bodies passing through the esophagus, thus providing additional space during deglutition. The trachea contains from sixteen to twenty of these rings, seven or eight of which are above the upper margin of the sternum. When the head and neck are in the long axis of the body, about two inches of the trachea are above the sternum, and by full extension of the head and neck this distance may be increased to three inches. The trachea is quite superficial at its upper extremity, but rapidly becomes deeply situated as it descends; this is one of the reasons for preferring high tracheotomy.

Relations of the Cervical Portion of the Trachea.—In front are the skin; the superficial fascia; the superficial layer of the deep fascia, which is here composed of two layers; a communicating branch between the anterior jugular veins, situated just above the sternum; the sterno-hyoid and sterno-thyroid muscles; the isthmus of the thyroid body; the inferior thyroid veins or thyroid plexus of veins; occasionally, the thymus gland or the remains of that gland; the pretracheal fascia, and the thyroidea ima artery when present. Occasionally, a high innominate artery or left innominate vein may be in front of the trachea at the root of the neck. Behind the cervical portion of the trachea is the esophagus. On each side of it are the lateral lobes of the thyroid body, the recurrent laryngeal nerves, the terminal portions of the inferior thyroid arteries, and the carotid sheaths inclosing the common carotid arteries, internal jugular veins, and pneumogastric nerves. The trachea will be more completely described under the section on the Chest.

Tracheotomy.—The windpipe may be opened either above or below the isthmus of the thyroid gland; the former procedure being known as high, the latter as low, tracheotomy. High tracheotomy is the easier of the two operations, because the first part of the trachea is less deeply placed and is somewhat larger

and less mobile, being, therefore, more accessible than the part just above the sternum. Furthermore, the inferior thyroid veins, lying upon the trachea below the isthmus, the occasional presence of a thyroidea ima artery, and in infants the upper part of the thymus gland, add to the difficulties of the low operation. It is also to be remembered that the innominate artery or the left innominate vein may cross the trachea higher than usual and might be encountered in the low operation.

For the performance of the operation the head is well extended and so held by an assistant that the median line of the face will be in line with the median line of the neck. A firm cylindric cushion or a large bottle is so placed under the back of the neck as to render its anterior region prominent. The parts are steadied with the fingers and thumb of one hand. The various landmarks, such as the pomum Adami and the cricoid cartilage, are recognized by palpation. The incision extends from about the lower border of the thyroid cartilage downward for two and a half inches in the median line. It is made from below upward, and divides skin and superficial fascia. The anterior jugular veins, which lie alongside of the median line, may now appear, and should be avoided by cutting between them and drawing them aside. The two layers of the superficial layer of the deep cervical fascia are then divided either upon a director or with the free hand. The interval between the flat pretracheal muscles is recognized, and the wound deepened by "blunt dissection"; the director or the handle of the knife being used to slit down the soft parts in the median line until the pretracheal fascia is reached. The pretracheal fascia is incised and the tracheal rings are fully exposed, the director or handle of the knee being again used in order to avoid hemorrhage. The isthmus of the thyroid gland is depressed, if need be, to gain additional space.

Hemorrhage having been checked and the tracheal rings fully exposed, the trachea is held steady with a tenaculum and a sharp narrow-bladed knife, with its cutting edge directed upward, is thrust into the windpipe and two or three rings divided from below upward. The edges of the tracheal wound are then held apart with a dilator, hooks, or a loop of silk passed through each side. False membrane, if present, is withdrawn, and the tracheal tube is inserted.

After opening the windpipe it will usually be noticed that respiration is much slower, owing to the fact that plenty of air is admitted; whereas prior to the operation the breathing was hurried, on account of the obstruction.

It is important during the operation that the trachea be kept exactly in the median line, otherwise it may be opened on one side, or, from being carelessly drawn to one side by the assistant, it may be missed altogether, and the operator, as has occurred, may expose the vertebral column before the error is recognized.

It is also essential to thoroughly expose the rings of the trachea by clearing away the pretracheal fascia; such exposure prevents the mistake of introducing the tracheal tube under that fascia, instead of into the windpipe, thereby increasing the respiratory difficulty.

In children the cricoid cartilage is sometimes divided in addition to the tracheal rings, thus converting the operation into a laryngo-tracheotomy.

In the low operation the same general rules are observed as in the high operation; the incision extends from the top of the sternum to the cricoid cartilage. After division of the skin and fasciæ, the wound is deepened by blunt dissection, for there is here, of course, more danger of hemorrhage than in the previously described operation. The inferior thyroid veins, or thyroid plexus of veins, which lie upon the pretracheal fascia, should be displaced, and the trachea thoroughly exposed, the forefinger being passed into the wound from time to time as the wound is deepened, in order to ascertain the relations of the tissues, recognize abnormal vessels, and feel the tracheal rings.

THE NOSE.

The **Nose** is the uppermost portion of the respiratory tract. It contains the special organs of the sense of smell, and removes particles of dust from and warms and moistens the inhaled air; therefore, when the nasal passages are occluded, disease of the lower portion of the respiratory tract is more likely to occur. It may be divided into the **nose** proper and the **nasal cavities** or **fossæ.**

The **Nose** proper resembles a pyramid with three sides, the posterior of which is wanting and directed toward the nasal cavities. The two lateral surfaces are triangular, covered by skin, and form a part of the face. The apex of the pyramid—the root of the nose—joins the forehead. Below its root it broadens into the **bridge** or **dorsum** of the nose. Sinking of the bridge of the nose occurs in children who are affected by congenital syphilis, and who suffer from syphilitic coryza or "snuffles." The severe nasal catarrh modifies the nutrition of the surrounding structures, and causes imperfect development of the adjacent bones. The two lateral borders of the nose are continuous with the face. The anterior border is free, and terminates below in the **lobule** or **tip** of the nose. The lateral surfaces, below, slope outward into the **alæ** or **wings** of the nose, which form the lower borders of those surfaces.

The **base** of the nose presents two apertures, the **anterior nares,** or nostrils, which are separated by a median pillar or **columna.** The anterior nares are

guarded internally by short stiff hairs, or vibrissæ, which sift small bodies out of the inhaled air. The anterior nares open into the **vestibule** of the nose, which is the portion of the nasal cavities within the cartilaginous portion of the nose proper. As the base of the nose is in a slightly lower plane than the floor of the nasal fossæ, the base of the nose should be elevated with the speculum in making an examination of the nasal cavities.

The **walls** of the nose proper are formed above by the nasal bones, the nasal spine of the frontal bone, and the nasal processes of the superior maxillary bones; and, below, by the lateral cartilages of the nose.

The **skin** is loosely adherent to the upper part of the nose, but is closely attached over the alæ and lobule. It contains sebaceous glands, which are especially numerous at the lower part of the nose. Therefore, acne and comedones are common in this location. *Acne*, or pimples, and other inflammatory affections upon the alæ and lobule of the nose are painful on account of the density of the tissues, which prevents swelling and causes increased pressure on the nerves. The skin of the nose is also commonly affected by acne rosacea and lupus, especially lupus erythematosus, which develops upon the nose, ears, and face more frequently than on other portions of the body. *Rodent ulcer*, another affection which has a predilection for the nose, frequently commences in the crease between the cheek and the ala of the nose. This is a not uncommon site for *epithelioma*.

Blood Supply.—The nose proper is supplied by the nasal, angular, infra-orbital, lateral nasal, and superior coronary arteries. The numerous and freely anastomosing vessels of the exterior of the nose communicate with those in the mucous membrane; hence it happens that in many cases of inflammatory disease of the nasal mucosa there is congestion of the cutaneous vessels.

On account of its free blood supply, the skin of the nose offers a good field for plastic operations. Restoration of the nose by a plastic operation is known as *rhinoplasty*. The flap may be derived from the forehead, as in the Indian method, or from the inside of the arm, as in the Tagliacotian method. The flaps may also be taken from the cheeks, or the flaps from the cheeks may be placed with their cutaneous surface inward and covered with a flap from the forehead. In the nose, as in the scalp, the free blood supply prevents sloughing of portions of the organ almost cut away and then reposited, and small scars are formed in the repair of wounds.

Nerve Supply.—The nose proper is supplied by the nasal, infra-trochlear, and infra-orbital nerves. The muscles of the nose proper, which have been considered with the description of the face, are supplied by the facial nerve.

The **veins** of the nose proper empty into the ophthalmic and facial veins. There is a network of rather large anastomosing veins in the tip of the nose.

The **lymphatics** of the nose proper pass to the submaxillary lymphatic glands.

Because of their exposed position and the absence of subcutaneous fat which protects underlying vessels, the lobule and alæ of the nose, like the pinna of the ear, are frequently frozen and may be the site of gangrene resulting therefrom.

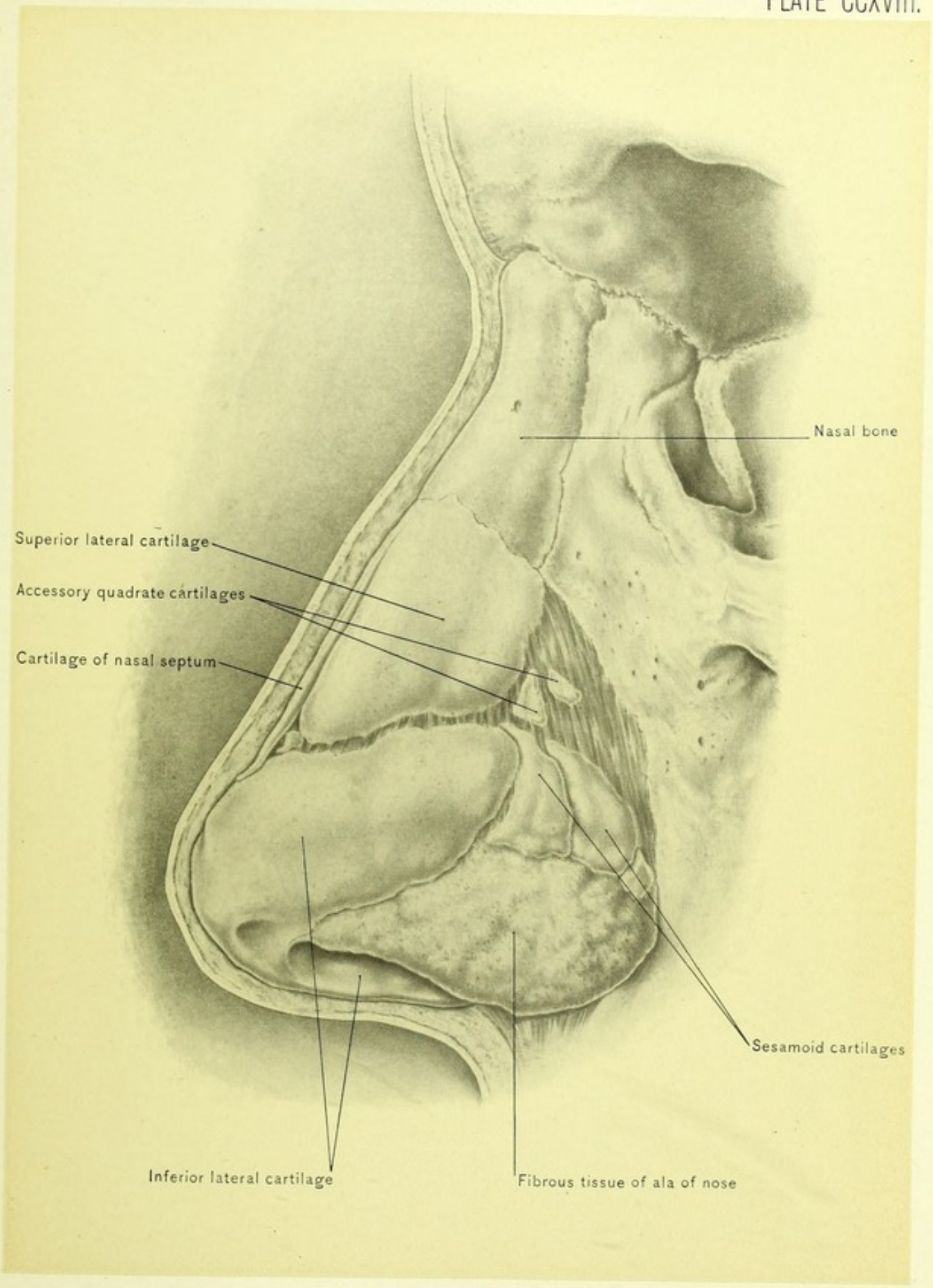
Dissection.—Remove the tissues covering the nasal bones and lateral cartilages of the nose.

The **nasal bones** are thick and narrow at their upper extremities, and thin, broad, and much exposed to injury at their lower portion; consequently these bones are more frequently fractured near their lower margins. A blow at the root of the nose is far more likely to break the cribriform plate of the ethmoid bone and the anterior walls of the frontal sinuses than the nasal bones. Fractures of the nasal bones may be reduced by manipulation of the fragments between the fingers externally and a grooved director introduced into the nasal fossæ. Owing to their vascularity, the nasal bones unite quickly. In congenital syphilis destruction of the bones, especially of those of the septum, causes the bridge of the nose to sink. Congenital protrusions of the membranes of the brain or the brain itself may occur at the root of the nose. They are known as sincipital meningoceles and encephaloceles, and appear because of incomplete union of the frontal bone with the cribriform plate of the ethmoid bone and with the nasal bones. The skin over these tumors may be highly vascular and present some resemblance to that over a nevus.

The **cartilages** in the framework of the nose consist of a superior and an inferior lateral cartilage and sesamoid cartilages on each side, and the cartilage of the septum.

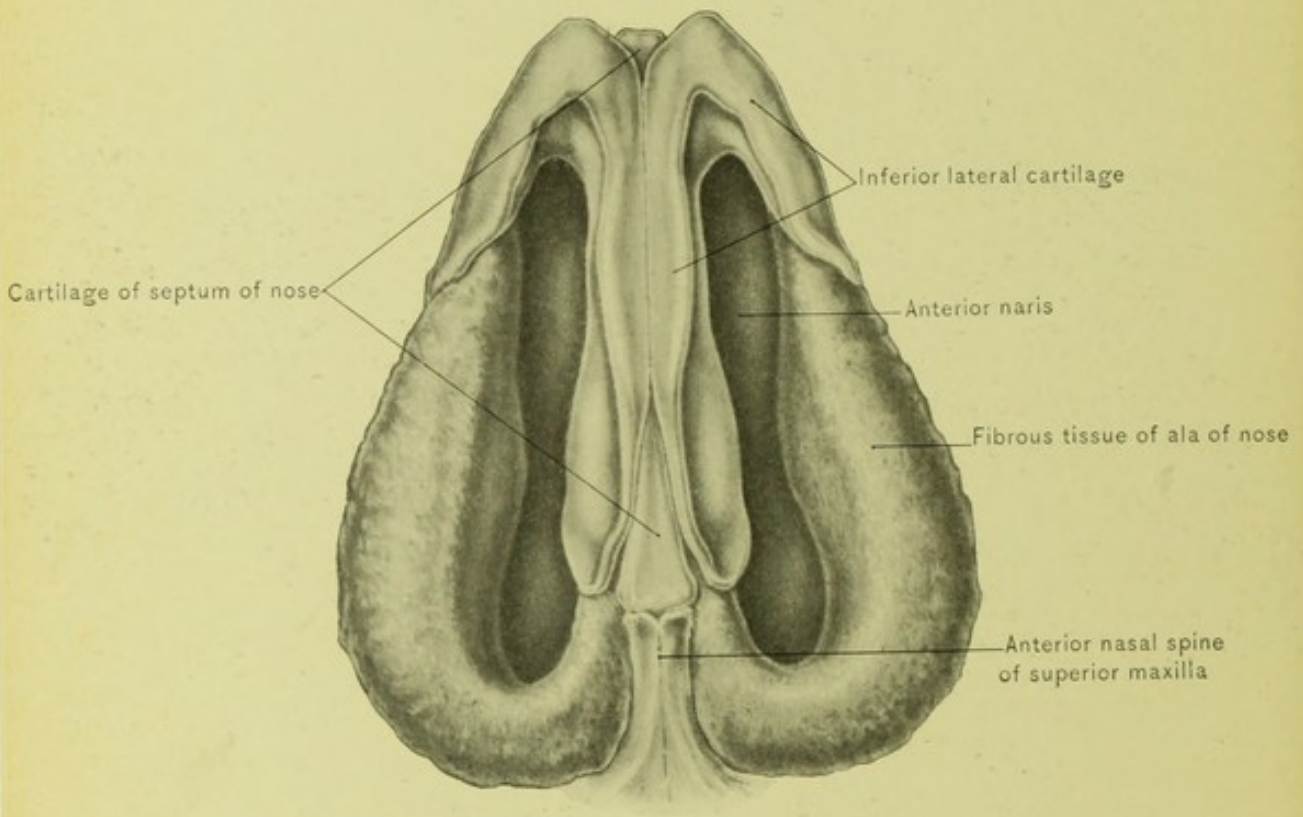
The *superior lateral cartilages* are triangular. Their anterior margins are partly continuous with the anterior border of the cartilage of the septum, to which they are closely applied. Their posterior margins are closely united to the superior maxillæ and the lower border of the nasal bones. Their inferior borders are attached to the inferior lateral cartilages. Their outer surfaces are covered by the skin and the muscular and fibrous tissue of the nose; and their inner surfaces by the nasal mucous membrane. When the superior lateral cartilage is detached from the nasal bone by traumatism, considerable pain in the nose is produced by injury of the nasal nerve, which emerges between this cartilage and the nasal bone.

The *inferior lateral cartilages* are sharply bent around in front of the anterior nares, so that they are composed of an inner and an outer portion. The inner portion lies in contact with the corresponding portion of the opposite inferior lateral cartilage on the inner side of the anterior naris, forming part of the columna. The outer portion is oval and curves backward in the ala of the nose. It

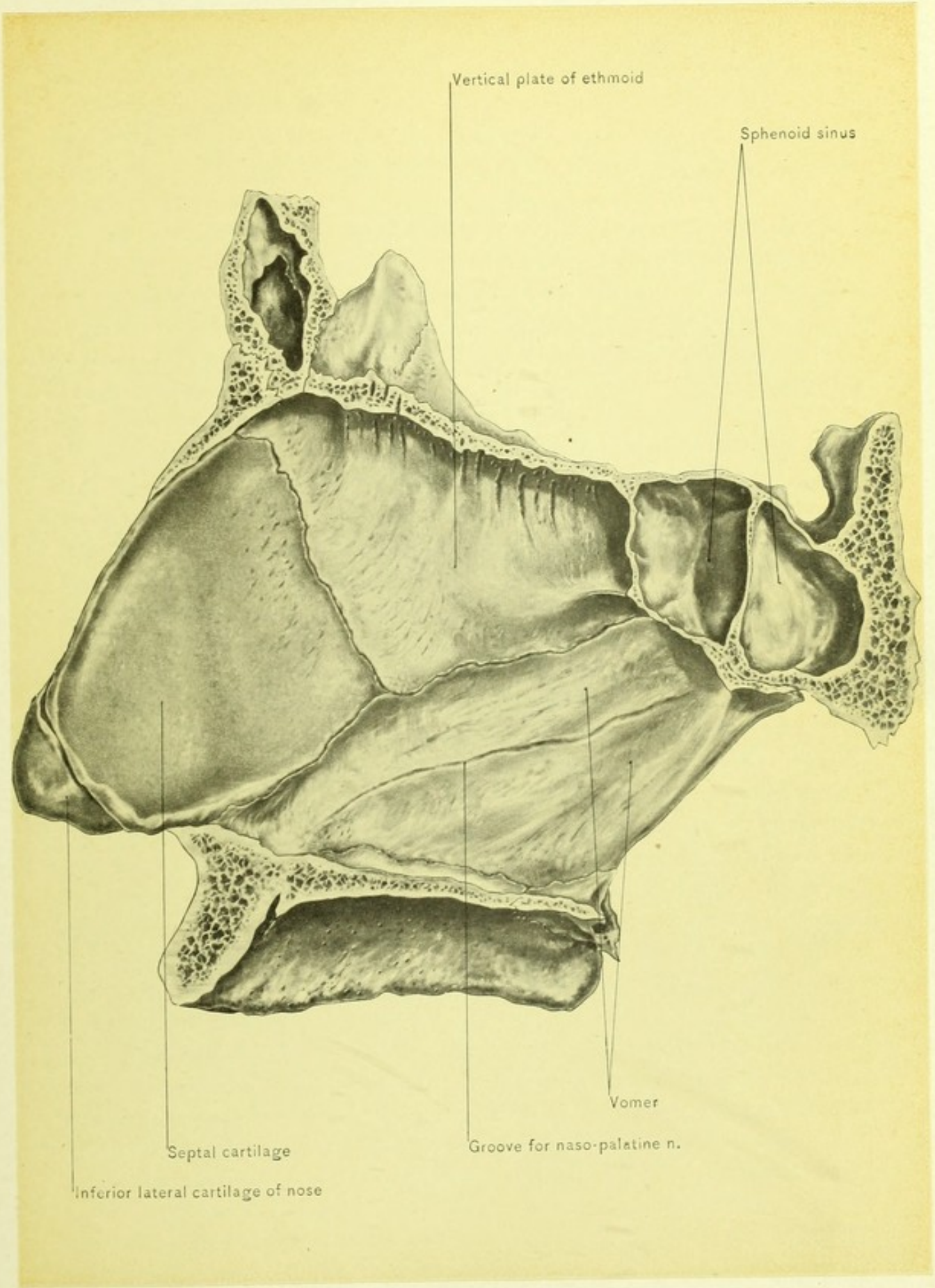


LATERAL CARTILAGES OF NOSE.

PLATE CCXIX.



CARTILAGES AT BASE OF NOSE.



NASAL SEPTUM.

is attached to the superior lateral cartilage and the superior maxilla by dense fibrous tissue, in which the sesamoid cartilages are found. The margin of the alæ of the nose is not formed by the inferior lateral cartilage, but by the dense fibrous tissue which forms the framework of the nose proper where the bones and cartilages are absent.

The *sesamoid or accessory cartilages* are usually four in number in each lateral wall of the nose proper. Two of these cartilages are situated in the fibrous tissue which connects the inferior lateral cartilage with the nasal process of the superior maxilla. Just above these are the other two, which are called the *accessory quadrate cartilages.* Additional sesamoid cartilages may be found in the fibrous tissue which completes the framework of the nose proper, but the four previously mentioned are the only constant sesamoid cartilages.

The *septal cartilage* is placed in the antero-inferior portion of the septum, filling the angular interval between the vertical plate of the ethmoid bone and the vomer. It is quadrilateral in form. Its posterior superior border is in contact with the vertical plate of the ethmoid bone, which is sometimes grooved to receive it. Its posterior inferior border joins the anterior nasal spine of the superior maxilla, and the vomer, which may be grooved for its reception. The upper portion of its anterior superior border is attached to the crest on the under surface of the junction of the nasal bones, and below the nasal bones the sides of this border are continuous with the superior lateral cartilages; it terminates just above the tip of the nose between the inner plates of the two inferior lateral cartilages. The anterior inferior border is short, and extends backward and downward, above the columna, to the anterior nasal spine, which it embraces.

The cartilages and other soft tissues of the cartilaginous portion of the nose may be destroyed by *lupus vulgaris*, the bones not being involved. The nose may be repaired by one of the methods of plastic operation (rhinoplasty) previously mentioned.

Dilating specula introduced into the anterior nares should not be inserted beyond the cartilaginous portion of the nose, on account of the pain produced by pressure upon resisting bony structures.

Dissection.—Hold the anterior segment of the skull so that the light enters the nasal cavities through the anterior nares, or pass a probe or a grooved director into the nasal cavities to determine to which side the nasal septum is deflected. Then cut through the tissues of the upper lip and through the lateral cartilages, close to that side of the septum which does not bulge. With the hard palate facing upward saw through the skull, close to the flat or concave side of the septum. The superior turbinated bone on one side may be broken, in which case it may be studied on the other side after removing the septum.

The **Nasal Cavities,** or **Fossæ,** two in number, are located between the base of the skull and the hard palate. They are wide below and become quite narrow above, where the middle and superior turbinated bones lie near the septum, and at times in contact with it. The vertical diameter of each nasal fossa is greater than the transverse diameter; and, therefore, forceps inserted into the fossæ should be opened vertically. The nasal cavities open upon the face by means of the vestibule and anterior nares, and into the naso-pharynx by means of the posterior nares. They are separated by the nasal septum.

The **nasal septum** is formed by the crest at the junction of the nasal bones, the nasal spine of the frontal bone, the vertical plate of the ethmoid bone, the cartilage of the septum, the vomer, the crest of the sphenoid bone, and by the crest situated at the line of junction of the two palatal processes of the two superior maxillæ and of the two horizontal plates of the palate bones. In children up to the seventh year and in primitive races the septum is straight in eighty per cent. of cases; but in the adult in seventy-six per cent. of persons it is deflected to one side, and more frequently to the left. This deflection should not be mistaken for a bony growth of the septum.

The frequency of deviation of the nasal septum is supposed to be due to the practice of always blowing the nose with the same hand. This condition, by obstructing one nasal fossa, retards breathing and impairs the resonance of the voice, which should be perfect in those who sing.

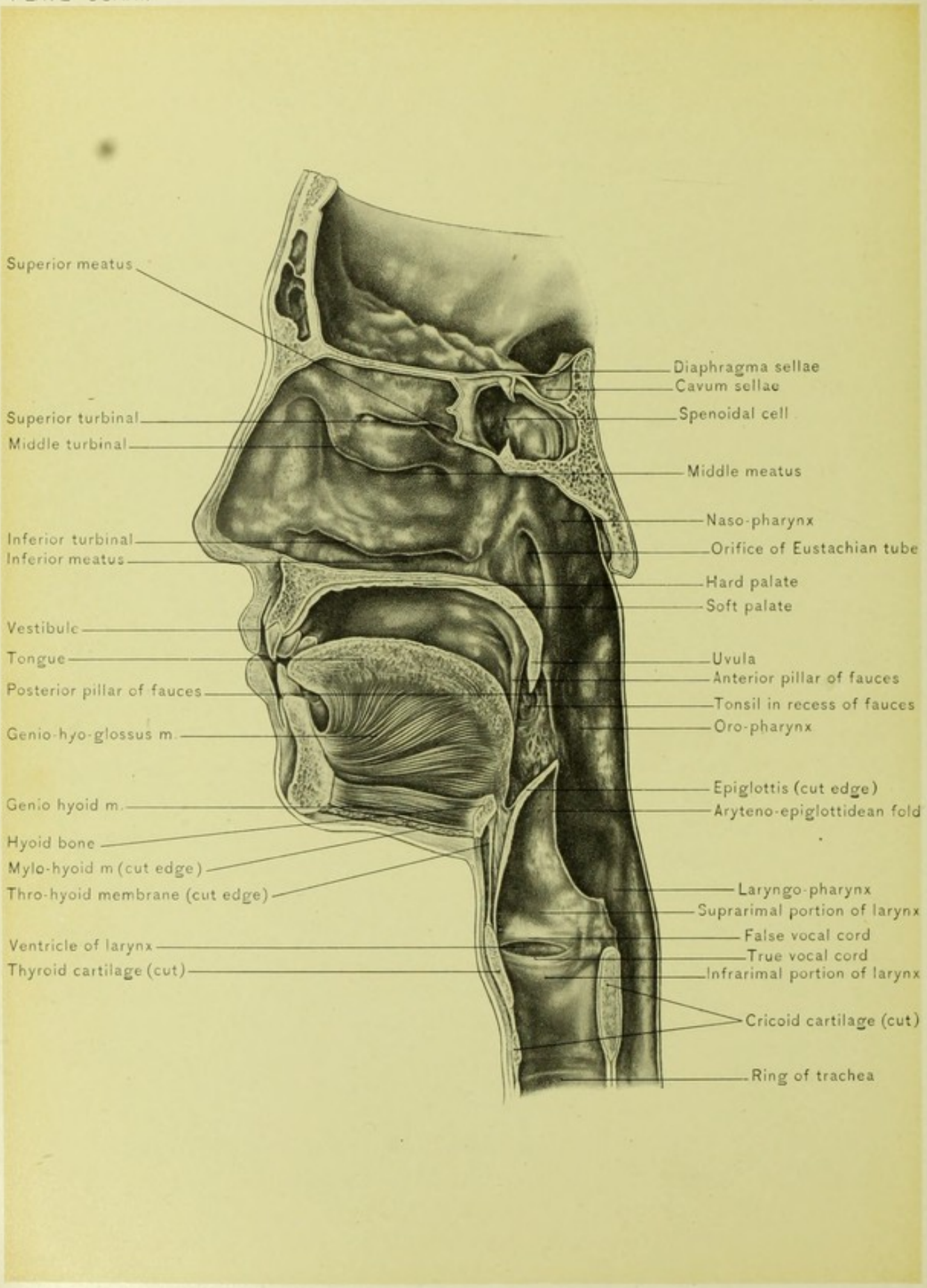
Perforation of the nasal septum may occur in persons exposed to the vapor of chromic acid in the manufacture of potassium bichromate, in syphilitic individuals, and in scrofulous persons, or may be a congenital condition.

The **roof** of the nasal cavities is formed by the nasal bones, nasal spine of the frontal bone, cribriform plate of the ethmoid bone, sphenoid turbinated bones, body of the sphenoid bone, alæ of the vomer, and sphenoid processes of the palate bones. The middle portion of the roof, formed by the cribriform plate of the ethmoid bone, is horizontal, its anterior portion slopes downward and forward, and its posterior portion downward and backward. A meningocele projecting through the roof of the nasal fossa into the nasal cavity has been mistaken for a polypus and removed, with a fatal result. In fracture of this portion of the base of the skull blood or cerebro-spinal fluid may escape through the nose.

The middle portion of the roof of the nose is so thin that it may easily be punctured and the cranial cavity entered by slender instruments or foreign bodies introduced in the nose, either intentionally or accidentally.

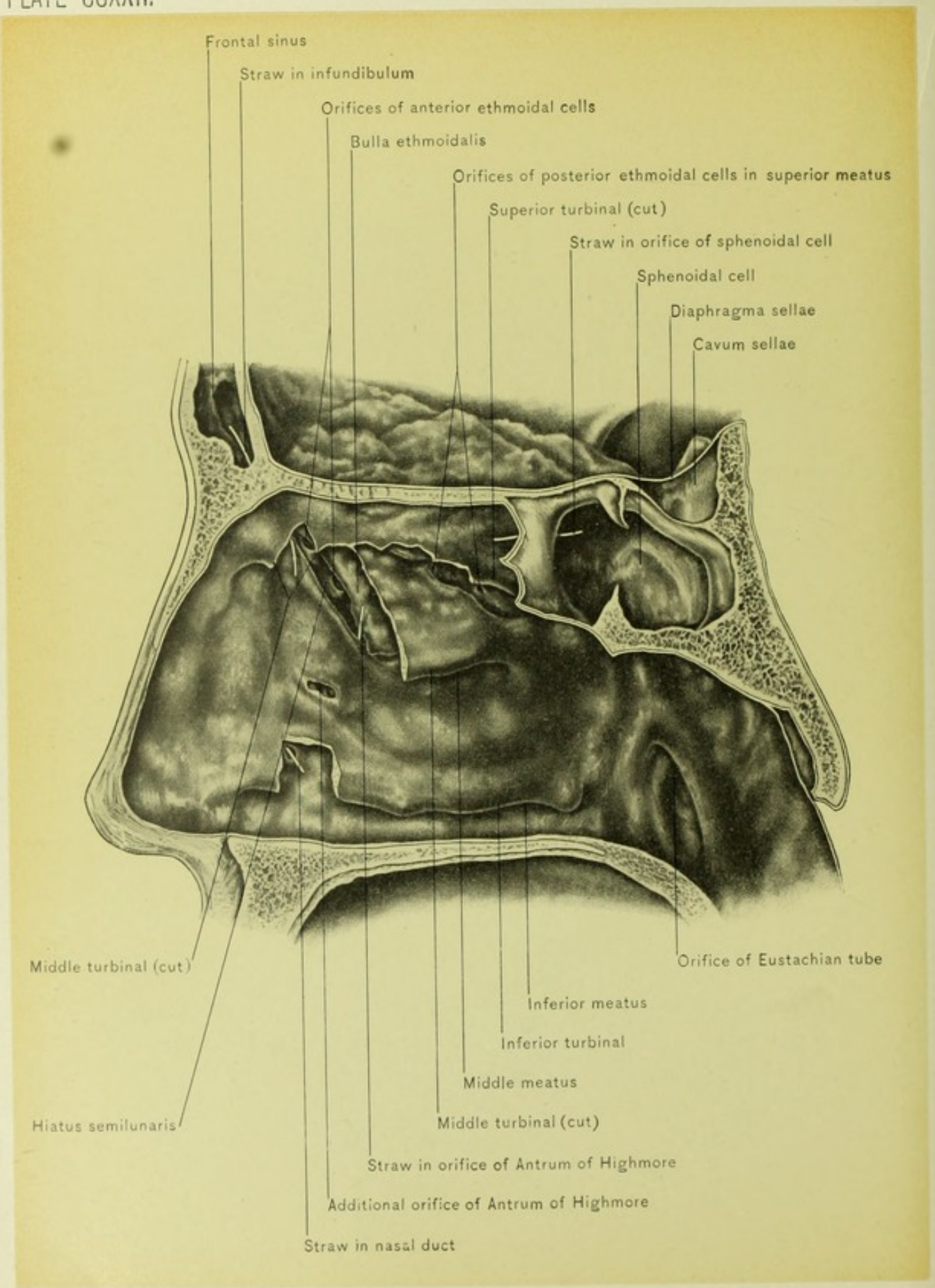
The **floor** of the nose is wider than the roof, being slightly more or less than one-half of an inch wide. It is formed by the palatal processes of the superior

PLATE CCXXI.



MEATUSES OF NOSE AND TURBINATED BONES—LATERAL VIEW.

PLATE CCXXII.



ORIFICES OF ACCESSORY AIR-CHAMBERS OF NOSE.

maxillæ and the horizontal plates of the palate bones. It is somewhat concave from side to side, and slopes slightly downward and backward.

The **outer wall** of the nasal fossa is formed by the nasal process and internal surface of the superior maxilla, the inferior turbinated bone, the lacrymal bone, the lateral mass of the ethmoid bone, the vertical plate of the palate bone, and the internal pterygoid plate of the sphenoid bone. The outer wall is made irregular by projection of the superior, middle, and inferior turbinated bones into the nasal cavity.

The **superior turbinated bone** is situated on the upper part of the outer wall in the posterior one-third of the cavity, its anterior and highest portion being about opposite the tendo oculi. The **middle turbinated bone** extends along the posterior two-thirds and the **inferior turbinated bone** along nearly the whole length of the outer wall of the nasal fossa. The recesses beneath the turbinated bones are called meatuses. Of these there are three—viz., the superior, middle, and inferior meatuses, each situated beneath the corresponding turbinated bone. The **superior meatus** is closed in front and opens downward and backward. It contains the orifices of the sphenoid cells or sinuses and of the posterior ethmoid cells. The orifice of the sphenoid cells is really in the roof of the nasal fossa at the level of the superior turbinated bone, and when that bone is divided into two plates, the orifice is opposite the space between them, known as the **fourth meatus** or **spheno-ethmoid recess of Meyer.** The **middle meatus** is open in front, behind, and below. In front it opens into a broad portion of the nasal cavity, called the *atrium* of the *middle meatus.* The atrium opens widely anteriorly into the vestibule, allowing most of the inhaled air to pass through the middle meatus. On the lateral or external wall of the middle meatus is a groove known as the **hiatus semilunaris,** which begins at the lower extremity of the infundibulum and curves from above backward and downward. The orifices leading to the antrum of Highmore and to the anterior ethmoid air cells are in this groove. The **bulla ethmoidalis** is the rounded upper boundary of the hiatus semilunaris. The orifice of the antrum of Highmore is about an inch above the floor of the nose. The **inferior meatus** opens chiefly downward and backward, so that more exhaled than inhaled air passes through it. It presents the inferior orifice of the lacrymo-nasal (nasal or lacrymal) duct, which carries the tears from the lacrymal sac to the nose. The opening of the nasal duct is at the under surface of the attached margin of the inferior turbinated bone, about an inch behind the anterior nares, and three-fourths of an inch above the floor of the nose. Instruments to be introduced into the inferior meatus must be directed toward the floor of the nose, or the anterior end of the inferior turbinated bone will guide them into the middle meatus, which is more widely open. Foreign bodies are most frequently

found in the inferior meatus. If these bodies are retained for a long time, concretions of calcareous matter adhere to them and thus *rhinoliths* are formed.

The turbinated bones or other portions of the walls of the nasal cavities may be the site of *necrosis*, which causes a purulent discharge usually from one nostril. The carious bone should be removed, and when the disease is situated high up, Rouge's operation offers a good exposure of the nasal cavities. In this operation the upper lip is everted, and the tissues of the lip and nose are detached from the external surface of the superior maxillæ.

A *chronic purulent discharge* from one nostril is usually caused by the presence of a foreign body or carious bone in the nasal fossa or one of its accessory cavities; and from both nostrils by constitutional disease, as syphilis.

The nasal cavities are divided, according to function, into the **olfactory portion,** which includes the superior meatus, middle turbinated bone, and upper two-thirds of the septum of the nose, and the **respiratory portion,** which includes the middle meatus, inferior turbinated bone, inferior meatus, and lower one-third of the septum.

The nasal cavities are lined by a **mucous membrane** (Schneiderian or pituitary membrane) which is continuous with that of the pharynx, sphenoid and ethmoid cells, frontal sinuses, antra of Highmore or maxillary sinuses, lacrymonasal ducts, and lacrymal sacs. This continuity with the adjacent mucous membrane and with the lining of the accessory cavities of the nose, as the various air sinuses are called, is very important to remember, for there is a marked interrelation existing between the diseases of these various parts. Empyema of the frontal and ethmoid air sinuses, for instance, and of the antrum of Highmore is usually dependent upon disease of the nasal mucosa. In the olfactory portion the mucosa is of a yellowish color, which gradually fades below, making no marked line between the mucous membrane of the two portions. Over the nasal septum it is rather firmly adherent to the underlying periosteum; at times submucous hematomata of the septum are seen after injury of the nose. On the anterior inferior portion of the septum the mucous membrane presents a little diverticulum, which is the remains of Jacobson's organ. This organ is more highly developed in the lower animals. At the upper two-thirds of the septum and outer wall (in the olfactory portion) the mucous membrane is delicate and thin, and contains the branches of the olfactory nerve. In the lower or respiratory portion of the nasal fossa the mucous membrane is thicker, more vascular, and pale red in color. This is especially noticeable over the lower borders and posterior extremities of the middle and inferior turbinated bones, where it is soft and boggy and projects beyond the bones. This condition is due to the presence of a large number of veins in the submucous layer of the mucous membrane of the middle and inferior

turbinated bones, and to the presence of cavernous spaces of erectile tissue in that of the inferior turbinated bone. In chronic nasal catarrh these cavernous spaces are distended with blood, the nasal cavity is occluded, and the individual is unable to breathe through the nose. The mucous membrane of the anterior extremity of the inferior turbinated bone, when distended, resembles a polypoid growth.

Instruments, such as specula or tubes of atomizers, introduced through the anterior nares should be directed slightly outward to avoid striking the septum, which causes pain, and to prevent injury to the mucous membrane, which often bleeds after slight traumatisms.

Mucous polypi are frequently developed in the nose, and usually from the mucous membrane of the superior or middle turbinated bone or near the hiatus semilunaris. They occlude the nasal cavity, may broaden the nose, compressing the nasal ducts, and may project through the anterior or posterior nares. They should be removed, and if they continue to recur, a portion of the adjacent bone should be removed, exercising sufficient care to avoid fracturing the cribriform plate of the ethmoid bone. Fibrous or sarcomatous polypi arise from the periosteum and more frequently from the roof of the nose.

Bleeding from the nose (**epistaxis**) is one of the prodromal symptoms of typhoid fever, but it is more commonly due to other causes, such as engorged vessels, as in plethoric individuals, or ulceration into an artery, and may be a symptom of fracture of the base of the skull, purpura hemorrhagica, hemophilia, scurvy, or ptomain poisoning, as from large abscesses. Hemorrhage from the nose is checked by the laity by pressure on the upper lip, which occludes the artery of the septum; by plugging the anterior nares; by raising the arm and increasing the expansion of the chest, which lessens the pressure in the veins; and by dropping a cold key down the back, or applying cold water to the back of the neck, and thus stimulating the vasomotor nerves. If the source of a serious hemorrhage can not be found, the bleeding can be checked by plugging both the anterior and posterior nares, which is done by introducing a strong thread, stiffened by soaking in gum and drying, into the nose and pharynx, and bringing it out through the mouth and attaching a plug of cotton to it; or a soft catheter may be threaded and carried through the nose into the pharynx. One end of the thread is brought out through the mouth with forceps, and the other through the nose in withdrawing the catheter. A plug of cotton the size of a walnut is then attached to the string, the two ends of which are tied together so that the plug can be pulled against the posterior nares, or withdrawn and reapplied if necessary. The instrument specially designed for plugging the posterior nares is Bellocq's cannula.

Ozena is the name given to any affection of the nasal fossæ giving rise to a foul discharge from the nose. A fetid purulent discharge from both nostrils may

be a symptom of atrophic rhinitis, syphilis, carcinoma, glanders, or occasionally necrosis; and from one nostril a symptom of rhinoliths (incrusted foreign bodies), necrosis, or empyema of one of the accessory cavities of the nose.

The **vestibule** of the nose is that portion of the nasal fossa within the cartilaginous portion of the nose, and is lined with skin which blends with the mucous membrane of the nose.

The **mucous glands** are most numerous over the posterior portion of the outer wall and septum of the nose. The position of these glands and the backward and downward slope of the nasal floor accounts for the gravitation of the mucus to the pharynx. Occlusion of the duct of a mucous gland causes the formation of a retention cyst.

Some lymphoid tissue is also found in the nasal mucous membrane.

Nerve Supply.—The nerve supply of the nasal mucous membrane is derived from the olfactory, nasal, and naso-palatine nerves, branches from Meckel's ganglion and the Vidian nerve, branches from the anterior superior dental nerve, and branches from the anterior palatine nerve.

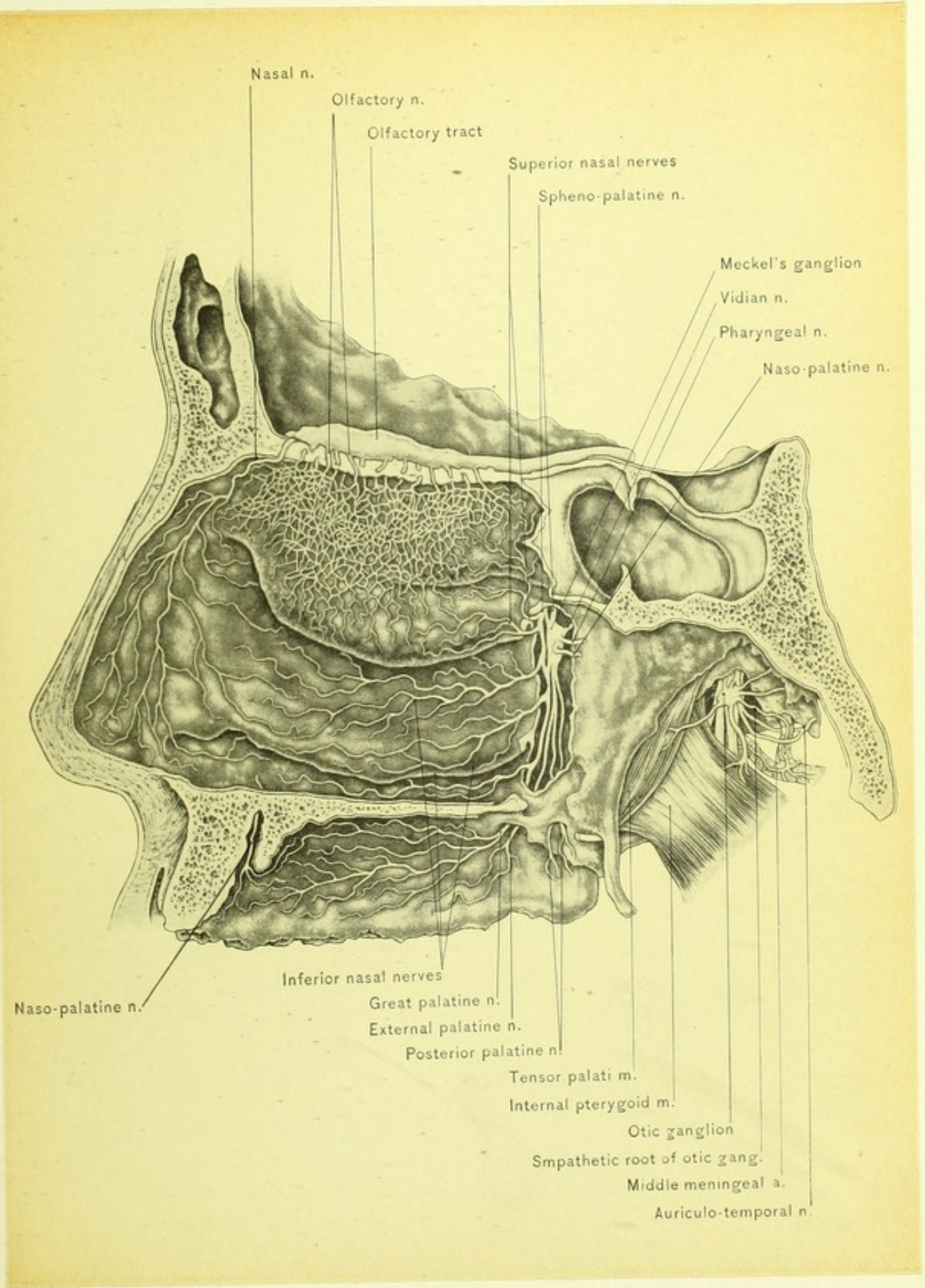
The **olfactory nerves,** which arise from the olfactory bulb, enter the nasal fossa by piercing the cribriform plate of the ethmoid bone as numerous branches. The internal or mesial branches ramify upon the upper one-third of the septum, and the external branches upon the superior turbinated bones and the surface of the ethmoid above and in front of these bones. They form plexuses in and beneath the mucous membrane. *Anosmia*, or loss of the sense of smell, after a severe blow upon the head is supposed to be due to rupture of the olfactory nerves where they pass through the cribriform plate.

The **nasal nerve** is a branch of the ophthalmic division of the fifth cranial nerve. It reaches the nasal fossa by passing through the slit at the side of the crista galli, runs downward in the groove on the internal surface of the nasal bone, and passes forward between the nasal bone and the upper lateral cartilage to supply the tip of the nose. It supplies branches to the anterior portion of both the outer wall and the septum of the nose.

The **naso-palatine nerve** is a branch of Meckel's ganglion, and enters the nasal fossa with the naso-palatine artery at the spheno-palatine foramen. It crosses on the body of the sphenoid bone to the septum, upon which it runs downward and forward, supplying its middle portion.

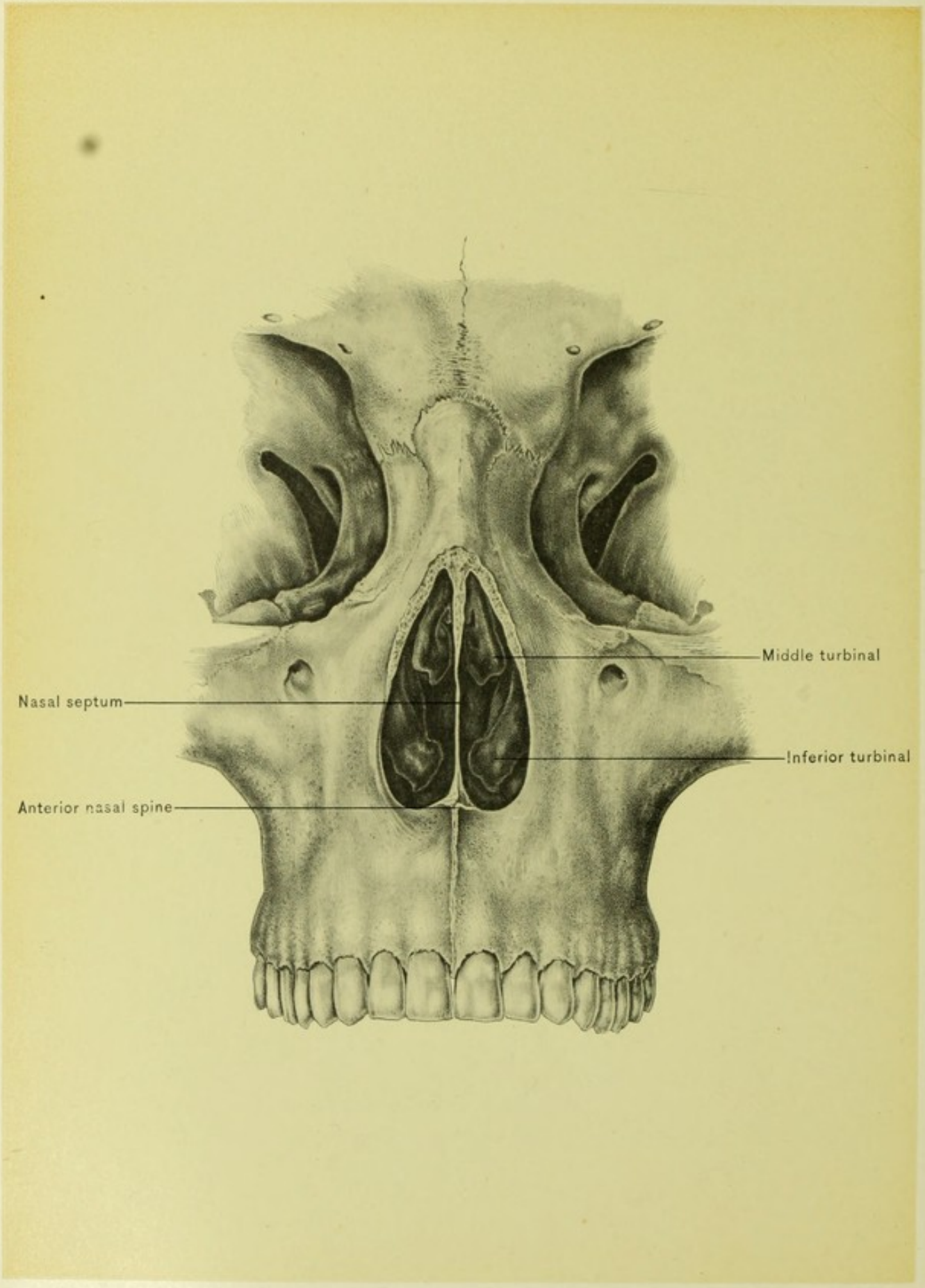
The branches from the **Vidian nerve** and the anterior branches of **Meckel's ganglion** are small. They supply the upper and back part of the septum and the superior turbinated bone. They can seldom be traced.

The branches of the **anterior superior dental branch of the superior maxillary nerve** supply the inferior turbinated bone and the inferior meatus. The



OLFACTORY NERVES.

PLATE CCXXIV.



ANTERIOR VIEW OF NASAL FOSSÆ.

branches from the anterior palatine nerve (inferior nasal nerves) run forward upon the middle and inferior turbinated bones.

Blood Supply.—The blood supply of the nasal cavities is derived from the spheno-palatine, descending palatine, anterior and posterior ethmoid arteries, and the artery of the septum.

The **spheno-palatine artery,** a branch of the internal maxillary, is the principal artery of the nasal fossa. It enters it at the spheno-palatine foramen with the naso-palatine nerve. Its internal branch, the naso-palatine, accompanies the naso-palatine nerve downward and forward upon the septum toward the anterior palatine foramen. Its external branches supply the outer wall of the cavity, the ethmoid cells, frontal sinus, and antrum of Highmore.

The **descending palatine artery** is also a branch of the internal maxillary artery. It gives off a few small branches to the posterior portion of the outer wall of the nasal fossa.

The **anterior and posterior ethmoid arteries** are branches of the ophthalmic artery. They supply the roof, upper portion of the septum, and outer wall of the nasal fossa, ethmoid cells, and frontal sinuses.

The **artery of the septum** is derived from the superior coronary branch of the facial artery. It supplies the columna and the lower portion of the septum.

The **veins of the nasal cavities** form a plexus under the mucous membrane. The plexus is drained by the veins which accompany the spheno-palatine artery and empty into the pterygoid plexus; those which follow the ethmoid arteries and empty into the ophthalmic vein; some which pass through the foramina in the nasal bone and nasal process of the superior maxilla to empty into the facial vein; and others which pass through the foramen cæcum to join the superior longitudinal sinus and through the cribriform plate of the ethmoid bone to join the intra-cranial veins.

The **lymphatic vessels** of the muco-periosteal lining and walls of the nasal fossæ terminate in the post-pharyngeal lymphatic gland, the internal maxillary lymphatic glands, the parotid lymphatic glands, and the superior deep cervical lymphatic glands. Through the cribriform plate of the ethmoid bone these vessels communicate with the intra-cranial lymphatics and the subdural space, affording a channel through which meningitis may be produced by caries of the upper portion of the wall of the nose. Involvement of the post-pharyngeal, internal maxillary, parotid, and superior deep cervical lymphatic glands may also result from disease of the nasal fossæ.

In **anterior rhinoscopy,** or examination of the nasal fossa through the anterior naris, the following structures can be observed: The septum, which should occupy a vertical position, and, if it deviates toward the fossa under examination, it

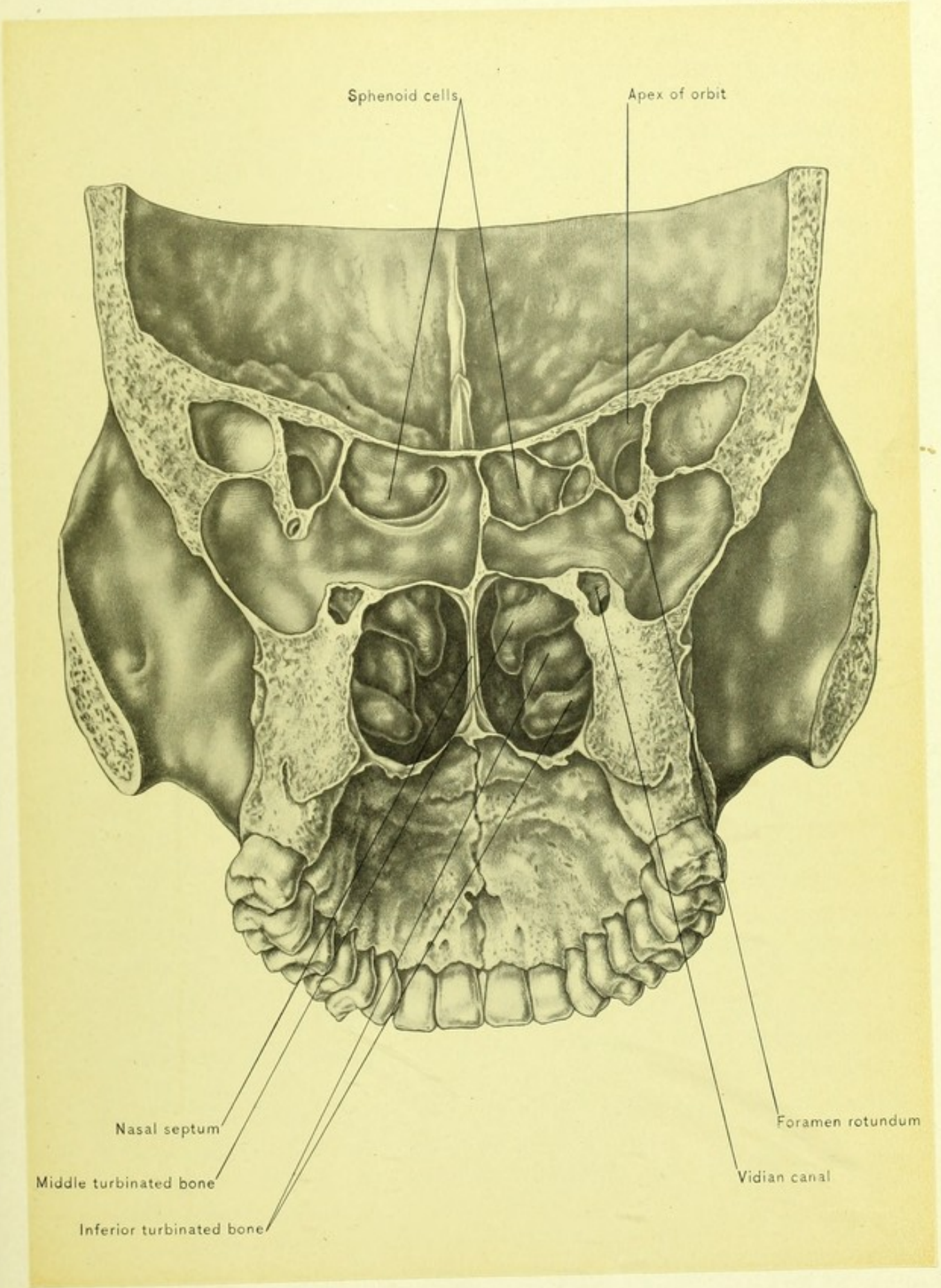
should not be mistaken for a tumor; the floor of the nose; the inferior turbinated bone, which extends backward along the outer wall of the fossa; the middle meatus; the middle turbinated bone; and high up the superior meatus and the anterior extremity of the superior turbinated bone.

Posterior rhinoscopy, or examination of the nasal fossæ through the posterior nares is quite difficult, and can be performed only after some practice. A small mirror, similar to a laryngoscopic mirror, is inserted behind the soft palate, while the patient breathes through the nose and the tongue is depressed by the examiner. By means of light reflected through the mouth the following structures can be seen: The posterior nares, separated by the posterior margin of the nasal septum; the upper or attached portion of the inferior turbinated bone; the middle meatus; the middle turbinated bone; the superior meatus; the superior turbinated bone; the roof of the naso-pharynx; the upper part of the posterior wall of the naso-pharynx; the pharyngeal tonsil; the upper part of the lateral wall of the naso-pharynx; the pharyngeal recess; and the profile of the trumpet-shaped orifice of the Eustachian tube.

Nasal douche.—In nasal catarrh the nasal fossæ are frequently cleansed by spraying or douching with an alkaline solution. In using the nasal douche the solution flows in one anterior naris and out through the other, elevation of the soft palate against the posterior wall of the pharynx preventing the solution from passing into the oro-pharynx. The bottom of the vessel containing the solution should not be placed above the level of the eyebrows, and the head should be inclined slightly forward so that the solution will not enter the Eustachian tubes, the orifices of which are on a level with the posterior extremities of the inferior turbinated bones. If the solution should enter the middle ear through the Eustachian tube, otitis media and deafness might result.

Dissection.—The student should now turn the superior turbinated bone upward, and with a probe search for the orifices of the sphenoid sinus and posterior ethmoid cells; remove the anterior portion of the middle turbinated bone, to find the orifices of the antrum of Highmore, anterior ethmoid cells, and the infundibulum, and cut away the anterior portion of the inferior turbinated bone to see the inferior opening of the lacrymo-nasal duct. The frontal and sphenoid sinuses have been opened in sawing through the skull, so they can be satisfactorily studied.

The **frontal sinuses** are situated between the inner and outer tables of the frontal bones, at the position of the superciliary eminences and glabella. They are absent before the seventh year, when they originate as extensions of the anterior ethmoid cells, and reach their full development at about the twentieth year. The anterior or external bony wall of the sinuses is the thicker of the two, and, upon careful examination, it can usually be seen to consist of two laminæ, between



POSTERIOR VIEW OF NASAL FOSSÆ.

which there is a thin diploic layer. The weakest and thinnest portion of this external wall is just above the inner angle of the orbit, and when a collection of pus in the frontal sinus bursts externally, it is usually at this point that the opening occurs. Such a fistulous opening may be mistaken by the careless observer for a fistula lachrymalis.

The frontal sinuses are extremely variable in size and form. A thin osseous partition usually separates one sinus from the other; this septum may, however, be incomplete. In many cases these sinuses extend backward for a considerable distance over the roof of the orbit. Additional septa may divide the cavity into subcompartments, and, furthermore, one or two of the ethmoid cells may bulge into the sinus. In women they are comparatively small. In some individuals they are quite small, or even absent, and this is said to be the common condition in skulls which have a midfrontal suture. They open into the middle meatuses of the nasal fossæ by means of the infundibula. They are lined by mucous membrane, which is an extension of that of the nose and is supplied by filaments of the nasal nerve.

Congestion of the mucous membrane of the frontal sinuses, which is likely to be associated with acute coryza, or "cold in the head," produces the dull ache over the glabella and superciliary eminences in that affection. When drainage from the sinuses is insufficient, mucus becomes inspissated within them.

Empyema, or a purulent collection *in the frontal sinus*, is often associated with occlusion of the infundibulum, and, because of the unyielding character of the walls of the sinus, causes much pain. If the infundibulum is patulous, the pus appears in the middle meatus of the nose. For the proper treatment of this affection it is necessary to trephine the anterior wall of the sinus, reestablish the communication with the nose, and institute drainage by means of a tube passed into the nasal fossa. The incision is made just below the supra-orbital margin, and extends from the root of the nose outward for about an inch. A small trephine or a drill is applied just above the inner angle of the orbit, where the bone is thin.

The *external table of the skull may be fractured* and depressed at the position of the frontal sinuses without injuring the inner table or affecting the cranial contents, and the inspissated mucus escaping from the sinus may be mistaken for brain matter. These fractures are often accompanied by emphysema, in which case the air is derived from the nose by way of the infundibulum.

Living foreign bodies, such as centipedes, maggots, and insects, may enter the frontal sinuses by passing up the infundibulum.

A *polypus* is sometimes found in one of the frontal sinuses. It may originate in the sinus or in the nose, and enter the sinus by way of the infundibulum. If it

continues to enlarge, it may bulge the anterior wall or orbital wall of the sinus and displace the eyeball. It can be removed by trephining the anterior wall of the sinus.

Dissection.—The antrum of Highmore, or maxillary sinus, should be opened by sawing away part of its external wall.

The **antrum of Highmore,** or **maxillary sinus,** is an accessory air chamber of the nose, and is situated in the superior maxillary bone. It is irregularly pyramidal in shape, the base of the pyramid being directed toward the nose, and the apex toward the malar process of the superior maxilla. The base is formed by the external wall of the nasal fossa—*i. e.*, by the nasal surface of the superior maxilla, the maxillary process of the inferior turbinated bone, the uncinate process of the ethmoid bone, the vertical plate of the palate bone, and the lacrymal bone. In the upper and posterior part of this surface is the orifice of the sinus, which is so situated that drainage from the antrum is defective. Consequently, mucus or pus may be retained in the cavity, forming a mucocele or empyema of the antrum. The roof of the antrum is formed by the orbital plate of the superior maxilla, the floor by the alveolar process of the superior maxilla, the anterior or external wall by the facial surface of the superior maxilla, and the posterior wall by the zygomatic surface of the superior maxilla.

The antrum is usually larger in the male than in the female. In young subjects the antrum is small and its walls are quite thick; absorptive processes in old age may cause a defect in the anterior bony wall. The two antra are frequently asymmetric in size and shape. The roots of the first and second molar teeth often, and those of the premolars and canine teeth occasionally, form prominences in the floor of the cavity. It is evident that caries of these teeth and their fangs may lead to antral disease.

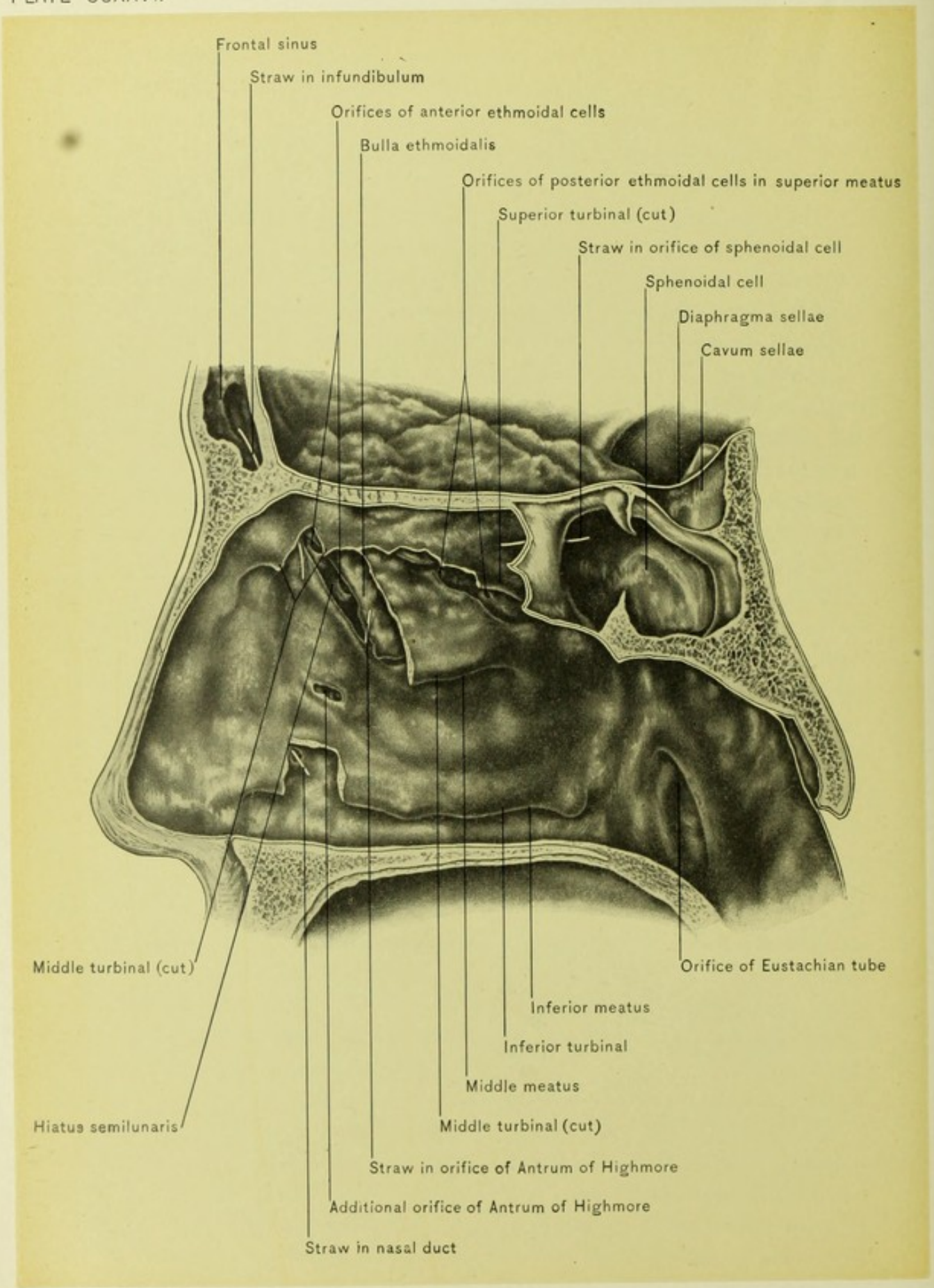
The *mucous membrane* of the maxillary sinus is thinner and less vascular than that of the nasal fossa.

The *orifice* of the antrum opens into the lower part of the hiatus semilunaris and the middle meatus of the nose. The orifice is small and rounded or elliptic. In empyema and mucocele of the antrum the orifice is usually closed by thickening of the mucous membrane of the nose in rhinitis. There may be one or more additional orifices leading into the nasal fossa.

The *tumors* which originate in the antrum may be either malignant or benign. By pressure upon the walls of the sinus they encroach upon the orbital and nasal fossæ, lacrymal duct, pterygo-maxillary region, and mouth, and cause bulging of the cheek. The malignant tumors are removed by excising the superior maxilla.

Empyema, or *abscess of the antrum*, may be caused by extension of catarrh from the nose to the antrum, with occlusion of the antral orifice, retention of

PLATE CCXXVI.



ORIFICES OF NASAL DUCT AND ACCESSORY AIR-CHAMBERS OF NOSE.

mucus, and formation of pus; by diseased fangs of teeth projecting into the cavity; by fevers, as scarlet fever; and by injury. If the orifice of the antrum is not occluded, the pus may escape into the middle meatus by overflowing, which is favored by lying upon a horizontal surface with the opposite side of the face resting upon that surface. If the orifice is closed, it will be necessary to drain the antrum by extracting a carious bicuspid or molar tooth which may cause the abscess, and forcing a trocar through the alveolus into the antrum. If the teeth are not diseased, the sinus may be opened by everting the upper lip and drilling or trephining the canine fossa just above the second bicuspid tooth, or by drilling the nasal wall of the cavity in the middle or inferior meatus of the nose.

In *dropsy of the antrum*, or hydrops antri, a glairy or thin serous fluid occupies the maxillary sinus. It arises from cystic degeneration of the mucous membrane.

Dentigerous cysts of the antrum arise through abnormal development of a tooth, which may be caused by failure to lose one of the temporary teeth.

The **ethmoid sinuses** or **cells** are situated in the lateral masses of the ethmoid bone. On each side they are divided into two sets—an anterior and a posterior. The anterior set forms a rounded eminence, the *bulla ethmoidalis*, situated in the outer wall of the nasal fossa just above the hiatus semilunaris, into which many of the cells open. The remaining anterior ethmoid cells open directly into the middle meatus of the nose. The posterior ethmoid cells open into the superior meatus of the nose. The ethmoid cells are lined by muco-periosteum continuous with that of the nasal fossa, and may be affected by catarrhal inflammation extending from the nose, by necrosis, mucocele, or malignant or benign growths.

The **sphenoid sinuses** or **cells** are located in the body of the sphenoid bone. They are usually two in number, being separated by a delicate septum. They are lined by muco-periosteum continuous with that of the nose and roof of the pharynx. Their orifices are situated in the posterior part of the roof of the nose, opposite the posterior extremity of the superior turbinated bone, and are said to open into the superior meatus of the nose. They may be the site of catarrh and malignant or benign growths.

Dissection.—The student should now remove the mucous membrane from the septum and the outer wall of the nose, and trace the vessels and nerves previously described. If the otic ganglion has not been destroyed and the part is in good condition, the ganglion may be seen by carefully removing the cartilaginous portion of the Eustachian tube and tracing upward the nerve to the internal pterygoid muscle. The ganglion will be found on the inner side of the inferior maxillary nerve, below the foramen ovale. For description of the otic ganglion, see volume I, page 555.

THE ORBIT.

The **Orbits** are two irregularly conic or pyramidal cavities which contain the eyeballs and their accessory structures—muscles, vessels, nerves, and fat. The walls of each orbit are lined with a loosely attached periosteum or periorbita. The orbit has an apex, a base, and four walls.

The **apex of the orbit** is directed backward, and is situated at the optic foramen, through which the optic nerve and ophthalmic artery enter the orbit.

The **base of the orbit** is directed outward and forward, and is the only wall of this cavity which is absent or not filled by bone. The margins of the base are: above, the supra-orbital margin; below, the infra-orbital margin. They project beyond the eyeball and protect it from injury by blows from large objects. The orbital margins are formed above by the frontal bone; externally, by the malar bone; internally, by the nasal process of the superior maxilla; below, by the malar bone and the body of the superior maxilla. The supra-orbital margin contains the supra-orbital notch—a landmark in operations upon the supra-orbital and infra-orbital nerves. This notch is situated at the junction of the inner one-third with the outer two-thirds of that margin, and transmits the supra-orbital vessels and nerves.

The **roof of the orbit** is formed by the orbital plate of the frontal bone and the lesser wing of the sphenoid bone. The frontal sinuses frequently project backward into that part of the orbital roof formed by the frontal bone; consequently tumors or an empyema of the frontal sinus may encroach upon the orbit and cause displacement of the eyeball and double vision—diplopia. At the outer side, near the base of the orbit, the roof presents a large depression—the lacrymal fossa—for the lacrymal gland; and at the inner side, near the base of the orbit, the small depression to which the pulley of the superior oblique muscle is attached. On account of the relation between the orbit and the cranial cavity and the tenuity of the intervening bony wall, a foreign body with a sharp point, such as a foil or stick, may enter the orbit, pierce the roof of that cavity, and penetrate the brain without producing an apparently grave external injury.

The **floor of the orbit** is formed by the superior maxilla, the malar bone, and the orbital plate of the palate bone. Beneath the greater portion of the floor is the antrum of Highmore, tumors of which may encroach upon the orbit, displace the eyeball, and cause diplopia.

The **outer wall of the orbit** inclines obliquely forward and outward, and is formed by the malar bone, the external angular process of the frontal bone, and the greater wing of the sphenoid bone. When dividing the optic nerve in excision of the eyeball, the scissors is more readily introduced on the outer side,

because of the greater space between the eyeball and the outer wall and the outward slope of that wall, which makes a larger angle with the optic nerve than does the inner wall.

The **inner wall of the orbit** is formed by the nasal process of the superior maxilla, the internal angular process of the frontal bone, the lacrymal bone, the os planum of the ethmoid bone, and the body of the sphenoid bone. Near the base of the orbit the inner wall presents a large depression—the lacrymal groove—which lodges the lacrymal sac and below leads into the lacrymal canal, which is lined by the muco-periosteal wall of the lacrymo-nasal duct. In the inner wall of the orbit, and separated from that cavity by a thin bony partition, are the ethmoid cells and the sphenoid cell or sinus. Tumors, empyema, or mucocele of these cells may encroach upon the orbit, displace the eyeball, and cause diplopia.

Measurements.—The antero-posterior diameter of the orbit is about one and three-fourth inches. At the base the vertical diameter is about one and one-fourth inches, and the transverse diameter about one and one-half inches.

The orbit is widely open anteriorly, and posteriorly it is in communication with the cranial cavity through the optic foramen and the sphenoid fissure, and with the pterygo-maxillary region and spheno-maxillary fossa through the spheno-maxillary fissure.

Blood may be extravasated into the orbit after fracture of one of the walls of that cavity, more commonly the roof. Tumors, blood, or pus may enter the orbit from the pterygo-maxillary region through the spheno-maxillary fissure, and from the cranial cavity through the sphenoid fissure. Blood extravasated into the orbit produces subconjunctival ecchymosis.

Dissection.—According to the level at which the calvaria has been removed, there will be found remaining more or less of the vertical plate of the frontal bone, covered in front by the soft parts. The soft tissues should be turned down after making two incisions down to the bone, one running vertically upward from the nasion and the other running parallel to the vertical incision, and starting from the external angular process of the frontal bone. Should there be much of the vertical plate of the frontal bone remaining, it should be removed with hammer and chisel almost as far down as the supra-orbital arch. The roof of the orbit should now be removed, either entirely or all of it except the supra-orbital margin, as suggested by Cunningham. In the former method two cuts, converging at the optic foramen, are made with a saw, leaving the bone around the optic foramen undisturbed, and then, by a firm tap with a mallet, breaking away the orbital roof, and turning it forward. In Cunningham's method the thin plate of bone covering the orbit is removed with a chisel and mallet, leaving intact the

ring of bone around the optic foramen and that constituting the supra-orbital margin. Care should be taken to avoid injuring two structures—the pulley of the superior oblique muscle and the orbital periosteum.

If at the time the dissection of this portion of the body is begun the eyeball has collapsed, it should be inflated. After the periosteum has been opened, carry a ligature loosely around the optic nerve by means of an aneurysm needle; then insert a blowpipe between the optic nerve and its sheath, thrusting it almost, if not quite, into the eyeball. Inflate until the ball is tense; then, while an assistant is slowly withdrawing the blowpipe, draw the ligature tight.

The eyeball is preferably inflated from the front, this procedure being less difficult, more successful, and allowing reinflation when necessary. In this method a sharp needle is introduced obliquely at the sclero-corneal junction. The blowpipe is then inserted through the puncture, and, after the eyeball is distended, withdrawn. The valvular character of the incision is sufficient to prevent rapid escape of the air.

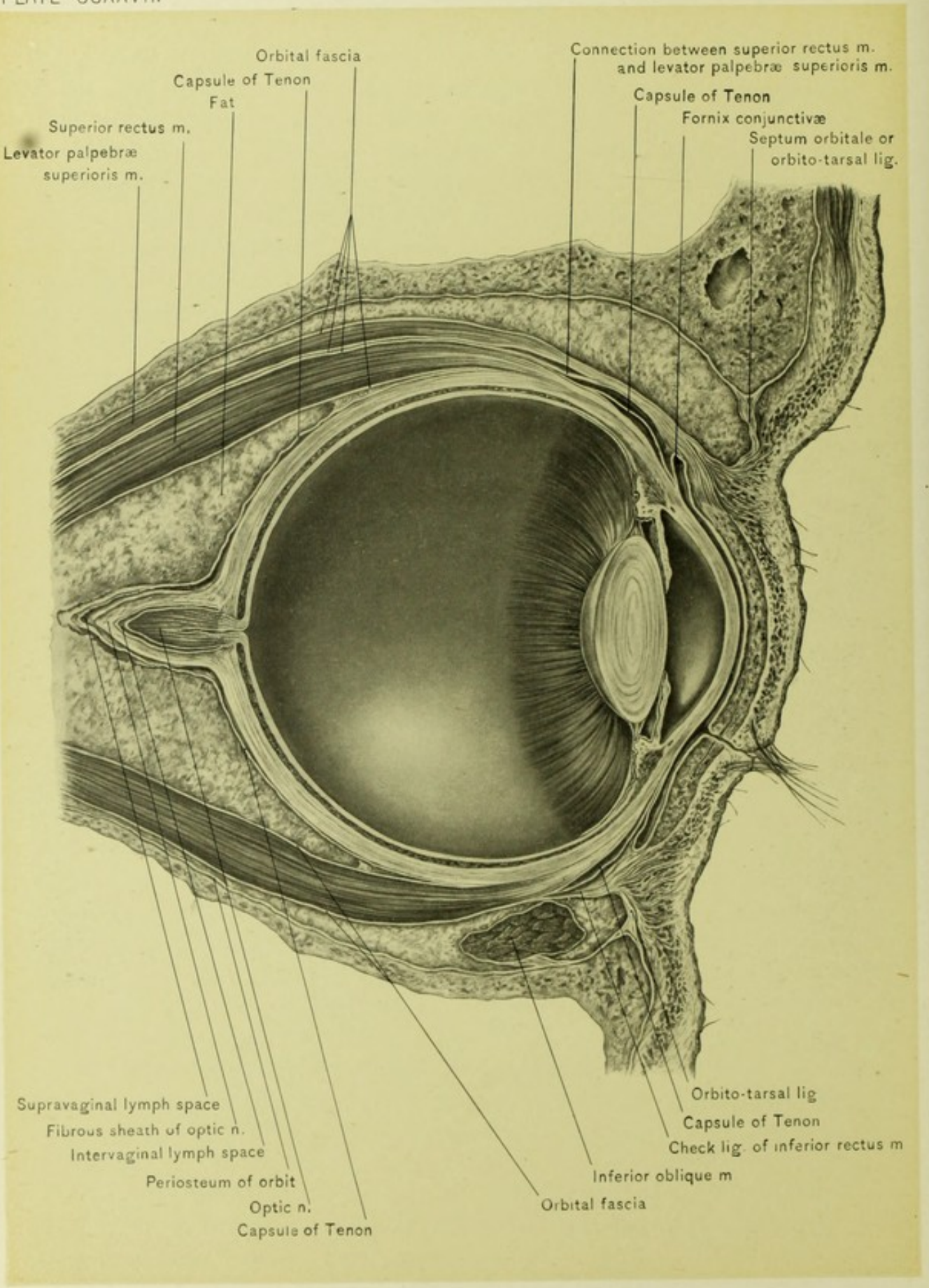
Orbital Periosteum or Periorbita.—The orbital roof having been removed, the periosteum comes into view. It incloses the structures which fill the orbit, and is but loosely attached to the bony walls. It is continuous posteriorly with the endosteal layer of the dura mater through the optic foramen and the sphenoid fissure. Anteriorly the periorbita divides at the orbital margins into two lamellæ —one is continuous with the periosteum on the facial surface of the bones which form those margins, and the other blends with the palpebral fascia of the eyelids.

Dissection.—Two incisions are now made through the periosteum. One is transverse, and runs parallel to the supra-orbital ridge; the other is longitudinal, and runs antero-posteriorly from the optic foramen to the middle of the first incision. Either a very sharp knife must be used, or else a nick should be made in the periosteum and the rest of the cutting done with scissors or with a knife in the trough of a small grooved director. The two flaps thus formed should be carefully turned aside, gently separating them from the underlying structures. Further dissection is much facilitated by drawing forward the eyeball and retaining it in position with a suture or hooks, taking care not to puncture the eyeball, and allow the escape of its contained air.

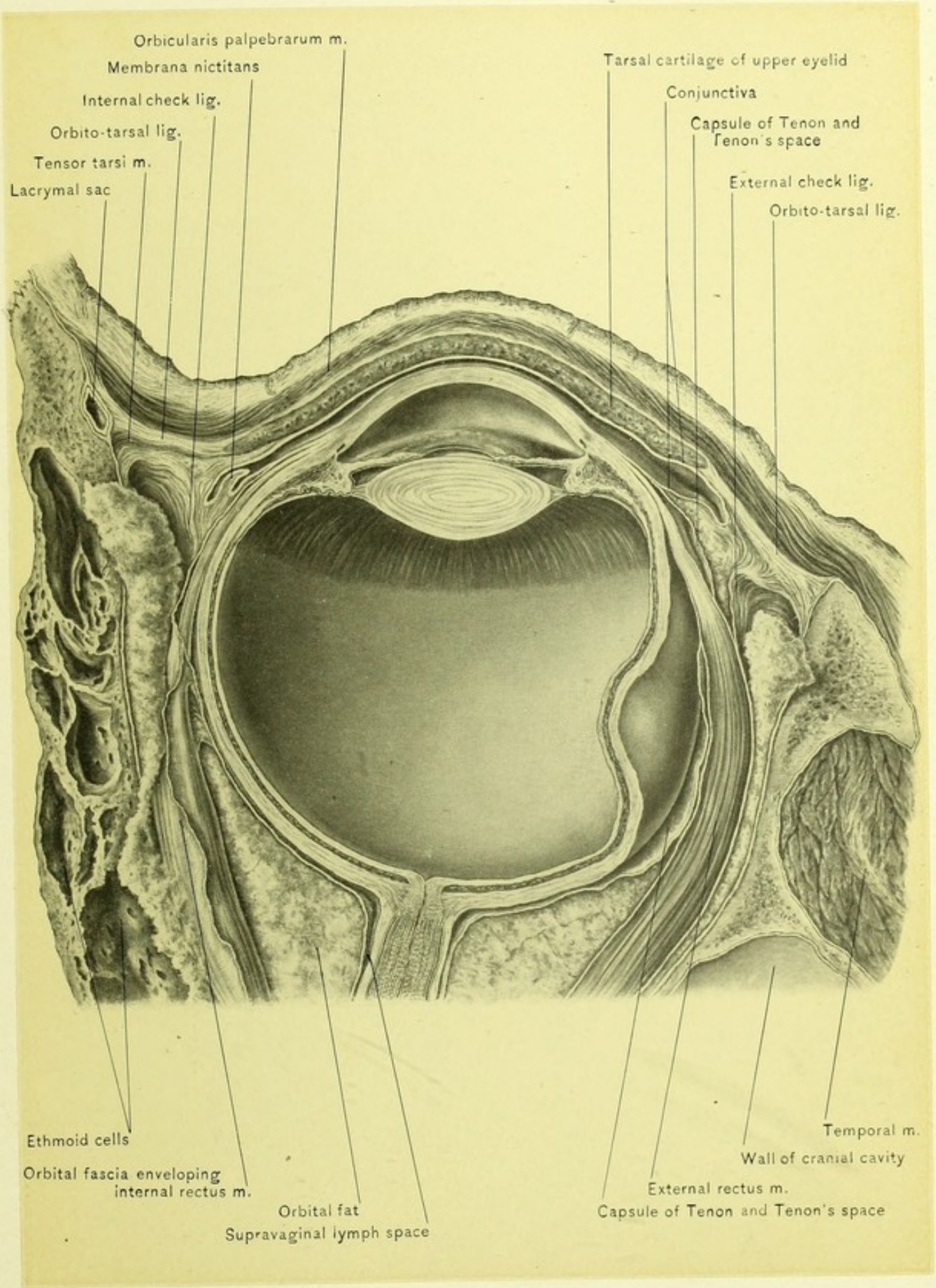
Structures Exposed by Removal of the Periosteum.—The orbital fat, orbital fascia, and frontal nerve are exposed as soon as the flaps of periosteum are reflected. Careful removal of some of the orbital fat will demonstrate a number of structures.

In the median line the frontal nerve is readily demonstrable without dissection. It lies upon the levator palpebræ superioris muscle, and its anterior portion is accompanied by the supra-orbital artery.

PLATE CCXXVII.



ORBITAL FASCIA AND CAPSULE OF TENON—SAGITTAL SECTION.



ORBITAL FASCIA AND CAPSULE OF TENON—TRANSVERSE SECTION.

Running along the outer wall of the orbit, and just above the external rectus muscle, will be seen the lacrymal nerve and artery.

At the front and outer part of the orbit the lacrymal gland appears resting against the lacrymal fossa in the under surface of the horizontal plate of the frontal bone.

Along the inner wall will be seen the superior oblique muscle. At its anterior portion the fibrous ring or pulley through which its tendon works can be demonstrated; and, well back in its course, the fourth or pathetic nerve will be seen entering its fleshy portion.

The orbital fat.—The posterior half of the orbit contains a large mass of stringy, coherent fat, which forms a soft pad or cushion for the support of the eyeball, and fills the interstices between the muscles, vessels, and nerves. The sinking in of the eyeball, coincident with the emaciation of disease or age, is due to partial absorption of this fat.

Orbital abscesses are situated in the orbital fat and may develop therein; they may arise from ocular inflammation, periostitis, injuries, or result from extension from adjacent cavities, as the ethmoid or sphenoid cells, antrum of Highmore, pterygo-maxillary region, or cranial cavity. If the abscess attains a large size, it displaces the eyeball forward, retards its movements, and, through pressure upon the ophthalmic vein and its tributaries, causes congestion of the conjunctiva and swelling of the eyelids.

Foreign bodies may lodge in the orbital fat for a long time without causing much disturbance.

Emphysema of the orbit, or air in the orbital fat, results from rupture of the orbital periosteum and fracture of the wall intervening between the orbit and one of the accessory air-chambers of the nose—viz., the frontal sinuses, ethmoid cells, sphenoid cells, and antrum of Highmore.

The **orbital fascia** resembles the deep fascia of other locations. It envelops and forms sheaths for the muscles, vessels, and nerves of the orbit, and sends partitions or septa into the orbital fat which separate it into lobules. Posteriorly, or at the apex of the orbit, the orbital fascia is continuous with the orbital periosteum around the origins of the muscles. It passes forward as a single layer between the muscles, and where each of the muscles is located it exists as two layers which envelop the muscle. Near the apex of the orbit it is thin and lax, but as it passes forward it becomes much stronger and more adherent to the muscles. About opposite the equator of the eyeball it divides into two laminæ—the anterior and the posterior. The anterior lamina of the orbital fascia passes forward to blend with the orbital periosteum at the orbital margin and to the deep surface of the palpebral fascia in the eyelids, thus forming a funnel-shaped parti-

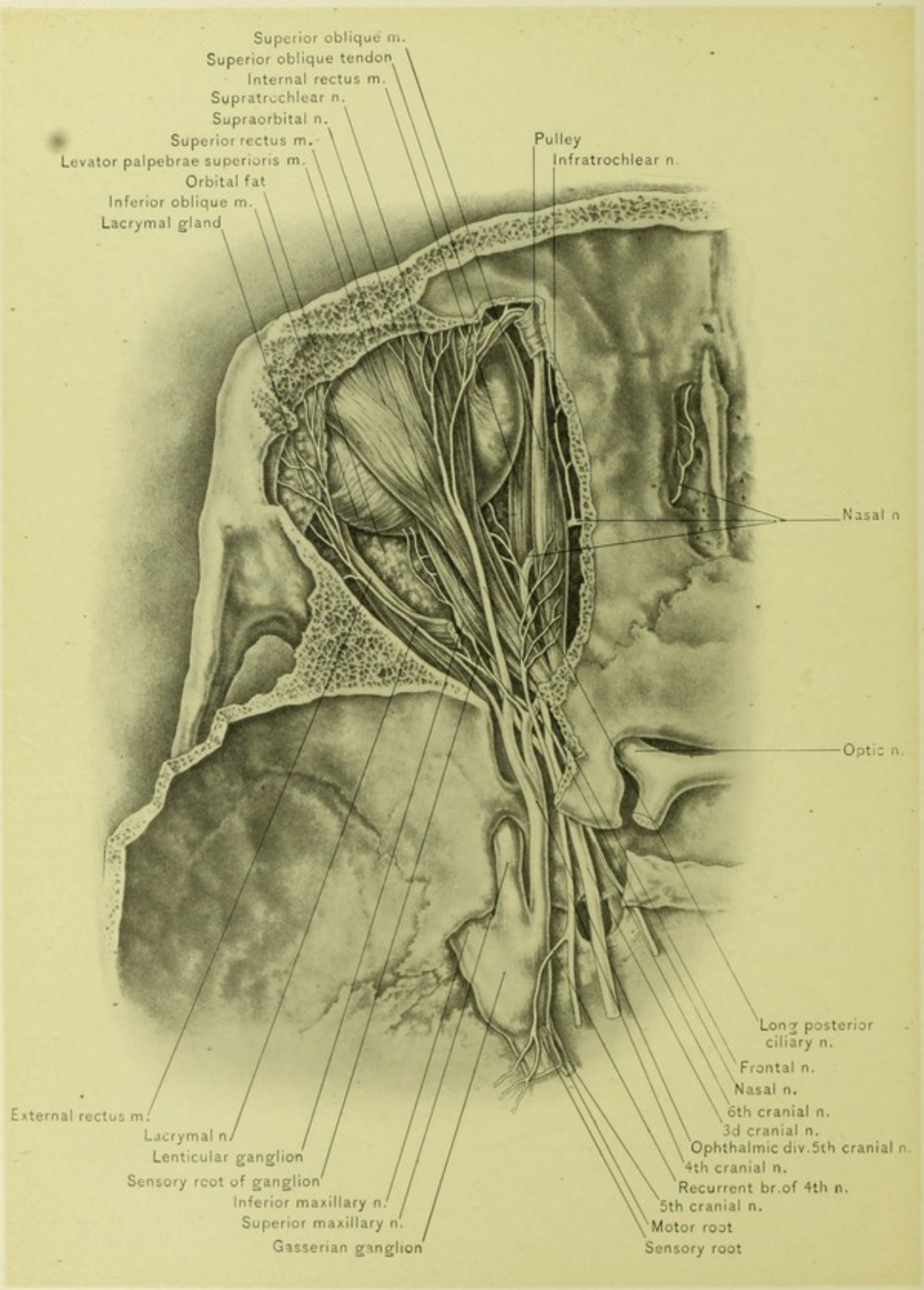
tion which supports the fornix of the conjunctiva. The posterior lamina turns backward behind the posterior one-third of the eyeball, and loosely envelops the optic nerve and its sheath.

The anterior lamina is a strong membrane throughout its extent, and that portion of it beneath the eyeball has been called the *suspensory ligament of the eyeball* because, after excision of the superior maxilla, the lower portion of the anterior lamina forms a hammock-like sling which supports the eyeball and prevents it from sinking downward. This ligament is attached externally to the malar bone, and internally to the crest of the lacrymal bone. Where the four rectus muscles are located the anterior lamina is stronger and forms *check ligaments* —the external and internal check ligaments being the stronger. The *external check ligament* passes outward and forward from the tendon of the external rectus muscle and under the lacrymal gland to be attached to the malar bone just behind the external palpebral ligament. The *internal check ligament* passes inward from the internal rectus muscle to be attached to the upper part of the crest of the lacrymal bone behind the tensor tarsi muscle. The check ligaments of the rectus muscles prevent extreme action of these muscles, and after the external or internal rectus muscle is divided, prevent the belly of the muscle from retreating far back into the orbit.

The *capsule of Tenon* is the membrane which envelops the posterior two-thirds of the eyeball. It is a thin, translucent, fibrous membrane formed by the posterior lamina and part of the anterior lamina of the orbital fascia, and extends from the insertions of the rectus muscles backward over the sclerotic coat of the eyeball almost to the place of entrance of the optic nerve. Here it is reflected backward over the sheath of the optic nerve to the apex of the orbit. The capsule approaches the sheath of the optic nerve in passing toward the apex of the orbit, but does not blend with it. The space between the sheath of the optic nerve and the capsule of Tenon is the *supra-vaginal lymph-space*, and that between the sclerotic coat and the capsule is *Tenon's space*. These are both lymph-spaces and are in communication. The capsule of Tenon is attached to the sclerotic coat and the sheath of the optic nerve by loose areolar tissue which permits free movement of the eyeball. The orbital surface of the capsule is in relation with the orbital fat. The capsule first comes into contact with the rectus muscles near the equator of the eyeball, where the capsule is pierced by the tendons of these muscles. The anterior margin of the capsule of Tenon forms a circular line connecting the insertion of the rectus muscles.

The posterior two-thirds of the eyeball and the capsule of Tenon might be said to form a ball-and-socket joint, permitting the various rotatory and gliding movements of the eyeball. The socket of the joint, or the capsule of Tenon, is

PLATE CCXXIX.



NERVES AND MUSCLES OF ORBIT.

held in position by the attachments of orbital fascia, and the globe is held in the socket chiefly by the rectus muscles.

After excision of the eyeball the muscles of the orbit are able to move the stump through their attachments to the capsule of Tenon.

The frontal nerve.—Of the three branches of the ophthalmic division of the fifth nerve, the lacrymal, the nasal, and the frontal, the last mentioned is by far the largest, and can be regarded as the continuation of the main trunk. It gains entrance to the orbit by way of the sphenoid fissure, lying external and on a plane slightly inferior to the fourth nerve. It then passes forward upon the levator palpebræ superioris muscle, between it and the orbital periosteum. At a point about midway between the sphenoid fissure and the supra-orbital notch it divides into its terminal branches—the supra-orbital and the supra-trochlear.

The **supra-orbital nerve** continues forward in the line of the frontal nerve, and with the supra-orbital artery leaves the orbit by way of the supra-orbital foramen or notch. It then turns upward on the forehead, and, dividing into an internal and an external branch, supplies the scalp as far back as the lambdoid suture. At the supra-orbital foramen it gives off a few filaments to the upper eyelid.

The **supra-trochlear nerve** runs toward the inner side of the orbit, and, as its name implies, passes over the pulley of the superior oblique muscle. There it gives off a twig which communicates with the infra-trochlear branch of the nasal nerve. It then passes out of the orbit accompanied by the frontal artery, gives a few twigs to the inner part of the upper eyelid, supplies the structures around the inner canthus of the eye and root of the nose, and sends a few filaments to the lining membrane of the frontal sinus.

The **lacrymal nerve** is the smallest branch of the ophthalmic division. It enters the orbit through the sphenoid fissure external to and slightly below the frontal nerve. It then courses along the outer wall of the orbit above the upper margin of the external rectus muscle accompanied by the lacrymal artery. Just behind the lacrymal gland it forms a loop of communication with the temporal branch of the orbital or temporo-malar nerve. From this loop and the immediate portion of the nerve, twigs are given off which enter the lacrymal gland. The remainder of the nerve continues forward, pierces the palpebral fascia, and supplies the skin and conjunctiva around the outer canthus of the eyelids.

The **fourth, pathetic, or trochlear nerve** enters the orbit through the inner end of the sphenoid fissure, occupying the highest position of all the structures which traverse it, and lying above and to the inner side of the frontal nerve. It is the smallest of all the cranial nerves. It passes over the origin of the levator palpebræ superioris muscle, lies to the inner side of the frontal nerve, and enters

the orbital surface of the superior oblique muscle, to which alone it is distributed.

The **lacrymal gland** is a distinctly lobulated structure, which lies in the outer part of the orbit under the external angular process of the frontal bone. It is composed of two portions of unequal size, which are separated by the aponeurotic expansion of the levator palpebræ superioris muscle. The separation is not perfect, there being gaps which allow of communication between the portions of the gland. Of the two portions, the upper is by far the larger, and is called the superior or orbital portion, or superior lacrymal gland; the lower and smaller part is called the inferior or palpebral portion, or inferior lacrymal gland.

The *superior lacrymal gland*, as stated, comprises the main part of the gland. It is about the size of a small almond. Its upper surface is convex, and its lower surface concave. It is inclosed by a capsule, from which run fibrous trabeculæ to be inserted into the posterior border of the orbital margin. These bands are called the *suspensory ligaments of the lacrymal gland.*

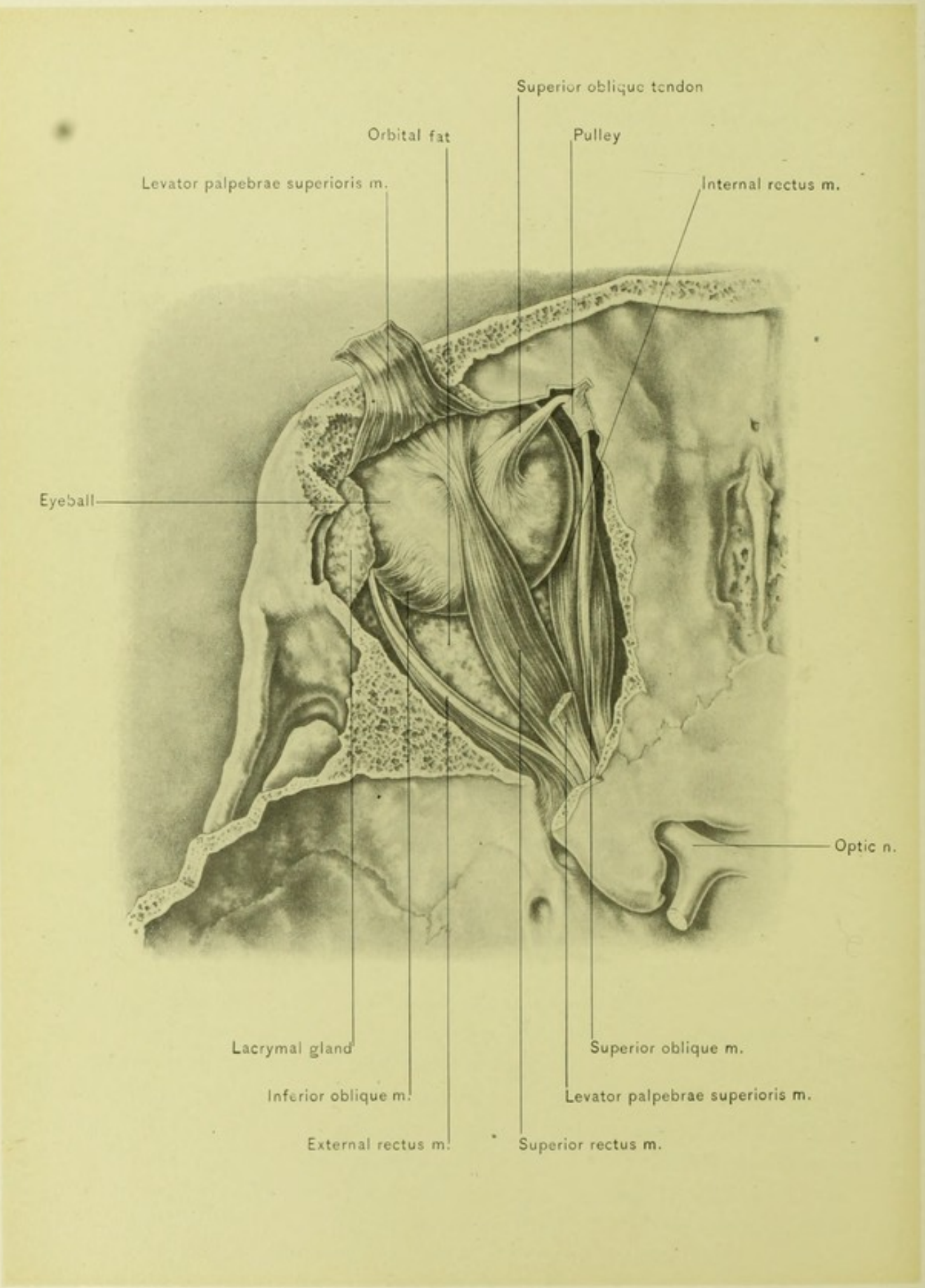
The *inferior lacrymal gland* is looser in texture. It extends into the outer one-third of the upper eyelid, and can be readily seen in this position when the eyelid is everted.

The lacrymal gland secretes the tears, which flow through ten to fifteen ducts into the outer part of the superior conjunctival fornix about four millimeters above the upper margin of the tarsal cartilage. The tears flow thence inward over the ocular conjunctiva to the puncta lachrymalia, and pass through the lacrymal canaliculi, lacrymal sac, and lacrymo-nasal duct into the inferior meatus of the nose.

The **Muscles of the Orbit** are the levator palpebræ superioris, superior oblique, superior rectus, external rectus, internal rectus, inferior rectus, and inferior oblique. With one exception—the inferior oblique—they arise from the margin of the optic foramen and diverge as they pass forward to their insertion.

The **levator palpebræ superioris muscle** pursues a forward course between the orbital periosteum and the superior rectus muscle, which lies immediately below it. It arises from the orbital roof, above and in front of the optic foramen, and passes forward, gradually widening. It expands into a broad aponeurosis, passes between the two portions of the lacrymal gland, and splits into three lamellæ. The uppermost lamella blends with the superior orbito-tarsal ligament; the middle lamella, the most easily demonstrable, is inserted into the anterior surface of the upper border of the tarsal cartilage; the lower lamella is attached to the conjunctival fornix. The margins of the tendon are attached to the margin of the orbit, and thus any excessive action of the muscle is prevented.

PLATE CCXXX.



MUSCLES OF ORBIT

Action.—It raises the upper eyelid and retains it in that position. The muscle relaxes, and the eyelid falls as one becomes sleepy.

Nerve Supply.—From the superior division of the motor oculi nerve, a branch which pierces the superior rectus muscle.

The **superior oblique muscle** takes its origin from the orbital roof at the upper and inner margins of the optic foramen. It extends as a fleshy belly along the upper and inner part of the orbital wall above the internal rectus muscle. It then narrows into a shining, slender tendon, which enters the ring-like pulley attached to the frontal bone. Leaving the pulley, the tendon changes its course to an outward and a backward direction. It then passes under the superior rectus muscle, and expands to be inserted into the sclera midway between the entrance of the optic nerve and the margin of the cornea, and between the superior rectus and external rectus muscles.

The *pulley* or *trochlea of the superior oblique muscle* is a fibro-cartilaginous ring, which is attached by a fibrous plate to the trochlear fossa in the under surface of the orbital plate of the frontal bone. The ring is lined by a synovial sheath, and this sheath is continued over its contained tendon. Chronic serous effusion into this synovial sheath sometimes exists in persons past middle life, and causes a cystic swelling at the upper and inner portion of the upper eyelid.

Action.—It rotates the eyeball inward, and as the muscle is inserted into the posterior portion of the globe, it draws the cornea downward and slightly abducts it. It counteracts the tendency of the inferior rectus muscle to rotate the cornea outward, and the tendency of the superior and inferior recti muscles to adduct the cornea.

Nerve Supply.—From the pathetic or fourth cranial nerve.

Dissection.—Divide the frontal nerve and levator palpebræ superioris muscle, and dissect the latter free from the underlying structures. While dissecting up the levator palpebræ superioris muscle, a nerve filament should be observed which passes through the underlying muscle—the superior rectus—and enters the under surface of the posterior portion of the levator palpebræ superioris muscle. This is the branch of the oculo-motor nerve, which supplies that muscle.

The **superior rectus muscle** is now fully exposed. It arises from the upper portion of the anterior margin of the optic foramen, and becomes broader as it passes forward between the levator palpebræ superioris muscle and the optic nerve. It is inserted by a thin, expanded tendon into the sclera, about one-fourth to one-third of an inch behind the upper margin of the sclero-corneal junction.

Action.—It rotates the eyeball upward, in addition to adducting and rotating the cornea inward—*i. e.*, it carries the cornea upward, adducts it, and slightly rotates it inward.

Nerve Supply.—From the superior division of the motor oculi nerve.

