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THE HEAD AND NECK OF THE HORSE

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THE
Topographical Anatomy
OF THE
Head and Neck of the Horse

BY

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PREFACE

The plan and aim of the present instalment of an account of the topographical anatomy of the horse are the same as those according to which the volumes on the limbs and the thorax and abdomen were prepared. It is hoped that the three volumes together will furnish, in sufficient detail but without over-elaboration, a description of the form and disposition of the parts of the horse's body that will help the student, and, perchance, the practitioner.

My grateful thanks are again tendered to Mr. James T. Murray for the time and care devoted to the preparation of the illustrations; to my colleague, Mr. T. Grahame, M.R.C.V.S., for assistance in reading the proof-sheets; and to the publishers.

O. C. B.

September, 1923.

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THE HEAD AND NECK.

In order to conform with the convenience of those who are engaged in the examination of other parts of the body, the dissector of the head and neck should begin with the structures that are ventral to the cervical vertebræ.

Before the removal of the skin, it will be observed that, in the lower part of the neck, there is a single, median, elongated prominence rounded from side to side, that divides into two rounded and divergent ridges about the middle of the neck. This is formed by the two sterno-cephalic muscles that, arising from the manubrium of the sternum close together, gradually separate towards their individual insertions into the mandible. Lateral to each muscle there is a groove, under which the jugular vein will be discovered during the course of the dissection. The groove is bounded laterally by the edge of the brachio-cephalic muscle, and, if followed towards the sternum, will be found to become very shallow just before it joins the supraclavicular fossa.

Between the divergent sterno-cephalic muscles is an elongated triangular area, slightly convex from side to side, formed by the trachea and larynx (covered by a thin sheet of muscle) and continued forwards between the two halves of the mandible.

Dissection.—Make a longitudinal incision through the skin in the midventral line from the manubrium of the sternum to the symphysis of the mandible, and turn the skin aside as far as, or slightly beyond, the edge of the brachio-cephalic muscle. The skin incision should be made with care, otherwise the underlying cutaneous muscle—which is very thin—will be injured, and there is even a risk that the muscle may be unwittingly reflected along with the skin.

Cutaneous nerves, derived from the cervical nerves from the second to the sixth inclusive, will be found crossing the long axis of the neck at fairly regular intervals.

M. CUTANEUS COLLI.—Throughout the greater part of the neck the cutaneous muscle is very thin, being composed of weak bundles that run in an oblique cranial and lateral direction ; but a fairly sudden and considerable thickening occurs in the region of the manubrium sterni, from which the muscle may be said to take its origin. Laterally the muscular fibres are lost in the superficial fascia and become adherent to the surface of the brachio-cephalic muscle.[1]

A cutaneous branch of the sixth cervical nerve should be noted crossing the surface of and supplying filaments to the thick sternal part of the cutaneous muscle.

Dissection.—Sever the sternal attachment of the cutaneous muscle, make a longitudinal incision through the muscle along the middle line of the neck, and reflect it from the surface of the underlying sterno-cephalic muscle.

In cleaning the m. sternocephalicus take care to secure a small nerve that runs between its lateral border and the jugular vein. It is well also, early in the dissection, to find the nerve that supplies the sterno-cephalic muscle. This is the ventral branch of the accessory nerve, which enters the muscle a short distance before the commencement of the tendon by which it is attached to the mandible.

M. STERNOCEPHALICUS. — The sterno-cephalic[2] is an elongated rounded muscle that takes origin from the manubrium of the sternum in common with its fellow of the other side of the neck. The right and left muscles lie alongside each other until the middle of the neck is reached. Here they diverge, and each tapers to a flattened tendon that passes underneath the parotid gland to be inserted into the border of the ramus of the mandible.

V. JUGULARIS.—The horse has only one jugular[3] vein on each side of the neck, this corresponding to the external jugular of other mammals. The position of the vein is clearly indicated on the surface of the body by the groove bounded by the sterno-cephalic and brachio-cephalic muscles. In the present dissection the vessel will be found without difficulty as it follows the border of the sterno-cephalic muscle.

The jugular vein is formed by the union of the external and internal maxillary veins at the posterior ventral angle of the parotid gland. It passes down the neck in the groove bounded by the adjacent borders of the sterno-cephalic and brachio-cephalic muscles, and, throughout the greater part of its course, is superficial in position, being covered only by the skin, the thin cutaneous muscle, and the cervical fascia. On approaching the entrance to the thorax, where it joins its fellow and the subclavian veins to form the cranial vena cava, it occupies a deeper position. As far as the level of the fifth cervical vertebra the vein lies upon the omo-hyoid muscle, which separates it from the trachea and

[1] The degree of development of the muscle varies very considerably. It may be so extensive as to cover the greater part of the sterno-cephalic muscle.