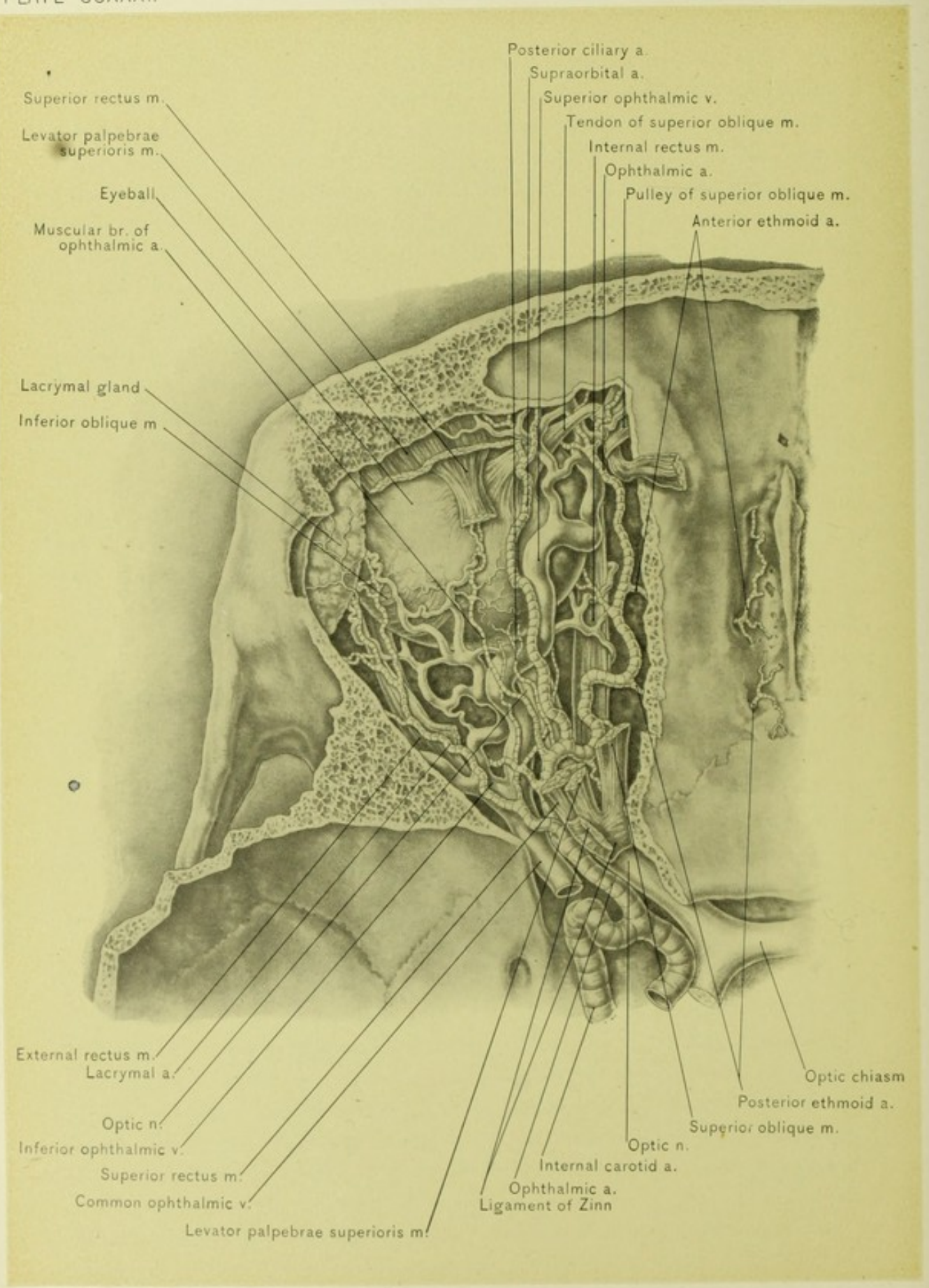
Dissection.—This is a very important stage of the dissection, and if care is not exercised, some of the important structures will be destroyed. Divide the superior rectus muscle and reflect it. While dissecting this muscle free from the underlying structures, observe a nerve filament entering the under surface of the posterior portion of the divided muscle. This nerve is the superior division of the oculo-motor nerve, and, as previously stated, sends a perforating branch through the superior rectus muscle to supply the levator palpebræ superioris muscle. Remove a quantity of loose fat, and when working on the outer side of the optic nerve, take especial care not to injure the lenticular ganglion or its connections. The optic nerve, as well as numerous structures above and upon each side of it, will now be exposed. These are the nasal nerve, the ophthalmic artery and vein, and the long ciliary branches of the nasal nerve, all of which cross the optic nerve. There may also be found the short ciliary nerves. These are more numerous than the long ciliary nerves, and one of the largest should be selected and followed backward until its source of origin, the lenticular ganglion, is reached. By careful work the roots of this ganglion can be worked out by tracing them backward from the ganglion. They will lead to the nasal nerve, the inferior division of the oculo-motor nerve, and the cavernous plexus of the sympathetic nerve.

In the posterior portion of the orbit the third nerve, the nasal branch of the ophthalmic nerve, the sixth nerve, and the ophthalmic vein can be seen passing between the heads of the external rectus muscle.

In the anterior portion of the orbit the reflected tendon of the superior oblique muscle can now be more readily seen, for reflection of the superior rectus muscle has exposed its terminal portion.

The **Nasal Nerve** is a branch of the ophthalmic division of the fifth nerve. It gains access to the orbit through the sphenoid fissure, and passes between the two heads of the external rectus muscle and between the divisions of the oculo-motor nerve. It then crosses to the inner wall of the orbit, passing over the optic nerve and immediately under the superior rectus muscle, taking a position between the superior oblique muscle and the internal rectus muscle. After giving off the infra-trochlear branch, it leaves the orbit through the anterior ethmoid foramen. It then takes the following course: Having passed through the anterior ethmoid foramen, it again becomes an occupant of the cranial cavity, lying between the dura mater and the cribriform plate of the ethmoid bone. Here it leaves the cranial cavity through the ethmoid fissure, or nasal slit at the side of the crista galli, and becomes an occupant of the nasal fossa. It has thus traversed in succession the cranial cavity, the orbit, the cranial cavity again, and, finally, the

PLATE CCXXXI.



ARTERIES AND VEINS OF ORBIT.

nasal cavity. It then gives off an internal and an external branch, and continues as the anterior or terminal branch.

The *internal* or *septal branch* supplies the anterior part of the septum.

The *external branch* supplies the anterior portion of the middle and inferior turbinated bones and the mucous membrane of the outer nasal wall.

The *anterior* or *terminal branch* runs downward in the groove on the under surface of the nasal bone, passes between the lower edge of the nasal bone and the superior lateral nasal cartilage, and supplies the sides and tip of the nose.

The **branches of the nasal nerve** in the orbit are four in number: the long root to the lenticular ganglion, the two long ciliary nerves, and the infra-trochlear nerve.

The *branch to the lenticular ganglion*, known as the long, upper, or sensory root of that ganglion, arises from the nasal nerve as it passes between the two heads of the external rectus muscle. It is very slender, and measures about one-half of an inch in length. It passes along the outer side of the optic nerve, and enters the posterior superior angle of the lenticular ganglion.

The *long ciliary nerves* are usually two in number. They arise from the nasal nerve as it crosses the optic nerve, and run along the inner side of the optic nerve to enter the eyeball by piercing the sclera. One of these nerves usually unites with one of the short ciliary nerves. Their course between the sclera and choroid is described with the eyeball.

The *infra-trochlear nerve* arises from the nasal nerve just before that nerve enters the anterior ethmoid foramen. It traverses the inner orbital wall below the superior oblique muscle and its pulley. It forms a loop of communication with the supra-trochlear nerve at times behind, but usually in front of, the pulley of the superior oblique muscle. It supplies the region around the inner canthus of the eyelids, including the lacrymal sac and the lacrymal caruncle.

The **Ophthalmic Artery** is a branch of the cavernous portion of the internal carotid artery. It enters the orbit by passing through the optic foramen in company with the optic nerve, holding a position to the outer side of, and a little below, the nerve. The ophthalmic artery, like arteries in other parts of the body in which the tissues must be freely movable,—*e. g.*, the facial and splenic arteries,—is very tortuous, to allow of its elongation. At first it lies to the outer side of the optic nerve, soon crossing over that nerve and running along and near the internal orbital wall, between the superior rectus and the internal rectus muscle. At the inner canthus of the eyelids it terminates by dividing into the nasal and frontal arteries.

The **branches of the ophthalmic artery** are the lacrymal, ethmoid, supra-orbital, retinal, ciliary, muscular, palpebral, nasal, and frontal.

The **lacrymal artery** is given off from the ophthalmic artery, between the superior rectus and the external rectus muscle, soon after the ophthalmic artery has entered the orbit. It accompanies the lacrymal nerve to the lacrymal gland, which it supplies, finally terminating in the conjunctiva and eyelids. It sends off twigs as follows: (1) A *recurrent branch*, which passes backward through the sphenoid fissure to anastomose with the middle meningeal artery; (2) *muscular branches* to the external rectus muscle; (3) *malar branches*, which traverse the malar bone to enter the temporal fossa, one anastomosing with the deep temporal arteries and middle temporal artery, and the other with the transverse facial artery; (4) *palpebral branches*, which form an arch in each eyelid with the palpebral branches of the ophthalmic artery; and (5) some *anterior ciliary branches*.

The **supra-orbital artery** arises from the ophthalmic artery as that vessel crosses the optic nerve. It accompanies the frontal nerve upon the levator palpebræ superioris muscle, emerging upon the forehead through the supra-orbital foramen. Having reached the forehead, it divides into a superficial and a deep branch, the former ramifying in the superficial fascia, and the latter in the areolar tissue layer of the scalp. It anastomoses with the anterior temporal artery, the angular artery, and the supra-orbital artery of the opposite side. Its branches are: (1) *Periosteal*, to the roof of the orbit; (2) *muscular*, to the adjacent muscles; (3) *diploic*, to the diploë and frontal sinus; (4) *trochlear*, to the pulley of the superior oblique muscle; and (5) *palpebral*, to the upper eyelid.

The **central artery of the retina** arises from the ophthalmic artery just anterior to the optic foramen. It enters the optic nerve obliquely, about one-half of an inch behind the eyeball, and traverses the nerve to reach the interior of the eyeball and supply the retina.

Ciliary arteries.—Of these there are three sets—short posterior, long posterior, and anterior.

The *short posterior ciliary arteries* are about twelve in number, and arise from the ophthalmic artery. They run tortuously forward and pierce the sclerotic coat in a ring around the optic nerve, to be distributed to the choroid coat of the eyeball.

The *long posterior ciliary arteries* are two in number, and, arising from the ophthalmic artery, pass forward on each side of the optic nerve to pierce the sclerotic coat of the eyeball. They then run between the choroid and sclerotic coats as far forward as the ciliary body and iris.

The *anterior ciliary arteries* are branches of the muscular and lacrymal arteries, and are about eight in number. They pass forward in company with the tendons of the rectus muscles, and run beneath the conjunctiva. They then pierce the

sclera, about one-fourth of an inch behind the sclero-corneal junction, and terminate in the great arterial circle around the iris and in the ciliary processes.

The **ethmoid arteries** are two in number—posterior and anterior.

The *posterior ethmoid artery* passes outward between the internal rectus muscle and the superior oblique muscle, and enters the posterior ethmoid foramen. Having reached the posterior ethmoid cells, it gives off branches which nourish their walls and the lining mucous membrane. It then enters the cranial cavity, and gives off branches to a small area of dura mater and nasal branches which pass downward through the cribriform plate of the ethmoid bone, to supply the mucous membrane of the roof of the nose.

The *anterior ethmoid artery* is larger than the posterior ethmoid artery, and traverses the anterior ethmoid foramen in company with the nasal nerve. It accompanies the nerve in the cranial cavity, and out of that cavity through the ethmoid fissure into the nose. Its branches are the following: (1) *Ethmoid*, to the walls and mucous membrane of the anterior ethmoid cells; (2) *meningeal*, to the dura mater in the anterior cranial fossa; (3) *nasal*, to the outer and anterior part of the mucous membrane of the nose; (4) *frontal*, to the frontal sinus; and (5) *terminal*, which accompanies the terminal branch of the nasal nerve to the skin of the nose.

The **muscular branches of the ophthalmic artery** are variable in number and origin, and are distributed to the muscles of the orbit. They give off the greatest number of the anterior ciliary arteries.

The **palpebral arteries** are two in number—superior and inferior. They arise from the ophthalmic artery, either separately or by a common trunk, almost opposite the pulley of the superior oblique muscle. They pass one above and the other below the tendo oculi, run between the tarsal cartilage and the orbicularis palpebrarum muscle, near the edge of the eyelid, and anastomose with the palpebral branches of the lacrymal artery, thus forming a vascular arch in each eyelid. They also supply the lacrymal duct and caruncle and the adjacent conjunctiva.

The **nasal artery** is the lower terminal branch of the ophthalmic artery. It leaves the orbit by piercing the orbito-tarsal ligament or palpebral fascia above the tendo oculi. It then passes down the side of the nose, and anastomoses with the angular or lateral nasal branches of the facial artery.

The **frontal artery** is the upper of the terminal branches of the ophthalmic artery. It leaves the orbit at the inner canthus of the eyelids by piercing the palpebral fascia, and passes upward on the forehead, anastomosing with the supra-orbital artery, the anterior temporal artery, and the frontal artery of the opposite side.

The **Ophthalmic Veins** are three in number. They are the common ophthalmic vein, superior ophthalmic vein, and inferior ophthalmic vein. Neither

these veins nor their tributaries have valves. Their anastomosis is fairly free, the communications being with veins corresponding to the arteries with which the branches of the ophthalmic artery anastomose.

The **common ophthalmic vein,** formed by the union of the superior and inferior ophthalmic veins, is short and thick. It passes between the heads of the external rectus muscle, through the sphenoid fissure, and enters the cavernous sinus.

The **superior ophthalmic vein** is considerably larger than the inferior ophthalmic vein. It commences at the inner portion of the upper eyelid by a free anastomosis with the frontal, supra-orbital, and angular veins, and, following a straighter course than the ophthalmic artery, crosses over the optic nerve to reach the inner end of the sphenoid fissure, where it joins the inferior ophthalmic vein to form the common ophthalmic vein.

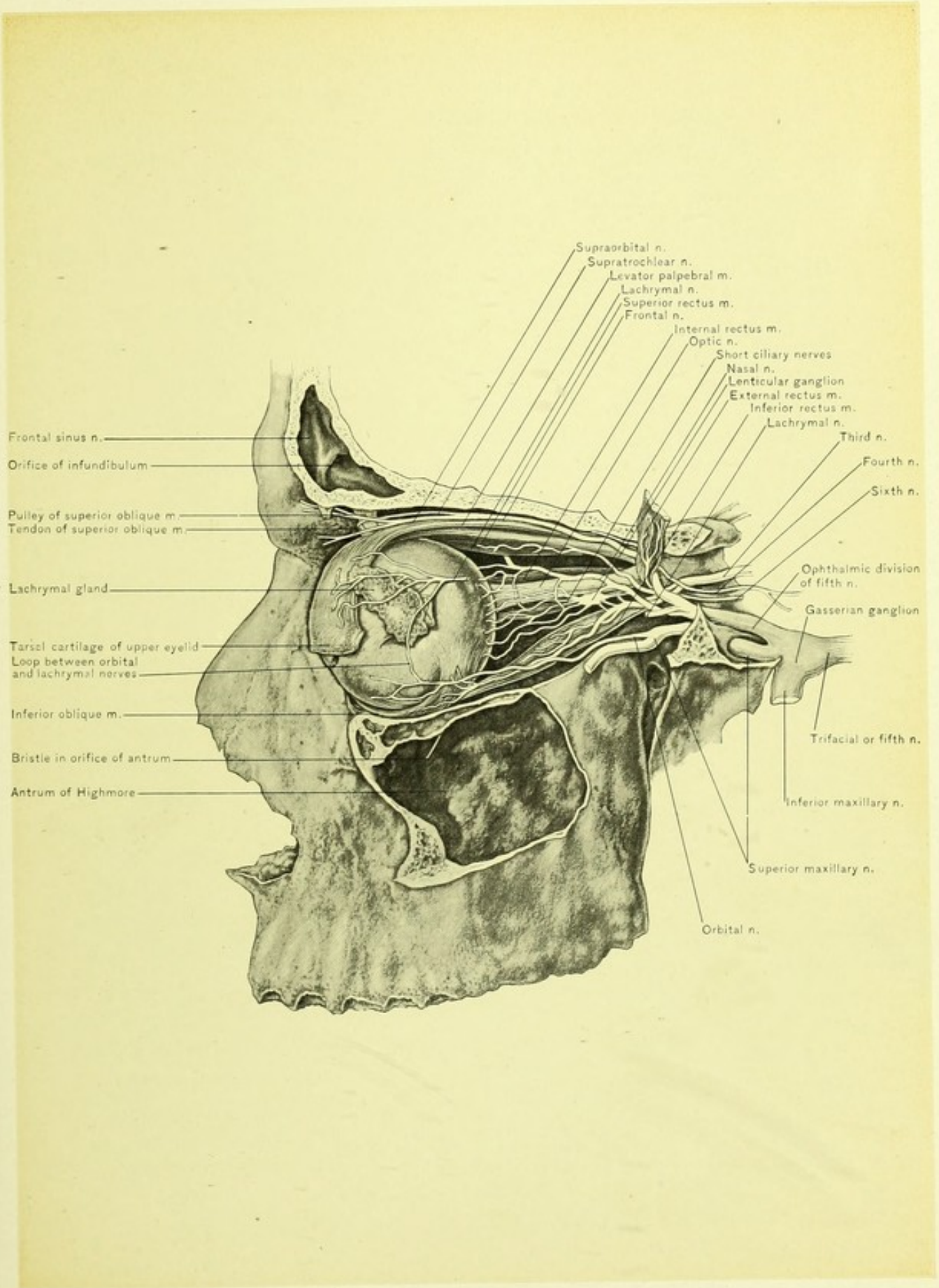
The **inferior ophthalmic vein** is formed by the union of the inferior muscular and posterior ciliary veins in the lower external portion of the orbit. It lies below the plane of the optic nerve, and communicates with the pterygoid plexus of veins by a twig which passes through the spheno-maxillary fissure. It then runs backward to the rear of the orbit, and joins the superior ophthalmic vein, as previously described. The inferior ophthalmic vein, as well as the superior, empties at times directly into the cavernous sinus.

Phlebitis of the ophthalmic veins may extend to the cavernous sinus and cause fatal thrombosis.

Pulsation of the ophthalmic vein and of the orbit may be produced by an arterio-venous aneurysm between the internal carotid artery and the cavernous sinus. Pulsation of the orbit may also be caused by traumatic aneurysm of one of the arteries of the orbit, or pulsation transmitted to the terminal portion of the ophthalmic vein from an aneurysm of the internal carotid artery.

The **Lenticular, Ophthalmic,** or **Ciliary Ganglion** is a small, reddish body, slightly larger than the head of an ordinary pin. It is of quadrilateral outline, and both its surfaces are slightly convex. It lies about one-fourth of an inch in front of the sphenoid fissure, and between the optic nerve on the inner side and the external rectus muscle on the outer side. It is usually situated at the outer side of the ophthalmic artery, to which it is, at times, closely adherent. Like all the sporadic ganglia connected with the fifth nerve, it has afferent and efferent filaments. The afferent filaments are three in number, and are termed its roots; the efferent filaments are the branches of distribution.

The **roots** are motor, sensory, and sympathetic. The motor, or short root, is derived from that branch of the oculo-motor nerve which runs to the inferior oblique muscle. It enters the posterior inferior angle of the ganglion. The



NERVES OF ORBIT.

sensory or long root springs from the nasal branch of the ophthalmic division of the fifth nerve. It passes along the outer side of the optic nerve, and enters the posterior superior angle of the ganglion. The sympathetic root has its origin in the cavernous plexus, and is somewhat difficult to dissect satisfactorily. It enters the back portion of the ganglion in one of three ways: most commonly in company with the sensory root, more rarely alone, in the form of a bunch of fine filaments, and least frequently in company with the motor root.

Branches.—From the anterior border of the ganglion about six delicate filaments are given off, which run forward to the eyeball and, by subdividing, number twenty when they reach the globe. They are termed the short ciliary nerves. They surround the optic nerve and pierce the sclerotic coat in a circle around the entrance of that nerve. Having penetrated the sclerotic coat, they are joined by the long ciliary nerves. They are ordinary sensory and trophic nerves to the eyeball, and motor nerves to the radiating fibers of the iris, the ciliary muscle, and the sphincter iridis. The motor oculi filaments supply the circular muscular fibers of the iris; and the sympathetic fibers supply the radiating muscular fibers of the iris.

The **Third, Motor Oculi,** or **Oculo-motor Nerve** lies in the outer wall of the cavernous sinus, holding the highest position of all the nerves situated there. It passes to the sphenoid fissure, and here divides into a superior and an inferior division. These divisions then pass through the sphenoid fissure and between the heads of the external rectus muscle, separated from each other by the nasal branch of the ophthalmic nerve.

The superior division, the smaller of the two, has already been traced. It supplies the superior rectus muscle and the levator palpebræ superioris muscle.

The inferior division very soon breaks up into three branches. Two of these are comparatively short, and enter the ocular surface of the two muscles to which they are distributed,—the inferior and internal recti muscles,—the branch to the internal rectus muscle passing under the optic nerve. The third branch pursues a longer course, and runs along the floor of the orbit to supply the inferior oblique muscle. It occupies the interval between the inferior and external rectus muscles and enters the inferior oblique muscle at its posterior border. It gives off, near its origin, the motor root to the lenticular ganglion.

The oculo-motor nerve supplies the lenticular ganglion and the muscles of the orbit, with the exception of the external rectus and superior oblique muscles. Through the lenticular ganglion it supplies the ciliary muscle and the sphincter iridis.

The **Sixth,** or **Abducent Nerve,** passes forward in the inner wall of the cavernous sinus, lying on the outer side of, and slightly posterior to, the internal carotid artery. It enters the orbit through the inner part of the sphenoid fissure,

between the inferior division of the oculo-motor nerve and the ophthalmic vein. It then passes between the heads of the external rectus muscle, to terminate in the ocular surface of that muscle and supply it.

Arrangement of the Nerves of the Orbit, in the walls of the cavernous sinus and in the sphenoid fissure, is as follows: In the *outer wall of the cavernous sinus* there are, from above downward, the third nerve, the fourth nerve, and the ophthalmic division of the fifth nerve; in the inner wall is the sixth nerve, in relation with the outer side of the internal carotid artery. These nerves are separated from the cavity of the sinus by its endothelial lining. In the *sphenoid fissure* the lacrymal, frontal, and pathetic or fourth nerve occupy a higher plane than the other nerves, and are found in the order named from without inward. They pass above the origin of the muscles, while the other nerves and the ophthalmic vein are lower down and enter the orbit between the two heads of the external rectus muscle. The nerves lying on a lower plane in the sphenoid fissure are, from without inward, the superior division of the oculo-motor nerve, the nasal nerve, the inferior division of the oculo-motor nerve, and the abducent or sixth nerve. The ophthalmic vein lies to the inner side of the sixth nerve.

The **optic nerve** enters the orbit through the optic foramen, in company with the ophthalmic artery, and passes into the eyeball about one-tenth of an inch, or 2.5 millimeters, internal to the posterior pole of that organ. It is invested by a sheath of dura mater and arachnoid, and is surrounded by an extension of the capsule of Tenon, the orbital fat and vessels, and the rectus muscles. It is pierced and traversed by the vena centralis retinæ and arteria centralis retinæ.

The **External Rectus Muscle** is seen along the outer wall of the orbit. It has two heads of origin: the upper head arises from the outer margin of the optic foramen, beneath the superior rectus muscle, and the lower head, partly from the ligament or tendon of Zinn and partly from a small spine of bone situated on the lower margin of the sphenoid fissure. Between these two heads pass the third nerve, the nasal nerve, the sixth nerve, and the ophthalmic vein. The external rectus muscle is inserted by an expanded tendon into the sclerotic coat of the eyeball about one-fourth to one-third of an inch behind the outer margin of the cornea.

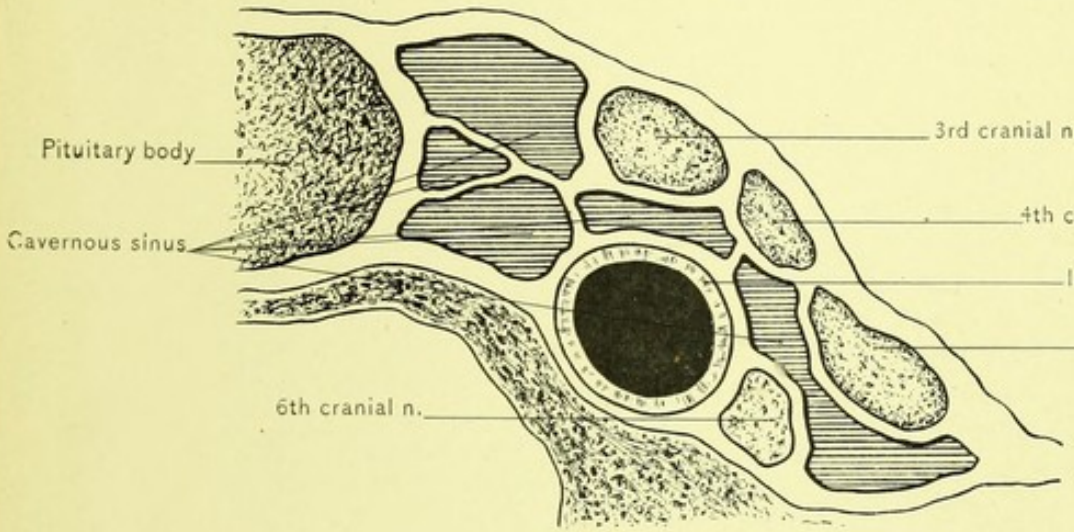
Action.—It abducts the cornea.

Nerve Supply.—From the abducent or sixth cranial nerve.

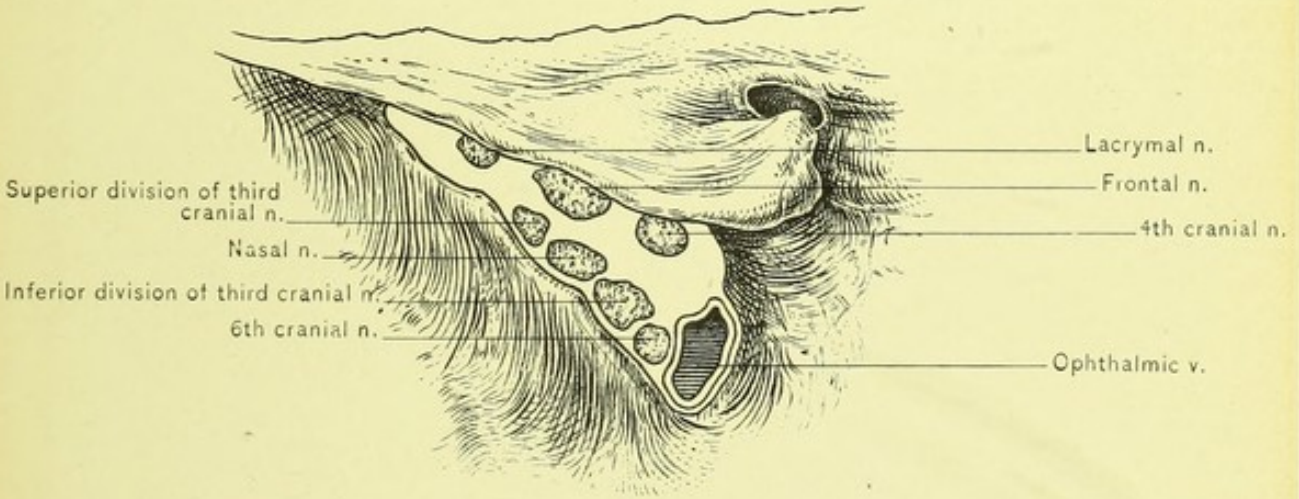
The **Internal Rectus Muscle** lies along the inner wall of the orbit, below the superior oblique muscle, ophthalmic artery, and nasal nerve. It arises through the ligament or tendon of Zinn from the inner margin of the optic foramen, and is inserted into the sclerotic coat of the eyeball about one-fourth to one-third of an inch behind the inner margin of the cornea.

Action.—It abducts the cornea.

Nerve Supply.—From the inferior division of the third cranial nerve.

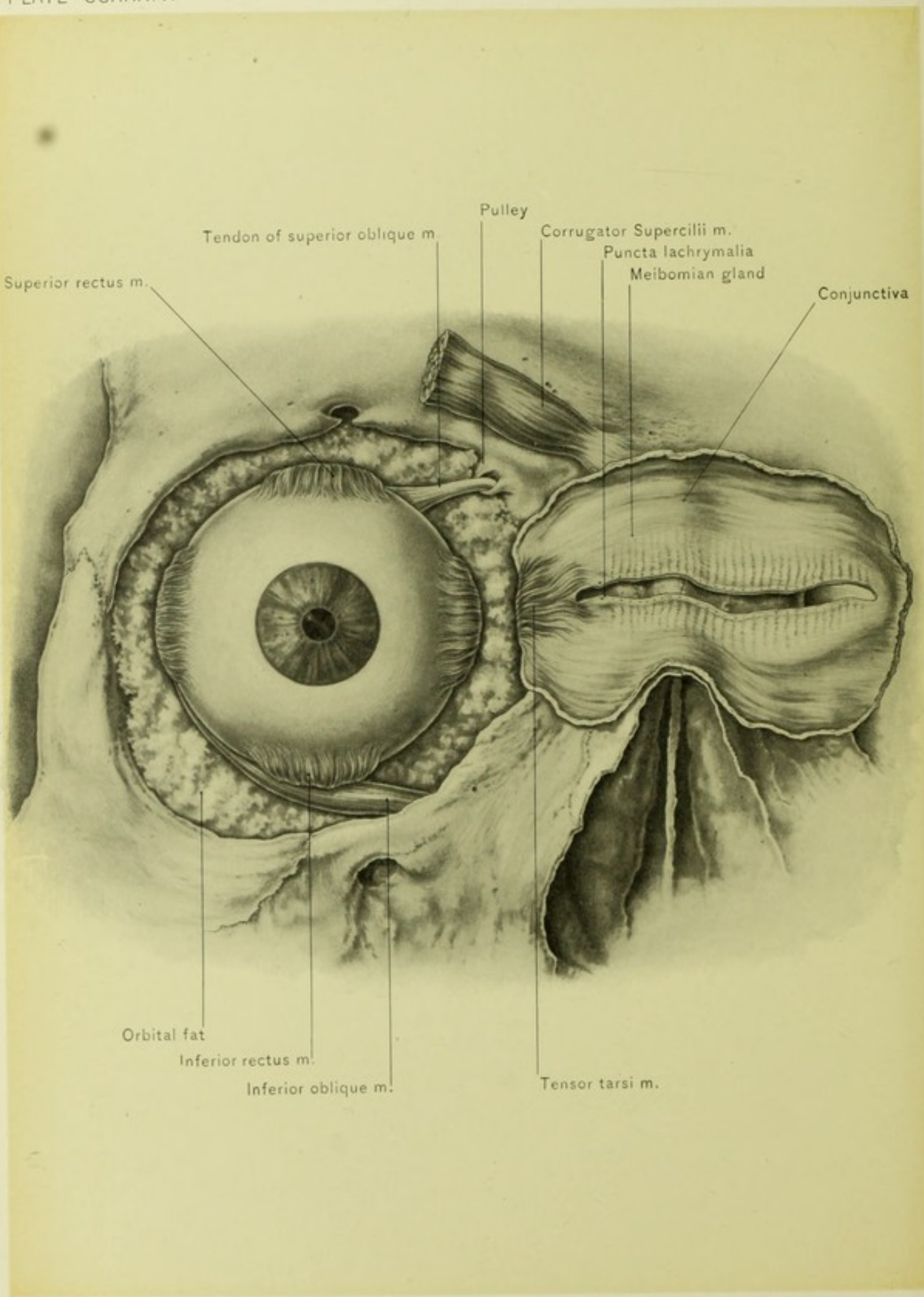


SECTION OF CAVERNOUS SINUS.



STRUCTURES TRAVERSING SPHENOID FISSURE.

PLATE CCXXXIV.



TENSOR TARSI AND CORRUGATOR SUPERCILII MUSCLES.

The **Inferior Rectus Muscle** arises from the lower margin of the optic foramen through the ligament or tendon of Zinn. It passes forward along the floor of the orbit and below the optic nerve, and is inserted into the sclerotic coat of the eyeball about one-fourth to one-third of an inch from the lower margin of the cornea.

Action.—It depresses the cornea, adducts it, and rotates it outward.

Nerve Supply.—From the inferior division of the motor oculi or third cranial nerve.

The inferior rectus muscle can be better studied after the dissection of the vessels, the nerves, and the other muscles has been completed, and those structures have been removed.

Ligament of Zinn.—By observation of the ocular surfaces of the origin of the *four rectus muscles*, it will be seen that these muscles arise from a common tendinous ring which is attached around the optic foramen. This common tendon may be divided into a superior and an inferior common tendon. The *superior common tendon* is attached to the upper margin and the upper outer part of the margin of the optic foramen, and gives origin to the superior rectus muscle, part of the internal rectus muscle, and the upper head of the external rectus muscle.

The inferior common tendon, or *ligament of Zinn*, is attached to the lower part of the inner margin, the lower margin and the lower part of the outer margin of the optic foramen, and gives origin to the inferior rectus muscle and part of the internal rectus muscle, and the lower head of the external rectus muscle.

Dissection.—The inferior oblique muscle is next exposed. Its position and relations differ much from those of the other orbital muscles, and it can best be seen after the following dissection: Release the eyeball from any position in which it may be held. Evert the lower eyelid, and remove the conjunctiva from it at the inferior fornix. Remove the fat lying in the floor of the anterior portion of the orbit, and clean the exposed muscle. In doing this be careful not to cut the nerve which enters the posterior border of the inferior oblique muscle.

The **Inferior Oblique Muscle** arises by a flat tendon from the orbital plate of the superior maxilla to the outer side of the orbital orifice of the lacrymal duct. It passes outward and backward under the inferior rectus muscle, and then upward between the globe and the external rectus muscle. It ends in a membranous tendon which is inserted into the sclera on the upper and outer side of the globe, below and external to the insertion of the superior oblique muscle.

Action.—It rotates the eyeball outward, and elevates and abducts the cornea. In abducting the cornea it counteracts the tendency of the superior rectus muscle and inferior rectus muscle to adduct the cornea.

Nerve Supply.—From the longest branch of the inferior division of the oculo-motor nerve, which enters the muscle at its posterior margin.

Dissection.—The ocular conjunctiva should now be removed from the sclerotic coat of the eyeball as far forward as the margin of the cornea, so that the positions of the attachments of the four rectus muscles can be observed.

The rectus muscles are inserted by thin, flat, slightly expanded tendons into the sclerotic coat of the eyeball, one-fourth to one-third of an inch from the margin of the cornea.

Action.—The actions of the rectus and oblique muscles of the orbit are somewhat complex, as almost every movement of the eyeball is performed by two or more muscles. In considering the movements of the eyeball it must be remembered that the globe can not be moved away from its position, in which it is closely retained by the capsule of Tenon and the attachments of the orbital fascia, forward movement being prevented by the rectus muscles. The only movements of the eyeball are rotation around any axis of the globe, limited by the attachments of the orbital fascia existing between the muscles and the adjacent structures, as the orbital periosteum and the palpebral fascia. These movements are more easily understood if only the motion of the cornea is considered.

Adduction of the cornea is performed by the internal rectus muscle, and abduction of the cornea by the external rectus muscle and the two oblique muscles.

Elevation of the cornea, as in looking directly upward, is performed by the superior rectus muscle, the inferior oblique muscle preventing adduction of the cornea and rotation of the cornea inward. Rotation of the cornea inward is movement of the uppermost portion of the cornea inward and downward.

Depression of the cornea is performed by the inferior rectus muscle, the superior oblique muscle preventing adduction of the cornea and rotation of the cornea outward.

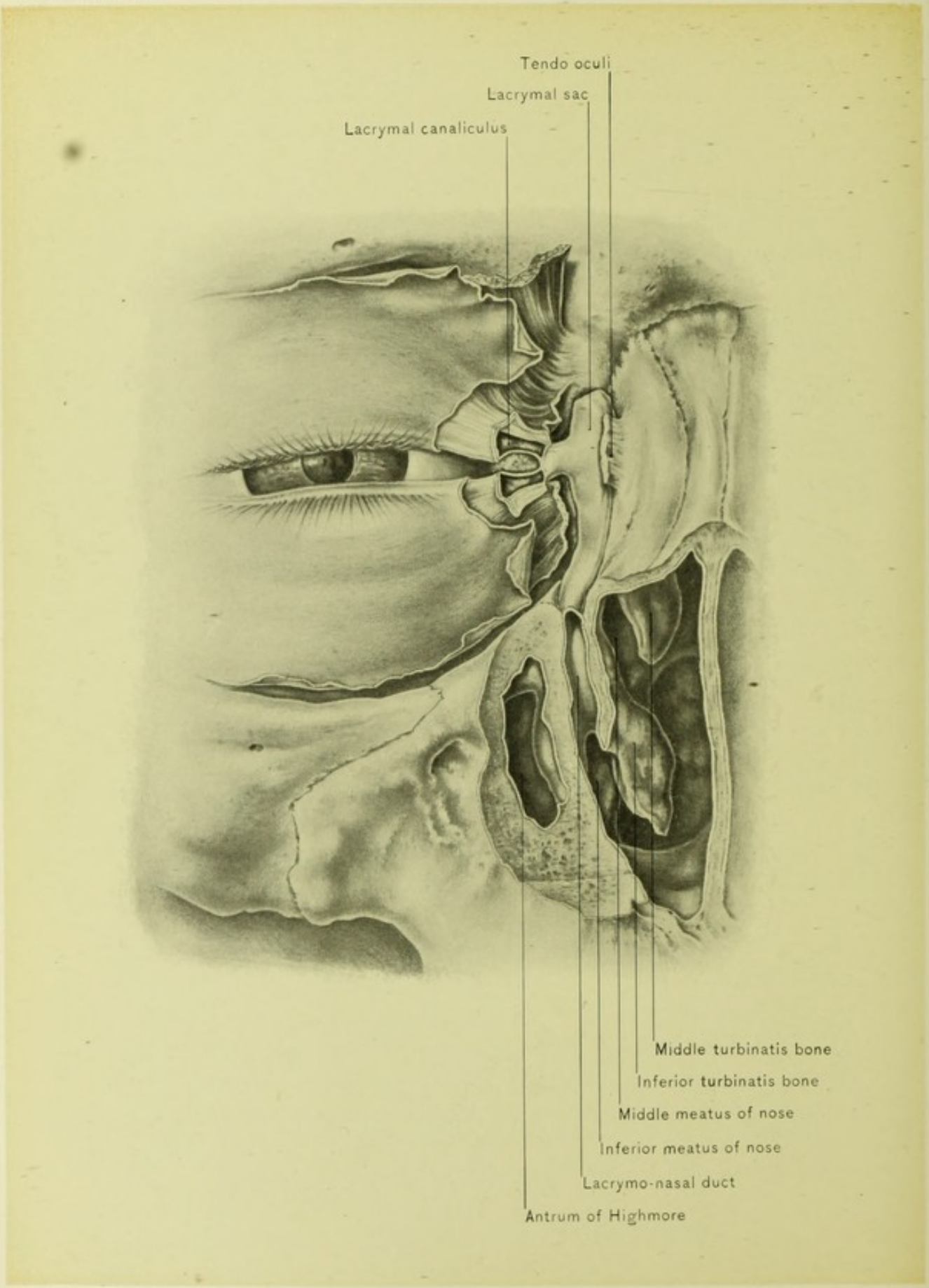
Rotation of the cornea inward is performed by the superior rectus muscle and the superior oblique muscle, and rotation of the cornea outward by the inferior rectus muscle and the inferior oblique muscle. Rotation of the cornea is not a common movement, and it occurs when the head is inclined to one side.

Movement of the cornea in an oblique direction is performed chiefly by two of the rectus muscles, as upward and outward by the superior rectus and external rectus muscles.

Excessive action of the various muscles is prevented by the attachments of the anterior lamella of the orbital fascia.

Strabismus, or deviation of the sagittal axis of one eyeball from its normal position, occurs when one or more muscles are excessively active or the opposing

PLATE CCXXXV.



LACRYMAL APPARATUS.

muscles are insufficiently active. This condition is more commonly caused by defective refraction in the affected eye or unequal refraction in the two eyes. The first requisite is to correct the defect in refraction, and as a last resort the tendon or tendons of the hyperactive muscle or muscles may be divided. After division of the tendon, extreme retraction of the muscle is prevented by the anterior lamella of the orbital fascia.

Dissection.—The temporo-malar nerve is the last structure to be dissected. The orbital contents must be removed completely, and the nerve will be found in a pad of fat in the retiring angle between the inferior and external orbital walls.

The **Temporo-malar** or **Orbital Nerve** arises from the superior maxillary nerve in the spheno-maxillary fossa, and reaches the orbit by passing through the spheno-maxillary fissure. It then divides into two branches—temporal and malar.

The **temporal branch** forms a loop of communication with the lacrymal nerve, and then runs beneath the orbital periosteum to reach the spheno-malar foramen. Having traversed this foramen and entered the temporal fossa, it pierces the deep layer of the temporal fascia. It runs upward between the two layers of the temporal fascia for a short distance, and pierces the superficial layer of that fascia. It communicates with the temporal branch of the facial nerve, and is distributed to the skin of the anterior temporal region.

The **malar branch** runs forward in the orbital fat, and leaves the orbit by passing through the malar foramen. It communicates with the malar branch of the facial nerve and supplies the skin of the cheek.

The **Lymphatics of the Orbit** pass through the spheno-maxillary fissure to the internal maxillary and deep parotid lymphatic glands.

THE LACRYMAL APPARATUS.

Dissection.—Insert slender probes into the puncta lachrymalia and lacrymal canaliculi, and open the latter as far as the lacrymal sac.

The **Lacrymal Canaliculi** are two narrow canals, one in each eyelid, extending from the lacrymal punctum to the lacrymal sac. For a short distance from the lacrymal punctum the course of each canaliculus is vertically away from the margin of the lid, then, turning abruptly, it forms a right angle, passes inward, and pierces the inner division of the tendo oculi to reach the lacrymal sac. Before entering the lacrymal sac the lacrymal canaliculi of the upper and lower lids

frequently join and open into the sac by a common orifice. In passing a probe into the lacrymal canaliculi their angular course should be remembered.

Dissection.—Next make a vertical section through the upper and the lower eyelid, to demonstrate their several layers of tissue.

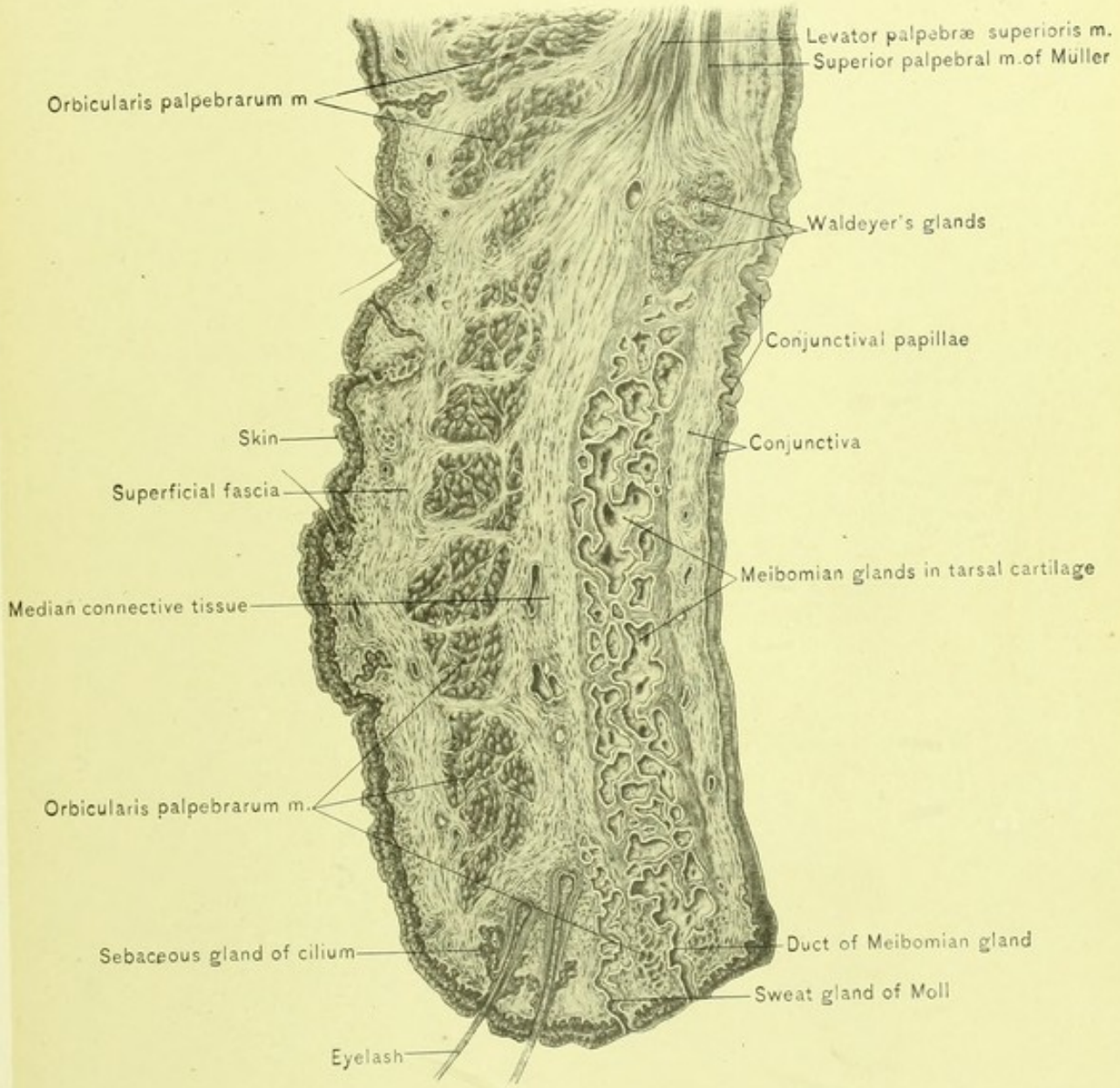
The **Eyelids** are composed of skin, superficial fascia, orbicularis palpebrarum muscle, areolar tissue, palpebral ligaments, orbito-tarsal ligaments, tarsal cartilages, Meibomian glands, conjunctiva, vessels, nerves, and lymphatic vessels. The upper eyelid also contains the aponeurosis of the levator palpebræ superioris muscle. The most superficial layer is the skin; the second layer is the superficial fascia, which contains no fat in this location; the third layer is composed of delicate areolar tissue; in the fourth layer are the tarsal cartilage, the orbito-tarsal ligament, the palpebral ligaments, the Meibomian glands, and in the upper lid the aponeurosis of the levator palpebræ superioris muscle; the fifth layer is composed of conjunctiva and subconjunctival tissue. The eyelids are described in volume I, pages 512–520.

Dissection.—Open the lacrymal sac, and, after passing a probe through the lacrymo-nasal duct, saw away the anterior wall of that duct.

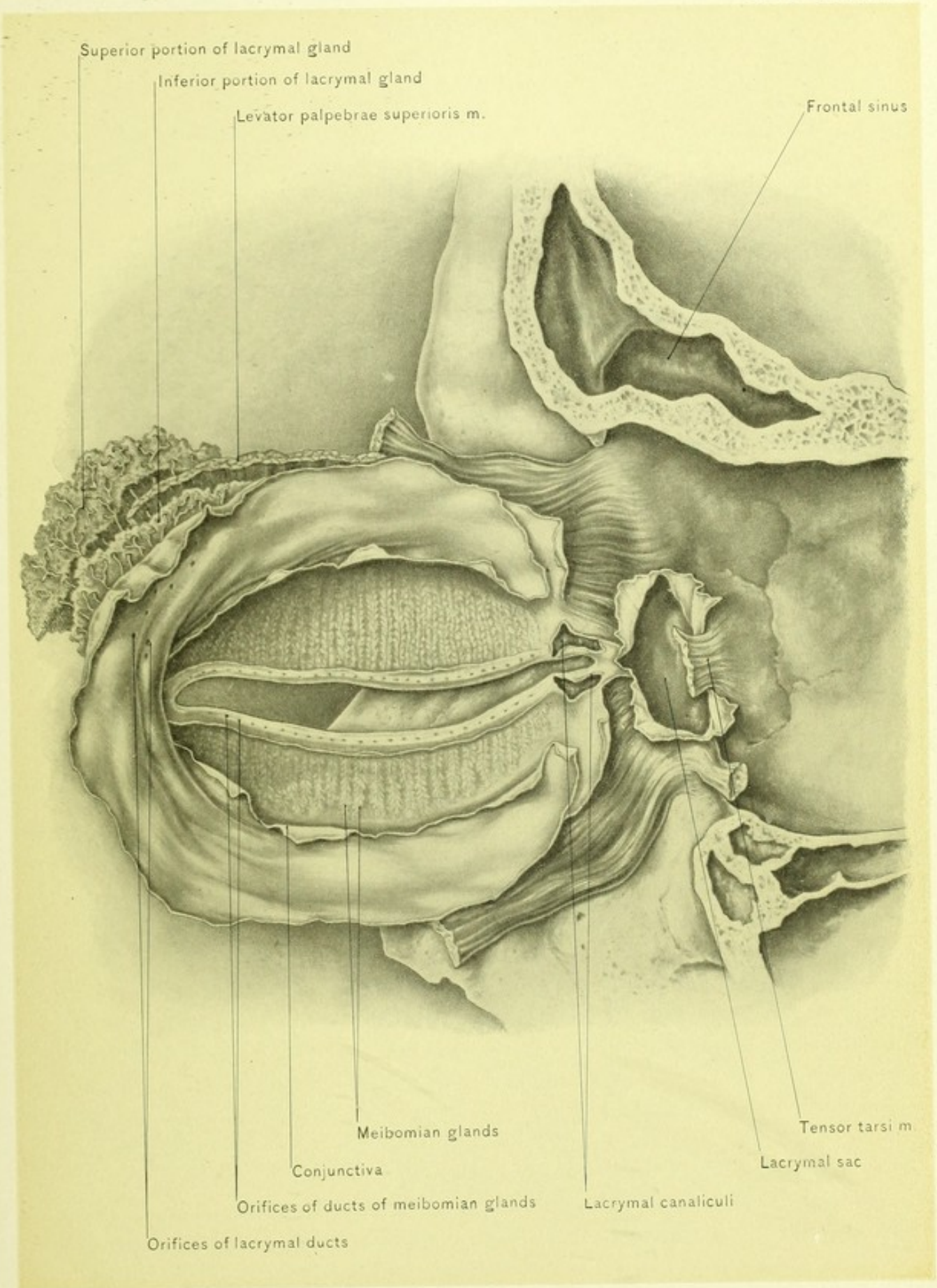
The **Lacrymal Sac** is the upper, dilated end of the lacrymo-nasal duct, and rests in the lacrymal groove, which is a depression in the lower anterior portion of the inner wall of the orbit. The lacrymal sac is invested by a fibrous capsule, which is attached to the margins of the lacrymal groove, and is continuous with the orbital periosteum. It is lined with mucous membrane, which is continuous with that of the lacrymal canaliculi and lacrymo-nasal duct. Loose submucous tissue attaches mucous membrane to the fibrous capsule.

The **Lacrymo-nasal, Nasal,** or **Lacrymal Duct** extends from the lacrymal sac to the uppermost part of the anterior portion of the inferior meatus of the nose. It is directed downward and slightly backward and outward. Its walls are formed by the superior maxillary, lacrymal, and inferior turbinated bones, and are lined by mucous membrane continuous with that of the nose and lacrymal sac, the sac and the duct forming the **Lacrymal Canal.** The nasal orifice of the duct is guarded by a valvular flap of mucous membrane.

The **Course of the Tears** is from the lacrymal gland at the outer part of the upper fornix of the conjunctiva and the accessory lacrymal glands in the eyelids, inward over the conjunctiva to the lacrymal puncta, and thence successively through the lacrymal canaliculi, lacrymal sac, lacrymal duct, and inferior meatus of the nose. If the lower eyelid is everted or inverted so that the tears do not enter the lacrymal punctum, or there is an obstruction in the lacrymal canaliculi or nasal duct, or the tears are secreted too rapidly for the capacity of the puncta, as in weeping, the tears flow over the cheek.



SAGITTAL SECTION OF UPPER EYELID.



MEIBOMIAN GLANDS AND LACRYMAL APPARATUS.

THE EYEBALL.

The **eyeball** is a globular body, so situated in the orbital fossa as to be protected by the orbital margins from injury by large objects. It is freely movable around its axes, in order that objects may be seen without appreciable muscular effort.

The **mobility of the eyeball** is permitted by the relation existing between the globe and the capsule of Tenon, which has been described with the orbit. The eyeball and capsule of Tenon form a ball-and-socket joint. Backward, lateral, vertical, and oblique movements of the eyeball en masse are prevented by the attachments of the orbital fascia to the orbital margins and palpebral fascia, and forward movement of the organ is checked by the rectus muscles; therefore the only movements of the eyeball are those of rotation around its axes. Excessive rotation is prevented by the attachments of the anterior lamella of the orbital fascia and its thickened portions, designated check ligaments.

Exophthalmos, or protrusion of the eyeball from the orbit, may be caused by tumors or foreign bodies in the orbit, myopia, and enlargement of the eyeball by disease. It sometimes exists slightly after tenotomy of one of the rectus muscles, and may be a sign of exophthalmic goiter.

Sinking of the eyeball occurs after partial absorption of the orbital fat in wasting diseases, and is associated with general emaciation.

Being a globular body, the eyeball has an **anterior pole,** located at the center of the cornea; and a **posterior pole,** at the center of the posterior segment of the eye, which is the portion covered by the sclera. It also has an **equator,** midway between the two poles; an **axis,** or **sagittal diameter,** connecting the two poles; a **vertical** and a **transverse diameter** at the equator. It is not quite spheric, because the cornea is a segment of a smaller sphere, and projects forward like a watch-glass, increasing the sagittal diameter or axis; the transverse is slightly greater than the vertical diameter. The axis, or sagittal diameter, measures about 24.5 millimeters; the transverse equatorial diameter, about 23.9 millimeters; and the vertical equatorial diameter, about 23.5 millimeters. From these measurements it will be seen that the eyeball is slightly elongated from behind forward, and compressed from above downward. The axes of the two eyeballs are parallel with each other, although the axes of the two orbits are divergent anteriorly.

Dissection.—By the time the orbit has been dissected, the human eyeball will be so far decomposed that it can not be easily nor profitably dissected. Fortunately, an adequate substitute is found in the eye of a pig, a sheep, or a bullock. Of these, the pig's eye corresponds more nearly in size to the human

eye; but the bullock's eye, on account of its comparative grossness, is more easily dissected. At least a half dozen bullocks' eyes should be procured before the dissection is commenced. The globe must be thoroughly cleaned down to the sclerotic. Perhaps the best way to accomplish this is as follows: With scissors and forceps make a circular incision through the conjunctiva close to and parallel with the margin of the cornea. The conjunctiva, capsule of Tenon, fat, fascia, and muscles are then gradually worked free from the sclera from before backward, as far as the point of entrance of the optic nerve. When about half way back, the venæ vorticosæ will be seen emerging; and when near the optic nerve, the circle around it, formed by the posterior ciliary arteries and ciliary nerves, will be noticed.

The **Conjunctiva** is a mucous membrane covering the anterior surface of the eyeball and the posterior surface of the eyelids. It consists of a parietal layer, the palpebral portion, which lines the eyelids, and of a visceral layer, the ocular portion, which covers the anterior one-third of the eyeball. The visceral layer is subdivided into a sclerotic and a corneal portion.

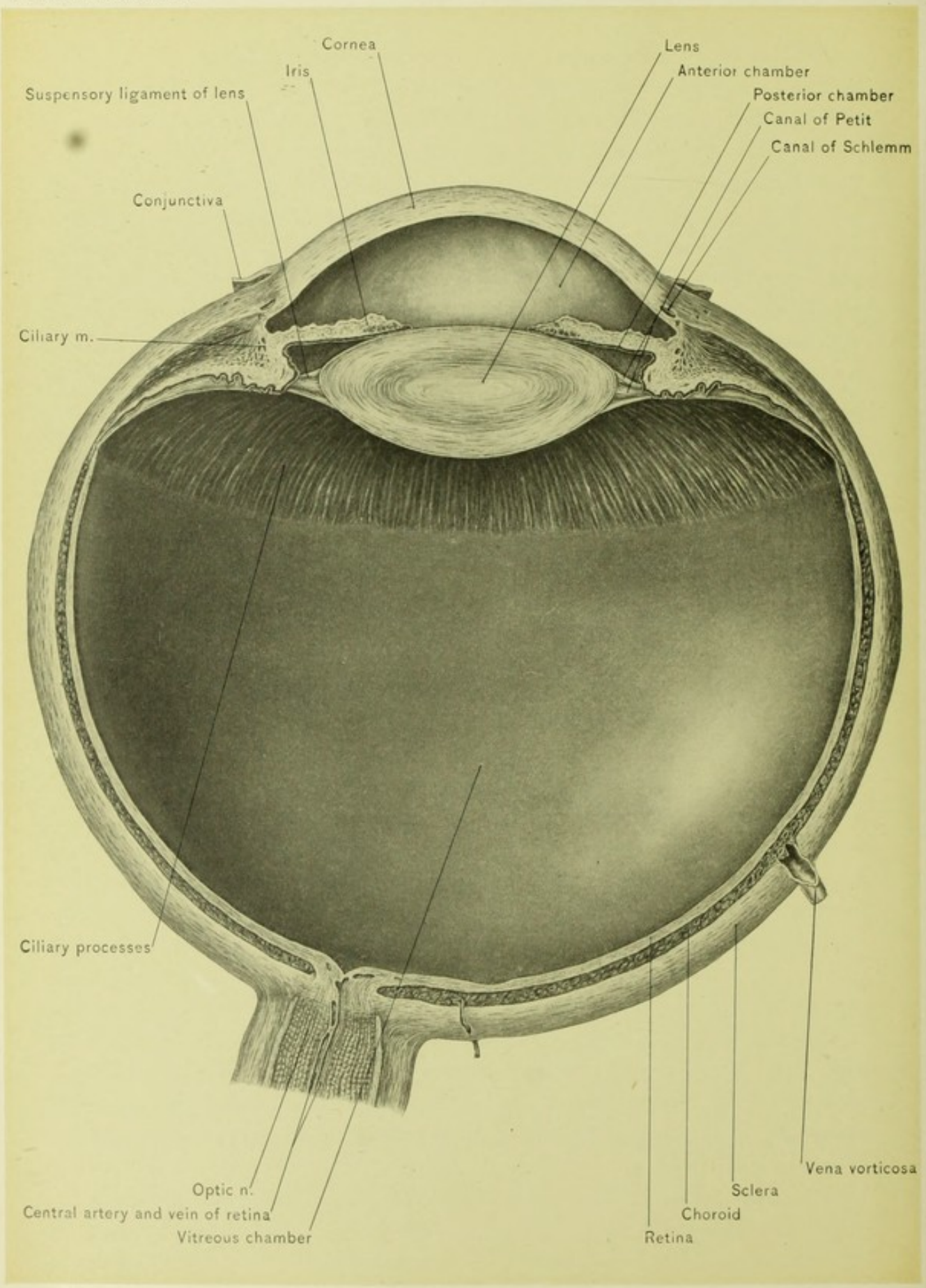
The **palpebral portion of the conjunctiva** has been described with the eyelids under the Dissection of the Face.

The **sclerotic portion of the conjunctiva** is loosely adherent, except at the margin of the cornea. It contains small blood-vessels, which are derived from the palpebral vessels, branches of the lacrymal, infra-orbital, supra-orbital, and frontal vessels, which will not be perceptible under perfectly normal conditions. Congested conjunctival vessels are distinguished from the anterior ciliary vessels by the fact that the former move with the conjunctiva, while the latter are fixed in the sclerotic and remain stationary. The lax submucous tissue which connects the conjunctiva with the sclera permits the surgeon to slide flaps of conjunctiva. Its laxity accounts for the occurrence of subconjunctival hemorrhages after sudden, severe muscular effort, as in paroxysms of whooping cough. The hemorrhages, if associated with traumatism about the head, should be viewed with suspicion, as they may result from fracture of the anterior fossa of the skull with leakage of blood into the orbit. The blood does not become dark in color, but remains red, because oxygen passes to it through the conjunctiva.

The **corneal portion of the conjunctiva** consists of layers of epithelial cells, and forms the anterior layer of the cornea. It is closely adherent, perfectly transparent, and gives the cornea its mirror-like characteristics. It contains no blood-vessels.

Extensive destruction of the conjunctiva may be produced by caustics accidentally introduced between the eyelids and the eyeball. This more frequently occurs under the lower eyelid, on account of its position. The lid may adhere to

PLATE CCXXXVIII.



MERIDIONAL SECTION OF EYE.

the globe, causing **symblepharon**; or cicatricial contraction may produce inversion of the eyelid and eyelashes (**entropion**). Adherence of the two raw surfaces may be prevented by sliding a bridge of conjunctiva from above the cornea, and placing it upon the raw surface below. Entropion may also be caused by cicatricial contraction in chronic conjunctivitis. In purulent conjunctivitis (**purulent ophthalmia**), which is usually due to infection of the conjunctiva by gonorrheal pus, the great danger lies in involvement of cornea, which may produce permanent blindness.

Coats and Refracting Media of the Eye.—The eyeball contains three superimposed coats, inclosing three refracting media, or so-called humors. The coats, named from without inward, are a fibrous, a vascular, and a nervous coat.

The refracting media, enumerated from before backward, are the aqueous humor, the crystalline lens, and the vitreous humor.

The **Fibrous Coat** is composed of two portions—the sclera and the cornea.

Dissection.—To observe all parts of the sclerotic coat clearly, it should be detached from the underlying tissues and removed. To do this it should be incised at the equator—*i. e.*, midway between the center of the cornea (the anterior pole) and the corresponding posterior point (the posterior pole). A sharp knife should be used to make a short cut just deep enough to expose the black, underlying choroid. A pair of scissors with delicate blades and sharp points should then be used to complete the equatorial incision. With the handle of the scalpel the halves of the sclerotic coat should be separated from the subjacent tissues, as one removes the skin of an orange. At only two points will any difficulty be met. One is at the entrance of the optic nerve, where it is necessary to cut off the optic nerve close to the choroid; the other point is anteriorly, where the ciliary body is attached to the sclera. By the use of slight force this attachment can be torn with the forceps, and the anterior moiety, composed of the sclera and the cornea, removed entire. This results in escape of the aqueous humor. The remainder of the globe should be laid aside in diluted alcohol until required for further study.

The **sclera,** or **sclerotic coat,** incloses the posterior five-sixths of the eyeball, the remaining anterior one-sixth of its wall being completed by the cornea. It is incomplete posteriorly at the entrance of the optic nerve, the opening (*foramen scleræ*) being partially filled by a layer of sclerotic tissue, called the *lamina cribrosa*. It is white, opaque, and tough, and maintains the normal conformation of the globe. It consists of interlacing bundles of white, fibrous connective tissue. It is thickest posteriorly, and thinnest just behind the insertions of the rectus muscles, about one-fourth to one-third of an inch or six to eight millimeters from the cornea, where it is sometimes ruptured in cases of injury to the eyeball.

Between the cornea and the insertions of the tendons of the rectus muscles it again becomes thicker, on account of its reinforcement by fibers from those tendons. In disease of the eye, such as glaucoma, in which there is increased intra-ocular tension, compression of the ciliary nerves against the unyielding sclerotic coat causes intense pain.

At its anterior margin the sclerotic coat is directly continuous with the cornea, and the slight groove at this point is called the *scleral sulcus*. About one-fourth of an inch, or six millimeters, behind the sclero-corneal junction the sclerotic coat receives the insertions of the rectus muscles. At this point also it receives and transmits the anterior ciliary vessels, which form a ring around the cornea; congestion of these vessels is evident in iritis. In the sclera, just behind the sclero-corneal junction, is a circular blood channel surrounding the margin of the cornea; it is called the *canal of Schlemm*. This canal transmits venous blood, and is in close relation with certain lymph spaces in the pectinate ligament of the iris, called the *spaces of Fontana*. In conjunction with the spaces of Fontana the canal of Schlemm, by absorbing the excess of aqueous humor, is supposed to maintain the normal intra-ocular tension, exaggeration of which results in the grave disease, glaucoma.

The *lamina cribrosa* is in the posterior portion of the sclera, and is the place of entrance of the optic nerve, whose dural and pial investments blend with the sclera. Minute openings which form a circle around the the lamina cribrosa transmit the posterior ciliary vessels and nerves. The point of entrance of the optic nerve is not at the posterior pole or in the visual axis of the eye, but lies about one-tenth of an inch, or 2.5 mm., to the nasal side of, and slightly below, it. As this nerve passes through the sclera it is constricted, and instead of passing as a compact bundle, it is broken up into fasciculi which separately pierce the fibrous lamina mentioned—the lamina cribrosa. The lamina has an opening in the center larger than the perforations produced by the individual nerve bundles; this is called the *porus opticus*, and transmits the arteria centralis retinæ.

Except at the entrance of the optic nerve and the sclero-corneal junction, the sclerotic is but feebly attached to the subjacent vascular coat. Its innermost layer—which, on account of its deep color, is called the *lamina fusca*—is in relation with the vascular coat, to which it is attached by a layer of loose connective tissue called the *lamina suprachoroidea*.

The **cornea** is the circular anterior window of the eyeball, and comprises about one-sixth of the circumference of the globe. It is perfectly transparent, and is somewhat thinner at its center than at its periphery. Its transparency is lost in interstitial keratitis (inflammation of the corneal tissue), which is frequently caused by syphilis. It is more highly convex than the remainder of the eyeball,

and consequently forms part of a smaller sphere than does the sclera, and hence projects further than does the latter. The student can readily prove this fact by closing his own eye and moving the loose skin of the upper lid over the globe with his finger. The cornea is part of the fibrous coat of the eye, and at its periphery is continuous with the sclera. Owing to the fact that the transition of the sclera into the cornea occurs first on the inner aspect of the former, the sclera seems to overlap the cornea; thus the margin of the cornea becomes beveled on its external aspect and the sclera on its internal aspect. This apparent overlapping being greater above and below than at the sides, the transverse diameter of the cornea slightly exceeds the vertical. It is in front of the aqueous humor, which is interposed between it and the iris and lens.

The cornea being convex, assists in bringing rays of light to a focus upon the retina. If the convexity of the cornea is excessive, the rays are brought to a focus before reaching the retina, and the person suffers from **near-sightedness** or **myopia.** If the cornea is insufficiently convex, the rays reach the retina before being collected to a focus, and the person suffers from **far-sightedness** or **hypermetropia.** When the curvature of the cornea is irregular, the rays of light are not regularly brought to a focus. The error of refraction resulting is known as **astigmatism,** which may also be produced by irregular refraction in the lens.

The cornea consists of five layers: the anterior epithelium, the anterior limiting membrane (membrane of Bowman), the substance proper, the posterior limiting membrane (the membrane of Descemet), and the posterior endothelium.

The *anterior epithelium* and *posterior endothelium* of the cornea serve to prevent absorption of liquid from the tears and from the anterior chamber of the eye. The opacity of the corneal tissue after death is due to imbibition of fluid into the lymph channels of the cornea. If the anterior epithelial layer, composed of the conjunctiva, is broken, and lead lotions are used, lead salts may be deposited and impair the transparency of the cornea.

The *substance proper* (substantia propria) is composed of numerous laminæ of modified connective tissue, between which are freely anastomosing lymph channels, through which it is nourished. Like the other layers of the cornea, it contains no blood-vessels. These vessels end in loops at its periphery. In **interstitial keratitis** these laminæ are affected, and effusion into the lymph channels causes haziness and loss of transparency of the cornea.

Ulcers and wounds of the cornea, as a rule, heal readily, notwithstanding the absence of blood-vessels. Ulcers may, however, perforate the cornea. Perforating ulcers or wounds of the cornea allow the aqueous humor to escape. With the stream of the escaping aqueous humor the pupillary margin of the iris may be prolapsed through the opening in the cornea. Scars resulting from ulcers or

wounds of the cornea may produce an opacity resembling a small puff of smoke (*nebula*), or a pearly white opacity, which is designated *leukoma*. These opacities, if situated at the center of the cornea, interfere with the passage of light to the most sensitive portion of the retina, making it necessary to form an artificial pupil.

Abscesses of the cornea gravitate between the laminæ to the lower part of the cornea, producing a crescentic collection called *onyx*—because of its resemblance to the crescents at the roots of the finger-nails. These abscesses should be evacuated early to avoid perforation, escape of the aqueous humor, and protrusion of the iris.

In elderly persons there is frequently seen an opacity of the corneal tissue near the margin of the cornea; this opacity usually begins at the upper part of the cornea, and then at the lower; subsequently, the extremities of the two hazy crescents meet, and a complete **arcus senilis** results. This condition is due to fatty or hyaline degeneration of the corneal tissue, probably the result of defective vascular supply.

In **pannus** the cornea appears to contain blood-vessels. Through irritation from granular lids or inverted eyelashes blood-vessels grow into the corneal conjunctiva, and later may enter the corneal tissue.

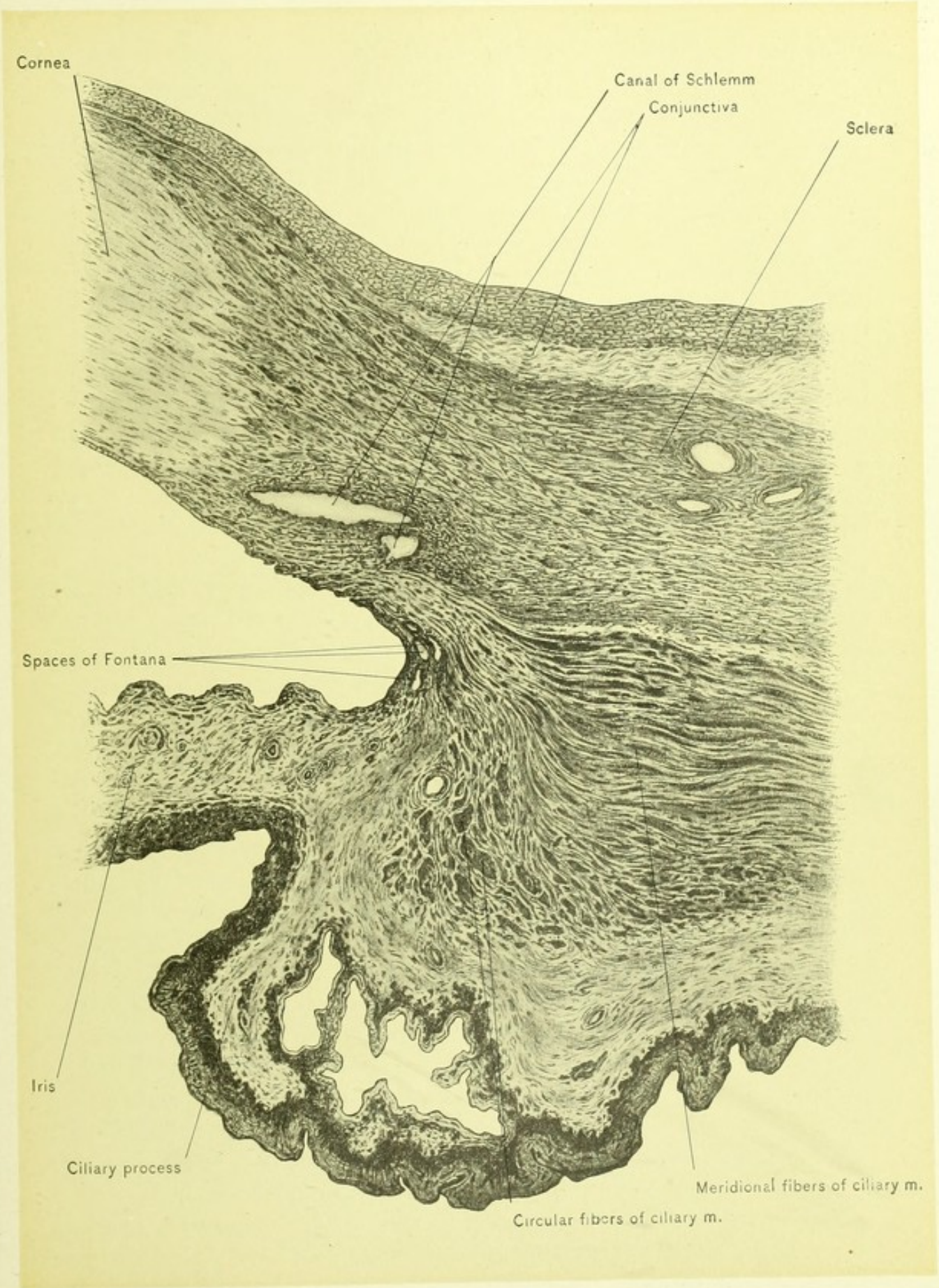
Staphyloma of the cornea is a bulging forward of a corneal scar and adherent iris. It is produced by increased intra-ocular tension pushing forward the iris and even the lens against a weakened cornea, and causing repulsive disfigurement.

A **conic cornea** is thin, protrudes further forward than normally, and retains its transparency. As a result, vision is imperfect.

Blood Supply.—The blood supply of the cornea is indirectly derived from the anterior ciliary and long posterior ciliary arteries. No blood-vessels are found in the cornea, nutrition being supplied by imbibition of lymph into the lymph channels of the cornea. The lack of a direct blood supply accounts for the tendency of the cornea to become inflamed in poorly nourished persons.

Nerve Supply.—The cornea receives a rich nerve supply from the ciliary nerves. Its nerves are merely axis cylinders, and, therefore, do not affect its transparency. From pressure on the ciliary nerves in increased intraocular tension, as in glaucoma, the cornea is anesthetized.

The Pectinate Ligament of the Iris.—At the corneal margin the fourth layer of the cornea, the posterior limiting membrane, breaks up into fibrillæ, some of which run into the base of the iris. These comprise the pectinate ligament of the iris, and bridge over the angle between the cornea and the base of the iris. This ligament contains lymph spaces, called the *spaces of Fontana*, which communicate,



MERIDIONAL SECTION OF CILIARY REGION OF EYEBALL.

on the one hand, with the anterior chamber of the eye, and, on the other, with the canal of Schlemm.

The **Vascular Coat,** or the uveal tract, is the middle coat of the eye. It has been exposed throughout by the previous dissection. It consists of three portions: the most anterior portion is the iris, the perforated circular curtain which hangs in front of the lens; the next portion is the ciliary body, which lies behind the iris; and the third, posterior and largest, is the choroid.

The **iris,** as previously stated, is the anterior portion of the middle tunic, and is a perforated circular curtain interposed between the lens and the cornea. It is attached only at its margin, where it is joined to the cornea anteriorly by means of the pectinate ligament of the iris, and by the ciliary body posteriorly. These attachments are not very strong; consequently, in injuries of the eye the iris may be torn away from the cornea and ciliary body without damage to either of these two structures. It is contractile and expansile, and floats in the clear aqueous humor, separating the anterior chamber of the eyeball from the posterior chamber, which communicate with each other through the central opening of the iris, called the **pupil.** In the fetus the pupil is closed by the pupillary membrane, which disappears before birth. By change in size of the pupil the iris regulates the amount of light admitted to the interior of the eye. Both contraction and dilatation of the pupil are active processes, the presence of circular and radiating muscle fibers having been demonstrated. Near the pupil the posterior surface of the iris is in contact with the lens, hence in iritis the iris may adhere to the lens, producing **posterior synechia;** when the iris adheres to the cornea, **anterior synechia** results.

The iris receives much support from contact with the lens; consequently, when the lens is dislocated posteriorly or after cataract operations, the iris may be tremulous through lack of support.

The **Argyll Robertson pupil** is one which does not respond to stimulation by light, but retains its power of accommodation for distance. It is a diagnostic sign in locomotor ataxia, and has been observed in cerebral syphilis, general paralysis of the insane, and poisoning by carbon bisulphid.

The **color** of the iris varies in different individuals, and is largely dependent on the amount and position of its pigment. In blue eyes the stroma of the iris is entirely free from pigment, the latter being confined to the posterior pigment layer, from which position it is seen through the superimposed strata of the iris. With the darker eyes the stroma cells of the iris also acquire pigment; in light gray eyes this is small in amount, in brown eyes greater, while in the darkest eyes the colored particles are very numerous, and sometimes appear as almost continuous pigmented areas; in albino eyes, on the other hand, even the retinal portion

of the iris is devoid of pigment (Piersol). The color of the iris may be greatly altered during inflammation of that structure, through effusion into the tissues of the iris. The swelling thus produced causes sluggish movement of the iris, and encroachment upon the pupil.

Blood Supply.—This is derived from the ciliary vessels; consequently, iritis is usually associated with choroiditis.

Nerve Supply.—The nerve supply of the iris is derived from the ciliary nerves. The radiating muscle fibers are supplied through the lenticular ganglion by the sympathetic nerve, and the circular fibers through the lenticular ganglion by the third cranial nerve.

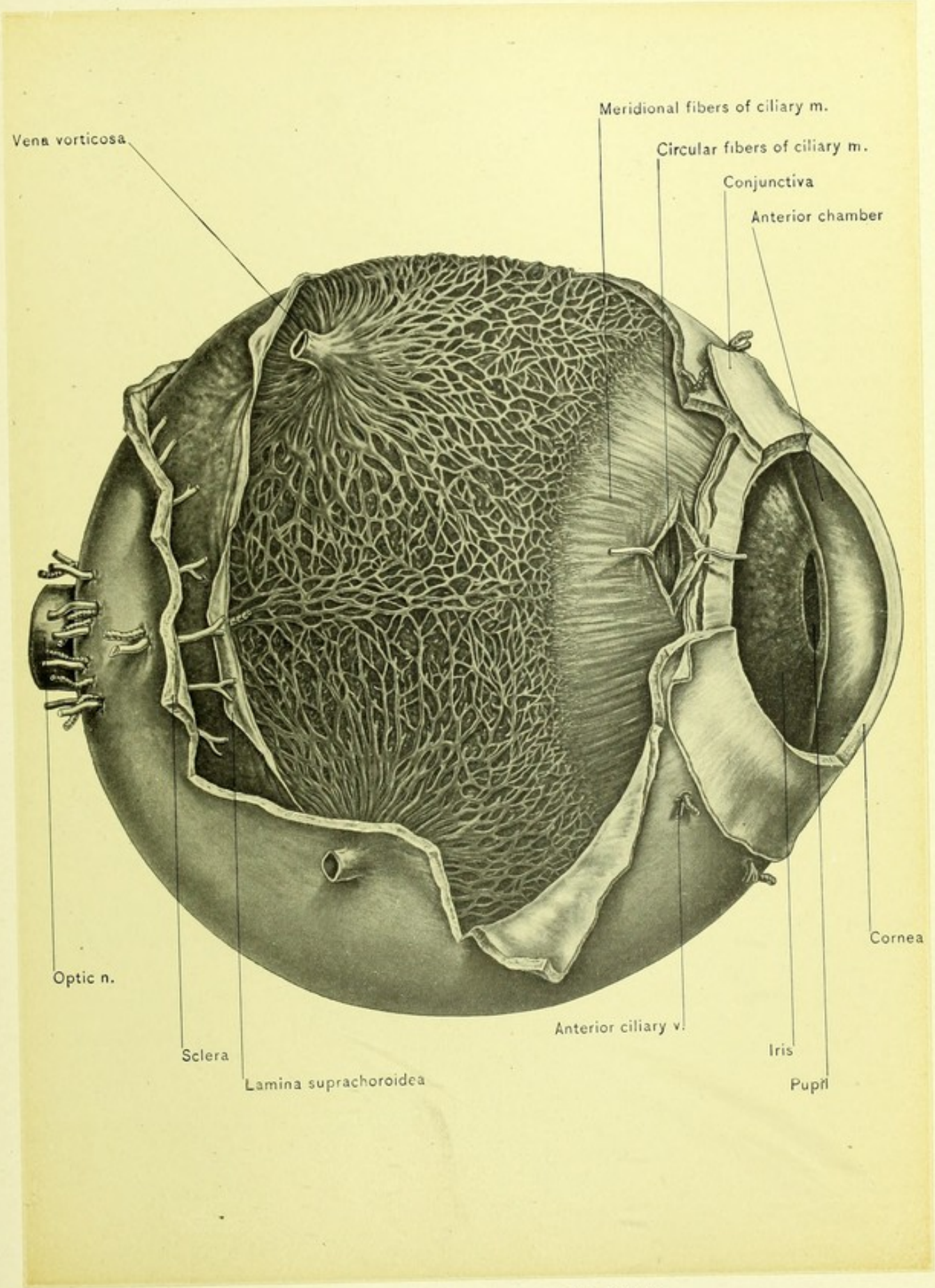
The path for the iris reflex (that is, the contraction and dilatation of the pupil induced by variations in the amount of light falling into the eye) is along the optic nerve and tract to the geniculate body, or perhaps the anterior pair of corpora quadrigemina, thence to the nucleus of the motor oculi, along the latter nerve to the ciliary ganglion, and then through the ciliary nerves to the iris. Interference with this path by lesions in the optic nerves or tracts or in the central nervous system leads to disturbances which the clinician utilizes for diagnostic purposes.

Coloboma, or a cleft of the iris, is the most common congenital defect of the iris; it is usually situated below the pupil, and is due to persistence of the choroid cleft of the embryo.

Aniridia, or absence of the iris, is a rare defect; it is usually bilateral.

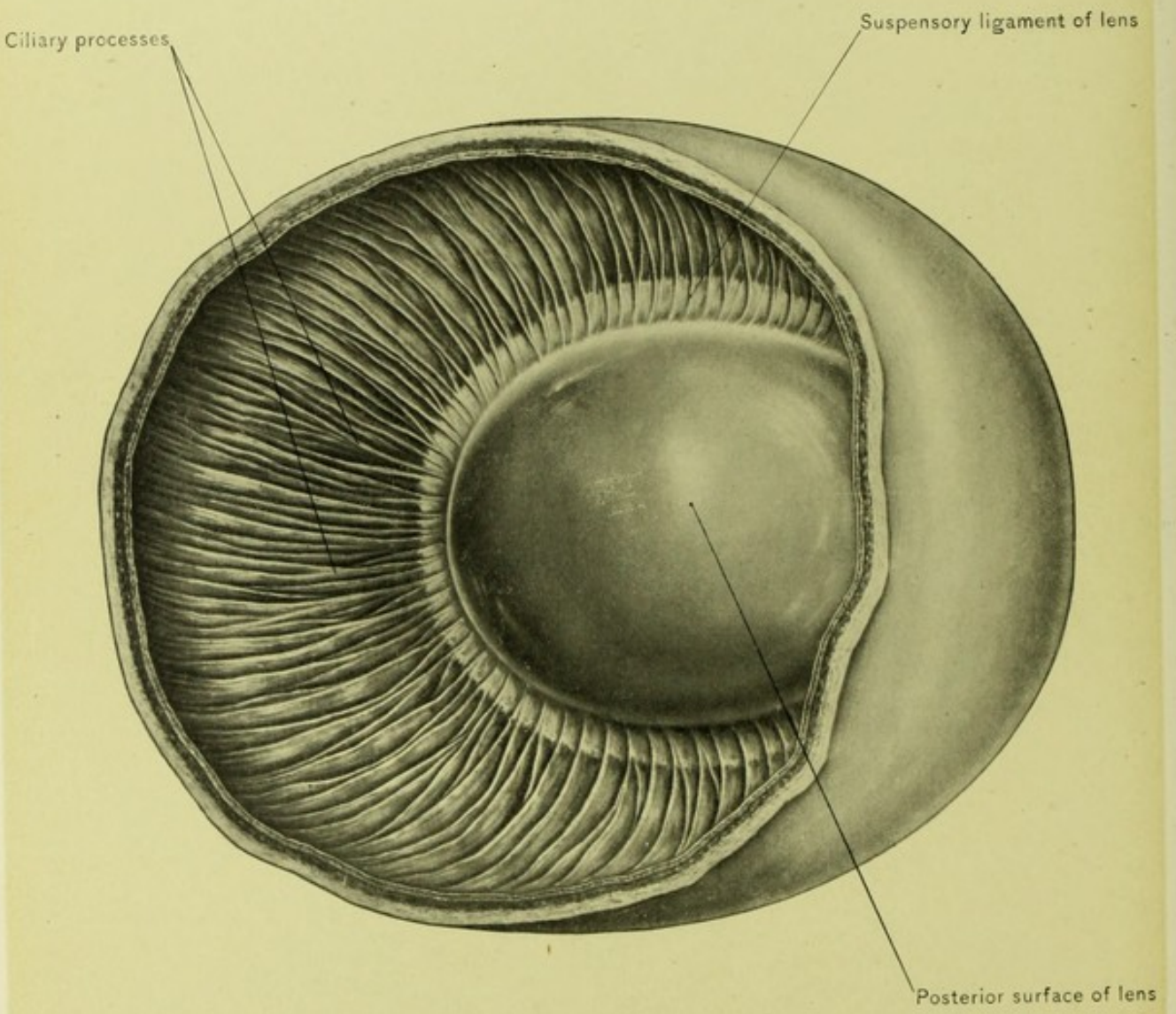
The **ciliary body,** or **cyclon,** the intermediate portion of the middle tunic or uveal tract, is composed of two portions—the ciliary muscle and the choroid portion or ciliary processes. It extends from the posterior, or ciliary, margin of the iris to a point opposite the ora serrata of the retina. In meridional sections of the eyeball it is triangular. The outer side of the triangle is formed by the ciliary muscle, and is in contact with the sclera; the postero-internal side is directed toward the vitreous chamber of the eyeball, and contains the ciliary processes; the anterior side is directed toward the aqueous chamber, and gives attachment to the margin of the iris at about its middle. The ciliary body is well supplied with branches from the ciliary vessels and nerves. Inflammation spreads rapidly from it to the iris, choroid, retina, and cornea. It is called the dangerous area of the eye, because traumatic inflammation of the ciliary body in one eye may be followed by sympathetic ophthalmia beginning in the ciliary body of the other eye. This is supposed by some to be due to the rich nerve supply of that region.

The **ciliary muscle** forms a conspicuous white band between the choroid and the iris, and behind the sclero-corneal junction. It bears on its inner surface the ciliary processes. In cross section of the ciliary body or longitudinal section of the eyeball it appears as a triangular band of muscle fibers. The shorter anterior



EXTERNAL AND MIDDLE COATS OF THE EYEBALL.

PLATE CCXLI.



CILIARY REGION (FROM LION'S EYE IN MUSEUM OF UNIVERSITY OF PENNSYLVANIA).

side of the triangle extends from the sclero-corneal junction toward the ciliary processes; and at the angle of junction of the other two sides it joins the anterior margin of the choroid. It consists of fasciculi of muscular tissue, the interstices of which are filled with similar strands of connective tissue. The muscular tissue, like all similar structure in the eyeball, is composed of involuntary muscle fibers arranged in two sets—*meridional* and *circular*. The meridional or longitudinal muscle fibers arise from the sclera and the sclero-corneal junction, pass backward, and are inserted into the choroid opposite the ciliary processes. The circular muscle fibers, or ring muscle of Müller, are placed internal to the meridional fibers in the ciliary body, and encircle the attached margin of the iris.

Blood Supply.—The ciliary muscle and ciliary body are supplied with blood from the long posterior ciliary and anterior ciliary arteries.

Nerve Supply.—The ciliary body and ciliary muscle depend upon the long and short ciliary nerves for their nerve supply, the ciliary muscle being supplied by fibers of these nerves derived from the third cranial nerve.

Action.—The ciliary muscle possesses the function of accommodation, and permits variation in the degree of convexity of the lens to enable the rays of light to reach a focus on the retina. The ciliary muscle pulls upon the ciliary processes and relaxes the suspensory ligament of the lens; lessened tension upon this ligament relaxes the capsule of the lens, and allows the anterior surface of the lens to bulge forward. In the hyperopic or long-sighted eye, in which the antero-posterior axis of the eyeball is too long, the ciliary muscle is overworked in endeavoring to bring the rays of light from near objects to a focus upon the retina; consequently, in hyperopia the ciliary muscle, and especially the ring muscle of Müller, is hypertrophied. After a severe illness, or frequent and long-continued periods of reading, this muscle is unable to perform the required amount of work, and the hypermetropic state ensues, which should be relieved by a convex lens. As the third cranial nerve supplies the internal rectus muscle as well as the the ciliary muscle, and does not supply the external rectus muscle, convergent squint is frequently associated with hypermetropia. A properly selected convex lens removes the cause of the spasm of the internal rectus muscle, and the strabismus disappears.

Dissection.—Secure a fresh eye, and with a sharp, thin-bladed knife or a pair of scissors cut the globe in half slightly anterior to the equator. Scoop out the jelly-like vitreous, leaving intact the lens and its attachments. Place the bowl-like preparation, thus produced, in a shallow tray containing dilute alcohol, and wash out the pigment with a small camel's-hair pencil. A clear posterior view of the ciliary processes will then be secured. To see them from in front another dissection should be made. The cornea may be removed by making a circular incision just anterior to the sclero-corneal junction. Four meridional incisions

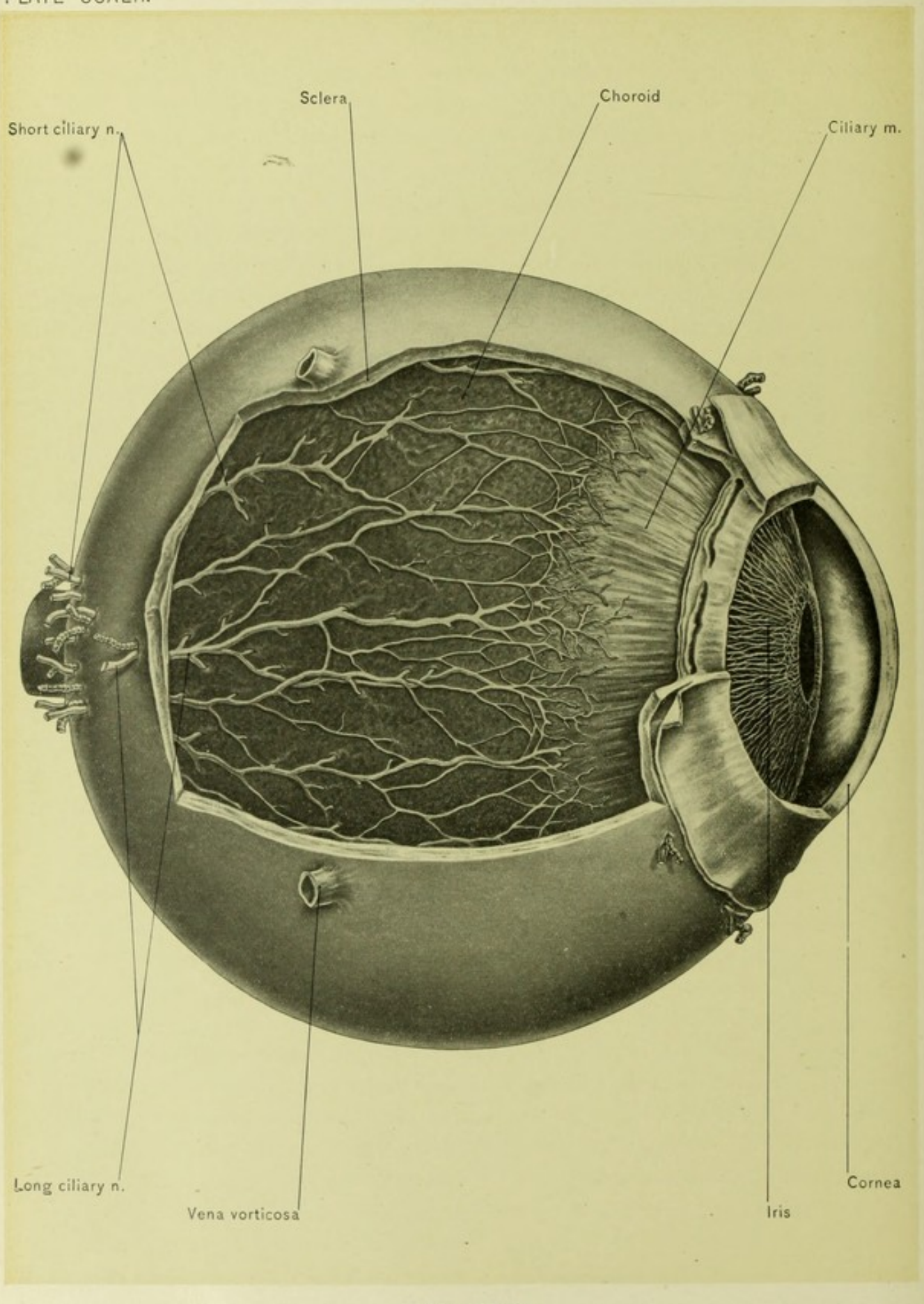
should be made through the sclera and carried backward to about one-quarter of an inch from the posterior pole of the eye. The flaps thus formed should be pinned back, and the whole preparation placed in dilute alcohol held in a wax- or cork-lined tray. With delicate forceps and scissors the iris is then removed, when an anterior view of the ciliary processes may be had.

The **ciliary processes** are some seventy or eighty irregular projections from the internal surface of the ciliary body. They are longitudinal folds of the forward continuation of the choroid. Their broader extremities are directed forward and form a circle,—*corona ciliaris*,—which gives attachment to the suspensory ligament of the lens. Toward the posterior part of the ciliary body they become less prominent and subdivide, the inner surface of the ciliary body here being almost smooth and forming the *orbiculus ciliaris*. The ciliary processes are the most vascular portion of the eyeball; like the choroid, they are composed of a connective-tissue stroma, pigment, and numerous blood-vessels. By osmosis from the blood-vessels of the eyeball the aqueous humor is supposed to be replenished. As the iris and the anterior portion of the ciliary body are continuous and their blood-vessels are in free communication, iritis seldom exists without cyclitis; hence the resultant disease is called irido-cyclitis.

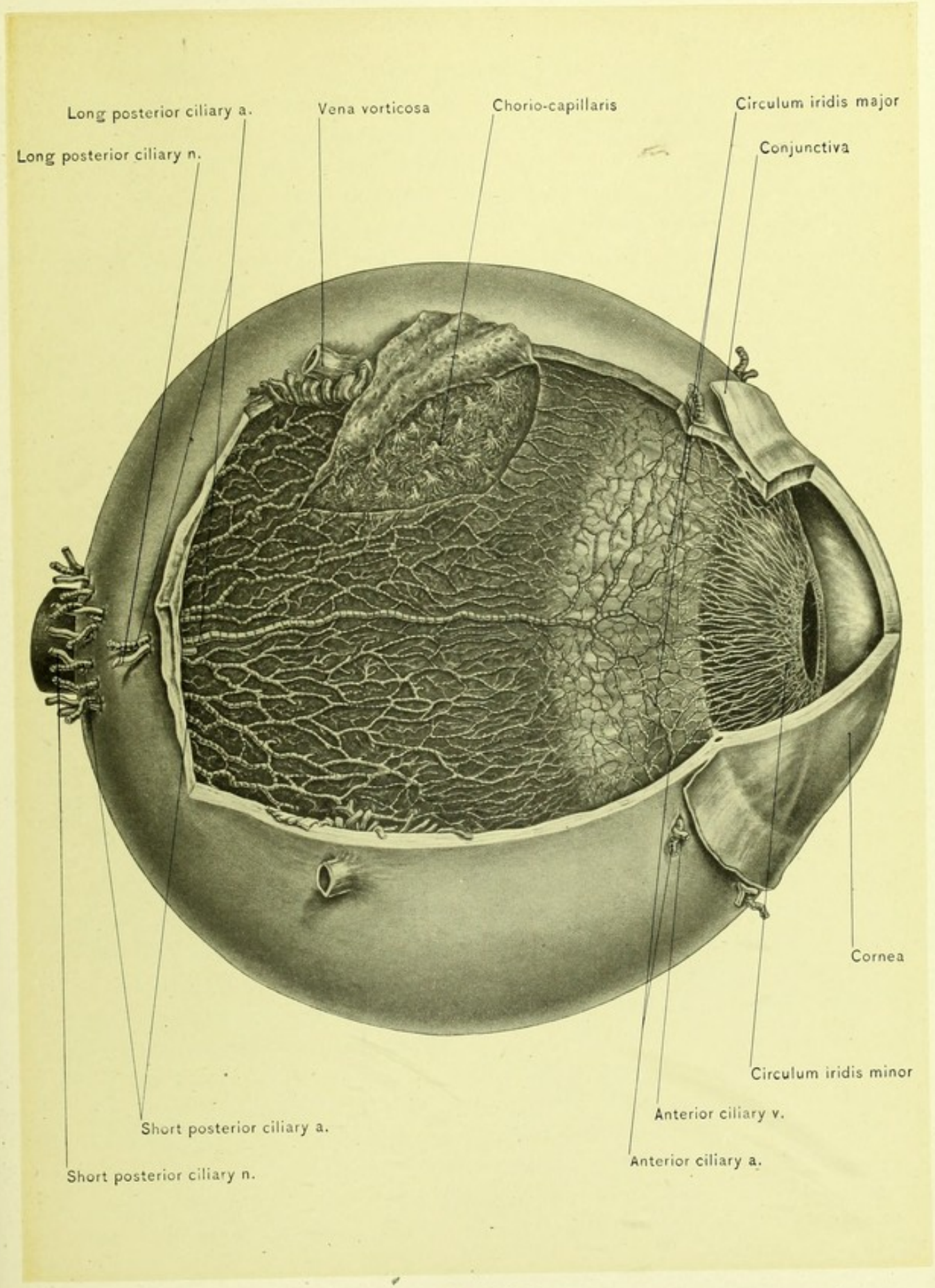
The **choroid proper** extends from the posterior termination of the ciliary body to the optic nerve, by which it is pierced. It is found in the posterior portion of the globe, like the sclera, and consists mainly of blood-vessels, areolar tissue, and pigment. Externally, it is in relation with the sclerotic coat, to which it is connected by its outermost layer—the lamina suprachoroidea; internally, it is in contact with the pigment layer of the retina.

It is composed of four layers—viz., the lamina suprachoroidea, the layer containing large vessels, the chorio-capillaris, and the lamina vitrea. Its outer layer, the *lamina suprachoroidea*, is in immediate contact with the sclera, and is composed of loose areolar, nonvascular tissue containing pigment. This layer is so loosely connected with the lamina fusca of the sclera that extensive hemorrhages may occur between the sclera and choroid after traumatism of the eye. The third and fourth layers are vascular in character. The third is the layer of choroid stroma, and contains large blood-vessels. The most conspicuous of these vessels are the four *venæ vorticosæ*, each of which is formed by numbers of veins converging at one point and forming a whorl. They are located at equidistant points along the equator of the eyeball, and to them the small veins converge, returning the blood from the whole uveal tract. The *chorio-capillaris* is the inner vascular layer, and is composed of capillary blood-vessels. The *lamina vitrea*, vitreous or glassy lamina, is the fourth or internal layer. It supports the retinal pigment, which usually adheres to it when the retina is removed.

PLATE CCXLII.



CILIARY NERVES.



CILIARY ARTERIES.

The choroid contains so much pigment that it is one of the few structures affected by primary **melanotic sarcoma.**

The **ciliary nerves** have two sources of origin—the long ciliary nerves arise from the nasal branch of the ophthalmic nerve, and the short ciliary nerves spring from the lenticular ganglion. They pierce the sclera around the optic nerve, and pass forward between the sclera and the choroid; at the posterior part of the globe they groove the inner surface of the sclera and are intimately attached to it. They pass forward to the ciliary body, where they break up to form a plexus, from which fibers are distributed to the ciliary muscle, the iris, and the cornea. Compression of these nerves against the resisting sclera in increased intra-ocular tension, as in glaucoma, causes intense pain in the eyeball and anesthesia of the cornea.

The **ciliary arteries** consist of the short posterior, long posterior, and anterior. The *short posterior ciliary arteries* are from twelve to twenty in number; they pierce the sclera around the optic nerve, and are distributed to the choroid. The *long posterior ciliary arteries* pierce the sclera just external to the circle formed by the perforations for the short ciliary arteries, and run forward in the choroid. In the ciliary body around the attached margin of the iris they anastomose with the anterior ciliary arteries. These inosculations form the *circulum iridis major;* branches from this circle enter the iris, and at the outer margin of the sphincter muscle of the iris anastomose and form the *circulum iridis minor.*

The *anterior ciliary arteries* are eight in number, two arising from each of the arteries which supply the rectus muscles. They pierce the sclera near the sclero-corneal junction, and enter into the circulum iridis major. The ciliary arteries and nerves are also described with the orbit.

The **veins** which have their origin in the middle coat of the eyeball are the venæ vorticosæ and the anterior ciliary veins. The *venæ vorticosæ* have been previously described with the choroid and the orbit. The *anterior ciliary veins* arise from small veins in the ciliary muscle, and pierce the sclera near the margin of the cornea, receiving veins connected with the canal of Schlemm. They also receive conjunctival and episcleral veins, and empty into the veins which accompany the arteries to the rectus muscle.

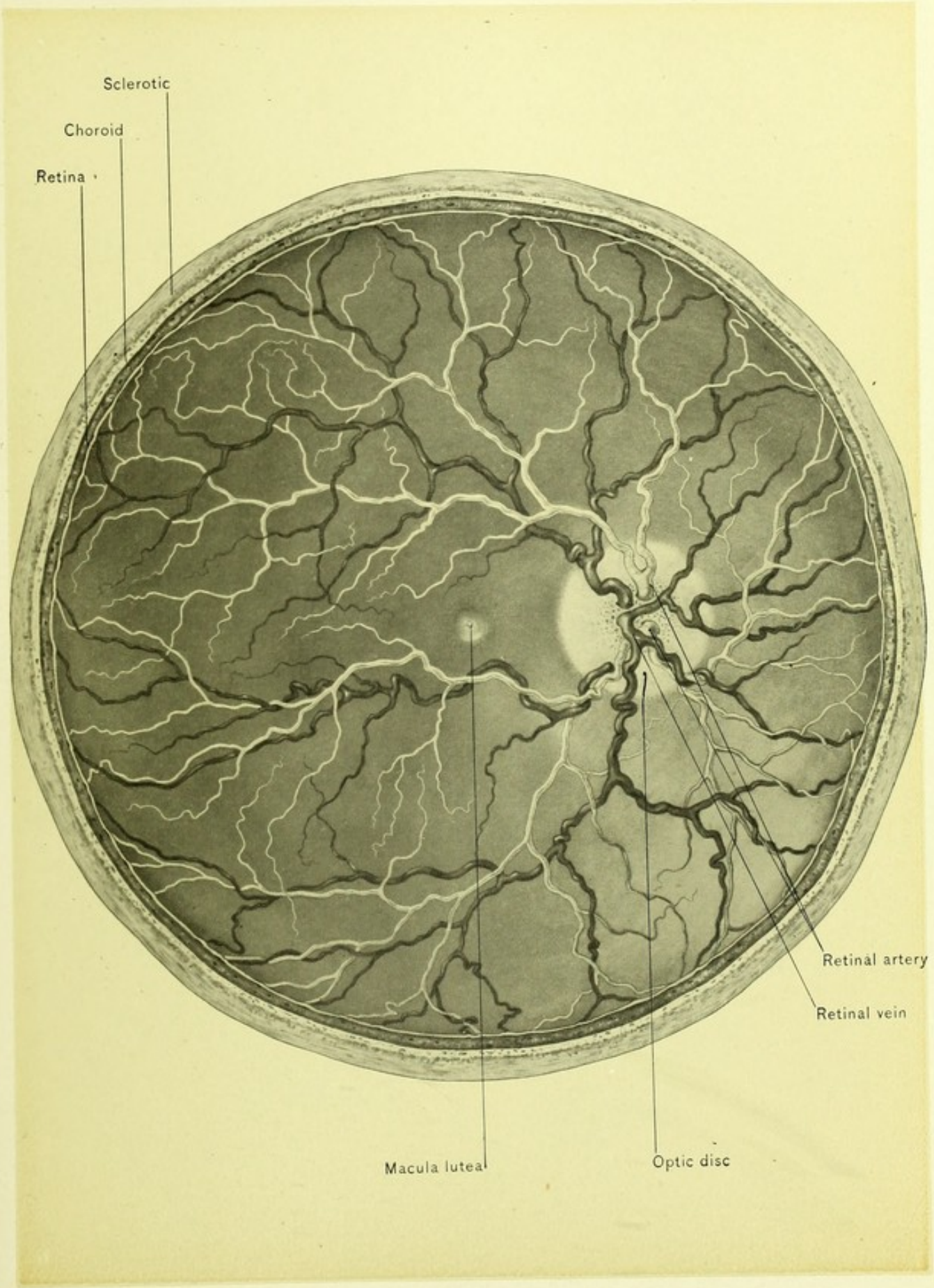
Dissection.—The choroid, ciliary body, and iris should be carefully stripped from that eyeball in which they were exposed. This should be done under diluted alcohol, and when completed, the retina will be seen. If a portion of the detached choroid is inspected, on its inner surface irregular black patches will be observed. These are fragments of the pigment layer of the retina which have become detached on account of their firm adhesion to the lamina vitrea of the choroid.