[2] *Sternum* [L.], *στέρνον* (sternon) [Gr.], breast or chest ; *Cephalicus* [L.], κεφαλικός (cephalicos) [Gr.], pertaining to the head (κεφαλή).

[3] *Jugularis* [L.], pertaining to the neck (*jugulum*).

the common carotid artery. Caudal to the fifth vertebra the right jugular is related to the carotid artery and the trachea, and the left vein to the artery and the œsophagus.

The following tributaries join the jugular at different points in its course :—

(1) The *thyroid vein* (v. thyreoidea) is a large vessel that joins the jugular close to its commencement, and corresponds to an artery of the same name that will be disclosed as the dissection proceeds. It will be found later that this vein drains the pharynx and larynx in addition to the thyroid gland.

(2) *Muscular*, *tracheal* and *œsophageal* veins enter the jugular at numerous points as it travels down the neck.

(3) The *ascending cervical vein* (v. cervicalis ascendens) is often the last tributary, and sometimes joins the subclavian vein instead of the jugular.

(4) The *cephalic vein* (v. cephalica), a superficial vein of the thoracic limb, sinks into the triangular space (supraclavicular fossa) at the root of the neck to join the jugular close to its termination.

The small *ramus colli* of the seventh cerebral nerve appears between the parotid gland and the inferior auricular muscle, is connected with the second cervical nerve, and follows the dorsal border of the jugular vein to supply the skin and cutaneous muscle of the neck.

N. CUTANEUS COLLI.—The cutaneous nerve of the neck is derived from the second cervical, which pierces the brachio-cephalic muscle on a level with the commencement of the jugular vein. One (or more) of its branches is connected with the ramus colli of the seventh cerebral nerve. Another branch runs horizontally forwards into the space between the two halves of the mandible.

Dissection.—As the jugular vein affords an excellent opportunity for the study of the valves that are present in nearly all the veins of the body, the vessel should be incised longitudinally. The valves are pocket-like folds of the innermost coat of the vein and occur at fairly regular intervals in pairs (occasionally three valves may occur at the same level). Each valve has a convex margin attached to the wall of the vein, and a free slightly concave border. The mouth of the pocket formed by the valve looks towards the heart, so that a reflux of blood fills the pocket, causes the valve to bulge into the interior of the vein, and thus occludes the lumen of the vessel. Coinciding in position with the valve there is a dilatation of the wall of the vein, with the result that the vessel, when distended with blood, presents a beaded appearance.

Cut across both sterno-cephalic muscles about the middle of the neck and turn them aside.

M. STERNOHYOIDEUS: M. STERNOTHYREOIDEUS. — These two muscles have a common origin from the manubrium of the sternum.

They are further inseparably blended until the middle of the neck is reached, where a short rounded tendon terminates the common fleshy belly. The combined muscle, up to this point, is narrow and flattened, is in contact with its fellow of the opposite side of the neck, and lies between the sterno-cephalic muscle and the trachea. At the intermediate tendon the sterno-hyoid and sterno-thyroid muscles separate.

The *sterno-hyoid*[1] *muscle* continues along the trachea, in contact with its fellow muscle, and is inserted into the body of the hyoid bone.

The *sterno-thyroid*[2] *muscle* diverges from the middle line, passes between the trachea and the omo-hyoid muscle, and is inserted, by a thin narrow tendon, to the lateral surface of the thyroid cartilage, near its caudal border (the ventral part of the oblique line of the cartilage).

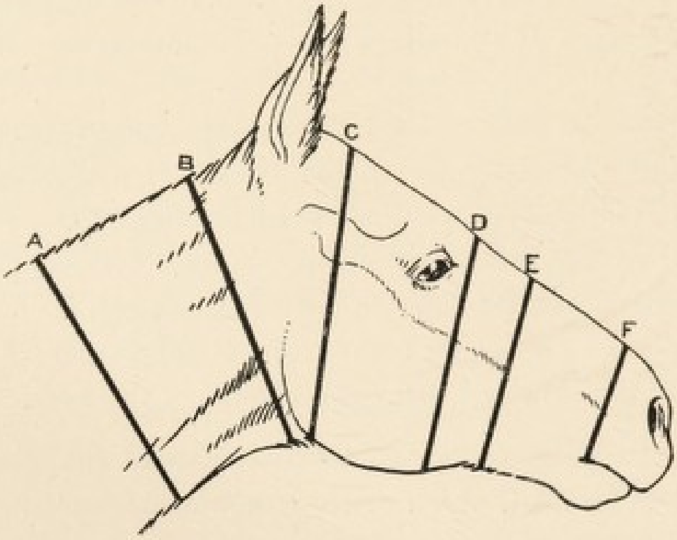


Fig. 1.—Key-outline to indicate the plane of the sections of the neck and head, illustrated in later figures.

The small nerve supplying these muscles should be looked for medial to the external maxillary vein, and afterwards on the ventral-lateral border of the trachea. It is derived from the first and second cervical nerves.

M. OMOHYOIDEUS.—The origin of the omo-hyoid[3] muscle from the subscapular fascia is revealed during the dissection of the thoracic limb. Its thin, flattened belly crosses the deep face of the brachio-cephalic muscle (to which it is firmly bound), and passes obliquely over the lateral surface of the trachea to reach the body of the hyoid bone, to

[1] *Sternum* [L.], στέρνον (sternon) [Gr.], breast or chest; ὑοειδής (hyœides), [Gr.], U-shaped, from the resemblance of the human hyoid bone to the letter U.

[2] *Sternum* [L.], στέρνον (sternon) [Gr.], breast or chest; θυρεός (thyreos) [Gr.], a shield; εἶδος (eidos) [Gr.], form, from the shield-like cartilage (thyroid) to which the muscle is attached.

[3] ὦμος (ōmos) [Gr.], shoulder; ὑοειδής (hyœides) [Gr.], U-shaped.

which it is inserted in common with the sterno-hyoid muscle. In the cranial half or more of the neck the omo-hyoid muscle lies between the jugular vein and the common carotid artery.

The small nerve of the muscle, derived from the first cervical, should be sought a short distance from the hyoid attachment.

A. CAROTIS COMMUNIS.—As it lies ventral to the trachea at the entrance to the chest, the bicarotid trunk divides into the right and left common carotid[1] arteries. Each of these as it travels up the neck crosses the line of the trachea very obliquely, so that, while the artery at its commencement is ventral to the trachea, its termination is dorsal to this tube. While the right artery is in contact medially with the trachea, the left vessel is related also to the œsophagus.

Running along the dorsal border of each common carotid artery is the nerve cord formed by the vagus and the sympathetic, while along the ventral border is the recurrent nerve. Dorsally each artery is in contact with the longus colli and longus capitis muscles. The scalenus lies lateral to the artery in the lower part of the neck, and the omo-hyoid muscle is in a similar relation from the sixth (or fifth) cervical vertebra onwards. As has already been noted, caudal to the fifth cervical vertebra the carotid artery and the jugular vein lie together.

The right and left common carotid arteries end on the wall of the pharynx, about the level of the cricoid cartilage of the larynx, by dividing into the occipital and the internal and external carotid arteries.

The branches of the common carotid artery are as follows :—

(1) *Rami musculares.*—Branches of varying size supply the muscles ventral to the trachea, and the brachio-cephalic, longus colli, longus capitis and scalenus muscles.

(2) *Rami œsophagei* and *rami tracheales* supply the œsophagus and trachea respectively.

(3) Very small *rami lymphoglandulares* supply the middle group of cervical lymph glands.

(4) *A. parotidea.*—An artery of considerable size supplies the ventral part of the parotid gland.

(5) *A. thyreoidea (cranialis).*—The thyroid artery is the largest branch of the common carotid, from which it arises within a short distance of the termination of this vessel. The artery pursues a curved course round the cranial end of the thyroid gland, furnishing numerous branches from the concave side of the curve to the gland itself and the

[1] καρωτίς (carotis) [Gr.], from κάρος (caros), deep sleep. It is stated that the ancients believed that sleep was induced by an increased flow of blood through the arteries passing to the head.

adjacent muscles. From the convexity of the curve arise the *laryngeal* and *ascending pharyngeal arteries* (a. laryngea: a. pharyngea ascendens).

At this point it should be noted that the deep fascia of the neck forms a well-defined investment for the trachea, and a sheath for the common carotid artery and the nerves related thereto.

N. VAGUS ET TRUNCUS SYMPATHICUS.—The thick nerve-cord that lies dorsal to the common carotid artery has been formed underneath the parotid gland by the union of the vagus or tenth cerebral nerve and the sympathetic trunk. The two nerves separate at the entrance to the chest. With very little difficulty the dissector can resolve the common cord into a smaller, more dorsal portion—the sympathetic trunk—and a larger, ventral part—the vagus [1] nerve.

No branches leave either the vagus or the sympathetic in the region now being examined.

N. RECURRENS.—The recurrent nerve, a branch of the vagus, takes origin within the chest, which it leaves by following the ventral part of the lateral face of the trachea. In the neck the nerve runs along the ventral medial border of the common carotid artery to the larynx, where it terminates as the *caudal laryngeal nerve* (n. laryngeus caudalis), which will be examined later.

The right recurrent nerve is in contact medially with the trachea: the left nerve is similarly related to the œsophagus. In the neck each nerve supplies branches to the trachea (rami tracheales) and œsophagus (rami œsophagei).