The **Retina,** the third and innermost coat of the eye, is the nervous tunic. It is the end organ of the optic nerve specialized for the function of vision. Morphologically, it extends from the point of entrance of the optic nerve at the foramen scleræ to the free margin of the iris. It consists of three parts: The posterior portion is situated between the choroid and the vitreous body, and extends from the optic nerve entrance to the ciliary body, where the retina suddenly becomes thin along an irregular line, thus forming the **ora serrata.** This posterior portion is called the optic part, or **pars optica retinæ,** and terminates at the ora serrata. The next portion, the ciliary part, or the **pars ciliaris retinæ,** lines the inner surface of the ciliary body, extending as far forward as the insertion of the iris. The anterior portion lines the internal surface of the iris, and is called the **pars iridica retinæ.** The pars optica retinæ is the only part which has much visual function; because the pars ciliaris and pars iridica retinæ are mainly continuations of the pigment layer beyond the ora serrata, at which the highly specialized layers of the retina suddenly diminish in thickness.

When viewed from the interior, a circle is seen at the point of entrance of the optic nerve. This is called the *optic disc.* It is sometimes called the porus opticus, but this name should be applied only to the foramen in the lamina cribrosa traversed by the central artery of the retina. This disc lies one-tenth of an inch or two and one-half millimeters to the inner side of the posterior pole of the eye. As this is the *blind spot* of the retina, it is placed outside of the direct line of vision. Exactly in the center of the retina, at the posterior pole, and in the direct line of vision, a small yellow spot, called the *macula lutea,* is seen in a fresh eye; the depression in the center of the macula lutea is termed the *fovea centralis.* The macula lutea is the point at which vision is most acute. For that reason it is situated in a line with the centers of the lens, pupil, and cornea, so that it receives the rays of light brought to a focus by the lens. Rays from other points, passing through the lens, strike other portions of the pars optica retinæ and produce collateral vision, which is less distinct.

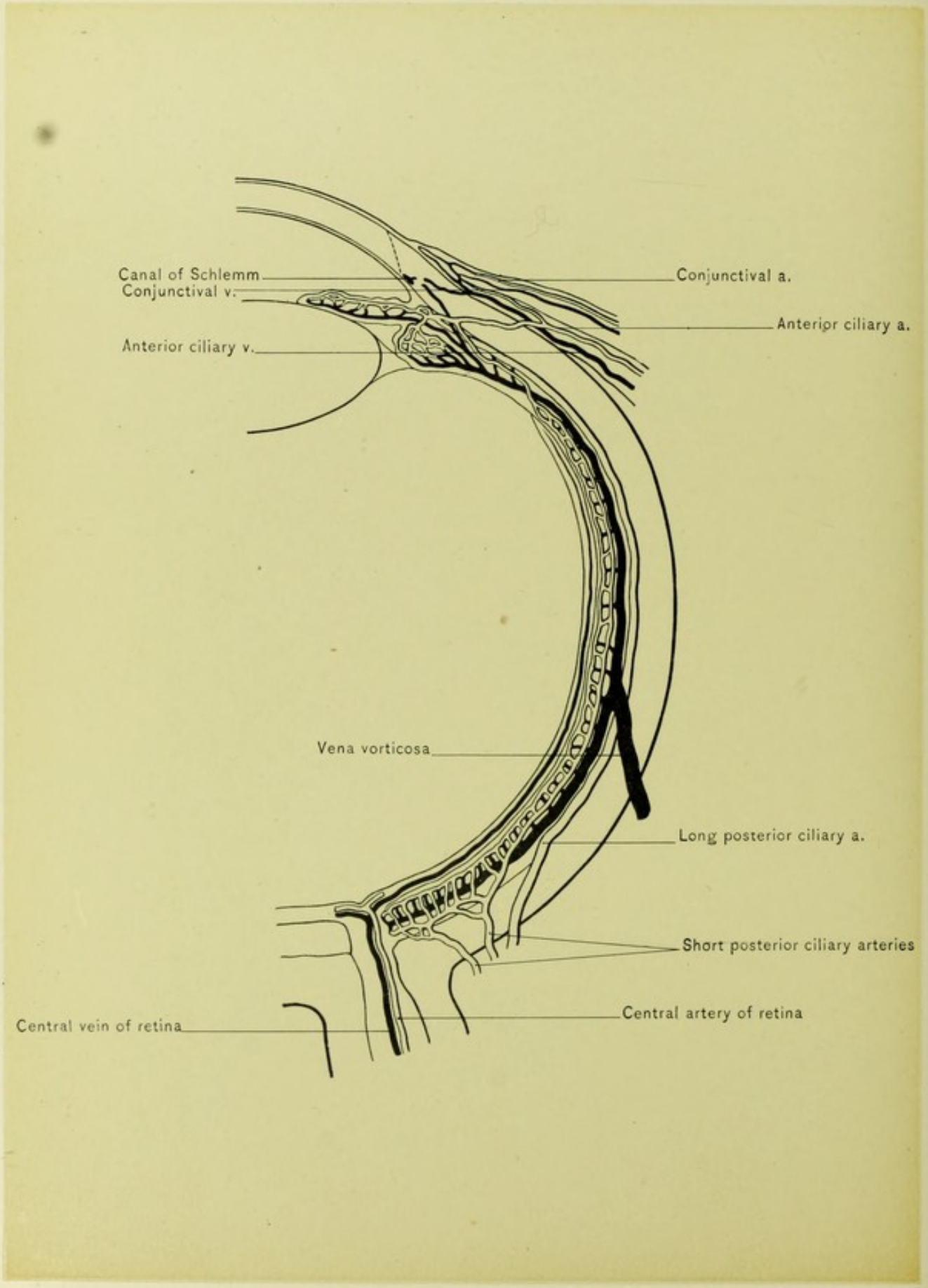
The retina is derived from the two layers of the optic cup, which is an extension of the anterior cerebral vesicle and is, therefore, ectodermic in origin. The outer layer of the cup remains as the pigment layer of the retina, while the inner layer gives rise to the remaining and more specialized portion of it. During life the inner layer is pink and transparent; but after death it becomes hazy and opaque.

Blood Supply.—The blood supply of the retina is derived partly from the arteria centralis retinæ, which can be seen entering the eye at the optic disc. It gives off an ascending and a descending branch, each of which has a small nasal



RETINA OF POSTERIOR ONE-HALF OF RIGHT EYEBALL (ENLARGED).

PLATE CCXLV.



BLOOD-VESSELS OF EYEBALL (AFTER LEBER)

branch. Like the vessels of the brain, lungs, etc., its branches are end arteries, not anastomosing in the substance of the retina with each other or with the ciliary arteries. Probably the greater portion of the nourishment of the retina is derived from the posterior ciliary vessels, through the chorio-capillaris of the choroid.

The **retinal veins** converge to form two vessels which enter the optic nerve at the optic disc, and soon join to form one vena centralis retinæ, which pursues a course in the nerve corresponding to that of the artery.

Dissection.—The method of Anderson Stuart will be found the most satisfactory for studying the vitreous body and lens. A perfectly fresh eyeball should not be used: it should be kept from one to three days before being utilized, according to the season of the year. The three tunics are divided at the equator and turned back. This is done carefully and over a vessel of diluted alcohol, into which the so-called "eye kernel," composed of the vitreous body and lens, is allowed to fall. The "eye kernel" is then placed in a strong picrocarmin solution for a few minutes, and when removed, it should be well washed. By this method the hyaloid membrane, the lens capsule, and the zone of Zinn are stained red. If the solution is shaken gently, the coloring matter may enter the hyaloid canal, which may thus be recognized.

The **Vitreous Body** is a soft, gelatinous, perfectly transparent substance, composed of semi-solid connective tissue. It occupies the posterior cavity or vitreous chamber of the globe. The *vitreous chamber* is bounded behind and laterally by the retina, and in front by the lens and the zone of Zinn. The vitreous body consists of the vitreous substance, inclosed by the **hyaloid membrane,** except anteriorly, where the vitreous substance comes into direct contact with the lens capsule, receiving the lens into a depression, the **patellar fossa** of the vitreous body. It has an indistinctly reticulated structure, and may contain small corpuscular bodies which occasionally produce shadows upon the retina, the so-called **muscæ volitantes.** Running from the optic disc to the center of the posterior surface of the lens is a narrow canal, lined by a prolongation of the hyaloid membrane, and called the **hyaloid canal, canal of Stilling,** or **canal of Cloquet.** During fetal life this canal transmits an artery to the lens, the hyaloid artery, and in the adult contains the remains of the supporting connective tissue or rarely an atrophied vessel.

The **Zone of Zinn, Zonula of Zinn,** or **Suspensory Ligament of the Lens,** is the thickened portion of the hyaloid membrane extending from the ciliary body to the lens. At the ora serrata the hyaloid membrane becomes attached to the ciliary body and remains so attached as far as the peripheral or anterior ends of the ciliary processes. From the apices of the ciliary processes thick bands of the hyaloid membrane pass over to the lens, going to its periphery and

anterior surface. The hyaloid membrane, in this region, is thrown into numerous folds, caused by the plications of the choroid portion of the ciliary body, to which it is so closely apposed. At the ciliary margin of the ligament these folds become converted into stiff fibers, which form two series. One series consists of those fibers which spring from the apices of the ciliary processes; the other, of those which spring from the depressions between the processes. The former are inserted into the periphery and adjacent parts of the posterior portion of the capsule of the lens, and the latter go to the anterior surface of the lens, blending with the superficial layers of the anterior portion of the lens capsule.

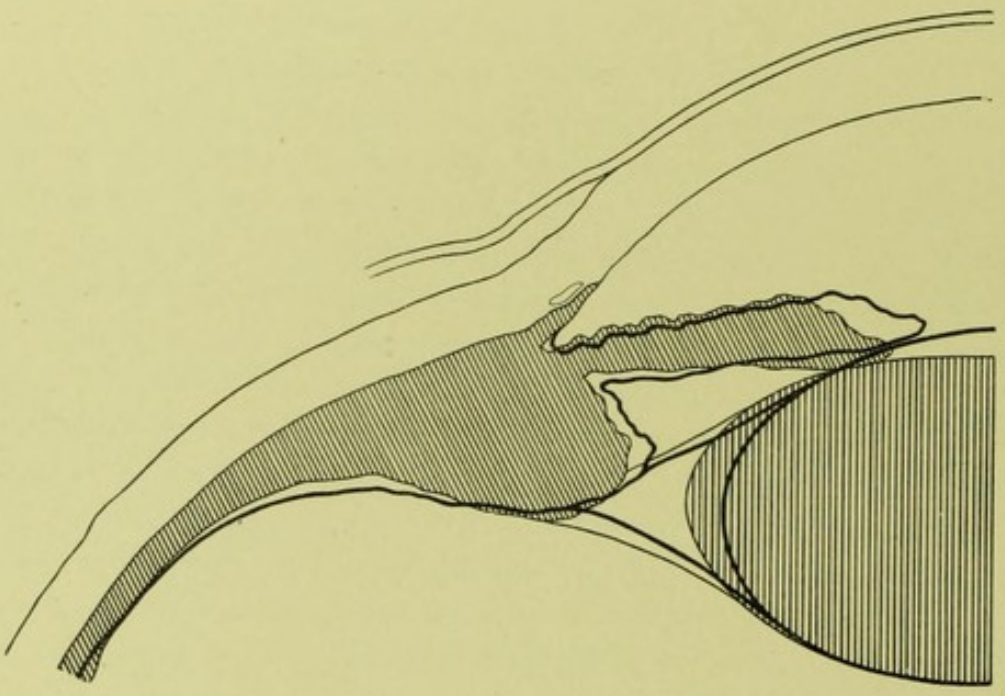
The lens is, in this manner, maintained in its position. The tension of the zone of Zinn is varied by contraction of the ciliary muscle; when this muscle contracts, the suspensory ligament is relaxed; thus, the lens is less firmly compressed, and by its own elasticity becomes more convex, and its focal distance is decreased. This function is known as **accommodation.**

The **Canal of Petit** is a narrow lymphatic channel which encircles the margin of the lens, is triangular on section, and is bounded in front by the anterior lamina of the suspensory ligament of the lens, behind by the hyaloid membrane, and internally by the capsule of the lens. It is subdivided into two portions by the fibers of the posterior lamina of the suspensory ligament of the lens. The lymph in the canal of Petit is derived from the ciliary vessels, and is supposed to supply nutrition to the lens.

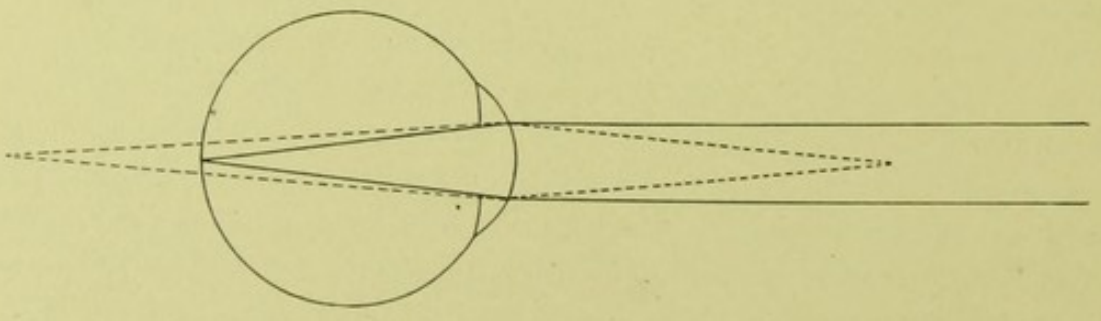
Dissection.—By carefully inserting a fine blowpipe into the canal of Petit it may be distended by air or a colored fluid. When so dilated, it presents a series of sacculations, due to the undulations in the zone of Zinn produced by the ciliary processes. Remove the lens by cutting through the zone of Zinn with a pair of scissors.

The **Crystalline Lens** is a biconvex, circular body, lying behind the iris and aqueous humor, and in front of the vitreous body. Its rounded margin is a short distance from, and parallel with, the corona ciliaris of the ciliary body, to which it is firmly attached by the suspensory ligament of the lens. The center of the anterior surface of the lens is the anterior pole, and the center of the posterior surface is the posterior pole. The convexity of the anterior surface of the lens is not so great as that of the posterior surface. The central portion of the anterior surface is opposite the pupil, and in contact with the aqueous humor of the anterior chamber. At the margin of this central portion the lens is in contact with the posterior surface of the pupillary margin of the iris; external to this margin the curvature of the lens carries it away from the iris; this interval between the lens and iris is the posterior chamber of the eye, and is filled with part of the aqueous humor. Posteriorly, the lens is received into the patellar fossa of

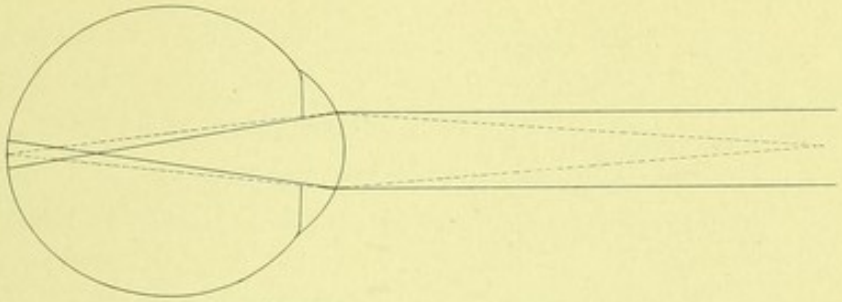
PLATE CCXLVI.



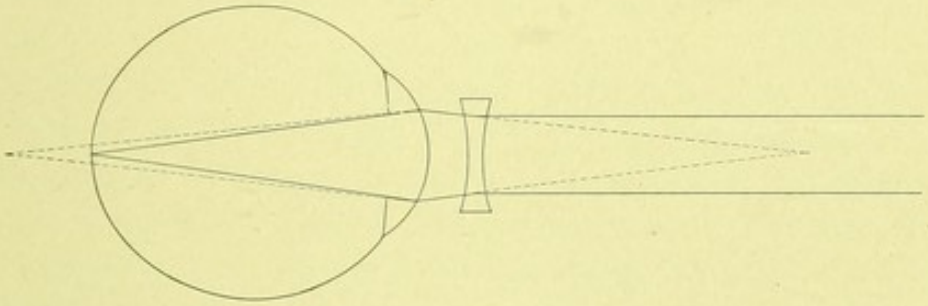
THE DARK AREAS REPRESENT THE LENS, IRIS, AND CILIARY BODY AT REST; AND THE BROAD OUTLINES INDICATE THE CHANGED POSITION OF THOSE STRUCTURES DURING ACCOMMODATION (AFTER FUCHS).



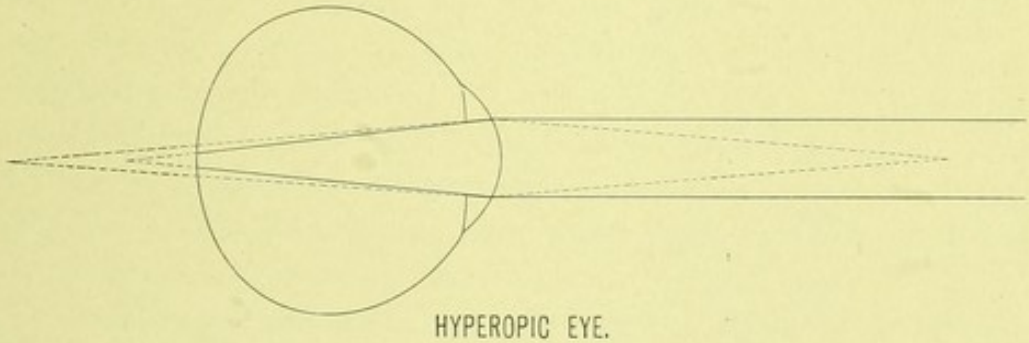
EMMETROPIC EYE.



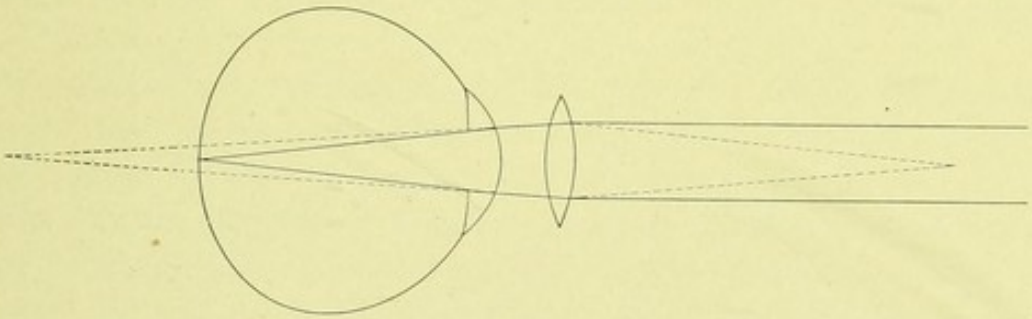
MYOPIC EYE.



MYOPIC EYE WITH CONCAVE LENS.



HYPEROPIC EYE.



HYPEROPIC EYE WITH CONVEX LENS.

the vitreous body. Peripherally, it is in relation with the zone of Zinn and the canal of Petit.

The lens is composed of the lens capsule and the lens substance. The **capsule of the lens** is the strong, elastic, transparent membrane which surrounds the lens substance. The **lens substance** is a transparent, gelatinous material, translucent in the cadaver, and composed of transparent fibers joined by a transparent cement. The **cortex,** or peripheral portion, is soft, and the central portion, or **nucleus,** is firm.

Dissection.—With a sharp knife divide the anterior part of the capsule of the lens, and then express the lens substance through the opening as one squeezes the pulp of a grape from its skin; the capsule and lens substance can now be examined.

The capsule of the lens or the suspensory ligament may be ruptured by traumatism, and the lens escape into the vitreous or aqueous humor. If the anterior portion of the capsule is torn, the aqueous humor will enter and produce opacity of the lens. This is done purposely in the treatment of soft cataract, so that the lens substance may be absorbed by the aqueous humor.

In **presbyopia,** or old-age sight, the power of accommodation is diminished through the loss of elasticity of the lens. This occurs between the ages of forty and fifty years. In an emmetropic eye which has become presbyopic parallel rays come to a focus on the retina, and distant objects are easily seen, but, through loss of accommodation, near objects are not discerned so readily. As hyperopic eyes constantly require the function of accommodation, gradual loss of this function causes them to feel the effects of presbyopia at an earlier age than emmetropic or myopic eyes. A myopic eye may never suffer from the effects of presbyopia, because it requires no accommodation.

A **cataract** is a diminution in the transparency of the capsule or substance of the lens. After extraction of the cataractous lens, much of the refractive power of the eyeball is lost; consequently, highly convex glasses are required to bring the rays of light to a focus on the retina.

The **Chambers of the Eyeball** are two in number in addition to the vitreous chamber. Both are in front of the lens; both are lymph spaces and contain aqueous humor, and they are separated from each other by the iris.

The **anterior chamber** of the eye is bounded in front by the cornea and behind by the iris and that portion of the lens which presents at the pupil. It communicates with the posterior chamber through the pupil. At its external angle it is bounded by the pectinate ligament of the iris. This angle, which is formed by the peripheral portions of the cornea and iris, is called the *angle* or *sinus of the anterior chamber,* or the *filtration angle.* Knowledge of the anatomy of

the structures at this angle is most important, for it is here that the excess of the aqueous humor escapes into the spaces of Fontana, and thence by way of the canal of Schlemn into the anterior ciliary veins, thus reducing intra-ocular tension.

Hypopyon is a collection of pus in the anterior chamber of the eye, and arises from suppurative inflammation of the cornea, iris, ciliary body, and choroid. Pus passes from the ciliary body through the pectinate ligament of the iris or the attached margin of the iris to reach the anterior chamber, causing cloudiness of the aqueous humor, and its solid portion gravitates to the most dependent part of the anterior chamber, varying its position with movements of the head. Hypopyon is crescentic in form, like onyx, but the latter is stationary.

The **posterior chamber** of the eye is a circular space, triangular on cross-section, and situated behind the iris. It is bounded in front by the iris; behind, by the lens and zone of Zinn; and externally, by the anterior portion of the ciliary body. It is limited internally by the pupillary margin of the iris.

The **Lymphatic System of the Eyeball** contains no lymphatic vessels except those of the conjunctiva, the lymph being in spaces. These spaces are divided into an anterior and a posterior set.

The **anterior lymph passages** of the eye include the lymph spaces of the cornea and iris, and the anterior and posterior chambers of the eyeball.

The *lymph spaces of the cornea* are situated between the lamellæ of the corneal substance. At the periphery of the cornea the lymph flows into the conjunctival lymphatic vessels.

The *lymph spaces* of the iris open into the aqueous humor of the anterior chamber of the eye at small indentations called the *crypts of the iris*, and at the periphery of the iris communicate with the spaces of Fontana.

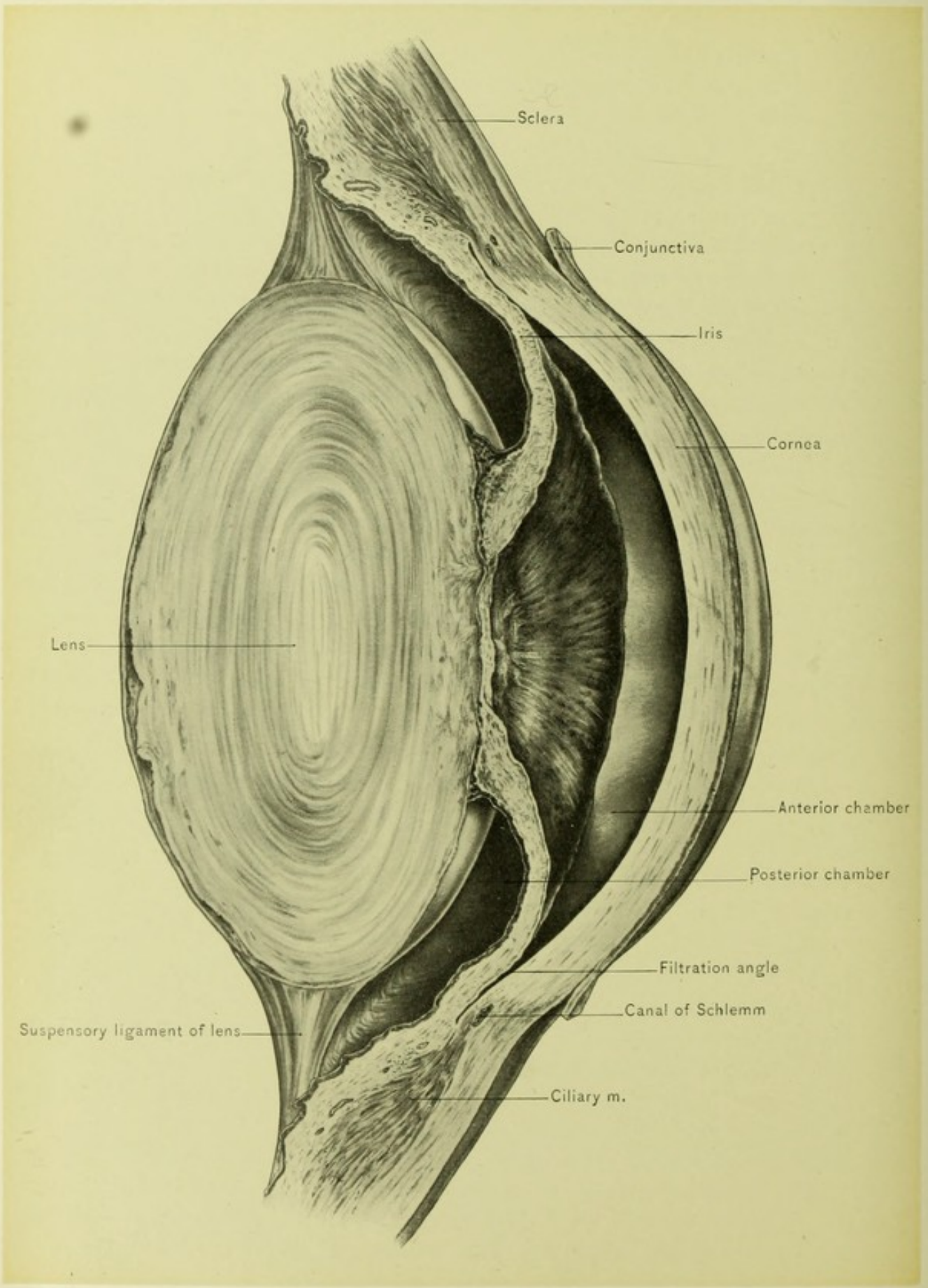
The *aqueous humor* is composed of lymph situated in the anterior and posterior chambers of the eye. It is secreted in the posterior chamber from the plexus of vessels in the ciliary body, and partly from the vessels in the posterior surface of the iris. The aqueous humor passes from the posterior chamber through the pupil into the anterior chamber of the eye, and escapes by way of the spaces of Fontana, the canal of Schlemm, and the anterior ciliary veins.

The **posterior lymph passages** of the eye include the hyaloid canal, the perichoroid space, Tenon's space, the intervaginal space of the optic nerve, and the supra-vaginal space.

The *hyaloid canal*, or central canal of the vitreous body, extends from the optic disc forward to the posterior pole of the lens. In the embryo it contains the hyaloid artery, which disappears later, although the canal remains as a lymph channel which is drained by the intervaginal space of the optic nerve.

The *perichoroid lymph space*, situated between the choroid and the sclera, is

PLATE CCXLVIII.



ANNULAR POSTERIOR SYNECHIA.

continued along the vessels of the choroid and especially along the venæ vorticosæ. Its lymph escapes into Tenon's space by perforations in the sclera around the venæ vorticosæ.

Tenon's space, situated between the sclera and Tenon's capsule, drains the peri-choroid space, and opens into the supra-vaginal space.

The *intervaginal lymph space* is situated between the dural and pial sheaths of the optic nerve, and is subdivided into a subdural and subarachnoid space by the extension of the arachnoid membrane of the brain along the optic nerve. It opens into the subdural and subarachnoid spaces of the brain.

The *supra-vaginal lymph space* is situated between the dural sheath of the optic nerve and the posterior extension of Tenon's capsule.

The greater portion of the lymph of the eyeball escapes by way of the chambers of the aqueous humor, spaces of Fontana, canal of Schlemm, and anterior ciliary veins; consequently, any obstruction in the anterior lymph channels causes increased intra-ocular tension. Such obstruction occurs in **annular posterior synechia,** in which the whole pupillary margin of the iris is adherent to the anterior surface of the capsule of the lens, and prevents the lymph of the posterior chamber, which is derived from the ciliary vessels, from entering the anterior chamber. The pressure thus produced in the posterior chamber causes the peripheral portion of the iris to project forward against the cornea, obliterating the filtration angle, or sinus of the anterior chamber, and preventing escape of lymph from the anterior chamber of the eyeball. In this manner the serious disease of the eye, *glaucoma*, which is characterized by increased intra-ocular tension, is produced. Glaucoma also develops from conditions not so readily demonstrable, as hypersecretion of lymph, and other causes of retention of lymph, in the eyeball.

In **emmetropia,** or normal vision, parallel rays of light or those from distant objects are brought to a focus on the retina when the eye is at rest, and divergent rays or those from near objects do not reach a focus on the retina without some exercise of the function of accommodation. Normal vision occurs in an eye whose axis, or sagittal diameter, is of the normal length, and whose media possess the proper refractive index.

In **hyperopia, hypermetropia,** or far-sightedness, the axis, or sagittal diameter of the eye, is usually too short, although hyperopia may be due to absence of the lens, decreased convexity of the refracting surfaces of the eye, or diminished power of refraction in the refractive media of the eye. The result is that when the ciliary muscle is at rest, parallel rays of light or those from distant objects, and divergent rays or those from near objects, come in contact with the retina before being brought to a focus, forming circular diffusion of the light

and a blurred image. The ciliary muscle compensates for the defect by contracting and allowing increased convexity of the lens; but the severe strain causes local and remote disorders, and, on account of failure of the muscle to perform the work required, reading becomes difficult. The defect is corrected by converging the rays with convex glasses.

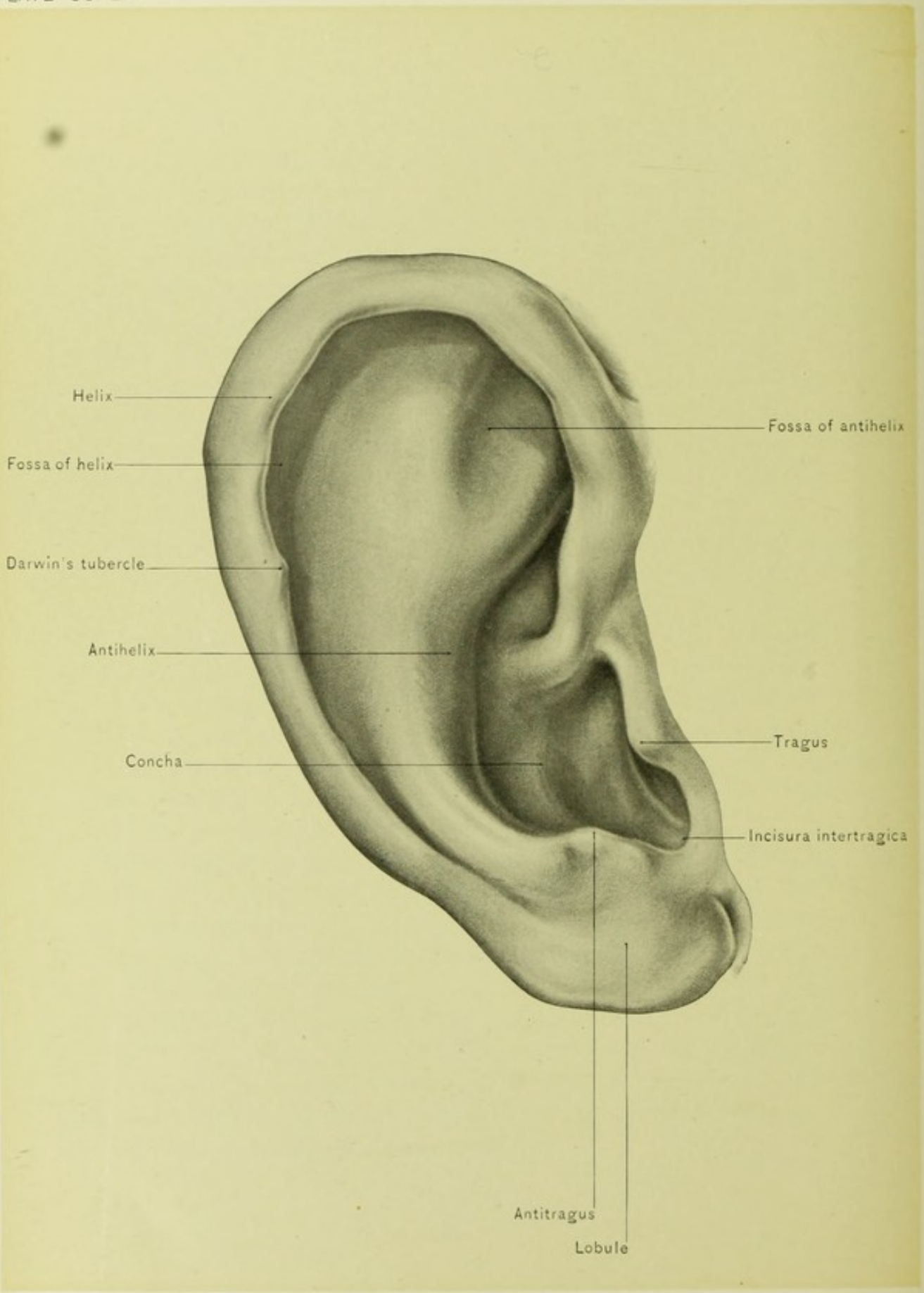
In **myopia,** or near-sightedness, the antero-posterior, or sagittal, diameter is too long, and parallel rays of light are brought to a focus in front of the retina, so that distant objects are indistinct because the image is blurred. Divergent rays or those from near objects at a certain distance are brought to a focus upon the retina. Myopia occasionally results from increased refractive power of the lens; when this occurs in an old person, *second sight* is produced and convex glasses may be discarded. As there is no mechanism in the eye which can compensate for the defect, and the patient can see near objects, continued eye strain may cause more serious disease of the myopic eye. The defect is corrected by concave glasses which cause the rays to diverge.

Exenteration of the orbital contents is performed for malignant disease. The external canthus is split, and the orbital contents, including the periosteum, are all removed except at the apex of the orbit.

Evisceration of the eyeball is performed in staphyloma of the cornea and disfiguring leukoma. The cornea is circumcised at the sclero-corneal margin, and all the contents of the globe and the middle and internal coats of the eyeball are carefully removed, leaving the sclera intact. The opening is enlarged vertically and a glass ball is inserted into the cavity of the eye. The sclera is stitched vertically over the glass ball and the conjunctiva transversely. After the wound heals, an artificial shell may be inserted over the stump.

Enucleation or excision of the eyeball.—The eyelids are separated with a speculum, and the ocular conjunctiva is divided close to and entirely around the cornea. The conjunctiva and capsule of Tenon are pushed backward over the eye. The rectus muscles are grasped with forceps at their insertions and divided back of the forceps. The globe is drawn forward and inward, and the optic nerve and adjoining structures are divided with scissors along the outer side of the eyeball. The eye is then drawn out of its socket, and the remaining adherent tendons and other structures are severed. The cavity is irrigated with cold sterile water, and the stumps of the rectus muscle are sutured together. The wound is cleansed, and a sterilized dressing applied.

PLATE CCXLIX.



PINNA.

THE ORGAN OF HEARING.

The organ of hearing consists of three portions—the external, middle, and internal ear. The **External Ear** comprises the auricle or pinna and the meatus auditorius externus; the former is of but slight importance physiologically; the latter is the canal which leads inward to the tympanic membrane. The **Middle Ear** is composed of the tympanum, the mastoid antrum, and the mastoid cells. The tympanum, an air chamber, communicates with the naso-pharynx by means of the Eustachian tube, and contains a chain of movable bones—the auditory ossicles. The mastoid antrum and mastoid cells are air chambers accessory to the tympanum. The **Internal Ear,** or **Labyrinth,** is made up of a complex arrangement of cavities; it contains a fluid,—the perilymph,—together with a membranous cast of the bony structures known as the membranous labyrinth; the latter contains the endolymph, and within it are the specialized neuro-epithelial cells and the terminations of the auditory nerve.

THE EXTERNAL EAR.

The **Pinna** consists of a pliable framework of yellow, elastic cartilage covered with integument. The external surface is concave, and conducts the sound waves to the external auditory meatus, yet accidental or intentional amputation of the pinna causes but slight diminution in acuteness of hearing. The outer concave surface presents a number of elevations and depressions. The **helix** is the incurved border of the pinna. At the free border of the helix there is often to be seen a more or less prominent, rather triangular projection, known as the **Darwinian tubercle;** it is analogous to the pointed tip of the ear of quadrupeds. The **fossa of the helix** is the groove formed by the inward curvature of the helix. In front of the helix, and running parallel with it, is a rounded prominence, the **antihelix,** which divides anteriorly and above into two portions inclosing the **fossa of the antihelix** (*fossa scaphoidea*). The antihelix curves around a large concavity,—the **concha,**—which leads to the external auditory meatus. Anterior to the concha is a blunt projection, the **tragus.** This is really a portion of the wall of the external auditory meatus, and to it a number of stiff hairs are often attached. Opposite the tragus is a small projection, the **antitragus;** between the two is a notch, the **incisura intertragica.** The lowest portion of the pinna—the **lobule**—is devoid of cartilage, and is composed of fibro-areolar and adipose tissue. The lobule may gradually be slit in two by heavy ear-rings, and a fibrous or keloid tumor may arise from the scar which forms where the lobule has been pierced.

The pinna is developed in the embryo from six small tubercles which form at the external extremity of the first branchial cleft. As a result of imperfect fusion of these tubules **supernumerary auricles** or **auricular fistulæ** may occur near the external auditory meatus. If the orifice of one of these fistulæ is closed, a **dermoid cyst** of the pinna forms. Supernumerary pinnæ or auricles may also develop at the external extremity of the other branchial clefts.

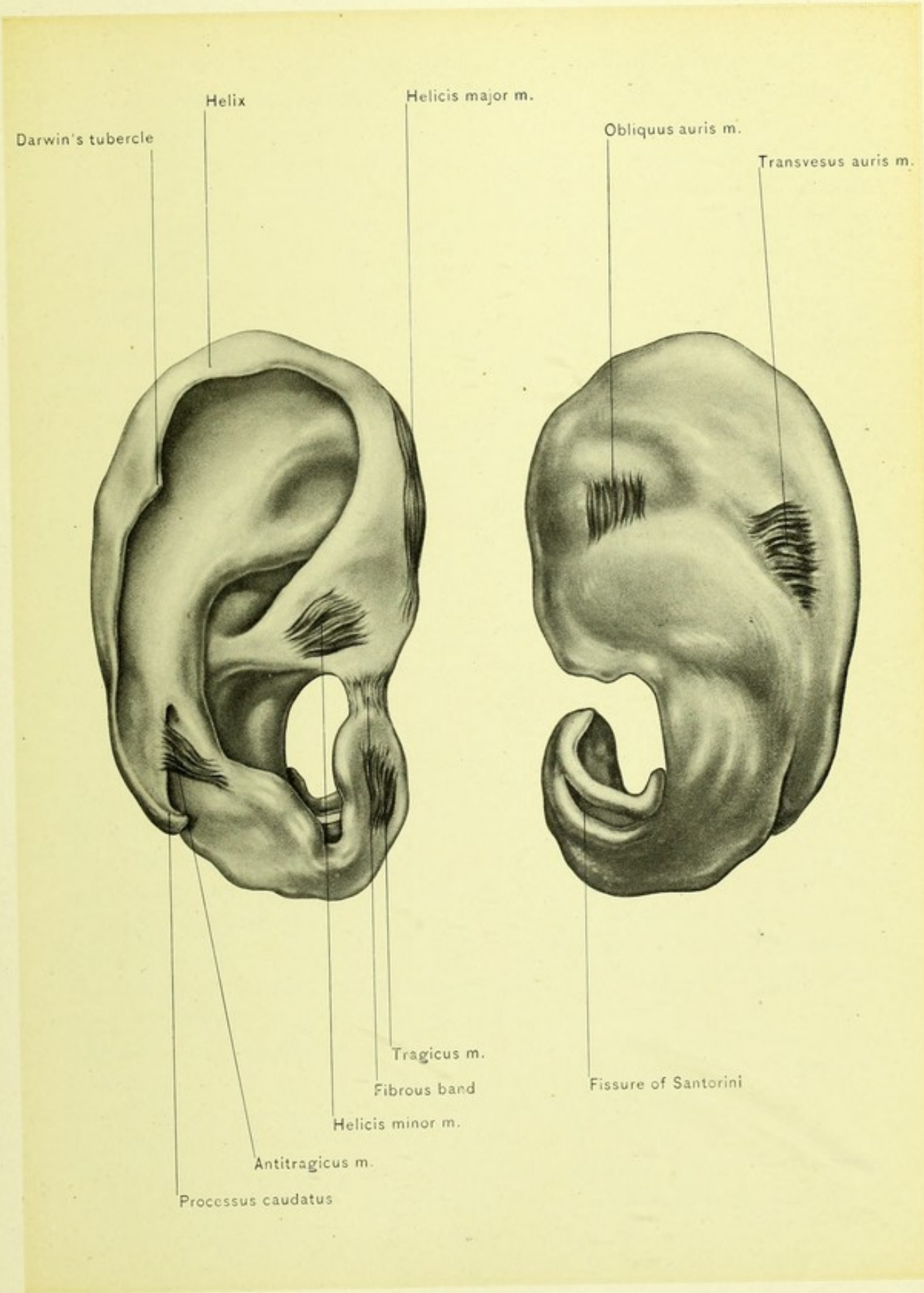
The **integument of the auricle,** which is continuous with that lining the external auditory meatus, is thin, and contains sebaceous glands and, in certain situations, hairs and sudoriferous glands. The sebaceous glands are most abundant in the concha, where their orifices can often be seen, filled with foreign material, in persons who are careless as to cleanliness. *Sebaceous cysts* not infrequently develop in the skin of the pinna. The integument is more firmly attached over the concave surface of the pinna than on the convex or cranial surface. Hemorrhagic effusions beneath the skin or between the cartilage and its perichondrium, as a result of trauma, are not uncommonly seen in pugilists; they are known as *othematomata*. On account of the close union between the skin and the concave surface of the pinna, inflammatory affections are painful in this location. In chronic gout subcutaneous deposits of sodium urate, termed *tophi*, are found in the pinna.

The **subcutaneous tissue of the pinna** forms a thin lamina almost devoid of fat. The lack of subcutaneous fat, which affords protection from cold to the blood-vessels, and the exposed position of the pinna account for the frequency of **frost-bite** in this location, which occasionally causes gangrene of the pinna.

The yellow, elastic **cartilage of the auricle,** which gives form to that structure, presents several fissures and processes; there is a fissure between the origin of the helix and the tragus which is filled with fibrous tissue. The lower end of the antihelix is divided into two parts, one of which terminates in a pointed extremity called the **processus caudatus.** At the anterior portion of the pinna, near the first curve of the helix, there is a projection,—the **spina helicis,**—and behind it is a short cleft—the **fissure of the helix.** Bands of fibrous tissue—the so-called **ligaments of the pinna**—connect this structure with the cranium, and others unite the various parts of the cartilage. Anteriorly a band of fibrous tissue connects the spina helicis with the root of the zygoma, and fibrous tissue attaches the concha to the mastoid process posteriorly.

The **intrinsic muscles of the auricle** are small, rudimentary, and unimportant. The extrinsic muscles have been described with the face.

Blood Supply.—The arteries, with which the pinna is well supplied, are derived from the posterior auricular, occipital, and superficial temporal arteries. They are accompanied by corresponding veins.



INTRINSIC MUSCLES OF PINNA.

Nerve Supply.—The sensory nerves of the pinna are derived chiefly from the auriculo-temporal and auricularis magnus, although filaments are contributed by the occipitalis minor and the auricular branch of the vagus nerve; the motor nerves to the muscles of the auricle are derived from the facial nerve. As the back of the pinna is supplied by the auricularis magnus and small occipital nerves and the lobule by the auricularis magnus nerve, pain in the pinna may be caused by irritation of the cervical nerves in caries of the cervical vertebræ or by enlarged cervical lymphatic glands.

The **lymphatics of the pinna** are numerous, and pass to the preauricular or superficial parotid lymphatic glands and to the posterior auricular lymphatic glands.

The **External Auditory Canal** is a slightly curved passage, convex upward, which leads inward and a little forward for a distance of about twenty-four millimeters, or one inch, to the membrana tympani. The highest portion of the canal is about at its middle. Drawing the pinna upward and backward has a tendency to straighten the canal; this is done prior to inspection of the canal or to introduction of instruments. Owing to the obliquity of the tympanic membrane, the anterior and inferior walls of the external auditory meatus are the longer, and the internal extremity of the canal is wedge-shaped, terminating in a narrow recess—the **sinus** of the external auditory meatus. Small **foreign bodies** which have lodged in the sinus of the canal must be removed carefully, as the instruments must approach the membrana tympani closely. The meatus is elliptic at the external orifice, the vertical diameter of the canal being the greater; near the membrana tympani the transverse diameter is the greater. Although the orifice of the external meatus is elliptic, ear specula which are round are more desirable than the elliptic instruments, for they can be rotated while being introduced. The outer one-third of the wall of the external auditory meatus is cartilaginous and continuous with the cartilage of the pinna; this portion is about eight millimeters, or three-eighths of an inch, in length, and the cartilage presents one or two fissures, known as the **incisuræ Santorini,** which are filled with fibrous tissue. The inner or osseous portion is somewhat longer, and measures less in diameter than the cartilaginous portion, its average length being about sixteen millimeters, or five-eighths of an inch. At birth the osseous portion is represented merely by an incomplete bony ring,—the **annulus tympanicus,**—and a mass of epithelial cells and cerumen fills the canal.

The **integument** lining the meatus is thin, and firmly attached to the underlying parts; consequently inflammatory processes, such as furuncles, are accompanied by considerable pain; the cutaneous lining is continued over the tympanic membrane as a delicate covering, forming the outer layer of that structure.

Hairs and sebaceous glands are found in the cartilaginous portion of the meatus, as well as slightly modified sweat glands which secrete the cerumen, or ear wax. When the cerumen, or wax, is secreted too rapidly, the meatus becomes occluded, and deafness and tinnitus aurium result. No hairs or glands are found in the osseous portion of the external auditory meatus.

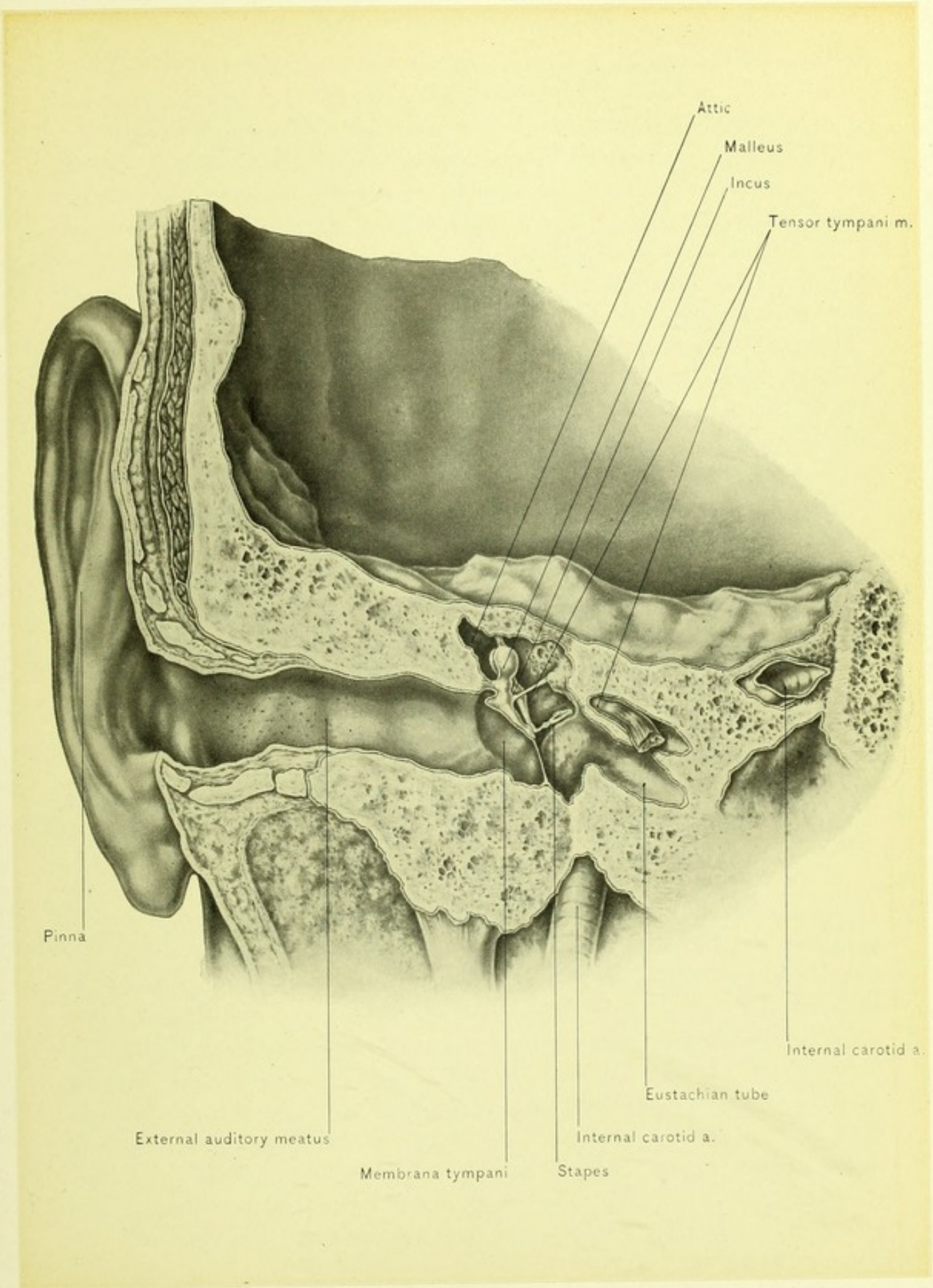
In **otitis externa** the skin of the external auditory meatus is inflamed, and there may be a purulent discharge from that canal.

Occlusion of the external auditory meatus may occur as a congenital defect or from the presence of polypoid growths arising from granulations projecting through a perforation in the membrana tympani in chronic otitis media, from exostoses from the bony wall, from foreign bodies, or from an excessive quantity of cerumen.

Foreign bodies may remain in the external auditory meatus for many years without causing injury or inconvenience, and they may not be discovered until otoscopic examination for some condition in no way connected with the presence of the foreign body. Unskilful attempts at removal have inflicted nearly all the injury following the presence of these foreign bodies. No attempt should be made to remove a foreign body until it is seen in the meatus. Insects or other foreign bodies may be removed by syringing gently with a slender stream of warm water. If this fail, a small hook, which can be made of a hair-pin, should be inserted and kept in view, the canal being well illuminated. If the walls of the canal are swollen, removal of the foreign body should be deferred until the swelling has subsided.

Relations.—A portion of the parotid gland is in relation with the lower and anterior wall of the external auditory meatus; this explains how parotid tumors can cause narrowing of that canal, and how abscesses of the parotid gland might open into it, the fissures in the cartilage affording a favorable situation for perforation. The anterior wall of the meatus is also in relation with the condyle of the lower jaw, so that firm closure of the mouth has a tendency to narrow the lumen of the meatus. When the condyle is driven forcibly backward, as by a blow or a fall on the chin, the bony wall of the meatus may be fractured. The posterior and upper walls of the canal are formed by parts of the mastoid and of the squamous portion of the temporal bone, and often only a thin, osseous partition separates it from the mastoid cells, so that caries of the osseous wall of the external auditory meatus may be followed by mastoid disease.

Blood Supply.—The blood supply of the external auditory meatus is derived from branches of the internal maxillary, posterior auricular, and superficial temporal arteries.



EXTERNAL AND MIDDLE EAR.

The *veins* accompany the corresponding arteries and empty into the temporal, internal maxillary, and posterior auricular veins.

Nerve Supply.—The nerve supply of the external auditory meatus is derived from branches of the auriculo-temporal, the auricularis magnus, and the auricular branch of the vagus nerve. Interesting reflex disturbances are at times caused by the presence of foreign bodies, wax, or specula through irritation reflected along the auricular branch of the pneumogastric nerve and referred to the parts supplied by the parent trunk; coughing, faintness, and nausea and vomiting may be induced in this manner. Sneezing is also produced by the presence of foreign bodies or specula in the external auditory meatus. The irritation is reflected probably along the auriculo-temporal nerve to the Gasserian ganglion or other centers of the fifth nerve, and thence referred to the nose through branches of the superior maxillary nerve. Cough produced by irritation reflected from the ear is termed **ear cough.** **Earache** associated with toothache in the upper teeth may be explained in the same manner. Earache frequently is associated with toothache in the lower teeth and disease of the tongue; the pain in the ear is due probably to irritation reflected along the inferior dental nerve and lingual nerve, and referred to the ear through the auriculo-temporal, the other sensory branch of the inferior maxillary nerve.

The **lymphatics of the external auditory meatus** follow the veins, and terminate in the parotid and posterior auricular lymphatic glands.

Dissection.—The tympanum is to be opened with a chisel by the removal of its bony roof (tegmen tympani); the opening is made to the outer side of the elevation produced by the superior semicircular canal, and is enlarged carefully, uncovering also the mastoid antrum and the internal auditory meatus.

THE MIDDLE EAR.

The **Middle Ear,** or **Tympanum,** is a small, irregular air chamber, situated in the petrous portion of the temporal bone, and lined with mucous membrane; it is interposed between the external auditory meatus and the internal ear. Its antero-posterior length measures about twelve millimeters, or one-half of an inch; its width is from two millimeters to four millimeters, or from one-twelfth to one-sixth of an inch, and it is narrowest opposite the center or umbilicus of the tympanic membrane which is opposite the promontory; vertically it is about thirteen millimeters, or somewhat more than half an inch, in depth; this last measurement includes the recessus epitympanicus, or attic.

The **attic,** or **recessus epitympanicus,** is the highest portion of the tympanic cavity. It is situated above the level of the membrana tympani,

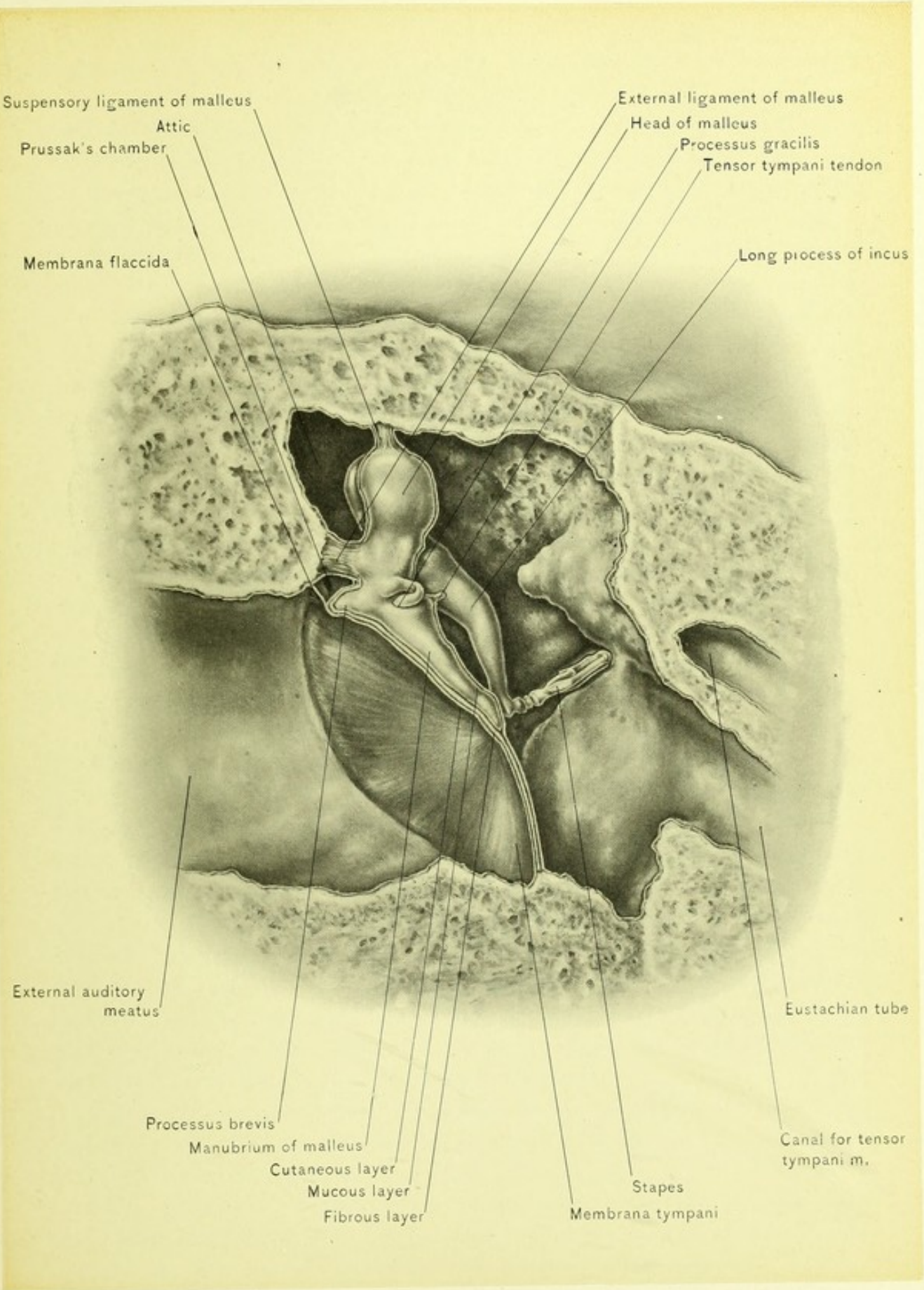
and contains the head of the malleus and part of the incus, and leads into the mastoid antrum.

The **roof of the tympanum** consists of a thin plate of bone—tegmen tympani—which separates the tympanum from the cranial cavity; it forms part of the antero-superior surface of the petrous portion of the temporal bone. Destruction of this osseous lamina or extension through it of the inflammatory process in chronic otitis media may lead to meningeal or cerebral complications, such as extradural abscess, meningitis, abscess of the temporo-sphenoid lobe of the cerebrum, and cerebellar abscess. In children under one year of age the presence of the petro-squamosal suture in the tegmen tympani favors this complication.

The **floor** is formed by a thin, bony plate situated between the tympanum and the jugular fossa. Destruction of this plate of bone by caries in otitis media may cause fatal hemorrhage or septic thrombosis of the internal jugular vein, embolism, and metastatic abscess.

The **anterior wall** is quite narrow, and is deficient superiorly, inasmuch as the Eustachian tube opens into the tympanum in this situation about four millimeters, or one-sixth of an inch, above the floor. Just above the entrance of the tube is the opening of the canal which lodges the tensor tympani muscle. Owing to the position of the tympanic orifice of the Eustachian tube above the level of the floor of the tympanum, fluid which has entered the tympanum by way of the Eustachian tube, through snuffling water in surf-bathing or in using the nasal douche, can not all escape through the tube, and otitis media is likely to result. Below the orifice of the Eustachian tube the anterior wall is composed of a thin, bony lamina, situated between the tympanum and the carotid canal. Caries of this thin plate of bone may occur in otitis media, and ulceration into the internal carotid artery with fatal hemorrhage may follow.

The **Eustachian tube** is the anterior extension of the tympanic cavity which connects the middle ear with the naso-pharynx; it passes inward, downward, and forward from the tympanum, is about thirty-five millimeters, or an inch and a half, in length, and in its several portions varies from two to five millimeters, or from one-twelfth to one-fifth of an inch, in diameter. It consists of an osseous and a cartilaginous portion, the former being about twelve millimeters, or one-half of an inch, long, and the latter about twenty-five millimeters, or one inch, long. The *cartilaginous portion* is somewhat trumpet-shaped, being widest at the *pharyngeal* orifice. It is formed by a cartilaginous plate which is triangular in shape and folded upon itself, thus leaving on the inferior and external aspect of the tube an interval which is filled with fibrous tissue (fascia salpingo-pharyngea), and by a part of the tensor palati muscle called the *dilator tubæ*. (See also description of pharynx.) The *bony portion*, which is smaller than the carti-



ANTERIOR VIEW OF RIGHT TYMPANUM.

laginous portion of the tube, is situated at the junction of the squamous and petrous portions of the temporal bone; the *isthmus tubæ*, its narrowest portion, is situated at the junction of the bony and cartilaginous parts. The Eustachian tube is lined with mucous membrane which is continuous with that of the naso-pharynx and that lining the middle ear. Consequently inflammatory processes of the naso-pharynx, by direct continuity of the tissues, may lead to involvement of the middle ear. The tympanic orifice of the Eustachian tube is situated in the anterior wall of the tympanum, about four millimeters above the floor of that cavity, and the pharyngeal orifice is in the lateral wall of the naso-pharynx, behind the posterior naris, at the level of the posterior extremity of the inferior turbinated bone. Normally the canal is closed, except during swallowing, when it is opened by the tensor palati muscle, levator palati muscle, and the salpingo-pharyngeus, which is the portion of the palato-pharyngeus muscle attached to the Eustachian tube. The action of these muscles during swallowing affords an opportunity to inflate the middle ear by way of the nose, naso-pharynx, and Eustachian tube.

In **Politzer's method of inflation of the middle ear** the patient takes some water in his mouth; the nozle of a caoutchouc bag which contains air is inserted into one nostril; the nostrils are closed with the fingers of one hand; and as the patient swallows the water the bag is suddenly and forcibly compressed with the other hand. In the **method of Valsalva** the patient closes the mouth and nose firmly and puffs out the cheeks by a forcible effort at expiration. Air is driven through the Eustachian tube, and a sense of pressure and fullness is felt in the middle ear. This method is not altogether safe, on account of the increased tension produced in the blood-vessels and the danger of hemorrhages and apoplexy. The middle ear may also be inflated by the caoutchouc bag and Eustachian catheter; the method for introducing the catheter is described with the pharynx.

The Eustachian tube may be closed by the extension of hypertrophic nasal and naso-pharyngeal catarrh into the tube, or the pharyngeal orifice of the tube may be obstructed mechanically by growths of the nose or naso-pharynx. Occlusion of this tube causes autophony, or loud but muffled sound of the individual's voice, tinnitus aurium, or false sounds in the ears, a sensation of tension or distention in the ears, and more or less deafness.

In the mucous membrane of the Eustachian tube and near the pharyngeal end of the tube there are a few *mucous glands* and a quantity of lymphoid tissue; this latter is sometimes referred to as the *tubal tonsil.*

Relations.—On the outer side of the Eustachian tube are the tensor palati and levator palati muscles, the otic ganglion, the inferior maxillary nerve, and the middle meningeal artery; on the inner side is the wall of the pharynx.

Blood Supply.—The blood supply of the Eustachian tube is derived from the ascending pharyngeal, middle meningeal, and Vidian arteries.

Nerve Supply.—The nerve supply of the Eustachian tube is derived from the Vidian nerve and the tympanic plexus.

The **posterior wall of the middle ear** presents at its upper portion a large opening which leads into the mastoid antrum; through this opening the mucous membrane is continuous from one cavity to the other, so that inflammation in the middle ear may lead to involvement of the mastoid air cells. Below the opening into the antrum, near the inner wall of the tympanum and posterior to the fenestra ovalis, is a hollow, cone-shaped projection known as the *pyramid*, at the summit of which there is a perforation for the passage of the tendon of the stapedius muscle. External to the pyramid is the *iter chordæ posterius*, through which the chorda tympani nerve passes.

As the **Mastoid Antrum and Mastoid Cells** communicate with the middle ear, they are cavities accessory to the tympanic cavity.

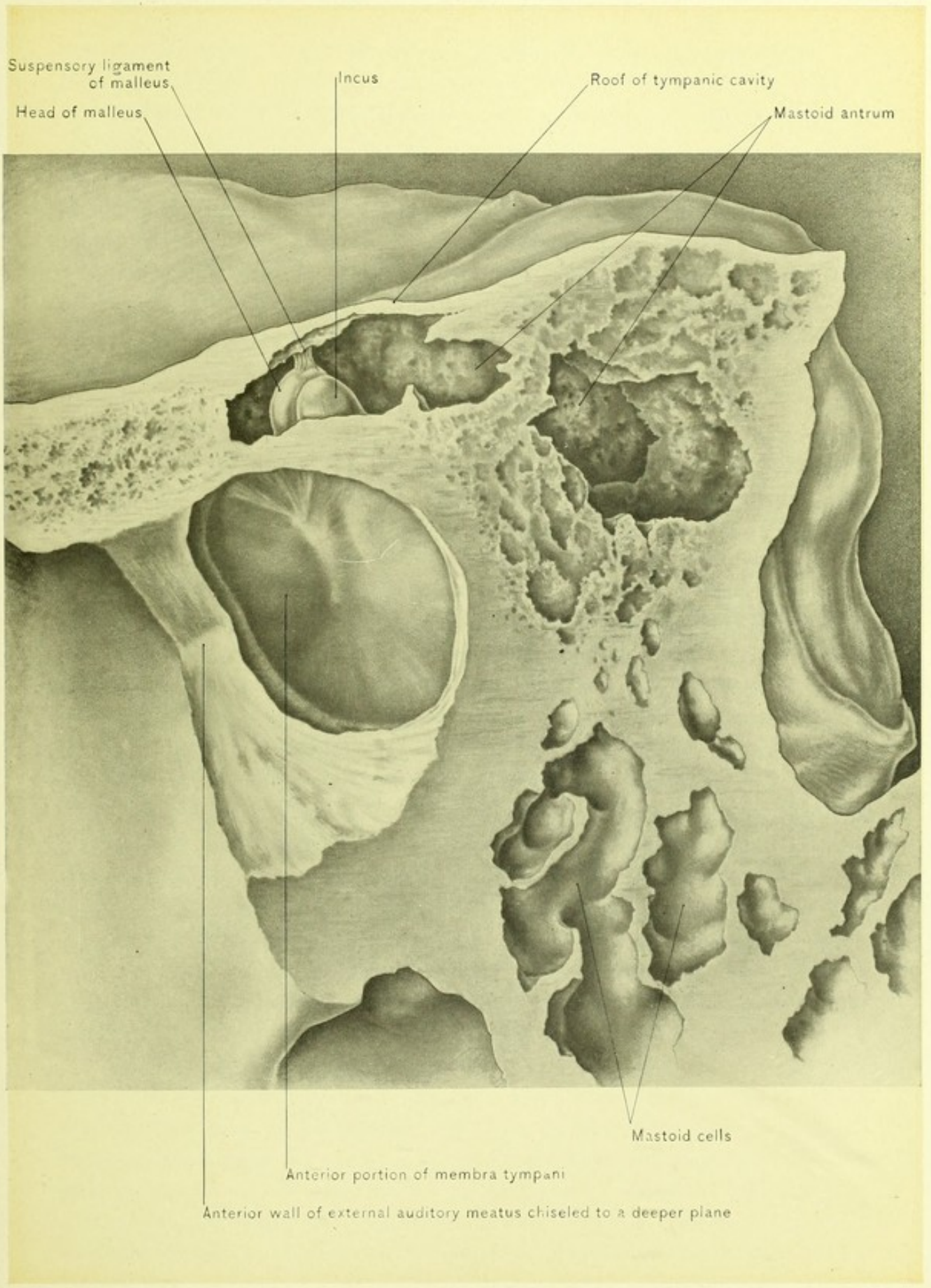
The **mastoid portion of the temporal bone** contains numerous spaces, some of which are filled with air; these communicate with the middle ear, and are called mastoid cells; other spaces which occupy the tip of the process are filled with marrow. Of the air cavities, the *mastoid antrum* is the largest and most important. Leidy described the mastoid antrum as a part of the tympanum.

The **Mastoid Antrum** is an air cavity of variable size, usually about that of a large pea, or from four to six millimeters in diameter, and is situated posterior to the tympanum, about on a level with the highest part of that cavity. It is lined with mucous membrane or muco-periosteum, which is directly continuous with that of the attic of the tympanum and mastoid cells. The mastoid antrum is present at birth.

The **roof of the mastoid antrum** (tegmen antri) is a thin plate of bone about one millimeter in thickness, situated external to the eminence produced by the superior semicircular canal; it separates the mastoid antrum from the cranial cavity, and is perforated by minute veins which empty into the superior petrosal sinus; at times the tegmen is distinctly cribriform, and it may be partly or wholly absorbed in old age.

The **floor of the antrum,** which is not infrequently on a lower level than the communication between the tympanum and antrum, is formed by the substance of the mastoid portion of the temporal bone, and usually contains the orifices of some of the other mastoid cells.

The **anterior wall of the antrum** is thin, and may be perforated; it separates the mastoid antrum from the bony part of the external auditory meatus. Inflammatory processes may extend from the mastoid antrum through this wall to the



MEMBRANA TYMPANI AND ITS INCLINATION.

external auditory meatus, or vice versâ. Through this wall a mastoid abscess may be evacuated by way of the external auditory meatus.

The **posterior wall of the antrum** is a bony lamina of variable thickness, separating the antrum from the groove for the sigmoid sinus; through it small veins pass from the middle ear and mastoid antrum to the sigmoid sinus. By way of these veins septic material due to otitis media or mastoid disease may reach the sigmoid portion of the lateral sinus, and cause septic thrombosis and embolism.

The **inner wall of the mastoid antrum** is from nine-sixteenths to three-fourths of an inch, or fourteen to eighteen millimeters, distant from the base line of the supra-meatal triangle (MacEwen). The facial canal lies in the inner wall of the passage from the mastoid antrum to the tympanum. This canal, which is separated from the tympanum by a thin, osseous lamina, is situated above the oval window of the tympanum; on the inner side of the antro-tympanal passage-way the canal curves and then descends to the stylo-mastoid foramen. The wall of the canal is thin in children, and may be defective in that portion which lies over the oval window; the nerve is therefore more likely to suffer from neuritis in otitis media in children than from the same disease in adults.

The **outer wall of the mastoid antrum** is formed by the descending plate of the squamous portion of the temporal bone; the antrum is from one-half to three-fifths of an inch, or from twelve to fifteen millimeters, distant from the surface of the bone. In an infant the outer wall of the mastoid antrum is about two millimeters in thickness, and in a child nine years of age it is ten millimeters thick (Symington). In the second year this wall rapidly increases in thickness. In infants the descending plate of the squamosal bone is separated from the mastoid process by a suture, the masto-squamosal suture. In adults this suture at times persists wholly or partially. In children, on account of the tenuity of the external wall of the mastoid antrum and the presence of this suture, pus may find its way to the exterior through the middle ear and mastoid antrum, and form a subperiosteal abscess over the mastoid portion of the temporal bone. In some cases this wall has been perforated spontaneously by absorption of the bone. In these cases an air tumor, or **pneumatocele,** which can be inflated through the Eustachian tube may form over the mastoid process.

The **Supra-meatal Triangle of MacEwen** is bounded above by the posterior root of the zygoma, which runs nearly horizontally backward; the antero-inferior boundary is formed by the posterior and upper margin of the bony meatus; the posterior boundary is formed by a perpendicular line extending from the most posterior portion of the bony meatus to the posterior root of the zygoma. The apex of this triangular area is directed forward, and the area itself is usually somewhat depressed. Through this triangle the mastoid antrum may be reached

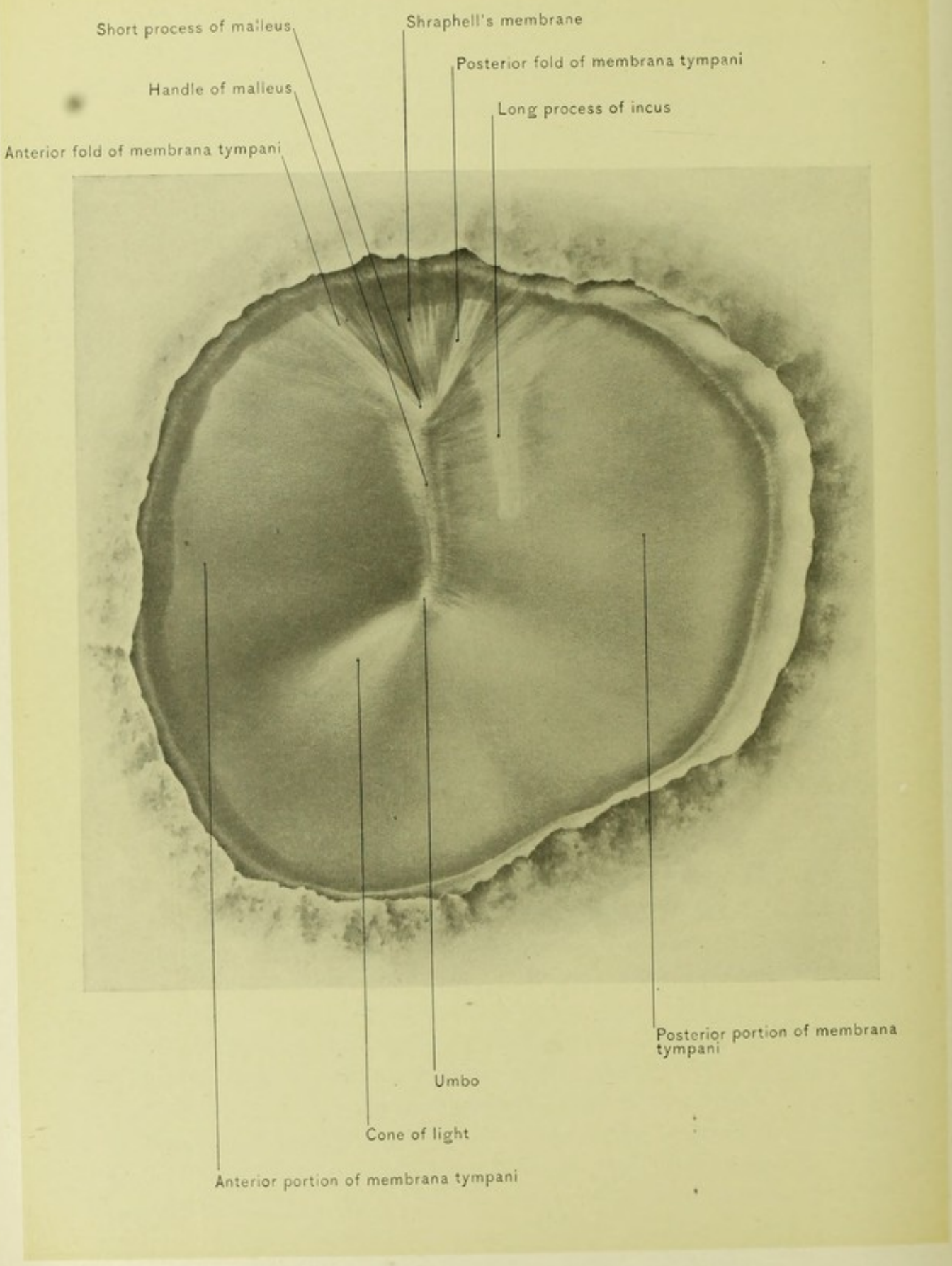
with safety, if the perforation be directed inward and somewhat upward and forward, or parallel with the external auditory meatus. If the mastoid process is opened behind this triangle, the knee of the sigmoid portion of the lateral sinus is in danger of being injured, particularly if the perforation be made directly inward, as that sinus is only from three to six millimeters from the posterior extremity of the mastoid antrum. The posterior root of the zygoma indicates the level of the floor of the cranial cavity; should the operator pierce the bone above this line, the cranial cavity is likely to be opened. As previously stated, the mastoid antrum in the adult is usually from one-half to three-fifths of an inch, or from twelve to fifteen millimeters, from the surface of the bone; for this reason the chisel or gimlet should enter the mastoid antrum at a depth not greater than fifteen millimeters. As the result of long-standing disease, the bone over the mastoid antrum may be thickened and sclerosed. If the inner wall of the antrum is encroached upon, the facial nerve may be injured by the chisel or other instruments used by the operator.

The **Mastoid Cells** vary exceedingly as to number and size. They are absent at birth, and prior to puberty they are few in number. They attain their full development in the young adult, and occupy the greater portion of the mastoid process, opening directly or indirectly into the mastoid antrum. They are lined with muco-periosteum which is continuous with that of the mastoid antrum. Posteriorly they cease abruptly at the occipito-temporal suture. They are separated from the sigmoid portion of the lateral sinus by a thin plate of bone, through which veins pass from these cells to the sinus, affording a ready means of infection and of production of septic thrombosis of the sinus.

The **Outer Wall of the Middle Ear** is formed by the membrana tympani and, to a slight extent, by bone.

The **membrana tympani** is an elliptic or, at times, oval membranous disc, attached to a grooved ridge of bone at the bottom of the external auditory meatus. Its greatest diameter, measured from its posterior and upper portion forward and downward, is ten millimeters in length; the vertical measurement is slightly less; it is one-tenth of a millimeter in thickness. The membrane is situated obliquely, its outer surface being directed outward, downward, and forward. It is directed downward and outward at an angle of about forty-five degrees, and forward and outward at an angle of about ten degrees. In the infant, at birth, this obliquity is greater and the membrane is almost horizontal. Its outer surface is concave, the center being the deepest point of the concavity, for the extremity of the handle of the malleus is here attached, and, as it were, draws the membrane inward. The depressed center is known as the *umbo*. The bony ring to which the tympanic membrane is attached is incomplete above, leaving a notch (*notch of*

PLATE CCLIV.



EXTERNAL VIEW OF MEMBRANA TYMPANI OF LEFT EAR.

Rivini), which is filled in by a thinner and looser portion of the membrane, known as the *membrana flaccida*, or *Shrapnell's membrane*. The membrana tympani consists of three layers: an outer cuticular covering; a middle, fibrous layer; and an inner, mucous lining.

Inspection.—When viewed through a speculum during life, the membrana tympani is of a pearly gray color, and appears smooth and polished. Extending downward and backward with its apex at the umbo is a *cone of light*, which is of value in the diagnosis of disease of the tympanum and membrana tympani. The handle of the malleus and its short process, and, posterior to the handle of the malleus, the long process of the incus, can frequently be seen through the membrane. From the short process of the malleus two folds extend to the margins of the notch of Rivini; these are known as the *anterior* and the *posterior fold* of the membrane, and between them is the *membrana flaccida*, so named on account of its laxity. Owing to this laxity perforations of the membrana flaccida give rise to but slight loss of hearing. The remainder and major portion of the drum is known as the *membrana tensa*.

Perforation or rupture of the membrana tympani is frequently produced by traumatism, as by slender foreign bodies accidentally pushed far into the external auditory canal, or by the escape of pus in otitis media. Perforation of the membrana flaccida occurs more commonly when the disease is confined to the attic; perforation of the posterior portion, when the disease is confined to the mastoid antrum; and perforation of the lower portion of the membrana tensa is most frequent on account of its low position. Owing to the inelasticity of the membrane, perforations do not gape much. Traumatic perforations heal readily, whereas those associated with suppurative otitis media seldom close. Granulation tissue from the inflamed mucous membrane of the tympanum projecting through the perforation forms *polypoid growths* which conceal the opening, and sometimes hide the tympanic membrane. These growths are associated with copious suppuration.

Paracentesis of the tympanum, or puncture of the tympanic membrane, is frequently practised by the surgeon to relieve tension and allow of the discharge of pus.

The point selected is in the lower or subumbilical portion of the membrane, or wherever the bulging is greatest. Paracentesis of the upper portion of the membrane is attended by danger of injuring the malleus, incus, or chorda tympani nerve, and paracentesis of the lower portion of the membrane must be cautiously performed, for the inner wall of the tympanum is situated only from two millimeters to four millimeters, or from one-twelfth to one-sixth of an inch, internal to the tympanic membrane.

After the membrana tympani has been destroyed by ulceration and the malleus and incus have escaped with the pus, a plug of cotton inserted into the tympanum against the stapes will serve as an *artificial membrana tympani.*

Blood Supply.—The blood supply of the membrana tympani is derived mainly from the tympanic branches of the internal maxillary and internal carotid arteries.

Nerve Supply.—The chief nerve supplying the external surface of the membrana tympani is the auriculo-temporal. According to Sappey, Arnold's nerve (the auricular branch of the vagus) supplies the lower portion of this surface of the membrane, and branches from the tympanic plexus supply the inner surface. The membrane is quite sensitive.

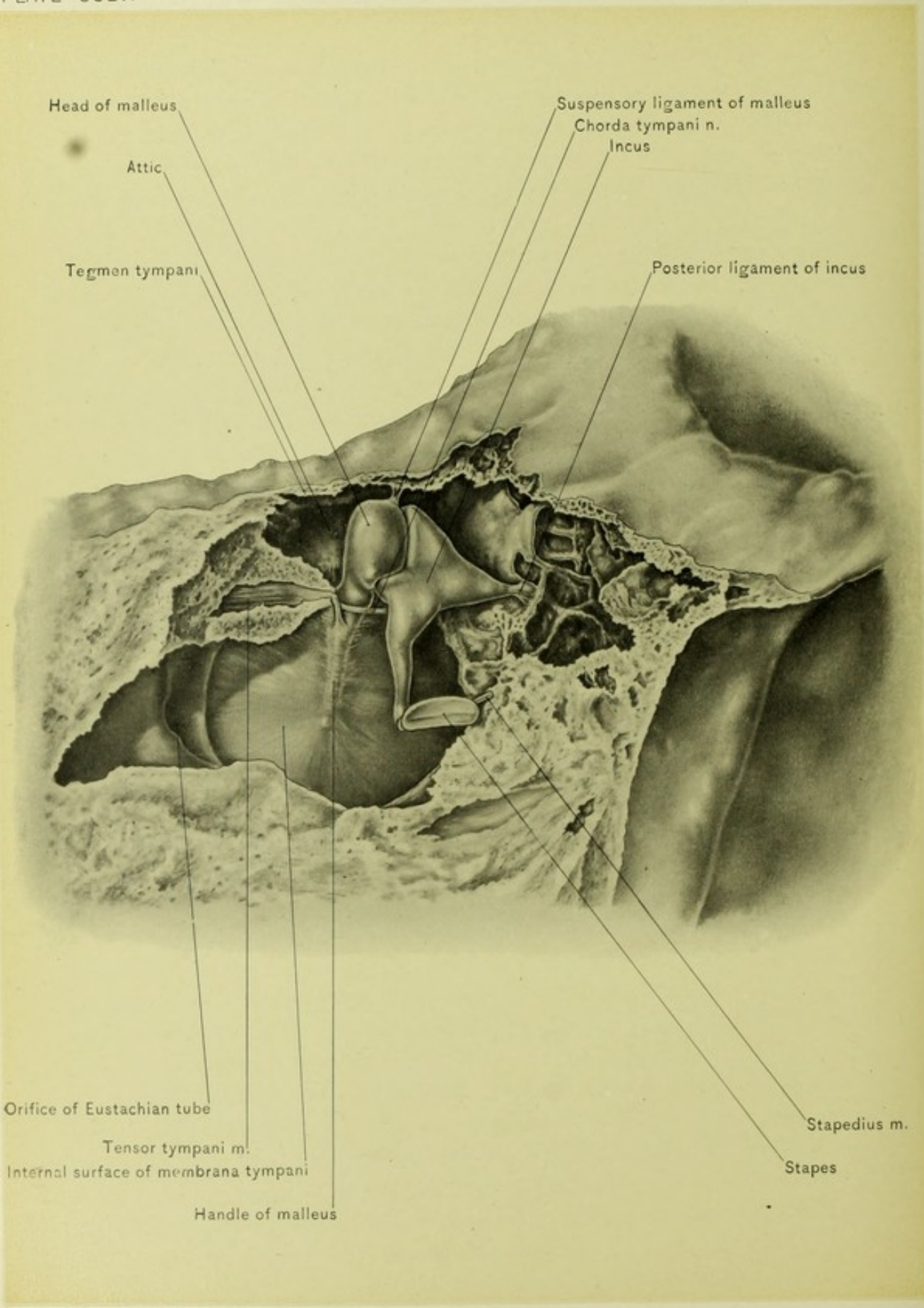
The **inner wall of the tympanum** presents several points for examination. A conspicuous rounded elevation, the *promontory* produced by part of the first turn of the cochlea, is seen; on it are faintly marked grooves for the tympanic plexus of nerves. Above the posterior portion of the promontory is a transverse oval foramen,—the *fenestra ovalis*, or oval window,—which leads into the vestibule, and when the ear ossicles are *in situ*, is closed by the base of the stapes. Behind it is the *pyramid*, at the summit of which is an opening for the tendon of the stapedius muscle. Below the promontory is the *fenestra rotunda*, or round window, an opening which leads into the scala tympani of the cochlea, and in the recent state is closed by the *membrana tympani secundaria.* At the junction of the inner wall and roof of the tympanum, above the oval window, is a rounded ridge of bone passing antero-posteriorly; this is produced by the facial canal or aqueductus Fallopii, which lodges the facial nerve. The bony lamina separating this nerve from the cavity of the middle ear is quite thin, especially in children, and in otitis media the facial nerve may become affected by neuritis, leading to paralysis of the muscles of expression upon the corresponding side of the face.

The **mucous membrane of the tympanum** lines the tympanic cavity, and is continuous with the mucous membrane of the Eustachian tube and with that of the mastoid antrum. It forms the inner layer of the tympanic membrane, and is reflected over the ossicles, the tendons which enter the tympanic cavity, and the nerves of the middle ear.

Middle ear disease may be followed by various complications, the most common of which is inflammation of the mastoid antrum and mastoid air cells, resulting in mastoid abscess. As the mucous membrane of the middle ear is directly continuous with that of the mastoid antrum, it will readily be seen how the inflammatory process may extend from the nose to the naso-pharynx, Eustachian tube, tympanum, mastoid antrum, and mastoid cells.

Through carious destruction of the tegmen antri or tegmen tympani or

PLATE CCLV.



INTERNAL VIEW OF RIGHT TYMPANUM.

through the perivascular lymphatics and the veins which pierce the tegmen, **extradural abscess, meningitis, thrombosis of the superior petrosal sinus, and cerebral and cerebellar abscess** may result from otitis media and mastoid disease. **Thrombosis of the sigmoid sinus** and consequent septic embolism may occur by extension of the inflammation along the veins from the mastoid antrum, mastoid cells, and tympanum which empty into the sigmoid sinus.

In **otitis media** the pus usually escapes by perforation of the membrana tympani, and may pass out through the Eustachian tube into the pharynx, or through the canal for the tensor tympani muscle. In **mastoid disease** the pus usually escapes through the tympanum and membrana tympani, and may, after destruction of the compact bone on the intracranial surface of the mastoid process, enter the cranial cavity and form an extradural abscess; or it may enter the neck over or under the prevertebral fascia, point on the external surface of the mastoid process, or escape directly into the external auditory meatus.

The **Auditory Ossicles** consist of the malleus, the incus, and the stapes, which form a chain of three small bones that transmit the impulses of sound waves from the membrana tympani to the perilymph and endolymph of the internal ear. The ossicles and the ligaments and tendons attached to them are covered by the mucous membrane of the tympanum.

The **malleus,** or **hammer,** consists of a head, a neck, a handle, or manubrium, the processus brevis, and the processus gracilis. The rounded *head* is situated in the attic, the highest portion of the tympanic cavity, and above the level of the membrana tympani; it is connected with the roof of the cavity by fibrous tissue which forms the so-called *superior ligament of the malleus.* On the posterior aspect of the head of the malleus is a cartilage-covered surface which articulates with the body of the incus. Below the head of the malleus is the *neck.* The *manubrium,* or handle, is connected with the fibrous layer of the tympanic membrane, and is situated between this layer and the mucous lining. The *processus brevis* is a small prominence below the neck, and gives attachment to the tensor tympani muscle. The *processus gracilis* is a long and slender process which passes forward to the Glaserian fissure. In the adult it is often largely represented by fibrous tissue.

The **incus,** or **anvil,** resembles in shape a bicuspid tooth with diverging fangs; it consists of a body and two processes. The *body* presents a concavo-convex articular surface for the head of the malleus; the joint between these bones is surrounded by a capsular ligament and lined by a synovial membrane. The *short process* passes backward, and is connected to the posterior wall of the tympanum by fibrous tissue. The *long process* descends almost parallel with the manubrium of the malleus, but posterior and internal to it. It terminates in a

small, knobbed projection, the so-called *os orbiculare*, which articulates with the head of the stapes.

The **stapes,** or **stirrup,** consists of a head, a neck, two crura or branches, and a foot-piece or base. The *head* articulates with the os orbiculare of the incus. This joint has a capsular ligament, and is lined by a synovial membrane. The two *crura* diverge as they leave the neck, are grooved on their concave sides, and are attached to the *foot-piece* or *base*, which fits into the oval window. The base of the stapes is united to the margin of that opening by fibrous tissue.

In otitis media the ligaments associated with the ossicles become indurated and stiffened; through loss of mobility the chain of bones can not transmit impulses to the internal ear, and deafness supervenes. In such cases hearing may be improved by removal of the perforated membrana tympani, the malleus and incus, or by massage administered by means of sound. Caries of the malleus and incus not infrequently occurs in otitis media, and they are occasionally discharged with the pus in that disease.

The **Ligaments** situated in the tympanum are associated with the ossicles. They consist of the superior, the anterior, the external, and the internal ligaments of the malleus, the ligament of the incus, and the capsular ligaments.

The **superior** or **suspensory ligament of the malleus** is a slender, fibrous band which is attached to the outer part of the roof of the tympanum and to the highest part of the head of the malleus. It limits downward and outward movement of the head of the malleus and inward rotation of the manubrium of that bone.

The **anterior ligament of the malleus** is a strong, fibrous band which surrounds the processus gracilis of the malleus. It is attached to the anterior wall of the tympanum around the Glaserian fissure, and to the anterior aspect of the head and neck of the malleus. It limits movement of any amplitude except in a forward direction. It occasionally contains muscular fibers, and has been described as the *laxator tympani muscle.*

The **external ligament of the malleus** is fan-shaped. Its apex is attached to the neck of the malleus, and its base to the margins of the notch of Rivini. It limits outward rotation of the handle of the malleus.

The **internal ligament of the malleus** is the sheath of the tendon of the tensor tympani muscle, and extends from the tip of the processus cochleariformis to the margins of the insertion of the tensor tympani tendon, which is near the root of the handle of the malleus on its inner surface. It limits outward movement of the handle of the malleus.

The **ligament of the incus** is a short, thick band which attaches the extremity of the short process of the incus to the posterior wall of the tympanum near the orifice of the mastoid antrum.

The **capsular ligaments** surround the articulations between the malleus and incus, and the incus and stapes.

The **Muscles of the Tympanum** are the stapedius and the tensor tympani.

The **stapedius muscle** takes its origin from the interior of the pyramid; its tendon passes through an aperture in the apex of the pyramid, and is inserted into the neck of the stapes.

Nerve Supply.—The nerve supply of the stapedius muscle is derived from a branch of the facial nerve.

Action.—It draws the head of the stapes backward, thus pressing the posterior part of the base of that bone against the border of the oval window, and regulating the pressure in the vestibular contents or perilymph and endolymph.

The **tensor tympani muscle** is larger than the stapedius muscle, and is situated in a bony canal which lies parallel with the Eustachian tube. It arises from the cartilage of the Eustachian tube, the adjacent surface of the great wing of the sphenoid bone, and the walls of the canal in which it lies. The tendon of the muscle winds around the end of the processus cochleariformis, passes outward in the tympanum, and is inserted into the handle of the malleus near its root.

Nerve Supply.—The nerve supply of the tensor tympani muscle is derived through a branch from the otic ganglion, from the motor root of the trifacial or fifth cranial nerve.

Action.—It draws the malleus inward, thus tightening and steadying the membrana tympani and compressing the perilymph of the internal ear. Abnormal action of this muscle is one of the causes of snapping, buzzing, or ringing sounds in the ears.

Blood Supply of the Middle Ear.—The blood supply of the middle ear is derived from the tympanic branches of the internal maxillary and internal carotid arteries, stylo-mastoid branch of the posterior auricular artery, the petrosal branch of the middle meningeal artery, and a branch of the ascending pharyngeal artery which passes up the Eustachian tube.

The *veins of the middle ear* empty into the temporo-maxillary vein, the superior petrosal sinus, the lateral sinus, the internal jugular vein, and the pharyngeal veins; numerous small venous channels pass through the tegmen tympani, communicating with the veins of the dura mater. These veins afford paths by which inflammatory processes may extend from the tympanum to the venous sinuses, internal jugular vein, meninges, and brain.

The **Lymphatics of the Middle Ear** terminate in the posterior auricular and parotid lymphatic glands.

Nerve Supply of the Tympanum.—The nerve supply of the tympanum is

derived from numerous sources, for there are several nerves which enter the tympanic plexus of nerves.

The relation of the facial nerve to the tympanum has already been considered.

The **chorda tympani nerve,** a branch of the facial nerve, enters the tympanum through an opening in the posterior wall (iter chordæ posterius), passes through the outer portion of the middle ear near the upper part of the tympanic membrane, crosses the handle of the malleus, and then enters a small, bony canal (iter chordæ anterius) near the Glaserian fissure. In the middle ear it is covered by the tympanic mucous membrane. Involvement of this nerve in otitis media may lead to abnormalities of the sense of taste on one side of the anterior portion of the tongue.

The **tympanic plexus of nerves** ramifies in the grooves on the promontory and inner wall of the tympanum, and supplies the mucous membrane of the tympanum. It is formed by the tympanic branch of the glosso-pharyngeal nerve, a branch of the great superficial petrosal nerve, a branch of the small superficial petrosal nerve, and the small deep petrosal nerve.

The *tympanic branch of the glosso-pharyngeal nerve* arises from the petrous ganglion of the glosso-pharyngeal nerve, and passes into the tympanum through a foramen in the floor near the inner wall of the tympanum.

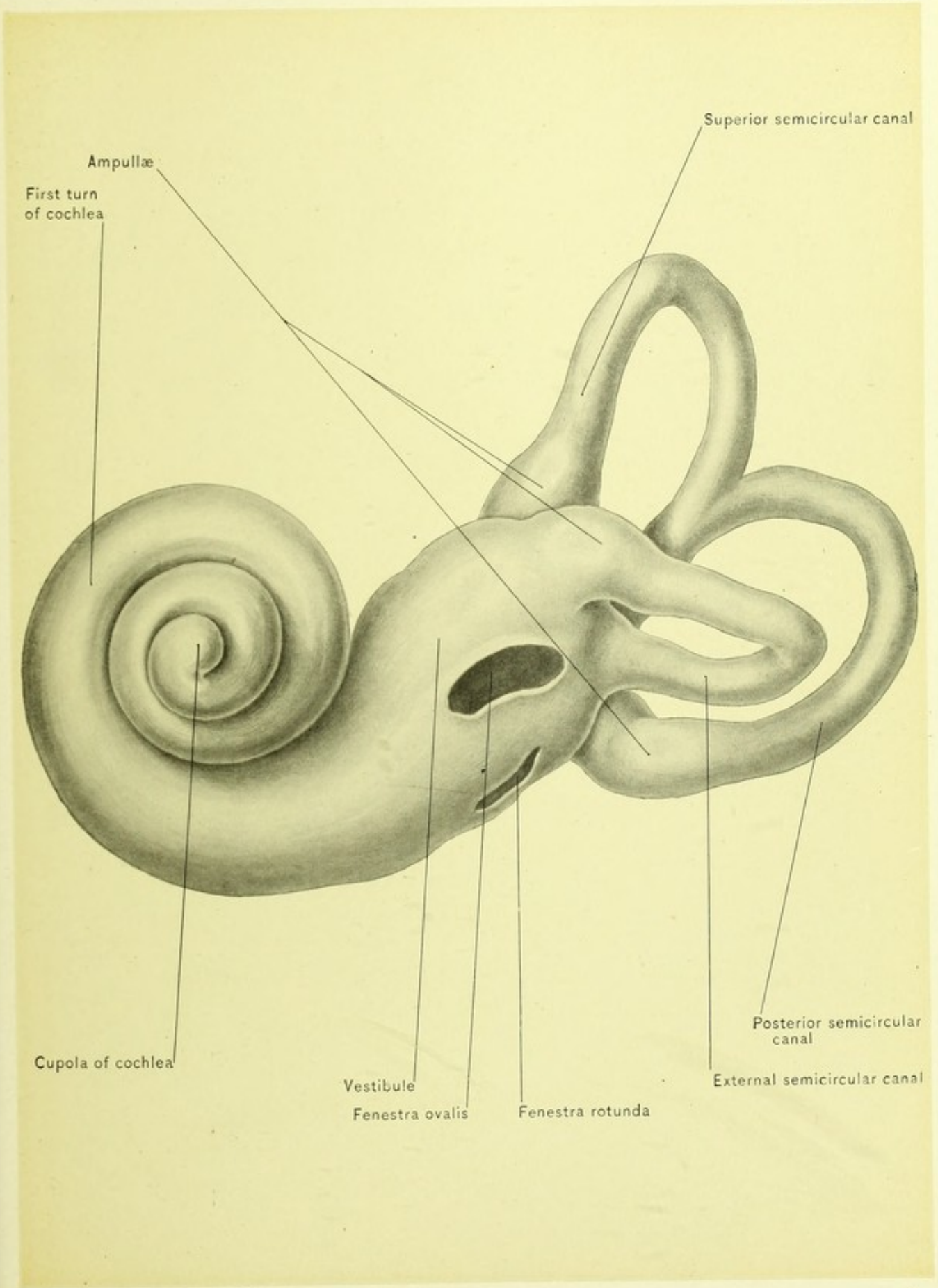
The *branch of the great superficial petrosal nerve,* which is derived from the facial nerve, passes into the tympanum through a foramen in the inner wall of that cavity just anterior to the oval window.

The *branch of the small superficial petrosal nerve,* which is also derived from the facial nerve, enters the tympanum near the canal for the tensor tympani muscle.

The *small deep petrosal nerve,* or tympanic branch of the carotid plexus of the sympathetic nerve, enters the tympanum through the carotico-tympanic canal.

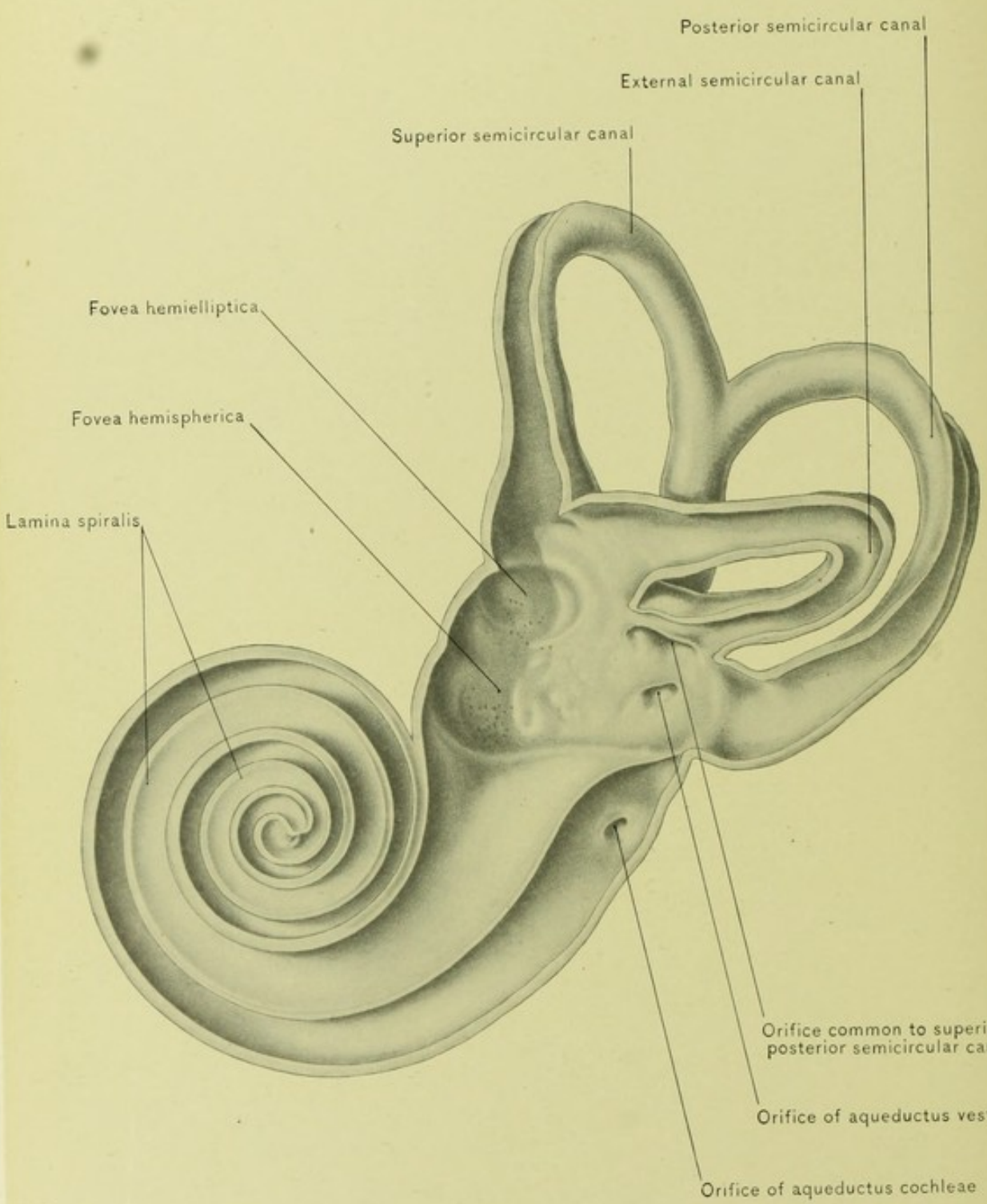
The motor nerves to the tensor tympani and stapedius muscles have already been described.

Otitis media and dentition.—Acute otitis media is frequently associated with eruption of the teeth, and is also believed to result from reflected irritation produced by carious or by artificial teeth. This complication of dentition may be explained by the connection existing between the nerves which supply the tympanum and those supplying the teeth. The great superficial petrosal nerve communicates with the tympanic plexus of nerves and, through the Vidian nerve, joins Meckel's ganglion, which is associated with the superior maxillary nerve. The nerves to the upper teeth are derived from the superior maxillary nerve. The small superficial petrosal nerve communicates with the tympanic plexus



EXTERNAL VIEW OF BONY LABYRINTH, OR COCHLEA AND SEMICIRCULAR CANALS.

PLATE CCLVII.



INTERIOR OF OSSEOUS LABYRINTH OF LEFT INTERNAL EAR.

of nerves, and joins the otic ganglion, which is associated with the inferior maxillary nerve. The inferior dental nerve, which supplies the lower teeth, is a branch of the inferior maxillary nerve.

THE INTERNAL EAR.

The **Internal Ear** or **Labyrinth.**—The most important portion of the organ of hearing consists of a series of complex cavities—the bony labyrinth, within which is the membranous labyrinth.

The **Bony Labyrinth** is made up of three intercommunicating cavities,—the vestibule, the cochlea, and the semicircular canals,—which are lined by a delicate periosteum.