LYMPH GLANDS.—Three more or less scattered groups of lymph glands are associated with the common carotid artery. The *cranial cervical lymph glands* (lymphoglandulæ cervicales craniales) lie in a groove between the trachea and œsophagus immediately caudal to the pharynx and underneath the caudal angle of the parotid gland. The group contains three or four glands. The *middle cervical lymph glands* (lymphoglandulæ cervicales mediæ) are very variable in size. Generally they are small, and it may be even impossible to find them during an ordinary dissection. When present they lie on the side of the trachea ventral to the common carotid artery about the middle of the neck. The *caudal cervical lymph glands* (lymphoglandulæ cervicales caudales) form a group of considerable size ventral to the trachea

[1] *Vagus* [L.], wandering, rambling. The nerve "wanders" from the head, down the neck and through the thorax into the abdomen.

at the entrance to the chest, where they are continuous with the cranial mediastinal glands of the thorax.

Associated with the cervical lymph glands there is a relatively large lymphatic vessel (*tracheal trunk*) on each side of the neck. This follows the common carotid artery across the lateral face of the trachea, and, on the right side of the body, can generally be followed to the caudal group of cervical glands. On the left it ends by joining the thoracic duct as this is entering the venous system.

Dissection.—In order to obtain a clear view of the trachea, cut across the common belly of the sterno-hyoid and sterno-thyroid muscles, and turn these aside.

THE TRACHEA.—The trachea[1] is a cartilaginous and membranous tube extending from the larynx (roughly from the level of the articulation between the atlas and the epistropheus) down the middle line of the neck and into the thorax, where it ends opposite the fifth or sixth intercostal space by dividing into the right and left bronchi. In the neck the tube is slightly flattened dorso-ventrally, the dorso-ventral diameter, in an animal of average size, being about 5 cm., while the transverse diameter is about 6 cm. The width of the tube, is, however, not quite uniform, as there is a certain amount of narrowing in the neighbourhood of the larynx as well as near the thoracic inlet.

The main relations of the trachea in the neck are as follows. At first the œsophagus is dorsal to the trachea, but later it passes towards the left, and the trachea then comes into contact with the longus colli muscle. On each side of the windpipe are the thyroid gland, the common carotid artery, the vagus, sympathetic and recurrent nerves, the lymph glands of the neck and the lymphatic vessels connected therewith, the omo-hyoid and scalene muscles, and, on the right side, the jugular vein. Ventral to the trachea are the sterno-cephalic, sterno-hyoid, and sterno-thyroid muscles.

The skeleton of the trachea consists of a variable number (48 to 55) of incomplete rings of cartilage (cartilagines tracheales) joined together by membranous and elastic ligaments (ligamenta annularia trachealia). The interruption in the continuity of each ring occurs in the dorsal part of the tube, where transverse muscular fibres (m. trachealis) occur. The first tracheal cartilage is joined to the cricoid cartilage of the larynx by the crico-tracheal ligament (ligamentum cricotracheale), in series with, but looser than, the annular ligaments.

The dissector should isolate one or two of the tracheal cartilages, when he will find that they are thickest (2-3mm.) and narrowest in the

[1] τραχεῖα (tracheia) [Gr.], rough (artery).

ventral part of the tube, and that they thin away dorsally where they are broader and occasionally divided. Generally the ends of the cartilage do not quite meet, though sometimes they may even overlap.

The interior of the trachea is lined by a smooth mucous membrane closely adherent to the cartilages, except along the dorsal wall, where it is loose.