The **membranous labyrinth** is a cast of the bony labyrinth, but is considerably smaller than the latter; between the two there is a space lined with endothelium and containing a fluid called the **perilymph.** The parts of the membranous labyrinth are the utricle, the saccule, the membranous semicircular canals, and the duct or canál of the cochlea, all of which are lined with epithelium and contain the **endolymph.**

The **vestibule,** situated between the cochlea and semicircular canals, is an ovoid bony cavity, the antero-posterior diameter of which is about five millimeters, or one-fifth of an inch. On the outer or lateral wall is the *oval window* in communication with the tympanum; as previously stated, this is closed in the natural state by the base of the stapes and the periosteal lining of the vestibule. At the anterior portion of the inner or median wall is a round depression, the *fovea hemispherica*, the bottom of which is pierced by numerous small openings for the transmission of the vestibular branch of the auditory nerve. Posterior to the fovea hemispherica is a vertical crest, the *crista vestibuli.* In the posterior portion of the inner wall is the small opening of the *aqueductus vestibuli*, a canal which extends to the posterior surface of the petrous portion of the temporal bone, and lodges the ductus endolymphaticus and a minute vein. At the lower and anterior portion of the vestibule is the comparatively large opening leading to the scala vestibuli of the cochlea. In the posterior portion of the vestibule are the five round openings of the semicircular canals. On the roof of the vestibule is an oval fossa, the *fovea hemielliptica.*

The **semicircular canals,** three bony tubes about one-twentieth of an inch, or one and one-fourth millimeters, in diameter, are situated behind the vestibule. The superior semicircular canal lies nearly in the sagittal plane of the body, the posterior, in the coronal plane, and the external, in a transverse plane; consequently they occupy positions about at right angles to one another. Each forms

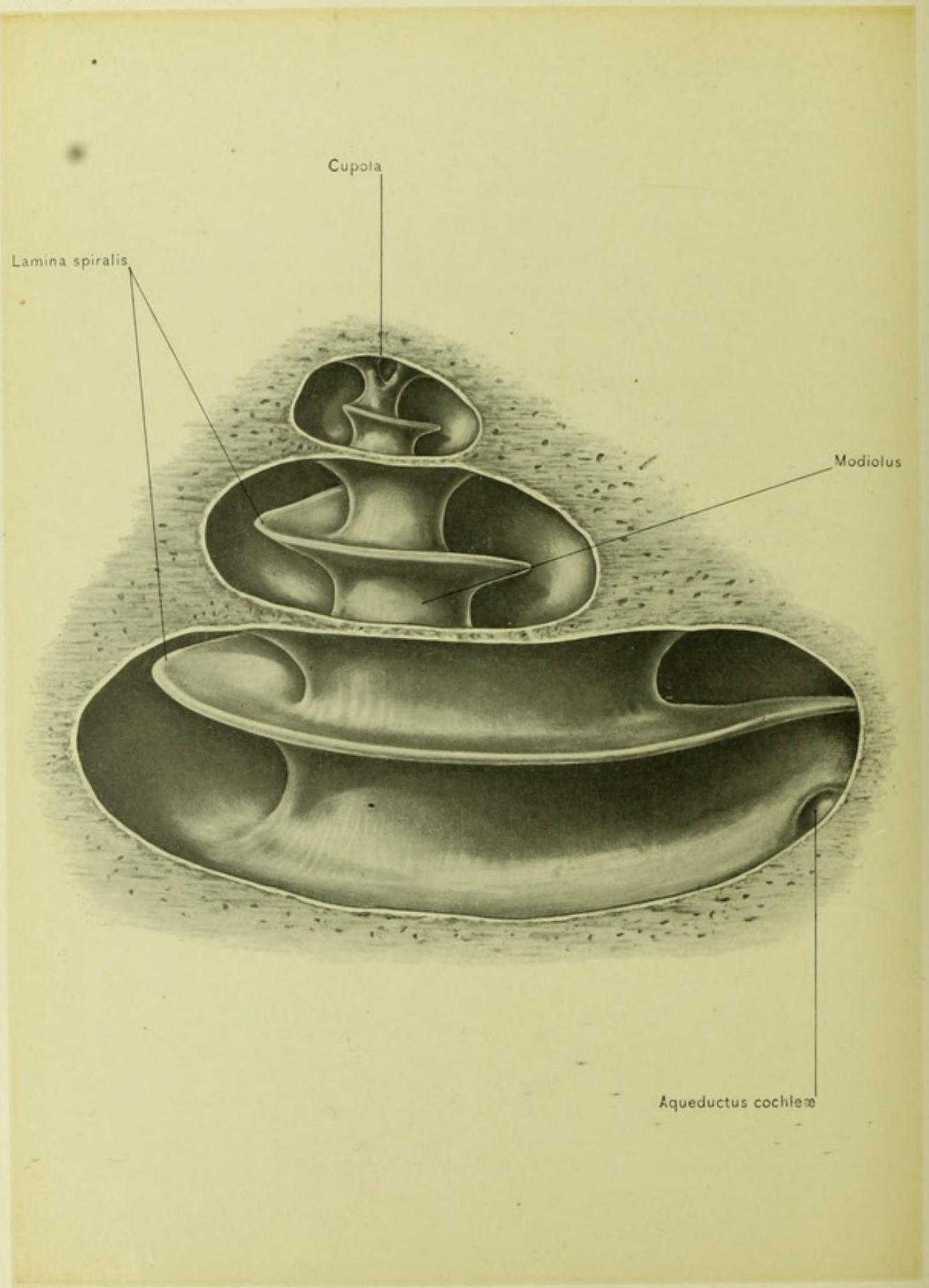
more than a semicircle, and upon one extremity of each canal is an enlargement, the *ampulla*. They open by five orifices into the vestibule, as the non-ampullated extremities of the superior and posterior canals join, and have a common orifice. From the positions of these canals in the sagittal, coronal, and transverse planes, it may be inferred that they are in some way associated with the maintenance of equilibrium. The occurrence of vertigo from increased pressure in the perilymph and endolymph increases the probability of this theory.

The **cochlea** is situated anterior to the vestibule. When isolated from the investing bony substance it appears as a cone, the apex of which looks outward and somewhat downward and forward. The *base* is perforated by numerous foramina for branches of the auditory nerve, and is directed toward the meatus auditorius internus. The base is nearly two-fifths of an inch, or ten millimeters, in diameter, and the height of the cone is about one-fourth of an inch, or six millimeters. The cochlea consists of a nearly horizontal central axis, the *modiolus* or *columnella*, around which is wound a spiral tube, in a manner similar to the spirals in certain snail shells. The *modiolus* has numerous canals in its interior for branches of the auditory nerve; the largest is the *canalis centralis modioli*. The **spiral canal** diminishes in diameter as it approaches the apex of the cochlea, makes two and one-half turns around the axis, and terminates in a closed extremity, the *cupola*. Projecting into the spiral canal from the modiolus is the bony *lamina spiralis*, which does not reach the outer wall of the cochlea. From the free border of the lamina spiralis or near it two membranes extend, in the natural state, the *membrana basilaris* and the *membrane of Reissner*. These two membranes are connected with the outer wall of the cochlea and inclose between them the *cochlear duct*, or *scala media;* they are, in fact, two parts of the membranous cochlea. By the bony lamina spiralis and the two membranes just alluded to the spiral canal is divided into three parts: the *scala tympani* and the *scala vestibuli*, between which is the *scala media*.

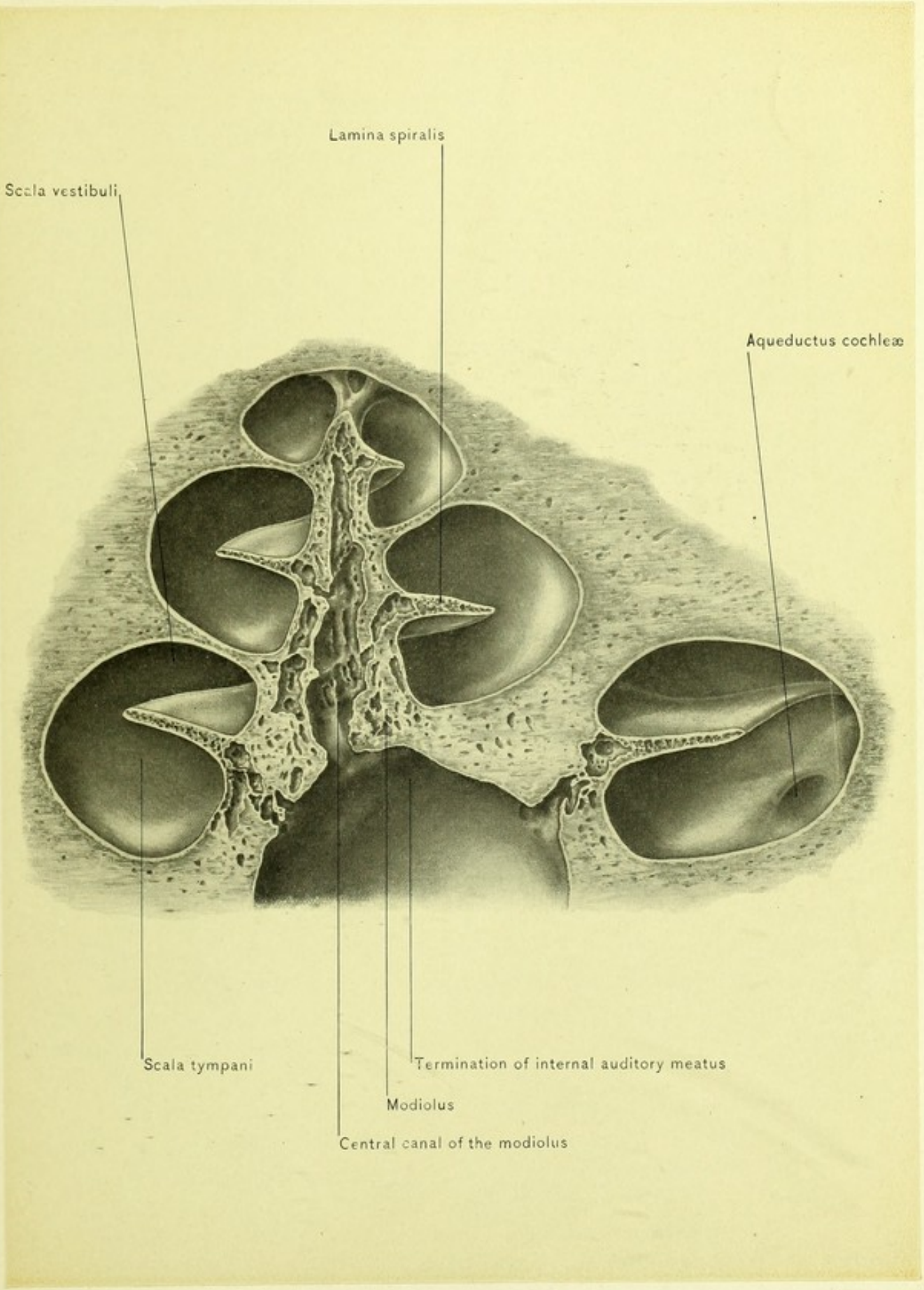
The *scala tympani* is on the basal side of the lamina spiralis, and opens into the tympanum at the fenestra rotunda, though in the natural state this opening is closed by the *membrana tympani secundaria*. The *scala vestibuli* is on the opposite side of the lamina spiralis, and opens into the vestibule. These two scalæ communicate with each other by an opening at the summit of the cochlea, known as the *helicotrema;* they contain the perilymph. The *perilymph* is in communication with the subarachnoid space of the brain along the sheath of the auditory nerve.

The **Membranous Labyrinth,** the earliest formed and therefore the oldest part of the organ of hearing, lies within the osseous labyrinth, from which it is separated in most places by the perilymph. It contains the **endolymph** and the terminations of the auditory nerve, and it is lined by epithelium.

PLATE CCLVIII.



INTERIOR OF OSSEOUS PORTION OF COCHLEA.



SECTION OF OSSEOUS PORTION OF COCHLEA.

In the vestibule are found two vesicles, the **utricle** and the **saccule,** the former lying partly in the fovea hemielliptica, and the latter in the fovea hemispherica. The membranous semicircular canals open into the utricle by five orifices. Filaments of the vestibular branch of the auditory nerve are distributed to a thickened portion of the walls of the utricle which contains calcareous masses, the **otoliths.** The saccule, which is smaller than the utricle, receives branches of the auditory nerve through the perforations in the fovea hemispherica; as in the utricle, these nerves are distributed to a thickened portion of the wall of the cavity, which is covered with otoliths. Passing from the saccule along the aqueductus vestibuli is a slender tube, the **ductus endolymphaticus,** which expands into the **saccus endolymphaticus,** a blind pouch which lies on the posterior surface of the petrous portion of the temporal bone beneath the dura mater; this canal is joined by a small tube from the utricle, and thus the two portions of the membranous vestibule are brought into direct communication. The saccule communicates with the scala media or membranous labyrinth of the cochlea by means of a short tube, the **canalis reuniens.**

The **membranous semicircular canals** are about one-fourth the diameter of the osseous canals in which they lie; their extremities are ampullated.

The **membranous cochlea, cochlear duct,** or **scala media,** lies between the scala tympani and scala vestibuli, as already stated. It follows the windings of the spiral tube of the cochlea, and ends blindly at both extremities, though near its basal end it communicates with the saccule by the canalis reuniens. Within the scala media is found the **organ of Corti,** a complex arrangement of modified epithelial cells to which the final ramifications of the cochlear branch of the auditory nerve are distributed. The description of the more minute structure of the internal ear is not within the province of this book, and for these details the reader is referred to works on systematic anatomy and histology.

Aural vertigo is indicated by ringing in the ears or head, dizziness, reeling, and nausea and vomiting in succession. It is produced by abnormal increase of pressure in the membranous labyrinth. Cerumen or instillation of cold liquids into the external auditory meatus may produce this symptom, and it may result from abnormal conditions in the middle ear and reflected irritation in gastric catarrh. Aural vertigo has been termed **Ménière's disease.**

Blood Supply.—The blood supply of the internal ear is derived from the auditory artery, a branch of the basilar, which enters the internal auditory meatus with the auditory nerve, and divides into branches for the cochlea and vestibule.

The *veins* which drain the internal ear are the vena aqueductus cochlea and vena aqueductus vestibuli. The vena aqueductus cochlea receives the veins of the

cochlea, passes through the aqueductus cochleæ, and empties into the internal jugular vein. The vena aqueductus vestibuli receives the veins from the vestibule and semicircular canals, and empties into the superior petrosal sinus.

The **Lymphatics of the Internal Ear** terminate in the tympanic and intracranial lymphatic vessels.

The **Auditory Nerve** is the nerve of the special sense of hearing. In the internal auditory meatus it divides into two branches, the cochlear and the vestibular; the former is distributed to the cochlea, and the latter to the walls of the membranous vestibule and ampullæ of the semicircular canals.

THE MEMBRANES AND VESSELS OF THE BRAIN.

The dura mater, the meningeal vessels, the sinuses of the dura mater, and the mode of exit of the cranial nerves from the cranial cavity are described in volume I, pages 568 to 599. We now resume the study of the brain, the dissection of which has been facilitated by one of the processes for preserving and hardening that organ.

THE ARACHNOID.

The **Arachnoid,** the second of the three membranes of the brain, is intermediate in position between the dura mater and the pia mater. It envelops the brain, and, like the dura mater, sends processes into the longitudinal and transverse fissures, between the hemispheres of the cerebellum, and, to a slight extent, into the fissure of Sylvius. It also surrounds the nerves, forming tubular sheaths for them as far as their points of exit from the skull. Unlike the pia mater, it does not dip into the sulci or fissures between the convolutions, but passes directly from one convolution to the other, bridging over the sulci. It forms a loose investment for the brain, and is continued downward over the spinal cord. Being a serous membrane, it presents to the naked eye a smooth, polished surface. It is connected by delicate connective tissue with both the dura mater and pia mater, but much more intimately with the latter.

The connection between the arachnoid and the pia mater makes the independent removal of the arachnoid very difficult. The arachnoid and pia mater

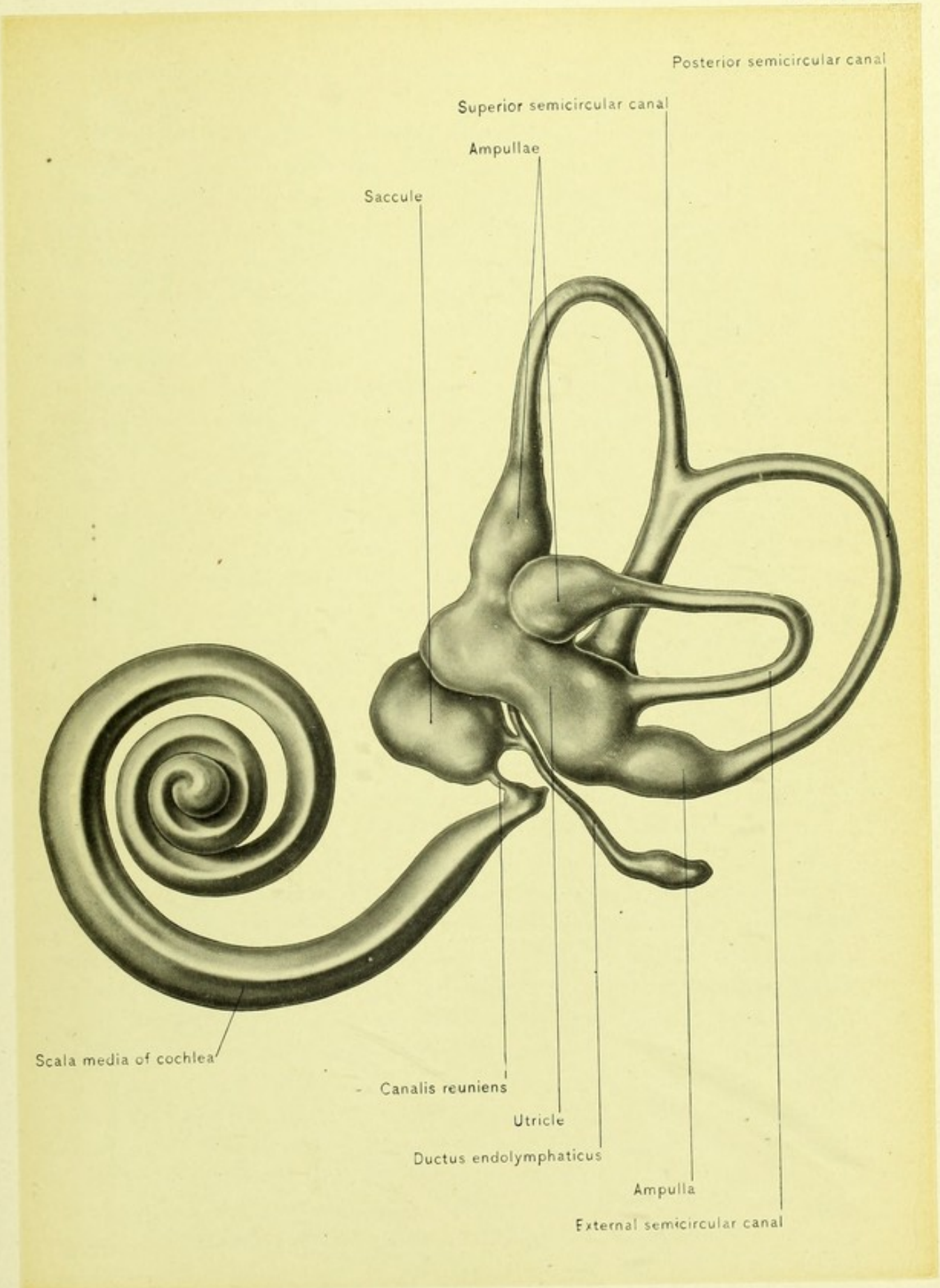


DIAGRAM OF MEMBRANOUS LABYRINTH.

can be separated, however, by inflating the subarachnoid space with air by means of a blowpipe.

The Subdural Space.—The arachnoid was formerly described as consisting of two layers—a parietal layer, lining the inner surface of the dura mater, and a visceral layer, reflected over the brain; in this respect it was said to resemble serous membranes elsewhere. It is now regarded as consisting of but one layer. The space between the dura mater and the arachnoid is known as the *subdural space*, and contains a small amount of fluid; this space was formerly styled the cavity of the arachnoid; it does not communicate with the subarachnoid space or with the ventricles.

The Subarachnoid Space.—The space between the arachnoid and the pia mater is known as the subarachnoid space; it is most pronounced at the base of the brain. Here the arachnoid membrane is thicker than elsewhere, and bridges over the interval between the temporo-sphenoid lobes and the space between the hemispheres of the cerebellum, partially occupied by the medulla oblongata. By the intervention of the pons this general subarachnoid space is subdivided into the *anterior* and the *posterior space*. The posterior space communicates with the subarachnoid space of the spinal cord and with the fourth ventricle of the brain through a small opening in the roof of the latter called the *foramen of Magendie*, and through two other apertures—the *foramina of Key and Retzius*—which are located at each lateral recess of the fourth ventricle. This space contains the cerebro-spinal fluid; because of this fact the brain may be said to lie on a water-bed. Projecting into this space are seen the larger blood-vessels on their way toward the brain; the lymphatics of the brain and spinal cord empty into this space, which is in communication with the perilymph of the internal ear and with the lymphatics of the nose.

Subarachnoid Cisterns is the name given to the more capacious portions of the subarachnoid space, the largest being the *cisterna magna*, situated between the adjacent surfaces of the medulla oblongata and cerebellum. The cisterna magna is the upward continuation of the posterior portion of the spinal subarachnoid space. The anterior portion of the spinal subarachnoid space is continued upon the anterior surface of the medulla oblongata and pons as the *cisterna pontis*, and communicates freely around the medullo-pontine furrow, or sulcus, with the cisterna magna, which is situated above and behind the medulla oblongata. The *cisterna basalis* is that part of the subarachnoid space situated between the tips of the temporo-sphenoid lobes and the crura cerebri, and in front of the pons; into it project the circle of Willis and the vessels connected with this circle. Laterally, the cisterna basalis extends into the Sylvian fissures; while anteriorly it extends into a minor space in front of the optic chiasm, and thence further

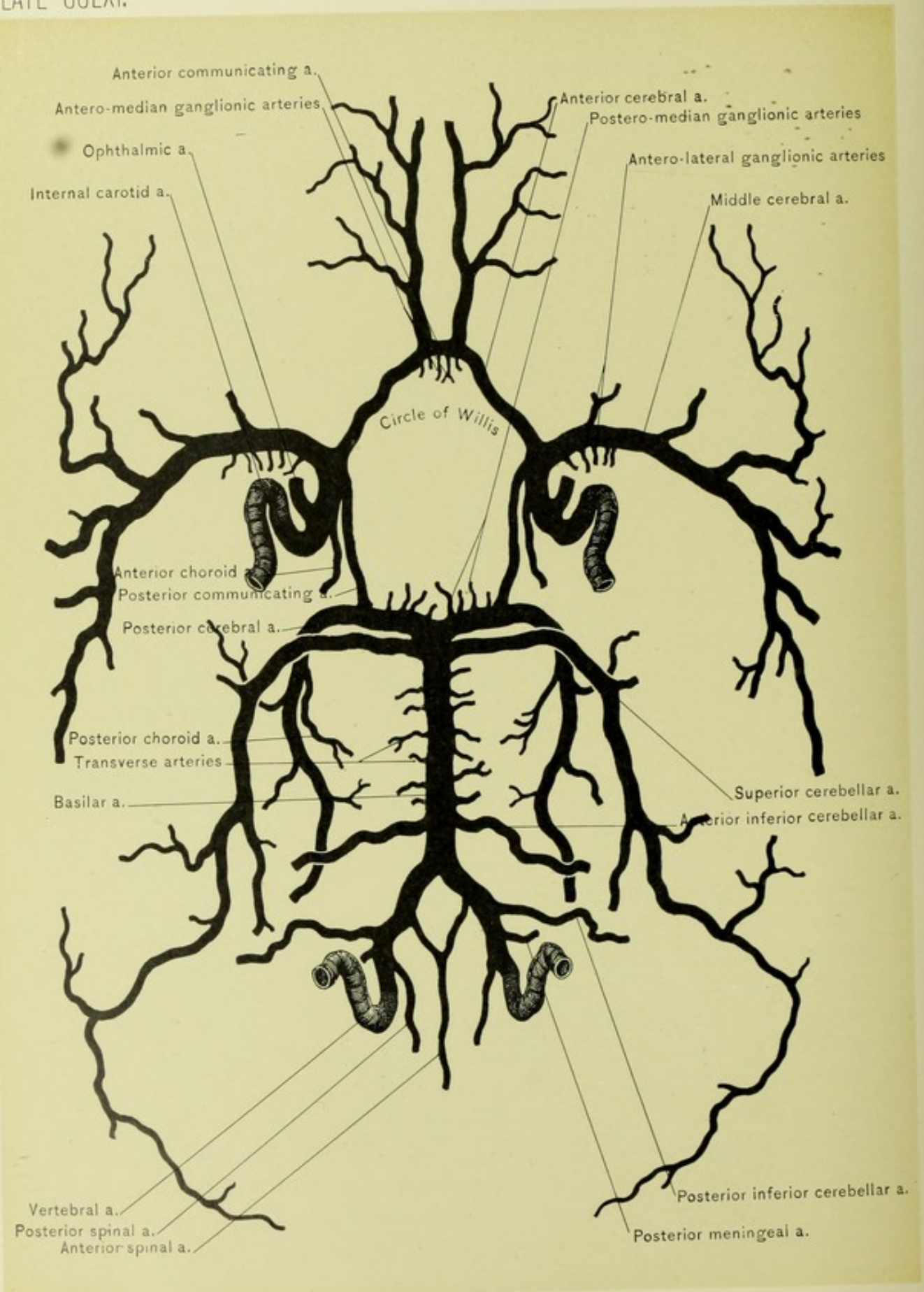
forward into the great longitudinal fissure. Another large space is found above the corpus callosum ; in the pia mater at the bottom of this space are the anterior cerebral arteries. Between the superior vermiform process of the cerebellum and the corpora quadrigemina is an additional space, which contains the veins of Galen. These spaces communicate very freely with one another, and with the fourth ventricle, as stated.

The **Cerebro-spinal Fluid** is a serous fluid, but, unlike ordinary serum, it is not coagulable. This fluid assists in protecting the brain and spinal cord from violent shocks and vibrations. It is secreted by the cells of the ependyma over the fringe-like, vascular processes of the choroid plexus, and slightly by the cells of the arachnoid. However, it is chiefly derived from the choroid plexuses of the lateral ventricles, and to a less extent from the choroid plexuses of the third and fourth ventricles. The fluid passes from the lateral ventricles to the third ventricle through the foramina of Monro, from the third to the fourth ventricle through the aqueduct of Sylvius, and from the fourth ventricle through the foramina of Magendie, Key, and Retzius, to the subarachnoid space of the brain and spinal cord ; some of the cerebro-spinal fluid passes directly from the fourth ventricle to the central canal of the spinal cord. This constitutes the course through which the cerebro-spinal fluid circulates, and equalizes the intra-cranio-spinal pressure. By exudation of plastic lymph at the base of the brain, meningitis, especially the tubercular variety, may cause obstruction of the foramina of Magendie, Key, and Retzius, and produce dropsy or hydrocele of the ventricles (*internal hydrocephalus*) ; hence, tapping of the lateral ventricles, which is sometimes practised in these cases, can give but temporary relief. Aspiration of the subarachnoid space through the anterior fontanel or of the spinal subarachnoid space, for hydrocephalus, is followed by a similar result. The sudden removal of a large quantity of the cerebro-spinal fluid, either by tapping the lateral ventricles or by aspirating through the anterior fontanel, is not without its dangers, and has been followed by severe convulsions. The normal quantity of intra-cranial lymph varies in amount from two drams to two ounces (H. Allen).

The cerebro-spinal fluid is supposed to escape from the subarachnoid space of the brain and spinal cord by way of the prolongations of the arachnoid along the cranial and spinal nerves ; these extensions of the subarachnoid space are in communication with the lymphatic vessels in the sheaths of those nerves, and in this manner the fluid reaches the general lymphatic system of the body. It is also supposed that some of the cerebro-spinal fluid escapes by way of the Pacchionian bodies directly into the sinuses of the dura mater.

Choked Disc.—In tubercular or other forms of inflammation of the membranes at the base of the brain with deposit of lymph, or in case of tumor at the

PLATE CCLXI.



CIRCLE OF WILLIS AND ARTERIES OF BRAIN.

base making pressure, the sheath of the optic nerve becomes distended, causing a congestion of the veins of the optic disc (choked disc), an important diagnostic sign. Pressure, however, does not suffice to explain all cases of "choked disc"; in many cases there is distinct inflammation of the optic papilla, so that the term papillitis would be preferable.

The **Lymphatics** of the brain open into the subarachnoid space.

The **Pacchionian Bodies** are enlargements of the normal villi of the arachnoid; they project from the surface of that membrane, and may perforate the overlying dura mater and cause absorption of the bone in their vicinity.

Dissection.—The next step in the dissection consists in removing the arachnoid from the base of the brain. The arteries entering the cranial cavity to supply the brain and the formation of the arterial circle of Willis are then to be carefully examined.

THE ARTERIES OF THE BRAIN.

The **Circle of Willis,** which lies in the pia mater and projects into the subarachnoid space, is formed by branches of the internal carotid and basilar arteries. It forms a heptagonal figure, although it is usually not exactly symmetric. This arrangement serves to equalize the flow of blood derived from the two internal carotid arteries and the basilar artery. Without this or some similar arrangement ligation of the common carotid, internal carotid, or vertebral artery would probably always result in softening of the brain. This circle is formed by the *two posterior cerebral arteries,* which are the terminal divisions of the basilar, the *two internal carotid arteries,* the *two posterior communicating branches* of the internal carotid arteries, which connect the latter with the posterior cerebral arteries, the *two anterior cerebral arteries* (branches of the internal carotid arteries), and the *anterior communicating artery,* a transverse branch which connects the anterior cerebral arteries. This circle is in relation with the several structures which are situated in the interpeduncular space, and form the floor of the third ventricle.

The arteries which enter the cranial cavity for the supply of the brain are the two internal carotid and the two vertebral.

The **Internal Carotid Artery,** one of the two terminal branches of the common carotid, enters the cranial cavity by way of the carotid canal, pierces the cartilage which fills the middle lacerated foramen, and ascends by the side of the body of the sphenoid bone along the inner wall of the cavernous sinus. Upon the inner aspect of the anterior clinoid process it pierces the dura mater, gives off the ophthalmic artery, and passes between the optic and oculo-motor nerves. Having reached the anterior perforated space at the inner extremity of the

fissure of Sylvius, it gives off the posterior communicating and the anterior choroid arteries, and divides into the anterior and middle cerebral arteries.

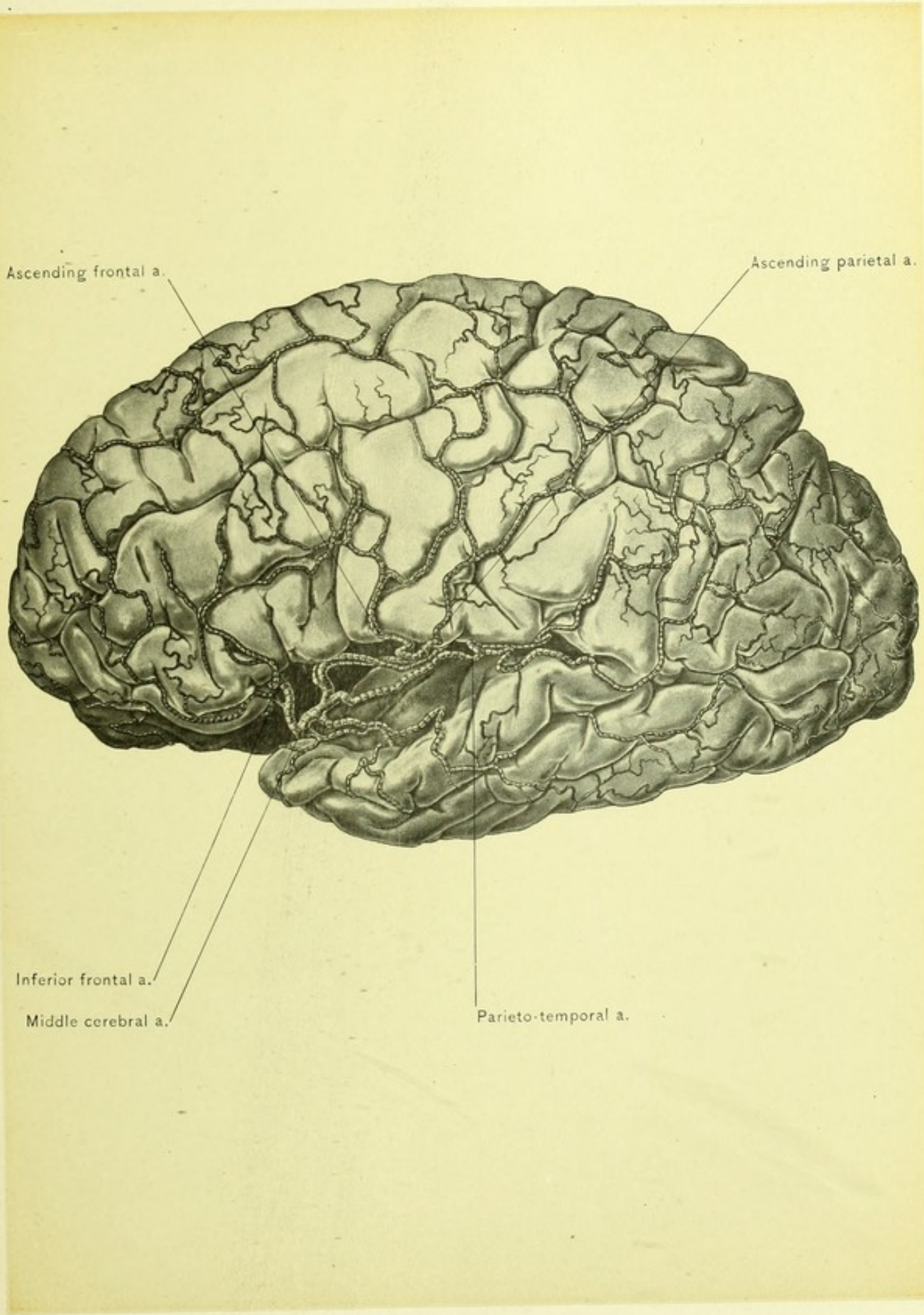
The **Anterior Cerebral Artery** runs forward and inward across the anterior perforated space and the lamina cinerea, and between the optic and olfactory nerves, to reach the longitudinal fissure. Here it is joined to the anterior cerebral artery of the opposite side by a transverse branch, the anterior communicating artery. It now curves around the genu of the corpus callosum, and runs backward along the upper surface of the corpus callosum and at the bottom of the longitudinal fissure of the cerebrum as far as the splenium of the corpus callosum, where it anastomoses with the posterior cerebral artery.

At its commencement the anterior cerebral artery gives off a few antero-median branches to the anterior extremity of the caudate nucleus. At the bottom of the longitudinal fissure it gives off branches to the corpus callosum, the frontal lobe, marginal gyrus, quadrate lobule, and gyrus fornicatus.

The **Anterior Communicating Artery,** the shortest artery in the body, lies on the lamina cinerea in front of the optic commissure, and connects the two anterior cerebral arteries across the longitudinal fissure. It also gives off antero-median ganglionic branches which pierce the lamina cinerea, and a small branch to the anterior extremity of the corpus callosum. Sometimes this vessel is absent, when the two anterior cerebral arteries have no connection, or form a common trunk, and then divide.

The **Middle Cerebral Artery** (Sylvian), the largest branch of the internal carotid, runs outward deeply within the fissure of Sylvius, and supplies the motor area of the brain. It gives off branches which supply the caudate and lenticular nuclei, the internal capsule, the optic thalamus, and the surface of the brain, as follows: Small branches which pass through the bottom of the fissure of Sylvius to the head of the caudate nucleus; antero-lateral branches, which pass through the anterior perforated space and supply the body and tail of the caudate nucleus, the internal capsule, and the optic thalamus; a branch, the lenticulo-striate, which passes through an aperture in the anterior perforated space and supplies the lenticular and caudate nuclei. The lenticulo-striate artery is called by Charcot the *artery of cerebral hemorrhage*, as it has so frequently been found ruptured in this condition. Finally, opposite the island of Reil, the middle cerebral artery gives off cortical branches which supply the operculum and the temporal and parietal lobes, especially the supra-marginal and angular gyri.

The **Posterior Communicating Artery** arises from the posterior surface of the internal carotid, and runs directly backward, parallel to and on the inner side of the oculo-motor nerve, to join the posterior cerebral artery. It varies in size, being sometimes so large as to give the impression that the posterior cerebral artery is its



MIDDLE CEREBRAL ARTERY.

continuation. A great difference in the size of the vessels of the two sides is not infrequently seen. It gives off branches to the uncinate convolution, with which it is in relation, and a branch, the middle thalamic, which passes vertically through the hippocampal sulcus to the optic thalamus.

The **Anterior Choroid Artery** is given off by the internal carotid just beyond the posterior communicating artery. It passes backward and outward under the tip of the temporo-sphenoid lobe of the cerebrum, to enter the descending cornu of the lateral ventricle on its way to supply the hippocampus major, corpus fimbriatum, and choroid plexus.

The **Vertebral Artery,** a branch of the first portion of the subclavian, enters the cranial cavity by way of the foramen magnum and runs upward around the medulla oblongata, between the hypoglossal nerve and the anterior root of the first cervical or suboccipital nerve. Thence it runs forward along the medulla oblongata to the inner side of the hypoglossal nerve, and joins the vertebral artery of the opposite side at the lower border of the pons, to form a single trunk, the basilar artery. The branches given off from the vertebral artery within the cranial cavity are the posterior meningeal, the anterior and posterior spinal, and the posterior inferior cerebellar artery.

The **Posterior Meningeal Artery** arises from the vertebral artery opposite the foramen magnum, and supplies the bone and dura mater of the occipital fossa.

The **Anterior Spinal Artery** arises from the vertebral artery near its termination in the basilar, and joins the anterior spinal artery of the opposite side about the level of the foramen magnum. The common trunk then runs downward along the anterior median fissure of the spinal cord, in the pia mater. In its course it is reinforced by successive branches at the level of each vertebra; these branches are derived from the vertebral, the ascending cervical, the intercostal, the lumbar, the ilio-lumbar, and the lateral sacral arteries, all of which branches enter the spinal canal by way of the intervertebral foramina, and by their mesial union form a continuous anterior spinal artery which extends along the entire length of the anterior median fissure of the spinal cord.

The **Posterior Spinal Artery,** smaller than the anterior, arises from the vertebral artery at the side of the medulla oblongata, and passes backward to the side of the posterior surface of the spinal cord, where it divides into two branches, one of which descends behind and the other in front of the posterior roots of the spinal nerves. Like the anterior spinal, it is reinforced at the successive vertebral levels by branches derived from the vertebral, the intercostal, the lumbar, the lateral sacral, and the common trunk of the anterior spinal artery by branches which run around the sides of the spinal cord.

The **Posterior Inferior Cerebellar Artery,** the largest branch of the vertebral

artery, arises from that vessel near its termination (sometimes this branch may arise from the basilar artery); it winds backward around the medulla oblongata, between the pneumogastric and spinal accessory nerves; it then runs over the inferior cerebellar peduncle to the under surface of the cerebellum, there to divide into two branches—an outer and an inner; the outer branch traverses the under surface of the hemisphere of the cerebellum, which it supplies, and running along the outer margin of the cerebellum, it anastomoses with the superior cerebellar artery; the inner branch, practically the continuation of the main vessel, runs in the groove between the hemisphere of the cerebellum and the vermiform process, both of which it supplies. The posterior inferior cerebellar artery also sends branches to the fourth ventricle, and anastomoses with the corresponding vessel of the opposite side, and with the superior cerebellar artery.

The **Basilar Artery,** formed by the union of the two vertebral arteries at the posterior border of the pons, runs along the median line of the anterior, or lower, surface of the pons as far as its anterior, or upper, border, where it divides into its two terminal branches—the posterior cerebrals. Running on each side of, and almost parallel with, the basilar artery, are the sixth, or abducent, nerves. With the brain *in situ*, the vessel lies on the dorsal surface of the body of the sphenoid bone. Its branches, named from behind forward, are the transverse, the internal auditory, the anterior inferior cerebellar, the superior cerebellar, and the two terminal.

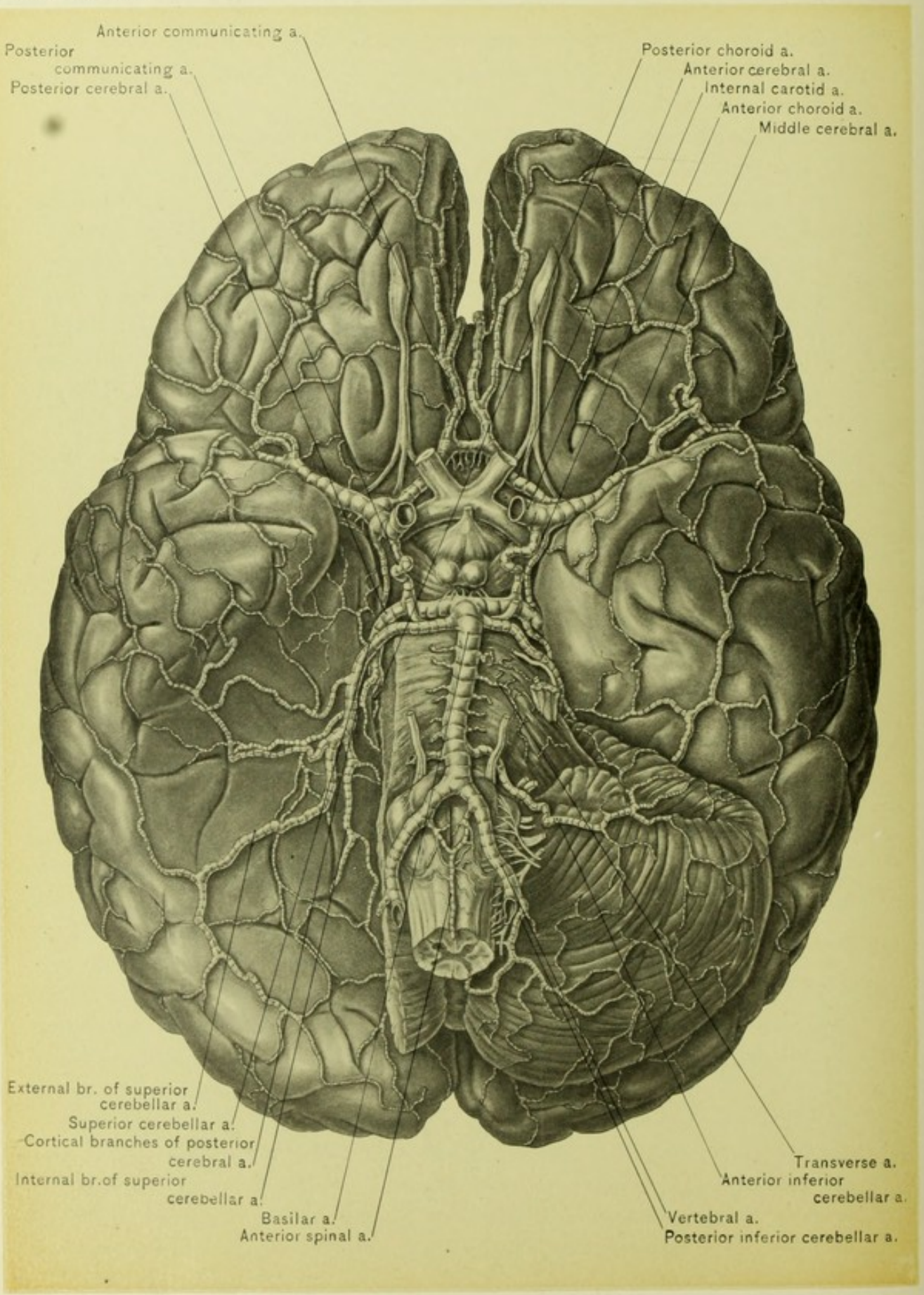
The **Transverse Arteries** are numerous small branches which arise from the basilar upon each side, run in the direction their name indicates, and supply the pons and the adjacent portion of the cerebrum.

The **Internal Auditory Arteries,** one on each side, spring from the basilar artery and may arise from the transverse arteries. Each accompanies the corresponding auditory nerve into the internal auditory meatus, where it runs between the facial and auditory nerves, and, reaching the bottom of the meatus, passes into the internal ear.

The **Anterior Inferior Cerebellar Arteries,** one on each side, arise from the basilar artery near its middle. Each artery passes outward and backward over the pons and the middle crus of the cerebellum. It terminates at the fore part of the under surface of the hemisphere of the cerebellum, to which it is distributed. It anastomoses with the posterior inferior cerebellar artery.

The **Superior Cerebellar Arteries,** one on each side, arise from the basilar so near its bifurcation as to be sometimes mistaken for the posterior cerebral arteries. The superior cerebellar artery is separated from the posterior cerebral artery by the oculo-motor nerve. The superior cerebellar arteries pass outward around the crura cerebri, lying nearly parallel with the pathetic nerves, and reach the

PLATE CCLXIII.



ARTERIES AT BASE OF BRAIN.

upper surface of the cerebellum. Here they divide into branches which anastomose with the corresponding artery of the opposite side and with the inferior cerebellar artery.

The **Posterior Cerebral Arteries,** the two terminal branches of the basilar, wind around the crura cerebri, and, running parallel with the superior cerebellar, from which they are separated by the oculo-motor nerves, reach the inner surface of the posterior part of the cerebrum. As noted, they are joined to the internal carotid arteries by the posterior communicating branches of the latter vessels. They supply the occipital and temporo-sphenoid lobes, and anastomose with the anterior and middle cerebral arteries.

Like the anterior and middle cerebral arteries, the posterior cerebral gives off central and cortical branches. The central branches are as follows: Small branches which pass through the posterior perforated space to supply the optic thalamus and the walls of the third ventricle; the posterior choroid, which passes through the transverse fissure to reach the velum interpositum and the choroid plexus; while others run to the optic thalamus, crus cerebri, and corpora quadrigemina. The cortical branches are distributed to the adjacent parts of the temporal and occipital lobes.

Anastomoses of Cerebral Arteries.—Between the cortical and the central branches of the arteries which supply the brain there is no anastomosis; consequently, these two sets of branches form two independent systems. The cortical branches, however, may and do anastomose with each other, but seldom sufficiently to nourish a portion of the brain from which the blood current through the main artery supplying it has been cut off. In other words, the central vessels differ from the vessels of the upper or lower extremity in not being able to establish a collateral circulation which will perform the office of the principal vessel in the event of its being seriously disabled. In this respect they resemble the vessels of the lungs, kidneys, and retina. The central branches do not anastomose with each other; therefore, obstruction of one of the chief vessels of the brain will result in softening of the region supplied by its central branches, while softening of the region supplied by its cortical branches does not necessarily follow.

Peculiarities of the Arteries to the Brain.—In studying the course of the four large arteries—the two internal carotids and the two vertebrals—which enter the cranial cavity to supply the brain, the dissector will doubtless become aware of the following peculiarities: First, their length and tortuosity; second, that the four arteries anastomose freely by means of the circle of Willis; and, third, that their numerous and small branches run through the third and innermost membrane of the brain,—the pia mater,—by means of duplications of which they reach the interior of the brain. The tortuosity of these arteries diminishes

the force of the current of blood, thus lessening the danger of apoplexy; and, through the circle of Willis, the pressure in the four arteries is equalized.

THE VEINS OF THE BRAIN.

The **Veins of the Brain** empty into the sinuses of the dura mater (see description of the sinuses, vol. I); they do not accompany the corresponding arteries.

The **Veins of the Cerebrum** consist of a superficial or cortical and a deep or central set. The former ramify in the pia mater and empty directly into the sinuses; the latter empty into the sinuses indirectly through the medium of the veins of Galen.

The Cerebellar Veins.—The veins which run over the superior surface of the cerebellum empty into the veins of Galen and the straight sinus, while all of those which traverse the lower surface of the cerebellum empty into the inferior petrosal, lateral, and occipital sinuses.

Absence of Valves.—The veins and sinuses of the brain are destitute of valves. Their absence may be compensated for in the superior longitudinal sinus by the presence of the chordæ Willisii, and by the fact that the veins which empty into this sinus pass from behind forward in a direction opposite to that of the blood current, and that in entering the sinus they pass obliquely through its wall.

THE PIA MATER.

The **Pia Mater,** the innermost of the three membranes which cover the brain, invests it most intimately, and sends processes into all the fissures of the cerebrum and between most of the laminæ of the cerebellum. It is the vascular membrane of the brain, and carries the minute branches of the two internal carotids and the two vertebral arteries, and the veins which return the blood conveyed to the brain by these vessels, all of which are associated by delicate connective-tissue fibers. The author would liken the connective-tissue element of the pia mater to a grape arbor, and the vessels running over and through the interstices to the grape vine. Added to the above are numerous minute vessels, given off from the inner surface of the pia mater, which pass perpendicularly into the substance of the brain.

Only two of the processes of the pia mater receive special names—the **velum interpositum** and the **choroid plexuses** of the third and fourth ventricles. The former reaches the interior of the brain by way of the transverse fissure. Both the velum interpositum and the choroid plexus will be described with the ventricles of the brain. The portions of the pia mater which cover the crura cerebri

and the pons have a different appearance from the rest of the membrane, and present a dense fibrous structure which contains but few vessels.

Nerve Supply.—The pia mater is supplied with nerves by branches from the sympathetic, trifacial, and glosso-pharyngeal nerves.

THE BRAIN.

Dissection.—If the arachnoid and the pia mater have been allowed to remain in place thus far, they should now be removed, with the exception of that portion of the pia mater which is prolonged inward between the splenium of the corpus collosum above and the pineal gland and the corpora quadrigemina below, to form the velum interpositum which is placed between the corpus callosum and fornix above and the optic thalami, pineal gland, and corpora quadrigemina below. The removal of these membranes exposes the surface of the brain; and in dissecting them from the base of the brain care should be taken not to detach any of the cranial nerves.

Definition and Weight.—The brain, or encephalon, is the intracranial mass of nervous matter, or that portion of the cerebro-spinal axis which is contained within the cavity of the cranium. Its average weight in the adult male is forty-nine and one-half ounces, and in the female forty-four ounces.

Divisions.—The brain is composed of four main portions: The cerebrum (large brain); the cerebellum (small brain), which is second in size; the pons Varolii, which is third in size; and the medulla oblongata, the smallest, yet physiologically the most important.

Position of the Pons.—Of these four portions the pons Varolii is the center around which the three remaining portions are not only grouped, but to which they are connected in the following manner: To the cerebrum by the crura cerebri, the cerebellum by the crura cerebelli (middle peduncles of the cerebellum), and the medulla oblongata by the anterior pyramids and part of the lateral tracts. The pons rests upon the posterior surface of the body of the sphenoid bone and the upper part of the basilar process of the occipital bone.

Position of the Cerebrum.—The cerebrum occupies all the upper part of the cranial cavity, concealing from view the other portions of the brain when one looks from above, and rests upon the floor of the anterior and middle fossæ of the skull, and the tentorium cerebelli. The tentorium cerebelli, in addition to supporting the cerebrum, separates it from the cerebellum and protects the latter from pressure by the cerebrum.

Position of the Cerebellum.—The cerebellum occupies the space between the tentorium cerebelli and the floor of the posterior cranial fossa.

Position of the Medulla Oblongata.—The medulla oblongata is continuous below with the spinal cord, and rests upon the posterior part of the basilar process of the occipital bone.

Contour.—The brain is convex upon its upper and lateral surfaces, and irregular upon the lower or basilar surface, where it conforms to the base of the skull. The form of the surface of the brain is largely that of the interior of the cranium, but not sufficiently so as to make phrenology an exact science.

Structures at the Base of the Brain.—In dissecting the brain the most suitable article upon which to place it is an ordinary dinner plate covered with a thick layer of absorbent cotton wet with alcohol. This soft bed will prevent the convolutions from being flattened when the brain is laid on its upper surface to study the structures forming the base. These are the inferior surfaces of the frontal and temporo-sphenoid lobes of the cerebrum, which are irregular and conform to the inequalities of the base of the skull, this relation explaining why contusion of the cerebrum is more common at the basilar surface of these lobes than elsewhere; the fissure of Sylvius, which separates the frontal from the temporo-sphenoid lobe; the olfactory tracts and bulbs; the longitudinal fissure; the corpus callosum and its peduncles; the anterior perforated spaces; the optic commissure and the terminal parts of the optic tracts; the lamina cinerea, the tuber cinereum and a part of the infundibulum—the remaining part, with the pituitary body, having been described; the corpora albicantia, or mammillary eminences; the posterior perforated space; the crura cerebri; the pons Varolii; the middle crura of the cerebellum; the lateral hemispheres of the cerebellum; the medulla oblongata; the posterior extremity of the inferior vermiform process of the cerebellum; and, finally, the roots of the cranial nerves.

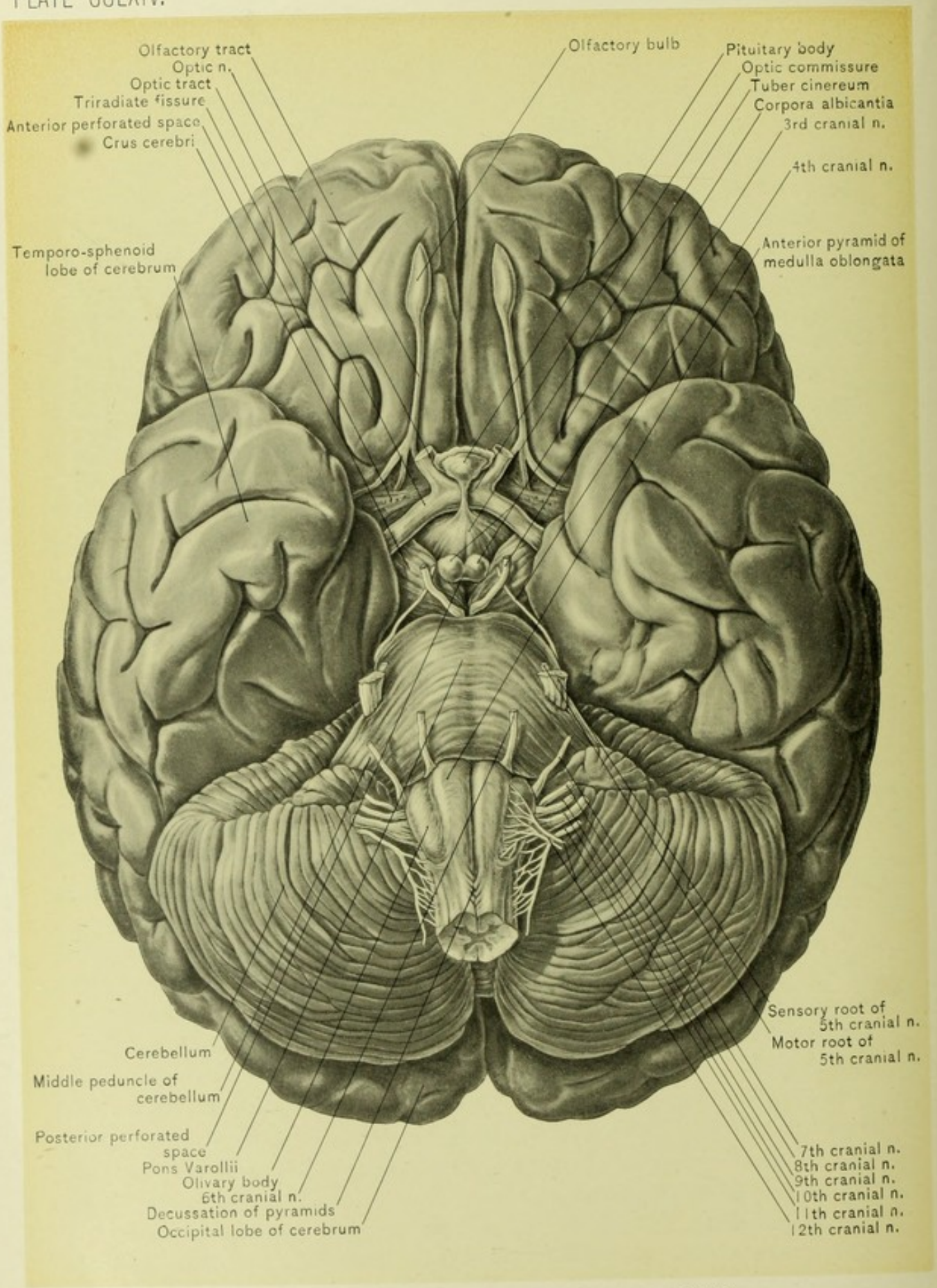
Frontal Lobes.—The inferior or orbital surfaces of the frontal lobes are triangular in shape, and separated in front by the longitudinal fissure. Their bases are directed backward, and formed by the fissure of Sylvius. They present two well-pronounced sulci or fissures—the triradiate, or orbital, and the olfactory. These, as will be seen later, divide them into their convolutions.

The **Olfactory Tract and Bulb** are seen occupying the olfactory sulcus.

Temporal Lobes.—The inferior surface of the temporal or temporo-sphenoid lobe, is slightly convex anteriorly and concave posteriorly, and thus accommodates itself in front to the portions of the middle cranial fossa formed by the greater wing of the sphenoid and the anterior surface of the petrous portion of the temporal bone, and behind to the convex tentorium. It presents the termination of two well-pronounced sulci—the third temporal and the inferior occipito-temporal.

Fissure of Sylvius.—Between the inferior surfaces of the adjacent frontal and temporo-sphenoid lobes is seen the fissure of Sylvius, the largest of the prim-

PLATE CCLXIV.



BASE OF BRAIN AND SUPERFICIAL ORIGIN OF CRANIAL NERVES.

ary fissures of the cerebrum, through which runs the middle cerebral artery; into this fissure extends the lesser wing of the sphenoid bone, and from the floor of its anterior portion projects the island of Reil, or central lobe of the cerebrum.

The **Longitudinal Fissure** separates the two frontal lobes, and if the cerebellum is lifted, the fissure will be seen to separate completely the two occipital lobes.

Corpus Callosum.—By carefully separating the frontal lobes, the beak or rostrum of the corpus callosum will be seen in addition to two white bands,—the peduncles of the corpus callosum,—which are continued backward and outward on each side of the rostrum across the anterior perforated space to the commencement of the fissure of Sylvius.

The **Anterior Perforated Spaces,** one on each side, are situated at the inner extremity of the fissure of Sylvius. Each space is triangular in shape, bounded in front by the frontal lobes and the roots of the olfactory tracts, externally by the apices of the temporo-sphenoid lobes and the fissure of Sylvius, and posteriorly by the optic tract. They are crossed by the peduncles of the corpus callosum and the external olfactory root; they transmit small vessels, chiefly branches of the middle cerebral artery, to the corpora striata, which lie immediately above the spaces.

The **Optic Commissure** or **Chiasm,** from which arise the optic nerves, lies between the anterior perforated spaces and behind the anterior inferior portion of the longitudinal fissure. It is formed by the union of the optic tracts—two white cords seen running on the outer side of the crura cerebri.

The **Interpeduncular** or **Intercrural Space** is a lozenge-shaped or quadrilateral area, bounded by the optic commissure in front, the pons Varolii behind, and the optic tracts and the crura cerebri at the sides. It contains the tuber cinereum, the intra-dural portion of the infundibulum, the corpora albicantia, the posterior perforated space, and the oculo-motor nerves. These structures, except the last mentioned, form the floor of the third ventricle with the exception of its anterior part, which is formed by the structure next to be described—the lamina cinerea.

Lamina Cinerea.—To expose the lamina cinerea to the best advantage, displace backward the optic commissure, above which it lies. It will then be seen to extend from the beak or rostrum of the corpus callosum, to which it is attached in front, to the tuber cinereum, to which it is attached behind. It is composed of gray matter continuous with the anterior perforated spaces.

The **Tuber Cinereum** is a gray eminence, situated behind the optic commissure and in front of the corpora albicantia. It is a hollow conic process continuous with the infundibulum, which connects the third ventricle with the pituitary body. The *infundibulum* pierces the diaphragma sellæ, a process of the dura mater which bridges the pituitary fossa.

The **Pituitary Body** (**Hypophysis Cerebri**) is the small body which occupies the pituitary fossa or sella turcica and is covered superiorly by the diaphragma

sellæ. It is composed of an anterior and a posterior lobe which differ in size, structure, and origin. The *anterior lobe* is much the larger, is of reddish-gray color, and is an isolated process of the wall of the buccal cavity of the embryo. The *posterior lobe* is the smaller, is lodged in a depression in the anterior lobe, is of yellowish-gray color, and is a process of the brain. It is the only part of the pituitary body structurally continuous with the infundibulum, which, in passing from the floor of the third ventricle to the pituitary body, pierces the diaphragma sellæ.

The **Corpora Albicantia** (bulbs of the fornix), two knobs situated behind the tuber cinereum, are formed by the anterior crura of the fornix, and the bundles of Vicq d'Azyr from the optic thalamus, which reach the base of the brain.

The **Posterior Perforated Space** is triangular in shape, its base corresponding to the corpora albicantia; its apex, to the pons Varolii; and its sides, to the crura cerebri. It gives passage to postero-median ganglionic branches of the posterior cerebral and posterior communicating arteries, which run to the optic thalami.

The **Crura Cerebri,** or cerebral peduncles, are two large cylindric masses of white and gray matter. They are about three-fourths of an inch, or eighteen millimeters, long, broader in front than behind, and composed of the longitudinal fibers of the pons Varolii, together with some fibers from the cerebellum. They commence at the anterior border of the pons, from which they emerge, and then pass forward and outward. They traverse the superior occipital foramen in the tentorium cerebelli in company with the superior peduncles of the cerebellum, the oculo-motor and pathetic nerves, and the basilar artery, and each enters the anterior and inner aspect of the corresponding temporo-sphenoid lobe. The optic tract and the pathetic nerve pass around the outer border of the corresponding crus cerebri, while the oculo-motor nerve winds around the inner border. Later, when making sections of the brain to study the arrangement of its interior, the crura cerebri will be cut across, when the *locus niger*, a gray nucleus in the interior of each crus, will be exposed. The nucleus separates the fibers of the crus cerebri into two sets: a lower and smaller—the *crusta*—and an upper and larger—the *tegmentum*.

The **Pons Varolii,** or **Tuber Annulare,** the central figure in the group of the four divisions of the brain, is composed chiefly of white matter, and is situated behind the crura cerebri, in front of the medulla oblongata, and between the hemispheres of the cerebellum. It is about an inch, or twenty-five millimeters, long, and rather more than this in width; from its dorsal to its ventral surface it measures about three-fourths of an inch, or eighteen millimeters. It is markedly convex from side to side and slightly so from before backward, and presents an antero-posterior median groove which accommodates the basilar artery. It consists principally of two sets of fibers—a transverse, or superficial, and a longitudinal, or deep, set. The former set extend laterally into each hemisphere of the cerebellum, forming the middle peduncles, or great transverse commissure, of

the cerebellum; and the latter set extend forward and outward and help to form the crura of the cerebrum. Making their exit through the sides of the pons, are the trifacial nerves. The upper surface of the pons forms a part of the floor of the fourth ventricle.

The **Medulla Oblongata,** the smallest of the four divisions of the brain, is the enlarged upper end of the spinal cord. It extends from the lower border of the pons, from which it is separated by a transverse groove, to the lower border of the foramen magnum. In addition to the medulla oblongata the three membranes of the spinal cord, the vertebral artery, and the spinal accessory nerves pass through the foramen magnum of the occipital bone. Its upper surface lies in the depression between the hemispheres of the cerebellum. It is pyramidal in shape; about one and a quarter inches, or thirty-two millimeters, long; three-quarters of an inch, or eighteen millimeters, wide at its broadest part, which is its upper portion; and half an inch, or twelve millimeters, in thickness. It forms part of the sides and the largest and most important part of the floor of the fourth ventricle. Its further description will be deferred until the dissection of the cerebrum is completed.

The **Hemispheres of the Cerebellum** are situated chiefly upon each side of the medulla oblongata. The arrangement of the gray matter which forms the surface of the cerebellum differs from that of the cerebrum in the following respects: In the cerebrum it is arranged in convolutions or gyri separated by fissures, while in the cerebellum it is arranged in closely applied laminæ. The upper and lower surfaces of the hemispheres are divided into lobes, which will be described with the dissection of the cerebellum. By lifting up the medulla oblongata, the depression or valley between the two hemispheres of the cerebellum will be partly exposed. There will also be visible the inferior surface of the middle lobe, or inferior vermiform process, that portion of the cerebellum which forms the roof of the fourth ventricle; projecting beyond the medulla oblongata is the posterior extremity of the inferior vermiform process of the cerebellum, called the tuber valvulæ.

Next examine the roots of the cranial nerves from before backward in the order in which they are named.

THE ORIGINS OF THE CRANIAL NERVES.

The **First Cranial** or **Olfactory Nerve** is devoted to the special sense of smell; it is seen upon the base of the brain as the olfactory tract and bulb; in reality, the olfactory bulbs and tracts represent a portion of the brain, and are more highly developed in certain of the lower animals. The olfactory

nerves proper, about twenty in number, which arise from the olfactory bulbs, have been divided in removing the brain from the skull. The olfactory tract arises by two so-called roots, an external and an internal. The external or long root, composed of white matter, crosses the anterior perforated space to the anterior end of the hippocampal gyrus of the temporo-sphenoid lobe; and the inner or mesial root, also composed of white matter, passes backward and inward to the anterior extremity of the gyrus fornicatus. Between these two diverging roots is a small triangular area of gray matter (trigonum olfactorium), which receives a few fibers from the olfactory tract; when these fibers are conspicuous, they form what is sometimes called the middle or gray root. The tract thus formed is lodged in the olfactory sulcus of the cerebrum, and is surrounded at the anterior extremity by a small rounded mass of gray matter, the olfactory bulb.

The **Second Cranial** or **Optic Nerve,** which also represents a portion of the brain, is the nerve of vision, and arises from the optic commissure, which is formed by the union of the optic tracts. The optic tracts arise from the corpora geniculata, the nates of the corpora quadrigemina, and the optic thalami. Each tract is composed of three sets of fibers,—an outer, a middle, and an inner,—which have the following arrangement: the outer set passes directly to the optic nerve of the same side, the middle set to the optic nerve of the opposite side, and the inner set to the optic tract of the opposite side. On account of the course of the nerve-fibers from the optic tracts to the nerves a lesion of one optic tract causes **hemianopsia,** or obliteration of vision in the corresponding halves of both eyes: as, for example, a lesion of the left optic tract causes loss of vision in the left half of both eyes.

The **Third Cranial** or **Oculo-motor Nerve** arises superficially from a groove on the inner side of the crus cerebri, just anterior to the pons, and deeply from a nucleus in the floor of the aqueduct of Sylvius. It is a motor nerve, and supplies all the muscles of the eyeball except the superior oblique, the external rectus, and radiating fibers of the iris.

The **Fourth Cranial, Pathetic,** or **Trochlear Nerve** is the smallest of the cranial nerves, and apparently arises at the outer side of the crus cerebri. Its real superficial origin is from the valve of Vieussens, or superior medullary velum, immediately behind the testes or posterior pair of corpora quadrigemina. The deep origin is from a nucleus in the floor of the aqueduct of Sylvius in close relation with the nucleus of the oculo-motor nerve. In the substance of the valve of Vieussens it decussates with the opposite fourth cranial nerve. It then winds around the outer side of the crus cerebri, and appears at the base of the brain at the anterior border of the pons. It is a motor nerve, and supplies the superior oblique or trochlearis muscle.

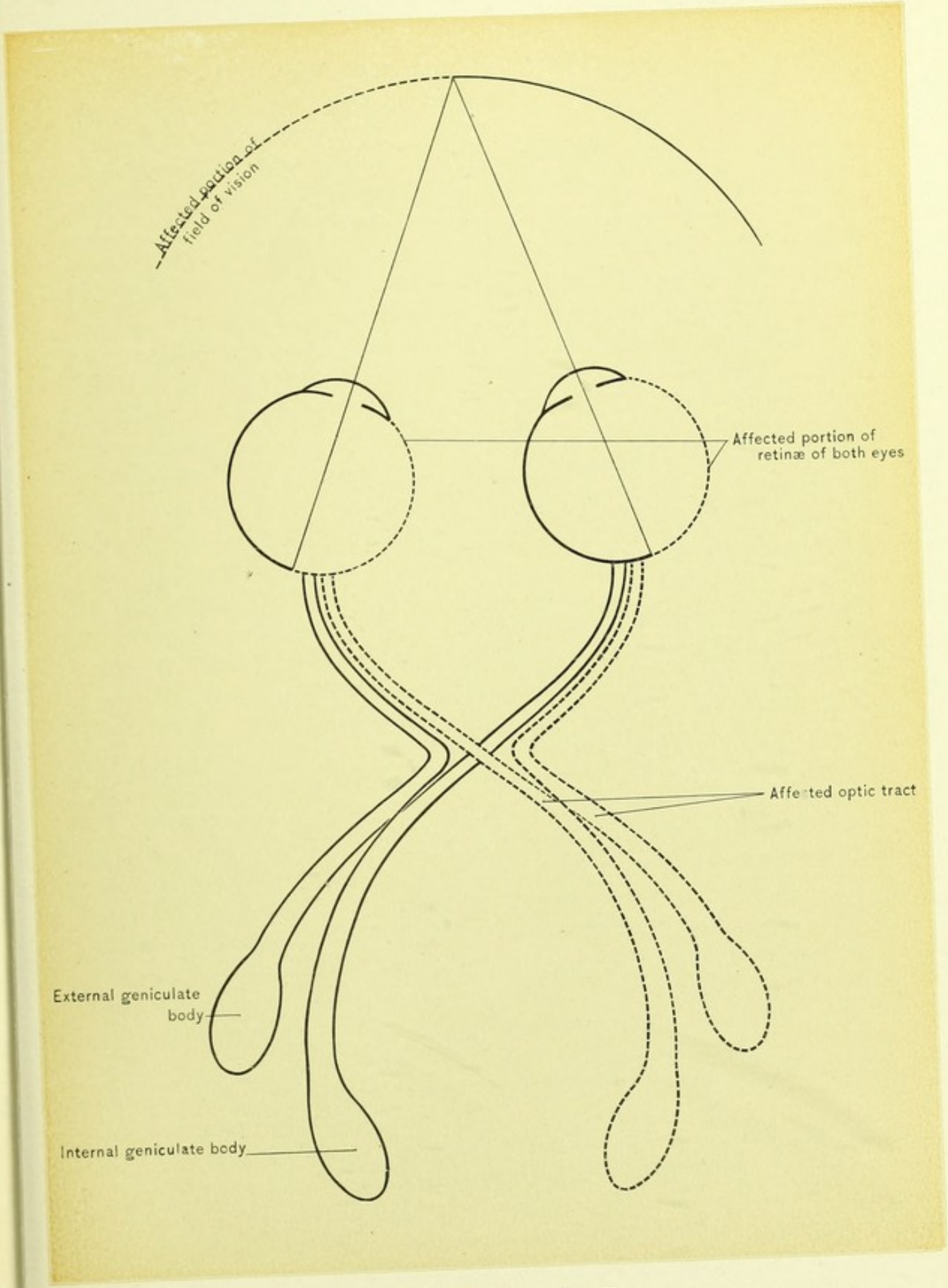


DIAGRAM OF OPTIC TRACTS.

The **Fifth Cranial, Trigeminus,** or **Trifacial Nerve,** the largest of the cranial nerves, arises from the sides of the pons by two roots—a larger, posterior or sensory root, and a smaller, anterior or motor root. These roots can be traced to the floor of the fourth ventricle and to the gray matter in the lower part of the medulla oblongata and in the upper part of the spinal cord. It is the only cranial nerve which resembles a spinal nerve in arising by two roots,—a posterior, or sensory, and an anterior, or motor,—and in having a ganglion on the posterior root. The trifacial is a mixed nerve. It distributes sensory filaments to the dura mater, pia mater, orbit, eyelids, nose, gums, teeth, tonsils, palate, sphenoid cells, ethmoid cells, frontal sinus, maxillary sinus, nasal fossæ, pharynx, articulation of the lower jaw, ear, parotid gland, scalp, forehead, and face; gustatory filaments to the anterior two-thirds of the tongue; and motor filaments to four of the muscles of mastication—the temporal, masseter, and the external and internal pterygoids.

The **Sixth Cranial** or **Abducent Nerve** arises superficially from the anterior pyramid of the medulla oblongata and the interval between the anterior pyramid and the olive, close to the lower margin of the pons. Its deep origin is from the floor of the fourth ventricle. It is a motor nerve, and supplies the external rectus muscle of the eyeball.

The **Seventh Cranial** or **Facial Nerve** arises as two portions. The *pars intermedia of Wrisberg* arises deeply from the forepart of the nucleus of the ninth cranial nerve, in the floor of the fourth ventricle. Its superficial origin is at the lower border of the pons, external to the facial nerve proper and between the olivary and restiform bodies. The pars intermedia of Wrisberg is considered a portion of the glosso-pharyngeal or ninth cranial nerve, its nucleus being continuous with that of the ninth cranial nerve. Its fibers are believed to enter the chorda tympani nerve. Thus, all of the special sensory fibers to the tongue are derived from the glosso-pharyngeal nerve. The *facial nerve proper* has its deep origin in the floor of the fourth ventricle, its fibers winding around the nucleus of the sixth cranial nerve. It arises superficially from the medulla oblongata in the groove between the olivary and restiform bodies. The facial is a motor nerve, its range of distribution is large, and its connections with other nerves are numerous. It supplies the stapedius muscle, gives off the chorda tympani nerve, the posterior auricular nerve, the nerve to the posterior belly of the digastric, and a branch to the stylohyoid muscle. In addition it supplies the muscles of expression and the buccinator muscle.

The **Eighth Cranial** or **Auditory Nerve,** situated immediately beneath or external to the facial, is really two nerves, and arises deeply from three nuclei,—Deiters', the accessory, and the chief nucleus,—which are all situated in the medulla oblongata. From these nuclei two roots arise which embrace the restiform

body, the lateral root arising principally from the accessory nucleus, and the mesial root from the chief nucleus and Deiters' nucleus. Its superficial origin is external to that of the facial nerve—from the groove between the olivary and restiform bodies of the medulla oblongata. From the close relation between the facial and auditory nerves at their exit from the side of the medulla oblongata, they have been described as two separate portions of the seventh cranial nerve, and on account of their difference in consistency, the facial portion was called the portio dura and the auditory portion the portio mollis. The auditory nerve is the nerve of the special sense of hearing, and supplies the internal ear. The lateral root is continued into the cochlear nerve, supplies the cochlea, and is the nerve of the sense of hearing. The mesial root is known as the vestibular nerve and supplies the vestibule and semicircular canals; it is associated with maintenance of equilibrium of the body.

The **Ninth Cranial** or **Glosso-pharyngeal Nerve** arises from the floor of the fourth ventricle in common with the pneumogastric nerve and the accessory portion of the spinal accessory nerve. It emerges from the same groove in the medulla oblongata as the facial and auditory nerves, but below them. It is distributed to the tympanum, the stylo-pharyngeus muscle, the mucous membrane of the pharynx, the tonsil, and the back of the tongue. The glosso-pharyngeal is a sensory and motor nerve, as well as the nerve of the special sense of taste, as it supplies the circumvallate papillæ at the back of the tongue.

The **Tenth Cranial** or **Pneumogastric Nerve** (nervus vagus or par vagum), the longest of the cranial nerves, commences within the cranium, extends through the neck and chest, and terminates in the upper part of the abdomen. It arises deeply from the floor of the fourth ventricle, and superficially from the side of the medulla oblongata by ten or fifteen filaments, which emerge from the medulla oblongata through the groove between the lateral column and the restiform body and below the glosso-pharyngeal nerve. The pneumogastric nerve contains both motor and sensory fibers. It supplies the dura mater, the external ear, the pharynx, the larynx, the esophagus, the trachea, the lungs, the heart, and some abdominal viscera—viz., the liver and stomach.

The **Eleventh Cranial** or **Spinal Accessory Nerve** consists of two portions—an upper or accessory, and a lower or spinal. The **accessory portion,** the smaller, arises deeply from the floor of the fourth ventricle in common with the ninth and tenth cranial nerves. Superficially, it arises by fine filaments from the side of the medulla oblongata below the origin of the pneumogastric nerve, and emerges with it through the same groove. The **spinal portion,** the larger, arises by several filaments from the side of the spinal cord, between the ligamentum denticulatum and the posterior roots of the spinal nerves as low down as

the sixth cervical nerve. It gains entrance to the cranial cavity by way of the foramen magnum of the occipital bone, and passes out through the middle compartment of the jugular or posterior lacerated foramen. In the latter situation the accessory portion leaves it to join the ganglion of the trunk of the vagus. The spinal accessory is a sensori-motor nerve, and supplies the sterno-mastoid and trapezius muscles.

The **Twelfth Cranial** or **Hypoglossal Nerve** arises superficially from the side of the medulla oblongata by several filaments which emerge through the groove between the anterior pyramid and the olivary body; its deep origin is from the posterior portion of the floor of the fourth ventricle. The filaments of this nerve are collected into two bundles which perforate the dura mater separately before passing through the anterior condyloid foramen, in which they unite to form the trunk of the nerve. The hypoglossal is a motor nerve. It supplies the extrinsic muscles of the tongue—viz., the genio-hyo-glossus, hyo-glossus, and the stylo-glossus. Through fibers derived from the pneumogastric and sympathetic nerves it supplies a meningeal branch to the dura mater, and through fibers derived from the second and third cervical nerves it supplies motor branches to the genio-hyoid, sterno-hyoid, sterno-thyroid, omo-hyoid, and thyro-hyoid muscles.

THE CEREBRUM.

The brain is now laid on its base and the upper surface examined. This surface is formed entirely by the cerebrum, and is seen to consist of two halves, called hemispheres, which are separated from each other in the median line by the longitudinal fissure. This is one of the two largest fissures of the brain, the other being the horizontal fissure.

The Longitudinal Fissure.—By gently separating the hemispheres the longitudinal fissure will be seen to reach the base of the brain both in front and behind, while the intervening portion is rendered more shallow by a transverse band of white matter, the *corpus callosum*, which may therefore be said to form its floor. Running through the bottom of the fissure from before backward, and over the superior surface of the corpus callosum, are the anterior cerebral arteries; this fissure also lodges the falx cerebri and its contained sinuses, the superior and the inferior longitudinal.

The Horizontal Fissure.—The posterior ends of the hemispheres of the cerebrum are separated from the cerebellum by the horizontal fissure, the deep central or purely intra-cerebral portion of which is known as the *transverse fissure* or the *fissure of Bichat*. The horizontal fissure accommodates the tentorium cerebelli and its contained sinuses,—the straight, the lateral, and the superior petrosal,—while

the deep portion, or the transverse fissure, transmits the pia mater into the interior of the cerebrum, where that membrane forms the velum interpositum.

Convolutions and Fissures.—The surfaces of the hemispheres of the cerebrum are composed of convolutions or gyri—elevations of gray matter which are separated by fissures or sulci. The greater the development of the hemisphere, the more numerous are the fissures and convolutions, as the increased depth and number of the fissures afford additional area to be covered with gray matter. In studying the fissures and convolutions from the fresh brain for the first time, that of a new-born child answers best, as the arrangement of these structures is somewhat simpler and agrees better with the description of the brain given in text-books.

Dissection.—Before studying the component parts of the brain by making sections, it is better carefully to study the surface anatomy of the hemispheres of the cerebrum. This entails separating the cerebrum from the remaining divisions of the brain and carrying an incision from the bottom of the longitudinal fissure through the median line of the corpus callosum and the structures in the median line of the cerebrum under the corpus callosum; this renders it possible to examine the three surfaces of each hemisphere of the cerebrum to the best advantage. To separate the cerebrum from the remainder of the brain, it is necessary to divide the crura cerebri and superior peduncles of the cerebellum, the latter being exposed by lifting up the posterior lobes of the cerebrum. In order to do this, and also to obtain the best idea of the topographic relations of the different parts of the brain, the dissector should have at least two good brains at his disposal.

Variations.—The two hemispheres of the cerebrum are not always the same in size, the left being usually the larger. This is supposed to be due to the fact that the blood supply of this side of the brain is more direct, as the left common carotid, and also the left subclavian artery, which gives origin to the vertebral, arise directly from the arch of the aorta.

Surfaces.—Each hemisphere of the cerebrum presents three surfaces; an outer,—convex or lateral,—an inner or median, and an inferior or basilar. The basilar surface rests in the anterior and middle cranial fossæ and upon the tentorium cerebelli.

Arrangement of the Convolutions.—As has been noted, the surfaces of the hemispheres of the cerebrum are composed of gray matter arranged in folds, elevations, convolutions, or gyri; these, in turn, are separated by furrows, fissures, valleys, or sulci varying in length, depth, and importance. As Ecker well states, the chief or primary convolutions are like great mountain chains whose direction lends to a region its characteristic features. The secondary folds originate by the splitting of a primary convolution into smaller ones by the formation of longitudinal furrows, as secondary mountain ridges arise from the forma-

tion of longitudinal valleys. The deepest fissures, which separate the principal convolutions from each other, may be named the primary; those which separate the secondary convolutions from each other, the secondary; and, finally, the tertiary convolutions are those little gyri which jut out into the primary fissures from the sides of the principal convolutions, and, therefore, give to the bottom of the fissure a zigzag route. While the features of the principal convolutions are always arranged with considerable uniformity, numerous variations exist in the arrangement of the secondary and tertiary convolutions. There are several reasons for this: one is that there are sometimes only a few secondary fissures, while in other cases there are quite a number; again, in some cases tertiary convolutions which are ordinarily invisible come to the surface; while in others, convolutions which are usually superficial sink deeper; in the former case the fissures are bridged over, and in the latter new convolutions exist in places where there usually is none. The general arrangement of the fissures and convolutions of the two hemispheres is moderately symmetric, yet slight differences always occur.

The **Cerebral Fissures,** besides being classified as primary and secondary fissures, are subdivided into complete and incomplete fissures. *Complete fissures* extend through almost the entire thickness of the cerebrum, thus producing elevations in the lateral ventricles; examples of such fissures are the hippocampal and portions of the collateral and calcarine fissures. *Incomplete fissures* are furrows of variable depth which do not cause protrusions in the ventricles.

It is by means of the convolutions and fissures of the brain that the amount of the gray matter is greatly increased, without unduly augmenting the size of the brain; furthermore, the pia mater is thus enormously increased in extent, because it follows the windings of the gyri and fissures, and its vessels, which supply the cortex, are enabled to break up into fine branches before penetrating the brain tissue.

Lobes.—Each hemisphere of the cerebrum is incompletely divided by the deeper, and therefore the more important, of the fissures into the following parts, or lobes: the frontal, the parietal, the temporal or temporo-sphenoid, and the occipital. In addition to these four lobes there is a fifth lobe—the central lobe, or island of Reil; but as this projects into the bottom of the fissure of Sylvius, and can not be seen without drawing apart the sides of the latter, it will be described with the fissures. The individual lobes are distinct from each other on certain surfaces only, while on other surfaces they run into each other, and are without definite boundaries. The fissures are the landmarks which guide us in mapping out the hemispheres into districts, or lobes, and also in locating the individual convolutions. Hence our first task in the study of the surfaces of the hemispheres of the cerebrum is to locate the principal fissures.

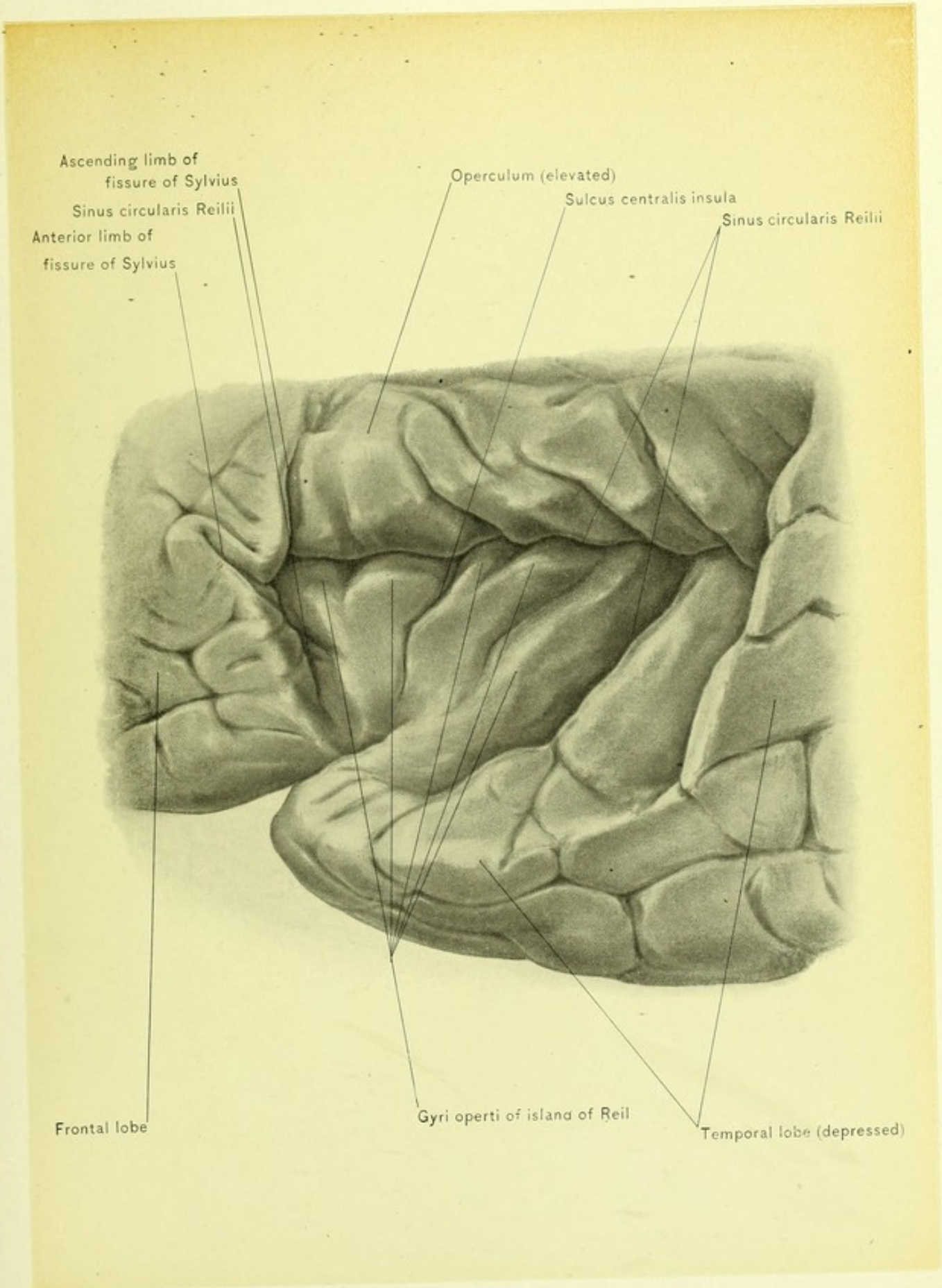
The **Primary Fissures of the Cerebrum** are, in the order of their importance, the fissure of Rolando or the sulcus centralis, the fissure of Sylvius, and the parieto-occipital fissure. The fissure of Sylvius is found partly on the inferior, or basilar, and chiefly on the outer, convex, or lateral surface of the cerebrum; the fissure of Rolando, or sulcus centralis, only on the lateral surface of the cerebrum; and the parieto-occipital fissure, chiefly on the median or inner surface, and slightly on the outer surface of the cerebrum.

The **fissure of Sylvius,** within which is lodged the lesser wing of the sphenoid bone, and through which passes the middle cerebral artery, commences on the basilar surface of the hemisphere of the cerebrum, at the anterior perforated space, in a depression called the *vallecula Sylvii.* Thence it extends outward to the external convex surface of the cerebrum, where it divides into two limbs: an ascending or vertical and a posterior or horizontal, which runs backward and upward to end in the parietal lobe. The *main portion* of the fissure is that which occupies the base of the brain. The *ascending limb* passes upward for about one inch, or twenty-five millimeters, into the frontal lobe in front of the precentral fissure, and is separated from the latter by the posterior part of the inferior or third frontal convolution, which arches around the end of the ascending limb. Immediately in advance of the ascending limb there runs forward and upward from the main portion of the fissure a third limb, the *anterior limb.* This limb, which is nearly of the same length as the ascending limb, runs directly forward into the substance of the inferior frontal convolution.

The **island of Reil,** or the **central lobe,** is seen in the bottom of the fissure of Sylvius at the angle of separation of the ascending and horizontal limbs by drawing widely apart the sides of the horizontal limb of the fissure of Sylvius and lifting the operculum. It comprises a series of from five to seven small convolutions, surrounded by a limiting sulcus (*sulcus circularis Reilii*). The convolutions of this lobe are arranged so that they radiate from the apex, which looks downward and forward. A fissure, the *sulcus centralis Reilii,* running in about the same direction as the fissure of Rolando, divides it into an anterior and a posterior portion. Additional smaller fissures are seen between the convolutions of the island of Reil.

The **operculum** is that portion of the hemisphere of the cerebrum formed by the base of the inferior frontal convolution, the lower end of the ascending frontal and lower part of the ascending parietal convolution, and therefore immediately overhangs the island of Reil. The latter is external to the corpus striatum, and its fissures accommodate some of the branches of the middle cerebral artery.

Calloso-marginal Fissure.—Before attempting to trace the course of the fissure of Rolando, examine the inner surface of the hemisphere of the cerebrum and locate a secondary fissure running above the corpus callosum. It lies midway



ISLAND OF REIL.

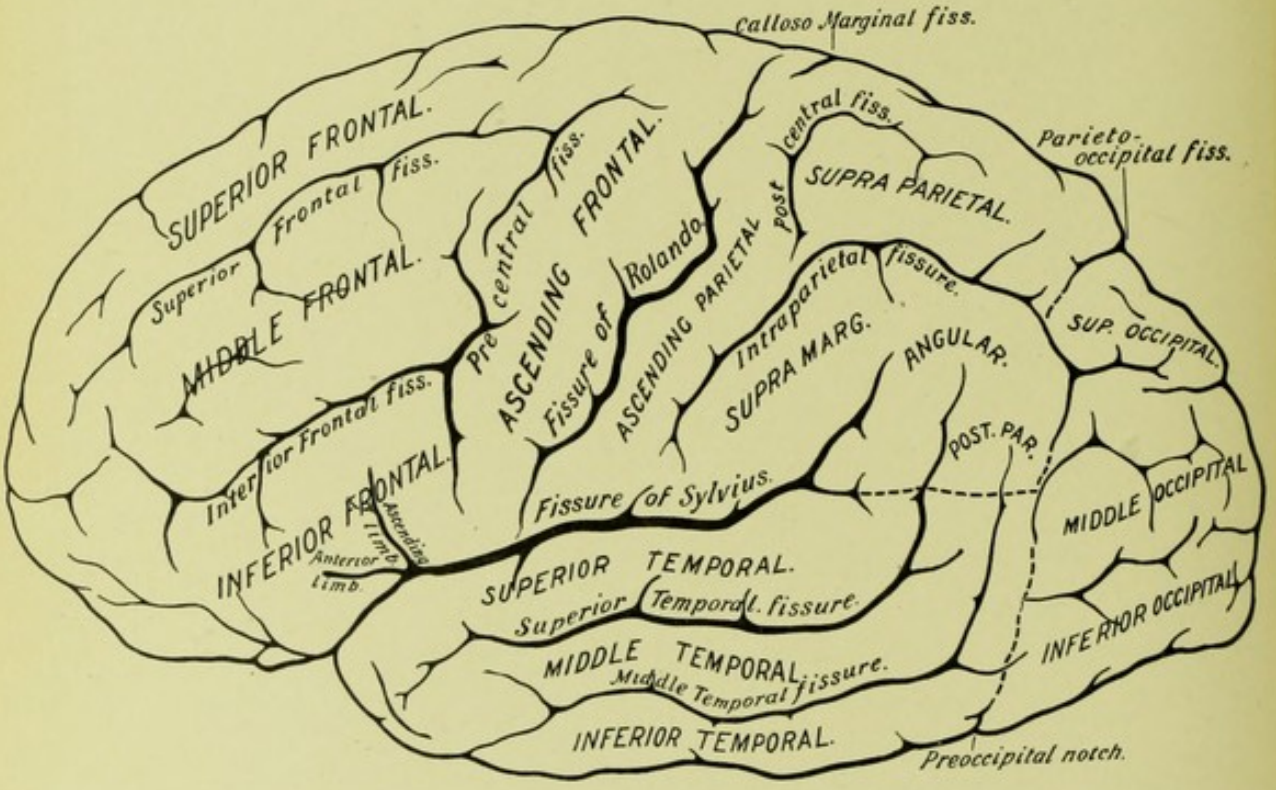


DIAGRAM OF LATERAL SURFACE OF CEREBRUM.

between the upper surface of the latter and the upper border of the hemisphere, and terminates upon the external surface of the hemisphere near this border and almost opposite the posterior end of the corpus callosum. This is the calloso-marginal fissure.

The **fissure of Rolando,** or **central fissure,** is the most important of the three primary fissures of the brain, both from the surgical and descriptive standpoints. It runs through the motor area of the cortex of the cerebrum, upon which so many operations have been performed in recent years. It commences at the upper border of the hemisphere of the cerebrum just external to the longitudinal fissure and immediately in front of the terminal part of the calloso-marginal fissure. From here it runs obliquely downward and forward over the outer surface of the hemisphere at an angle with the anterior part of the longitudinal fissure of about 71.5 degrees, terminating a slight distance above the horizontal limb and about one inch, or twenty-five millimeters, behind the ascending limb of the fissure of Sylvius. The calloso-marginal fissure is very rarely bridged over by a secondary convolution, and, therefore, there should be no difficulty in locating it. The fissure of Rolando presents two more or less distinct bends, called its genua ; the superior genu, located at the junction of its middle third and upper third, has its convexity projecting backward ; the inferior genu is somewhat nearer the lower extremity of the fissure, and its convexity points forward. In proportion as the frontal lobes increase in size and the brain in general attains higher development the fissure runs more obliquely backward (Ecker).

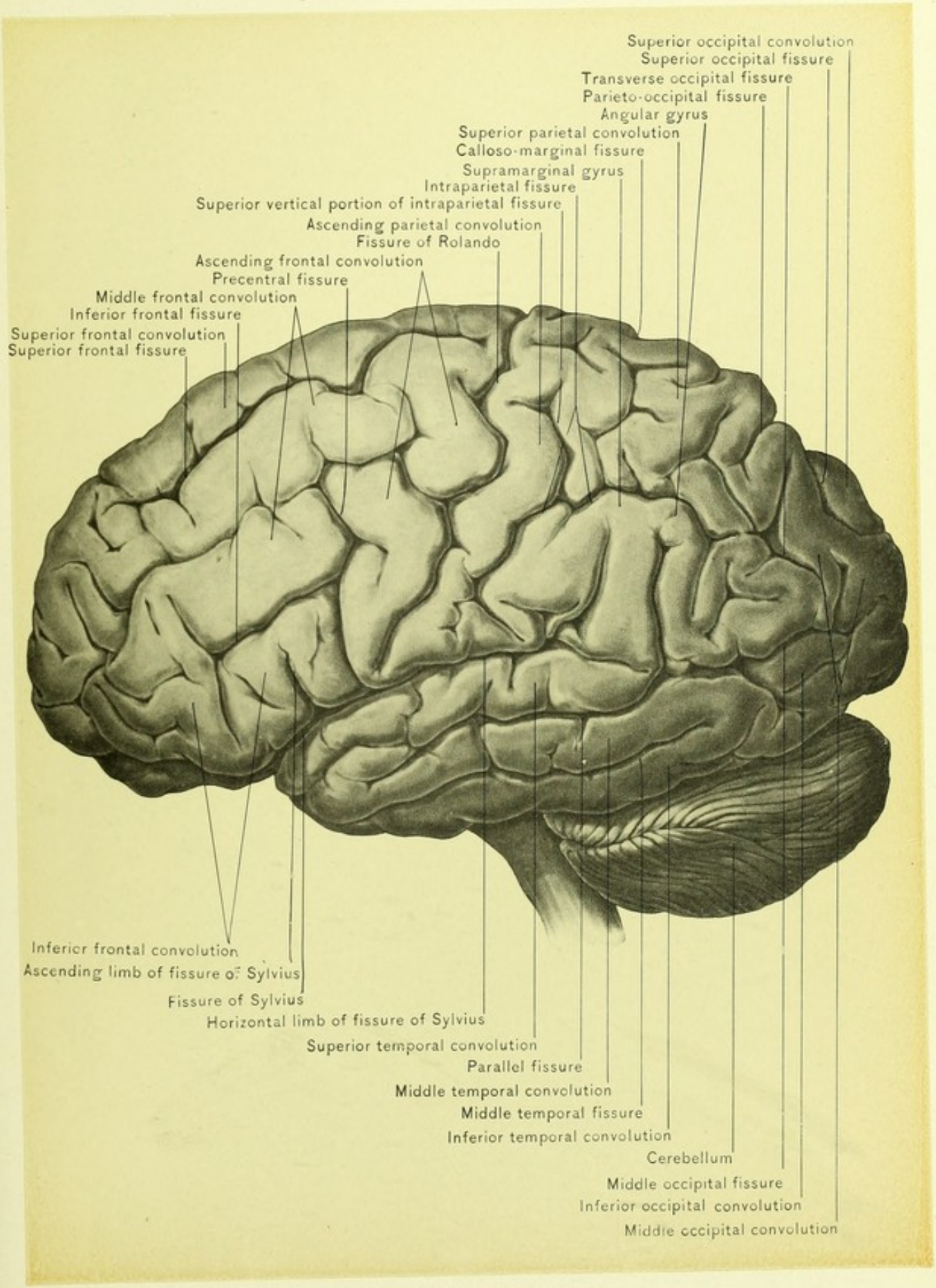
The **parieto-occipital fissure,** the smallest of the three primary fissures of the cerebrum, commences on the median surface of the hemisphere of the cerebrum about one and one-half inches, or thirty-seven millimeters, behind the corpus callosum. It begins on the inferior occipito-temporal surface at the junction of the apex of the lingual lobule with the isthmus of the gyrus fornicatus, and runs backward and upward to reach the upper border of the hemisphere ; thence it runs outward and forward on the external or convex surface for about one inch, or twenty-five millimeters, and midway between the fissure of Rolando and the posterior extremity of the cerebrum. It is joined by a secondary fissure, the *calcarine,* the direction of which is nearly horizontal. The fissure may be said to consist of two portions, a median and a lateral, found respectively on the median and external surfaces of the cerebrum. The first occipital convolution arches around the end of the lateral portion of the fissure. The lateral portion of the parieto-occipital fissure is not always well marked, often appearing merely as a slight indentation upon the outer or convex surface of the hemisphere, while the median portion of the fissure is uniformly well developed.

The **Frontal Lobe,** the largest of the cerebral lobes, includes that portion of

the hemisphere of the cerebrum in front of and above the main portion of the fissure of Sylvius, and that portion in front of the fissure of Rolando; upon the inner surface it includes the corresponding portion of the hemisphere above the calloso-marginal fissure. There is generally no line of demarcation between the frontal and parietal lobes upon the mesial surface of the hemisphere, but extension of the fissure of Rolando into the longitudinal fissure (a condition sometimes existing) designates the posterior limit of the frontal lobe on this surface.

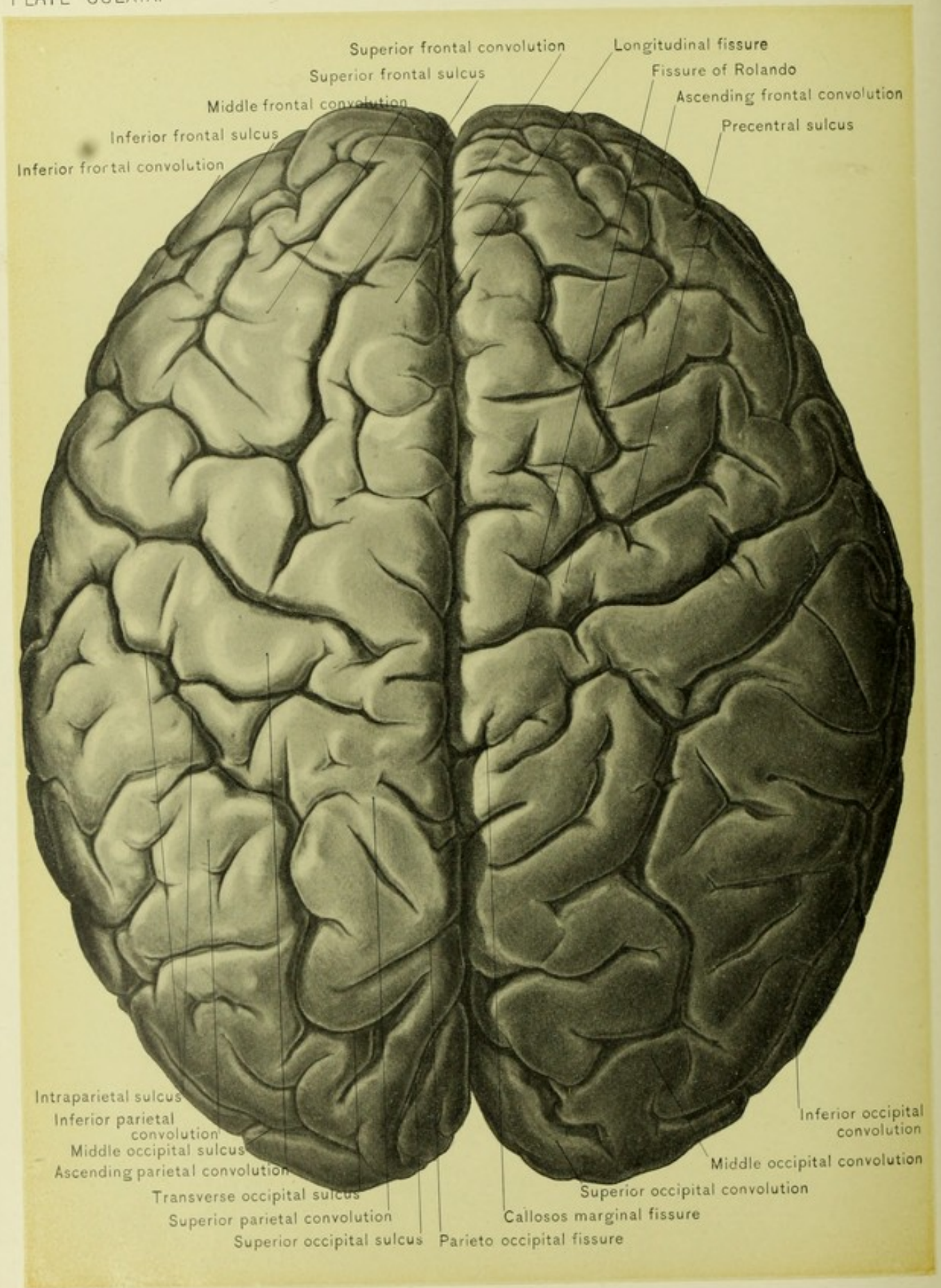
The **Parietal Lobe** includes that portion of the lateral surface of the hemisphere of the cerebrum above the horizontal limb of the fissure of Sylvius, and a line representing the extension of the same limb backward to meet the posterior boundary of the lobe; also behind the fissure of Rolando and in front of the lateral portion of the parieto-occipital fissure. Upon the inner surface it includes that part of the hemisphere in front of the mesial portion of the parieto-occipital fissure; it is unlimited in front on this surface for want of a line of demarcation between it and the frontal lobe, but, as previously stated, by extending the fissure of Rolando into the longitudinal fissure, its anterior superior limit would be represented. The parietal lobe is only partly separated behind from the occipital lobe, by the lateral portion of the parieto-occipital fissure and the transverse occipital fissure; the latter is a secondary fissure which is not always present. From the temporo-sphenoid lobe, below, there is no attempt at complete separation. At the lower margin of the lateral surface of the hemisphere of the cerebrum, between the occipital and temporo-sphenoid lobes, is the *preoccipital notch* produced by the impression of the veins which enter the lateral sinus. If a line be drawn to this notch from the extremity of the lateral portion of the parieto-occipital fissure, the upper part of this line, with the lateral portion of the fissure, will about represent the junction of the parietal and occipital lobes. The lower part of the line will represent the line of junction of the occipital and temporo-sphenoid lobes. This notch must not be confounded with another impression, sometimes described as the preoccipital notch, produced by the superior border of the petrous portion of the temporal bone (Brooks).

The **Occipital Lobe** includes that portion of the convex surface of the hemisphere of the cerebrum behind the lateral portion of the parieto-occipital fissure, and a line connecting the extremity of this fissure with the preoccipital notch. Upon the inner surface of the hemisphere it includes that part behind the mesial portion of the parieto-occipital fissure. Upon the basilar surface there is no line of demarcation between it and the temporo-sphenoid lobe. The inferior surface of this lobe will be described with the same surface of the temporo-sphenoid, as two of the most important secondary fissures here seen occupy both of these lobes, and extend without breach of continuity from one to the other.



EXTERNAL SURFACE OF CEREBRUM.

PLATE CCLXIX.



SUPERIOR SURFACE OF CEREBRUM.

The **Temporal** or **Temporo-sphenoid Lobe** comprises that portion of the lateral surface of the hemisphere of the cerebrum below the horizontal limb of the fissure of Sylvius, and a line representing its continuation backward, and in front of the lower part of the line connecting the preoccipital notch with the extremity of the lateral portion of the parieto-occipital fissure. Upon the inferior surface of the cerebral hemisphere it lies immediately behind the main portion of the fissure of Sylvius; it is not separated on this surface from the occipital lobe. A line drawn from the preoccipital notch to the isthmus of the gyrus fornicatus marks the line of union of the temporo-sphenoid and occipital lobes (Brooks).

The **Island of Reil,** or the fifth lobe of the cerebrum, is described with the fissure of Sylvius.

The arrangement of the primary fissures and the boundaries of the lobes of the cerebral hemispheres having been given, the description of the secondary fissures and convolutions naturally follows. Secondary convolutions frequently bridge these secondary fissures, making it difficult to trace them.

The **Frontal Lobe** is situated in the angle between the vertical and the horizontal plates of the frontal bone, and extends backward beyond the coronal suture. It is that portion of the hemisphere in front of the fissure of Rolando, and above the anterior part of the horizontal limb of the fissure of Sylvius. Like the cerebral hemisphere, it has three surfaces: a lateral or convex, an inferior or basilar, and an inner or mesial. Upon the lateral surface are three secondary fissures: the superior and the inferior frontal, the direction of which is horizontal, and the precentral or transverse, whose direction is vertical. The ascending and the anterior limbs of the fissure of Sylvius are also in relation with it. The superior and inferior frontal fissures run parallel with the longitudinal, and the precentral follows a course nearly parallel with that of the lower half of the fissure of Rolando.

The **superior frontal fissure** commences a short distance in front of the fissure of Rolando, and runs forward and downward parallel with the longitudinal fissure, the gyrus included between the longitudinal fissure and superior frontal fissure being the first or superior frontal convolution.

The **inferior frontal fissure** usually commences in the precentral fissure, but sometimes in front of it, and runs forward and downward about midway between the superior frontal fissure and the lower border of the frontal lobe. Between the superior and the inferior frontal fissure lies the middle or second frontal convolution, and between the inferior frontal fissure and the lower margin of the lobe the inferior frontal convolution is situated.

The **precentral fissure** lies in front of and parallel with the fissure of

Rolando; its lower end is between the latter fissure and the ascending limb of the fissure of Sylvius. This fissure usually consists of two parts, a superior and an inferior precentral fissure, the former of which is, as a rule, continuous with the superior frontal fissure, and the inferior at times with the inferior frontal fissure.

The **ascending frontal convolution** is situated between the precentral fissure and the fissure of Rolando, and extends along the entire anterior border of the latter fissure. This convolution is continuous with the ascending parietal convolution around both ends of the fissure of Rolando, immediately behind which the latter convolution is situated.

The **superior** or **first frontal convolution** is continuous posteriorly with the ascending frontal, internally with the marginal, and anteriorly upon the basilar surface with the gyrus rectus and the internal and anterior orbital convolutions.

The **middle** or **second frontal convolution** is continuous in front with the anterior orbital convolution and the anterior extremities of the superior and inferior frontal convolutions. Posteriorly, it frequently bridges the precentral fissure, and joins the ascending frontal convolution. .

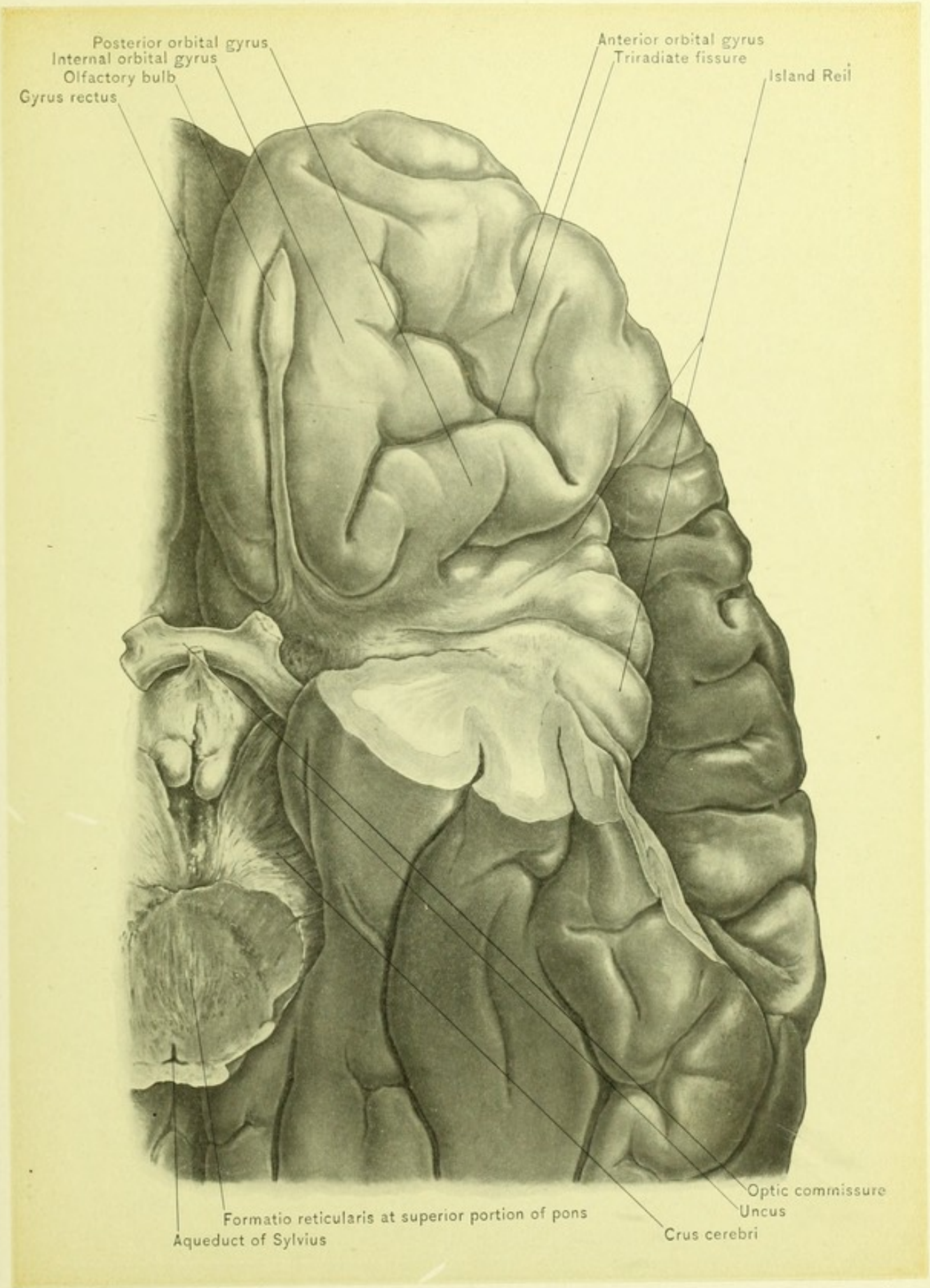
The **inferior** or **third frontal convolution** is continuous behind with the ascending frontal convolution, and in front, upon the inferior or basilar surface, with the anterior and posterior orbital convolutions. Through the medium of the anterior and ascending limbs of the fissure of Sylvius, both of which extend into this convolution, it is divided into three parts: namely, that in front of the anterior limb, the pars orbitalis; that between the anterior and the ascending limb, the pars triangularis (base of triangle looks upward); and that behind the ascending limb, the pars basilaris (Brooks). This convolution, as before mentioned, assists in the formation of the operculum.

The **inferior** or **orbital surface** of the frontal lobe is triangular in shape; the base, directed backward, is formed by the anterior perforated space and the main portion of the fissure of Sylvius. The apex is directed forward, and is formed by the curving of the convolutions in passing from the convex to the orbital surface. The sides are formed by the longitudinal fissure and the lower border of the hemisphere. On this surface are two secondary fissures, the olfactory and the orbital.

The **olfactory fissure** runs parallel with the longitudinal fissure and a short distance external to it. It lodges the olfactory tract and bulb.

The **orbital** or **triradiate fissure** is situated about the middle of the portion of this surface, which lies external to the olfactory fissure. It consists of a main portion, which is directed forward and runs nearly parallel with the olfactory fissure, and of two branches, one directed backward and inward, and the other outward.

The **gyrus rectus** is situated between the olfactory and longitudinal fissures.



INFERIOR SURFACE OF FRONTAL LOBE.

It is continuous in front with the superior or first frontal convolution, and internally with the marginal convolution.

The **internal, anterior,** and **posterior orbital gyri** are located between the branches of the triradiate fissure, and are named from their relation to the branches of the fissure. They are continuous respectively with the first, second, and third frontal convolutions.

Inner surface of the frontal lobe.—Upon this surface are tertiary fissures, the chief of which runs for some distance parallel with the calloso-marginal fissure, and partly divides the convolution of this surface into two portions.

The **marginal gyrus** lies between the calloso-marginal fissure and the upper and anterior margin of the hemisphere of the cerebrum. This convolution commences below the rostrum of the corpus callosum at the anterior perforated space, and extends upward and backward between the calloso-marginal fissure and the margin of the hemisphere, as far as a line which represents the continuation of the precentral fissure into the longitudinal fissure. It is continuous along the margin of the hemisphere with the superior or first frontal convolution.

The **Parietal Lobe** is that portion of the hemisphere situated behind the fissure of Rolando, above the horizontal limb of the fissure of Sylvius, and in front of the lateral limb of the parieto-occipital fissure. The portion of the lobe below the lateral limb of the parieto-occipital fissure and beyond the termination of the horizontal limb of the fissure of Sylvius is continuous with the occipital lobe by means of *annectant gyri*. The limit of the parietal lobe behind is represented by the lateral limb of the parieto-occipital fissure, and a line previously described, which extends from the end of that fissure to the preoccipital notch. It presents two surfaces, a lateral or convex, and an inner or mesial.

Upon the *lateral surface* one and sometimes two chief secondary fissures are to be seen. When but one fissure is present, it is the intra-parietal, and when two fissures are present, they are the intra-parietal and the post-central.

The **intra-parietal fissure** commences above the horizontal limb of the fissure of Sylvius, a short distance behind the fissure of Rolando, and runs upward, parallel to the lower portion of the latter fissure; it then turns backward, runs nearly parallel with the longitudinal fissure, and terminates in the occipital lobe, most commonly in the transverse occipital fissure. The posterior portion of the horizontal part of the intra-parietal fissure is often separated from the main fissure by a bridging convolution.

The **post-central fissure,** when present, exists either as a continuation of the ascending limb of the intra-parietal fissure beyond the junction of the ascending with the horizontal limb, thus making the intra-parietal fissure T shaped, or it is entirely separated from the ascending limb of the intraparietal fissure. The

former is the arrangement more commonly seen. The post-central fissure runs parallel to the upper portion of the fissure of Rolando almost to the longitudinal fissure.

Convolutions.—Through the medium of the intra-parietal fissure or of the intra-parietal and post-central fissures the lateral surface of the parietal lobe is divided into three principal convolutions: the ascending parietal or post-central, the superior parietal, and the inferior parietal. The inferior parietal convolution is further subdivided into the supra-marginal and angular convolutions.

The **ascending parietal** or **post-central convolution** lies immediately behind the fissure of Rolando, in front of the ascending limb of the intra-parietal fissure, and the post-central fissure when present, and above the horizontal limb of the fissure of Sylvius. It is continuous with the ascending frontal convolution around the ends of the fissure of Rolando, and with the superior parietal convolution. It runs parallel with the ascending frontal convolution; its lower extremity extends to the horizontal limb of the fissure of Sylvius, forming the posterior part of the operculum; its upper extremity is limited by the longitudinal fissure, and, with the corresponding end of the ascending frontal convolution, forms the para-central lobule.

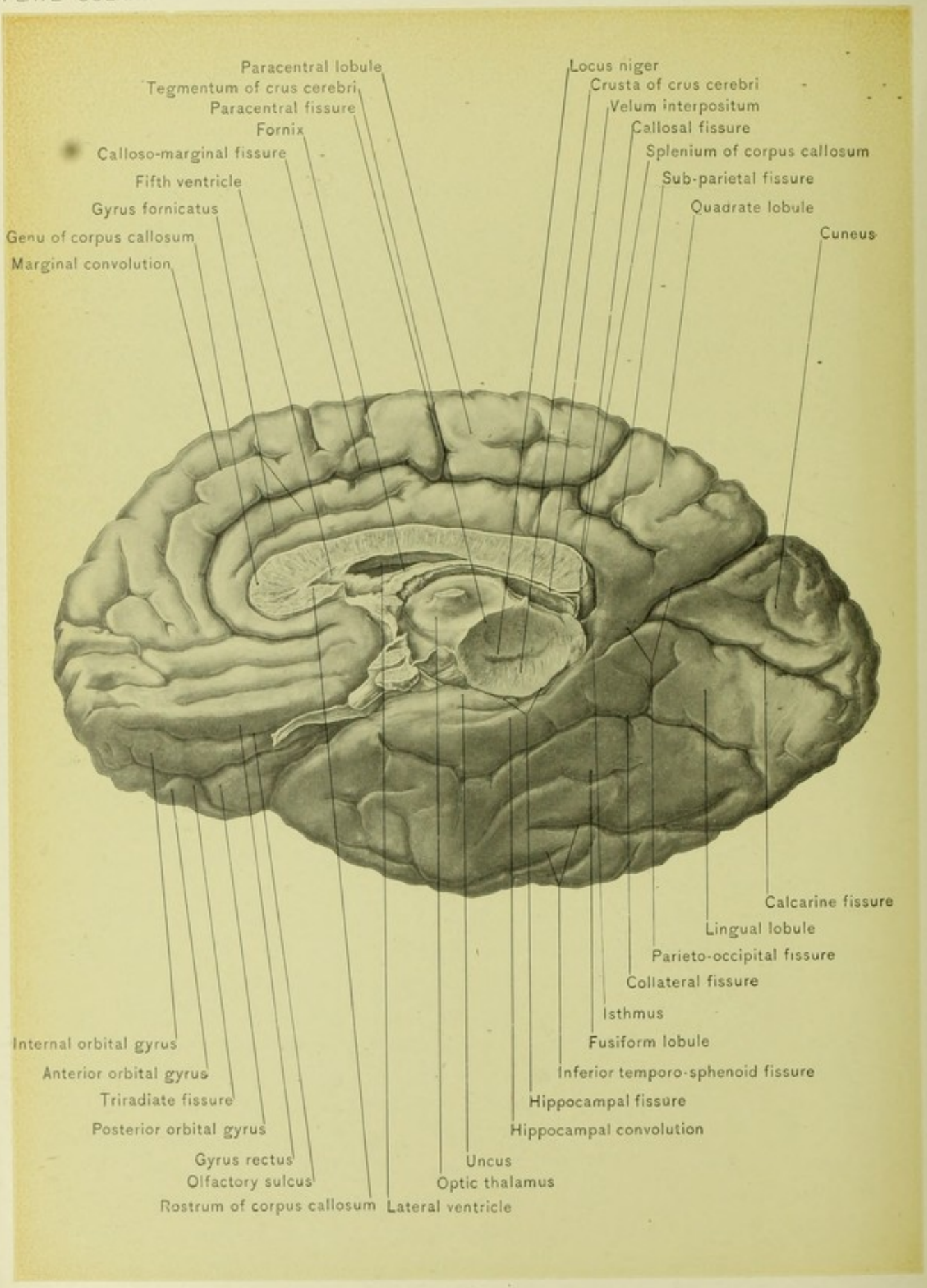
The **superior parietal convolution** lies behind the ascending parietal convolution, with which it is continuous. It is situated between the longitudinal fissure and the horizontal limb of the intra-parietal fissure, and extends posteriorly as far as the lateral portion of the parieto-occipital fissure. Around the extremity of this fissure it is continuous with the first occipital convolution through the medium of the first annectant gyrus. On the mesial aspect of the hemisphere it is continuous with the quadrate lobule or precuneus.

The **inferior parietal convolution** lies behind the ascending limb and below the horizontal limb of the intra-parietal fissure, and above the horizontal limb of the fissure of Sylvius. Posteriorly it is connected with the second occipital convolution by means of the second and third annectant gyri, and also with the superior temporal and the middle temporal convolution. It is subdivided into two convolutions, the supra-marginal and the angular.

The *supra-marginal convolution* includes the anterior portion of the inferior parietal as far as the posterior extremity of the horizontal limb of the fissure of Sylvius. It winds around this limb and becomes continuous with the superior temporal convolution and the angular convolution.

The *angular convolution* is the posterior portion of the inferior parietal convolution; it lies behind the terminal part of the horizontal limb of the fissure of Sylvius as it inclines upward. It winds around the posterior end of the superior temporal fissure, and becomes continuous with the second occipital convolution

PLATE CCLXXI.



MEDIAN AND INFERIOR SURFACES OF CEREBRUM.

through the medium of the second and third annectant gyri. It is also continuous with the middle temporal convolution.

The post-parietal convolution.—In some brains the middle temporo-sphenoid fissure terminates in the inferior parietal convolution, and with the fissure of Sylvius and the superior temporo-sphenoid, or parallel, fissure divides this convolution into three, as follows: that winding around the extremity of the horizontal limb of the fissure of Sylvius forms the supra-marginal gyrus; that around the posterior extremity of the superior temporo-sphenoid fissure, the angular gyrus; and that around the posterior extremity of the middle temporo-sphenoid fissure, the post-parietal gyrus. The last-mentioned convolution is continuous with the third occipital convolution (Heath).

Upon the inner or median surface of the parietal lobe the terminal part of the **calloso-marginal fissure,** one of the most important secondary fissures, is seen and is mentioned in describing the fissure of Rolando. This fissure commences below the anterior extremity, or rostrum, of the corpus callosum. Thence it runs parallel to, and a short distance above, the corpus callosum, from which it is separated by the convolution of the corpus callosum or gyrus fornicatus, to nearly opposite the posterior extremity or splenium of the corpus callosum. Here it turns upward and pursues a slightly backward course, terminating on the superior border of the hemisphere of the cerebrum, immediately posterior to the fissure of Rolando. The calloso-marginal fissure, particularly the anterior part, is frequently bridged over by small convolutions.

The **subparietal fissure** is a much smaller fissure, which commences at the point where the terminal portion of the calloso-marginal fissure begins to turn upward. For all practical purposes it may be considered the continuation backward of the main portion of the calloso-marginal fissure.

The **paracentral fissure,** not always present, is a small tertiary fissure running out of the main portion of the calloso-marginal, on a line with the anterior limit of the median end of the ascending frontal convolution. When present, it marks definitely the posterior limit of the marginal convolution.

Convolutions.—Through the medium of the calloso-marginal, paracentral, subparietal, and parieto-occipital fissures the inner surface of the parietal lobe is divided into two lobules or convolutions—the precuneus, or quadrate, and the paracentral, the former being posterior to the latter.

The **precuneus,** or **quadrate lobule,** lies between the median limb of the parieto-occipital and the terminal portion of the calloso-marginal fissure and above the subparietal fissure.

The **paracentral convolution** includes the median ends of the ascending parietal and ascending frontal convolutions. It lies immediately in front of the

terminal portion of the calloso-marginal fissure, above the horizontal portion of this fissure, and behind the paracentral fissure, or a line representing the extension of the precentral fissure of the frontal lobe into the longitudinal fissure.

The **Occipital Lobe** forms the posterior extremity of the hemisphere of the cerebrum, and is next to the smallest of the five divisions of the hemisphere of the cerebrum—the island of Reil being still smaller. It is triangular in shape, with its base directed forward and its apex backward ; it fills the superior fossa of the occipital bone, and rests upon the tentorium cerebelli. It presents three surfaces : a lateral or convex, an inner or mesial, and a tentorial or basilar surface. Owing to the absence of a distinct line of demarcation the lateral surface of the occipital lobe is continuous with the corresponding surface of the parietal and temporo-sphenoid lobes, and the basilar surface of this lobe with the corresponding surface of the temporo-sphenoid lobe. The inner surface of the occipital lobe is clearly marked off from the corresponding surface of the parietal lobe by the median limb or main portion of the parieto-occipital fissure. A line drawn from the extremity of the lateral limb of the parieto-occipital fissure over the external surface of the hemisphere to the preoccipital notch, and continued across the basilar surface to meet the end of the median limb of this fissure, will practically mark off the anterior limit of this lobe upon these two surfaces.

In studying the convolutions comprising the different lobes of the cerebrum, those of the occipital are the most difficult to understand. Upon the lateral surface of this lobe are three horizontal fissures, the superior, the middle, and the inferior occipital, with sometimes a fourth fissure, vertical in direction, and known as the transverse occipital fissure. The transverse and the superior occipital fissure, the least variable of the four fissures, are the most important in tracing the convolutions of this surface.

The **transverse occipital fissure,** into which the intra-parietal frequently opens, runs over the lateral surface of the lobe a short distance behind the terminal portion of the lateral limb of the parieto-occipital fissure.

The **superior occipital fissure** runs from before backward as though it were a continuation of the horizontal limb of the intra-parietal fissure.

The **middle occipital fissure** is seldom well developed, and extends from before backward.

The **inferior occipital fissure** is frequently interrupted by bridging convolutions, and runs from before backward along the line of junction of the lateral and basilar surfaces of the lobe.

Convolutions.—Through the medium of the superior, middle, and inferior occipital fissures the lateral surface of the occipital lobe is divided into the superior or first, the middle or second, and the inferior or third occipital convolution.

The **superior occipital convolution** lies between the longitudinal and superior occipital fissures, and commences at the posterior end of the superior parietal convolution, to which it is connected by the first annectant gyrus. It then winds around the extremity of the lateral limb of the parieto-occipital and the mesial end of the transverse occipital fissure, when present, and becomes continuous with the cuneus, a wedge-shaped lobule seen upon the inner surface of the lobe.

The **middle occipital convolution** lies between the superior and middle occipital fissures, and commences at the outer side of the intra-parietal fissure, and behind the angular gyrus, to which it is connected by the second and third annectant gyri.

The **inferior occipital convolution** lies between the middle and inferior occipital fissures, and is connected to the inferior or third temporo-sphenoid convolution by the fourth annectant gyrus.

Upon the inner surface of the occipital lobe there is but one secondary fissure, the calcarine, and one lobule, the cuneus.

The **calcarine fissure** commences, usually, by two branches close to the lower border of the posterior extremity of the hemisphere of the cerebrum, runs almost horizontally forward along the margin formed by the median and basilar surfaces of the hemisphere, and joins the parieto-occipital fissure at an acute angle behind and below the posterior extremity of the corpus callosum. This fissure gives rise to a prominence, the calcar avis or hippocampus minor, seen in the posterior horn of the lateral ventricle.

The **cuneus** is a triangular lobule situated between the median limb or main portion of the parieto-occipital fissure and the calcarine fissure. Its base is directed upward and backward, and is formed by the inner border of the superior occipital convolution; its apex is directed downward and forward, and corresponds to the angle of union of the calcarine and parieto-occipital fissures.

The fissures and convolutions of the basilar surface of the occipital lobe are uninterruptedly continuous with those of the corresponding surface of the temporo-sphenoid lobe, and therefore the inferior surface of these two lobes will be studied as the lower occipito-temporal surface.

The **Temporal** or **Temporo-sphenoid Lobe** is that part of the hemisphere of the cerebrum which extends into the middle cranial fossa, its posterior portion resting upon the tentorium cerebelli. It lies behind the commencement of the basilar or main portion of the fissure of Sylvius, in front of a line drawn over the lateral surface of the hemisphere of the cerebrum from the extremity of the lateral limb of the parieto-occipital fissure to the preoccipital notch, and below the horizontal limb of the fissure of Sylvius and a line representing its continuation

backward. The posterior portion of this lobe is continuous with the parietal and occipital lobes, as mentioned under the description of those lobes.

Surfaces.—The temporo-sphenoid lobe presents an external, lateral or convex and an inferior or basilar surface. In addition some anatomists describe an upper or Sylvian surface in relation with the horizontal limb of the fissure of Sylvius. Upon the lateral surface are three secondary fissures which run horizontally: the superior temporo-sphenoid or parallel fissure, the middle temporo-sphenoid, and the inferior temporo-sphenoid fissure. Of these fissures, the superior temporo-sphenoid or parallel is the most constant, and lies entirely on the lateral surface, while the middle and the inferior are much more variable. They are seldom developed with equal clearness, and are frequently interrupted and bridged by convolutions. The middle temporo-sphenoid fissure lies almost entirely on the lateral surface, while the greater part of the inferior temposo-sphenoid fissure is on the basilar surface.

The **superior temporo-sphenoid** or **parallel fissure** commences near the anterior extremity or apex of the lobe. It then runs backward and upward, parallel with the horizontal limb of the fissure of Sylvius,—hence the name of parallel fissure,—and terminates in the inferior parietal convolution, its posterior extremity being surrounded by the angular convolution.

The **middle temporo-sphenoid fissure** commences on the basilar surface of the lobe, and runs upward and backward, parallel with the superior temporo-sphenoid fissure. It terminates in the inferior parietal conlution, its posterior extremity being surrounded by the post-parietal convolution.

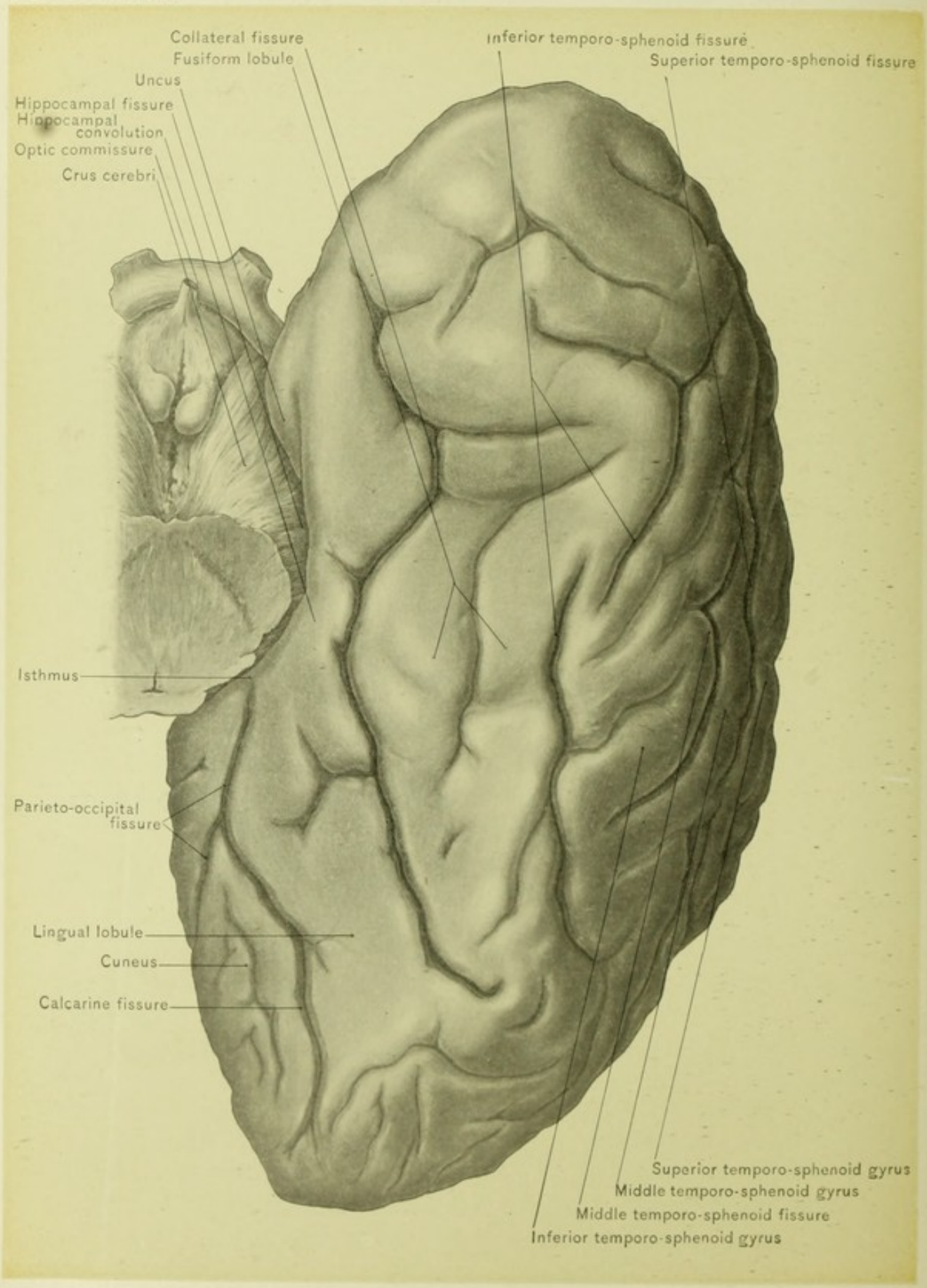
The **inferior temporo-sphenoid fissure** lies in great part on the basilar surface, near the margin of the hemisphere, and terminates posteriorly on the lateral surface; it separates the inferior temporo-sphenoid convolution from the lateral occipito-temporal convolution or fusiform lobule.

Convolutions.—Through the medium of the superior, middle, and inferior temporo-sphenoid fissures the lateral surface of the temporo-sphenoid lobe is divided into three convolutions: the superior temporo-sphenoid, the middle temporo-sphenoid, and the inferior temporo-sphenoid convolution.

The **superior temporo-sphenoid** or **infra-marginal convolution** lies between the horizontal limb of the fissure of Sylvius and the parallel fissure; it is continuous at its posterior part with the supra-marginal and angular convolutions.

The **middle temporo-sphenoid convolution** lies between the parallel fissure and the middle temporo-sphenoid fissure, being clearly marked off above by the parallel fissure. Its lower boundary is by no means so constantly well marked, and it is frequently continuous with the inferior temporo-sphenoid convolution. It is continuous posteriorly with the angular convolution.

PLATE CCLXXII.



INFERIOR SURFACE OF OCCIPITAL AND TEMPORAL LOBES.

The **inferior temporo-sphenoid convolution** lies along the lateral margin of the hemisphere, between the middle temporo-sphenoid fissure and the inferior temporo-sphenoid fissure; it passes above the preoccipital notch, and is continuous behind with the third occipital convolution. Upon the basilar surface of the lobe it is continuous with the external occipito-temporal convolution, or fusiform lobule.

The **upper** or **Sylvian surface of the temporo-sphenoid lobe** is in contact with the operculum, and intimately related to the island of Reil; it presents two or three transverse convolutions.

The fissures and convolutions presenting on the *basilar surface* being continuous with those of the occipital lobe, they will be described as part of the lower occipito-temporal surface.

Collateral fissure.—The basilar surface of the temporo-sphenoid lobe contains the greater portion of the inferior temporo-sphenoid fissure, as previously described. That portion of this surface which is continuous with the occipital lobe, and designated as the lower occipito-temporal surface, presents a constant and important secondary fissure, the inferior occipito-temporal or collateral fissure. This commences at the posterior extremity of the occipital lobe; thence it runs forward parallel to and below the calcarine fissure, nearly to the apex of the temporo-sphenoid lobe, extending almost as far as the commencement of the Sylvian fissure. It is sometimes bridged over by a secondary convolution. It produces the eminentia collateralis, a prominence in the floor of the descending cornu of the lateral ventricle, seen at the point of divergence of the middle and posterior cornua of the ventricle. Through the medium of the collateral and hippocampal fissures the lower occipito-temporal surface is divided into three convolutions: the fusiform lobule, the lingual lobule, and the hippocampal or uncinate convolution. The hippocampal convolution and the lingual lobule are but portions of the internal or mesial occipito-temporal convolution.

The **lingual lobule** lies between the collateral fissure on the outer side, and the calcarine fissure on the inner side. It occupies chiefly the occipital part of the lower occipito-temporal surface. It is wide behind and narrow in front.

The **hippocampal** or **uncinate convolution** lies between the collateral fissure on the outer side and the hippocampal on the inner side. It is formed by the union of the isthmus or posterior continuation of the gyrus fornicatus with the lingual lobule at the anterior extremity of the mesial limb of the parieto-occipital fissure. It continues forward, bordering the hippocampal fissure and embracing the crura cerebri, to terminate immediately behind the anterior perforated space by turning upward and backward upon itself in the *uncus*.

The **external** or **lateral occipito-temporal convolution,** or **fusiform lobule,** lies between the collateral fissure on the inner side, and the inferior temporo-

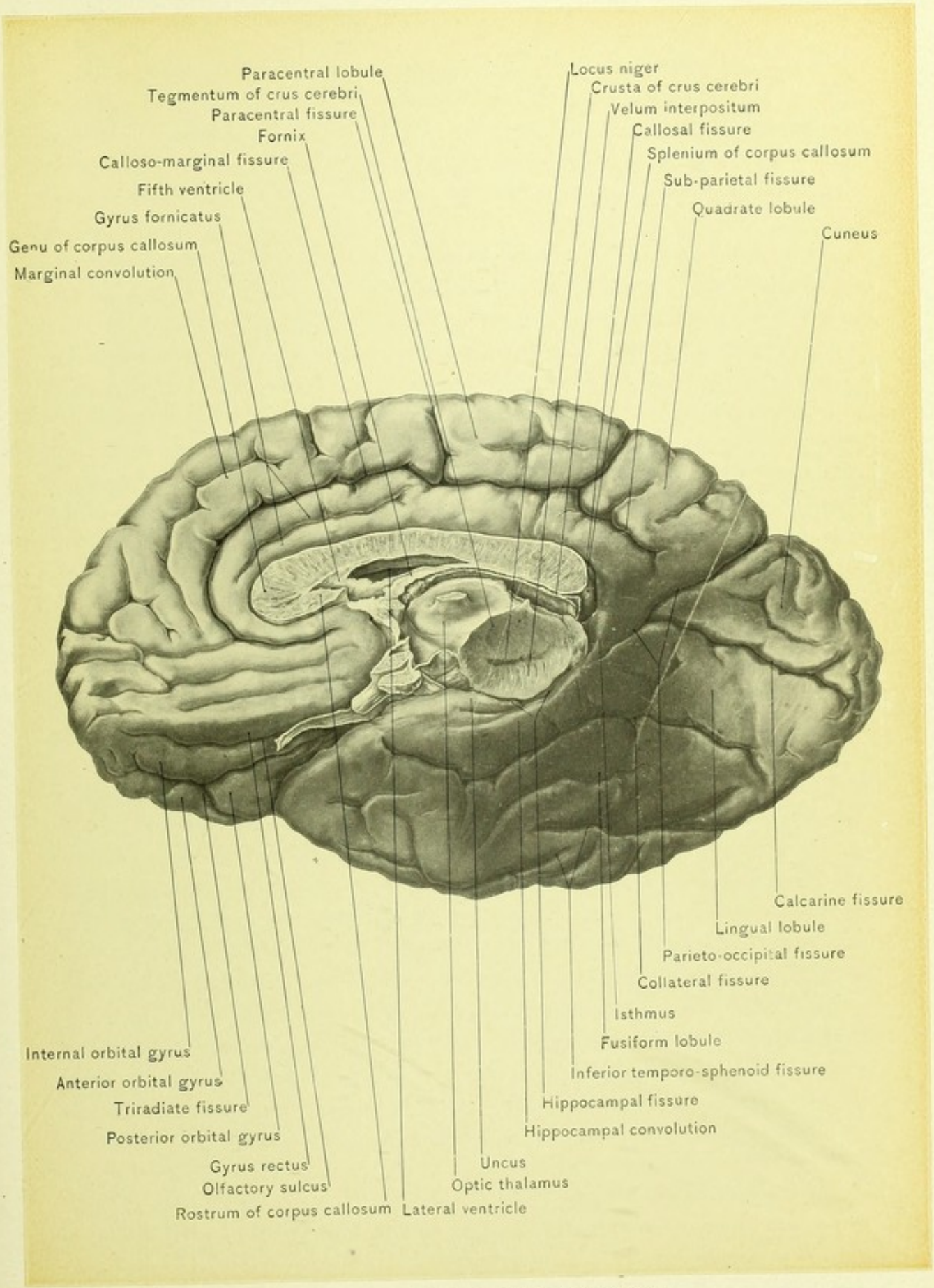
sphenoid fissure, when present, on the outer side. When the inferior temporo-sphenoid fissure is wanting or is incomplete, the lateral boundary of this convolution is indistinct. It extends from the apex of the temporo-sphenoid lobe to the posterior extremity of the occipital lobe.

The **hippocampal** or **dentate fissure,** previously mentioned as being bordered by the hippocampal convolution, corresponds to the lateral portion of the transverse fissure of Bichat. It is situated in front of the calcarine fissure, between the crura cerebri and the hippocampal convolution, and extends outward, downward, and forward from the splenium of the corpus callosum to the uncus. It produces the cornu Ammonis or hippocampus major, a prominence forming part of the inner wall of the middle cornu of the lateral ventricle. By drawing the hippocampal convolution away from the crus cerebri, thus widening the hippocampal fissure, there will be seen a band of gray matter which reaches from the splenium of the corpus callosum to the uncus. This is the free edge of the hippocampal convolution, and its notched appearance is produced by the choroid arteries, which pass through the fissure with the pia mater into the descending horn of the lateral ventricle; this gray matter is known as the *fascia dentata*, or the *dentate convolution.*

The remaining fissures seen on the inner surface of the hemisphere of the cerebrum are the calloso-marginal and the callosal fissure, and the remaining convolution is the gyrus fornicatus.

The **calloso-marginal fissure,** the terminal portion of which was mentioned when describing the location of the fissure of Rolando, commences below the rostrum of the corpus callosum, curves forward around the genu, and backward above the body of the corpus callosum. It runs about midway between the corpus callosum and the upper border of the hemisphere to a point opposite the splenium of the corpus callosum, where it turns upward and slightly backward to terminate on the upper border of the hemisphere of the cerebrum, immediately behind the commencement of the fissure of Rolando. From the point where the fissure turns upward to reach the margin of the hemisphere there is frequently found, following the original direction of the calloso-marginal, a small fissure which separates the quadrate lobule from the gyrus fornicatus. This, under the name of the subparietal fissure, is a branch of the calloso-marginal, as is also the paracentral fissure. The calloso-marginal fissure is not infrequently bridged over in places by secondary convolutions which connect the marginal gyrus with the gyrus fornicatus.

The **callosal fissure,** or ventricle of the corpus callosum, commences below the rostrum, follows the superior surface of the corpus callosum, and terminates behind the splenium of the corpus callosum in the hippocampal fissure.



MEDIAN AND INFERIOR SURFACES OF CEREBRUM.

The **gyrus fornicatus** lies between the calloso-marginal fissure and the callosal fissure. It commences in front of the anterior perforated space, between the rostrum of the corpus callosum and the marginal convolution, follows the superficial surface of the corpus callosum, and terminates below the splenium of the corpus callosum in a narrow extremity, the *isthmus*, which joins the hippocampal convolution.

The **Limbic Lobe** includes a number of convolutions arranged in a ring-like manner; some of the parts are quite rudimentary in the human brain, and are the representatives of more highly developed structures in some of the lower animals. The limbic lobe is made up of the gyrus fornicatus, hippocampal gyrus, the rudimentary gyrus supra-callosus of Zuckerkandl (formed by the peduncles of the corpus callosum, fascia dentata, and the longitudinal striæ on the upper surface of the corpus callosum), together with half of the fornix and the corresponding lamina of the septum lucidum. This lobe is bounded by the calloso-marginal and collateral fissures, and each extremity of it is continuous with one of the roots of the olfactory tract.

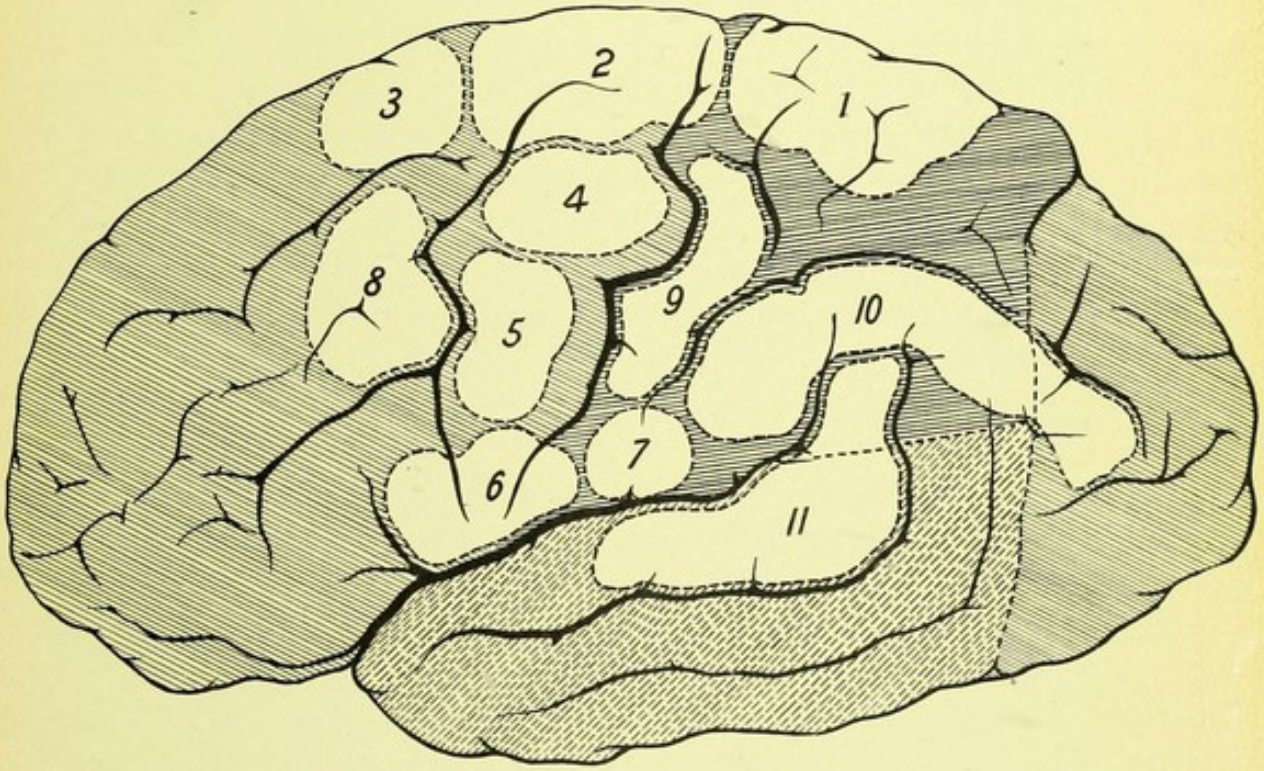
CRANIO-CEREBRAL TOPOGRAPHY.

Sensory and Motor Areas.—Having completed the study of the fissures, the lobes, and the convolutions of the hemisphere of the cerebrum, consider the functions of the convolutions in certain areas of the surfaces of the cerebrum before commencing the dissection of that part of the brain. The two principal regions of the hemisphere are the motor area and the sensory area. The motor area comprises the posterior ends of the superior, middle, and inferior frontal convolutions, the ascending frontal convolution, the ascending parietal convolution, and the adjoining part of the superior parietal convolution. The sensory area of the surface of the cerebrum has been imperfectly outlined on account of the greater difficulty attending its localization.

The Silent Region.—The anterior two-thirds of the superior, middle, and inferior frontal convolutions, or that portion of the frontal lobe which practically lies in advance of the coronal suture with the brain in its natural position, is the *prefrontal* or *silent region* of the brain, where, if a lesion be present, it does not give rise to any localizing symptoms. The author has frequently seen the prefrontal region severely injured in gunshot wounds with entire absence of any paralytic symptoms. He has also seen cases of abscess of this region with similar absence of any localizing symptoms. One case in particular in his experience was that of a large abscess of the left prefrontal region, which followed a punctured fracture of the cribriform plate of the ethmoid bone. The patient was a boy, who, while playing with a hoisted umbrella, threw it up in the air. In its descent it turned,

and a portion of one of the ribs passed into his left nostril and penetrated the cranial cavity, fracturing the cribriform plate of the ethmoid bone, tearing through the dura mater, and finally entering the frontal lobe. A brain abscess developed —so considered at the time and afterward proved by autopsy. The collection occupied the left prefrontal lobe, and at no time in the course of the disease were there any localizing symptoms. The function over which this region of the brain is believed to preside is that of the higher mental faculties, and in disease or injury of this region, particularly upon the left side, there is very apt to be more or less hebetude, dullness of intellect, and lack of self-control.

Motor Centers.—The motor area embraces the centers which preside over the movements of the opposite side of the body, and is conveniently divided into thirds—an upper, a middle, and a lower. The upper third includes the centers which control the movements of the muscles of the lower extremity; the middle third, the centers which control the movements of the muscles of the upper extremity; and the lower third, the centers which control the movements of the muscles of the face, the mouth, and the tongue. It would seem from recent investigation that the centers for *tactile sensation* are located in the same area as that occupied by the motor centers, for some loss of tactile sense may accompany motor paralysis; hence the centers about to be described are at times referred to as the sensori-motor areas. There is some evidence in favor of locating the centers for *muscular sense* in the region just posterior to the motor area, in the neighborhood of the great longitudinal fissure. The following is a detailed description of the location of the individual centers of the motor and sensory areas (Ferrier): The centers which control the movements of the opposite leg and foot, such as are concerned, for example, in walking, are situated in the anterior part of the superior parietal convolution, at its junction with the ascending parietal, in the paracentral lobule and part of the quadrate lobule. The upper part of the ascending frontal convolution with the neighboring part of the base of the superior frontal convolution include the centers which control the various complex movements of the arms and legs, such as climbing, swimming, etc. The posterior third of the superior frontal convolution anterior to the junction of its base with the ascending frontal includes the centers for the forward extension of the arm and hand, as in reaching forth the hand to touch something in front. The upper part of the middle third of the ascending frontal convolution includes the centers for those movements of the hand and forearm which call into action the biceps, as supination of the hand and flexion of the forearm. The ascending frontal convolution, at about the junction of its middle and lower thirds, includes the centers which control the action of the elevators and depressors of the angle of the mouth.



Centers for (1) Opposite leg and foot, as in walking (2) Arms and legs, as in climbing or swimming. (3) Forward extension of arm and hand. (4) Supination of hand and flexion of forearm. (5) Elevators and depressors of angle of mouth. (6) Lips and tongue in talking (7) Platysma myoides muscle. (8) Lateral movement of head and eyes, elevation of eyelids, and dilatation of pupil. (9) Movement of fingers and wrist. (10) Vision. (11) Hearing.

MOTOR AND SENSORY AREAS OF CEREBRUM (AFTER FERRIER).

The base of the third frontal convolution and, to a slight degree, the lower end of the ascending frontal and ascending parietal convolutions include the centers for the movements of the lips and tongue in talking. This region is known as *Broca's region*, disease of which on the left side causes aphasia, or loss of the power of speech. The speech center, however, is not always in the left side of the brain. In left-handed persons it is located, as has been demonstrated clinically, in the base of the right third frontal convolution.

Aphasia is of two varieties, the motor or ataxic, and the sensory or amnesic. In the motor variety there is inability to properly coordinate the muscles presiding over articulation, while in the sensory variety there is loss of memory for words. The speech center is connected with the centers of hearing and vision through the medium of the associating fibers of the cerebrum, and also, through the medium of the speech tract, with the centers in the medulla oblongata which give origin to the nerves which are employed in speech. Only through this connection between the speech center, the centers of hearing, and the centers of vision can the two forms of sensory aphasia—namely, word-deafness and word-blindness—be understood. The ability to write is, as a rule, lost in cases of destruction of the motor area for speech.

The lower third of the ascending parietal convolution, at its junction with the inferior parietal, includes the center which controls the movements of the platysma myoides muscle in bringing about retraction of the angle of the mouth. The base of the middle frontal convolution includes the center for lateral movements of the head and eyes, with elevation of the eyelids and dilatation of the pupil. The middle third of the ascending parietal convolution includes the centers for the movements of the fingers and wrist.

The cortical centers for the different muscles and limbs overlap to a certain extent, so that while there is a more or less distinct focus of representation for a given set of muscles, adjacent parts of the cortex are also concerned in governing the muscles presided over by the focus; hence total paralysis does not necessarily follow removal of a limited area of the cortex of the cerebrum.

The supra-marginal and angular convolutions, in addition to the occipital lobe, include the *centers of vision;* these, taken together, have been termed by Ferrier the occipito-angular region. The posterior part of the superior temporo-sphenoid convolution includes the *centers of hearing.* The anterior extremity of the hippocampal convolution or uncus includes the *center of smell,* while in close proximity to the center of smell is the *center of taste.* The convolution of the corpus callosum and the posterior part of the hippocampal convolution include the *center of touch.*

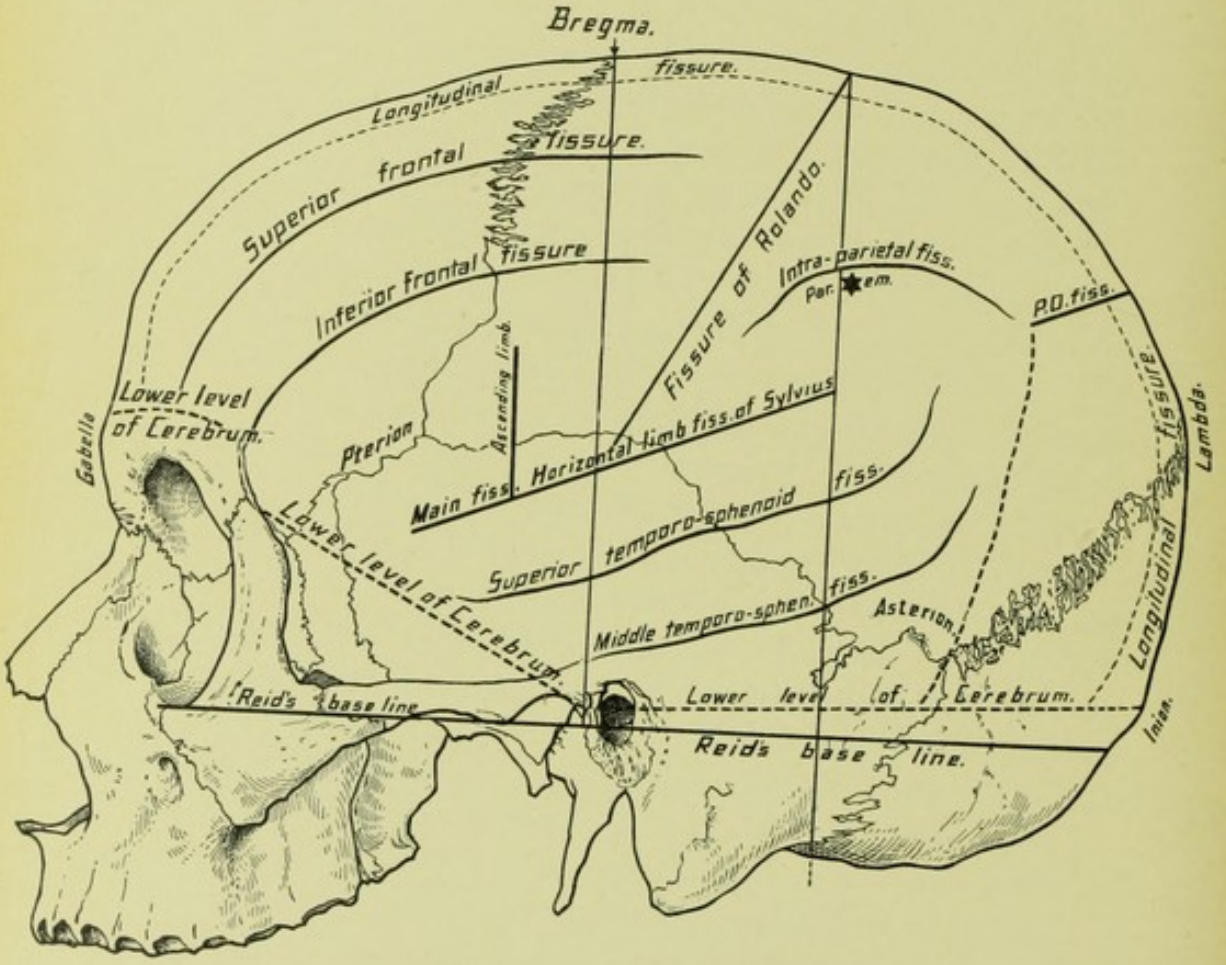
Each occipital lobe receives visual impulses from one-half of both retinæ, so

that a unilateral cerebral lesion may produce what is known as *hemianopsia*, a symmetric defect in the field of vision of the two eyes.

Disease of the Cortex of the Cerebrum.—Irritation of the motor area, as by a small meningeal hemorrhage, meningitis, or the application of a weak Faradic current, causes twitching or convulsive movements of the muscles of the opposite side. When the motor area is destroyed by disease or injury, there is complete paralysis of motion of the opposite side. If both the motor and the sensory areas are involved in the pathologic process, both sensation and motion of the opposite side will be affected. In trephining for focal, or Jacksonian, epilepsy it is customary when the brain cortex has been exposed to apply a weak Faradic current to that portion believed to include the centers which are concerned in the initial convulsive seizure; in other words, the convulsive movements which the patient exhibited during the attacks are reproduced by the application of the current. In this manner the different centers presiding over the various movements of the opposite side can be located. When the affected centers have been definitely located, the entire thickness of the gray matter in the affected area is excised. This naturally results in paralysis of the parts over whose motion they have heretofore presided. The arrest of any bleeding and closing and dressing the wound complete the operation. It is hardly necessary to say that if a lesion such as an enlarged Pacchionian body, a cyst, a cicatrix, or a neoplasm is found, it should be excised. This operation demonstrates, therefore, the effect of both irritation and destruction of the motor area. In following up the cases of Jacksonian epilepsy treated by operation, it is interesting to note that the paralysis which follows the excision of the cortex diminishes, after a time, to such an extent as to permit of a return of the convulsions. These operations, therefore, afford but temporary relief in the great majority of cases. The return of function occurs through the compensatory action of the neighboring cells.

Abolition of the function of certain groups of centers in the motor area of the cortex cerebri results in one or other of the following varieties of paralysis: If of the arm and leg, it is called brachio-crural paralysis, or hemiplegia; if of the leg alone, crural monoplegia; if of the arm alone, brachial monoplegia; and if of the face alone, facial monoplegia. Facial monoplegia seldom occurs alone, and is most commonly associated with aphasia, owing to the close proximity of the facial and speech centers.

The centers of hearing, vision, smell, and taste may be irritated by various lesions, so that hallucinations of these senses may, like motor disturbances, arise from irritation of the motor cortex. Thus, the so-called sensory equivalent of a Jacksonian convulsion is produced, and from the character of this attack deductions as to the location of the lesion may be drawn.



LINES FOR FISSURES, LOWER LEVEL OF CEREBRUM.

Dissection.—Shave the scalp upon one side of the head, and upon the other, turn its entire thickness down in one flap. Upon that side where the skull wall is exposed remove half of the calvaria with a saw or a chisel and mallet. Next reflect the dura mater in one flap and dissect off the arachnoid and pia mater to expose the fissures and convolutions.

A familiarity with certain of the cranial landmarks is essential in the study of cranio-cerebral topography. These include the glabella (a point between the eyebrows), the frontal eminence, the external angular process of the frontal bone, the zygomatic arch, the preauricular fossa (the depression in front of the tragus on a level with the upper border of the external auditory meatus), the external auditory meatus, the mastoid process, the parietal eminence, and the external occipital protuberance or inion.

The Lower Level of the Cerebrum.—A line drawn horizontally across the forehead through the upper part of the glabella approximately corresponds to the lower level of the cerebrum in front. A line drawn from the external angular process of the frontal bone through the preauricular fossa to the external occipital protuberance approximately corresponds to the lower level of the cerebrum at the sides and behind. The **cerebellum** lies below that portion of the last-mentioned line included between the posterior border of the mastoid process and the inion.

Longitudinal and Transverse Fissures.—A line drawn from the glabella over the vertex and along the median line to the inion corresponds to the position of the longitudinal fissure. A line drawn from the inion along the superior curved line of the occipital bone to a point an inch, or 2.5 centimeters, above the external auditory meatus corresponds to the position of the transverse fissure.

Fissure of Sylvius.—To indicate the position of the fissure of Sylvius, draw a line from a point one and one-fourth inches, or three centimeters, behind the external angular process of the frontal bone to a point three-fourths of an inch, or two centimeters, below the most prominent part of the parietal eminence. The first three-fourths of an inch, or two centimeters, of the line represent the main fissure; and the remainder of the line, the horizontal limb of the fissure. The ascending limb of the fissure is represented by drawing a line one inch, or 2.5 centimeters, in length vertically upward from the point of termination of the main fissure—that is, three-fourths of an inch, or two centimeters, from its commencement, or five centimeters behind the external angular process of the frontal bone.

Reid's base line is drawn from the lower border of the orbit through the center of the external auditory meatus. This line is of assistance in locating the fissure of Rolando.

Fissure of Rolando.—To represent the position of the fissure of Rolando, first draw two perpendicular lines from the base line to the line representing the

position of the great longitudinal fissure. The anterior of these passes through the preauricular fossa, and the posterior passes along the posterior border of the mastoid process. From the point of intersection of the posterior perpendicular line with that of the great longitudinal fissure to the point of intersection of the anterior perpendicular line with that of the horizontal limb of the fissure of Sylvius, draw a third line, which represents the position of the fissure of Rolando. The fissure of Rolando may also be located by drawing a line downward, outward, and forward from a point one-half of an inch, or one centimeter, behind a point midway between the glabella and inion and at an angle of 71.5 degrees with the anterior portion of the line for the longitudinal fissure. The angle formed by the fissure of Rolando and the anterior portion of the longitudinal fissure varies, but, in any instance, the line for the fissure is merely an approximate guide. The fissure measures about three and three-eighth inches, or eight and one-half centimeters, in length. Upon each side of and running parallel with the fissure of Rolando are the ascending frontal and ascending parietal convolutions, each of which occupies a space about three-fourths of an inch, or two centimeters, in width.

Parieto-occipital fissure.—Extend the line indicating the horizontal limb of the fissure of Sylvius backward to that of the longitudinal fissure, and the lateral limb of the parieto-occipital fissure will be represented by about the posterior inch, or 2.5 centimeters, of this line. The lateral portion of the parieto-occipital fissure is also found from three to three and one-half inches, or eight to nine centimeters, above the external occipital protuberance.

Frontal Lobe.—Through the medium of the lines indicating the course of the primary fissures of the hemisphere the lobes are mapped out. The frontal lobe lies external to the line of the longitudinal fissure, in front of the line of the fissure of Rolando, and above the lines for the lower level of the cerebrum and for the main and horizontal limbs of the fissure of Sylvius. The course of the secondary fissures and the position of the convolutions of this lobe will be represented by the following lines: A line drawn from the supra-orbital notch backward and parallel with the line of the longitudinal fissure to within about three-fourths of an inch, or two centimeters, of the line of the fissure of Rolando indicates the course of the superior frontal sulcus. A line drawn from the external angular process of the frontal bone upward and backward along the temporal ridge to within about three-fourths of an inch, or two centimeters, of the line of the fissure of Rolando indicates the course of the inferior frontal fissure. A line drawn three-fourths of an inch, or two centimeters, in front of, and parallel with, the lower two-thirds of the line of the fissure of Rolando indicates, approximately, the course of the precentral fissure. The superior frontal convolution

corresponds to the interval between the lines of the longitudinal and superior frontal fissures. The middle frontal convolution corresponds to the interval between the lines of the superior and inferior frontal fissures. The inferior frontal convolution corresponds to the interval between the line of the inferior frontal fissure and the lines representing the fissure of Sylvius and the lower level of the cerebrum in front. The ascending frontal convolution corresponds to the interval between the lines of the fissure of Rolando and the precentral fissure.

The **Parietal Lobe** lies between the lines of the longitudinal fissure and the horizontal limb of the fissure of Sylvius, and between the line of the fissure of Rolando and that of the lateral limb of the parieto-occipital fissure. The boundary between the parietal and occipital lobes is indicated approximately by a line drawn from the lateral limb of the parieto-occipital fissure to the posterior border of the base of the mastoid process. The course of the intra-parietal fissure and the position of the convolutions of the parietal lobe are represented as follows: To indicate the course of the intra-parietal fissure, draw from a point one-half of an inch, or one centimeter, external to the end of the lateral limb of the parieto-occipital fissure to a point three-fourths of an inch, or two centimeters, behind the lower end of the fissure of Rolando, a line which is convex forward; the lower third of the line should run parallel with the fissure of Rolando. The interval bounded by this line and the lines of the fissures of Rolando, the longitudinal fissure, and the lateral limb of the parieto-occipital fissure will correspond to the ascending and superior parietal convolutions. The ascending parietal convolution runs parallel with the line of the fissure of Rolando, and corresponds to the space directly behind it to the extent of three-fourths of an inch, or two centimeters, while the remaining portion of the space included in the above boundaries corresponds to the superior parietal convolution. The inferior parietal convolution, including the supra-marginal and angular gyri, corresponds to the interval bounded by the line of the intra-parietal fissure, that of the horizontal limb of the fissure of Sylvius, and the line drawn from the lateral limb of the parieto-occipital fissure to the posterior margin of the base of the mastoid process. The supra-marginal gyrus lies under the most prominent part of the parietal eminence.

The **Occipital Lobe** lies behind the line drawn from the lateral limb of the parieto-occipital fissure to the posterior margin of the base of the mastoid process.

The **Temporal** or **Temporo-sphenoid Lobe** lies below the line of the horizontal limb of the fissure of Sylvius and above the upper border of the zygoma, and a line representing the continuation of the latter backward to a point slightly above the superior curved line of the occipital bone. The posterior boundary of this lobe corresponds approximately to a line drawn from the external portion of the

parieto-occipital fissure to the posterior limit of the base or root of the mastoid process. This lobe in front reaches as far as the posterior superior border of the malar bone. A line drawn parallel with and one inch, or two and one-half centimeters, below the line of the horizontal limb of the fissure of Sylvius indicates the course of the superior temporo-sphenoid fissure. A line drawn parallel with and three-fourths of an inch, or two centimeters, below the latter line, indicates the course of the middle temporo-sphenoid fissure. The superior temporo-sphenoid convolution corresponds to the interval between the line of the horizontal limb of the fissure of Sylvius and the line of the superior temporo-sphenoid fissure. The middle temporo-sphenoid convolution corresponds to the interval between the lines of the superior and middle temporo-sphenoid fissures.

Individual Variations and How to Determine Them.—It is to be borne in mind that the brain of one individual differs from that of another, and, therefore, there is no method which will in all instances represent the position of the fissures and convolutions with absolute correctness. After the brain cortex is exposed in an operation, the Faradic current can be applied to decide what portion of the motor area of the cortex has been exposed. It can be readily appreciated that through so small an opening as that made by the trephine it is scarcely possible to recognize special fissures and convolutions, especially when we recollect how difficult it is at times to locate them in the dissection of the brain.

Indications for Trephining.—Excluding trephining for fracture of the skull, the cranial cavity is opened for one of several purposes—namely, to expose the superior and inferior maxillary nerves when it is purposed to excise one or both for trifacial neuralgia; for the removal of the Gasserian ganglion, as described; to remove a blood clot; to control hemorrhage from one or both branches of the middle meningeal artery; to open the lateral sinus in septic thrombosis consequent upon middle ear disease; to remove part of the brain cortex, as in Jacksonian epilepsy; to remove a brain tumor or a foreign body; to evacuate an abscess; to relieve intra-cranial pressure; to tap the lateral ventricles; for the relief of otherwise uncontrollable headache when the point of greatest pain can be located; and for traumatic epilepsy.

To Expose the Lateral Sinus.—In septic thrombosis of the lateral sinus consequent upon middle ear disease that portion of the sinus in relation with the mastoid process, the sigmoid portion, is exposed. To reach this portion, first draw two lines, one vertical through the middle of the mastoid process, and a second on a level with the roof of the external auditory meatus and at a right angle to the first. At the point of junction of these two lines apply the center pin of a one-inch trephine. The most superficial portion of this sinus is not so deeply situated as the mastoid antrum, being, as a rule, about one-fourth of an inch, or six milli-

meters, from the surface of the bone. Before removing the clot from the sigmoid sinus the internal jugular vein should be ligated, to control hemorrhage and prevent dissemination of emboli. As a thrombus of the sigmoid sinus seldom occurs except as a complication of disease of the mastoid antrum, the latter is usually opened first, and then it is desirable to expose the sinus on its anterior aspect by removing the bony tissue between the antrum and the sinus, which often contains the channels through which the sinus has become infected.

Localized Affections.—In operating for focal epilepsy, brain tumor, or blood clot the trephine is applied to the skull directly over the part of the brain believed to be the site of involvement, as determined by localizing symptoms. The lines which indicate the courses of the fissures are the principal guides.

Foreign Bodies.—In the removal—or perhaps it would be better to say the attempt at removal—of a foreign body, as these are most commonly bullets and in the majority of cases located with difficulty, the cranial cavity is attacked at the wound of entrance. The operation of trephining in this class of cases increases the chance of finding the foreign body and establishes drainage.

Temporo-sphenoid Abscess.—The most common forms of intra-cranial abscess are temporo-sphenoid, cerebellar, and extradural, which are usually the result of middle ear disease. In operating for temporo-sphenoid abscess, which is usually located in the posterior half of the lobe, first draw two parallel lines at right angles to Reid's base line, the anterior passing through the center of the external auditory meatus, and the other about one and one-fourth inches, or three centimeters, behind it. Apply the center pin of the trephine over a point one and one-fourth inches, or three centimeters, above Reid's base line and between the two vertical lines (Barker).

Cerebellar Abscess.—In operating for cerebellar abscess, which is usually situated in the front and outer part of the hemisphere of the cerebellum, apply the center pin of the trephine at a point one and one-half inches, or four centimeters, behind the center of the external auditory meatus, and one inch, or two and one-half centimeters, below Reid's base line (Barker).

Extradural Abscess.—The point over which to trephine in extradural or subdural abscess must depend, in a great degree, upon the presence of localizing symptoms. The constitutional evidences of pus and the history of the case, together with circumscribed edema and localizing symptoms, such as spastic contraction or paresis of certain muscles, would constitute the most reliable guides. Septic meningitis, as far as the constitutional symptoms are concerned, frequently so closely simulates cerebral abscess that a differential diagnosis, in the absence of localizing symptoms, is impossible.

To Tap the Lateral Ventricles apply the center pin of the trephine one and

one-quarter inches, or three centimeters, behind the center of the external auditory meatus and the same distance above Reid's base line. The ventricle is reached by carrying a grooved director obliquely forward and upward toward a point two and one-half to three inches, or six to seven and one-half centimeters, above the opposite external auditory meatus. The distance to which the grooved director must be inserted to reach the ventricle is from two to two and one-quarter inches, or five to five and one-half centimeters (Keen).

Headache and Traumatic Epilepsy.—In otherwise uncontrollable headache, when the point of greatest pain can be located, the trephine is applied at that point. In traumatic epilepsy the trephine is applied to the site of the original injury.

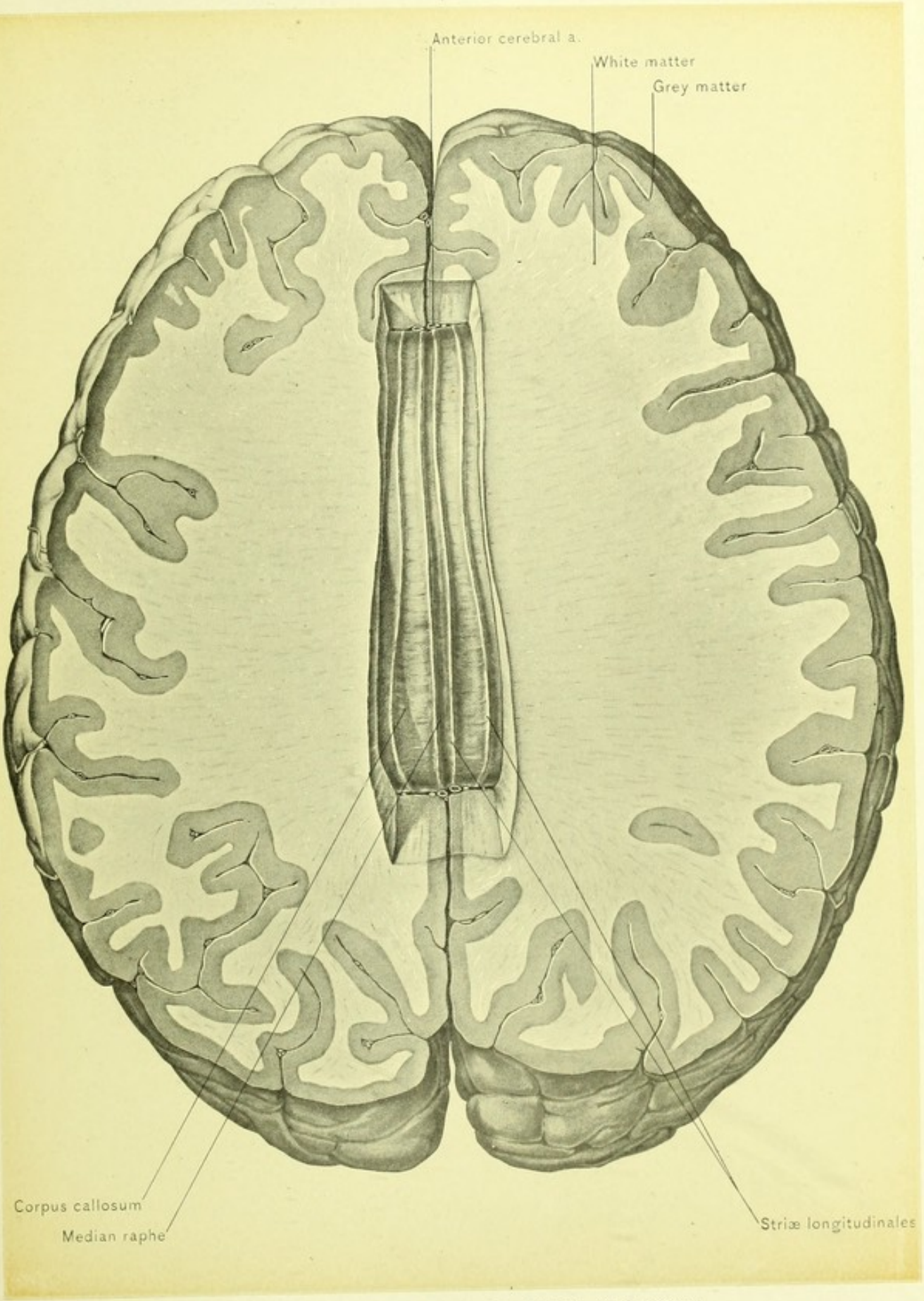
Craniectomy, or removal of a section of the calvaria to allow expansion of the brain in cases of idiocy, is, in the author's opinion, inadvisable, and might be compared to removal of a section of a nutshell to allow increased growth of a nut, the kernel of which is dead.

THE INTERIOR OF THE CEREBRUM.

Material.—In order to study the brain to the best advantage the dissector, as previously remarked, should have at least two preserved brains at his disposal. One brain may be used for the study of the fissures, convolutions, and interior of the brain; and the other for making sections of the brain.

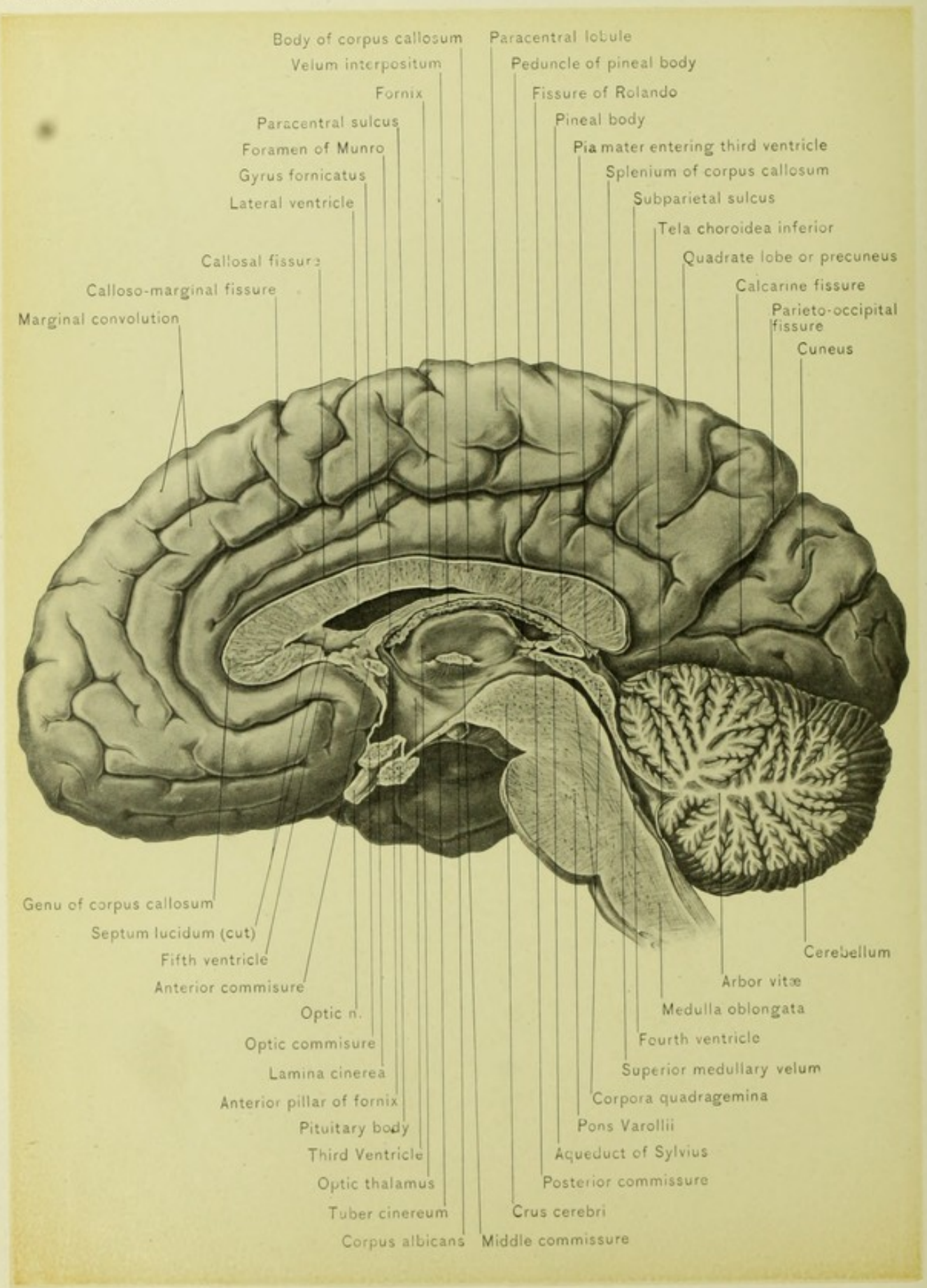
Dissection.—Having completed the study of the fissures and the convolutions, next examine the interior of the cerebrum. Place the brain on its base, and separate the hemispheres of the cerebrum, to widen the longitudinal fissure, thus exposing the bottom of the fissure. This is formed in great part by a mass of white matter,—the corpus callosum, or the great transverse commissure of the cerebrum,—while in front of and behind the corpus callosum the fissure extends without interruption to the base of the brain. Make a horizontal section of one or both hemispheres on a level with the floor of the longitudinal fissure. When both hemispheres are sliced away to the level of the floor of the longitudinal fissure, the upper surface of the corpus callosum is well exposed. The corpus callosum can now be studied from two points of view: from above in the present dissection, and from the side by looking at its sagittal section, seen in the preparation previously made by severing the two halves of the brain in the line of the longitudinal fissure.

The **Corpus Callosum,** the great transverse commissure of the cerebrum, is a transverse band of white matter which spans the longitudinal fissure and connects the hemispheres of the cerebrum for nearly half their length. The *falx cerebri*



CORPUS CALLOSUM AND HORIZONTAL SECTION OF CEREBRUM.

PLATE CCLXXVII.



INTERNAL SURFACE OF CEREBRUM AND SECTION OF VENTRICLES OF BRAIN.

touches the posterior portion of the corpus callosum ; the greater part of the body of the corpus callosum and its anterior extremity are separated for a considerable distance from the falx cerebri. The corpus callosum is slightly convex from before backward on the upper surface, is between three and four inches, or seven to ten centimeters, in length, and extends nearer to the anterior than to the posterior end of the cerebrum. It is wider behind, where it measures about one inch, or two and one-half centimeters, and is thicker at each end, especially at the posterior extremity, than in the middle. It forms the roof of the lateral ventricles, which are cavities located within the hemispheres of the cerebrum. On its dorsal surface, extending along its middle line, a linear depression exists, the **raphe.** On each side of the raphe, and running parallel with it, are two slightly elevated longitudinal bands, the **striæ longitudinales,** or **nerves of Lancisi.** External to these are the faintly marked **striæ longitudinales laterales,** or **tæniæ tectæ,** which, with the brain intact, underlie the convolutions of the corpus callosum, or gyri fornicati. The tæniæ tectæ are separated bundles of a group of fibers known as the **cingulum,** which forms part of the callosal and hippocampal gyri. The fibers proper of the corpus callosum run transversely, as its name, the great transverse commissure, implies. The corpus callosum consists of a main portion or body, seen best on longitudinal section, and of two extremities, the anterior and the posterior.

The **anterior extremity,** or **genu,** is formed by the bending downward and then backward of the corpus callosum ; from this bend it is continued to the base of the brain as the beak, or *rostrum*, which is the reflected portion of the genu, and is thin and narrow. Within the concavity of the genu is situated the septum lucidum, which contains between its layers the fifth ventricle. The rostrum of the corpus callosum has previously been described with the base of the brain ; it is connected to the tuber cinereum by the lamina cinerea. It gives off two bands of white substance, which are continuations of the nerves of Lancisi and form the peduncles of the corpus callosum. These then diverge from each other and run backward and outward across the anterior perforated space to the tips of the temporal lobes, meeting the inner roots of the olfactory tracts. The fibers from the genu of the corpus callosum pass outward and forward and then inward, into the prefrontal region, forming the *forceps minor.*

The **posterior extremity of the corpus callosum,** or **splenium,** is formed by a bending of the corpus callosum downward and forward upon itself, thus making a free, thickened, rounded border. This border forms the upper boundary of the central part of the transverse fissure, and beneath it passes the process of the pia mater known as the velum interpositum. The splenium is connected anteriorly with the fornix. The fibers of the splenium which curve outward and backward over the posterior horn of the lateral ventricle constitute the *forceps major ;* some

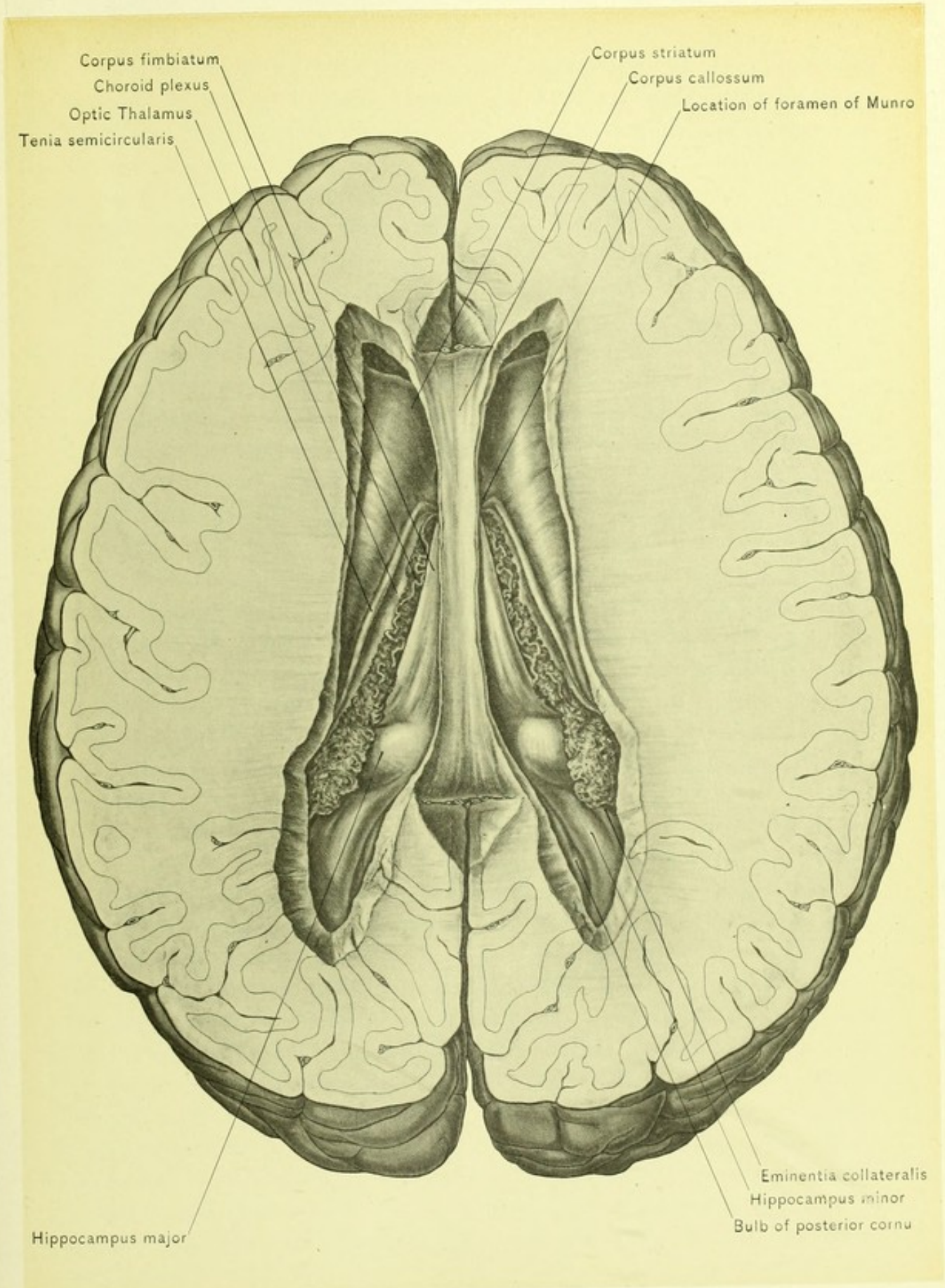
of these fibers form a long, rounded elevation, the bulb of the posterior cornu of the lateral ventricle.

The under surface of the body of the corpus callosum is connected along the middle line with the fornix and the septum lucidum, while laterally it forms the roof of the lateral ventricles.

Dissection.—Make two sagittal incisions from before backward, through the corpus callosum, from three-eighths to one-half an inch, or one centimeter, to each side of the median line; this will open the lateral ventricles—cavities which occupy the interior of the hemispheres of the cerebrum. To expose the interior of one or both lateral ventricles so as fully to disclose the contained structures, cut away with a pair of scissors as much of the corpus callosum on each side of the incision as may be necessary. This dissection will not open the middle or descending cornu; to accomplish this a section of the lateral portion of the hemisphere (temporo-sphenoid lobe) must be removed. This can be done either from without inward or from within outward by following the course of the cornu with the scalpel.

The **Lateral Ventricles** (trihorned ventricles, ventriculi tricornes) are two irregularly shaped cavities, one of which is situated in each hemisphere of the cerebrum. They communicate with the third ventricle by way of the foramina of Monro, and through the third ventricle with the fourth ventricle, by way of the aqueduct of Sylvius, or iter e tertio ad quartum ventriculum. They are lined by a membrane, the ependyma, whose function is to secrete part of the cerebro-spinal fluid. Each of the ventricles, which are separated in front by a vertical partition, the septum lucidum, consists of four parts: a body, or central portion, and three horns, or cornua. The cornua are designated anterior, middle or descending, and posterior, and extend, respectively, into the frontal, the temporo-sphenoid, and the occipital lobe of the cerebrum.

The **body of the lateral ventricle** is triangular in shape in a coronal section, its antero-posterior diameter being the longest, and its vertical diameter the shortest. It extends from the foramen of Monro to the splenium of the corpus callosum. It is bounded *above* by the corpus callosum; *internally*, by the posterior narrow portion of the septum lucidum, and the attachment of the corpus callosum to the fornix; and *externally*, by the merging angle formed by the corpus callosum and the white substance of the hemisphere. Its *floor* is formed by the following parts, named in their order from without inward: the intra-ventricular portion of the corpus striatum, or caudate nucleus, the tænia semicircularis and a small vein of the corpus striatum contained in an oblique groove, the optic thalamus, the choroid plexus, half of the body of the fornix, with its lateral edge or corpus fimbriatum.



BODIES, ANTERIOR CORNUA, AND POSTERIOR CORNUA OF LATERAL VENTRICLES.

The **anterior cornu of the lateral ventricle** is triangular in shape on coronal section of the brain. It extends forward, downward, and outward into the frontal lobe. It curves around the anterior end of the corpus striatum, and diverges from the anterior cornu of the lateral ventricle of the other side as it passes forward. It is bounded *above* by the fibers of the corpus callosum (*forceps minor*), which curve outward and forward; *internally*, by the septum lucidum, which separates it from the corresponding cornu of the opposite ventricle; in *front*, by the genu of the corpus callosum; and externally, by the caudate nucleus. Its *floor* is formed in great part by the caudate nucleus, which projects into it, and to a slight extent by the rostrum of the corpus callosum.

The **posterior cornu of the lateral ventricle,** the smallest of the three cornua, commences in the body of the ventricle opposite the splenium of the corpus callosum, and at the same point as the middle cornu. It extends horizontally backward, outward, and then inward into the occipital lobe. Its *roof* is formed by those fibers of the splenium of the corpus callosum (*forceps major*) which pass backward and outward and become continuous with the white matter of the occipital lobe. On its *inner wall* is seen the hippocampus minor, or calcar avis, produced by the calcarine fissure; above this is a smaller prominence, the bulb of the cornu, produced by the bulging of the fibers of the forceps major into the cavity, above and internal to the hippocampus minor. On the *floor* is seen a slight elevation, produced by the fasciculus longitudinalis inferior, which passes from the occipital to the temporal lobe. At the point where the middle and posterior cornua meet a triangular, smooth surface is seen, called by Schwalbe the trigonum ventriculi.

The **middle** or **descending cornu of the lateral ventricle,** the longest of the three cornua, may be considered the continuation of the cavity of the ventricle into the temporal lobe; it commences opposite the splenium of the corpus callosum, in the body of the ventricle, at the same point at which the posterior cornu begins. It extends backward and outward around the posterior extremity of the optic thalamus, and then runs downward, forward, and inward to reach the base of the brain, terminating about an inch, or 2.5 centimeters, from the tip of the temporo-sphenoid lobe. Its *roof* is formed by those fibers of the body of the corpus callosum (tapetum) which pass outward and become continuous with the white matter of the temporo-sphenoid lobe, and by the tail of the caudate nucleus, the tænia semicircularis, and the amygdaloid tubercle. The *floor* is formed in great part by the eminentia collateralis. Upon the *inner wall* are seen the following structures, named from without inward: the hippocampus major, and pes hippocampi, the corpus fimbriatum, the choroid plexus, and the fascia dentata or dentate convolution.

Dissection.—Next make a transverse section of the remaining portion of the body of the corpus callosum at about its middle, and dissect one half forward and the other half backward. If carefully executed, this dissection exposes the fornix and the septum lucidum.

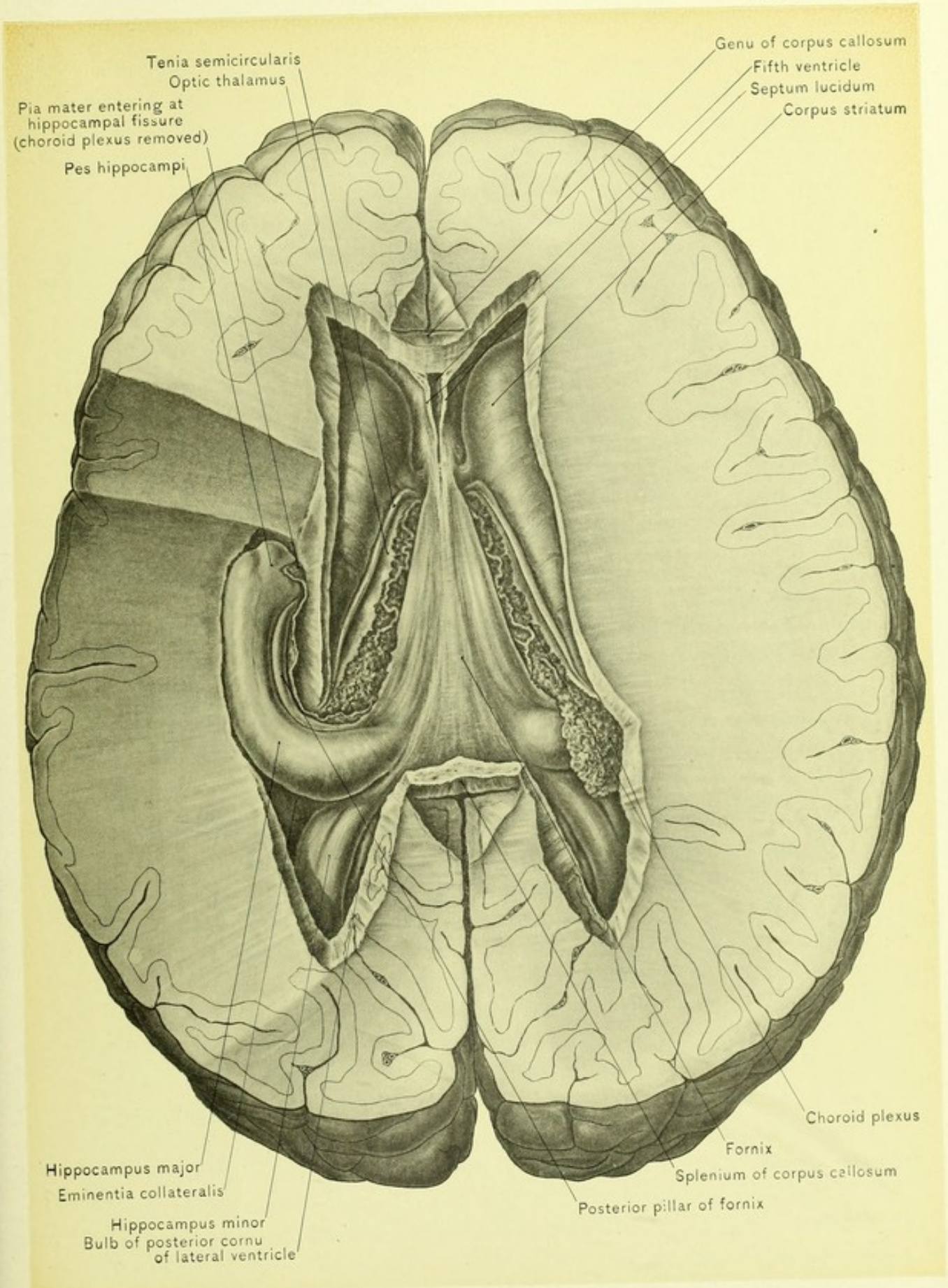
The **Fornix,** the longitudinal commissure of the cerebrum, is a triangular mass of white matter situated beneath the corpus callosum, and is continuous posteriorly with the splenium of the corpus callosum. It overlies the velum interpositum, which separates it from the third ventricle and the optic thalamus. It consists of a main portion, or body, and an anterior and a posterior crura.

The **body of the fornix** is triangular in shape, the apex of the triangle being directed anteriorly. The fornix is adherent behind to the splenium of the corpus callosum, and is attached above and in front to the septum lucidum, and above and behind to the corpus callosum; below, it rests upon the velum interpositum, and lies above the third ventricle. The sides of the body of the fornix project into the lateral ventricles, overlapping the inner portion of the optic thalami and choroid plexuses. The fibers of the under surface of the fornix behind are so arranged as to give rise to the designation *the lyre,* which has been bestowed upon them.

The **anterior crura,** or **pillars of the fornix,** are two cylindric bundles of nerve-fibers which are given off from the anterior extremity or apex of the body of the fornix, whence they diverge and descend in front of the optic thalami and the foramina of Monro and then through the gray matter in the sides of the third ventricle, to the base of the brain, where they form the white matter of the corpora albicantia, or mammillary eminences. Fibers pass from the corpora albicantia to the optic thalami; these fibers constitute the bundles of Vicq d'Azyr, and are probably not directly continuous with the fibers of the fornix. In their descent the anterior pillars are joined by the tæniæ semicirculares and by fibers from the septum lucidum and peduncles of the pineal gland. Between the anterior crura and the anterior extremities of the optic thalami are the oval openings of communication between the lateral ventricles and the third ventricle, the foramina of Monro.

The **posterior crura,** or **pillars of the fornix,** arise posteriorly from each side of the body of the fornix, whence they diverge and descend into the middle cornua of the lateral ventricles. Here each crus lies within the concavity of the curve described by the hippocampus major as far as the pes hippocampi. The lateral borders of the posterior crura of the fornix are known as the **corpora fimbriata,** or **tæniæ hippocampi.**

The **septum lucidum** is a triangular vertical partition situated between the



FORNIX AND LATERAL VENTRICLES, AND DESCENDING CORNU OF LEFT LATERAL VENTRICLE.

anterior portion of the bodies of the two lateral ventricles and between the anterior cornua of those ventricles. The base of the triangle is directed downward and forward, and the apex backward, into the narrow interval between the anterior part of the body of the fornix below, and the corpus callosum above. The septum lucidum is attached above to the under surface of the body of the corpus callosum; in front, to the concavity of the genu of the corpus callosum; and below, to the rostrum of the corpus callosum and to the body and anterior crura of the fornix. It is composed of two laminæ, between which is the cleft-like interval known a the fifth ventricle.

The **fifth** or **Sylvian ventricle** is not provided with an outlet, but is a completely inclosed space. Each of the laminæ of the septum lucidum, which bound this ventricle laterally, consists of an inner gray layer, a middle white layer, and an outer layer of ependyma which is part of the ependyma that lines the lateral ventricles. The fifth ventricle differs from the other ventricles in its mode of development; it is a portion of the great longitudinal fissure which has become inclosed by the formation of the corpus callosum and fornix.

Dissection.—With a pair of scissors slice away a horizontal section from the superior portion of the septum lucidum, when, with a little care, the laminæ can be pushed apart and the fifth ventricle opened. Should the ventricle contain more than the usual quantity of fluid, it can be more readily seen than if it were in a normal state.

Before reflecting the fornix examine the structures seen within the lateral ventricle, commencing with the corpora striata, which project into the anterior cornua.

Corpus Striatum.—The corpora striata (anterior cerebral ganglia) are the anterior pair of basal ganglia. The portion seen within the anterior cornu of the lateral ventricle is the intra-ventricular portion, or caudate nucleus. It is so called in contradistinction to the larger extra-ventricular portion, or lenticular nucleus, which occupies the white substance of the hemisphere of the cerebrum. To expose both the lenticular nucleus and the caudate nucleus in one dissection it is necessary to make horizontal sections of the hemisphere; these sections will be described further on.

The **Caudate Nucleus** is a pear-shaped mass of gray matter having its broad extremity, or head, directed forward into the forepart of the body and the anterior cornu of the lateral ventricle, and its narrow extremity, or tail, directed outward and backward. It lies to the outer side of the optic thalamus, and is prolonged into the roof of the middle horn of the lateral ventricle as far as its anterior extremity, where it terminates in the amygdaloid tubercle. Crossing the surface of the caudate nucleus are numerous small veins emptying into the vein of the

corpus striatum, which lies in the groove between the caudate nucleus and the optic thalamus.

The **Tænia Semicircularis,** or **Stria Terminalis,** is a very narrow longitudinal band of white fibers, which lies in the groove between the caudate nucleus and the optic thalamus, and conceals from view the vein of the corpus striatum. It extends from the anterior crus of the fornix, with which it is continuous in front, backward through the floor of the body of the ventricle, and into and along the roof of the middle cornu as far as the amygdaloid tubercle, where it ends. Where the surface of the anterior portion of the tænia semicircularis is more transparent and less dense than elsewhere was called by Tarinus the "horny band."

The **Optic Thalami** (posterior cerebral ganglia), the posterior pair of basal ganglia, can not be seen to advantage at this stage of the dissection without disarranging the parts overlying them and until the fornix and the velum interpositum have been removed; their description, therefore, will be deferred. It is sufficient to say here that the optic thalamus is an oblong mass of white and gray matter lying to the inner side of the caudate nucleus and the tænia semicircularis, part of the upper surface of which is hidden by the choroid plexus, the corpus fimbriatum, and the lateral portion of the body of the fornix.

The **Choroid Plexus** is a red, convoluted, vascular fringe, formed in the free margin of the velum interpositum, extending from the foramen of Monro backward over the optic thalamus into the descending cornu of the lateral ventricle, where it lies on the hippocampus major and extends to the end of this cornu of the ventricle. It is covered throughout by the ventricular epithelium, or ependyma, which passes from the corpus fimbriatum to the tænia semicircularis and optic thalamus; the ependyma thus separates the plexus from the cavity of the ventricle. Behind and between the foramina of Monro the choroid plexus of one lateral ventricle becomes continuous with that of the other, and from the point of junction the choroid plexuses of the ventricle extend backward.

The **Corpus Fimbriatum, Tænia Hippocampi,** or **Fimbria,** a narrow band of white matter, is the edge of the posterior crus of the fornix, which rests upon the posterior end of the optic thalamus, the choroid plexus intervening, and is continued into the descending cornu of the lateral ventricle. Here it rests between the concave margin of the hippocampus major and the pia mater, which passes through the hippocampal fissure. It extends as far as the uncus of the hippocampal gyrus.

The **Hippocampus Major,** or **Cornu Ammonis,** is the prominent convex, white eminence which forms part of the floor and inner wall of the descending cornu of the lateral ventricle, and extends throughout the entire length of this cornu. It is produced by extension of the hippocampal fissure into the descending cornu of

PLATE CCLXXX.

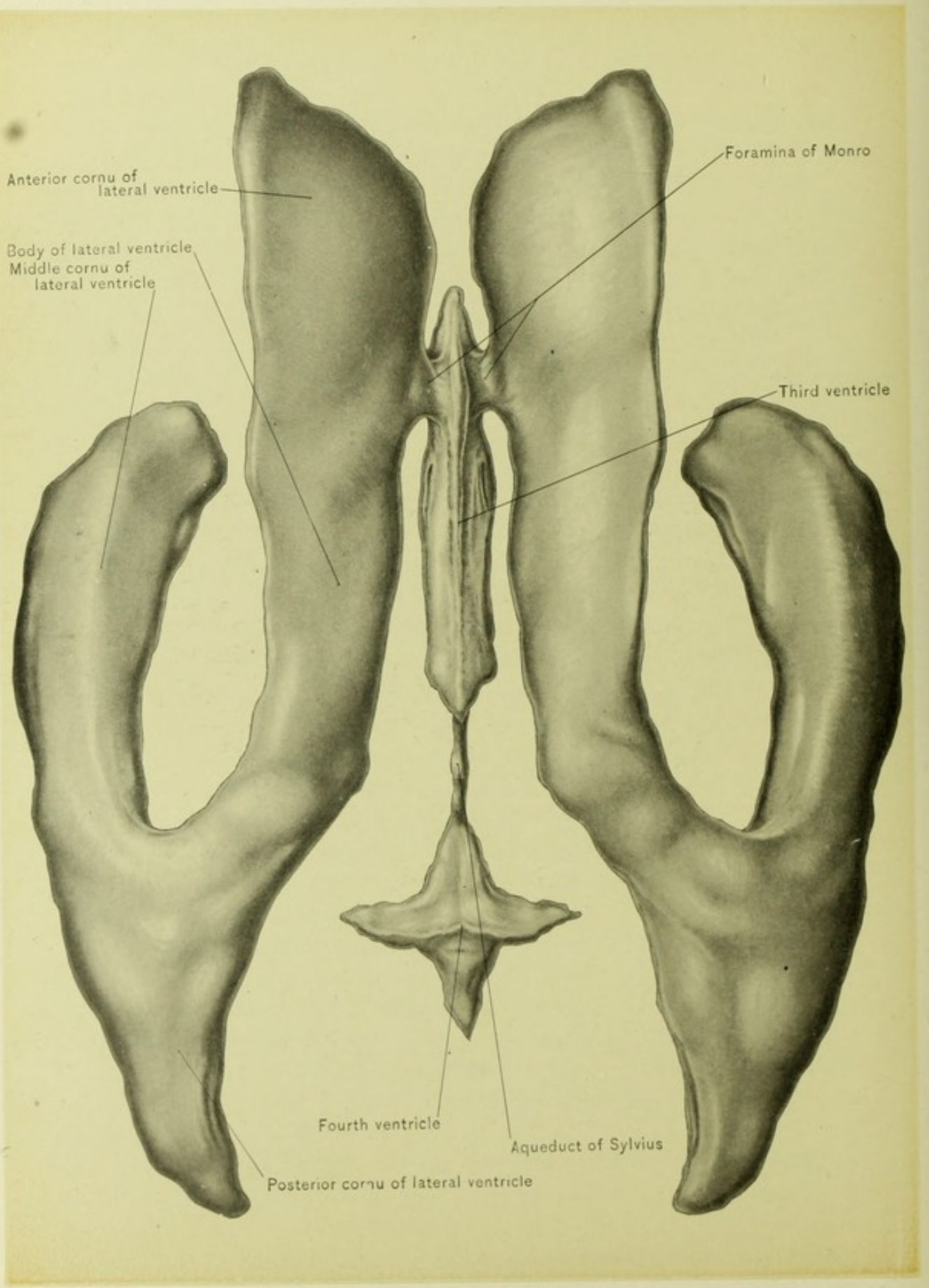


DIAGRAM OF THE VENTRICLES—SUPERIOR VIEW.

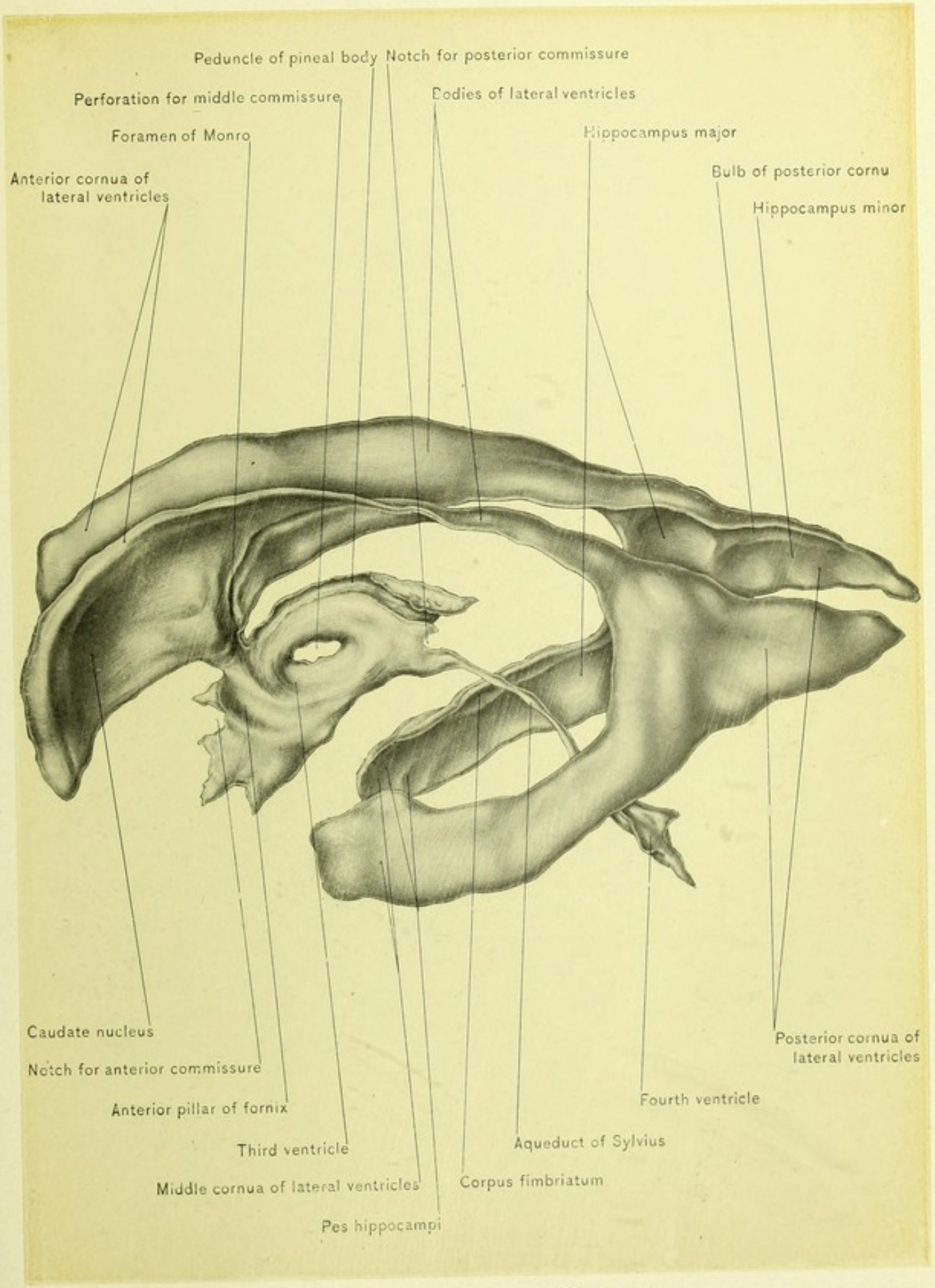


DIAGRAM OF THE VENTRICLES—LATERAL VIEW.

the lateral ventricle. Along its antero-superior or concave margin is the corpus fimbriatum. Its anterior extremity, the *pes hippocampi*, is enlarged, and presents two or more grooves, so that it somewhat resembles the paw of an animal.