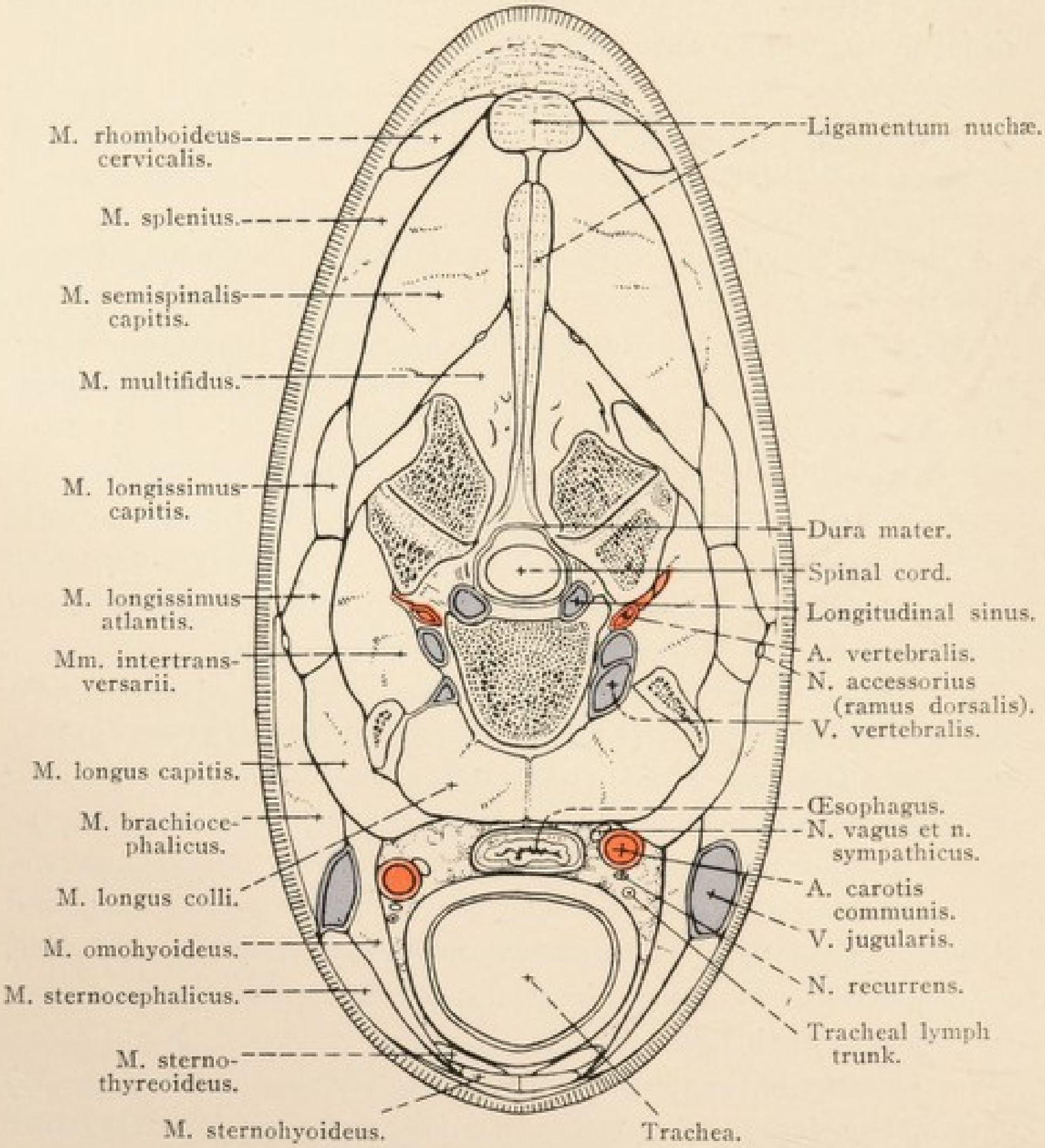


Fig. 2.—Transverse section of the neck at the level indicated by A in Fig. 1 ; looking forward.

The œsophagus.—The œsophagus,[1] a muscular and membranous tube 125-150 cm. in length, is that part of the alimentary canal which intervenes between the pharynx and the stomach. For descriptive purposes it is divided into cervical, thoracic and abdominal parts, with the first of which the present dissection is concerned.

[1] οἴσειν (oisein) [Gr.], to carry. φάγημα (phagema) [Gr.], food.

The cervical part (pars cervicalis) is at first in the middle line and immediately dorsal to the trachea, but an inclination towards the left soon becomes noticeable, and in the greater part of the neck the gullet is wholly to the left of the median plane. From the fourth or fifth cervical vertebra onwards it is directly to the left of the trachea.

At its origin, the œsophagus is related dorsally to the diverticulum of the auditory tube of Eustachius and the longus capitis and longus colli muscles. Ventrally it lies on the cricoid cartilage and the dorsal crico-arytenoid muscles; while laterally it is in contact with the common carotid artery and its associated nerves. On a level with the fifth cervical vertebra the gullet is dorsally related to the longus colli muscle, is in contact with the trachea medially, and has the left common carotid artery, the vagus, sympathetic, and recurrent nerves, and the omo-hyoid muscle as lateral relations. In the vicinity of the entrance to the chest, the left jugular vein lies along the lateral face of the œsophagus.

Some details of the structure of the œsophagus can be determined with the naked eye. If a transverse section of the tube be made, it will be evident that, like other tubular parts of the alimentary canal, its wall is constructed in layers. On the outside is a loose, adventitious, areolar covering (tunica adventitia) by which the œsophagus is connected with the surrounding structures. The interior is lined by a thick, pale mucous membrane (tunica mucosa), thrown into longitudinal folds when the tube is not distended. The mucous membrane is attached to the muscular layer of the wall by a loose submucous tissue (tela submucosa).

The greater proportion of the thickness of the wall is formed of muscular tissue (tunica muscularis), red in colour in the fresh state,[1] and with fibres running in various directions. Though the arrangement of the bundles of fibres is complicated, it is possible to distinguish three closely connected strata. On the outside there is a layer of longitudinal fibres most clearly marked towards the pharyngeal end of the tube, where they form bundles running along its lateral margins. Within the longitudinal stratum are two layers of oblique or spiral fibres.

It should be noted that at the commencement of the œsophagus two divergent bundles of muscular fibres are continued on to it from the region of the raphe of the pharynx; these are interlaced with fibres continued from the cricopharyngeal muscle. Two other small bundles are also associated with the beginning of the œsophagus. These spring from the cranial border of the cricoid cartilage and the depression

[1] The muscular tunic of the œsophagus consists of red, striated fibres as far as where the tube crosses the base of the heart.

between the cricoid and arytenoid laryngeal cartilages, and cross the lateral borders of the gullet.