Dissection.—Carefully separate the inner border of the corpus fimbriatum from the choroid plexus of the descending cornu of the lateral ventricle, thus breaking through the epithelial lining of the ventricle; displace the choroid plexus inward, and slightly depress the corpus fimbriatum and hippocampus major. This procedure exposes the fascia dentata, and separates the margins of the hippocampal fissure.

The **Fascia Dentata,** or **Dentate Convolution,** a serrated band of gray matter, is the margin of the hippocampal convolution in relation with the hippocampal fissure. The serrations or indentations of the fascia dentata are produced by the vessels of the pia mater, which projects through the hippocampal fissure into the descending cornu of the lateral ventricle. The fascia dentata extends from near the splenium of the corpus callosum to the anterior extremity of the descending cornu of the lateral ventricle. As the epithelial lining of the ventricle must be divided in order to expose the fascia dentata, that convolution is external to the wall of the ventricular cavity.

The **Hippocampus Minor, Calcar Avis,** or **Ergot,** is a small, convex, white eminence which occupies the floor and inner wall of the posterior cornu of the lateral ventricle. It is produced by the calcarine fissure, and is at times but faintly marked.

The **Eminentia Collateralis,** or **Pes Accessorius,** may be recognized at its commencement as a smooth white eminence fitting into the angle of divergence of the hippocampus major and hippocampus minor, at the junction of the middle and posterior cornua of the lateral ventricle. It extends forward as the floor of the middle cornu of the lateral ventricle almost to the extremity of this cornu. It is produced by the collateral fissure.

Dissection.—Next divide the fornix transversely at about its middle, and reflect the one half forward and the other backward, thus exposing the greater part of that process of pia mater—the velum interpositum—which lies above the epithelial roof of the third ventricle. To expose thoroughly the velum interpositum, especially that part of it which occupies the central portion of the transverse fissure, make a longitudinal incision through the posterior part of the fornix and corpus callosum; then reflect these flaps laterally.

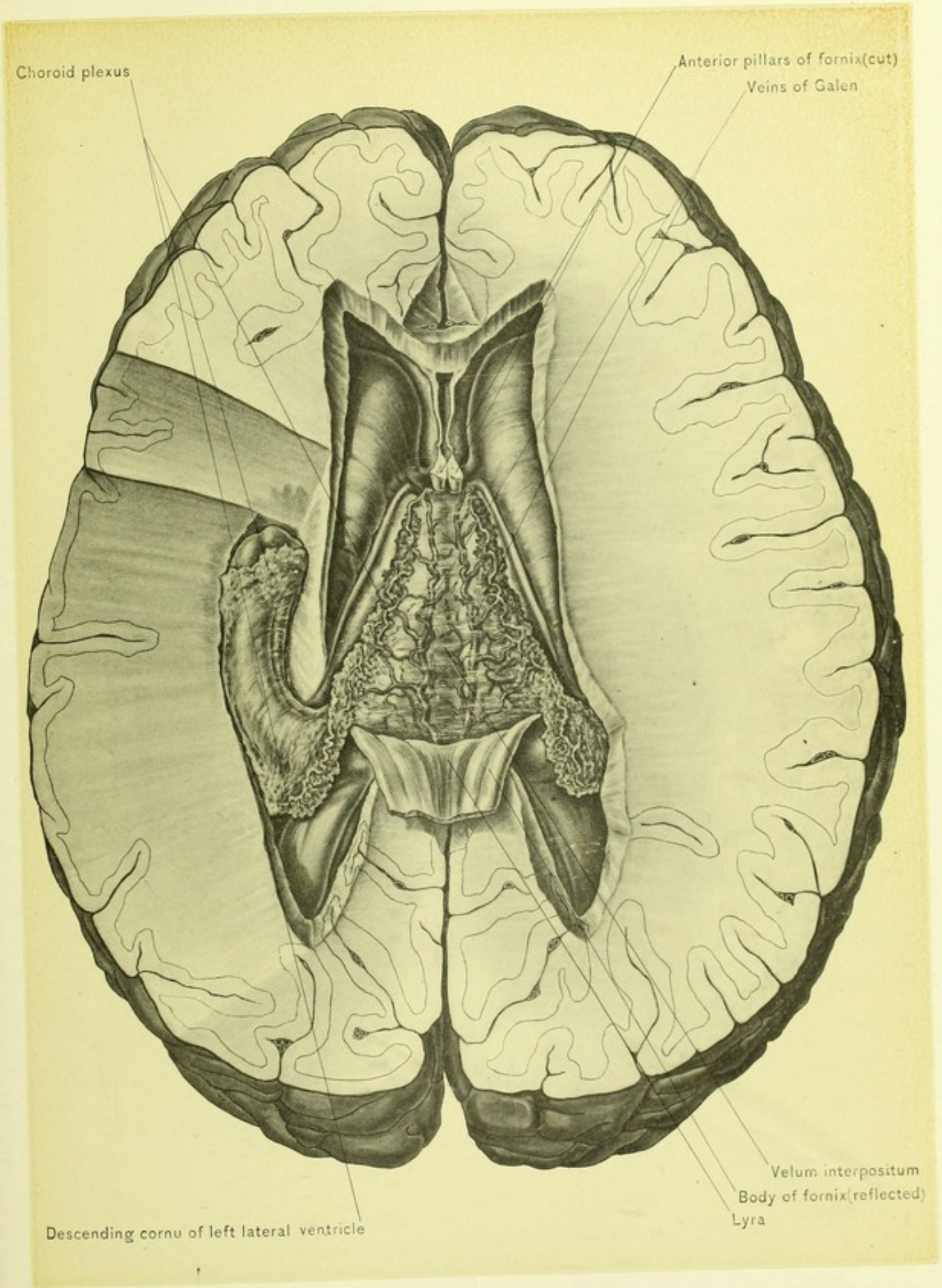
The **Velum Interpositum,** or **Tela Choroidea Superior,** is that process of the pia mater which reaches the interior of the brain by way of the horizontal portion of the transverse fissure, passing between the splenium of the corpus callosum and the corpora quadrigemina. It is a double layer of pia mater, and is triangular in

shape, like the fornix; it lies beneath the fornix and the corpus callosum. It covers the quadrigeminal bodies, the pineal body, the third ventricle, and part of the optic thalami. Its borders contain the choroid plexuses of the lateral ventricles, while in its under surface are situated the two choroid plexuses of the third ventricle. The latter plexuses are continuous with the choroid plexuses of the lateral ventricles just behind the foramina of Monro. Running one on each side of the median line of the velum interpositum, between its two layers, are the two veins of Galen, formed by the union of the veins of the corpora striata and the choroid veins, in addition to small twigs from surrounding structures. They unite posteriorly to form a single trunk, which joins the inferior longitudinal sinus to form the straight sinus at the junction of the inferior margin of the falx cerebri with the anterior margin of the tentorium cerebelli.

Dissection.—Raise the velum interpositum and the choroid plexuses and turn them backward. Especial care is necessary in raising the posterior part of the velum interpositum so as not to raise the pineal gland with it, as the gland is closely invested by the lower layer of pia mater entering the velum. This dissection exposes the third ventricle, the three commissures of that ventricle, the anterior crura of the fornix, the optic thalami, the pineal body and its peduncles, and the quadrigeminal body. In making the dissection it frequently happens that the middle commissure of the third ventricle is broken, and the dissector, if not familiar with this fact, might conclude that it was absent in the brain under examination.

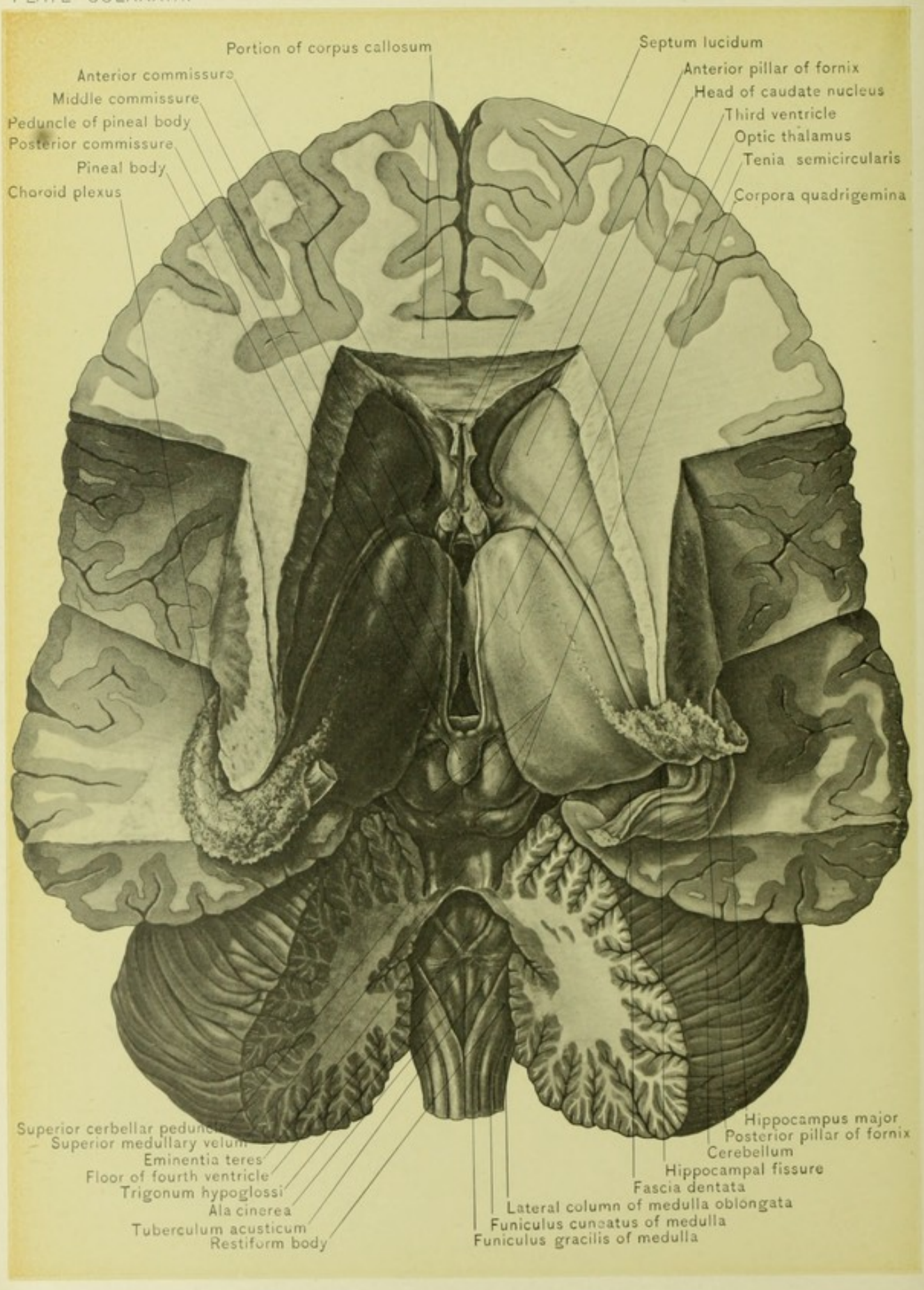
Fissure of Bichat.—Before describing the parts exposed by the removal of the velum interpositum, the great transverse fissure of the brain, or fissure of Bichat, which is now opened up throughout, should be carefully observed. To do this to the best advantage it is necessary to remove the velum interpositum and the choroid plexuses of the lateral and third ventricles with the adherent epithelium. The central horizontal or transverse portion of this fissure, through which the velum interpositum passes, is the continuation of the interspace between the cerebrum and the cerebellum seen in the undissected brain with the pia mater removed. This central portion is continuous with the lateral portions, or hippocampal fissures, which are seen in the dissection of the middle cornua of the lateral ventricles, thus making the fissure, as a whole, horseshoe shaped.

The **Third Ventricle** is a narrow, oblong cavity situated in the middle line of the cerebrum, between the optic thalami and the peduncles of the pineal body, and reaching to the base of the brain. It is wider and shallower behind than in front. It is bounded *above* by the velum interpositum, although its immediate roof is formed by a thin epithelial layer which is continuous with the lining epithelium or ependyma of the ventricle; on the *sides*, by the optic thalami and the peduncles



VELUM INTERPOSITUM AND CHOROID PLEXUS.

PLATE CCLXXXIII.



VENTRICLES AND NUCLEI OF THE BRAIN.

of the pineal body ; in *front*, by the anterior commissure and the anterior pillars of the fornix ; and *behind*, by the posterior commissure, the orifice of the aqueduct of Sylvius, and the pia mater, passing from the upper surface of the pineal body to the inferior layer of the velum interpositum. Its *floor* is formed by the bodies which fill the interpeduncular space of the base of the brain and the superior surface of the crura cerebri at their origin from the pons Varolii. The structures in the interpeduncular space are named, from before backward, the lamina cinerea, the tuber cinereum, the infundibulum, the corpora albicantia, and the posterior perforated space.

Commissures.—Stretching across the ventricle are the anterior, middle, and posterior commissures. The *anterior commissure* is situated in front of the anterior crura of the fornix. It is composed of white matter and connects the two temporal lobes of the cerebrum. The *middle commissure* is composed almost entirely of gray matter, is the largest, and is about one-half an inch, or twelve millimeters, in width. It connects the optic thalami, and, as has been observed, is frequently torn across in the dissection of the brain. The *posterior commissure*, the smallest of the three, is situated in front of and beneath the pineal body, and above the anterior opening of the aqueduct of Sylvius. It is composed of white matter, connects the optic thalami, and probably contains decussating fibers derived from various sources.

The **Foramina of Monro** are the orifices of communication between the lateral ventricles and the third ventricle. Each foramen is bounded in front by the corresponding anterior crus of the fornix, behind by the optic thalamus and choroid plexus, above by the anterior crus of the fornix, and below by the ependyma reflected from the optic thalamus to the anterior crus of the fornix. The two foramina have a common orifice in the third ventricle, thus forming a Y-shaped passage, called the *foramen commune anterius*, through which cerebro-spinal fluid in one lateral ventricle may enter the other lateral ventricle.

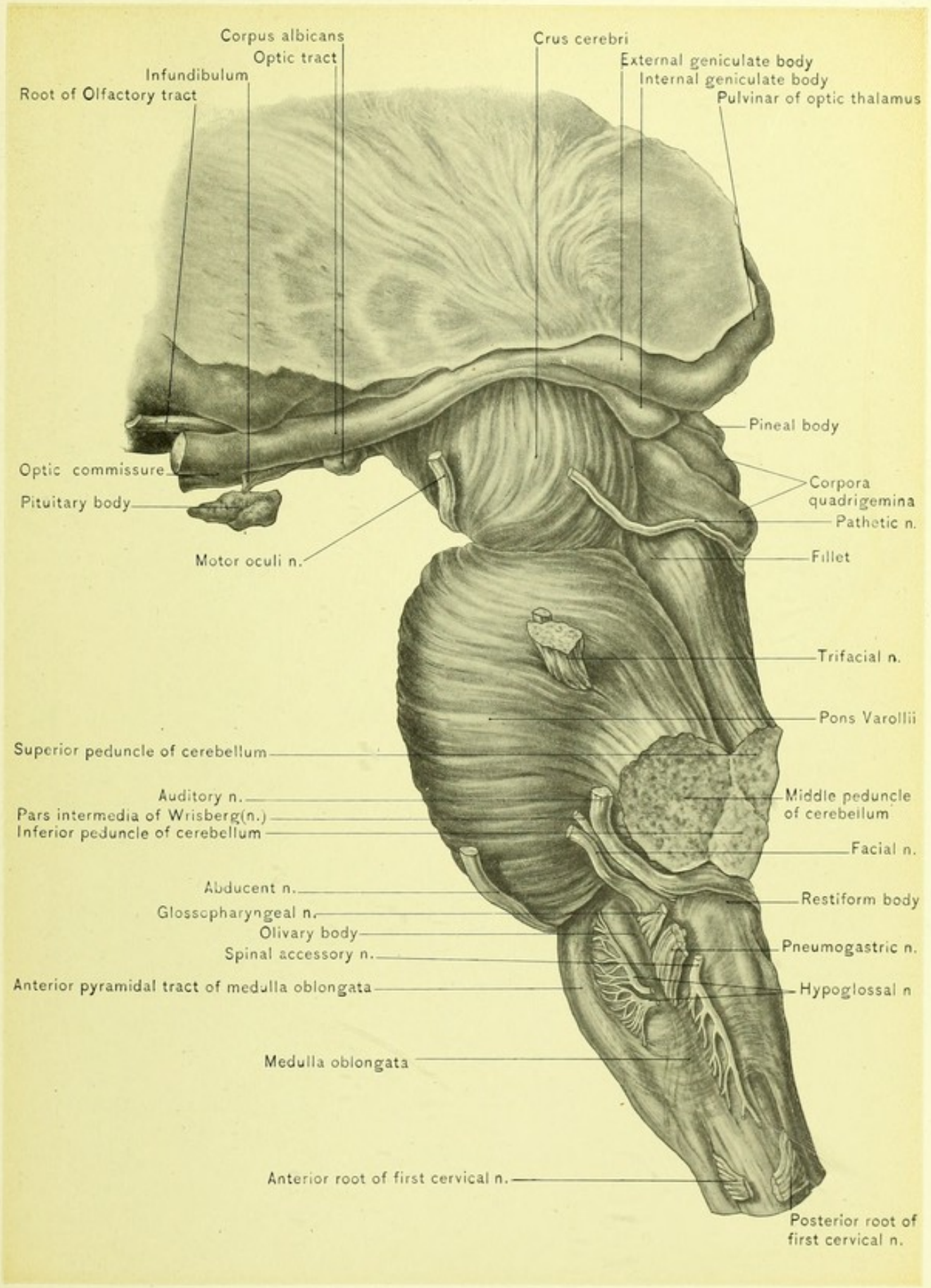
Aqueduct of Sylvius.—At the posterior extremity of the third ventricle, and beneath the posterior commissure, is seen the anterior orifice of the aqueduct of Sylvius, or iter e tertio ad quartum ventriculum. This is a narrow passageway about three-fourths of an inch, or two centimeters, in length, and passes beneath the quadrigeminal body to establish a communication between the third and fourth ventricles. It is lined with ependyma which is continuous with, and similar to, that lining the ventricles which it connects. Its *roof* is formed by the lamina quadrigemina, a plate of gray matter which supports the corpora quadrigemina. Its *floor* is formed by the tegmental portions of the crura cerebri. The gray matter in its floor contains the nuclei which give origin to the third and fourth cranial nerves.

The **Optic Thalami,** the posterior pair of cerebral ganglia, are two oval masses of white and gray matter. They are convex from before backward, and slightly so from side to side, and have their long axis directed obliquely from before backward and from within outward. They lie one upon each side of the third ventricle, between the tails of the caudate nuclei, and rest upon the crura cerebri. Each optic thalamus forms a large portion of the floor of the body of the lateral ventricle, while its posterior end projects into the descending cornu of that ventricle. Each optic thalamus consists of two extremities: an anterior, called the **anterior tubercle,** which forms the posterior boundary of the foramen of Monro, and a posterior, called the **pulvinar,** or **posterior tubercle.** The upper surface of each is partly free and partly covered by the choroid plexus of the lateral ventricle, the velum interpositum, and the lateral border of the body of the fornix. On its upper surface is situated an antero-posterior groove, called the **sulcus choroideus,** for the attachment of the velum interpositum. In the groove between the caudate nucleus and the optic thalamus lies the tænia semicircularis. The optic thalami are connected by the middle and posterior commissures of the third ventricle. Running along the upper border of each optic thalamus from behind forward are the peduncles of the pineal gland.

Geniculate Bodies.—The under surface of the posterior extremity of each optic thalamus, which forms part of the roof of the middle cornu of the lateral ventricle, presents two small gray eminences, the **internal** and **external geniculate bodies.** To see these bodies satisfactorily, turn the brain on its side and raise the posterior extremity of the optic thalamus. The internal geniculate bodies are connected internally with the nates of the corpora quadrigemina through the medium of the brachia, and externally are directly continuous with the optic tract.

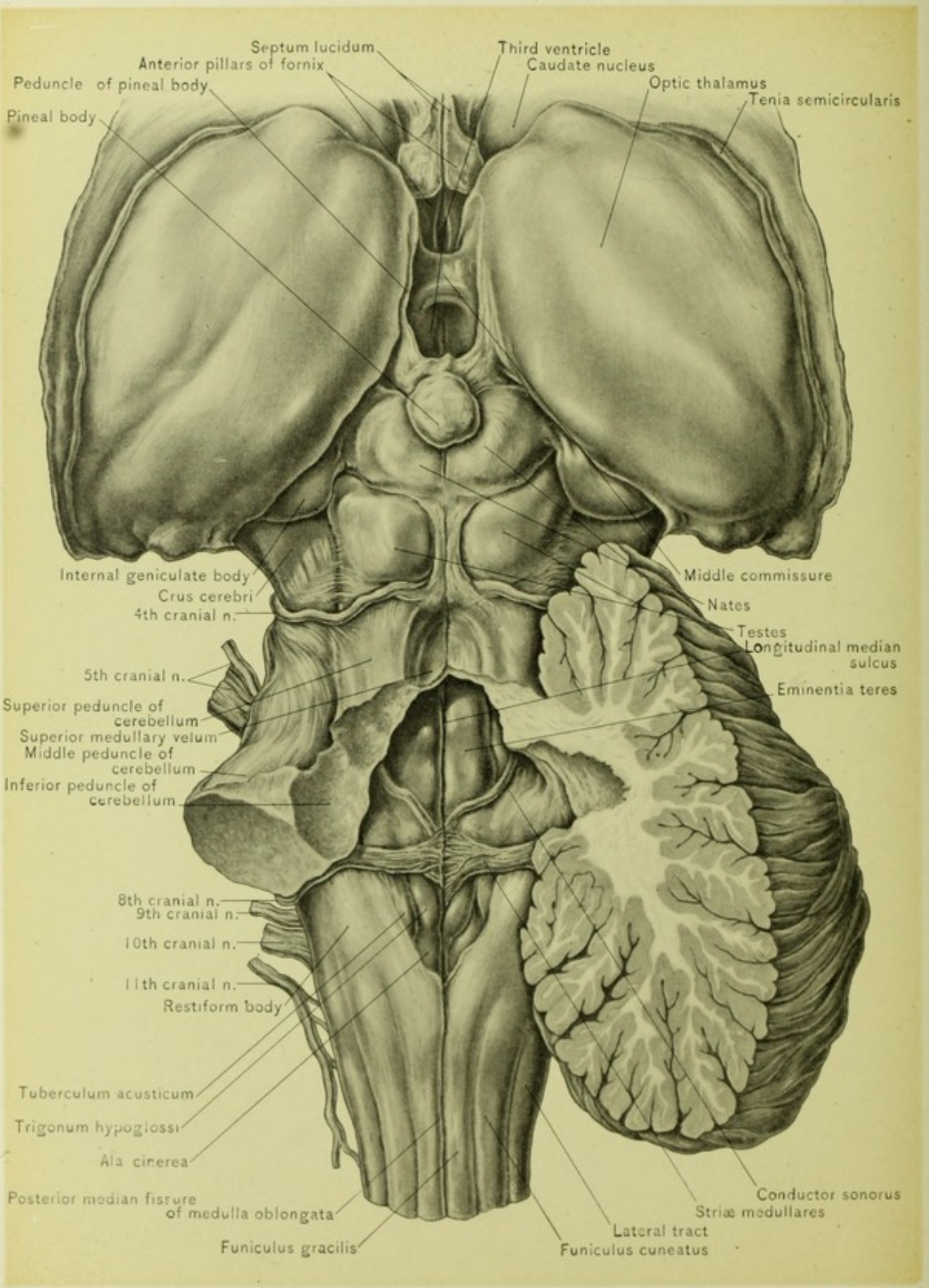
The **Pineal Gland** or **Body, Conarium,** or **Epiphysis Cerebri,** is a small, reddish gray, oval body, about one-fourth of an inch, or six millimeters, in length. It is directed forward and upward, and rests upon the groove between the anterior pair of the corpora quadrigemina and above the posterior commissure of the third ventricle. From the base of the pineal body a white crus, or peduncle, passes forward upon each side of the third ventricle and along the upper and inner surface of the optic thalami to the anterior crura of the fornix, with which the peduncles become continuous. Posteriorly they are joined together in front of the base of the pineal body, and are connected with the posterior commissure of the third ventricle.

The **Corpora Quadrigemina,** or **Optic Lobes,** are situated immediately behind the third ventricle, and are composed of four eminences. These are arranged in two pairs: an anterior or upper, the larger of the two, and called the **nates,** and a



LATERAL VIEW OF CORPORA QUADRIGEMINA, PONS, AND MEDULLA.

PLATE CCLXXXV.



THIRD AND FOURTH VENTRICLES AND CORPORA QUADRIGEMINA.

posterior or lower, called the **testes.** They are situated upon a layer of gray matter known as the **lamina quadrigemina,** which overlies the aqueduct of Sylvius. They give off anteriorly four bands or brachia, which are composed of white matter externally and gray matter internally. The *brachia of the nates,* or superior brachia, pass under the internal geniculate bodies into the optic tracts. The *brachia of the testes,* or inferior brachia, pass below and external to the brachia of the nates, and below the internal geniculate bodies leave the surface. The posterior quadrigeminal bodies or testes are each connected with the hemisphere of the cerebellum by a broad band of white matter, the superior peduncle of the cerebellum (*processus e cerebello ad testes*).

Dissection.—In order to see the superior cerebellar peduncles more clearly, the anterior extremity of the middle lobe of the cerebellum should be lifted slightly and pushed backward, or, better, a longitudinal incision should be carried through the middle of this lobe, and each half displaced laterally. This will expose these peduncles clearly and also show the fillet and the valve of Vieussens.

The **Superior Peduncle of the Cerebellum** (processus e cerebello ad testes) connects the hemisphere of the cerebellum with the opposite hemisphere of the cerebrum. It passes upward, forward, and inward along the side of the anterior part of the fourth ventricle, and beneath the corpora quadrigemina, where the fibers of the two peduncles decussate; beyond the corpora quadrigemina, along with the tegmental fibers of the crura cerebri, the fibers of each peduncle are continued to the optic thalamus and lenticular nucleus of the opposite hemisphere of the cerebrum.

The **Valve of Vieussens,** the anterior or superior medullary velum, is a triangular layer of white matter, narrow in front and broad behind, stretched between the superior peduncles of the cerebellum, and extending from the anterior extremity or nodule of the inferior vermiform process of the cerebellum to the corpora quadrigemina. It forms a portion of the roof of the fourth ventricle. Along the middle line of the upper surface is a longitudinal ridge, the *frenulum.* The lower half is overlapped by the *lingula,* a corrugated lobule of gray matter prolonged from the anterior extremity of the superior vermiform process. The trochlear nerves decussate within it, and emerge from its dorsal surface, just behind the inferior quadrigeminal bodies.

The **fillet** is a small, flat band or bundle of nerve fibers situated below and external to the superior peduncle of the cerebellum. It emerges from the pons at the upper limit of its posterior region, and appears as a triangular band which is situated above the crus cerebri and disappears under the testis and brachium of the testis.

Dissection.—If the superior and inferior vermiform processes of the cerebellum were not divided longitudinally when exposing the valve of Vieussens,

they should be divided now, and each half reflected laterally to expose the fourth ventricle.

The **Fourth Ventricle** is a quadrangular, lozenge-shaped space, situated between the cerebellum and the posterior surface of the medulla oblongata and pons Varolii.

The *roof* is formed anteriorly by the valve of Vieussens and the superior peduncles of the cerebellum, and posteriorly by the inferior medullary velum, the inferior vermiform process of the cerebellum, the choroid plexus, and the tela choroidea inferior. The *floor* is formed by the posterior surface of the medulla oblongata and pons Varolii. It is bounded laterally by the superior peduncles of the cerebellum above, and the inferior peduncles of the cerebellum below. The ventricle is lined by the ependyma or epithelial wall of the ventricles of the brain. The ventricle presents four angles, a superior, an inferior, and two lateral (also called the lateral recesses of the ventricle). The widest part of the ventricle corresponds to the interval between the lateral angles, which are at about its middle.

The **Tela Choroidea Inferior** is that part of the pia mater on the posterior surface of the medulla oblongata which completes the posterior part of the roof of the fourth ventricle. It contains three perforations: the foramina of Magendie, Key, and Retzius.

The foramen of Magendie is located in the median line near the inferior angle of the fourth ventricle. The foramina of Key and Retzius are located at the lateral recesses of the ventricle. By way of these openings the ventricle communicates with the general subarachnoid space.

The two **choroid plexuses** of the fourth ventricle are also derived from the pia mater by the intrusion of its folded edge into the roof of that cavity. They extend forward from the posterior angle of the fourth ventricle near the median line for a short distance, and then diverge to reach the lateral recesses of the ventricle.

The fourth ventricle communicates with the third ventricle by way of the aqueduct of Sylvius, and with the central canal of the spinal cord through an opening in the inferior angle which is dilated and is called the *ventricle of Arantius.*

The floor of the fourth ventricle is its most important part, for the reason that the nuclei of most of the cranial nerves are situated there. It is composed chiefly of gray matter continuous with the gray matter of the spinal cord. Occupying the middle line of the floor of the fourth ventricle is the **median longitudinal fissure.** It extends from the posterior orifice of the aqueduct of Sylvius to the posterior or inferior angle of the ventricle, which is at the point of divergence of the

PLATE CCLXXXVI.

TRANSVERSE SECTION OF CEREBRUM.

restiform bodies of the medulla. This fissure is continuous below with the central canal of the spinal cord. This portion of the fourth ventricle has received the name of **calamus scriptorius** because of the resemblance of the longitudinal fissure and the diverging posterior pyramids and restiform bodies to the point of a pen. Immediately to each side of the median furrow is a longitudinal ridge, the **eminentia teres.** Crossing this eminence in the lower half of the ventricle are bands of white matter, the auditory striæ or **striæ acusticæ.** To the outer side of the eminentia teres and anterior to the auditory striæ is a depressed area, the *superior fovea*, while behind the auditory striæ, and to the outer side of the eminentia teres, are two furrows so united as to form an inverted V, the *inferior fovea;* the floor of the inferior fovea is known as the **ala cinerea.**

The **trigonum hypoglossi** is the area of the floor of the fourth ventricle bounded by the longitudinal fissure, striæ acusticæ, and inferior fovea, and covers the nucleus of the hypoglossal nerve. The **tuberculum acusticum** is the triangular area situated between the inferior fovea and the clava of the funiculus gracilis, and extending forward under the striæ acusticæ.

In front of the superior fovea and external to the eminentia teres is a small eminence of dark gray matter, the **locus cæruleus.** Prolonged forward from the locus cæruleus, at the side of the eminentia teres and extending to the upper end of the floor of the ventricle, is a thin streak of dark gray matter, the **tænia violacea.** The locus cæruleus and tænia violacea are produced by the substantia ferruginea, whose dark color is seen through the overlying white matter. The **substantia ferruginea** is the dark, pigmented mass seen in sections of the upper part of the floor of the fourth ventricle. The ependyma lining the fourth ventricle is continuous through the aqueduct of Sylvius with that lining the third ventricle.

Dissection.—Next complete the dissection of the cerebrum by making horizontal sections of the corpora striata and optic thalami, carrying the incisions through to the external or lateral surface of the hemisphere. This will expose the caudate nucleus, the internal capsule, the lenticular nucleus, the external capsule, the claustrum, and the island of Reil from within outward in the order named.

The **Caudate Nucleus,** or intra-ventricular portion of the corpus striatum, is the more anterior of the gray basal ganglia, and has been described.

The **Internal Capsule** lies external to and behind the caudate nucleus, and separates the caudate from the lenticular nucleus, and the lenticular nucleus from the optic thalamus. The internal capsule, composed of white matter and somewhat crescentic or angular in shape, consists of a genu and two limbs, an anterior and a posterior. The *anterior limb*, named by Spitzka the caudo-lenticular portion, intervenes between the caudate and lenticular nuclei. The *posterior limb*, named by the same author the thalamo-lenticular portion, intervenes between the

optic thalamus and the lenticular nucleus. The *genu*, the point where the capsule presents the greatest angularity, is opposite the interval between the caudate nucleus and the optic thalamus.

Through the internal capsule the nerve fibers pass in their course from the gray matter of the cortex of the cerebrum and caudate and lenticular nuclei to the crus cerebri, which transmits these fibers from the cerebrum to the pons, medulla oblongata, and spinal cord. In addition to these fibers the internal capsule contains fibers from the cerebral cortex to the optic thalamus.

The anterior third of the internal capsule contains the fibers from the cortex of the prefrontal lobe, or silent region, the middle third, the fibers from the motor or Rolandic area of the cortex of the cerebrum, and the posterior third, the sensory fibers from the occipital and temporal lobes.

Destruction of the anterior two-thirds of the posterior segment of the internal capsule, which occurs in many cases of *apoplexy*, results in motor paralysis of the opposite side of the body. This paralysis is diffuse, and not confined to a group of muscles, as in lesions of the cerebral cortex, while destruction of the posterior part of the posterior limb of the internal capsule results in loss of sensation of the opposite side of the body. A small hemorrhage in the capsule will cause paralysis of that part of the opposite side of the body supplied by the fibers compressed by the clot of blood.

The **Lenticular Nucleus,** or extraventricular portion of the corpus striatum, is larger than the caudate nucleus, is oval in form, and lies behind and to the outer side of the caudate nucleus. It is separated from the caudate nucleus by the anterior limb and genu of the internal capsule, and from the optic thalamus by the posterior limb of the internal capsule.

The **external capsule** is a band of white matter which lies to the outer side of the lenticular nucleus, and joins the internal capsule below the lenticular nucleus.

The **claustrum** is a thin layer of gray matter, lying to the outer side of the external capsule.

The **Island of Reil,** previously described, is external to the claustrum, and separated from it by a layer of white matter.

White Matter of Cerebrum.—In the dissection of the cerebrum, which will be completed when the crura cerebri have been traced from the upper border of the pons to each hemisphere, it should be noted that the white matter of the cerebrum is composed of three systems or sets of medullated nerve fibers, the ascending or peduncular, the transverse commissural, and the longitudinal commissural. The *ascending* or *peduncular fibers* are those fibers of the crura cerebri which, in diverging to reach the nerve cells of the cerebral cortex, form the *corona*

radiata, so called on account of the crown-like radiation of its fibers. The *transverse commissural fibers* include the fibers of the corpus callosum and the anterior and posterior commissures of the third ventricle. The *longitudinal commissural fibers* include the fibers of the fornix, the striæ longitudinales of the corpus callosum, the tænia semicircularis, fibers in the gyrus fornicatus and gyrus hippocampi, and the peduncles of the pineal body. They also include the associating fibers: those fibers which connect the cells of neighboring and of more distant convolutions.

THE PONS VAROLII.

Dissection.—Having completed the dissection of the cerebrum, excepting the tracing of the crura cerebri, turn the brain so as to expose the base, and study the pons, then the medulla oblongata, and lastly the cerebellum.

The **Pons Varolii,** or **Tuber Annulare,** is that division of the brain through the medium of which the other three divisions of the brain are united. It is connected with the cerebrum, above, by the crura cerebri, or peduncles of the cerebrum; with the cerebellum, behind, by the middle peduncles of the cerebellum; and with the medulla, below, by the fibers of the pyramidal tract of the medulla oblongata. It is situated behind the crura cerebri, in front of the medulla oblongata, between and below the hemispheres of the cerebellum, and between the posterior portion of the temporo-sphenoid lobes of the cerebrum. In the cranial cavity it lies below the level of the superior occipital foramen of the tentorium cerebelli, and rests upon the basilar process of the occipital bone and the posterior surface of the body of the sphenoid bone. It is quadrangular in shape, and is composed chiefly of white matter, the fibers of which are arranged transversely and longitudinally. It presents two surfaces, an anterior and a posterior. The *anterior surface* is markedly convex from side to side, and slightly so from before backward, and measures transversely about one and one-half inches, or four centimeters, and is about one inch, or twenty-five millimeters, in length. The anterior surface is marked along the middle line by a groove, which is broader in front than behind, and lodges the basilar artery. The anterior surface presents two borders, an upper and a lower. The upper border, the longer, is convex, and arches beneath the crura cerebri. The lower border is almost straight, and is separated from the medulla oblongata by a transverse groove. The *posterior surface* is slightly concave from side to side, and forms part of the floor of the fourth ventricle. From the side of the pons the trifacial or fifth cranial nerve is seen emerging.

In coronal sections the pons can be divided into an anterior or ventral region, and a posterior or tegmental region. The *anterior region of the pons* is composed of transverse and longitudinal fibers. The *superficial transverse fibers* of the ante-

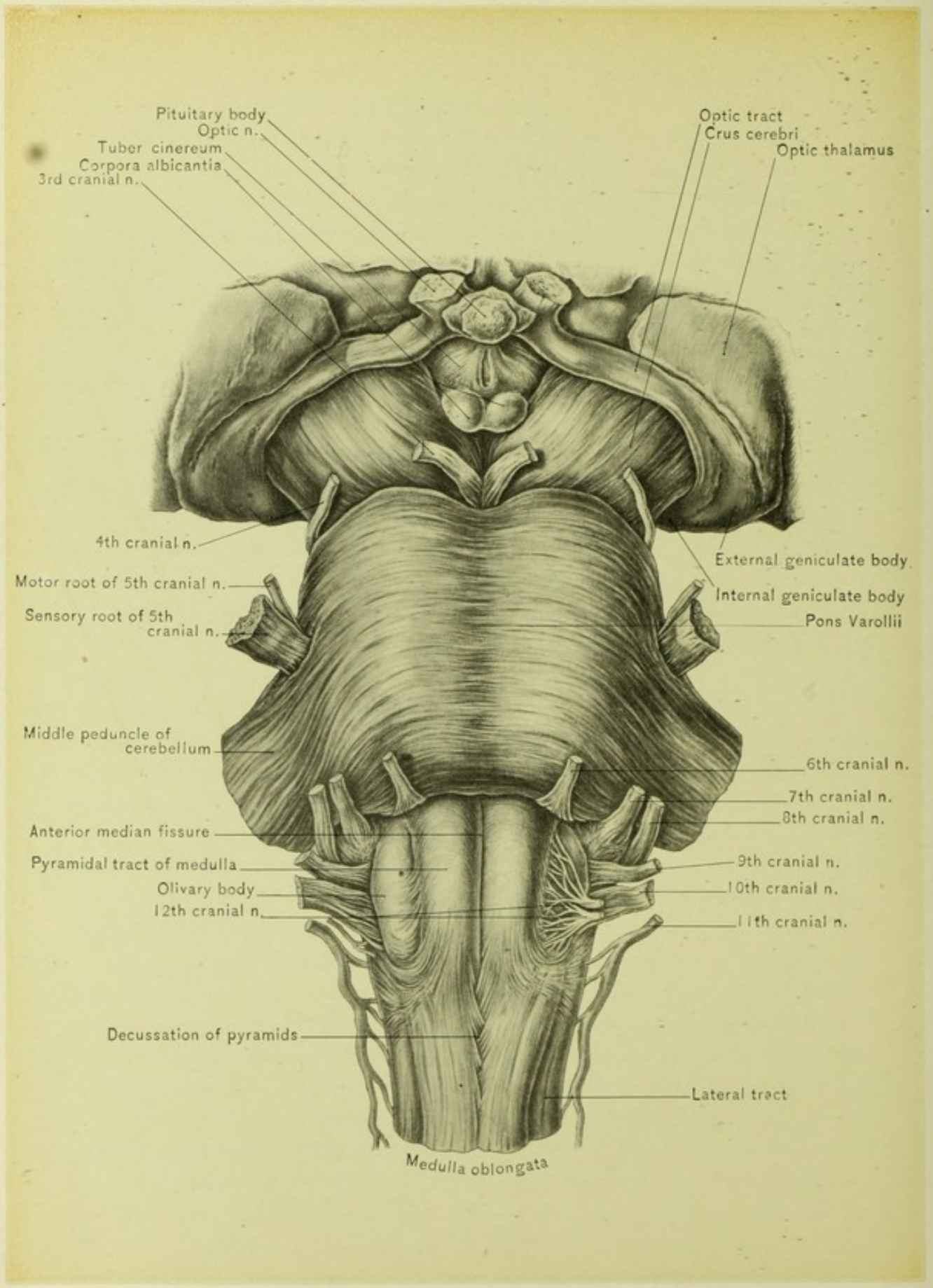
rior region of the pons pass obliquely outward and backward to the hemispheres of the cerebellum, forming the middle peduncles of the cerebellum. The *deep transverse fibers* of the anterior region of the pons are decussating fibers, which are crossing in the pons in passing from the cerebellar hemisphere of one side to the cerebral hemisphere of the opposite side. The *longitudinal fibers* are more deeply situated than the superficial transverse fibers, and are separated into bundles by the deep transverse fibers. They are the fibers of the pyramidal tracts of the medulla oblongata, passing upward to enter the crustæ of the crura cerebri.

In the *posterior* or *tegmental region of the pons* the chief structures observed are the tract of the fillet, which is seen nearest the anterior region, the formatio reticularis, the posterior longitudinal bundle, and the superior olivary nucleus. This region of the pons also contains the nuclei of the sixth and seventh cranial nerves, and a part of the nucleus of the eighth cranial nerve. While the importance of these nuclei has been clearly proved by clinical experience in cases of paralysis caused by hemorrhage occurring within the substance of the pons, as well as by microscopic investigation, they are not macroscopically visible.

Hemorrhage into the pons is usually followed by coma and sudden death, particularly if the hemorrhage is extensive, or if the blood escapes into the fourth ventricle. The decussation of the trifacial and the facial nerves takes place within the pons; if, therefore, a lesion—as, for example, a small hemorrhage—occur above the point of the crossing of the fibers of the facial nerve, paralysis of the face and body on the side opposite the lesion will occur; while if the lesion be immediately below the point of crossing, the paralysis of the face will be upon the side of the lesion and the hemiplegia upon the side opposite to the lesion, thus giving rise to the condition known as *crossed hemiplegia*. Nerve fibers from the motor cortical area for speech run through the pons, and may be involved in a lesion of the pons, thus giving rise to aphasia.

The **Crura Cerebri,** or **Peduncles of the Cerebrum,** are two large round bodies of white matter, about three-fourths of an inch, or two centimeters, in length, and broader in front than behind. They emerge from the upper border of the pons, whence they pass outward and forward to enter the under part of the hemispheres of the cerebrum. They pass through the superior occipital foramen in company with the superior peduncles of the cerebellum, the basilar artery, and the oculo-motor and pathetic nerves. Crossing the lower surface of the crura just before they enter the hemispheres of the cerebrum, and adherent to them, are the optic tracts, while in relation with their inner borders are the oculo-motor nerves, and with their outer margins, the pathetic nerves.

Dissection.—Divide one of the crura cerebri transversely, and a nucleus of



PONS, MEDULLA, AND SUPERFICIAL ORIGINS OF CRANIAL NERVES.

gray matter—the *locus niger*, or substantia nigra—will be seen in the interior of the crus. Through the medium of this nucleus the crus cerebri is divided into an upper or posterior portion and a lower or anterior portion. The upper or posterior portion is known as the tegmentum, and the lower or anterior portion as the crusta.

The **tegmentum of the crus cerebri** is composed largely of the longitudinal fibers of the tegmental region of the pons, which proceed from the lateral tract and posterior pyramids of the medulla oblongata; it also receives the fibers of the superior peduncle of the cerebellum. The tegmental fibers of the crus cerebri are sensory, and enter the hemisphere of the cerebrum below and through the optic thalamus, beyond which they form part of the corona radiata. The tegmentum contains two nuclei, the *subthalamic body* and the *tegmental* or *red nucleus*. The admixture of gray and white matter of the tegmentum forms the *formatio reticularis*.

The **crusta** is composed chiefly of the longitudinal fibers of the anterior region of the pons, which proceed from the anterior pyramids of the medulla. The fibers of the crusta are motor, and enter the hemisphere through the internal capsule, beyond which they form a part of the corona radiata. The inner one-fifth of the crusta contains fibers which are passing to the pons from the prefrontal lobe.

THE MEDULLA OBLONGATA.

The **Medulla Oblongata,** or **Bulb,** the upper continuation of the spinal cord, begins at the decussation of the pyramids or the upper border of the atlas, and extends to the lower border of the pons Varolii, being not quite one and one-half inches, or 3.5 centimeters, in length. It increases in width from below upward, and just below the pons it is about three-fourths of an inch, or two centimeters, wide. Its anterior or ventral surface rests partly upon the basilar portion of the occipital bone, and its posterior or dorsal surface is directed toward the vallecula of the cerebellum, which lodges part of the medulla. The anterior surface presents, in the median line, the *anterior median fissure*, which is the continuation upward of the anterior median fissure of the spinal cord, which fissure is, however, interrupted by white fibers crossing from one side to the other and forming the decussation of the pyramids. On its posterior aspect, for one-half the length of the medulla, is situated the *posterior median fissure* or sulcus, the continuation of the corresponding fissure of the spinal cord.

The medulla oblongata, like the spinal cord, is divided into an anterior, a lateral, and a posterior area. The *anterior area* is occupied by the anterior pyramids. The *lateral area* is occupied by the olivary body and the lateral column.

The *posterior area* contains the funiculus of Rolando, funiculus cuneatus, and funiculus gracilis, and in its upper portion is the restiform body.

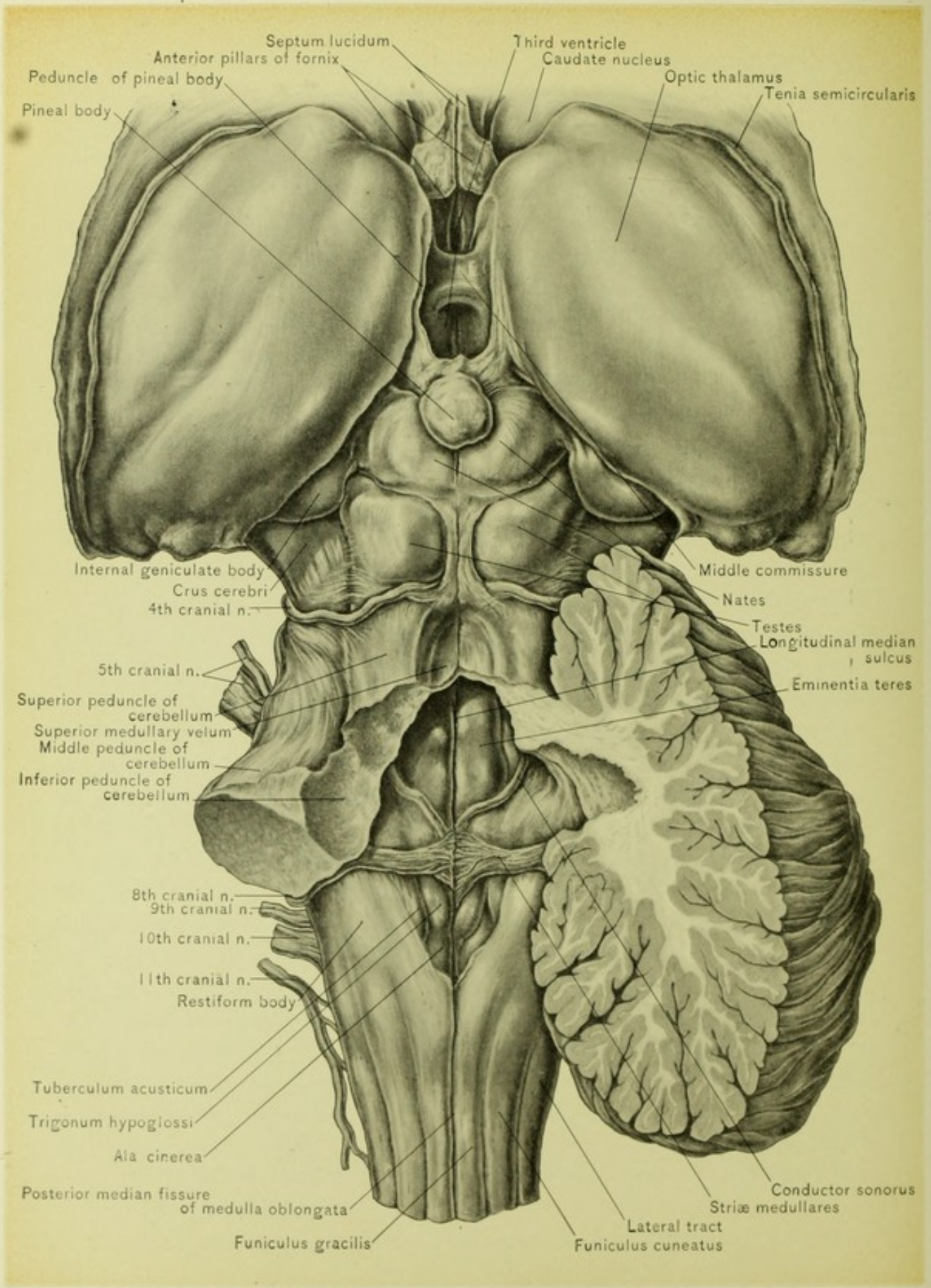
The **Anterior Pyramids,** or **Pyramids of the Medulla Oblongata,** are situated between the anterior median and antero-lateral fissures. They are larger above, but are somewhat constricted and rounded where they disappear beneath the superficial transverse fibers of the pons. On separating the anterior pyramids below, bundles of fibers will be seen decussating across the anterior median fissure. This decussation is produced by the innermost fibers of the pyramids, which are derived from the lateral or crossed pyramidal tracts of the spinal cord, and have reached the surface of the medulla oblongata at this point by cutting through the anterior horn of the gray matter of the spinal cord, and pushing aside the anterior pyramid. The outermost fibers, which form the smaller number of fibers of the pyramid, do not decussate, and continue downward as the direct pyramidal tract of the spinal cord; these fibers decussate in the anterior or white commissure of the spinal cord. The decussation of the pyramids of the medulla explains the fact that in disease or injury of the motor cortex of the brain the paralysis is found on the side of the body opposite to the lesion in the brain.

The continuation of the anterior ground bundle of the spinal cord is not seen in the anterior area of the medulla oblongata, as the fibers of that tract are depressed from the surface by the decussating bundles of the crossed pyramidal tract.

The **Olivary Body** is an oval prominence on the medulla oblongata, situated to the outer side of the anterior pyramid. It is separated from the anterior pyramid by a narrow longitudinal groove, the hypoglossal sulcus, or *antero-lateral furrow* of the medulla, which is continuous with the antero-lateral fissure of the spinal cord. The olivary body is limited posteriorly by the *post-olivary sulcus.* Like the anterior pyramid, it is broader above than below. It is separated from the pons by a deep groove, and is about one-half an inch, or twelve to fifteen millimeters, in length. Emerging from the hypoglossal sulcus or antero-lateral furrow are the roots of the hypoglossal nerve. Arching below and over the olivary body, and emerging from the anterior median and antero-lateral fissures, several white bundles are seen—the **superficial arciform fibers**—which enter the restiform body of the same side. If an oblique incision be carried through the olivary body, there will be revealed in its interior a nucleus of gray matter, the **corpus dentatum** of the olivary body. This nucleus is arranged in the form of a hollow capsule, and presents a convoluted outline partly incomplete at its inner side. Through this open part of the capsule passes a bundle of white fibers, the **peduncle of the olivary body.**

The **Lateral Tract of the Medulla Oblongata** is apparently the upward extension of the lateral column of the spinal cord, but it does not contain the crossed

PLATE CCLXXXVIII.



THIRD AND FOURTH VENTRICLES AND CORPORA QUADRIGEMINA.

pyramidal tract of the cord, which enters the pyramidal tract of the medulla oblongata, and the direct cerebellar tract of the cord leaves it to enter the restiform body. It is bounded in front by the antero-lateral furrow, and behind by the postero-lateral furrow. Emerging from the antero-lateral furrow or hypoglossal sulcus are the roots of the hypoglossal nerve, and from the postero-lateral furrow the roots of the glosso-pharyngeal, pneumogastric, and spinal accessory nerves emerge. As it ascends, the lateral tract of the medulla becomes less marked, the greater portion of it passing beneath the olivary body.

Dissection.—To examine satisfactorily the remaining portion of the medulla oblongata, lift it out from the interval between the hemispheres of the cerebellum, and displace it forward, thus exposing the posterior surface of the medulla, as well as that portion of the floor of the fourth ventricle formed by the medulla.

The **Funiculus of Rolando,** which lies posterior to the lateral tract and on the outer side of the funiculus cuneatus, is the upward continuation of a mass of gray matter—the substantia gelatinosa—which caps the posterior cornu of the gray matter of the spinal cord. This funiculus presents an enlargement on a level with the lower end of the olivary body, called the **tubercle of Rolando.**

The **Funiculus Cuneatus** lies between the funiculus of Rolando and the posterior median column or posterior pyramid. It is the widest and thickest of the columns of the medulla. Opposite the clava of the funiculus gracilis it forms a prominence called the **cuneate tubercle.**

The **Posterior Pyramid,** or **Funiculus Gracilis,** the continuation upward of the posterior median column of the spinal cord, lies immediately to the outer side of the posterior median fissure. At the lower end of the fourth ventricle it swells out and forms a prominence, called the **clava.** The cuneate tubercle and the clava are produced by accumulations of gray matter known respectively as the *cuneate and gracile nuclei;* almost all the fibers of the funiculus cuneatus and funiculus gracilis terminate in these nuclei.

The **Restiform Body** appears to be formed by the funiculus gracilis, the funiculus cuneatus, and the funiculus of Rolando, passes outward and upward, and then enters the cerebellum, forming the inferior peduncle of the cerebellum. Since the fibers of the funiculus cuneatus and funiculus gracilis terminate in the cuneate and gracile nuclei, they can not, therefore, strictly speaking, be said to be directly continued into the restiform bodies. The following are the more important of the sources from which the fibers of the restiform body are derived: "(1) From the lateral column of the spinal cord, through the direct cerebellar tract; (2) from the convoluted nucleus of the olivary body of the opposite side; (3) from the gracile and cuneate nuclei of the opposite side; (4) from the gracile and cuneate nuclei of the same side" (Cunningham). By the divergence of the restiform bodies the lateral

boundaries of the lower part of the fourth ventricle are formed, while the apex of the lower triangle of the ventricle is situated at the point of separation of the two clavæ. This divergence exposes the gray matter of the interior of the medulla, which forms the floor of the lower portion of the fourth ventricle and is continuous with the gray matter of the spinal cord.

Recapitulation.—Review the parts seen in studying the medulla from before backward. They are: The anterior median fissure, the anterior pyramid, the hypoglossal or antero-lateral fissure with the roots of the hypoglossal nerve, the olivary body, containing the corpus dentatum, the post-olivary sulcus, the lateral tract, the postero-lateral fissure with the roots of the glosso-pharyngeal, pneumogastric, and spinal accessory nerves, the funiculus of Rolando and its tubercle, the funiculus cuneatus with the cuneate tubercle, the funiculus gracilis with the clava, and the posterior median fissure.

Function.—The medulla is described by Ranney as "the true nerve center of animal life." Several of the cranial nerves have their primary, deep, or central origin wholly or in part in the medulla. Some of the centers contained within the medulla are the respiratory, the vaso-motor, the cardio-inhibitory, the diabetic, and a salivary center.

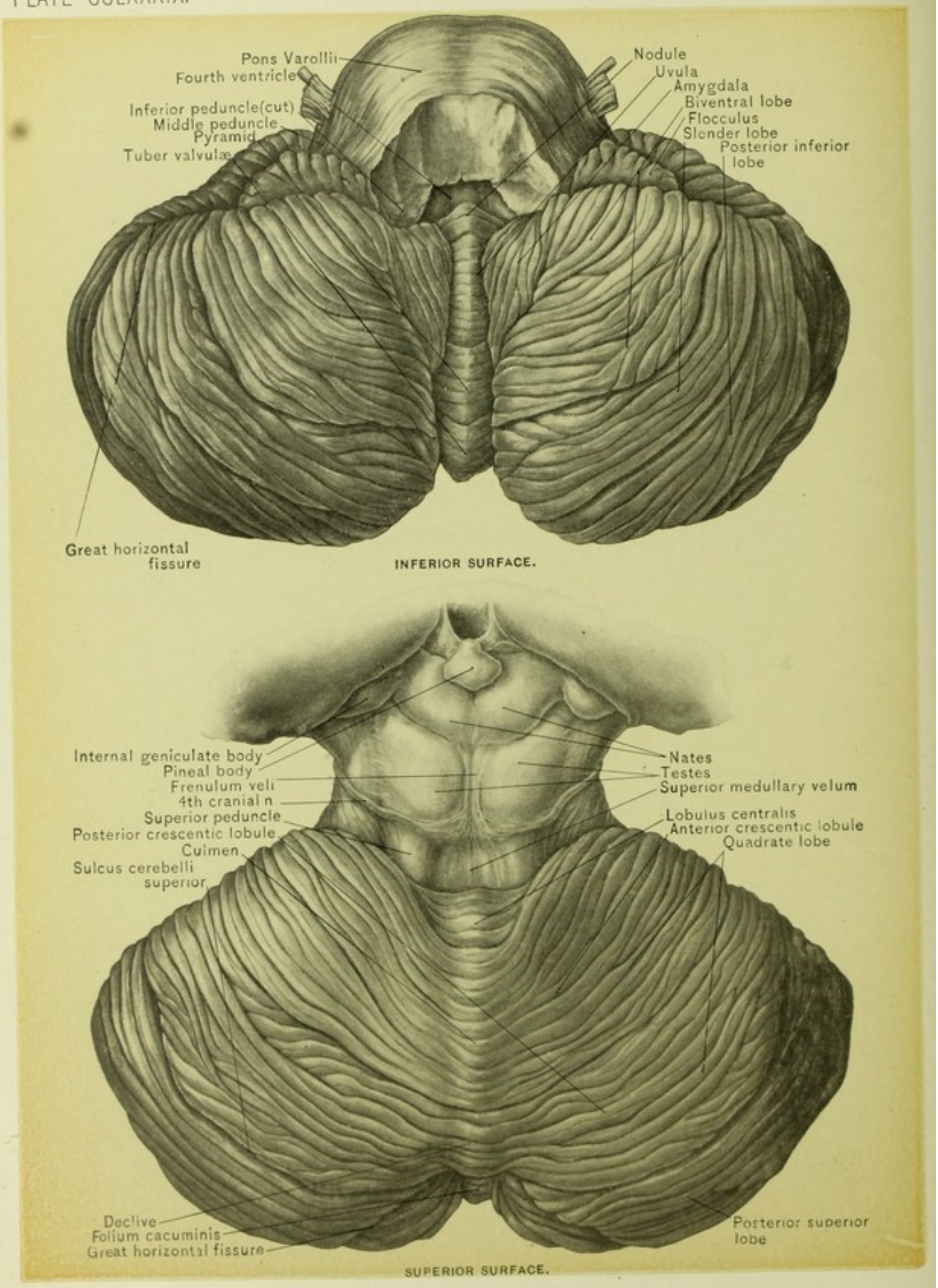
THE CEREBELLUM.

Position, Size, and Connections.—The cerebellum, or little brain, lies beneath the occipital lobes of the cerebrum, behind the pons, and above and upon both sides of the medulla oblongata. It occupies the inferior occipital fossæ, and lies beneath the tentorium cerebelli, which separates it from the cerebrum.

The surface of the cerebellum, like that of the cerebrum, is composed of gray matter, which is darker in color in the cerebellum, and arranged in *laminæ* instead of in convolutions. The cerebellum measures from three and one-half to four inches, or from nine to ten centimeters, in its transverse diameter, from two to two and one-half inches, or from five to six centimeters, in its antero-posterior diameter, and about two inches, or five centimeters, in its vertical diameter at the thickest part. It is attached to the cerebrum by the superior peduncles, to the pons by the middle peduncles, and to the medulla oblongata by the inferior peduncles of the cerebellum.

Lobes.—The cerebellum consists of two hemispheres and a central lobe,—the vermiform process, or vermis,—through the medium of which the hemispheres are united. The hemispheres are separated inferiorly by a comparatively wide and deep median groove, the **vallecula,** or valley, which is occupied in great part by the medulla oblongata; the inferior vermiform process of the cerebellum also pro-

PLATE CCLXXXIX.



INFERIOR AND SUPERIOR SURFACE OF CEREBELLUM.

jects into the valley. The hemispheres are separated in front by a notch, the **incisura cerebelli anterior,** which lodges the inferior pair of corpora quadrigemina and the superior cerebellar peduncles; and behind by another notch, the **incisura cerebelli posterior** or **incisura marsupialis,** which is the posterior extremity of the valley and lodges the falx cerebelli. The **central lobe,** or **vermiform process,** presents two aspects: an upper, seen as a slight elevation in the middle of the upper surface of the cerebellum, and called the superior vermiform process, and an inferior, which is called the inferior vermiform process. Passing along the free border of each hemisphere is the **great horizontal fissure of the cerebellum,** which commences at the point where the middle peduncle of the cerebellum enters the hemisphere, and extends backward and around to the other middle peduncle of the cerebellum. The horizontal fissure separates the upper from the lower surface of the hemisphere.

Dissection.—Before proceeding further with the study of the cerebellum, remove what remains of the cerebrum by carrying an incision through the optic thalami and the crura cerebri, and detach the pia mater from the cerebellum.

The **Superior Vermiform Process** is the upper surface of the vermiform process, or middle lobe of the cerebellum, and is raised above the level of the superior surface of the hemispheres of the cerebellum. It is divided into the following lobes: lingula, lobulus centralis, monticulus cerebelli, and folium cacuminis. The **lingula** overlies the posterior part of the superior medullary velum and is adherent to it. It is attached at its base to the lobulus centralis. The **lobulus centralis** lies immediately posterior to and below the corpora quadrigemina; it spreads out laterally into the *alæ of the hemispheres.* The **monticulus cerebelli** is divided into two parts, the *culmen* and the *clivus,* the latter being a sloping part: it is connected on each side to the quadrate lobe. The culmen joins the anterior crescentic division of the quadrate lobe, and the clivus joins the posterior crescentic division. The **folium cacuminis,** which connects the posterior superior lobes of the hemispheres, is posterior to the clivus.

The **Upper Surface of Each Hemisphere of the Cerebellum** slopes outward and backward from the superior vermiform process, and is divided into two lobes —the quadrate and the posterior superior lobe—by the **superior sulcus of the cerebellum,** which passes from the commencement of the transverse fissure toward the incisura cerebelli posterior. The **quadrate lobe** is situated anterior to the sulcus cerebelli superior, and extends nearly to the posterior end of the vermiform process, its laminæ passing without interruption through the monticulus cerebelli into the corresponding lobe of the opposite side. The quadrate lobe is divided by a small fissure into an *anterior crescentic* and a *posterior crescentic lobule.* The **posterior superior lobe** is situated posterior to the sulcus cerebelli superior and

along the posterior border of the hemisphere, and is joined to the posterior superior lobe of the opposite side by the folium cacuminis.

Dissection.—Displace the medulla oblongata forward, and expose the inferior vermiform process at the bottom of the vallecula.

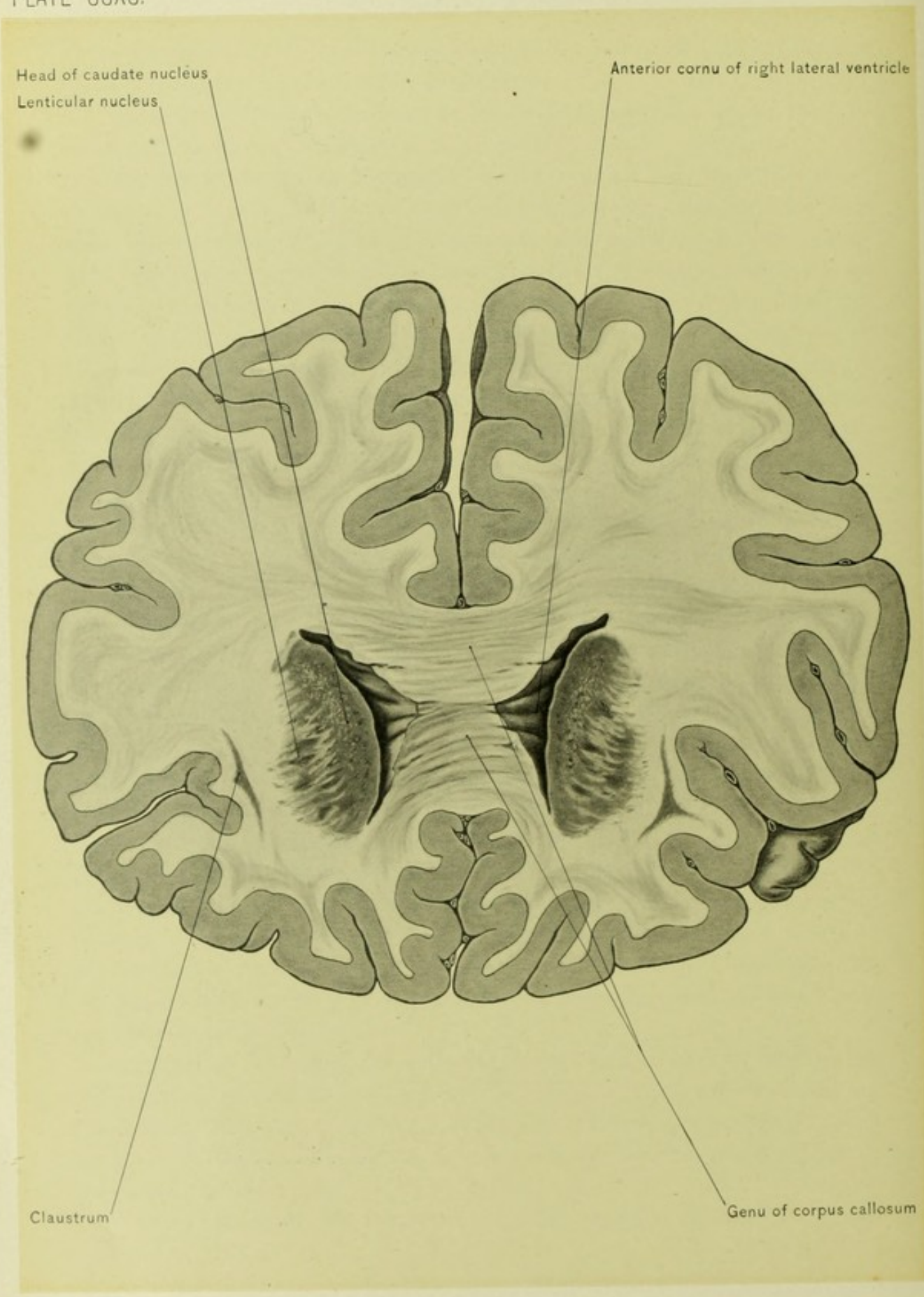
The **Inferior Vermiform Process** is divided into four lobes, named, from before backward, the nodule, the uvula, the pyramid, and the tuber valvulæ. The **nodule,** designated by Malacarne the **laminated tubercle,** is the anterior extremity of the inferior vermiform process, and projects into the fourth ventricle, forming a part of the roof of that ventricle. It is connected upon both sides to the flocculi, upon the under surface of the hemispheres, by a thin, semilunar layer of white substance, the **posterior** or **inferior medullary velum.** The **uvula,** situated directly behind the nodule, is an elongated lobe compressed laterally, and is connected on each side to the amygdaloid lobe, or tonsil, by an indented strip of gray matter, the **furrowed band.** The **pyramid,** situated behind the uvula, is the largest of the divisions of the process, and connects the biventral lobes of the hemispheres. The **tuber valvulæ,** the posterior extremity of the inferior vermiform process, connects the two inferior posterior and the two slender lobes of the hemispheres.

The **Under Surface of Each Hemisphere** of the cerebellum, which is convex and conforms to the occipital fossa in which it rests, is divided into five lobes, named, from before backward, the flocculus, the amygdala, or tonsil, the digastric or biventral, the slender, and the posterior inferior. The **flocculus,** the smallest lobe, is situated at the anterior part of the hemisphere, between the digastric or biventral lobe and the middle peduncle of the cerebellum, in the line of the great horizontal fissure of the cerebellum. The **amygdala,** or **tonsil,** is situated to the inner side of the digastric or biventral lobe, and between that lobe and the vallecula. It is connected with the uvula by the furrowed band. The *digastric* or *biventral,* the largest lobe, lies behind the flocculus, and external to the amygdala and the pyramid; it is connected with the digastric lobe of the other hemisphere by the pyramid. The *slender lobe,* or *lobulus gracilis,* lies immediately behind the digastric lobe, and external to the pyramid and the tuber valvulæ. The *posterior inferior lobe* lies between the posterior border of the hemisphere and the slender lobe, and external to the tuber valvulæ.

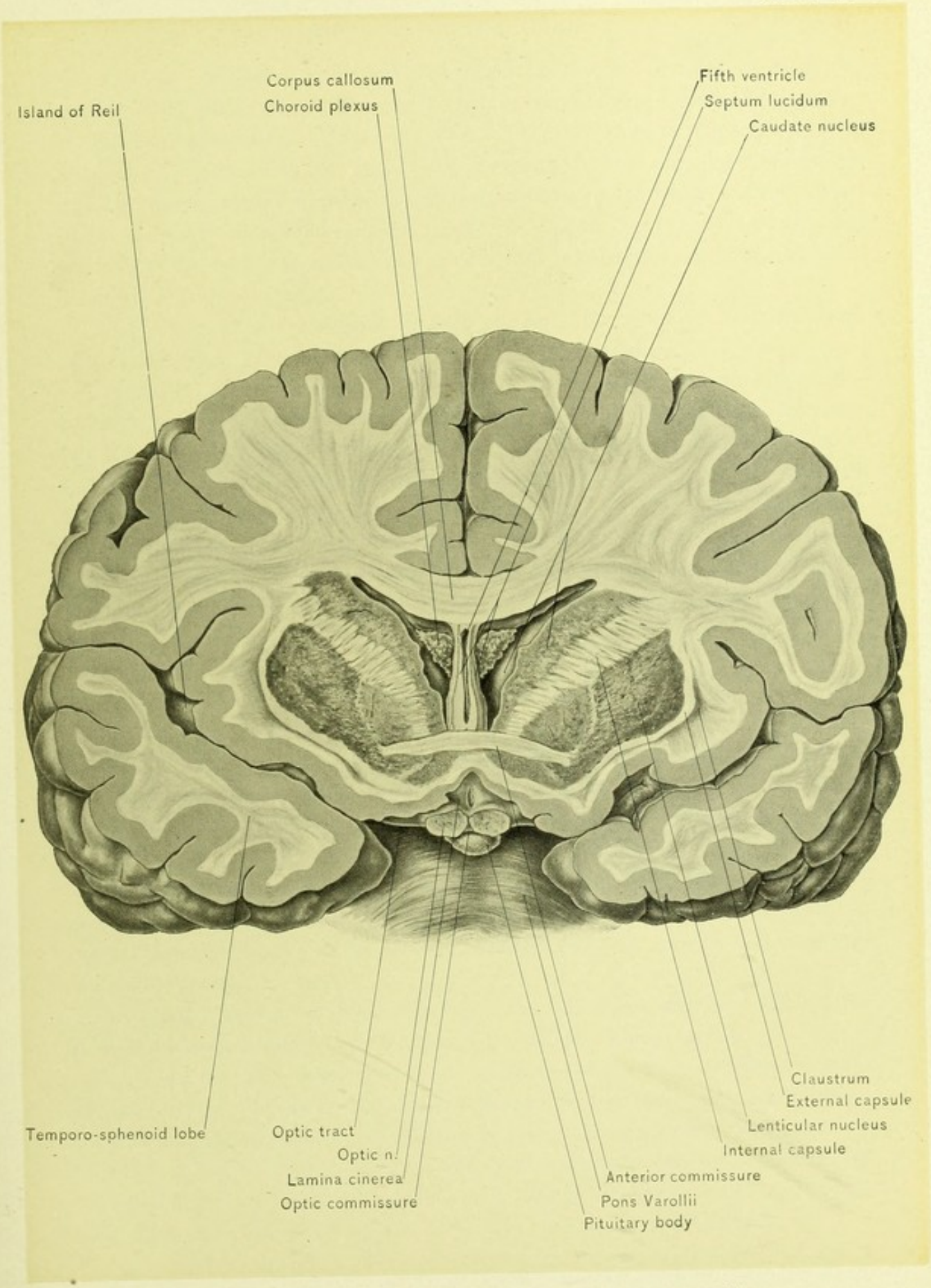
Dissection.—Cut away the amygdala on one side, or slice off the digastric and slender lobes until the amygdala can be turned out; this will expose the furrowed band, the posterior medullary velum and the fossa, known as the "swallow's nest" (*nidus hirundinis*), which is indented by the posterior medullary velum, the nodule, and the uvula.

The **Peduncles of the Cerebellum** are the superior, the middle, and the inferior.

PLATE CCXC.



CORONAL SECTION OF CEREBRUM.



CORONAL SECTION OF CEREBRUM JUST ANTERIOR TO OPTIC CHIASM.

The *superior peduncles* of the cerebellum connect the cerebellum with the cerebrum, and pass forward, forming the lateral boundaries of the anterior portion of the fourth ventricle. Under the floor of the aqueduct of Sylvius the two superior peduncles decussate; each peduncle then enters the opposite subthalamic region of the cerebrum, to reach the optic thalamus and lenticular nucleus. The *middle peduncles* connect the cerebellum with the pons. The *inferior peduncles* are formed by the restiform bodies, and connect the cerebellum with the medulla oblongata and spinal cord.

Dissection.—Carry a vertical incision through the center of the hemisphere of the cerebellum, to expose the white matter and gray nucleus.

Interior Arrangement.—In the interior of the white matter of the cerebellum is a gray nucleus, the corpus dentatum. The white matter sends processes into the laminæ of the gray matter, which forms the surface of the cerebellum, and give rise to the appearance that has been termed the *arbor vitæ*. The **corpus dentatum of the cerebellum,** like the nucleus of the same name in the olivary body, is arranged in the form of a capsule presenting a zigzag outline which is open at the inner side. Through this open part, or hilum, of the capsule a bundle of white fibers passes to the superior peduncles of the cerebellum and the valve of Vieussens.

SECTIONS OF THE BRAIN.

Having mastered the topography of the encephalon, together with its intraventricular aspect, in the study of which some of its parts were seen in horizontal sections, it will now be well to study coronal and sagittal sections, and so obtain a more accurate knowledge of the relations of the various parts of the encephalon.

A **sagittal section** lies in a vertical longitudinal plane, running antero-posteriorly, as if through the entire length of the brain through or parallel with the sagittal suture, hence it is so named; a section of this kind is not, however, limited to the median line.

A **coronal section** lies in a vertical transverse plane, running from side to side, at right angles to a sagittal plane; this is also called a frontal section.

A coronal section through the brain at the tips of the temporo-sphenoid lobes will traverse the anterior end of the lenticular nucleus of the corpus striatum, and one a short distance beyond this will pass through the anterior end of the caudate nucleus. A section passing through the optic commissure, or just behind it, will include the front of the optic thalami. A frontal section must, therefore, be made back of the optic commissure if it is to include both sets of basal ganglia.

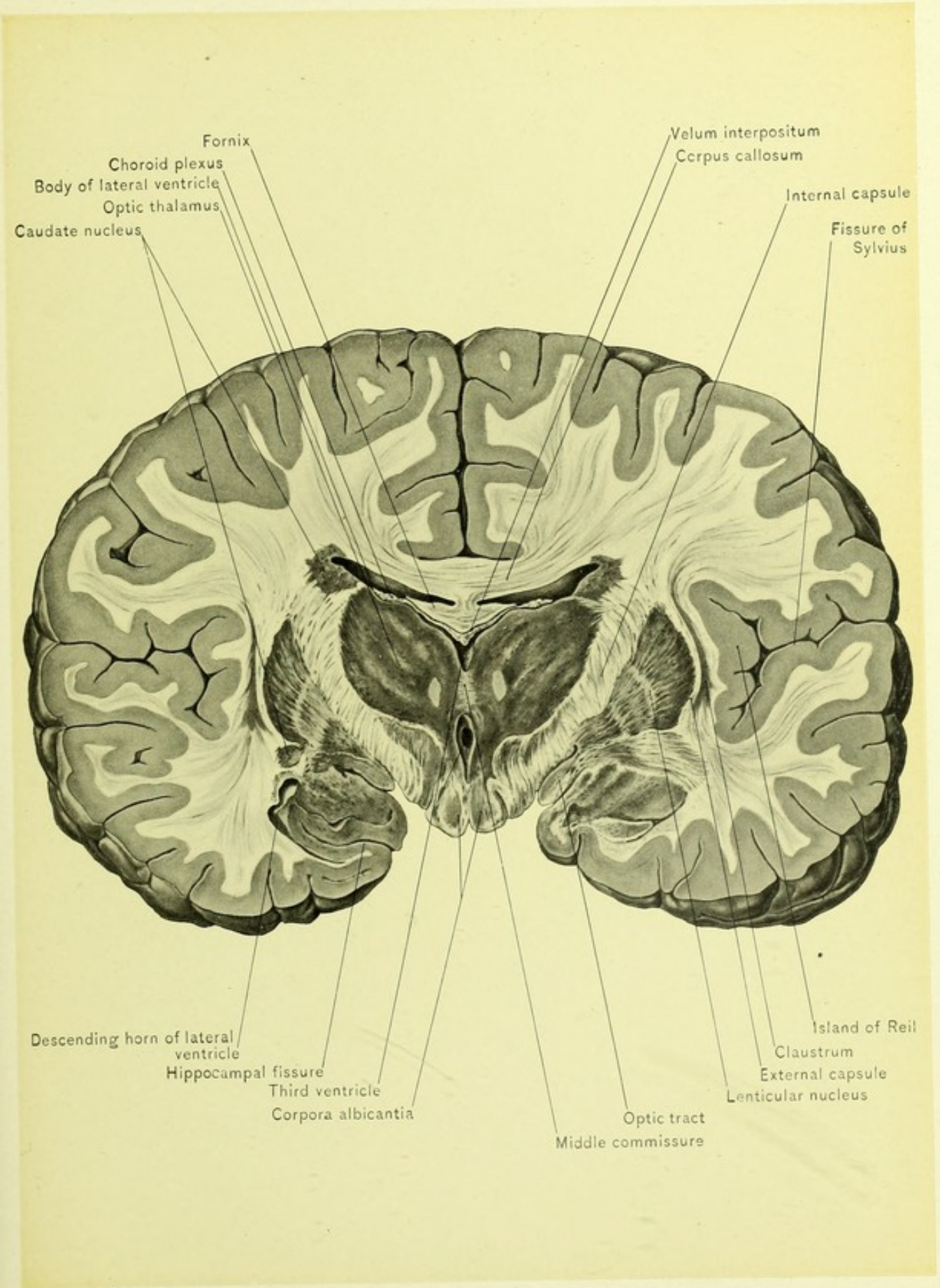
A coronal section about midway between the optic commissure and the tips of

the temporo-sphenoid lobes will not include the optic thalami. It will expose, from within outward, the septum lucidum, the lateral ventricle with the corpus callosum above it, the caudate nucleus, the internal capsule, the lenticular nucleus, the external capsule, the claustrum, the white matter, the island of Reil, and the fissure of Sylvius. The wedge shape of the lateral ventricle is plainly shown in this section, as is also the formation of its outer wall and part of its floor by the sloping caudate nucleus. The lenticular nucleus is clearly separated into three portions, defined by fine white curved lines extending between them.

When these sections are made further back, the anteriorly situated parts become smaller, and finally disappear, while the more posteriorly situated parts gradually increase in size; the caudate nucleus grows smaller and recedes toward the upper and outer angle of the lateral ventricle, while the optic thalamus occupies an increasing amount of the lower part of the outer wall of the lateral ventricle. Notable changes in the median line also occur, the fifth ventricle and the septum lucidum vanish, and the fornix and third ventricle appear instead, while the infundibulum, mammillary bodies, and posterior perforated spaces successively appear at the base. The crura cerebri at first appear to be separated, gradually coming closer, until they merge. The locus niger is distinctly visible, as are also the two adjacent divisions of the crura cerebri. The upper or front end of the pons comes into view, and at its upper edge the aqueduct of Sylvius appears. The velum interpositum, containing the choroid plexuses, becomes wider as the sections pass backward. The tæniæ semicirculares, the dentate fasciæ, the hippocampal gyri, and the middle cornua of the lateral ventricles are also seen in these sections.

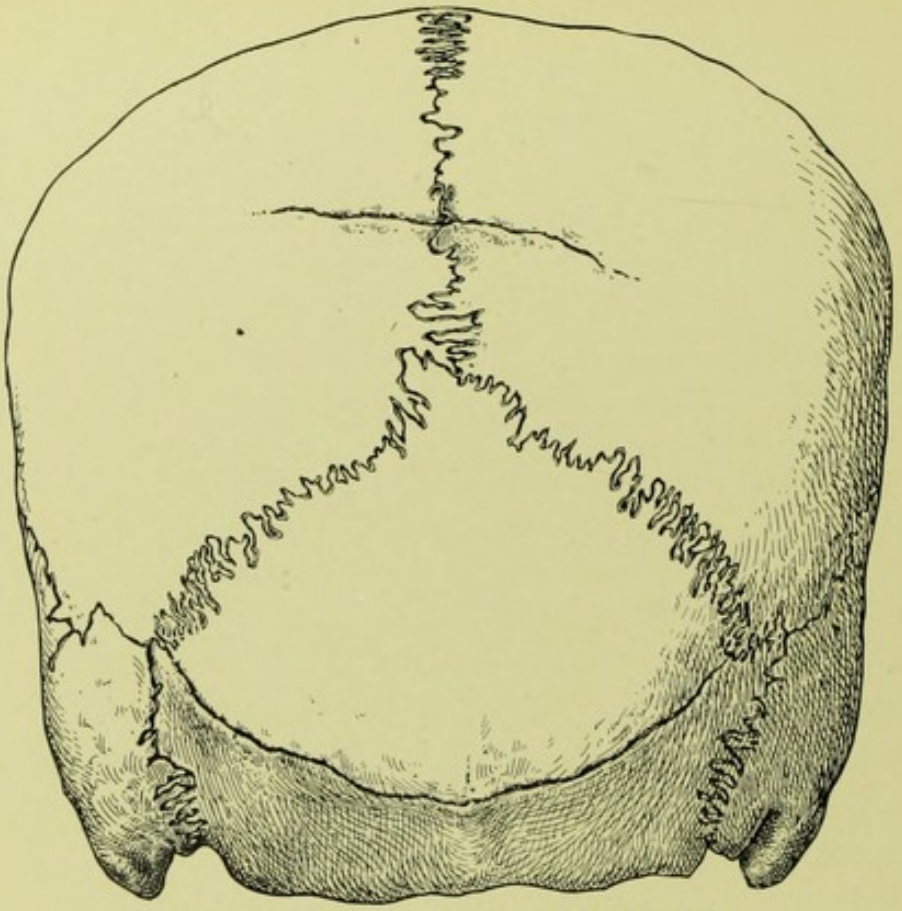
No study of the cerebrum is complete without a careful consideration of these sections, as they portray exactly the relations of the cortex and intra-encephalic parts to one another.

Sagittal sections do not offer so wide a field for the study of these relations, because of the rapid loss of important structures as the median line is departed from, though the length of the basal ganglia, and particularly of the caudate nucleus, is better shown in these sections than in other ways.

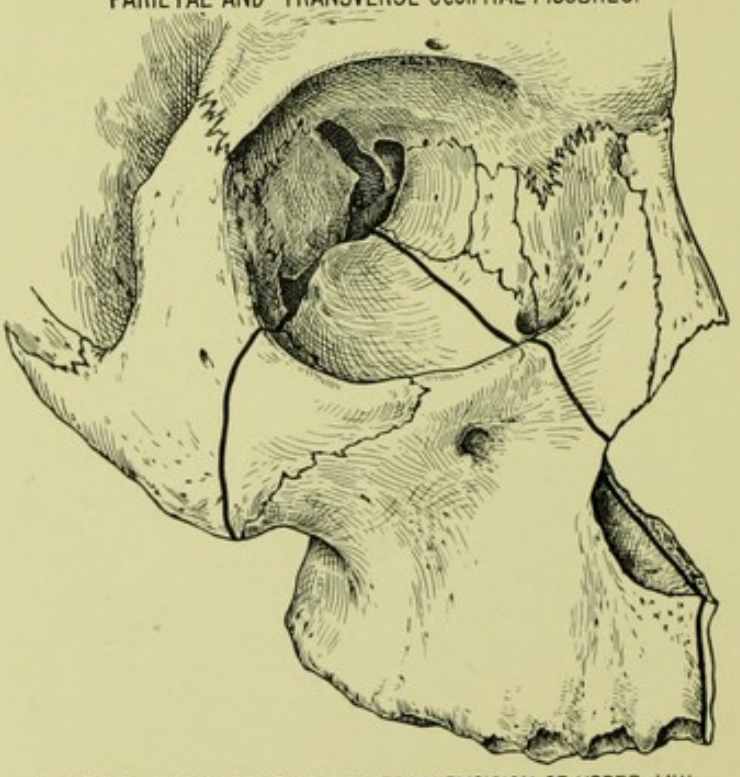


CORONAL SECTION OF CEREBRUM THROUGH CORPORA ALBICANTIA AND MIDDLE COMMISSURE.

PLATE CCXCIII.



PARIETAL AND TRANSVERSE OCCIPITAL FISSURES.



LINES IN WHICH BONE IS DIVIDED IN EXCISION OF UPPER JAW.

JOINTS OF THE HEAD AND NECK.

The **Joints of the Skull,** excepting the temporo-maxillary articulation and the articulations between the skull and the spinal column, are in the form of sutures which afford immobility and firmness with elasticity.

The **Sutures of the Skull** may be mistaken for fractures, and the Wormian bones, which are situated in the lines of the sutures, may be mistaken for fragments outlined by fractures.

The **sagittal suture** is situated in the median line of the vault of the cranium, and extends from the bregma to the lambda. The bregma is situated at the junction of the coronal and sagittal sutures, and at the point where a line, drawn perpendicular to Reid's base line at the preauricular fossa, crosses the median line of the cranial vault. The lambda is situated at the junction of the sagittal and lambdoid sutures, and about two and three-fourth inches, or seven centimeters, above the external occipital protuberance.

The **coronal suture** extends from the bregma downward, and slightly forward, toward the junction of the zygoma with the malar bone.

The **lambdoid suture** is situated at about the upper two-thirds of a line drawn from the lambda to the apex of the mastoid process of the temporal bone. Additional sutures not commonly present may exist in the vault of the cranium and be mistaken for fractures. These are the **frontal suture,** which extends forward between the halves of the frontal bone in the line of the sagittal suture, the **parietal fissure,** a short suture which crosses the sagittal suture one inch, or two and one-half centimeters, anterior to the lambda, and the **transverse occipital fissure,** which is a suture situated in the occipital bone near the level of the external occipital protuberance.

The **Temporo-maxillary Articulation** is the joint situated between the condyle of the inferior maxilla below, and the anterior part of the glenoid fossa and the eminentia articularis above. It is a ginglymo-arthrodial articulation, or hinge joint, modified to allow gliding movement. The ligaments of the temporo-maxillary articulation are the capsular ligament and the interarticular fibro-cartilage. The joint is strengthened by the spheno-mandibular and stylo-mandibular ligaments.

The **capsular ligament** is thin, especially at its anterior and inner portions. It is attached above to the margins of the articular surface formed by the eminentia articularis and anterior portion of the glenoid cavity of the temporal bone, and below to the neck of the lower jaw. Its external portion is much stronger than the remainder of the capsule, and is termed the external lateral ligament.

The *external lateral ligament* is attached above to the lower margin of the zygoma and the tubercle of the zygoma, its fibers passing downward and backward to be attached below to the outer surface and posterior margin of the neck of the lower jaw.

The **interarticular fibro-cartilage** is situated between the articular surfaces of the bones entering into the formation of the joint. Through conformation to these surfaces its upper surface is concavo-convex from before backward and convex laterally, and the posterior portion of its under surface is concave, to fit the condyle. It is thinner at its center, and thickest posteriorly, where it acts as a buffer and protects the thin bone of the glenoid fossa. Its margins are attached to the capsular ligament, and some of the fibers of the tendon of the external pterygoid muscle pass between the fibers of the anterior portion of the capsular ligament, to be inserted into the anterior margin of the interarticular fibro-cartilage.

The **synovial membranes** are two in number, the superior synovial membrane being separated from the inferior by the interarticular fibro-cartilage. When the interarticular fibro-cartilage is perforated, the two synovial sacs communicate.

The **spheno-mandibular** or **internal lateral ligament** is attached above to the spine of the greater wing of the sphenoid bone and adjacent part of the temporal bone, and below to the spine of Spix, or mandibular spine, which is situated on the inner surface of the lower jaw, below and internal to the inferior dental foramen. The internal lateral ligament is separated from the temporo-maxillary joint and lower jaw by the internal maxillary artery and vein, the middle meningeal artery, the external pterygoid muscle, the inferior dental vessels and the inferior dental nerve. Its lower extremity is pierced by the mylo-hyoid nerve.

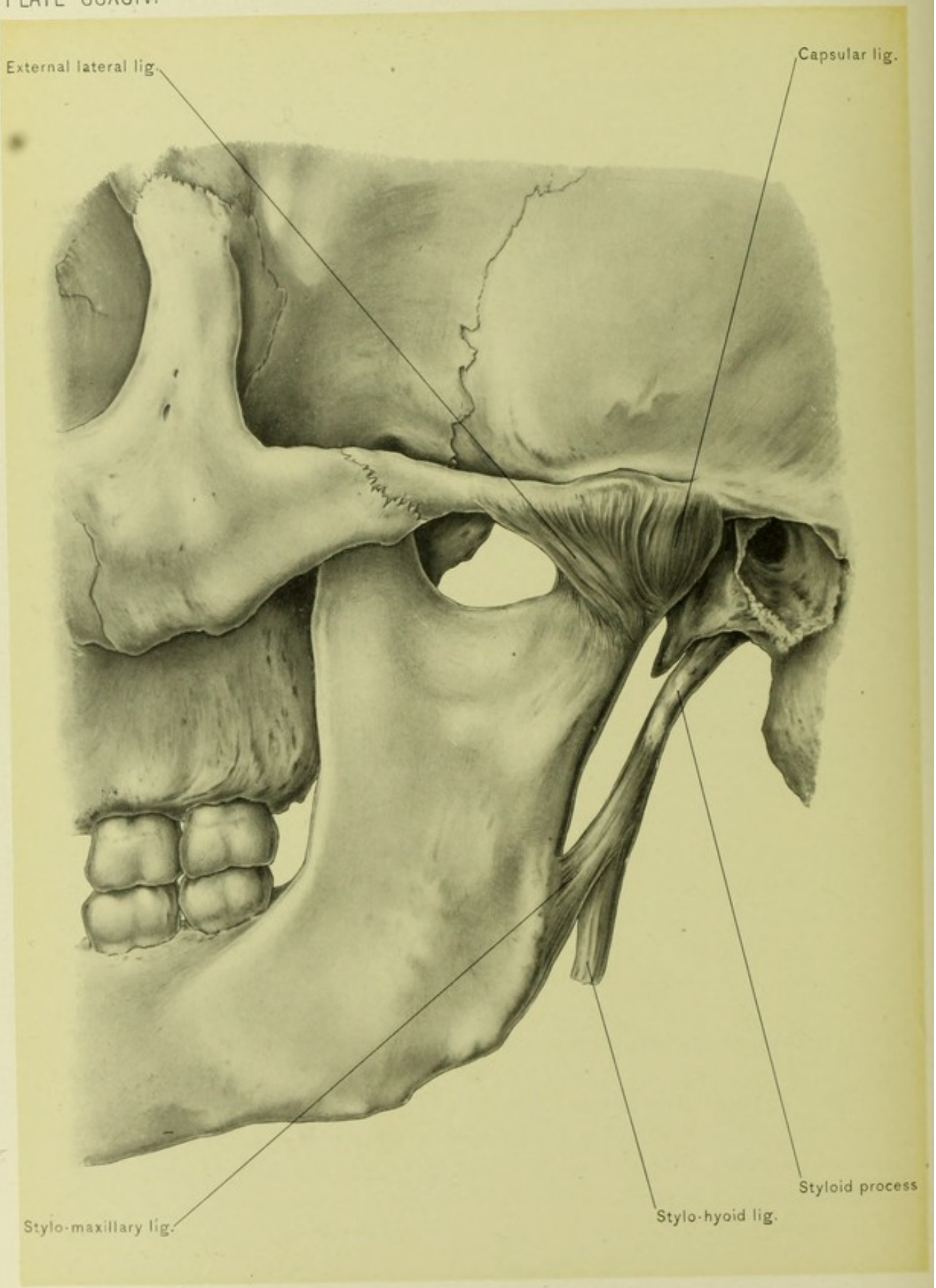
The **stylo-mandibular** or **stylo-maxillary ligament** is a part of that process of the deep cervical fascia which dips beneath the parotid gland. It extends from the styloid process of the temporal bone to the angle and posterior margin of the ramus of the lower jaw, separating the parotid from the submaxillary gland.

Blood Supply.—From the temporal, middle meningeal, and ascending pharyngeal arteries.

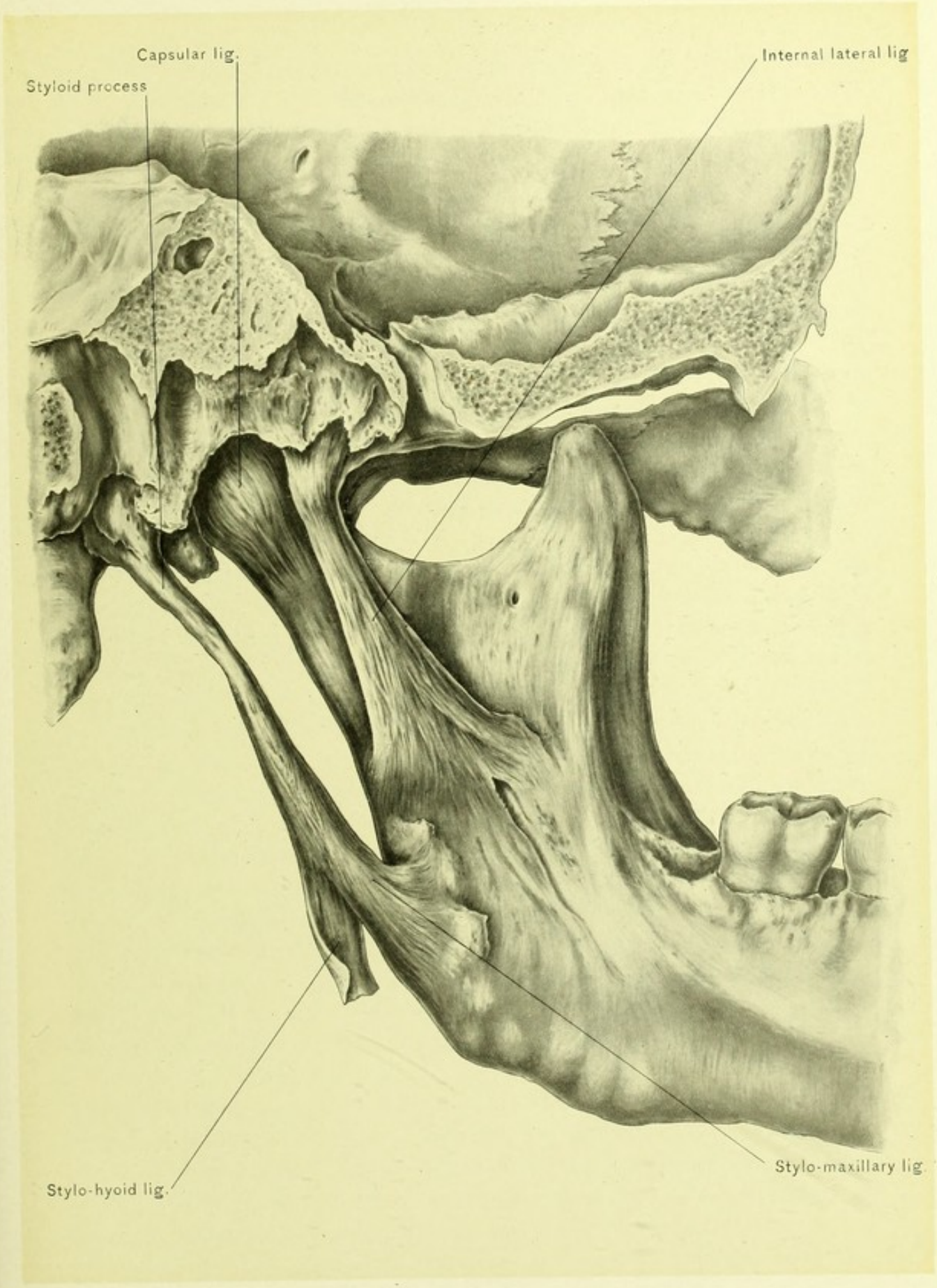
Nerve Supply.—From the auriculo-temporal and masseteric branches of the inferior maxillary nerve.

Movements.—Rotation of the condyle around a transverse axis occurs when the mouth is opened or closed, and gliding forward of both the condyle and the interarticular cartilage when the mouth is widely opened. If the mouth is opened too widely, as in a convulsive yawn, the condyle and interarticular fibro-cartilage may be completely or incompletely dislocated forward, and locked either in front of or upon the eminentia articularis. In closing the mouth the cartilage and condyle

PLATE CCXCIV.



TEMPORO-MAXILLARY ARTICULATION—EXTERNAL VIEW.



TEMPORO-MAXILLARY ARTICULATION—INTERNAL VIEW.

glide backward, and the condyle rotates on the cartilage in the reverse direction. These movements result in a combination of a hinge movement of the condyle with fore-and-aft gliding movement of the interarticular fibro-cartilage. Gliding movement of the interarticular fibro-cartilage forward occurs when the lower jaw and chin are thrust forward. Rotation of the condyle around the vertical axis of the neck of the lower jaw, associated with oblique gliding of the interarticular fibro-cartilage on the glenoid fossa, occurs in the oblique movements of the lower jaw in mastication.

The **Joints of the Neck** are those of the cervical portion of the spinal column, which have been described in volume I.

Dislocations.—Dislocation of the bones of the vault and base of the skull is almost entirely limited to the young skull. Such an accident rarely occurs in the adult skull, the firm union and overlapping of the bones preventing dislocation of these articulations. The squamous suture has been separated by dislocation of the temporal bone. Fractures in the line of the coronal, sagittal, and lambdoid sutures have occurred.

Dislocation of the lower jaw is of comparatively rare occurrence, and is usually forward and bilateral. *Forward dislocation* occurs while the mouth is wide open, as during convulsive yawning, manipulations of dentists, or from blows on the chin. Only a small amount of force is required at such a time to carry the condyle from a position just behind, to a point upon or immediately in front of, the summit of the eminentia articularis. The anterior portion of the capsular ligament is torn; the interarticular fibro-cartilage is usually dislocated with the condyle. The condyle is retained in its abnormal position by the upward traction of the temporal, masseter, and internal pterygoid muscles. *Backward dislocation* of the lower jaw may follow a blow on the chin, and the condyle may fracture the bony portion of the external auditory meatus or be driven into the cranial cavity.

Excisions.—Excision of the upper jaw is usually performed for malignant disease, as sarcoma or carcinoma of the maxillary sinus or antrum of Highmore. Generally but one superior maxilla is removed, although both upper jaws have been removed in one operation.

In excising the superior maxilla several anatomic facts are to be remembered. The upper jaw is in reality a shell of bone which envelops the maxillary sinus, forms a large part of the floor of the orbit, roof of the mouth, external wall of the nasal fossa, anterior wall of the spheno-maxillary fossa and pterygo-maxillary region, and bony basis of the front of the face below the infra-orbital ridge. Its strongest portions are the malar, alveolar, and palatal processes.

In the operation of excision of the superior maxillary bone the inferior tur-

binated bone, part of the malar bone, part of the palate bone, and the superior maxillary bone, except the upper part of its nasal process, are removed.

In the method of excision which is most commonly practised,—that is, by a median incision,—the first incision is begun one-half of an inch, or slightly less than one and one-half centimeters, below the inner canthus of the eyelids. It is carried downward along the groove between the nose and face, around the ala of the nose, below the base of the nose to the median line, and thence through the median line of the upper lip. This incision divides skin, superficial fascia, some of the muscles of expression, the angular artery and vein, the lateral nasal artery, the artery of the nasal septum, the superior coronary artery, and branches of the infra-orbital and facial nerves.

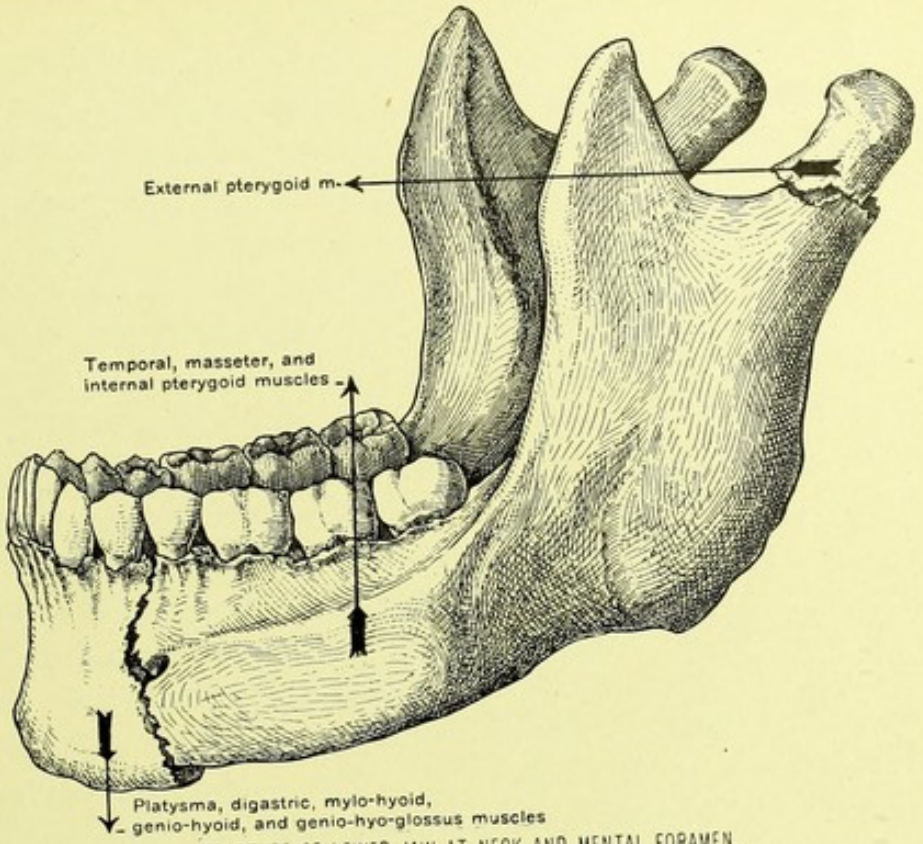
The second incision is carried from the point at which the first incision was commenced outward along the infra-orbital margin to a point over the malar bone. This incision divides a few insignificant blood-vessels. The tissues of the flap outlined are now quickly reflected outward, removing all of them down to the bone, not considering the periosteum. In elevation of this flap the infra-orbital vessels and nerve are divided.