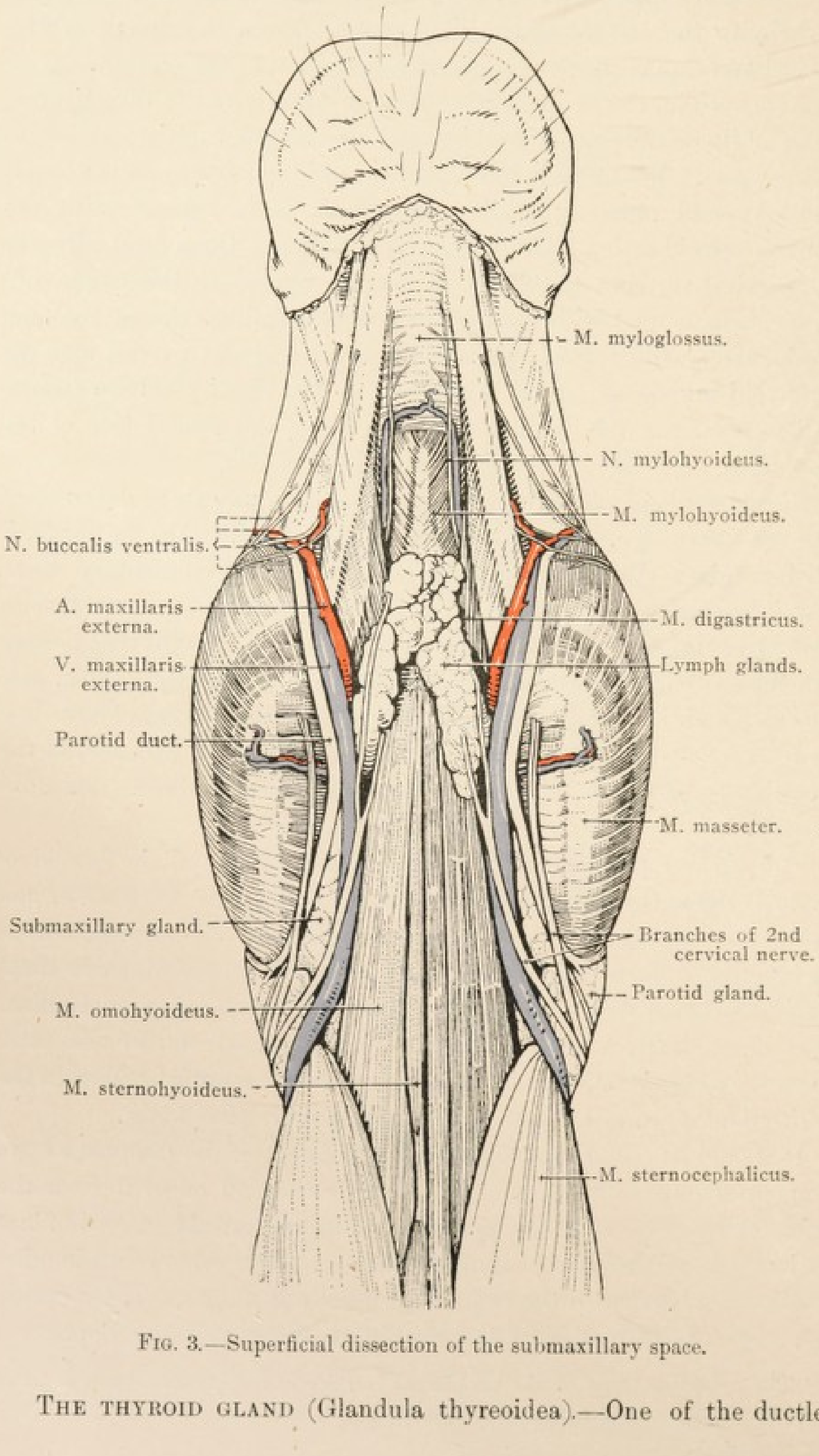


FIG. 3.—Superficial dissection of the submaxillary space.

THE THYROID GLAND (Glandula thyreoidea).—One of the ductless glands or endocrine organs, the thyroid[1] consists of two smooth, oval, reddish-brown *lateral lobes*, connected ventral to the trachea by an *isthmus*, which, in the adult horse, may be represented by a fibrous band only. The lateral lobes lie upon the first three or four tracheal cartilages, to which they are loosely attached, and are covered superficially by the caudal angle of the parotid gland and the sterno-cephalic and omo-hyoid muscles.

If an incision be made into the gland, the interior will be found to consist of granular tissue (composed of microscopic closed vesicles) from which a jelly-like *colloid* may be expressed. Surrounding the gland is a thin fibrous capsule.

It should be observed that, though the thyroid gland is not of large size, it is very richly supplied with blood by the thyroid artery.

The cranial cervical lymph glands are associated with the thyroid. Occasionally small masses of true thyroid tissue (accessory thyroids) may be found in the neighbourhood of the thyroid proper; and there is generally at least one small pale *parathyroid* either about the dorsal border of the lateral lobe or embedded in its deep face.

Dissection.—The dissector should now turn his attention to the elongated triangular interval bounded by the two halves of the mandible and a transverse line between the posterior border of the rami of this bone.

Begin the dissection by following the cutaneous nerves derived from the second cervical nerve. Then clean up a group of lymph glands that will be readily discovered in a groove formed by the muscles clothing the medial surface of the mandible and others attached to the hyoid bone.

The superficial nerves are twigs of the n. cutaneus colli, a branch of the second cervical, previously encountered during the dissection of the neck. They are generally two in number and follow the course of the external maxillary vein, with terminal filaments that can be traced as far as the symphysis of the mandible.

M. CUTANEUS.—Though the cutaneous muscle is readily demonstrated near the border of the mandible and over the parotid gland, it is so reduced nearer the middle line as to be practically absent.

The *submaxillary lymph glands* (lymphoglandulæ submaxillares) are grouped into an elongated mass, which occupies the groove bounded laterally by the digastric and pterygoid muscles and medially by the omo-hyoid, sterno-hyoid, and mylo-hyoid muscles. The right and left groups converge and become confluent in front. Superficially the glands are only covered by skin and a thin layer of fascia and cutaneous muscle.

[1] θυρεός (thyreos) [Gr.], shield, εἶδος (eidos) [Gr.], form. From the shield-like shape of the gland in the human subject.

Dissection.—The lymph glands must be removed so that the external maxillary vessels and the duct of the parotid gland may be adequately exposed.

V. MAXILLARIS EXTERNA.—The external maxillary vein is a continuation of the facial and begins at the margin of the mandible on a level with the anterior border of the masseter muscle. It runs backwards in the groove between the digastric and internal pterygoid muscles, then along the lower border of the submaxillary and parotid glands, and finally forms one of the two radicles of the jugular vein at the posterior ventral angle of the parotid.

The tributary veins that join the external maxillary are :—

(1) *V. sublingualis.*—The sublingual vein, a satellite of the artery of the same name, may join the lingual vein instead of uniting with the external maxillary directly.

(2) *V. lingualis.*—The lingual vein joins the external maxillary about the point where this vessel first comes into contact with the submaxillary gland.

(3) *Vv. glandulæ submaxillaris.*—From the submaxillary gland.

(4) *Rami musculares.*—From the omo-hyoid and sterno-hyoid muscles.

A. MAXILLARIS EXTERNA.—The external maxillary artery appears in the present dissection from the cleft between the omo-hyoid and internal pterygoid muscles at the anterior end of the submaxillary gland. In the region now being examined the artery follows the dorsal border of the vein of the same name, and curves over the edge of the mandible to gain the face, where it becomes the facial artery.

The only named branch from this part of the external maxillary is the *sublingual artery* (a. sublingualis), which is detached about the end of the submaxillary gland. It follows the dorsal border of the digastric muscle and disappears by piercing the mylo-hyoid muscle on a level with the third or fourth cheek-tooth, to end in the mucous membrane of the floor of the mouth. At or about the point at which the artery passes through the muscle, it gives off a very small *submental*[1] *artery* (a. submentalis) that supplies the mylo-glossal muscle and the skin about the symphysis of the mandible.

THE PAROTID DUCT (Ductus parotideus).[2]—The duct of the parotid is formed by the union of radicles at the anterior ventral angle of the gland and enters the present dissection by crossing the flattened tendon of insertion of the sterno-cephalic muscle. It then runs for a short

[1] *Sub* [L.], beneath. *Mentum* [L.], the chin.

[2] Often designated Stensen's or Steno's duct.

distance parallel to the external maxillary vein on the surface of the internal pterygoid muscle, but soon the duct and vein come into contact: the duct being ventral to the vein, and the vein ventral to the external maxillary artery. The three structures maintain this relative position as they turn round the margin of the mandible.

The termination of the parotid duct will be examined in connection with the cheek.