The fibro-cartilaginous lateral portion of the nose is detached from the superior maxilla, and the base of the nasal process of the superior maxilla is severed with a fine saw or a chisel. The periosteum is divided along the infra-orbital ridge, and elevated from the floor of the orbit, at the same time detaching the origin of the inferior oblique muscle of the eyeball. The inner part of the floor of the orbit is then divided with a small chisel. The malar bone is next severed at its middle with a small saw or chisel, and in a line which extends obliquely downward and outward. The saw is carried through the floor of the orbit until it reaches the spheno-maxillary fissure. The malar bone can be divided with strong bone forceps, which are not allowed to extend into the spheno-maxillary fissure. If the forceps are inserted too deeply into the fissure, the internal maxillary artery may be severed.

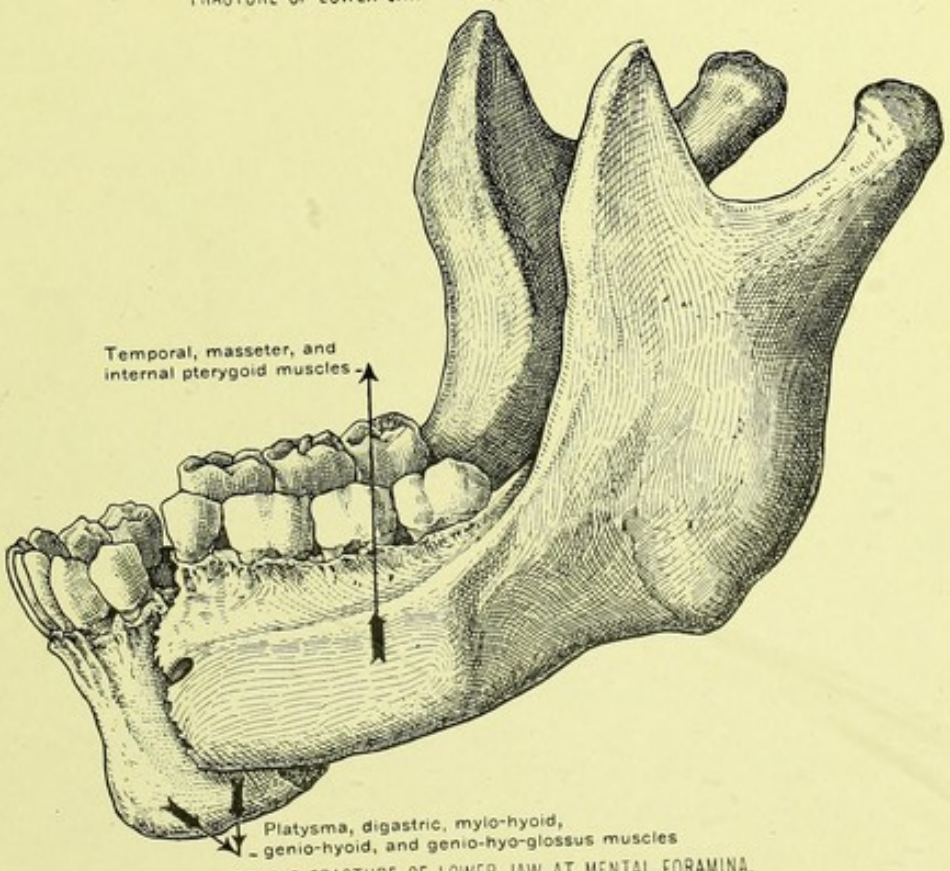
The central incisor on the diseased side is extracted, the muco-periosteum of the floor of the nose is divided close to the nasal septum, the muco-periosteum of the hard palate is severed in the median line, and the soft palate is thoroughly separated from the hard palate. With a slender saw introduced through the nose the hard palate is divided close to the nasal septum.

With one blade of the forceps at the infra-orbital ridge and the other at the alveolar process, the jaw is grasped with lion forceps, and loosened from the remaining attachments. This procedure fractures the vertical plate of the palate bone, and detaches the jaw from the pterygoid process of the sphenoid bone.

The vessels ruptured or divided in removing the superior maxilla are



FRACTURE OF LOWER JAW AT NECK AND MENTAL FORAMEN.



DOUBLE FRACTURE OF LOWER JAW AT MENTAL FORAMINA.

FRACTURES OF LOWER JAW.

branches of the third portion of the internal maxillary artery. They are the alveolar, infra-orbital, posterior palatine, pterygo-palatine, and naso-palatine arteries, or some of their branches. The application of the actual cautery may be required to check hemorrhage. The cavity may be packed with gauze, and the wound in the skin is closed. The gauze is subsequently removed through the mouth.

Excision of the lower jaw is performed for the removal of malignant growths of that bone. Usually but half of the bone is excised. Segments of the lower jaw are removed in extirpation of benign tumors of that bone. The incision is carried from the attached margin of the lower lip down the middle of the chin to the lower margin of the jaw, thence just below and parallel with the body of the jaw to the angle, and thence upward along the posterior margin of the ramus of the lower jaw to the level of the lobule of the ear. In making this incision the facial artery is secured between ligatures before it is divided. The skin, superficial fascia, platysma myoides muscle, and deep fascia are divided; the parotid, submaxillary, and sublingual glands and Stenson's duct must be avoided.

Beginning at the symphysis, the soft tissues are detached from the external surface of the bone with a periosteal elevator. The depressor labii inferioris, depressor anguli oris, buccinator, and masseter muscles are thus separated from the bone.

After extraction of one of the incisor teeth the bone is divided with a small saw. The divided end of the bone is next drawn outward, and the mylo-hyoid muscle and mucous membrane of the mouth are divided close to the bone, being careful to avoid injuring the sublingual or submaxillary gland or the lingual nerve.

The internal pterygoid muscle is detached from the bone with a periosteal elevator, and the internal lateral ligament of the lower jaw and inferior dental vessels and nerve are divided.

The jaw is now depressed, to bring the coronoid process into view. This process is then divided with a chisel and a mallet, and dissected out afterward, or the tendon of the temporal muscle is severed with curved scissors. The tendon of the external pterygoid muscle is divided with scissors, or detached with a periosteal elevator.

The capsular ligament is divided, and, after severing some few remaining attachments, as the stylo-maxillary ligament, the bone can be removed. After bleeding has been checked the wound is closed.

The structures to be avoided in this operation are the three salivary glands, Stenson's duct, the buccal and supra-maxillary branches of the facial nerve, the lingual and auriculo-temporal nerves, the external carotid, temporal, and internal maxillary arteries, and the temporo-maxillary and internal maxillary veins. The

vessels which must be divided are the facial, inferior labial, mental, mylo-hyoid, inferior dental, and masseteric arteries and veins.

Excision of the condyle of the lower jaw is performed most commonly for disease of the temporo-maxillary articulation causing impaired movement in that jaw.

A vertical incision is carried from the zygoma downward over the condyle of the lower jaw, to a point just above the position of the transverse facial artery, which is one centimeter, or less than one-half of an inch, below and parallel with the zygoma. A second incision is carried forward along the lower margin of the zygoma for one inch, or 2.5 centimeters. The flap thus outlined is reflected forward and downward, avoiding the temporal branches of the facial nerve. The posterior fibers of the masseter muscle are detached from the zygoma, and the capsule of the temporo-maxillary joint is opened.

The neck of the condyle is divided with a chisel or a small saw, the condyle being firmly held with a small hook. The condyle is twisted out of the glenoid fossa, and the external pterygoid tendon and capsular ligament are divided. The instruments are kept close to the bone, to avoid injuring the temporal, internal maxillary, and masseteric vessels, the auriculo-temporal and masseteric nerves, and the parotid gland.

Development of the Bones of the Skull.—The bones of the vault of the cranium are developed in membrane, and those of the base of the skull are formed in cartilage. Just before birth the bones of the vault are imperfectly ossified at their margins, so that they are joined by membrane instead of by sutures. This condition of the bones allows diminution in the diameters of the fetal skull at birth by overlapping of the bones of the cranial vault.

At birth the bones are incompletely ossified at the angles of the parietal bone; these membranous areas are called fontanels.

The **posterior fontanel** is triangular in shape, is situated at the lambda, and closes during the first few months after birth.

The **anterior fontanel** is quadrilateral, is located at the bregma, and closes during the latter half of the second year.

The **antero-lateral fontanels,** situated at the anterior inferior angles of the parietal bones, and the **postero-lateral fontanels,** situated at the posterior inferior angles of the parietal bones, close soon after birth. Imperfect or delayed ossification at the fontanels occurs in hydrocephalus.

Fractures of the Skull.—The bones of the skull in young children are not readily fractured. When force is applied to the vault of the skull of a young infant, it is merely indented, ossification being so incomplete that the bones are flexible.

The adult skull is not readily fractured, because its curves diffuse and diminish the breaking force, and, being composed of three tables of different consistence, its strength and elasticity are much enhanced. Other conditions which lessen the danger of fracture of the vault of the cranium are: The mobility of the scalp proper, the rounded shape of the cranial vault, and the mobility of the head. As age advances and the bones become less porous, less elastic, and, at the fortieth year, the sutures begin to be obliterated by ossification of the intersutural membrane the skull is more readily fractured. Either the external table or the internal table may be fractured without injury to the other table, but both tables are usually traversed by the fracture. On account of its brittleness and the diffusion of the force in passing through the bone, the inner table is much more splintered than the external. In depressed fractures of the vault the inner table may not be broken, the outer table being merely driven into the diploë or one of the frontal sinus

Fractures of the vault of the skull are due to direct violence. A fracture of the vault resulting from diffuse application of force, as in a fall upon the head, usually extends to the base of the skull by the shortest route, regardless of sutures or thickness of the bones traversed. This is more likely to occur if the fracture be linear. Fractures of the frontal region extend into the floor of the anterior cranial fossa, those of the parietal region into the floor of the middle cranial fossa, and those of the occipital region into the floor of the posterior cranial fossa.

Fractures of the base of the skull are caused by extension of a fracture from the vault of the skull and by direct or indirect violence. Fractures of the base by direct violence have been caused by foreign bodies having been driven through the roof of the orbit, nose, or pharynx. Fractures of the base by indirect violence usually result from the body falling upon the feet, knees, or buttocks, and from the upper part of the spinal column being driven against or through the occipital bone. In blows at the root of the nose the cribriform plate of the ethmoid bone may be fractured, and in a fall upon the chin the condyle of the lower jaw may be driven through the base of the skull at the middle cranial fossa. The cribriform plate of the ethmoid bone has been broken by counter-stroke by a blow in the occipital region.

In fracture of the base of the skull at the *anterior cranial fossa* blood may enter the orbit and produce a subconjunctival ecchymosis, or blood and cerebro-spinal fluid may escape from the nose through the anterior nares or posterior nares and mouth. The blood escaping into the orbit is derived from ruptured meningeal vessels, anterior or posterior ethmoid vessels, and ophthalmic artery or vein; that entering the nose escapes from the anterior or posterior ethmoid vessels, and the vessels of the nasal mucous membrane. In fracture of the cribriform plate of

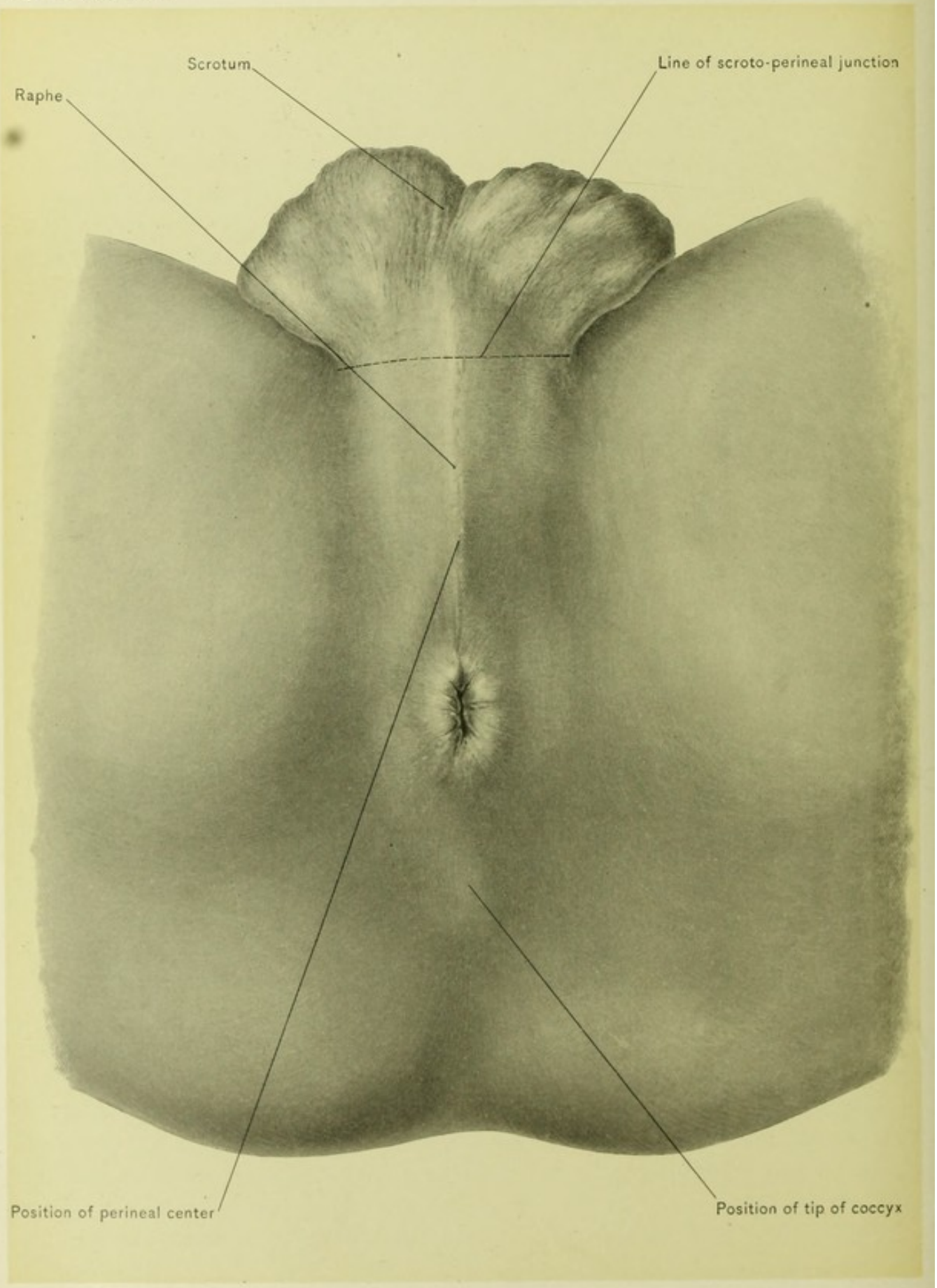
the ethmoid bone rupture of the olfactory nerves may cause loss of the sense of smell. In fractures at the *middle cranial fossa* blood and cerebro-spinal fluid may escape from the ear. To permit cerebro-spinal fluid to escape in this manner, the arachnoid, dura mater, bone and mucous membrane of the wall of the tympanum, and membrana tympani must be ruptured. In fracture of the base at this fossa the cavernous sinus may be ruptured, and if the fracture extend across the petrous portion of the temporal bone, the superior petrosal sinus, and the facial and auditory nerves may be injured. Laceration of the facial nerve causes paralysis of the muscles of expression and of the buccinator muscle; laceration of the auditory nerve causes deafness. In fractures of the base of the skull at the *posterior cranial fossa* blood may be extravasated into the tissues of the nape or posterior triangle of the neck. The symptoms of fracture of the skull are chiefly those of compression of the brain, produced by extravasated blood which arises from rupture of the meningeal vessels, sinuses of the dura mater, and diploic veins.

Fractures of the Bones of the Face are the result of direct violence. In **fracture of the nasal bones** emphysema of the soft tissues may occur. In **fracture of the lacrymal bone** obstruction of the nasal duct may cause the tears to flow over the cheek, and laceration of the muco-periosteal wall of the duct may induce emphysema of the soft tissues. In **comminuted fracture of the zygomatic arch** fragments of bone driven into the temporal muscle may interfere with the movements of the lower jaw in mastication.

Fracture of the bone of the upper jaw may cause profuse hemorrhage from a ruptured infra-orbital, superior dental, anterior palatine, or posterior palatine artery.

Fracture of the lower jaw occurs more frequently than fracture of any other bone of the face. It is usually broken by direct violence. In fractures of the *neck* of the lower jaw the condyle is drawn forward by the external pterygoid muscle. Imperfect apposition and persistent mobility of the fragments may induce excessive formation of callus, which may subsequently cause more or less ankylosis of the temporo-maxillary articulation. In fracture of the *ramus* of the bone there is slight displacement of the fragments, as the masseter and internal pterygoid muscles act as splints. In fracture in front of the attachment of the masseter muscle the posterior fragment is drawn upward by the masseter, temporal, and internal pterygoid muscles; if the plane of fracture extends obliquely backward and outward, the posterior fragment is also drawn inward by the internal pterygoid muscle. The anterior fragment is carried downward by the fracturing force, the platysma myoides, digastric, mylo-hyoid, genio-hyoid, and genio-hyo-glossus muscles. In *double fracture at the mental foramina* the middle fragment is carried downward

PLATE CCXCVII.



SURFACE OF MALE PERINEUM.

and backward by its weight, and the digastric, mylo-hyoid, genio-hyoid, and genio-hyo-glossus muscles. This displacement allows the base of the tongue to fall against the epiglottis, and thus asphyxiation may be produced.

MALE PERINEUM.

The **Perineum** is composed of all the structures which occupy the outlet of the pelvis. Its outline is quadrilateral. The *superficial boundaries* of the perineum are: in front, the scrotum, and at the sides and behind, the thigh and the buttocks. The *deep boundaries* are: in front, the pubic arch and subpubic ligament; behind, in the middle line, the tip of the coccyx; upon each side, the descending ramus of the pubis, the ascending ramus of the ischium, the tuberosity of the ischium, and the great sacro-ischiatic ligament overlapped by the gluteus maximus muscle. It measures laterally four or five inches, or ten or twelve centimeters, between the tuberosities of the ischia. Its depth is from two to three inches, or from five to seven centimeters, and about one inch, or two and one-half centimeters, at the pubes. The perineum is arbitrarily divided, by a transverse line through the tuberosities of the ischia, into an anterior or **urethral triangle** and a posterior or **anal triangle**. The urethral triangle, or perineum proper, transmits the urethra, and the anal triangle contains the anus and terminal portion of the rectum.

Dissection.—The subject should be placed on his back, the buttocks projecting slightly beyond the end of the table. A block of wood of sufficient size is then placed beneath the pelvis, to elevate the perineum to a convenient height. A medium-sized bougie or lithotomy staff should now be passed into the bladder, as it is more difficult to pass either of these instruments after the limbs have been placed in position for this dissection. To prevent the body from sliding away from the block and from the end of the table, a strip of bandage is placed across the abdomen, above the crests of the ilia, and tied at that end of the table which is beneath the buttocks. The legs and thighs are then strongly flexed and abducted. The legs are to be fixed in this position by first tying a roller bandage, two inches wide, around one leg, immediately below the flexed knee, and then passing it beneath the table, and finally around the other leg below the knee in the same manner. Finally, the flexed knees may be still further secured by fastening a roller bandage around one knee, then carrying it beneath the nape

of the neck, and tying it to the opposite knee. When the subject has been fixed upon the table in the manner directed, it will be impossible for the body to slip out of position. The dissection of this part can not be successfully carried out unless the cadaver be placed in the lithotomy position, as just described. The scrotum is raised and held forward by means of hooks.

Surface Anatomy.—A study of the surface exposed shows the skin of the perineum to be dark in color and covered with short, crisp hairs, which should be shaved before proceeding further. The surface will be seen to be slightly convex in the middle line, owing to the prominence caused by the bulb and the forward continuation of the corpus spongiosum, through both of which the urethra passes.

The bony prominences felt distinctly are: Anteriorly, the bodies of the pubic bones and the pubic arch; posteriorly, the tip of the coccyx; laterally, the descending rami of the pubes, the ascending rami and the tuberosities of the ischia.

The **perineal raphe** is a pigmented ridge in the skin, and extends from the anterior margin of the anus forward along the middle line of the perineum to the scroto-perineal junction, and is continuous with the median raphe of the scrotum. The median raphe is the line of safety of the perineum—that part where the blood-vessels are fewest. When practicable, in operations, incisions are made through this line.

The **central tendon of the perineum** or perineal center is in the line of the perineal raphe midway between the center of the anus and the line of junction of the scrotum with the perineum. At the perineal center, which is at the center of the base of the triangular ligament of the perineum, the two transversi perinei, the accelerator urinæ, and the sphincter ani muscles, and some of the anterior fibers of the levator ani muscle meet in a common tendon which is blended with the triangular ligament in this location. The **bulb of the corpus spongiosum** lies immediately above or anterior to this point, and the **artery of the bulb** runs just anterior to a line from the tuberosity of the ischium to the perineal center. When a knife is introduced at the perineal center and pushed upward and slightly backward, it will enter the membranous portion of the urethra. The perineal raphe and the perineal center are important landmarks in all operations performed in this region.

The **bulb of the corpus spongiosum** is comparatively small in the child (Bellamy) and large in advanced life; hence there is danger of wounding it in lateral perineal lithotomy in old men.

The **white line of the anus** is situated at the margin of the anus, at the junction of the skin and mucous membrane, and is a guide to the surgeon in

operations upon this part. It is the line of demarcation between the respective areas involved in internal and external hemorrhoids, and marks the position of the interval between the external and internal sphincter ani muscles.

The **anus** is the dilatable aperture at the lower extremity of the alimentary tract. It is situated in the anal triangle in the median line, and its center is one and one-half inches, or four centimeters, in front of the tip of the coccyx. The skin around it is pigmented and thrown into folds, which are most numerous posteriorly. In the creases between these folds there develop *fissures of the anus*, which are irritable, linear ulcers. In the integument immediately around the anus are situated a number of sweat glands, known as the **circum-anal glands.** Sebaceous glands are also found in connection with the hair of this region. Suppuration of these glands produces a superficial abscess, which must not be mistaken for abscess of the ischio-rectal fossa.

Congenital Defects.—Absence of the anus is known as **imperforate anus,** and occurs as a congenital defect. The operation for the relief of this malformation consists of searching for the rectum through an incision into the perineum immediately anterior to the coccyx; if the rectum can not be found, the only alternative is colotomy. Certain **dermoid cysts,** which are occasionally found in the coccygeal region, originate from the so-called post-anal gut, a portion of the hind gut situated posterior to the anal opening, which, normally, is obliterated. Termination of the urethra in the perineum is known as perineal **hypospadia.**

The **Ischio-rectal Fossæ** are situated at the side of the anus, between it and the tuberosities of the ischia. In the skin over one of these fossæ the mouth of a **complete fistula in ano** or an **incomplete external fistula in ano** is found; it is there that tenderness is detected in inflammation and abscess of the ischio-rectal fossæ.

Rectal Examination.—The rectum, one of the most important surgical avenues, should always be examined by the finger, and the parts in relation with the anterior wall should be carefully studied and their position accurately determined before dissecting the perineum. On introducing the finger into the bowel, with its dorsal surface presenting to the concavity of the sacrum and coccyx, the resistance offered by the contraction of the *external sphincter ani muscle* will first be felt, and for one inch, or two and one-half centimeters, above the external sphincter the resistance offered by the contraction of the *internal sphincter ani muscle* will be noticed. About a half inch above the internal sphincter ani and through the anterior wall of the rectum the prostate gland will be felt, the outline of which should be carefully defined in order to be able to draw comparisons when cases of hypertrophy of this organ are met. The *prostate gland* in the healthy adult is a body about the size of a large chestnut, and is felt from one and one-half to two

inches, or from four to five centimeters, from the anus. Its size and consistency are more satisfactorily perceived when the bladder is at least half full, the prostate gland under these circumstances being pressed downward toward the rectum and brought within more ready reach of the finger.

The *bas-fond of the bladder* is felt immediately beyond the prostate as a soft and somewhat elastic structure at a distance of two and one-half inches, or six centimeters, from the anus. When the bladder is distended, the finger, introduced into the rectum and placed in contact with the base of the bladder, can detect fluctuation when the fingers of the other hand are tapping over the hypogastric region. The *seminal vesicles* may be felt beyond the prostate gland as two soft oblong bodies at the sides of the bas-fond of the bladder; they are about two inches, or five centimeters, in length, and one-half of an inch, or twelve millimeters, in width. They are more satisfactorily palpated when the bladder is full. From the relation which the seminal vesicles hold to the rectum it follows that during a constipated defecation the pressure against the vesicles may be sufficient to cause the escape of some of their contents through the urethra. If this occurs in a nervous individual, it is likely to lead him to believe that he is suffering from spermatorrhea.

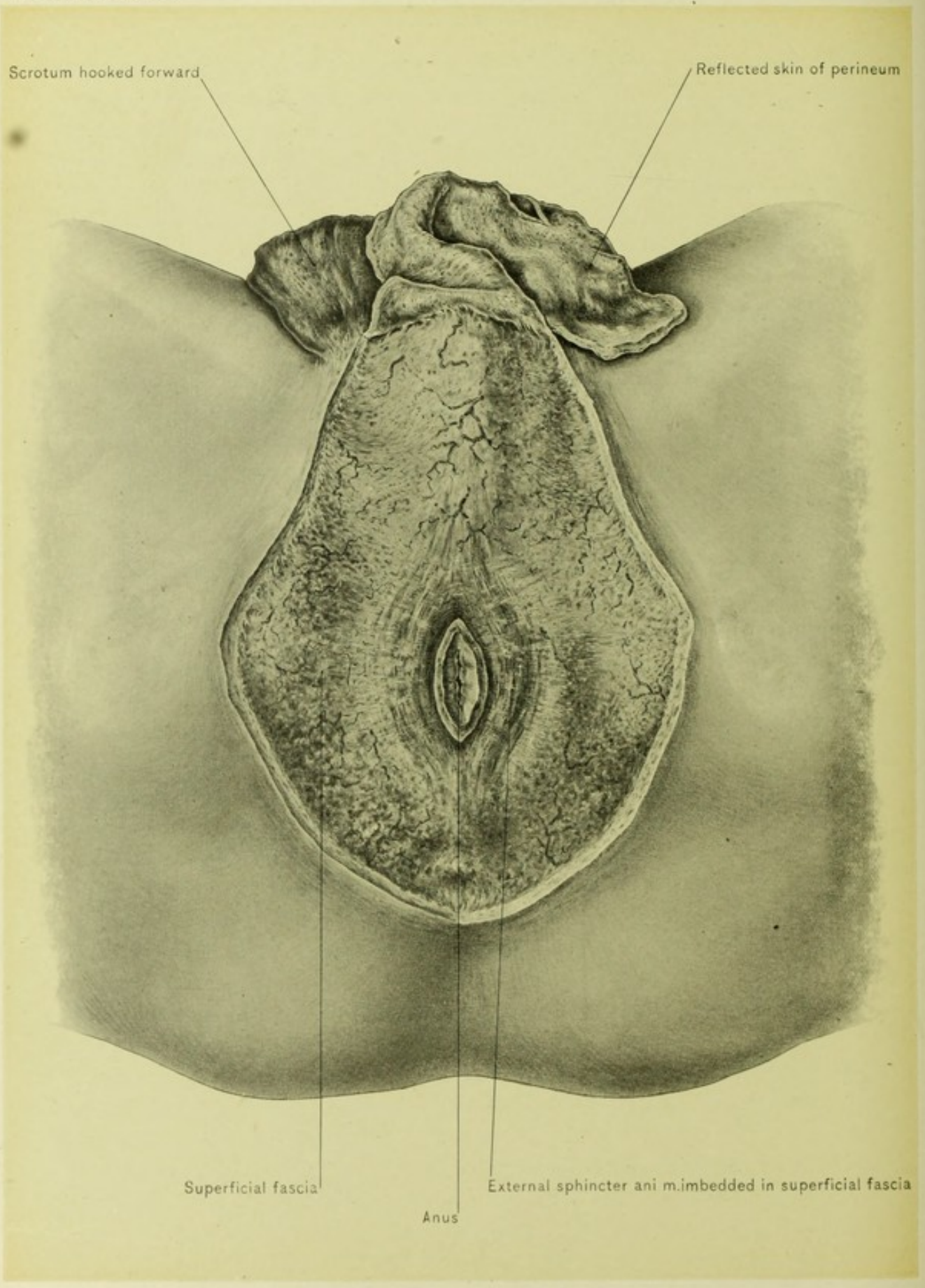
Through the anterior wall of the rectum, between the level of the internal sphincter ani muscle and that of the prostate gland, the track of the *membranous portion of the urethra* can be felt. It is important to remember this when attempting to pass an instrument into the bladder in obstruction of this portion of the urethra, as the finger in the rectum may act as a safe director and assist in locating the point of obstruction. In children the prostate gland is rudimentary, and the wall of the urethra at this point is less resistant, and, consequently, in passing an instrument into the bladder there is danger of perforating the urethra.

The larger semilunar folds of mucous membrane in the lower part of the rectum (especially the one projecting from the right side of the posterior wall), as described by Mr. Houston, are sometimes three or four in number, and frequently become the site of ulcerative inflammation; they may be easily detected by the finger. Division of the muscular fibers forming the floor of the ulcer may be necessary in order to effect a cure of the ulcerative process.

The ischio-rectal fossæ, which are on each side of the rectum, can be palpated through the rectum, thus affording a means of early detection of inflammation in these fossæ.

Dissection.—Having made the digital examination of the rectum as directed, the lower part of the bowel is moderately distended with rags, cotton, or oakum, and the margins of the anus are brought together with sutures. In the dissection of the perineum, as in that of the abdominal walls, it is preferable to raise the

PLATE CCXCVIII.



SUPERFICIAL FASCIA OF MALE PERINEUM.

skin in one large flap, and not to make a number of incisions, as is usually advised. Two incisions, cutting only through the skin, are to be made; each incision commences a short distance above the line of junction of the scrotum with the perineum, and is carried along the descending ramus of the pubes downward and outward, external to the tuberosity of the ischium, and meets the other incision posteriorly a short distance behind the tip of the coccyx. The flap thus marked out is reflected from behind forward, and should include the skin of the posterior one-third of the scrotum. Great care is necessary in removing that portion of the skin surrounding the anus, in order to preserve the external sphincter ani muscle, some of the fibers of which are inserted into the skin.

The **Skin** in the region of the perineum is thin and loosely connected with the subjacent parts, and hence blows in this location are attended by early and extensive ecchymosis. It is well supplied with blood vessels and nerves.

The **Superficial Fascia** of the entire perineum should be studied before the student begins the dissection of the individual triangles. Near the anus the superficial fascia contains considerable fat, which extends deeply upward upon each side of the rectum in the shape of a soft, elastic pad, which permits distention of the lower part of the rectum. Anteriorly or toward the scrotum, the fat diminishes in quantity, disappearing entirely in the scrotum, where it is replaced by the involuntary muscular fibers of the dartos.

The superficial fascia covering the urethral triangle consists of two layers—a superficial and a deep layer. The **superficial layer** contains more or less fat, and is continuous with the same layer of the superficial fascia of the scrotum and thighs and with the superficial fascia of the anal triangle. The **deep layer of the superficial fascia, or fascia of Colles,** is more membranous than the superficial layer, and has the same shape as the urethral triangle, which it covers. It is attached posteriorly to the lower edge or the base of the anterior layer of the triangular ligament, and winds around the posterior border of the transverse perineal muscles. It is attached on each side to the rami of the pubes and ischium, and for practical purposes is best described as being continuous with the deep fascia of the thighs at this point. Anteriorly, it is continuous with the dartos of the scrotum, which represents the superficial fascia of that region. It forms the immediate covering for the muscles of the urethral triangle or perineum proper.

In the anal triangle the superficial fascia is composed of but one layer—the adipose or superficial layer. By following the superficial fascia laterally from the anus, it will be seen to change from a pliant pad in the ischio-rectal fossa to a dense, tough layer over the tuber ischii. In this last region the fat lobules are separated by fibrous septa which connect the skin with the underlying bony

structures, a bursa intervening between the fascia and the bone. When the body rests on the tuberosities of the ischia, these bursæ act as cushions.

Dissection.—The superficial fascia, like the skin, is to be removed in one large flap, reflected from before backward. In the urethral triangle the superficial layer only is to be removed. The anal triangle, which includes the anus and the ischio-rectal fossæ, is to be dissected before the urethral triangle or perineum proper. The fat contained in the ischio-rectal fossæ is to be dissected out on one side, regardless of the blood vessels and nerves passing through it, while on the other side the blood vessels and nerves are to be carefully preserved.

The **External Sphincter Ani Muscle** encircles the anus, is subcutaneous, and closely adherent to the skin. It is attached behind to the tip of the coccyx, and in front to the central tendon of the perineum, there meeting the inner ends of the transverse perineal muscles, the posterior portion of the accelerator urinæ muscles, and some of the fibers of the levator ani muscles. A number of the longitudinal fibers of the rectum pass through the external sphincter ani muscle on their way to the skin.

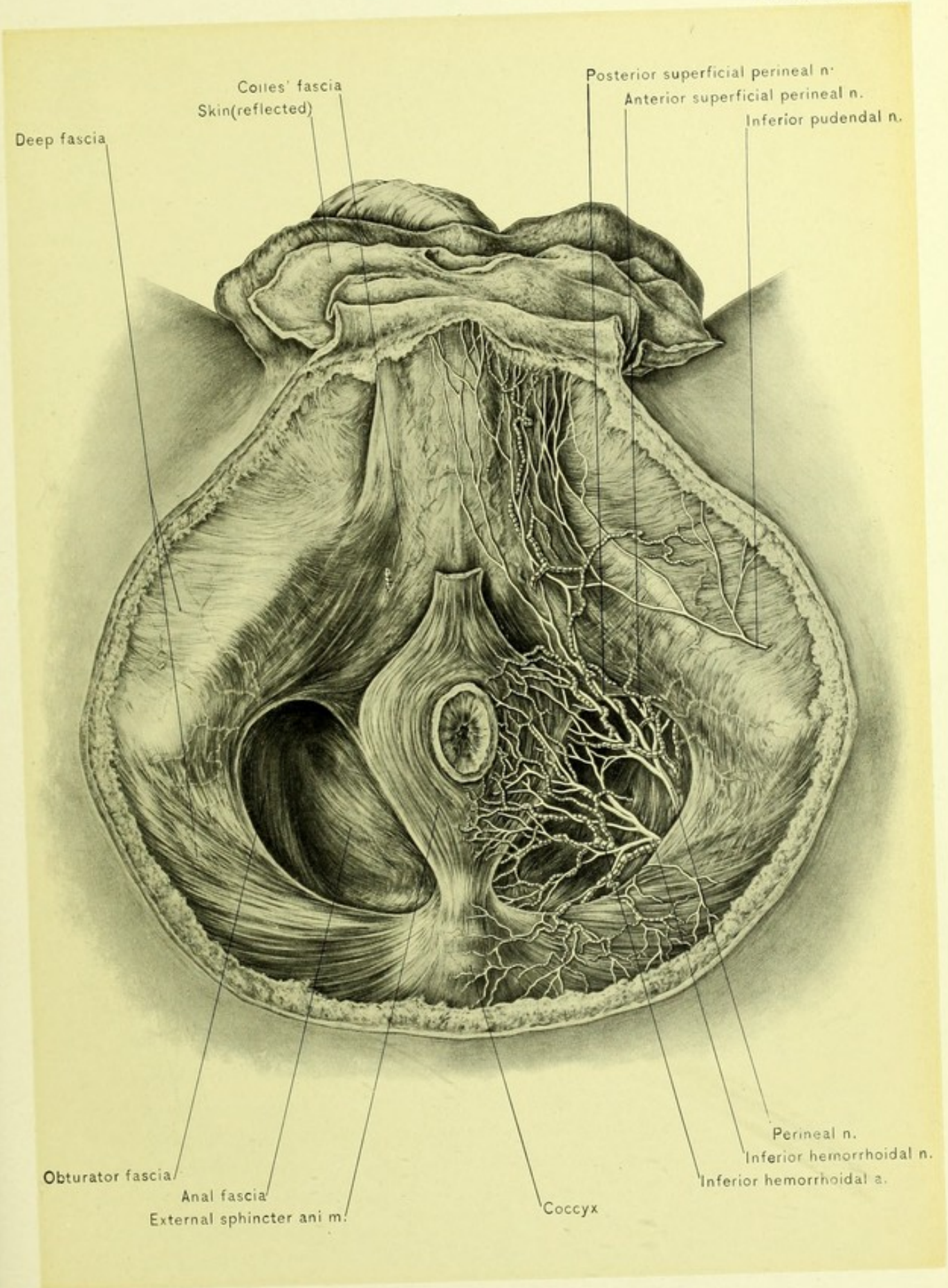
Superficially, it is in relation with the skin; deeply, with the levator ani muscles and internal sphincter ani muscle; internally, with the internal sphincter ani muscle and some of the rectal mucous membrane; and upon its lateral aspects, with the fat of the ischio-rectal fossæ.

Blood Supply.—From the inferior hemorrhoidal branches of the internal pudic artery. Its veins empty into the internal pudic vein, and its lymphatics into the inguinal glands.

Nerve Supply.—From the perineal, inferior hemorrhoidal, and fourth sacral nerves.

Action.—It is a voluntary aid to the closure of the anus. It flexes the coccyx and braces the central tendon of the perineum.

The **Ischio-rectal Fossæ** are the spaces intervening between the rectum internally, and the rami and tuberosities of the ischia externally. Each fossa is cuneiform in shape, its base being directed downward and formed by the skin and superficial fascia; the edge of the wedge is directed upward, and is situated at the line along which the anal fascia springs from the obturator fascia. The ischio-rectal fossa measures about two inches, or five centimeters, from before backward, one inch, or two and one-half centimeters, laterally, and between two and three inches, or five and seven centimeters, in depth, being deepest externally or near the tuberosity of the ischium. The inner wall (rectal) is the longest. The ischio-rectal fossa is *bounded* in front by the deep layer of the superficial fascia covering the transverse perineal muscle, and by the base of the triangular ligament of the perineum. Behind, it is bounded by the gluteus maximus muscle



ISCHIO-RECTAL FOSSÆ AND FASCIA OF COLLES OF MALE PERINEUM.

and the great sacro-sciatic ligament. The inner boundary is formed by the levator ani and coccygeus muscles, covered by the anal fascia. The external boundary is composed of the obturator fascia, the obturator internus muscle, and the ischium.

The **contents of the ischio-rectal fossa** are fat, inferior hemorrhoidal vessels and nerve, the origins of the superficial perineal artery and the perineal nerve, and the perineal branch of the fourth sacral nerve. In the outer wall are the internal pudic vessels and pudic nerve, and dorsal nerve of the penis, and beneath the inner wall is the rectum.

The internal pudic vessels, pudic nerve, and dorsal nerve of the penis are inclosed in a sheath (*the canal of Alcock*), formed by the obturator fascia, and are about an inch and a half, or four centimeters, above the lower border of the tuberosity of the ischium. The *external* or *inferior hemorrhoidal artery* and *nerve*, which are branches of the internal pudic artery and pudic nerve respectively, cross the space obliquely from the posterior portion of its outer wall. They divide into a number of branches which supply the lower part of the rectum, the levator ani, and the sphincter ani muscle, the superficial fascia, and the skin. The external or inferior hemorrhoidal arteries anastomose with the same vessels of the opposite side and with branches of the middle and superior hemorrhoidal arteries. The radicles of the inferior hemorrhoidal veins often become varicose, and form **hemorrhoids,** or **piles.** At the posterior border of the space the perineal branch of the fourth sacral nerve, which pierces the coccygeus muscle to supply the external sphincter ani, and some branches of the small sciatic nerve will be seen. The superficial perineal artery and the superficial perineal nerves run through the anterior and outer part of the space.

The **Anal or Ischio-rectal Fascia** covers and is in close relation with the superficial surface of the levator ani and coccygeus muscles. Externally, it springs from the obturator fascia just below the origin of the levator ani muscle; internally, it is continuous with the deep fascia covering the lateral portion of the external sphincter ani muscle; anteriorly, it is continuous with the deep layer of the triangular ligament, and at the anterior margin of the levator ani with the recto-vesical fascia; and posteriorly it blends with the deep fascia on the deep surface of the gluteus maximus muscle.

Ischio-rectal abscess.—The dependent position and the imperfect blood supply of the ischio-rectal fossæ permit the rather frequent occurrence of abscess in the soft fat of these fossæ. These abscesses should be opened early, as they soon distend the fossa and open in one of the two directions in which the pus meets with least resistance: namely, through the skin or into the rectum. An ischio-rectal abscess opening both into the rectum and through the skin forms a **complete fistula in ano.** When it opens only into the rectum, it forms an **incom-**

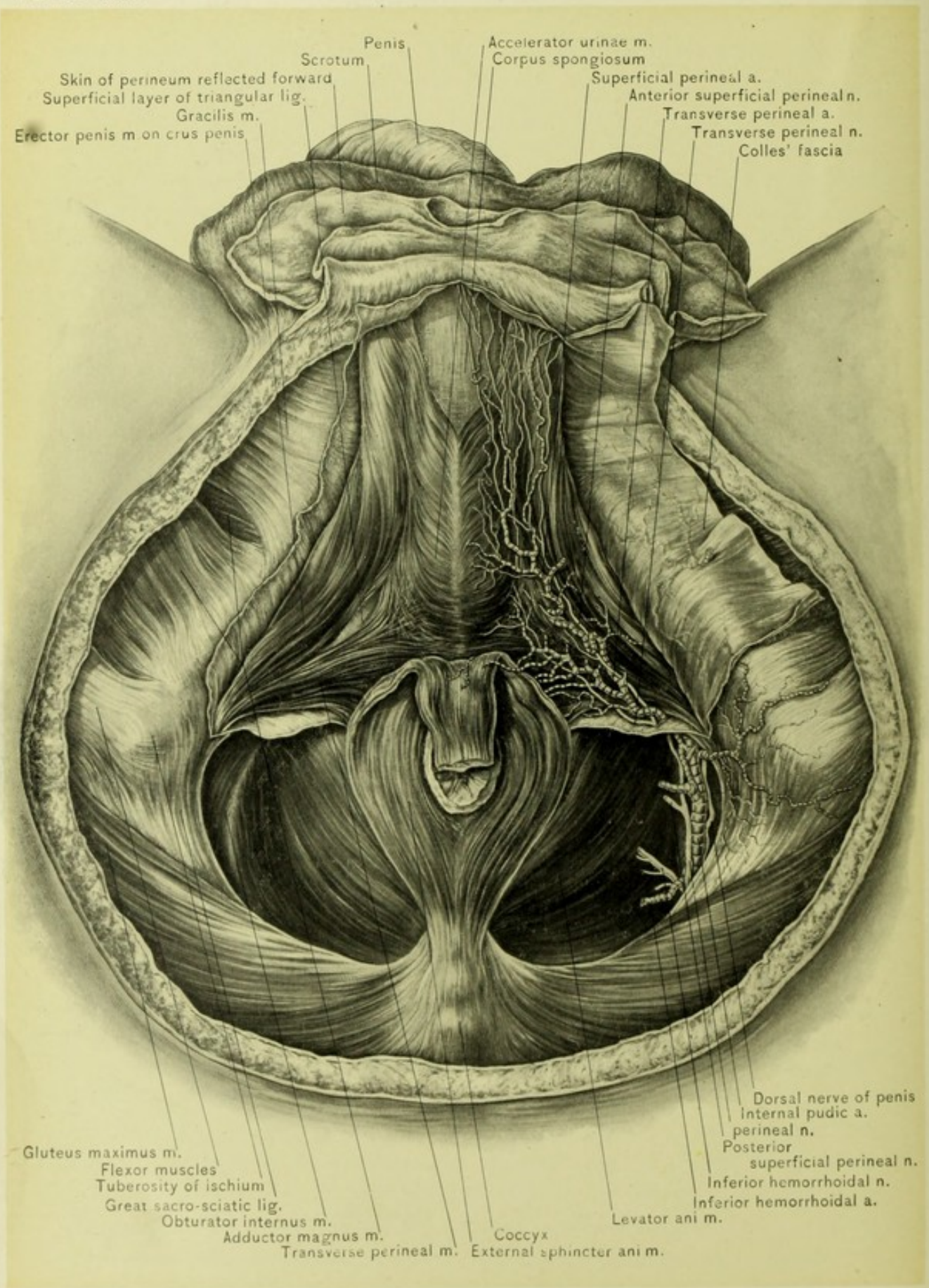
plete internal fistula ; and when it opens only externally, an **incomplete external fistula.** In complete fistulæ and incomplete internal fistulæ the tissues in the immediate neighborhood may become emphysematous through escape of gas from the rectum into the tissues. When the pus of an ischio-rectal abscess finds its way into the rectum, the opening is most frequently from one-half of an inch to one and one-half inches, or from one to four centimeters, from the anus, as the anal fascia and levator ani muscle and their attachments are barriers which divert the pus downward to the level of the internal sphincter ani muscle.

In opening an ischio-rectal abscess care is necessary to avoid wounding the rectum and the internal pudic vessels. The incision may be made from before backward in the line of the fibers of the external sphincter ani muscle, and slightly nearer to the tuber ischii than to the anus. This incision is followed by some bleeding, as the incision crosses the external hemorrhoidal vessels. The loss of blood, however, is so trifling that it is a matter of no importance.

The **Superficial** or **Anterior Intra-aponeurotic Space** of the perineum is situated in the urethral triangle, between the deep layer of the superficial fascia and the superficial or anterior layer of the triangular ligament. It contains the bulb of the corpus spongiosum ; the bulbous portion of the urethra ; the terminal portion of the ducts of Cowper's glands ; the crura of the penis ; the accelerator urinæ, erector penis, and transverse perineal muscles ; the superficial and transverse perineal vessels ; the anterior, and sometimes the posterior, superficial perineal nerves ; the terminal part of the inferior pudendal nerve ; the artery of the corpus cavernosum ; and the dorsal artery, vein, and nerve of the penis. Posteriorly, the space is divided into two lateral compartments by adherence of Colles' fascia to the median raphe of the accelerator urinæ muscle ; anteriorly, the two compartments are not completely separated.

Extravasated urine enters the superficial intra-aponeurotic space of the perineum proper when the urethra is ruptured at the junction of its bulbous and membranous portions. Having distended this space, the urine passes in the direction in which it meets the least resistance,—namely, into the scrotum,—and thence it passes over the body of the pubis, between the spine of the pubis and the symphysis pubis, into the abdominal wall by way of the scroto-abdominal passage. It is unable to gain access to the ischio-rectal fossæ on account of the attachment of the deep layer of the superficial perineal fascia to the base of the triangular ligament ; neither can it find its way externally upon the inner sides of the thighs on account of the attachment of the deep layer of the superficial fascia to the descending rami of the pubes and rami of the ischia ; it can not enter the pelvis, as the anterior layer of the triangular ligament is stretched across the urethral triangle as a firm, resisting diaphragm. Having reached the abdom-

PLATE CCC.



SUPERFICIAL MUSCLES, ARTERIES, AND NERVES OF MALE PERINEUM.

inal wall, it accumulates beneath the superficial fascia in this location, being unable to pass to the anterior surface of the thighs on account of the attachment of the deep layer of the superficial fascia of the abdomen to the deep fascia along Poupart's ligament and the outer lip of the crest of the ilium. Pus or blood within the superficial perineal interspace, if the effusion be extensive enough, will follow the same course. Owing to the density and attachments of the deep layer of the superficial fascia there will be little or no fluctuation in the perineum in cases of extravasated urine, and in abscess only a firm and tender swelling will be present.

Dissection.—The deep layer of the superficial fascia is removed by carrying a vertical incision from the base of the scrotum along the middle line as far as the posterior limit of the urethral triangle, where, at right angles to the first, a second incision is made, extending outward upon each side to the tuberosity of the ischium, thus severing its connection with the lower margin of the triangular ligament; each half can then be reflected laterally. This will expose the vessels, nerves, and muscles situated in the superficial intra-aponeurotic space. By displacing the adjacent borders of the accelerator urinæ and erector penis muscles the anterior layer of the triangular ligament can be seen.

The **Superficial Perineal Artery** arises from the internal pudic at the anterior and outer part of the ischio-rectal fossa. It pierces Colles' fascia at its junction with the base of the triangular ligament, and runs over, under, or through the transverse perineal muscle; thence forward, between the accelerator urinæ and the erector penis muscle, both of which it supplies, and is finally distributed to the scrotum, where it anastomoses with the external pudic branches of the common femoral artery. It is accompanied by the anterior superficial perineal nerve.

The **Transverse Perineal Artery** arises more commonly from the superficial perineal, where this vessel is in relation with the transverse perineal muscle; it may arise from the internal pudic artery. It runs inward, over, or under the transverse perineal muscle, which it supplies, to the central point of the perineum, where it anastomoses with the corresponding artery of the opposite side. It is severed in the operation of lateral lithotomy.

The **Veins** accompanying the foregoing arteries empty into the internal pubic vein.

The **Cutaneous Nerves of the Perineum** are the two superficial perineal (anterior and posterior) and the inferior pudendal.

The **anterior superficial perineal nerve,** a branch of the perineal division of the pudic in the ischio-rectal fossa, pierces Colles' fascia at its junction with the base of the triangular ligaments, passes over, under, or through the transverse perineal muscle, and accompanies the superficial perineal artery to the scrotum.

It gives off muscular branches to the levator ani and the superficial muscles, and cutaneous branches to the integument and fascia of the scrotum and around the root of the penis.

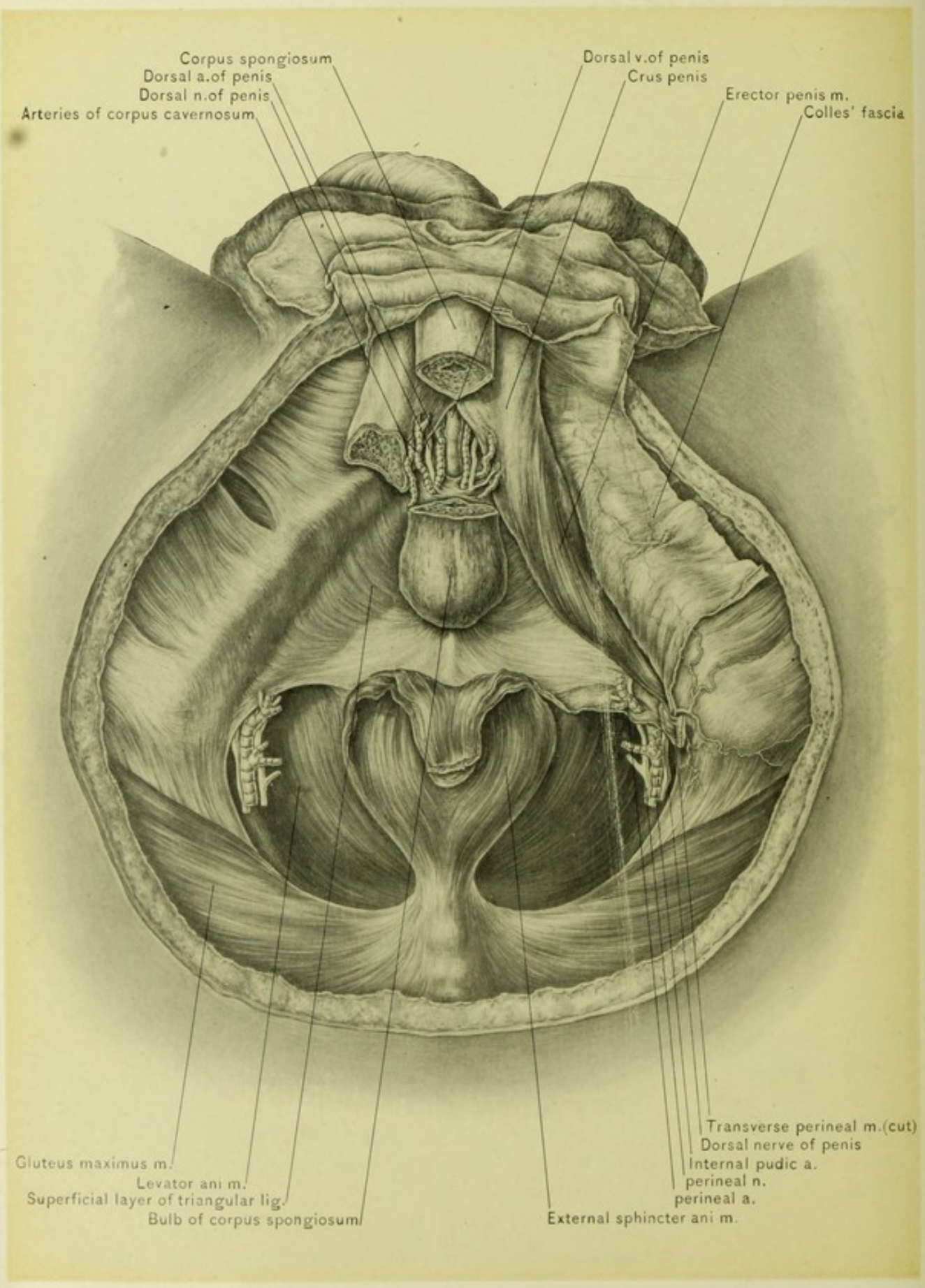
The **posterior superficial perineal nerve** is also derived from the perineal division of the pudic nerve in the anterior part of the ischio-rectal fossa. It runs forward in the superficial surface of Colles' fascia to the scrotum. Sometimes it pierces Colles' fascia at its junction with the base of the triangular ligament, and passes forward over or under the transverse perineal muscle, accompanying the superficial perineal artery. It sends filaments to the sphincter ani muscle and to the skin in front of the anus. It receives a communicating branch from the inferior hemorrhoidal nerve. At the back part of the scrotum it communicates with the anterior superficial perineal nerve and with the inferior pudendal nerve.

The **inferior** or **long pudendal nerve** is a branch of the small sciatic. It pierces the fascia lata about one inch, or two and one-half centimeters, above the tuberosity of the ischium, passes obliquely upward and inward over the ascending ramus of the ischium, and then runs forward over or pierces the deep layer of the superficial fascia of the perineum. It is distributed to the integument of the scrotum and outer part of the perineum, communicating with the posterior branch of the perineal nerve. It also communicates with the inferior hemorrhoidal nerve. Pain referred to the back of the thigh in affections of the perineum or scrotum in the male, and of the perineum or vulva in the female, is explained through the connection of the small sciatic nerve with the posterior superficial perineal nerve by means of the inferior pudendal.

The muscles occupying the superficial intra-aponeurotic space which are seen at this stage of the dissection are the accelerator urinæ in the median line, the erector penis at the side, and the transverse perineal below. They form two muscular triangles, the common perpendicular of which is formed by the acceleratores urinæ; the base of each triangle, by the transverse perineal; and the hypothenuse, by the erector penis.

The **Accelerator Urinæ Muscle** (*ejaculator seminis*, or *bulbo-cavernosus*) lies on the bulb of the corpus spongiosum and the portion of the corpus spongiosum just anterior to the bulb. It is a double muscle, the two halves being united in the middle line on the superficial surface of the bulb by a median tendon or raphe. It consists of three sets of fibers—posterior, middle, and anterior. The posterior fibers are inserted into the anterior layer of the triangular ligament on each side of the bulb, and some of the most posterior fibers are inserted beneath the crus penis into the middle of the ischio-pubic ramus; the middle fibers surround the bulb and the adjacent part of the corpus spongiosum, and join the fibers

PLATE CCCI.



SUPERFICIAL LAYER OF TRIANGULAR LIGAMENT OF MALE PERINEUM.

of the opposite muscle in a common tendon between the corpus spongiosum and the corpora cavernosa; the anterior fibers, which are the longest, pass around the corpus cavernosum, and, with the fibers of the opposite muscle, terminate in a common tendon covering the dorsal vessels of the penis.

Action.—The action of the accelerator urinæ muscle as a whole is to compress the bulb and to expel the last drop of urine in this part of the urethra, after the bladder has been emptied. It also assists in expelling the semen. The middle fibers, according to Krause, assist in the erection of the corpus spongiosum by compressing the erectile tissue of the bulb, and the anterior fibers assist in the same process, according to Tyrrel, by compressing the dorsal vein of the penis. The part the muscle plays in the emission of semen is involuntary.

The **Erector Penis Muscle** (*ischio-cavernosus*) covers the crus penis. It is narrower at each end than in the middle, and is situated along the lateral boundary of the urethral triangle. It arises by muscular and tendinous fibers from the inner surface of the tuberosity of the ischium behind the crus penis, from the crus itself, and from the ischio-pubic ramus on both sides of the crus. Its fibers ascend, cover the crus penis, and terminate in a small aponeurosis which is inserted into the inner, outer, and under surfaces of the crus.

Action.—The action of the erector penis muscle is to compress the crus penis and to assist in producing erection of the penis by retarding the escape of the venous blood.

The **Transverse Perineal Muscle** is small and lies along the base of the urethral triangle. It arises from the inner and forepart of the tuberosity of the ischium, and passes forward and inward to be inserted into the central tendon of the perineum, where it joins the corresponding muscle of the opposite side, the accelerator urinæ, the sphincter ani, and the anterior fibers of the levator ani. In the operation of lateral lithotomy this muscle is divided, thus establishing a communication between the two triangles of the perineum—the urethral and the anal. It is around the lower border of this muscle that the deep layer of the superficial fascia winds to become continuous with the base of the triangular ligament. The two transverse perineal muscles have been called collectively the perineal digastric muscle.

Blood Supply.—The blood supply of the accelerator urinæ, erector penis, and transverse perineal muscles is derived from the superficial and transverse perineal arteries.

Nerve Supply.—The nerve supply of the accelerator urinæ, erector penis, and transverse perineal muscles is derived from the muscular branches of the perineal nerve.

Dissection.—Divide and reflect the transverse perineal muscle and the crus

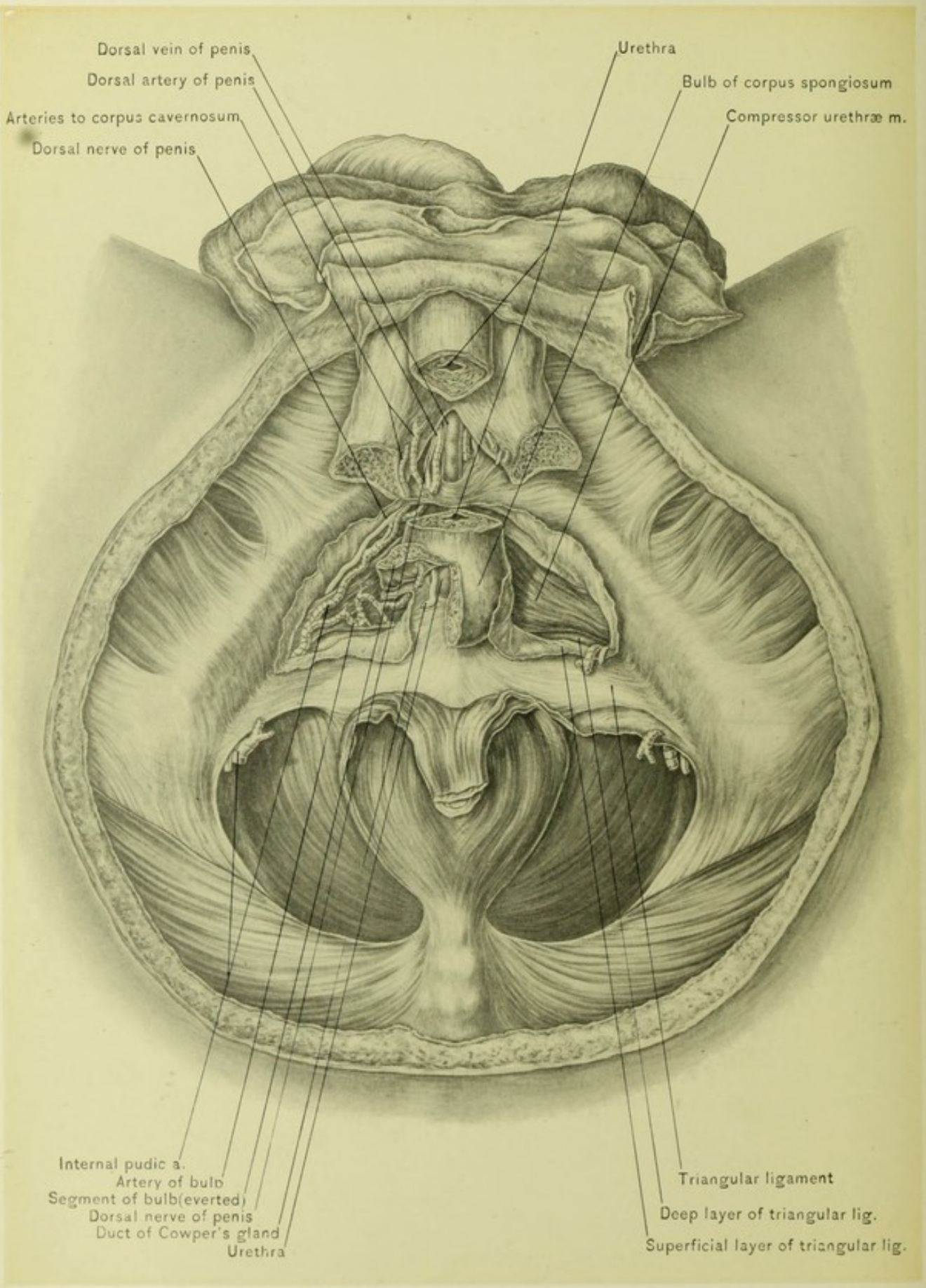
penis and erector penis muscle of one side, and remove the accelerator urinæ muscle from the bulb. The anterior layer of the triangular ligament, the bulb of the corpus spongiosum, and the dorsal artery, vein, and nerve of the penis are now exposed.

The **Triangular Ligament** is a strong fibrous membrane which stretches across that portion of the outlet of the pelvis occupied by the perineum proper. It measures about an inch and a half, or four centimeters, from base to apex, its base being directed backward and its apex forward. Like the obturator membrane, it is part of the ligamentous wall of the pelvis. This dense aponeurotic membrane has been described as the *inferior* or *superficial layer* of the triangular ligament, and the fascial partition passing on the deep surface of the compressor urethræ muscle has been called the *superior* or *deep layer of the triangular ligament.* In front the triangular ligament is attached to the subpubic ligament, except in the center, where the dorsal vein of the penis passes between these two structures; laterally, to the rami of the pubes and ischium more deeply than the crus penis; and near its base, in the median line, it blends with the central tendon of the perineum in the interval between the urethra and rectum. The base of the triangular ligament is continuous with the deep layer of the superficial perineal fascia; and its deep surface near its base, with the anal fascia and the superior layer of the ligament.

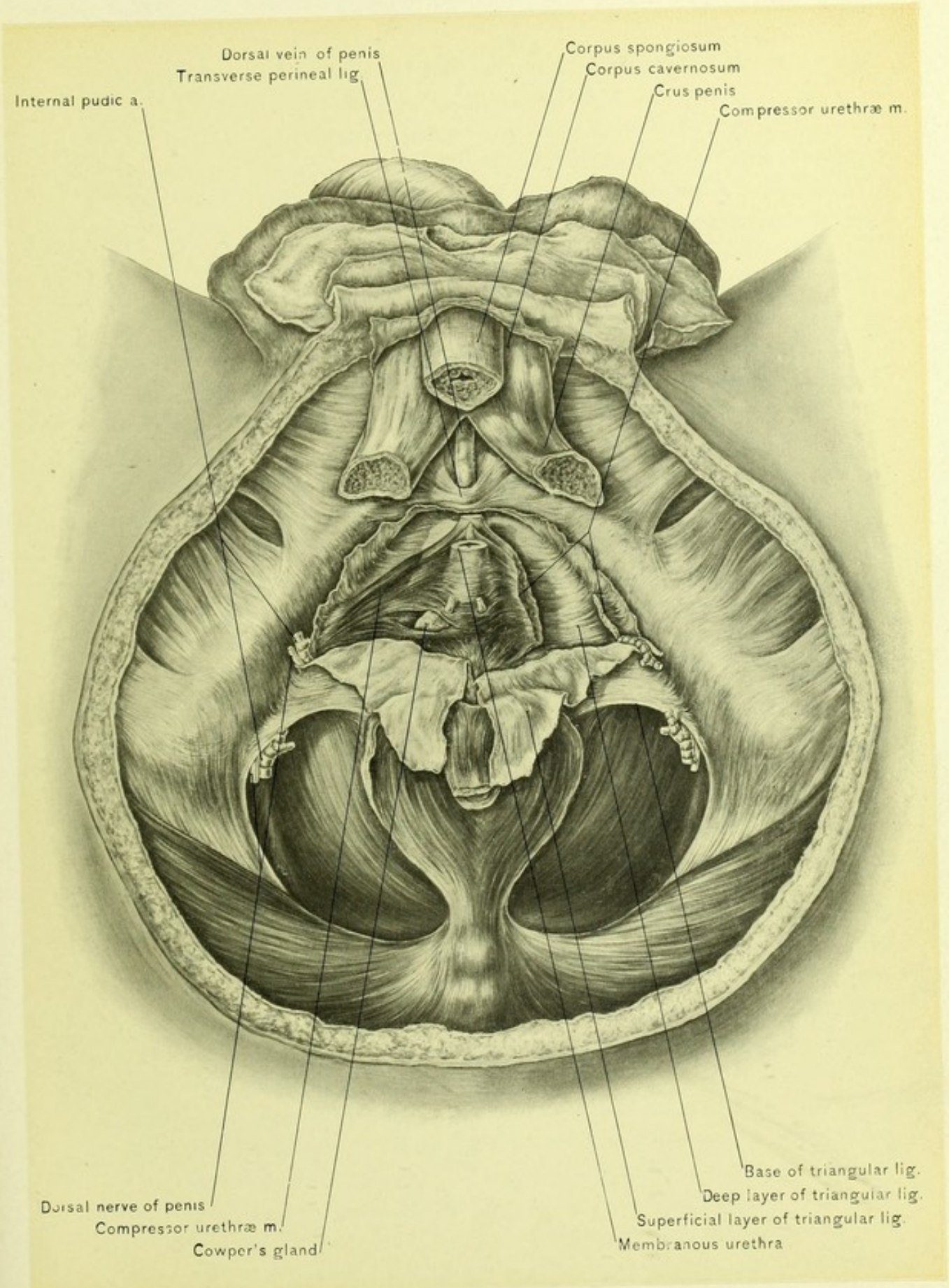
Near the subpubic ligament some of the fibers of the triangular ligament pass from one side of the pubic arch to the other, forming the **transverse perineal ligament.** In relation with the superficial surface of the triangular ligament are the contents of the superficial intra-aponeurotic space of the perineum previously described. Some of the fibers of the ligament are reflected upon the bulb of the corpus spongiosum, and strengthen its fibrous investment. About one inch, or two and one-half centimeters, below the symphysis pubis the triangular ligament is perforated by the urethra. It is also pierced by the arteries of the corpora cavernosa, the dorsal arteries and nerves of the penis, the arteries to the bulb, and the ducts of Cowper's glands, and, finally, at the base, where it becomes continuous with the deep layer of the superficial perineal fascia, by the superficial perineal vessels and nerves. In cases of rupture of the spongy urethra the triangular ligament prevents the urine from gaining access to the pelvis, and in cases of rupture of the membranous urethra it prevents the urine from escaping from the pelvis into the more superficial tissues of the perineum.

The first obstruction to the passage of an instrument through the urethra, provided it contains no strictures and is otherwise normal, is the lower margin of the urethral orifice of the triangular ligament; this natural obstruction is to be borne in mind when passing such an instrument. The base of this ligament is

PLATE CCCII.



DEEP VESSELS AND NERVES OF MALE PERINEUM.



TRIANGULAR LIGAMENT AND COMPRESSOR URETHRÆ MUSCLE.

divided in the operations of lateral and median lithotomy and in those perineal sections in which the membranous urethra is attacked.

Dissection.—The triangular ligament, or, as it is often described, the superficial layer of the ligament, is to be divided at its attachment to the rami of the pubes and ischium and turned inward, upon the side of the perineum from which the crus penis has been removed. Next carefully trace the structures occupying the deep intra-aponeurotic space of the perineum proper.

The **Deep Intra-aponeurotic Space of the Perineum** is situated in the perineum proper between the two layers of the triangular ligament. It contains the compressor urethræ muscle, the membranous urethra, Cowper's glands and their ducts, the arteries of the bulb, the internal pudic arteries, the internal pudic veins, the arteries of the corpora cavernosa, and the dorsal arteries, vein, and nerves of the penis.

The **compressor urethræ muscle** (*constrictor urethræ, deep transversus perinei*) consists of transverse fibers, and completely surrounds the membranous portion of the urethra. It arises on each side from the ischio-pubic ramus for the distance of about half an inch, or twelve millimeters. The fibers pass inward and separate into two sets, one of which passes anterior to, and the other posterior to, the membranous urethra. The muscles of the two sides are inserted into a median raphe, their most anterior fibers being inserted into the connective tissue filling the angular interval at the junction of the crura of the penis, and the most posterior fibers being inserted into the perineal center.

Blood Supply.—From the internal pudic artery and the artery of the bulb.

Nerve Supply.—From the perineal division of the pudic nerve.

Action.—The action of the muscle is to diminish the caliber of the membranous urethra and so to aid in the retention of urine in the bladder, to compress the veins of the penis in erection of that organ, and to assist in expelling urine and semen. Beneath the fibers of the compressor urethræ and surrounding the urethra are involuntary circular muscular fibers which are continuous with the muscular fibers of the bladder, and which assist in forcing forward the urine and the semen. The membranous urethra may be the site of spasmodic stricture, or urethrismus (Otis), resulting from some pathologic condition of the pendulous urethra : *i. e.*, a stricture of large caliber or a contracted meatus.

Cowper's glands are two small, yellow, racemose glands, each about the size of a pea, situated behind and below the membranous urethra, one on each side of the median line, in the substance of the compressor urethræ muscle. They are overlapped by the posterior end of the bulb, from which they are separated by the anterior layer of the triangular ligament. The duct of each gland—nearly an

inch, or two and one-half centimeters, in length—pierces the superficial layer of the triangular ligament, runs forward in the bulb along the floor of the bulbous urethra, and obliquely enters the bulbous urethra at its floor. In some bodies these glands are so small as to escape detection; they appear to decrease in size as age advances. Their secretion is accessory to the seminal fluid.

The **artery of the bulb** (*bulbo-cavernosus*) is a vessel of considerable size. It arises from the internal pudic artery just after it has pierced the deep layer of the triangular ligament, and passes inward and forward through the substance of the compressor urethræ muscle one centimeter anterior to a *line* drawn from the tuberosity of the ischium to the perineal center. It pierces the anterior layer of the triangular ligament to enter the posterior part of the bulb. Thence it continues forward in the corpus spongiosum and the compressor urethræ muscle, and supplies the bulbous and other portions of the corpus spongiosum with blood. It furnishes small branches to Cowper's glands. In the operation of lateral lithotomy it is specially desirable to avoid wounding this vessel, as the resulting hemorrhage is sometimes controlled with difficulty.

The **membranous portion of the urethra** is included between the two layers of the triangular ligament, and is situated about an inch, or two and one-half centimeters, below the pubic arch, from which it is separated by the dorsal vein of the penis and the subpubic ligament. It extends from the apex of the prostate gland behind to the bulb of the penis in front. With the exception of the external urinary meatus, it is the narrowest and least dilatable part of the entire urethra, and is without exception the most unfavorable location for stricture. It measures three-fourths of an inch, or less than two centimeters, along its upper surface and about one-half of an inch, or one and one-fourth centimeters, along its lower surface, its length inferiorly being considerably reduced by the projection backward of the bulb of the corpus spongiosum. It is separated from the rectum by the compressor urethræ muscle, Cowper's glands, the deep layer of the triangular ligament, and the levator ani muscle.

The **internal pudic artery,** the smaller of the two terminal divisions of the anterior trunk of the internal iliac artery, leaves the pelvis through the great sacro-sciatic foramen between the pyriformis and coccygeus muscles and above the sciatic artery. It crosses the external surface of the spine of the ischium under cover of the gluteus maximus muscle, and reenters the pelvis through the lesser sacro-sciatic foramen, where it crosses the obturator internus muscle. In this latter situation it is accompanied by two venæ comites, the perineal nerve, and the dorsal nerve of the penis, which are included with the internal pudic artery in the canal of Alcock, which is a tubular sheath formed by the obturator fascia. It runs forward in this canal, lying about an inch and a half, or four centimeters,

above the lower margin of the tuberosity of the ischium. It ascends along the ramus of the ischium, pierces the posterior layer of the triangular ligament, runs along the inner margin of the ramus of the pubis, between the fibers of the compressor urethræ muscle at its origin, and at the anterior part of the deep intra-aponeurotic space of the perineum gives off the artery of the corpus cavernosum, and continues through the anterior layer of the triangular ligament as the dorsal artery of the penis. The portion of the vessel exposed in this dissection is that included between the two layers of the triangular ligament, from which arises the artery of the bulb, already described.

The **artery of the corpus cavernosum** arises as one of the terminal branches of the internal pudic, pierces the anterior layer of the triangular ligament, enters the crus penis, and runs forward in the corpus cavernosum along the side of the pectiniform septum.

The **dorsal artery of the penis** arises as one of the terminal branches of the internal pudic artery, pierces the anterior layer of the triangular ligament, runs upward between the crus penis, and the body of the pubis, passes between the two layers of the suspensory ligament of the penis and runs in the dartos along the dorsum of the penis, between the dorsal vein and nerve, to the glans, around the base of which, with the dorsal artery of the opposite side, it forms a complete arterial circle. It supplies the integument of the penis.

The **internal pudic vein** accompanies the internal pudic artery, and receives branches corresponding to those of the artery, with the exception of the dorsal vein of the penis, which gives but a small branch to the internal pudic vein.

The **dorsal vein of the penis,** a rather large vessel, returns the blood from the skin, glans, prepuce, corpus spongiosum, and corpora cavernosa of the penis. It consists at first of two branches, which run along the dorsum of the penis and unite near the root into a single trunk. It runs between the two layers of the suspensory ligament of the penis, gives off a branch to the internal pudic vein, passes between the subpubic and triangular ligaments, and empties into the prostatic plexus of veins.

The **pudic nerve,** a branch of the lower part of the sacral plexus, accompanies the internal pudic artery from the pelvis over the spine of the ischium into the ischio-rectal fossa and into Alcock's canal. After giving off the inferior hemorrhoidal nerve at the posterior part of the external wall of the ischio-rectal fossa, it divides into two terminal branches—the perineal nerve and the dorsal nerve of the penis.

The **dorsal nerve of the penis,** the continuation of the pudic nerve, accompanies the internal pudic artery in Alcock's canal, through the posterior layer of the triangular ligament, and between the anterior and posterior layers of the

triangular ligament, finally to pierce the anterior layer and run along the outer side of the dorsal artery. It supplies the integument of the penis.

The **perineal nerve,** the shorter and larger of the two terminal divisions of the pudic nerve, is seen in the outer part of the ischio-rectal fossa. It divides into cutaneous and muscular branches. The cutaneous branches are the anterior and posterior superficial perineal nerves, and have already been described. The muscular branches supply twigs to the bulb and to the compressor urethræ, levator ani, transverse perineal, accelerator urinæ, and erector penis muscles.

The **subpubic ligament** is situated below the symphysis and bodies of the pubes, and between the rami of the pubes laterally. Its apex is directed upward and is fused with the inter-articular fibro-cartilage; its base is directed toward the membranous urethra. Between the subpubic and triangular ligaments is a small aperture for the passage of the dorsal vein of the penis.

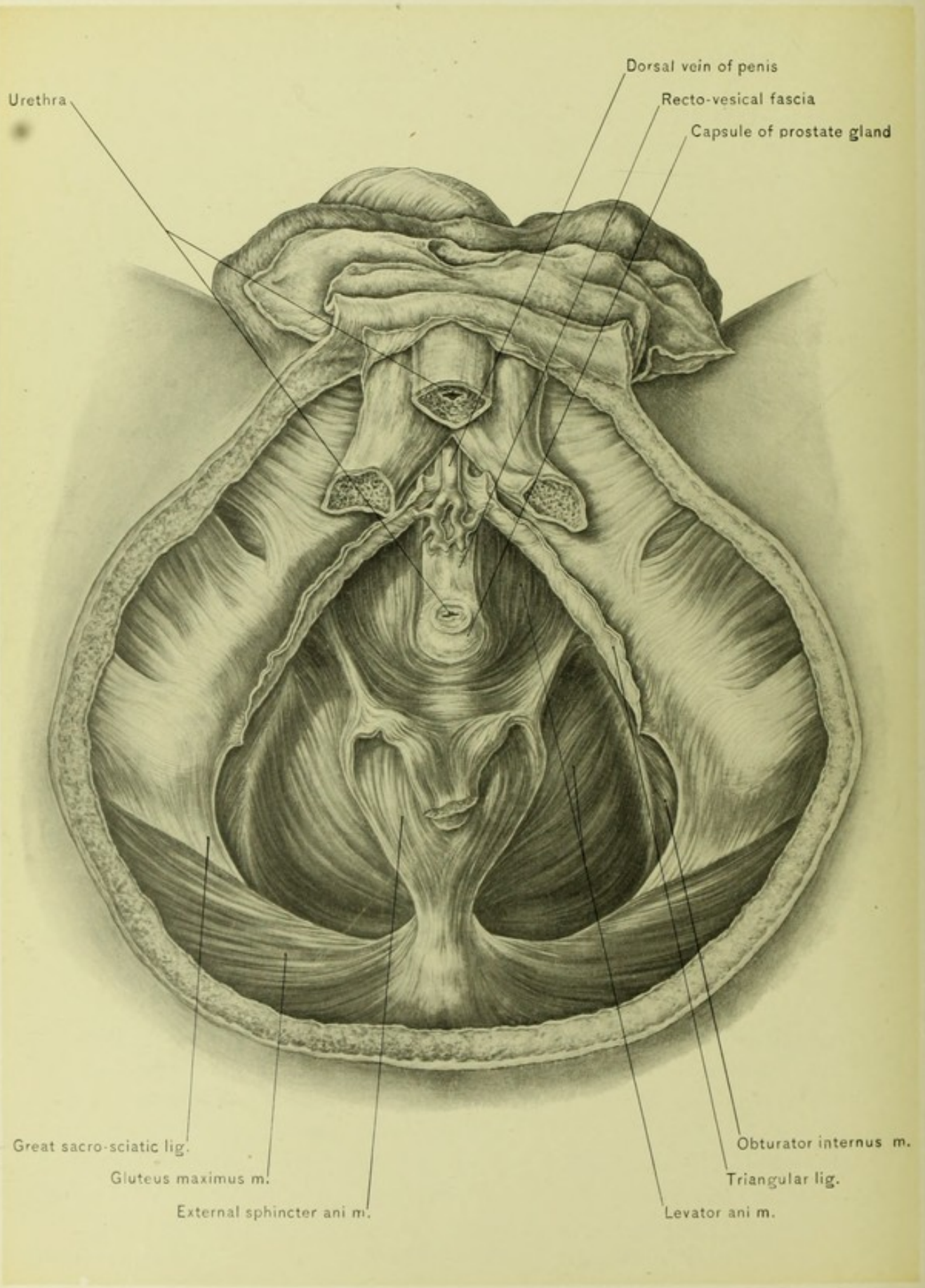
Dissection.—Remove the compressor urethræ muscle to expose the superior layer of the triangular ligament.

The **superior, deep,** or **posterior layer of the triangular ligament** is derived from the obturator division of the pelvic fascia, and is the fascial partition situated between the compressor urethræ and levator ani muscles. It is pierced by the membranous urethra, the internal pudic artery and veins, and the dorsal nerve of the penis. Laterally, it is attached to the ischio-pubic rami; anteriorly, to the subpubic ligament, from which it is partly separated by the dorsal vein of the penis; and posteriorly, it blends with the deep surface of the superficial layer of the triangular ligament at the posterior margin of the compressor urethræ muscle. Anterior to the anterior margin of the levator ani muscle the deep layer of the ligament is adherent to the recto-vesical fascia, and especially to that part forming the capsule of the prostate gland. This layer of the triangular ligament is thinner than the superficial layer, or triangular ligament proper, and the descriptions of the perineum would be less obscure and more accurate if the deep layer were considered the anterior part of the anal fascia. The anal fascia could then be described as adherent to the deep surface of the posterior portion of the triangular ligament, and as composed of an anterior and a posterior portion.

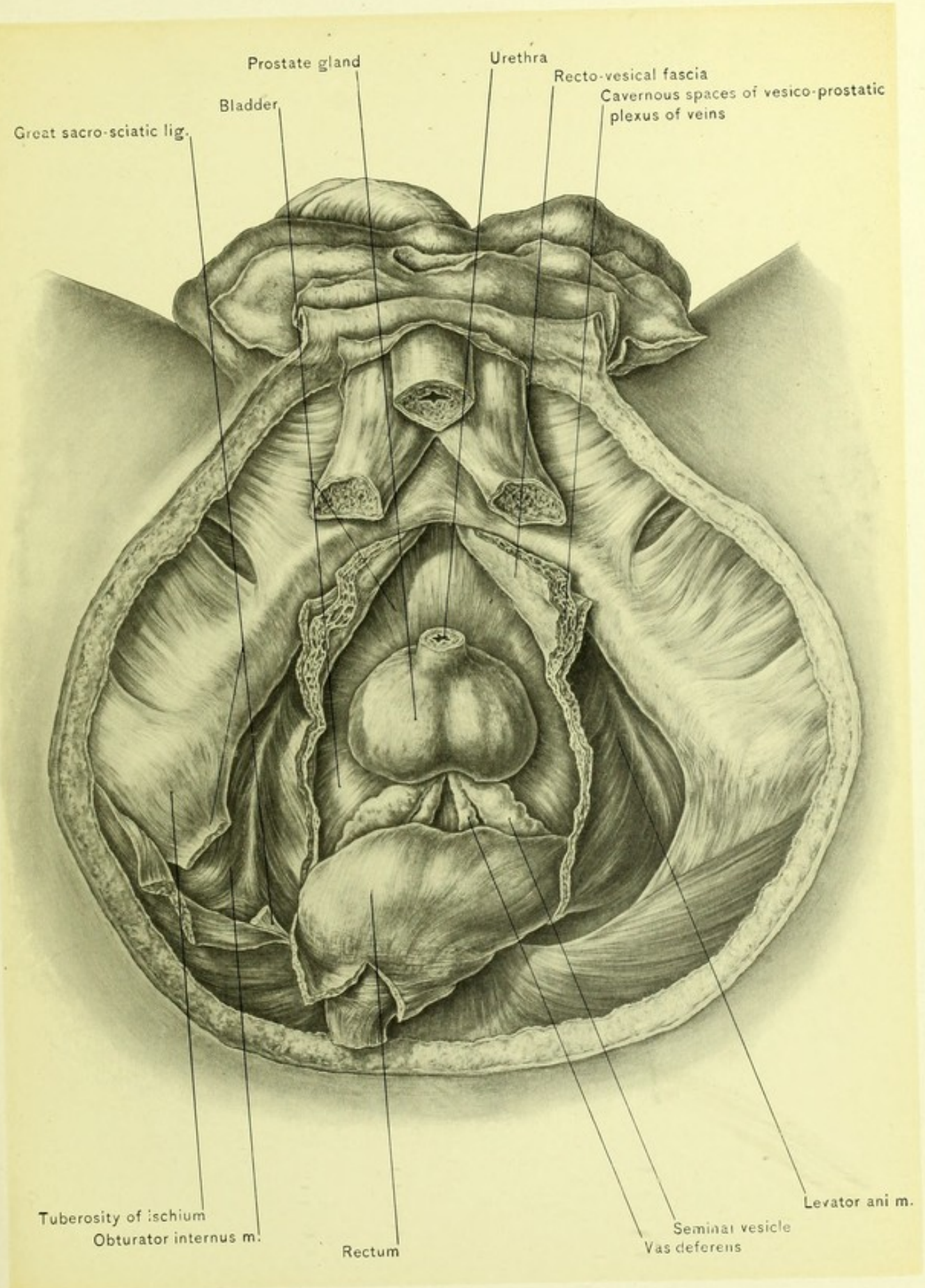
Dissection.—Remove the posterior or deep layer of the triangular ligament and the anal fascia to expose the inferior surface of the levator ani muscle.

The **Levator Ani Muscle** is a thin sheet of muscle which lies superficial to the recto-vesical fascia. Its anterior fibers arise from the lower portion of the posterior surface of the body of the pubis, between the recto-vesical fascia and the deep layer of the triangular ligament, and external to the pubo-vesical muscle; its posterior fibers arise from the pelvic surface of the spine of the ischium; and the intermediate fibers have an aponeurotic origin from the white line of the pelvic

PLATE CCCIV.



LEVATOR ANI MUSCLE OF MALE PERINEUM.



PELVIC ORGANS SEEN IN DISSECTION OF MALE PERINEUM.

fascia in the angle of divergence of the recto-vesical and obturator fasciæ. Its anterior fibers pass backward and downward around the lateral aspect of the prostate gland to be inserted into the central tendon of the perineum, and have been termed the *levator prostatæ*. Its intermediate fibers pass downward along the side of the rectum, are inserted into the side of the rectum, and interlace with the fibers of the external sphincter ani muscle. Its posterior fibers pass downward and inward and are inserted into the side of the lower part of the coccyx and the fibrous raphe connecting the coccyx with the rectum.

Nerve Supply.—From the inferior hemorrhoidal nerve and fourth sacral nerve.

Action.—It elevates the pelvic floor and the coccyx, thus compressing the abdominal and pelvic viscera and aiding in the expulsion of the contents of the rectum and bladder.

Dissection.—The rectum is to be displaced backward, after dividing the anterior and middle fibers of the levator ani muscle and the recto-vesical fascia, to expose the prostate gland, the neck and base of the bladder, the seminal vesicles, the terminal portions of the spermatic ducts, or vasa deferentia, the ejaculatory ducts, and the junction of the ureters with the bladder.

Lateral Lithotomy.—The first or superficial incision extends from the left of the median line, just behind the perineal center, backward and outward to a point between the anus and the tuberosity of the ischium and one-third nearer to the tuberosity than to the anus. The structures divided in this incision are: Skin; superficial fascia (both layers); the transverse perineal muscle, vessels, and nerve; the base of the anterior layer of the triangular ligament; and branches of the inferior hemorrhoidal vessels and nerves. In the second or deep incision the knife is engaged in the groove in the staff, and, with its edge toward the tuberosity of the left ischium, is carried through the membranous and prostatic portions of the urethra. This incision divides the compressor urethræ muscle, the membranous urethra, the posterior layer of the triangular ligament, some of the anterior fibers of the levator ani muscle, part of the left lobe of the prostate gland with part of its investing capsule and plexus of veins, and the neck of the bladder. The structures especially to be avoided in the superficial incision are the artery of the bulb, the rectum, and the internal pudic artery. The deep incision is not carried backward far enough to divide the entire breadth of the prostate, as this would be followed by infiltration of urine into the subperitoneal connective tissue of the pelvis, and would expose the patient to the risk of cellulo-peritonitis. The ejaculatory duct should not be wounded. Both lateral and median perineal lithotomy in elderly men are likely to be followed by considerable venous bleeding from wounds of the prostatic plexus of veins; in these cases it is safer immediately to

introduce the petticoat catheter and pack the wound; or, what will usually suffice, to introduce through the wound an English catheter, size about No. 20 French scale, and pack around it. When the entire breadth of the prostate and its capsule is divided, the urine will have ready access to the pelvis. In performing the operation of lateral lithotomy on children it is to be borne in mind, first, that the bladder holds a higher position in the pelvis than it does in the adult; second, that the prostate is but rudimentary, and difficulty may be experienced in reaching the bladder; and, third, that there is danger of severing the membranous urethra, especially if the finger be introduced into the bladder—a procedure which should never be practised in children.

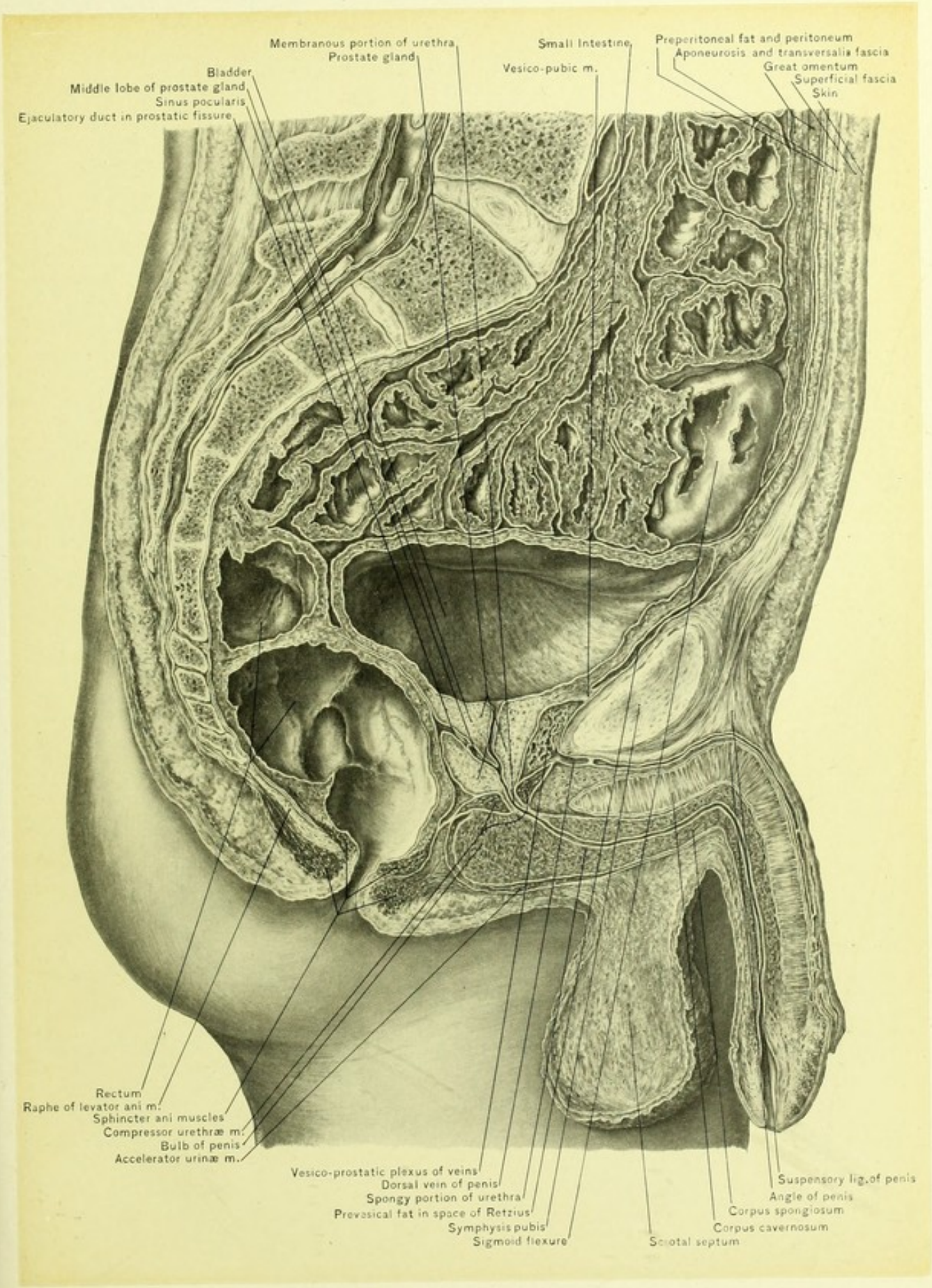
Median Perineal Cystotomy.—The structures divided in the operation of median perineal cystotomy are skin, superficial fascia (both layers), base of the triangular ligament, compressor urethræ muscle, and membranous urethra. The prostatic urethra, with that part of the prostate gland surrounding it, should be either cut or dilated. The parts especially to be avoided are the bulb of the penis, the artery of the bulb, and the rectum. The incision should not be carried entirely through the prostate, for the same reason as that stated in lateral lithotomy.

The **recto-urethral space** has been exposed by the previous dissection. The apex of this space is at the junction of the rectum with the middle lobe of the prostate. The sides are formed by the anterior fibers of the levator ani. This is the space through which the knife passes in the operation of median perineal cystotomy.

THE EXTERNAL GENITALS OF THE MALE.

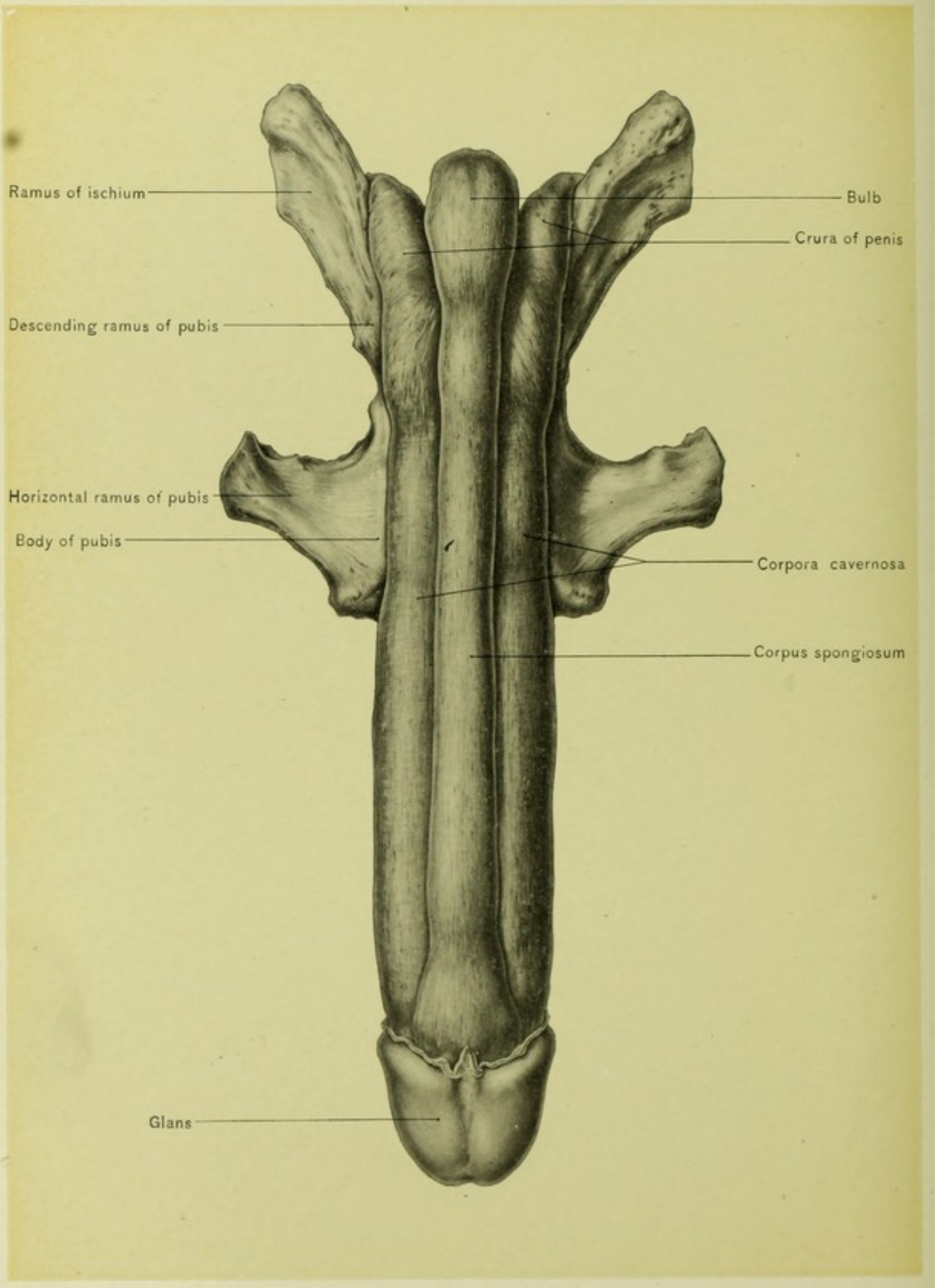
The **External Genital Organs of the Male** are the penis, testicles, spermatic cord, and scrotum. In their description the entire length of the urethra is included.

The **Penis** is composed of three elastic, rod-like bodies enveloped by fascia and integument. These bodies are the two corpora cavernosa and the corpus spongiosum. The two corpora cavernosa are situated side by side in the dorsal portion of the penis, and form about two-thirds of the bulk of the organ. They are slightly separated anteriorly, where they terminate in blunt, conic extremities, and are more widely separated posteriorly, where they commence as the crura of the penis; in the remainder of their extent they are closely united. The **crus penis,** the posterior portion of the corpus cavernosum, begins as a cuneiform body, is attached



MALE PELVIS AND PERINEUM—SAGITTAL SECTION.

PLATE CCCVII.



BODIES OF PENIS (DISTENDED).

on its external aspect to the inner surface of the ischio-pubic ramus, and lies between Colles' fascia and the triangular ligament. The two crura converge as they pass forward, and become closely adherent just anterior to the subpubic ligament. The corpora cavernosa are composed of erectile tissue, and are enveloped by a strong sheath—the **tunica albuginea.** The outer layer of the tunica albuginea invests both corpora cavernosa, and the inner layer projects dorsally between the corpora cavernosa, forming the **pectiniform septum,** which incompletely separates them. Each corpus cavernosum is supplied by the artery of the corpus cavernosum which traverses it.

The **corpus spongiosum** is situated in the under portion of the penis, in the groove between the corpora cavernosa. It is composed of erectile tissue surrounded by a sheath called the tunica albuginea, and through its erectile tissue passes the spongy portion of the urethra. It is divided into the bulb, body, and glans.

The **bulb of the penis** or of the corpus spongiosum is the posterior expanded portion of the corpus spongiosum, situated in the superficial interspace of the perineum proper and surrounded by the accelerator urinæ muscles. It is about four centimeters long and one and one-half centimeters wide. It transmits the bulbous part of the spongy portion of the urethra, which enters it at its deep surface and runs nearer to that surface.

The **body** of the corpus spongiosum is of uniform diameter, the urethra lying nearer to its inferior surface.

The glans is described below.

The penis is arbitrarily divided, for purposes of description, into a main portion and two ends, called the root, body, and glans.

The **root of the penis** is formed by the crura, which are the posterior portions of the two corpora cavernosa converging from their attachments to the sides of the subpubic arch to unite at the proximal end of the penis proper. The suspensory ligament of the organ, as it descends from the pubic symphysis and lower part of the linea alba of the abdomen, also forms part of the root of the penis. The form and dimensions of the erect penis are well demonstrated by making a deep narrow puncture in one or both crura penis and then inserting a blow-pipe and inflating the corpora cavernosa.

The **body** of the penis has the form of a prism with rounded margins, the corpus spongiosum and corpora cavernosa forming its lateral surfaces, and the corpora cavernosa its dorsal surface ; this is most noticeable when the organ is erect.

The **glans penis** is the peculiar cordate expansion of the corpus spongiosum around the tapering anterior extremities of the corpora cavernosa. It has a well-defined, elevated border, called the *corona of the glans,* the depression back of it

being called the *neck of the penis*. The vertical linear orifice at the apex of the glans is the *external urinary meatus*, or *external orifice of the urethra*.

The **skin of the penis** is pigmented, thin, and highly elastic, and is loosely attached to the body of the penis by the subcutaneous tissue. On the under surface of the penis it contains the continuation of the highly pigmented raphe of the perineum and scrotum. At the neck of the penis it extends over the glans as a double fold, called the *prepuce*, or *foreskin*. The skin of the glans is closely adherent. The *frenum of the prepuce* is a small median fold extending from the prepuce to the under surface of the glans. It contains vessels which cause considerable hemorrhage if cut or torn. The frenum of the prepuce is sometimes torn in coitus when the vaginal orifice is small.

Sebaceous glands are found in the skin of the penis. These are especially numerous at the neck of the penis, and secrete an odorous whitish substance, called *smegma præputii*. When the prepuce is long and covers the glans, this secretion collects, and its odor causes considerable annoyance. When the prepuce covers the glans and the preputial orifice is small, a **congenital phimosis** exists.

The **dartos** is the subcutaneous tissue of the penis, and is continuous with the dartos of the scrotum. Its more superficial portion is composed of loose connective tissue which permits excessive swelling in edema of the penis. Like the dartos of the scrotum, it contains unstriped muscle fibers. Its deep portion is more dense, and forms a **fascial sheath** of great elasticity, which invests the three bodies of the penis and at the angle of the penis is continuous with the suspensory ligament of the organ. The dartos extends between the two layers of skin forming the prepuce, and at the preputial orifice its muscular fibers, according to Sappey, form the *sphincter of the prepuce*.

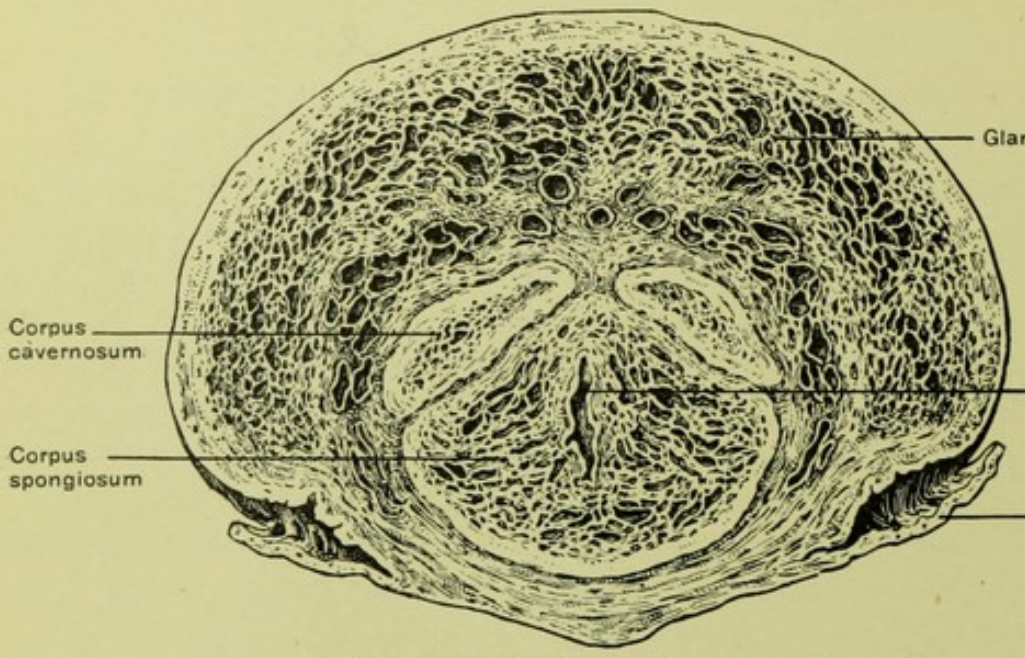
The **suspensory ligament of the penis** is a strong fibrous band which is attached to the lower part of the linea alba and to the front of the symphysis pubis; it blends with the fascial sheath of the penis just anterior to the bodies of the pubic bones.

The **angle of the penis** is at the point of suspension, or where the dependent portion of the flaccid organ is joined by the suspensory ligament.

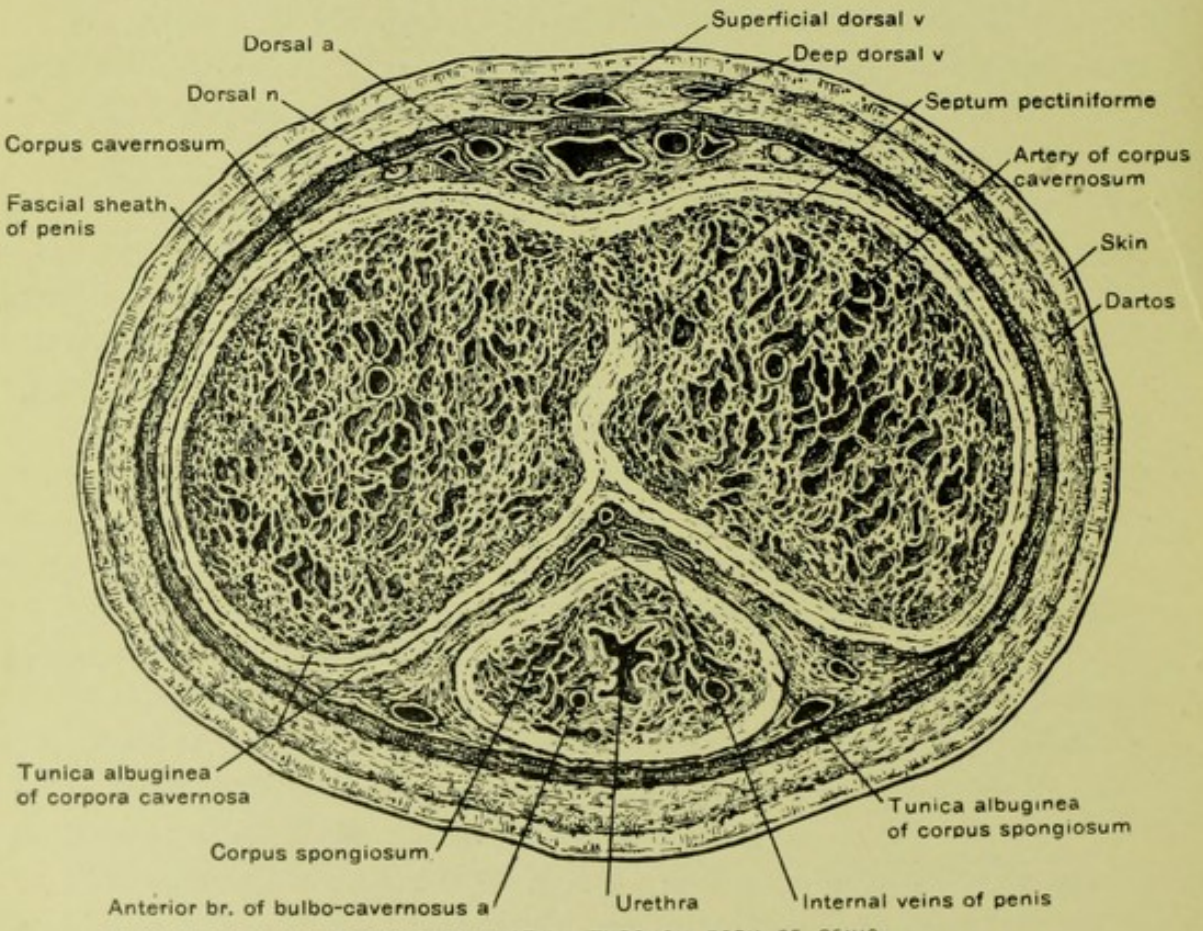
The **Urethra** is the urinary canal; it extends from the internal urinary meatus at the neck of the bladder through the prostate gland, triangular ligament, and spongy body of the penis to the external urinary meatus, and is divided into the prostatic, membranous, and spongy portions.

The length of the urethra in the flaccid condition of the penis, as determined by frozen sections, is from six to six and a half inches, or about sixteen centimeters, This may be increased by enlargement of the middle lobe of the prostate gland. The diameter of the canal varies with the size of the individual and the penis, the

PLATE CCCVIII.

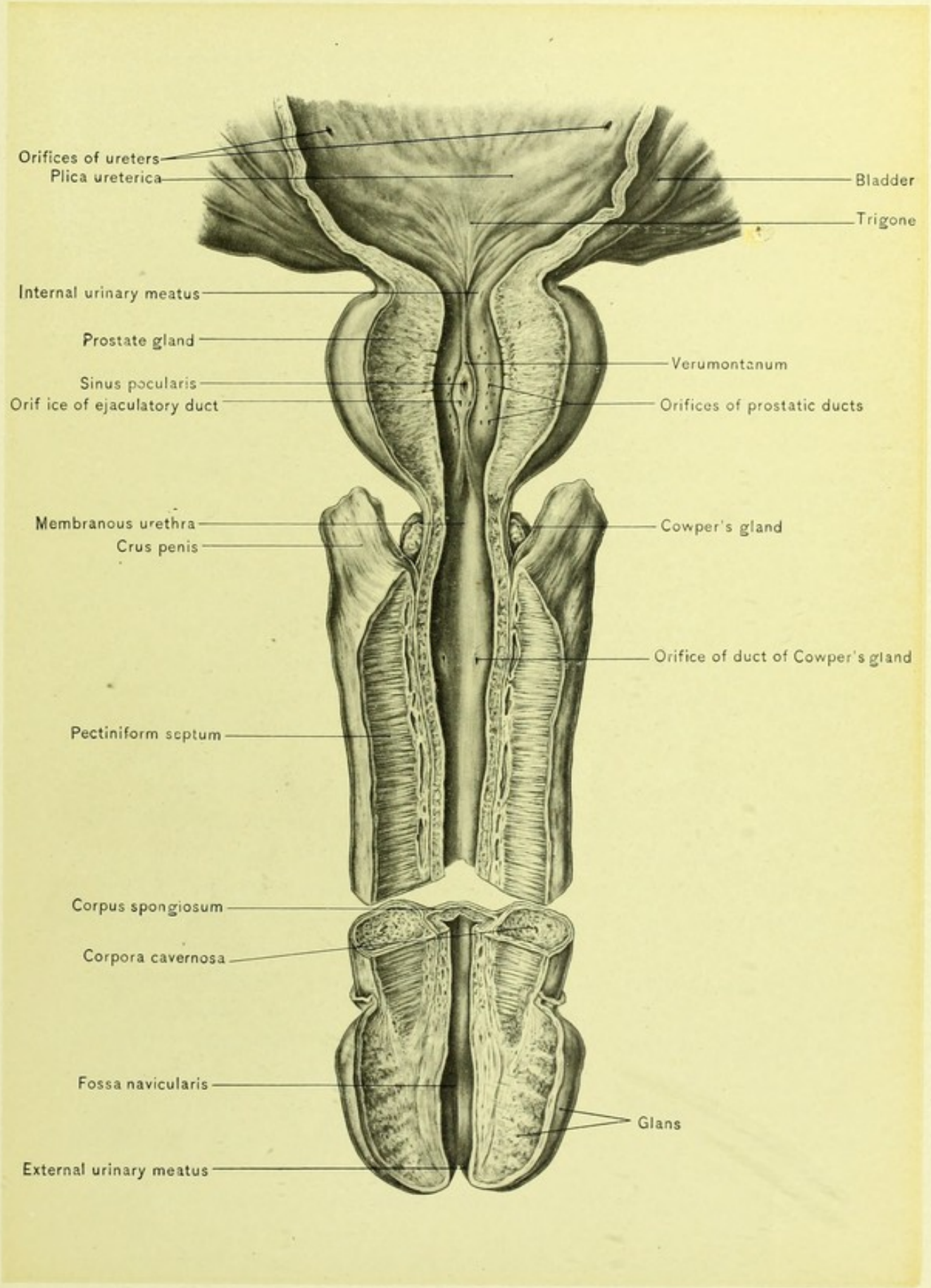


TRANSVERSE SECTION THROUGH BASE OF GLANS.



TRANSVERSE SECTION THROUGH BODY OF PENIS.

SECTIONS OF PENIS.



MALE URETHRA CLEFT DORSALLY.

ratio between the size (circumference) of the canal as compared with that of the penis being, according to Otis, about four to nine; but this is only relative, and varies.

The **prostatic portion of the urethra** is described with the prostate gland. It is about one and a quarter inches, or three centimeters, in length, and is directed downward and a little forward, being slightly curved, the concavity of the curve being upward. It is the widest and most dilatable portion of the urethra, and contains in its floor the orifices of the sinus pocularis, ejaculatory ducts, and prostatic ducts, and a ridge in the median line—the verumontanum.

The **membranous urethra** extends from the apex of the prostate gland to the superior surface of the bulb of the corpus spongiosum. It is the narrowest, shortest, and least dilatable portion of the urethra, the only narrower point being the external urinary meatus. Being fixed by its passage through the two layers of the triangular ligament, it is also the least movable portion. It is directed downward and forward, and measures from a half to three-fourths of an inch, or one and one-fourth to two centimeters, in length, its upper anterior wall being slightly the longer because of the convergence of the two layers of the triangular ligament as they pass downward and backward. The greater part of it is situated between the two layers of this ligament, is surrounded by the compressor urethræ muscle, and is separated from the subpubic ligament by an interval of about one inch, or two and one-half centimeters, and by the anterior part of the compressor urethræ muscle and a plexus of veins. Postero-laterally, it is in relation with Cowper's glands. Its wall contains some non-striated muscle fibers continuous with those of the prostate.

In uncomplicated *rupture of the membranous urethra* the urine passes into the deep perineal interspace, and there causes inflammation and suppuration. The density and attachments of the superficial layer of the triangular ligament prevent the pus from escaping superficially at the perineum proper, and it may burrow backward along the levator ani to the ischio-rectal fossa or upward into the pelvis, and cause pelvic cellulitis.

The **spongy urethra,** like the body in which it lies, has a posterior and an anterior expansion; the former, the *bulbous portion*,—about one and one-half inches, or four centimeters, in length,—is within the bulb; and the latter, the *fossa navicularis*,—about two centimeters long,—is within the glans penis.

When there is a tight stricture of the spongy portion of the urethra and ulceration of the mucous membrane behind the stricture, forcible micturition may rupture the urethra. If this accident occurs, the urine escapes into the erectile tissue, and the resulting inflammation may be so active as to cause gangrene of the glands and corpus spongiosum.

The **External Urinary Meatus** is a vertical slit at the apex of the glans, is

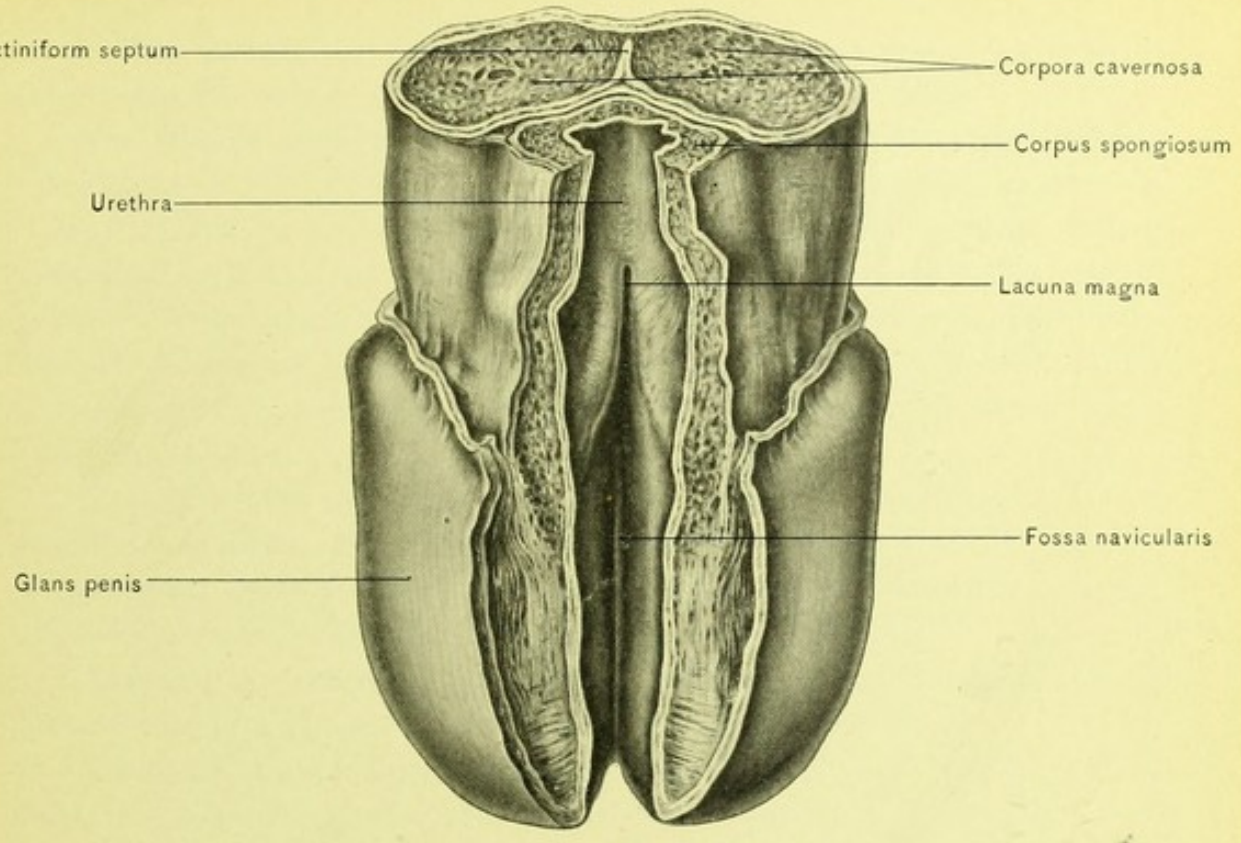
the external orifice of the urethra, and is the narrowest and least dilatable part of the canal; hence, an instrument which will pass the external meatus will pass through a normal urethra. To permit the passage of larger sizes of bougies it is sometimes necessary to enlarge the meatus by an incision downward toward the frenum of the prepuce.

The **narrowest places of the urethra** are (1) at the external urinary meatus, and (2) where the membranous portion passes through the superficial layer of the triangular ligament. Just behind these portions a calculus may lodge in the urethra. The **widest localities** are the fossa navicularis, bulbous portion, and center of the prostatic portion.

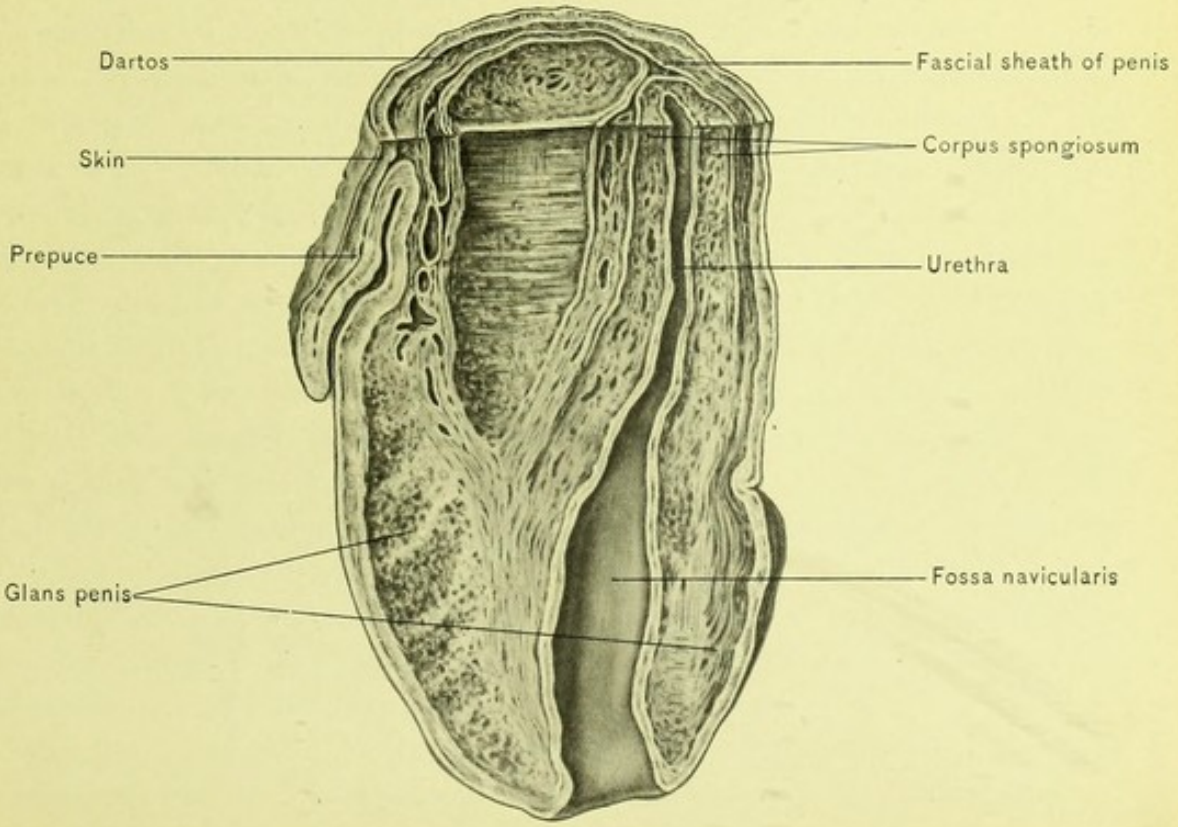
In the quiescent state the walls of the urethra are always in contact. The coaptation of the urethral wall is vertical at the external meatus and fossa navicularis, |; like an inverted ⊥ at the upper end of the navicular fossa; transverse — or stellate ✲ in the remainder of the spongy portion and in the membranous portion. It is like an inverted ∩ in the prostatic portion, on account of the projection of the verumontanum (colliculus seminalis). By these changes in shape the canal is rifled, thus causing the usual form of the urinary stream.

In **passing urethral bougies** or stiff catheters through the pendulous portion of the male urethra the canal accommodates itself to the curve of the instrument, but in passing through the portion posterior to the angle of the penis, which is almost immovable, the instrument must follow the direction of the urethra. In introducing a bougie the patient is in the dorsal recumbent position, and the penis is held vertically upward to obliterate the angle of the organ. The instrument is held parallel with and close to the crease of the groin and is passed into the urethra until the fixed portion of the canal is entered. Then the instrument is brought to the median plane of the body, and while retained in that plane is depressed between the legs. The advancing beak of the instrument must follow the curve of the canal as soon as it reaches the fixed portion of the urethra, and this is especially true in the bulbous and membranous portions. Difficulty in passage of instruments is more frequently encountered where the urethra passes through the superficial layer of the triangular ligament. Here the urethra is immovable and the broader bulbous portion suddenly narrows at its junction with the membranous portion at the superior surface of the bulb. No difficulty is encountered if the beak of the instrument is made to follow the roof of the canal. When strictures are present, false passages formed in introducing these instruments are usually just superficial to the superficial layer of the triangular ligament at the bulbo-membranous junction.

Rupture of the urethra may be produced by the body falling on the perineum astride some hard substance, and crushing the wall of the canal against the pubic



ANTERIOR PORTION OF URETHRA.



SAGITTAL SECTION OF ANTERIOR PORTION OF PENIS.

arch. The bulbous and membranous portions are more commonly involved, urine being extravasated into one or both of the perineal interspaces.

The **mucous membrane of the urethra** contains numerous simple follicular invaginations, called *glands of Littre* or *lacunæ*. One lacuna, situated in the dorsal wall of the urethra an inch, or two and one-half centimeters, from the external meatus, is larger than the others, is termed the *lacuna magna*, and may arrest the point of a small instrument passed into the urethra. The orifices of the ducts of Cowper's glands are in the floor of the bulbous portion of the urethra about one inch, or two and one-half centimeters, anterior to the superficial layer of the triangular ligament.

The **Diseases of the Penis** are many, and all are accompanied by more or less morbid worry incidental to diseases of the genital apparatus.

Venereal warts are frequently found upon the inner layer of the prepuce close to the corona, often resembling a cock's comb in form.

Chancres are generally located upon the margin or inner surface of the prepuce or corona glandis, where they are sometimes unnoticed.

Chancroids are similarly situated, but tend to spread rapidly, forming at times wide, irregular areas of ulceration which may destroy much of the prepuce and glans. They are then said to be phagedenic. These ulcers occasionally cause intense suffering and permanent deformity of the organ.

Gonorrhea is a specific urethritis accompanied by a profuse purulent discharge. The mucous membrane and submucous tissue of the urethra are swollen and infiltrated and less elastic than normally; consequently, rupture of the submucous tissue occurs during erection of the penis. The cicatricial tissue which develops contracts subsequently and forms a stricture. If the inflammation be sufficiently active, small areas of the mucous membrane may be ulcerated, eventually leaving a contracting scar and stricture which narrows the caliber of the canal. The inflammatory thickening and cicatricial contraction may be so great as to cause its permanent narrowing, thus obstructing the flow of urine and causing a damming-back in the bladder, ureters, and renal pelves. The inflammation may extend into the bladder, causing cystitis; into the prostatic ducts, giving rise to prostatitis; through the ejaculatory ducts to the seminal vesicles, causing vesiculitis; or from the ejaculatory ducts it may pass along one or both vasa deferentia to the epididymis and testicle, causing acute epididymitis and acute orchitis. Acute epididymitis is a far more common complication of gonorrhea than orchitis.

Chordee is a painful incident of gonorrhea, in which erection of the corpora cavernosa makes traction upon the underlying tender, swollen, and inflamed spongy body which is at the time less capable of elongation than normally, because

of infiltration with inflammatory exudate which decreases its elasticity. It therefore is submitted to great tension, and checks elongation of the corpora cavernosa, which become bowed, occupying the relation to the spongy body of a bow to its string. This condition also endangers the integrity of the mucous lining and submucous tissue of the urethra which may rupture and cause hemorrhage and additional inflammatory action and exudation.

Stricture consists in a narrowing of the caliber of part of the urethral canal, and is divisible into two varieties, *spasmodic* and *organic*. *Spasmodic stricture* is chiefly due to spasm of the compressor urethræ muscle, and therefore occurs in the membranous urethra. It is frequently encountered in the passage of sounds, catheters, and bougies. It also arises at times from internal causes, generally some form of nervous irritation. It has already been shown that the urethral canal is rifled, thus twisting the urinary stream. A stricture causes crossed streams in the canal, which often emerge in two or more jets, called *sprinkling*. Sprinkling is an inconstant symptom of spasmodic stricture because its cause is intermittent. *Organic stricture* is due either to a contracting scar of the urethral wall, or to plastic infiltration and thickening of the walls, with resulting narrowing of the canal. The sprinkling in these conditions is necessarily constant. The stream has diminished force, though the expulsive efforts are increased. Just behind these strictures there are frequently small ulcers or areas of catarrhal inflammation which give rise to a slight urethral discharge ("morning drop"), most noticeable after rising, because of the night's accumulation during abstinence from micturition.

Phimosis is a common condition among male children, in which the preputial orifice is so narrowed that the glans penis can not be uncovered.

In *circumcision*, the operation for the relief of phimosis, the prepuce is drawn well forward and a sufficient portion of the redundant prepuce removed, the glans penis being protected by a pair of circumcision forceps held between the apex of the glans and the line of incision. The mucous membrane is then divided from the preputial orifice to the neck of the penis and trimmed so that it can be accurately approximated to the remainder of the prepuce. The two surfaces are then sutured and a dressing is applied.

Paraphimosis is the condition in which a narrow foreskin has been drawn behind the corona, with resulting edema of the prepuce and enlargement of the glans from interference with the return circulation. It requires prompt relief to prevent strangulation of the parts beyond it and necrosis of the prepuce. Gradual compression of the glans slowly forces the blood backward through the annular constriction at the neck of the penis, and the prepuce can be drawn forward. This failing, the prepuce may be divided longitudinally, or a series of incisions may be

made in the edematous prepuce to allow escape of serum, lessen tension, and permit the prepuce to pass over the corona.

Epitheliomatous and **other malignant growths** of the penis require amputation of that organ.

Amputation of the Penis may be performed by the circular or the flap method. Hemorrhage is to be limited by tying a rubber ligature around the penis above the point of amputation. The skin incisions are then made down to the tunica albuginea. The corpus spongiosum is separated from the corpora cavernosa, and severed by cutting downward and forward. The urethra is dissected out and the corpora cavernosa are divided. The urethra is sutured to the skin in such a manner that its extremity will always be free, or a small hole is made in the posterior flap, through which the urethra may be protruded and sutured to the edges of this opening.

The parts divided in amputation of the penis include the skin, dartos, fascial sheath, the dorsal arteries, vein, and nerves, the corpora cavernosa with their surrounding tunica albuginea and contained arteries, and the corpus spongiosum with the urethra, artery of the corpus spongiosum, and tunica albuginea of the corpus spongiosum. In an amputation of the penis the skin must not be drawn too far forward lest the stump be left uncovered, and in circumcision the penis may be left uncovered if the skin be drawn too far over the glans before severing the prepuce.

Congenital malformations of the penis or of the urethra are not rare, although the more serious ones are not frequently seen. The external urinary meatus may be found on the side of the glans, near the pubis, or even in the groin. It may be circular, instead of a longitudinal slit, and may be so small that the urine can not flow freely. The entire urethra may be absent, with exstrophy of the bladder; or the bladder may be entirely absent, the ureters then ending in the rectum. Different portions of the urethra may be too fully developed, presenting diverticula, sinuses, or pouches, which may be affected by catarrhal or ulcerative processes. The fossa navicularis may be so developed that it will form a considerable pouch or culdesac. The verumontanum is sometimes so much enlarged as to obstruct the urethra.

Hypospadias is a congenital defect in which there is faulty development of the floor of the urethra; the opening through which the urine escapes being situated at some point between the normal site of the meatus and the scrotum, or as far posterior as the perineum proper. Depending upon the position at which the urethra opens, the various forms of hypospadias are known as glandular, penile, and perineal. If the opening is situated in the perineum and associated with a cleft scrotum, the appearance will be that of a female, with the exception of

the developed penis. Cases are on record where this condition at birth gave the impression that the infant was a female, the mistake not being discovered until the penis had time fully to develop.

Epispadias is a congenital defect in which there is a deficiency in the roof or upper wall of the urethra. The opening in the urethra may be situated at any point between the normal site of the external urinary meatus and the pubis. In some cases the defect is associated with congenital absence of the pubic symphysis and with exstrophy of the bladder.

The operations for restoring the urethra in hypospadias or epispadias consist of inverting and sliding flaps of skin so as to make the urethra extend to the glans.

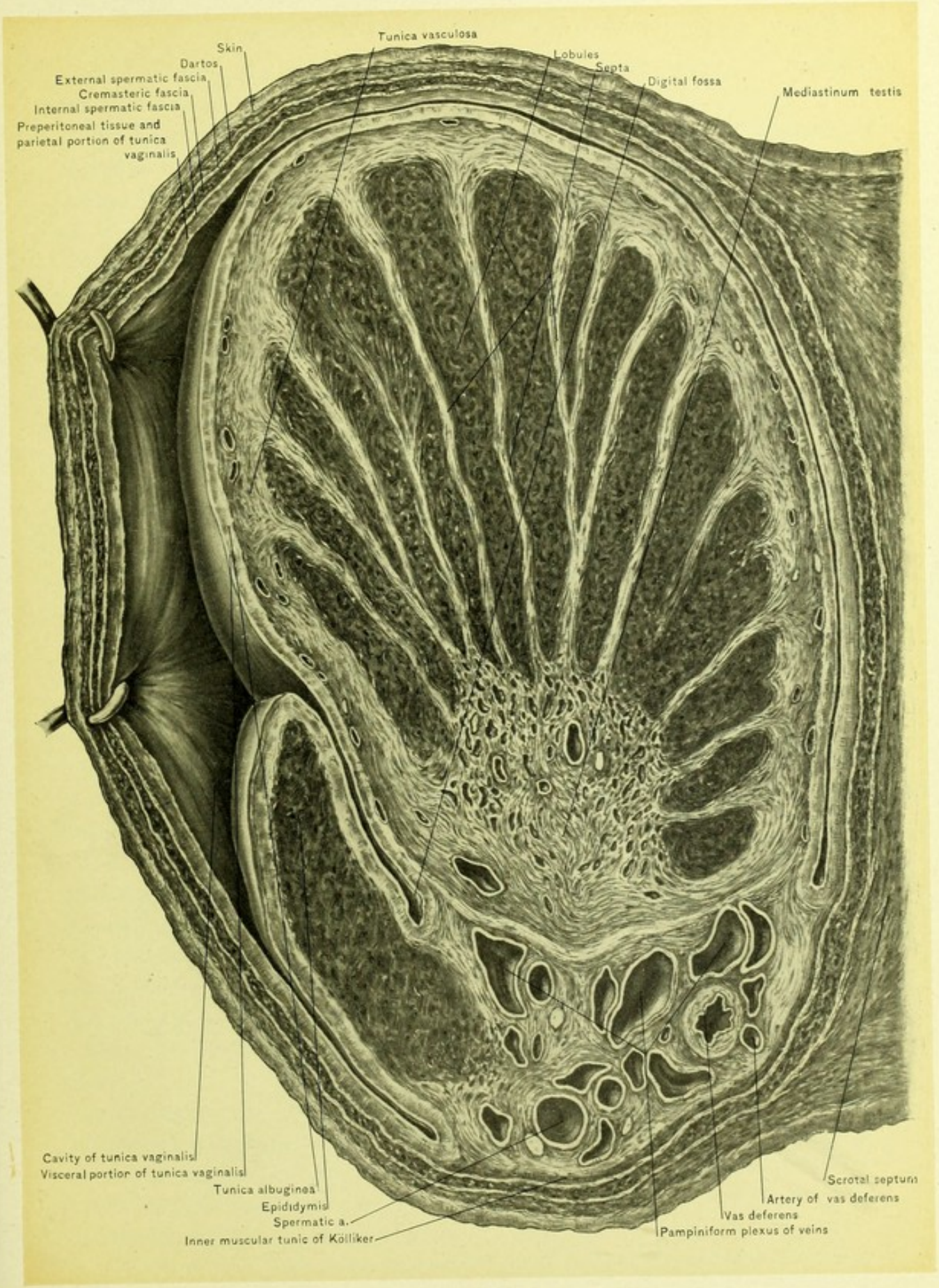
THE SCROTUM AND TESTICLE.

The **Scrotum** is the pouch which hangs from the anterior part of the perineum and subpubic region at the root of the penis; it contains the testicles and their pedicles—the spermatic cords. The layers of tissue in the scrotum or investing the testicles are: The skin, which forms a common investment for both testicles, and each testicle has an individual investment of dartos, external spermatic fascia, middle spermatic fascia, internal spermatic fascia, and tunica vaginalis.

The **integument of the scrotum,** formed chiefly by the prolongation downward of the integument of the abdomen and that of the perineum, is thin, translucent, and darker in color than that of the penis; it is provided with sebaceous glands and hairs, and is thrown into transverse folds (rugæ). The presence of the furrows between the folds on the surface of the integument offers favorable points for the deposit of cutaneous excretions and foreign material; the consequent irritation is at times one of the exciting factors in production of epithelioma of this part which, from the fact that it usually occurs in chimney-sweeps, is called "soot wart" or "chimney-sweeps' cancer." These furrows also favor retention of moisture, hence the liability of the scrotum to eczema and other cutaneous lesions. It is very elastic and permits of great distention, as is seen in large scrotal hernia, tumors of the testicle, and hydrocele.

Along the median line of the scrotum is the *median raphe*—a dark ridge, continuous with the median raphe of the perineum, which shows the line of union of the two halves of the scrotum. When the scrotum is distended, the superficial veins are rendered prominent, and should be avoided when tapping a hydrocele.

Dissection.—The integument of the penis and scrotum is reflected after making two incisions, one along the dorsum of the penis and the other along the under surface of that organ and along the raphe of the scrotum as far as the



TRANSVERSE SECTION OF TESTICLE AND SCROTUM.

junction of the latter with the perineum; the dartos of the penis and scrotum will then be exposed.

The **dartos** is the superficial fascia of the scrotum and penis. It contains no fat, and is a reddish-looking, thin, fascial layer, containing yellow elastic tissue and bundles of unstriped muscle fibers. Its superficial portion is elastic areolar tissue, and its deep portion is more membranous in character. It is continuous with the superficial fascia of the abdomen and perineum. In the scrotum the muscle fibers generally run at right angles to the scrotal wrinkles which they cause. The dartos sends a median partition into the scrotum between the two testicles, which forms an incomplete *scrotal septum*.

The **External Spermatic Fascia** is the fascia immediately beneath the dartos. It is the continuation of the intercolumnar fascia of the external abdominal ring, carried downward over the testicle and spermatic cord in the descent of the testicle.

The **Middle Spermatic** or **Cremasteric Fascia** contains longitudinal bundles of striated muscle fibers derived from the lower margin of the internal oblique during the descent of the testicle from the abdomen. It contracts, elevating the testicle, during active contraction of the abdominal muscles. Its contraction is also induced by gentle friction or stroking in the neighborhood of the groin and upper inner side of the thigh, producing the *cremasteric reflex*, which is of value in diagnosis of certain diseases of the nervous system.

The **Internal Spermatic** or **Infundibuliform Fascia** is the innermost fascial tunic of the spermatic cord and testicle, and is a process of the transversalis fascia of the abdominal wall, which was carried into the scrotum in the descent of the processus vaginalis and testicle.

The **Tunica Vaginalis** is the serous sac in relation with the testicle, and is the unobliterated portion of the processus vaginalis of the peritoneum which descended into the scrotum just in advance of the testicle.

The **Scrotal Fasciæ** may be greatly distended by *serous effusions* in dropsical conditions due to disease of the heart, kidney, or liver, or other circulatory obstruction, sometimes causing such tumefaction of the scrotum as to hide the penis. The scrotum may be distended by urine extravasated into the superficial perineal interspace.

The scrotum is also capable of enormous distention by inguinal hernia, the gut passing downward along the spermatic cord and into the scrotum, which may become as large as an average-sized human head. In such cases the glans may be the only portion of the penis which is visible, and even that may be concealed in a depression from which urine escapes.

Blood Supply.—The superficial and deep external pudic and the superficial

perineal arteries supply the skin and dartos, and the cremasteric branch of the deep epigastric artery supplies the cremasteric and the other two spermatic fasciæ.

Nerve Supply.—From the ilio-inguinal, genito-crural, and superficial perineal nerves, and the inferior pudendal branch of the small sciatic nerve.

The **veins of the scrotum** empty into the long saphenous vein, dorsal vein of the penis, and internal pudic vein. The scrotal *lymphatics* terminate in the inguinal glands situated near the inner part of Poupart's ligament, those of the testicle passing along the spermatic cord to enter finally the lumbar glands.

Elephantiasis scroti is a disease of the lymphatics, causing enormous enlargement of the scrotal tissues; Owen claiming to have been authentically informed of a case in the West Indies (by Mr. Wordsworth) that was computed to weigh 200 pounds, "to which the patient had been anchored for many years and declined separation by surgical operation."

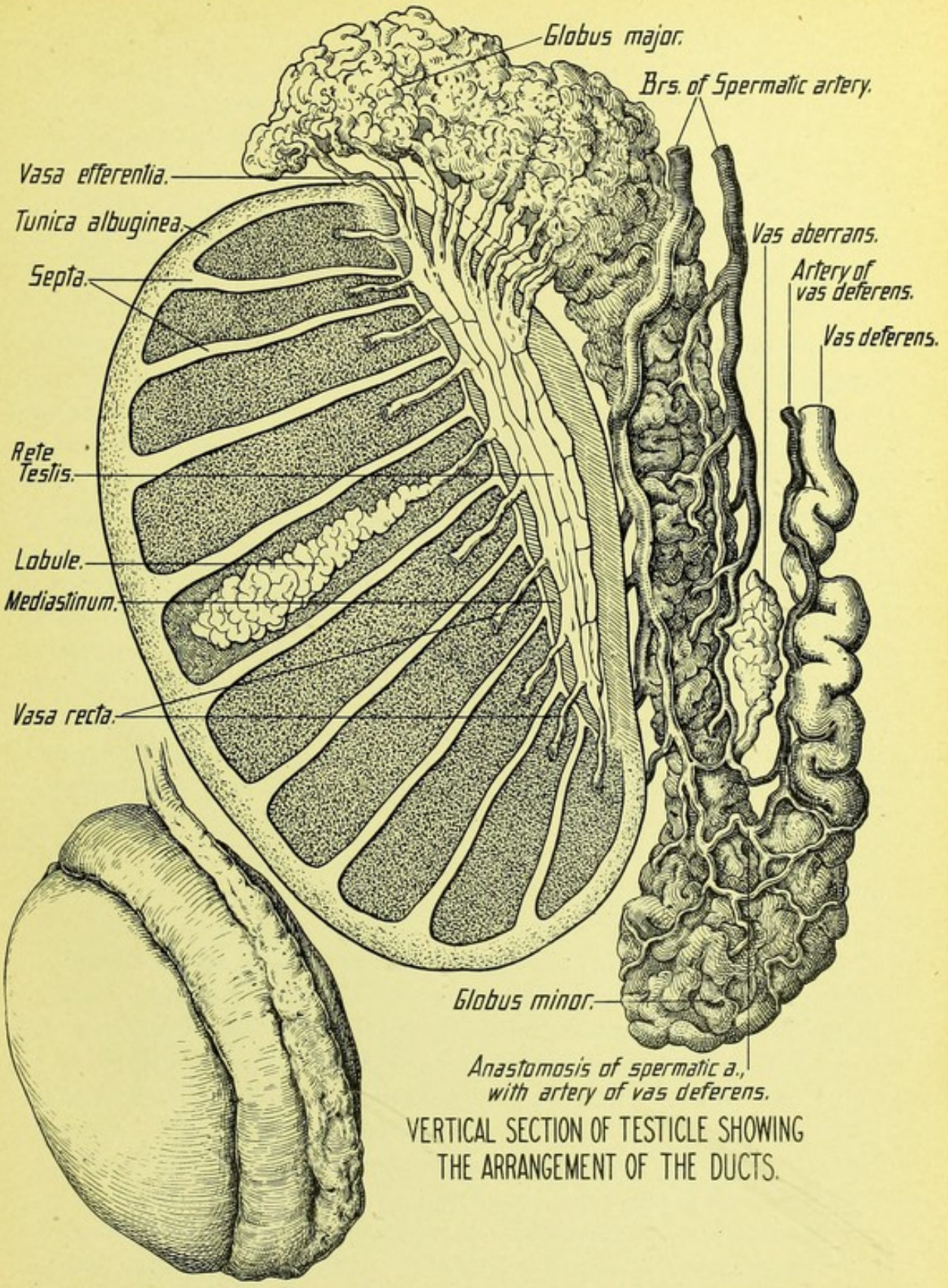
The **Testicle** is the homologue of the ovary, and is lodged in the scrotum, into which it descends from the abdomen through the inguinal canal just before or shortly after birth. Its connection with the internal abdominal ring is by means of the spermatic cord which is composed of the excretory duct, afferent and efferent vessels, nerves, and lymphatics of the testicle, the remains of the processus vaginalis, and the three spermatic fasciæ.

The testicle may not descend in the usual manner. It may remain in the abdomen, stop in the inguinal canal, descend too far and be found in the perineum, or descend through the femoral canal and saphenous opening and lodge between the superficial and deep fasciæ of the thigh. The descent of the testicle is described with the inguinal canal.

As the testicle hangs suspended by the spermatic cord in the scrotum its long axis is directed from below upward, forward, and outward. It is ovoid in shape, and a little flattened from side to side, measuring about one and a half inches, or four centimeters, in its long or vertical axis, about one and one-quarter inches, or three centimeters, in its antero-posterior diameter, and a little less than one inch, or two and one-half centimeters, in thickness, or transversely. Its weight usually ranges from five to six drams, or twenty to twenty-four grams. Its surface is formed by a smooth, white investment of dense fibrous tissue—the tunica albuginea.

The **hilum of the testicle** is at the posterior border of that organ, and is the place where the blood vessels, nerves, lymphatics, and seminiferous tubules leave or enter the testicle. In *inversion of the testicle* the contents of the spermatic cord have been twisted by rotation of the organ in its descent and the hilum is directed forward.

The **epididymis** is the rounded, elongated body with expanded ends which



VERTICAL SECTION OF TESTICLE SHOWING THE ARRANGEMENT OF THE DUCTS.

TESTICLE AND EPIDIDYMIS.

arches over the outer side of the posterior border and the upper end of the testicle. It is composed of a main portion, or **body**; an upper, larger, expanded extremity, termed the **globus major,** or **head of the epididymis**; and a lower, smaller expansion named the **globus minor,** or **tail of the epididymis.**

The head of the epididymis surmounts the posterior part of the upper end of the testicle, and is closely joined thereto by the vasa efferentia—ducts of the testicle entering the globus major. The body and tail of the epididymis are loosely attached to the postero-external aspect of the testicle by areolar tissue.

The **tunica vaginalis** is a serous sac which invests the testicle, and part of the head and body of the epididymis, and extends upward into the spermatic cord for half an inch, or one centimeter. It is the lower and unobliterated portion of the processus vaginalis of the peritoneum. It acts as a bursa for the protection of the testicle and the head of the epididymis. Its *parietal portion* lines the envelope of the testicle formed by the three spermatic fasciæ. The *visceral portion* covers the testicle except part of its posterior margin, the globus major, and the outer side of the body of the epididymis, and is in relation with the contents of the lower half inch of the spermatic cord. A deep depression of this tunic exists between the testicle and the body of the epididymis, externally and above, and is called the *digital fossa.* The visceral portion closely adheres to the dense white tunica albuginea of the testicle and gives it its glistening appearance.

Hydrocele of the tunica vaginalis is distention of the tunica vaginalis with serum. On account of the relation between the testicle and tunica vaginalis the testicle lies in the lower posterior part of the swelling, and is not endangered in tapping the hydrocele; but in inversion of the testicle this organ lies in the lower anterior part of the swelling and might be injured. Therefore it is advisable to locate the testicle, or to determine that it is not in the anterior portion of the swelling, before tapping a hydrocele.

In the radical operation for hydrocele, preferred by the author, a longitudinal incision is made over the tumescence, and the skin, dartos, external spermatic fascia, cremasteric fascia, internal spermatic fascia, and parietal layer of the tunica vaginalis are divided. The parietal layer of the tunica vaginalis is then dissected out and removed, thus destroying the cavity of the tunica vaginalis, the site of the hydrocele. The wound should be drained.

Hematocele is distention of the tunica vaginalis with blood.

Structure of the Testicle and Epididymis.—The testicle is invested by the *tunica albuginea*, which is a dense, firm, inelastic white, fibrous structure, which forms the true outer coat of the testicle. The tunica albuginea is about one-sixteenth of an inch, or one and one-half millimeters, thick throughout most of its extent, being thickest at the posterior margin of the gland under the epididymis, where it is in-

vaginated and forms the *mediastinum testis*. It sends off centripetally directed processes, called *trabeculæ*, which separate the interior of the testicle into compartments, within which lie the lobules of the testicle. The tunica albuginea is lined by the *tunica vasculosa*, which is chiefly composed of a plexus of blood-vessels. These lobules of the testicle are composed of the convoluted seminiferous tubules (tubuli seminiferi), from the epithelium of which the spermatozoa are formed. These tubules end in straight tubes (*vasa recta*) in the back part of the testicle, where the apices of the lobules converge. The straight tubes inosculate in the form of a network at the back of the organ, forming the *rete testis*, from the upper part of which emerge a series of tubes, called *vasa efferentia;* the tubules next become convoluted over the top of the testis, and are known as the *coni vasculosi;* the tubules of the coni vasculosi end in an arched collecting tubule surmounting them, and called the *tube of the epididymis;* the entire mass of vasa efferentia, coni vasculosi, and collecting tube forming the *globus major*, or *head of the epididymis*. The tube of the epididymis becomes much convoluted, is about fifteen feet long, descends behind the testis, and forms the *body and tail of the epididymis*. Behind the lower end of the testis it doubles upon itself in the globus minor, and becomes the vas deferens, which ascends back of the epididymis to become part of the spermatic cord. From the tube, where it forms the globus minor, and quite near the beginning of the vas deferens, are given off one or more offshoots, ending in blind extremities, called *vasa aberrantia*.

The testicle is not fully developed until puberty, and it retains its functional activity well into advanced life.

Blood Supply.—The blood supply of the testicle is derived from the spermatic artery. Its veins empty into the pampiniform plexus, the veins of which unite to form the spermatic vein.

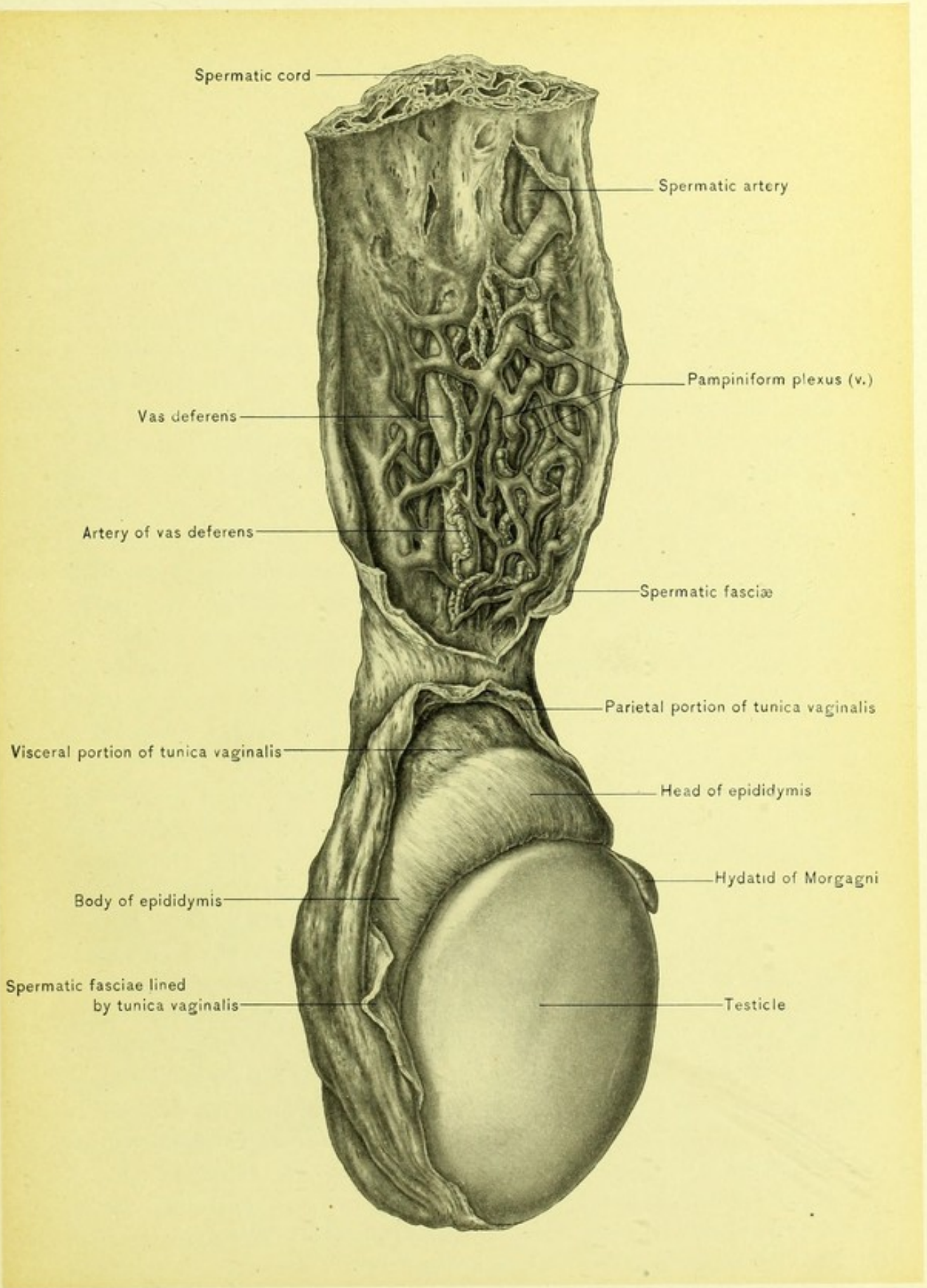
Nerve Supply.—The nerve supply of the testicles is derived from the spermatic plexus, which is indirectly derived from the solar plexus and from the hypogastric plexus, through the sympathetic nerves which follow the artery of the vas deferens.

Acute epididymitis is usually a complication of gonorrhea, and **chronic epididymitis** is evidence of constitutional disease, as syphilis or tuberculosis.

Acute orchitis is inflammation of the testicle. It is signalized by a dull, sickening pain, produced by pressure of the nerves against the inelastic tunica albuginea which retards swelling of the organ.

Chronic orchitis is presumptive evidence of some constitutional disease, generally either syphilis or tuberculosis.

Fungus is the term applied to a papillomatous growth of granulations projecting through a perforation in the tunica albuginea in suppuration of the testicle. It takes this form because of the unyielding character of the tunica albuginea.



RIGHT TESTICLE AND SPERMATIC CORD—ANTERIOR VIEW.

Atrophy of the testicle is natural in old age, but may occur prematurely as a disease. Senile atrophy is produced by fatty degeneration of the seminiferous tubules.

Dermoid cysts sometimes develop in the testicle. They are developmental curiosities, and should be removed.

Castration is the operation of removal of the testicle. It is a simple procedure, very ancient, and almost as commonly practised on men in the East as it is upon other animals in the Occident. It is a notable practice among the Mohammedans, who castrate their male slaves before placing them as servants in the harems.

Castration is performed by making an incision over the testicle, usually in a longitudinal direction. The skin, dartos, external spermatic fascia, cremasteric fascia, internal spermatic fascia, and the parietal layer of the tunica vaginalis are divided and the testicle brought into view, care being taken not to injure the scrotal septum. The testicle is drawn well downward, and the finger passed upward along the spermatic cord. The spermatic cord is freed from its surrounding structures, and its constituent vessels are ligated separately or *en masse*. These vessels are: The cremasteric artery, which lies in the fascial investment of the cord; the spermatic artery, in front of the vas deferens, surrounded by the spermatic or pampiniform plexus of veins; the artery of the vas deferens, close to the vas deferens; some small veins, and the spermatic duct. The proximal part of the spermatic cord is anchored in the wound and the cord is divided; the testicle is removed and the wound is closed.

Excision of the testicles is sometimes followed by atrophy of the prostate, a fact established for many years, but lately advocated as a cure for enlarged prostate; but experience has proved that little is gained by the operation.

Sterility of the male results from obstruction of the ejaculatory duct, vas deferens, or tube of the epididymis, or from inability of the testis to secrete spermatozoa, a condition which may be temporary or permanent and is physiologic as a senile change after the seventieth year.

Spermatorrhea is a term generally used to designate a passive flow of semen without sexual excitement and without orgasm. It is due to a weakened condition of the ejaculatory apparatus, so that the semen is not retained in the vesiculæ seminales, but is permitted to flow into the urethra as fast as formed. Excessive venery and abnormal sexual gratification are its most frequent causes, though organic defects of various kinds also give rise to it.

The **spermatic cord** is the pedicle by which the testicle is suspended in the scrotum; it extends from the upper end of the testis to the internal abdominal ring. It is composed of: (1) The vas deferens, which can be distinctly felt as a firm and rounded cord back of the vessels and nerves; (2) the spermatic artery (a

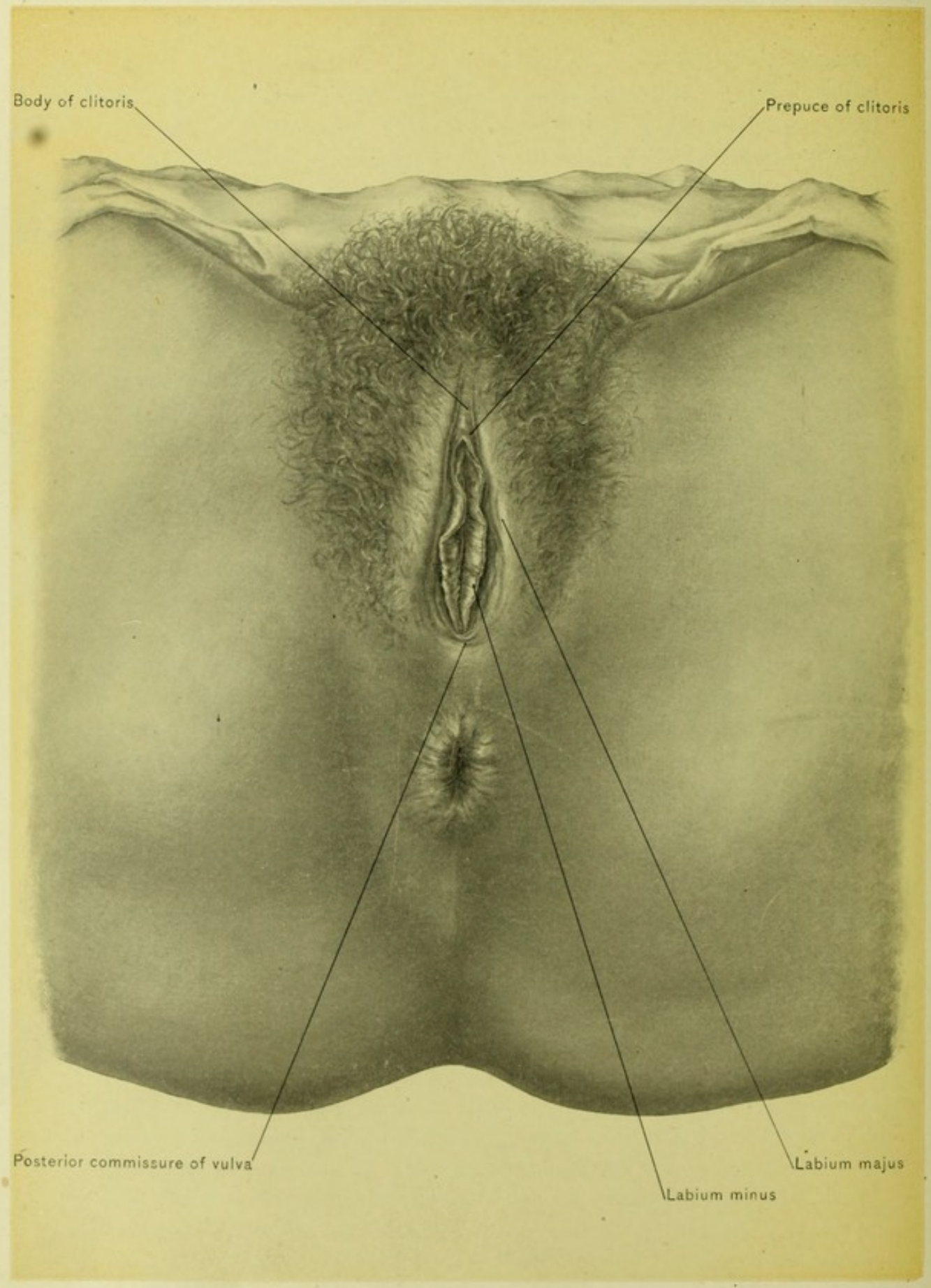
branch of the aorta) the artery of the vas deferens (a branch of the superior vesical), and the cremasteric artery (a branch of the deep epigastric artery); (3) the spermatic veins surrounding the artery and forming a plexus (pampiniform plexus); (4) lymphatics accompanying the vessels and emptying into the lumbar glands; (5) sympathetic nerves, which are branches of the renal, aortic, and hypogastric plexuses; (6) remains of the processus vaginalis in the form of a small fibrous cord; (7) Henle's internal cremaster, consisting of longitudinal fibers of pale muscle tissue; (8) fat and connective tissue derived from, and continuous with, the subserous areolar tissue. The constituents of the spermatic cord diverge as they are followed internally from the internal abdominal ring. The spermatic cord passes through the inguinal canal to reach the scrotum and it is sometimes abnormally followed by an indirect inguinal hernia.

Varicocele is an enlarged or varicose condition of the spermatic veins or pampiniform plexus. The fact that these veins are but poorly supported by the lax tissues of the scrotum, and the slight degree of compression to which they are subjected in the inguinal canal, help to explain the frequency of varicosity of these veins. This condition may cause atrophy of the testicle. The varicose plexus of veins eventually, or even at the beginning, may sag at the bottom of the scrotum upon the affected side (most often the left), so that on inspection and palpation the scrotum resembles a bag of worms. The condition is devoid of danger, except that it often begets morbid fears on the part of the patient, usually the result of suggestion. If large and associated with relaxation of the scrotum, varicocele causes a dull, heavy dragging sensation in the external genitals. In the radical operation for varicocele a longitudinal incision is made over the mass of veins; the skin, the dartos, the external spermatic fascia, the cremasteric fascia, and the internal spermatic fascia are divided and the mass of veins is separated from the spermatic duct. Two ligatures, preferably catgut, are then thrown around the mass of veins and the spermatic artery and securely tied, the ligatures being about one inch apart. The intervening portions of the veins and the spermatic artery are removed and the ends of the ligatures tied together. Subsequently, the blood supply of the testicles is derived from the artery of the vas deferens and the cremasteric artery. The wound is closed in the ordinary manner.

The **Hydatids of Morgagni** are two small bodies attached to the upper part of the testicle and the globus major. They each measure from one-half to one centimeter in length and contain clear fluid. One is pediculated and the other is sessile. They are the remains of the embryonic structure called Müller's duct.

The **Paradidymis, or Organ of Giraldès,** is an irregular yellowish patch, about one centimeter in breadth, situated in the lower part of the spermatic cord above the head of the epididymis, and covered by the visceral portion of the tunica

PLATE CCCXIV.



SURFACE OF FEMALE PERINEUM.

vaginalis. It is composed of blind tubules, and is the remains of part of the Wolffian body. The paradidymis and hydatids of Morgagni are common sources of cysts and other tumors. The cysts are among those classed as *encysted hydrocele of the epididymis*, which may also arise from the seminiferous tubules and their vasa aberrantia.

FEMALE PERINEUM.

Dissection.—The subject is placed upon the table in the same manner and position as described in the dissection of the male perineum.

Definition.—The perineum includes all those structures which fill the outlet of the pelvis.

Boundaries.—This space, as in the male, is of quadrangular or lozenge shape, bounded superficially in front by the upper border of the os pubis, at the sides and behind by the thighs and buttocks. The deep boundaries are the same as those of the male.

This general space is subdivided into two triangles by a line drawn transversely from one tuberosity of the ischium to the other—the posterior is called the **anal triangle;** the anterior, the **urethro-vaginal triangle** or **perineum proper.** The anatomy of the anal triangle, including the ischio-rectal fossæ, is the same as in the male. (See Male Perineum.)

The **Mons Veneris** is a cushion of fat and areolar tissue covered with rather firmly adherent integument and hair; it rests upon the external surface of the symphysis and bodies of the pubes. The area covered by hair ends abruptly above, at about the upper border of the mons veneris; in the male it is usually prolonged upward in the median line as far as the umbilicus. The mons veneris divides at its lower part into the two labia majora, the point of separation constituting the **Anterior Commissure of the Vulva.** The **Labia Majora** are prolonged downward and around the pudendal cleft or uro-genital fissure to unite below at the **Posterior Commissure of the Vulva.** The labia majora, which, like the mons veneris, are largely composed of fatty tissue covered with integument and hair, contain some smooth muscular fibers, vessels, and nerves. They are the female representatives of the scrotum. The inner surface of the labium majus is covered by delicate skin, which contains large sebaceous follicles.

The fatty tissue of the labia majora may develop excessively, thereby forming enormous lipomata. The labia majora, like the scrotum in the male, are affected by elephantiasis.

The **Labia Minora** (*nymphæ*) are two small cutaneous folds placed internal to the labia majora. They form the prepuce and frenum of the clitoris, and extend downward and outward from the sides and dorsum of this organ for about one and one-half inches, or four centimeters, to become continuous with the skin of the labia majora and the mucous membrane of the vagina. They may be concealed by, or project from, the labia majora. The nymphæ are covered with delicate integument; they contain sebaceous, but no mucous, glands, and are consequently to be regarded as cutaneous, and not as mucous, folds. Venous spaces and smooth muscular fibers in their interior produce an appearance similar to that of erectile tissue.

The **Pudendal Cleft** or **Uro-genital Fissure** separates the labia of the two sides and extends antero-posteriorly. In the erect position of the body it is almost horizontal. It is the representative of the raphe of the scrotum in the male.

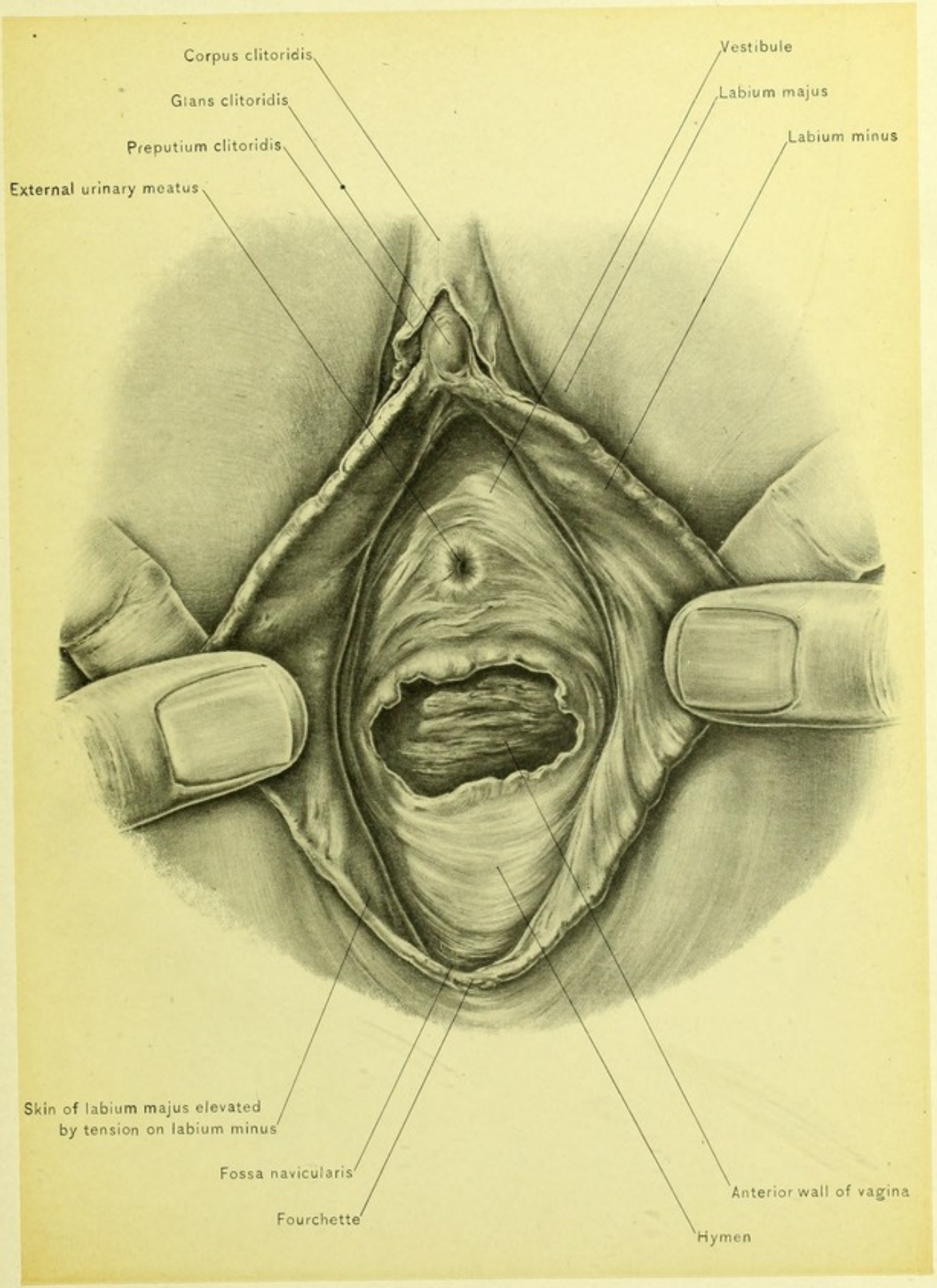
The **Clitoris,** about one and one-half inches, or four centimeters, long, is situated at the upper part of the pudendal cleft and, with the exception of its glans, is hidden by the labia minora, which form the *prepuce* and *frenum* of the clitoris. Its structure is similar to that of the penis, differing from the latter in having a smaller corpus spongiosum, which does not transmit the urethra, and is cleft posteriorly where it forms the bulbs of the vestibule. It is provided with a **suspensory ligament,** and consists of a **glans,** a **body,** and two **crura.** The **prepuce of the clitoris** is continuous with the labia minora. Despite the small size of the clitoris as compared with the penis, it has, proportionately, a much greater nerve supply.

The **Vestibule** is the triangular interval at the anterior part of the floor of the pudendal cleft, the apex of which is at the clitoris. The lateral boundaries of the vestibule are formed by the labia minora, and the base, by the upper margin of the orifice of the vagina.

The **External Urinary Meatus,** or **External Orifice of the Urethra,** is immediately above the center of the base of the vestibule. It is about one inch, or two and one-half centimeters, below the clitoris, and just above the orifice of the vagina. The mucous membrane projects at its orifice and forms a papilla which can usually be felt.

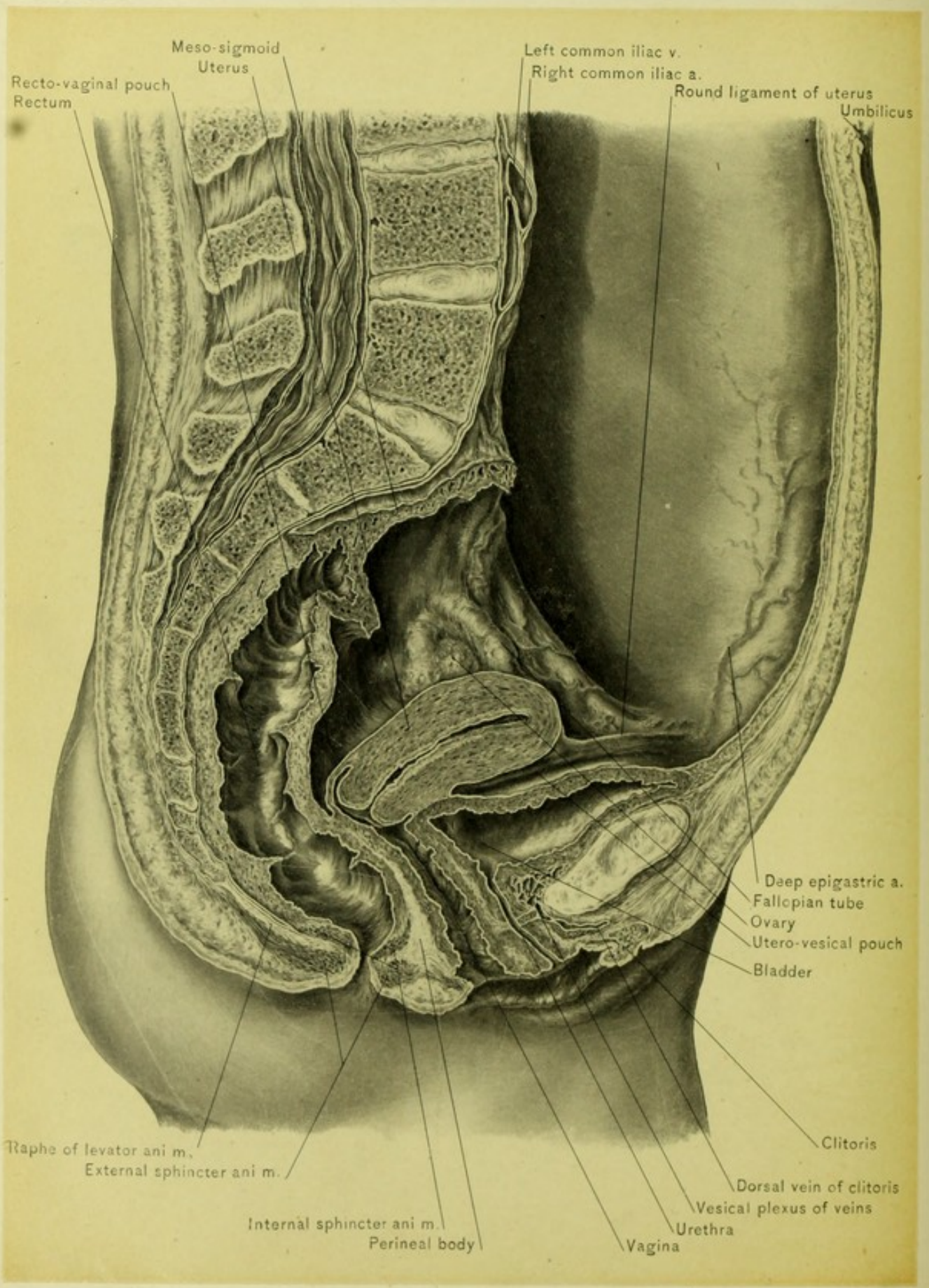
Catheters are sometimes introduced into the female urethra without exposure of the person, consequently there may be some difficulty in engaging the instrument in the external urinary meatus. The index-finger of the left hand is inserted into the vagina and with its palmar surface forward is held against the anterior wall of the vagina; then the catheter, held in the right hand, is carried along the palmar surface of the left index-finger; when it reaches the vaginal orifice, its beak is tilted forward and by slight manipulation enters the urethra.

The **Orifice of the Vagina** is situated immediately below the vestibule. It



EXTERNAL GENITALS OF VIRGIN.

PLATE CCCXVI.



FEMALE PELVIS AND PERINEUM—SAGITTAL SECTION.

may be partly closed by a fold of mucous membrane, the **Hymen,** and when this has been ruptured its remnants, the **Carunculæ Myrtiformes**—small projections of mucous membrane—are found around the vaginal orifice. The hymen is variable in form. It may be semilunar, annular, cribriform, or fimbriated. In imperforate hymen the menstrual fluid is retained in the uterus and vagina.

The **Ducts of the Vulvo-vaginal Glands** (**Bartholin's**) are situated at the side of the vaginal orifice toward its posterior portion, between the hymen and the labia minora.

The **Fourchet** is a small, transverse, crescentic fold of skin connecting the labia majora posteriorly, and is situated just internal to the posterior commissure of the vulva. It is usually ruptured in the first labor.

The **Fossa Navicularis** is the depression between the fourchet and the vaginal orifice.

The **Perineal Body** is the cuneiform mass of fibro-elastic and muscular tissue, located between the lower part of the rectum and vagina. The edge of the wedge is directed upward and the base, which measures about one inch, or two and one-half centimeters, is directed toward the skin. It is composed of the central tendon of the perineum or central part of the base of the triangular ligament, and fibers of the sphincter vaginæ, transverse perineal, external sphincter ani, levator ani, and deep transverse perineal muscles.

Rectal Examination.—The index-finger introduced into the rectum will recognize the resistance caused by the external and internal sphincter ani muscles; beyond these can be felt the external os uteri, the cervix, body, and fundus of the uterus, and, lastly, the appendages of the uterus—namely, the round ligaments, Fallopian tubes, and ovaries. This examination should always be made when dealing with obscure affections in the pelvis of the female. The vagina is the avenue through which digital exploration of the female pelvis is most commonly made, yet to make the examination more complete the possibilities of the rectal avenue should not be forgotten. This holds true, also, with certain diseases in the iliac and hypogastric regions of the abdomen.

Vaginal Examination.—When the index-finger is introduced into the vagina, the urethra is felt as a cord extending above the anterior vaginal wall from the vestibule to the neck of the bladder; the base of the bladder and anterior surface of the cervix uteri are palpated at the anterior fornix of the vagina; then the cervix and the external os uteri are felt. The body of the uterus, the ovaries, and the Fallopian tubes can be palpated at the side of the cervix. The ovaries are more readily palpated than the Fallopian tubes. Behind the posterior wall of the vagina the rectum can be easily recognized, and the terminal part of the sigmoid flexure can be made out through the posterior fornix

of the vagina, especially if those parts of the intestine contain feces. At the posterior fornix of the vagina the body and fundus of a retroverted uterus, tumors of the ovaries, distended Fallopian tubes, and the most tender point in a terminal appendicitis with the appendix directed into the pelvis may be palpated.

The **Urethro-vaginal Triangle** embraces the external genitalia (vulva, or pudendum). The **vulva,** or **pudendum,** includes the mons veneris, the labia majora, the labia minora (nymphæ), the clitoris, the vestibule, the external urinary meatus, the orifice of the vagina, upon each side of which are the orifices of the glands of Bartholin (vulvo-vaginal glands), the fourchet, the fossa navicularis, the posterior commissure, and the vertical cleft or longitudinal fissure (the uro-genital furrow).

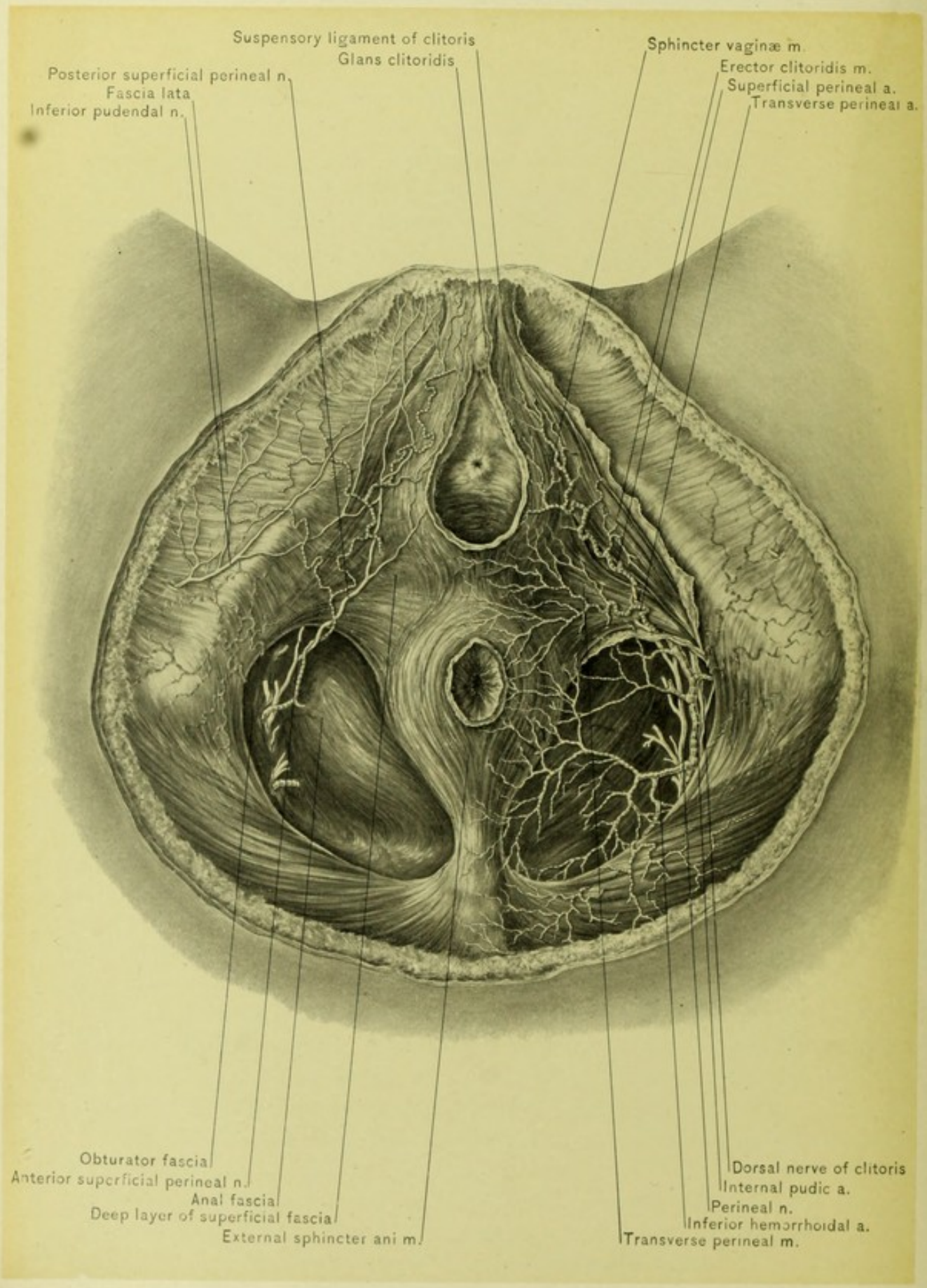
In a *bimanual examination* the uterus can be engaged between the finger in the vagina and the fingers of the other hand on the lower part of the hypogastrium, provided the bladder is approximately empty and the uterus is in its normal position. If a *speculum* be introduced into the vagina, the cervix uteri can be observed. In a virgin uterus the external os uteri is round, and in a uterus which has borne children the external os is transverse and elliptic. The anterior lip of the cervix is shorter and thicker than the posterior lip.

Dissection.—In making a dissection of this region, the vagina and rectum should be partly distended with oakum or any suitable material, and the adjacent surfaces of the labia majora and the margins of the anus approximated by stitches. The skin is removed in one flap from behind forward, and the superficial fascia from before backward, as in dissecting the male perineum. These tissues are supplied with vessels and nerves from the same corresponding sources as in the male.

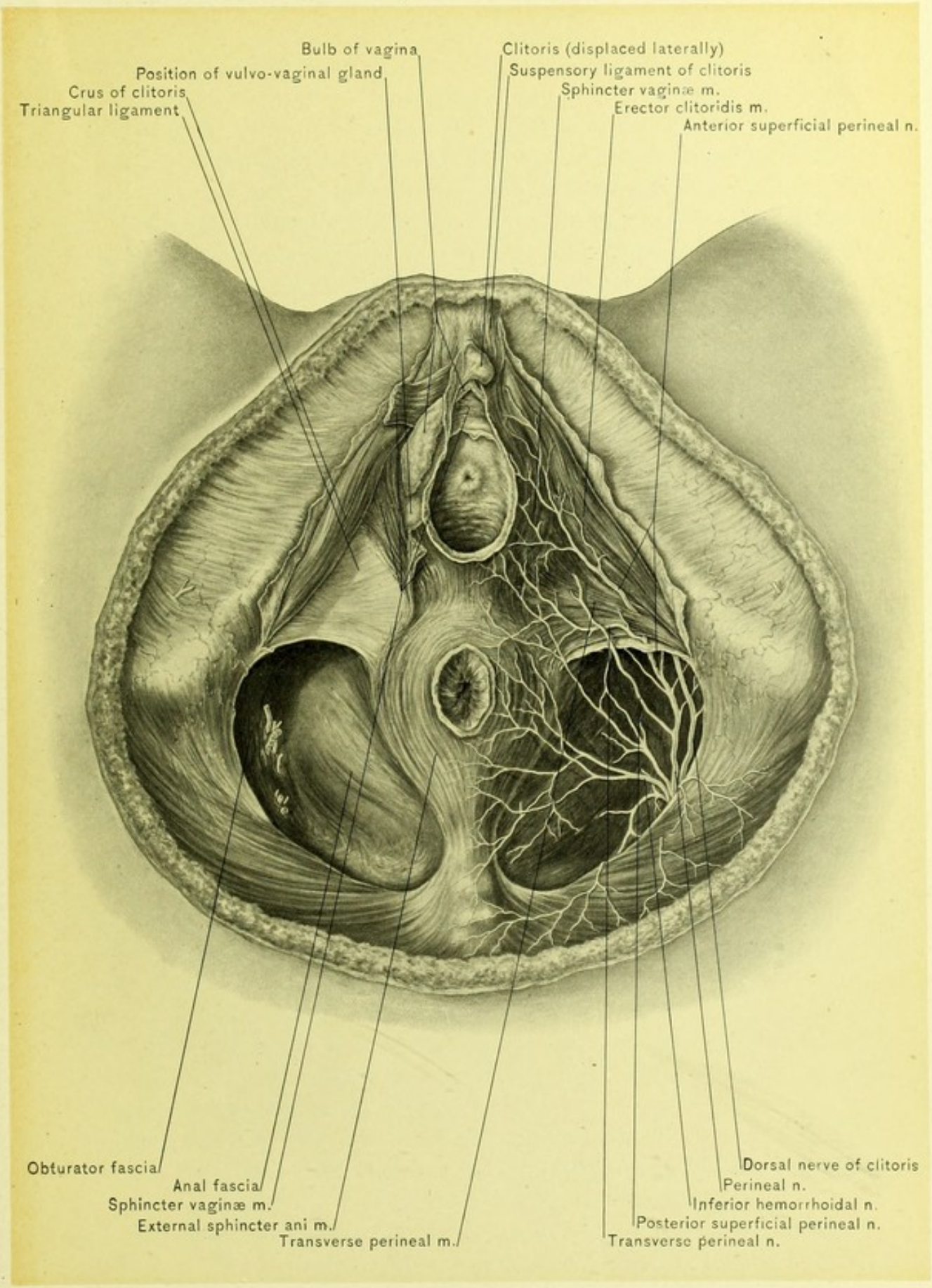
The **Superficial Fascia** consists of two layers—a superficial and a deep. The superficial layer is much richer in fat than in the male, and is continuous with the superficial fascia covering the anal triangle and with the same layer of the superficial fascia of the thighs and abdomen. As in the male, the deep layer is found only in the perineum proper, and its attachments are similar to those of Colles' fascia. It is not so strong as in the male, and internally it is continuous with the **dartos of the labia majora.** The unstriped muscular fibers forming the dartos are not so abundant as in the male. Internally, the dartos is divided by the pudendal cleft, and is continuous with the fibrous coat of the vagina.

The superficial fascia of the perineum bulges and is thickest at each side of the pudendal cleft, forming the labia majora. This mass of fat is widest and fullest at the side of the orifice of the vagina and narrowest at the side of the vestibule. The mass is the *pudendal sac,* which is the homologue of the sac formed by the dartos of the scrotum. It contains fat, overlies the site of the bulb of the vagina,

PLATE CCCXVII.



SUPERFICIAL PERINEAL INTERSPACE OF FEMALE PERINEUM.



TRIANGULAR LIGAMENT AND SUPERFICIAL PERINEAL INTERSPACE OF FEMALE.

and marks the position at which a pudendal hernia appears. The narrow anterior end of the sac is the neck. At this end it is joined by the frayed end of the round ligament of the uterus and the suspensory ligament of the clitoris.

The **Superficial Intra-aponeurotic Spaces** of the female perineum are situated between the deep layer of the superficial fascia and the inferior layer of the triangular ligament. They are two in number—one upon each side of the pudendal cleft. In the male there is one superficial perineal interspace, partly subdivided by an incomplete vertical septum. A collection of fluid in one of the superficial perineal interspaces will distend the labium majus and thence pass upward to the anterior abdominal wall, as would a similarly situated collection in the male. The *contents* of the superficial perineal interspace are: The sphincter vaginæ, transversus perinei, and erector clitoridis muscles, the bulb of the vagina, the superficial perineal vessels, the anterior superficial perineal nerve, the transverse perineal vessels and nerve, and the dorsal artery, vein, and nerve of the clitoris. In the female perineum, as in the male, there is a muscular triangle on each side formed by the sphincter vaginæ, erector clitoridis, and transversus perinei muscles.

Dissection.—Reflect the deep layer of the superficial fascia from within outward, to expose the structures situated in the superficial perineal interspace.

The **Superficial Perineal Artery,** larger in the female than in the male, is a branch of the internal pudic. It pierces the deep layer of the superficial fascia at its junction with the base of the triangular ligament, enters the superficial perineal interspace, and passes between the erector clitoridis and sphincter vaginæ muscles, supplying the contiguous parts. It anastomoses with the external pudic arteries, which are branches of the common femoral artery.

The corresponding veins accompany the artery and empty into the internal pudic vein.

The **Transverse Perineal Artery** is a branch of the superficial perineal or of the internal pudic, and passes transversely inward, over or under the transverse perineal muscle to the perineal body, anastomosing with the transverse perineal artery of the opposite side and with neighboring vessels.

Venæ comites accompany the artery and empty into the internal pudic vein.

The **Artery of the Bulb of the Vagina** (*bulbo-cavernosus*) is a branch of the internal pudic, corresponding to the artery of the bulb of the penis; it passes transversely inward to terminate in the bulb.

The veins accompanying the artery empty into the internal pudic vein.

The **Superficial Perineal Nerves** and the **Inferior Pudendal Nerve** are similar to the corresponding nerves in the male in origin and distribution.

The **Sphincter Vaginæ Muscle** (*bulbo-cavernosus*), the representative of the accelerator urinæ in the male, arises from the perineal body. Like the accelerator

urinæ, it consists of three sets of fibers—anterior, middle, and posterior. The anterior fibers join those of the opposite side upon the dorsum of the clitoris in an aponeurosis, a few fibers being inserted into the suspensory ligament of the clitoris; the middle fibers join those of the opposite side beneath the clitoris in an aponeurosis, which extends across the vestibule above the urethra; the posterior fibers are attached to the triangular ligament. Some of the most posterior fibers are inserted into the middle of the ischio-pubic ramus between the crus clitoridis and the triangular ligament.

Action.—To approximate the labia majora, thus closing the pudendal cleft, and assist in erection of the clitoris.

The **Transverse Perineal Muscle** arises from the ramus of the ischium immediately in advance of the tuberosity and passes inward and slightly backward, to be inserted into the perineal body, blending with the other transverse perineal, the external sphincter ani, the sphincter vaginæ, the deep transversus perinei, and the levator ani muscles.

Action.—To steady the perineal body.

The **Erector Clitoridis Muscle** (*ischio-cavernosus*), the homologue of the erector penis muscle, is in relation with the crus clitoridis, and its origin and insertion are similar to those of the erector penis muscle.

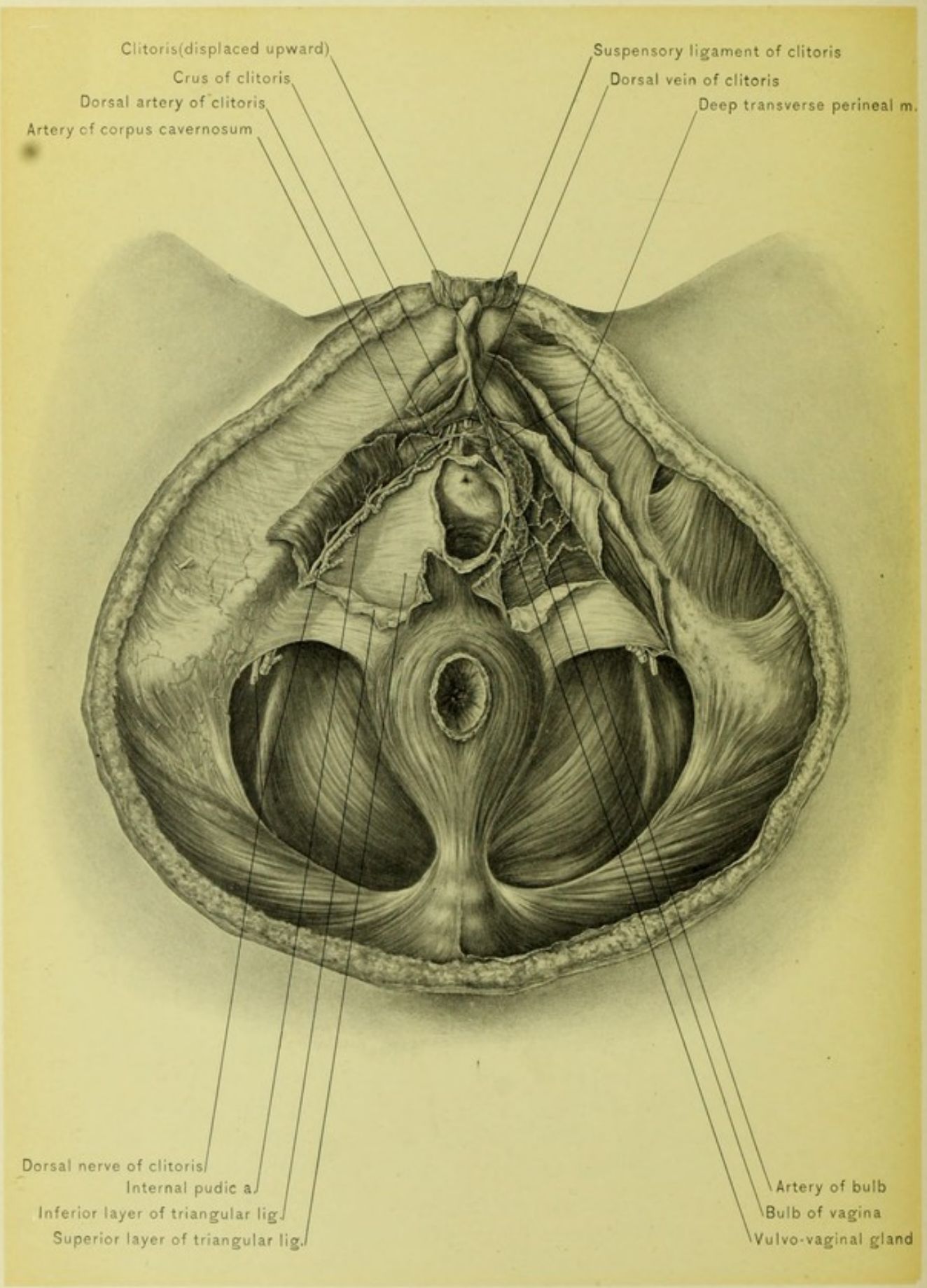
Action.—Similar to that of the erector penis muscle.

Blood and Nerve Supplies.—The blood and nerve supplies of the sphincter vaginæ, erector clitoridis, and transverse perineal muscles are derived from the same sources as that of their homologues in the male.

Dissection.—By separating the contiguous borders of the sphincter vaginæ and erector clitoridis muscles, and displacing the superficial perineal vessels and nerves and the inferior pudendal nerves, a portion of the inferior layer of the triangular ligament can be seen. The sphincter vaginæ, erector clitoridis, and transverse perineal muscles are now to be removed; the sphincter vaginæ and the erector clitoridis are reflected forward, and the transversus perinei is reflected inward. This dissection exposes the triangular ligament and the bulbs of the vagina and small elevations in the ligament produced by Bartholin's glands.

The **Bulbs of the Vagina** (*bulbs of the vestibule, semibulbs of the clitoris*), the homologues of the bulb of the penis, are two small pyriform erectile bodies situated one upon each side of the vestibule, behind the labia minora, beneath the sphincter vaginæ muscles, and on the superficial surface of the inferior layer of the triangular ligament. They are about one inch, or two and one-half centimeters, in length, and are composed of a plexus of veins communicating with the veins of the clitoris. Each bulb is surrounded by a fibrous capsule derived from the inferior layer of the triangular ligament. The narrow anterior extremities of the two

PLATE CCCXIX.



DEEP PERINEAL INTERSPACE OF FEMALE PERINEUM.

bulbs unite at the lower part of the root of the clitoris and extend forward as the slender corpus spongiosum. Rupture of one of the bulbs of the vagina, as the result of an injury, gives origin to a hematoma, known as a **pudendal hematocele ;** it most frequently occurs in pregnant women.

The **Vulvo-vaginal Glands** (*Bartholin's glands*) are two compound racemose glands which are the homologues of Cowper's glands in the male, but differ from the latter in size and situation. The vulvo-vaginal glands are placed on the deep surface of the inferior layer of the triangular ligament, and are invested by a capsule formed by fibers from the deep surface of the ligament, whereas Cowper's glands lie in the substance of the compressor urethræ muscle. They are larger than Cowper's glands, and are placed on each side of the orifice of the vagina on the deep surface of the inferior layer of the triangular ligament just behind the posterior ends of the bulbs of the vagina. They are about the size of a small bean, and measure one-half inch, or one centimeter, antero-posteriorly. Their ducts, three-quarters of an inch, or two centimeters, in length, open upon the inner aspect of the posterior part of the labia minora external to the hymen or carunculæ myrtiformes, where their orifices are marked by a small red depression at each side of the pudendal cleft. Abscess of these glands and cystic dilatations of their ducts sometimes occur.

The **Triangular Ligament of the Female Perineum** is similar to that ligament in the male ; it consists of two layers—an *inferior layer*, or *triangular ligament proper*, and a *superior layer* derived from the obturator division of the pelvic fascia. It is larger in the female than in the male, on account of the greater size of the outlet of the female pelvis, but it is weaker in the female because pierced by the vagina. Where the ligament is pierced by the vagina, it blends with the fibrous coat of that canal. The inferior layer is pierced by the vagina, urethra, anterior superficial perineal nerve, superficial perineal vessels, artery of the bulb, artery of the corpus cavernosum, dorsal artery, and nerve of the clitoris. The dorsal vein of the clitoris passes between the transverse perineal ligament and the subpubic ligament.

The **Ischio-perineal Ligament** is that strong portion of the triangular ligament attached laterally to the inner sides of the ischial rami just in advance of the tuberosities, extending mesially to be lost in the perineal body.

Dissection.—Next search for the prominence formed in the inferior layer of the triangular ligament by the vulvo-vaginal glands. After examining these glands, reflect the inferior layer of the triangular ligament backward as far as the posterior margin of the compressor urethræ or deep transverse perineal muscle, thus removing the superficial wall of the deep intra-aponeurotic space of the perineum. Then trace the artery of the bulb, and reflect the bulb forward.

The **Deep Intra-aponeurotic Space** of the female perineum, like the superficial interspace, is subdivided into two lateral portions by the vagina ; these two lateral parts communicate across the vestibule above the urethra. The contents of this space are the urethra, vulvo-vaginal glands, deep transverse perineal muscle, internal pudic vessels, arteries of the bulbs, arteries of the corpora cavernosa, dorsal arteries, and nerves of the clitoris.

The **Deep Transverse Perineal Muscle** (*compressor urethræ*) of the female is thicker and smoother than in the male, and arises from the middle of the ischio-pubic ramus for about one inch, or two and one-half centimeters. Its posterior fibers pass inward and backward for insertion into the perineal body ; its middle fibers, inward for insertion into the side of the vagina ; and its anterior fibers with the corresponding fibers of the muscle of the other side form a loop anterior to the urethra.

Blood and Nerve Supplies.—Same as for the homologue in the male.

Action.—To compress the urethra, draw the perineal body and lower part of the posterior vaginal wall forward, and support the pelvic floor.

The internal pudic vessels, artery of the bulb, artery of the corpus cavernosum, dorsal artery, and nerve of the clitoris follow a course so like the corresponding structures in the male that their further description is unnecessary. The **Dorsal Vein of the Clitoris** takes a course similar to that of the dorsal vein of the penis, and finally empties into the lower part of the vesical plexus of veins after communicating with the internal pudic vein.

Dissection.—To expose the superior layer of the triangular ligament remove the deep transverse perineal muscle and the vessels and nerves of the deep perineal interspace.

The **Superior or Deep Layer of the Triangular Ligament** is like that of the male, except that it is perforated by the vagina and blends with the fibrous coat of that canal. It is pierced by the vagina, the urethra, the internal pudic artery and veins, and the dorsal nerve of the clitoris.

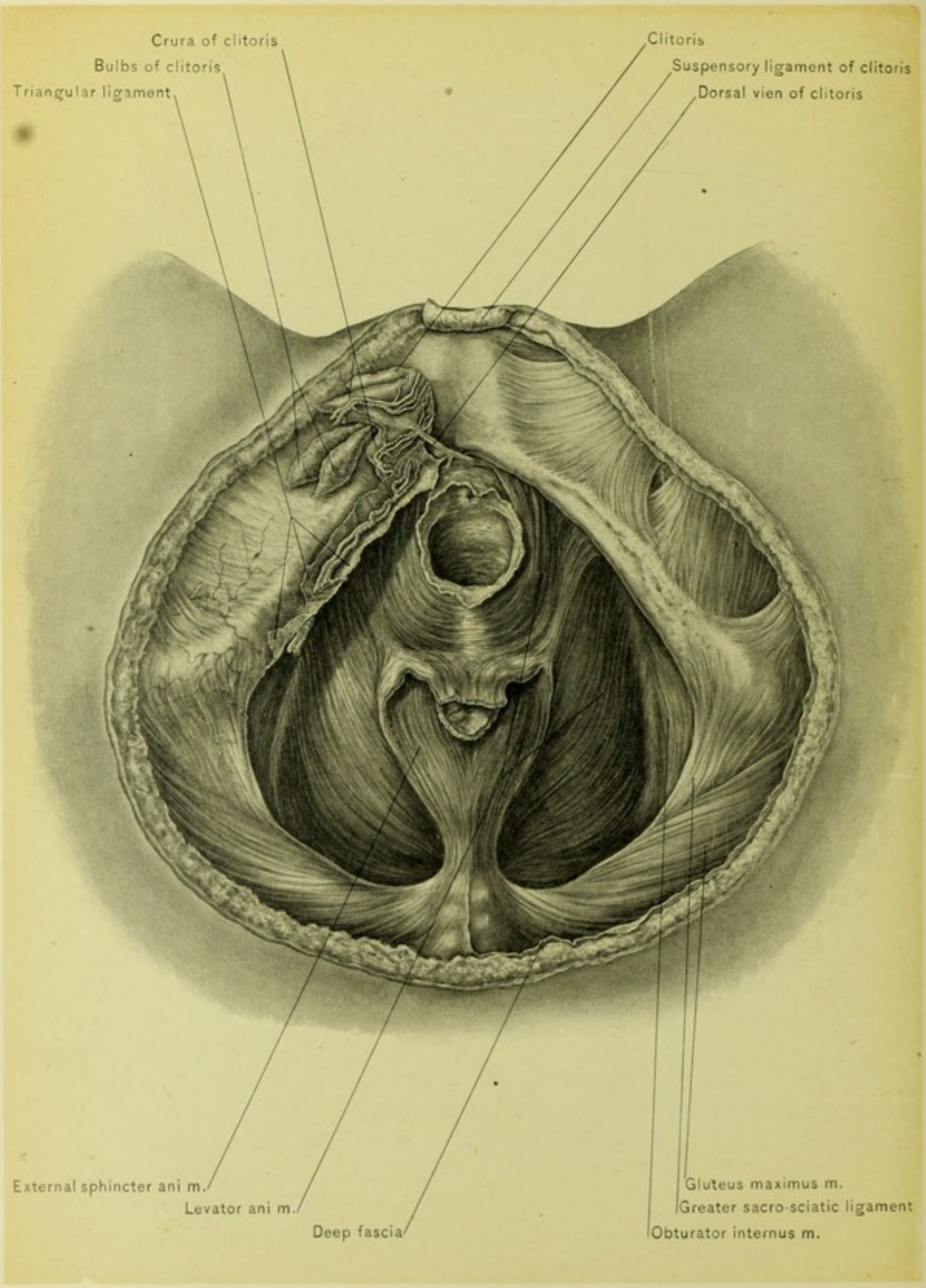
Dissection.—The superior layer of the triangular ligament is next removed. As the anal fascia has been removed in dissecting the ischio-rectal fossæ, the whole of the inferior surface of the levator ani muscle is now exposed.

The **Levator Ani Muscle** in the female differs from the corresponding muscle in the male only at its anterior portion, which closely embraces the sides and posterior wall of the vagina, whereas that part of the muscle in the male embraces the prostate gland.

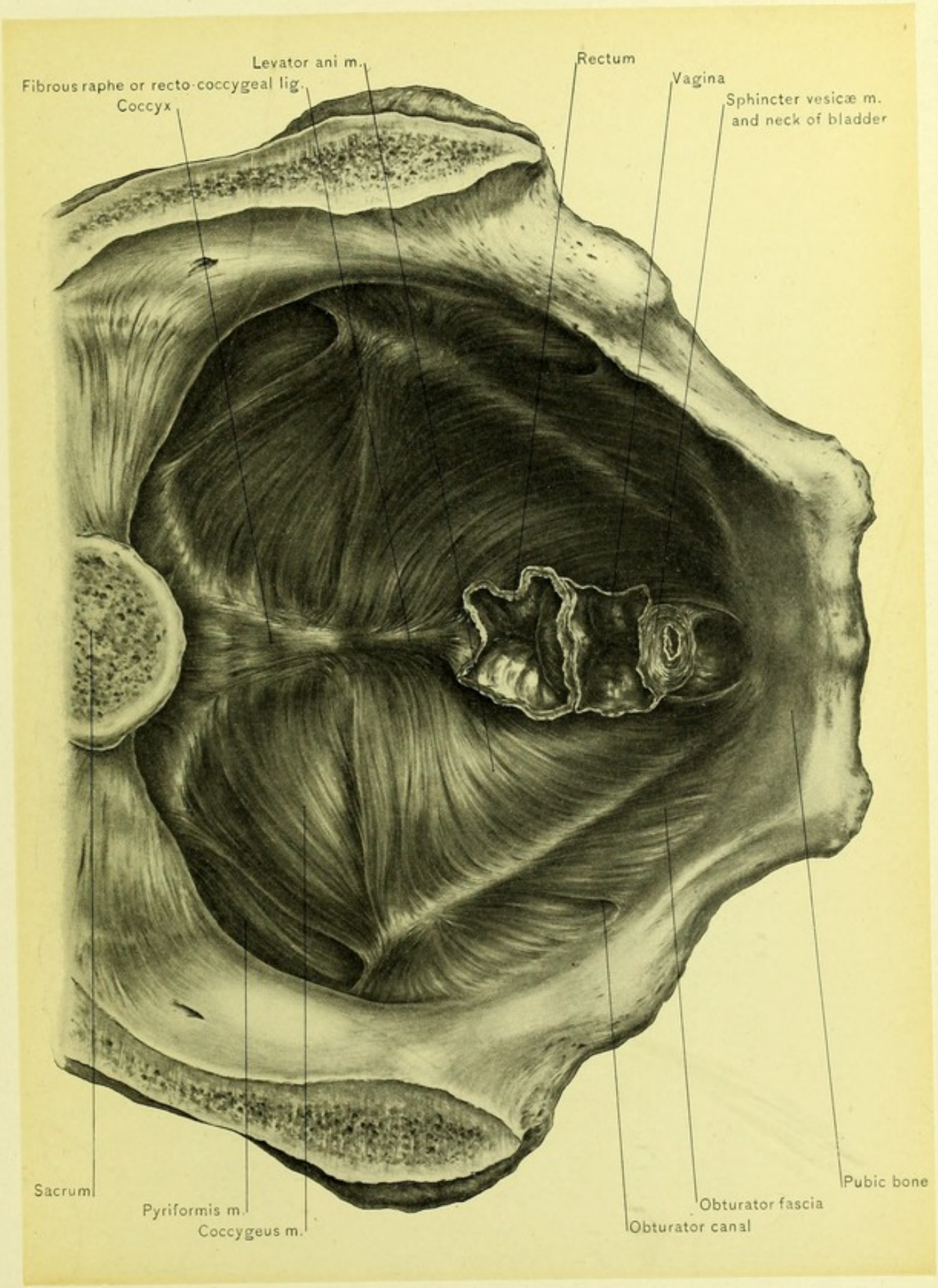
Nerve Supply.—Same as in the male.

Action.—Its action is similar : to assist in supporting and compressing the pelvic viscera.

PLATE CCCXX.



INFERIOR SURFACE OF LEVATOR ANI MUSCLE OF FEMALE.



MUSCLES IN FLOOR OF PELVIS—SUPERIOR VIEW.

The **Female Urethra** is only about one and one-half inches, or four centimeters, in length, and extends from the neck of the bladder to the external urinary meatus. As in the male, the meatus is the smallest place in the urethra. The urethra is directed downward and forward in front of the anterior vaginal wall close under the pubic arch, against which it is readily rolled by the finger in vaginal examinations. With the body in the erect position it is nearly vertical, and in the recumbent position nearly horizontal. It is slightly curved, with its concavity upward and forward. It is about one centimeter in diameter, but, having an inner mucous lining arranged in longitudinal folds, it may be widely dilated, thereby permitting the removal of vesical calculi through it. Coitus has been practised in it instead of the vagina. Adjacent to this mucous membrane is a thin layer of erectile and yellow elastic tissue; and outside of all is a thick layer of circular and longitudinal muscle-fibers, the former being external to the latter.

Inguino-labial hernia is a protrusion of some part of the intra-abdominal contents through the inguinal canal of the female along the round ligament of the uterus to the labium majus.

In a **pudendal hernia** the protruding mass reaches the labium majus by passing between the vagina and the ramus of the ischium. This form is uncommon, but on that account worthy of remembrance, because it might be mistaken for abscess or hematocele or a cyst of one of the vulvo-vaginal glands.

Hydrocele of the pudendum is analogous to hydrocele of the tunica vaginalis testis, and originates in the canal of Nück, which is in relation with the round ligament of the uterus in the inguinal canal, and is formed by the processus vaginalis of the peritoneum.

Lacerations of the Female Perineum may occur during labor. In the simple forms the perineum is ruptured in the median line at the posterior commissure of the vulva. The structures torn in incomplete lacerations are the vaginal wall, skin, and perineal body. In such lacerations the edges of the wound are separated by tension produced by the transverse perineal, deep transverse perineal, and levator ani muscles. If the rent is not sutured and repaired immediately, the wound heals by granulation, the floor of the pelvis is weakened, and disease and discomfort incident to prolapse of the uterus and other pelvic organs supervene. Compensation for the defect is partially provided by forward displacement of the perineal body and anus by the deep transverse perineal and levator ani muscles, if these muscles have not been ruptured. Deep lacerations extend through the sphincter ani muscles and anterior wall of the rectum, causing incontinence of feces. The perineal body, deep transverse perineal muscle, or levator ani muscle may be ruptured subcutaneously. In lacerations at the side of the vaginal orifice one of the bulbs of the vagina may be torn and, to check the persistent hemorrhage arising therefrom, a deep suture may be required.

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