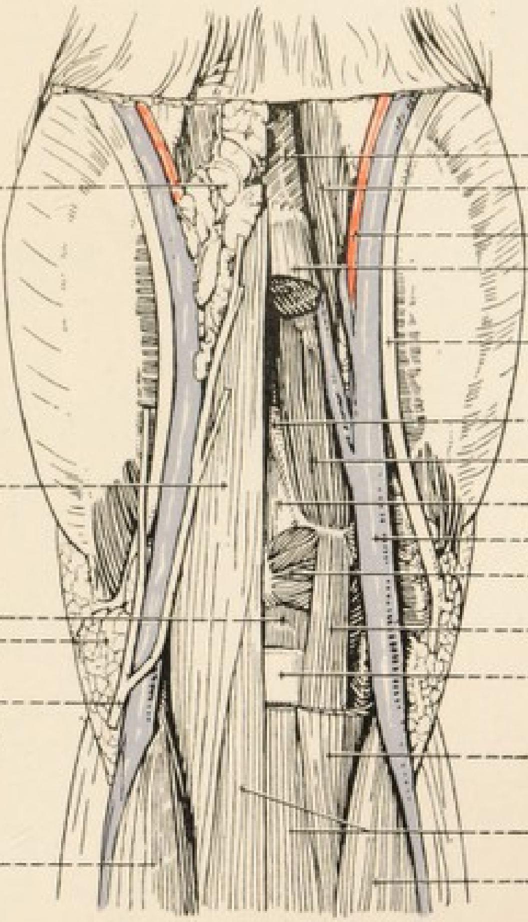


FIG. 4.—Dissection of the laryngeal region. First (left) and second (right) stages.

M. DIGASTRICUS.—As its name indicates, the digastric[1] muscle possesses two fleshy bellies joined by an intermediate tendon. At the present time it is possible to see the strong anterior belly only. This is inserted to the medial surface of the mandible close to the lower border of the molar part of this bone.

M. MYLOGLOSSUS.—The pale, thin mylo-glossal[2] muscle consists of transverse fibres springing from the medial surface of the mandible, close to the alveolar border, from the symphysis to the third or fourth

[1] δίς (dis) [Gr.], double. γαστήρ (gaster) [Gr.], belly.

[2] μύλη (myle) [Gr.], a mill; referring to the cheek teeth. γλῶσσα (glossa) [Gr.], the tongue.

cheek-tooth.[1] The fibres of the right and left muscles meet in the middle line.

M. MYLOHYOIDEUS.—The mylo-hyoid[2] muscle has a darker colour than that of the foregoing, behind which it is situated. Its origin is from the feeble mylo-hyoid line on the medial surface of the mandible, and its fibres meet in the middle line at a raphe that extends from the mandibular symphysis to the hyoid bone. Posteriorly the mylo-hyoid muscle is connected with the body, glossal process, and thyroid cornu of the hyoid bone.

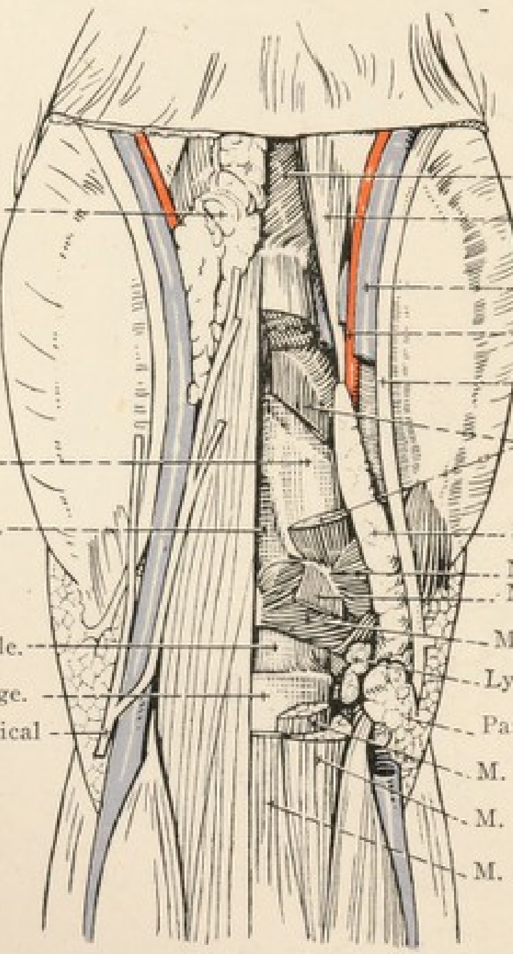


FIG. 5.—Dissection of the laryngeal region. First (left) and third (right) stages.

The mylo-glossal and mylo-hyoid form a muscular hammock in which the tongue rests.

N. MYLOHYOIDEUS.—The mylo-hyoid nerve is derived from the mandibular—a division of the fifth cerebral nerve—and is concerned in the supply of the mylo-hyoid and mylo-glossal muscles and the anterior belly of the digastricus. It becomes superficial between the digastric and mylo-hyoid muscles, and can be followed forwards to the symphysis

[1] The degree of development of the mylo-glossal muscle is very variable.
[2] μύλη (myle) [Gr.], a mill ; ὑοειδής (hyœides) [Gr.], U-shaped.

of the mandible. Traced backwards, it will be found to pursue an oblique course between the mandible and the mylo-hyoid muscle. The terminal part of its course is related to the submental artery.

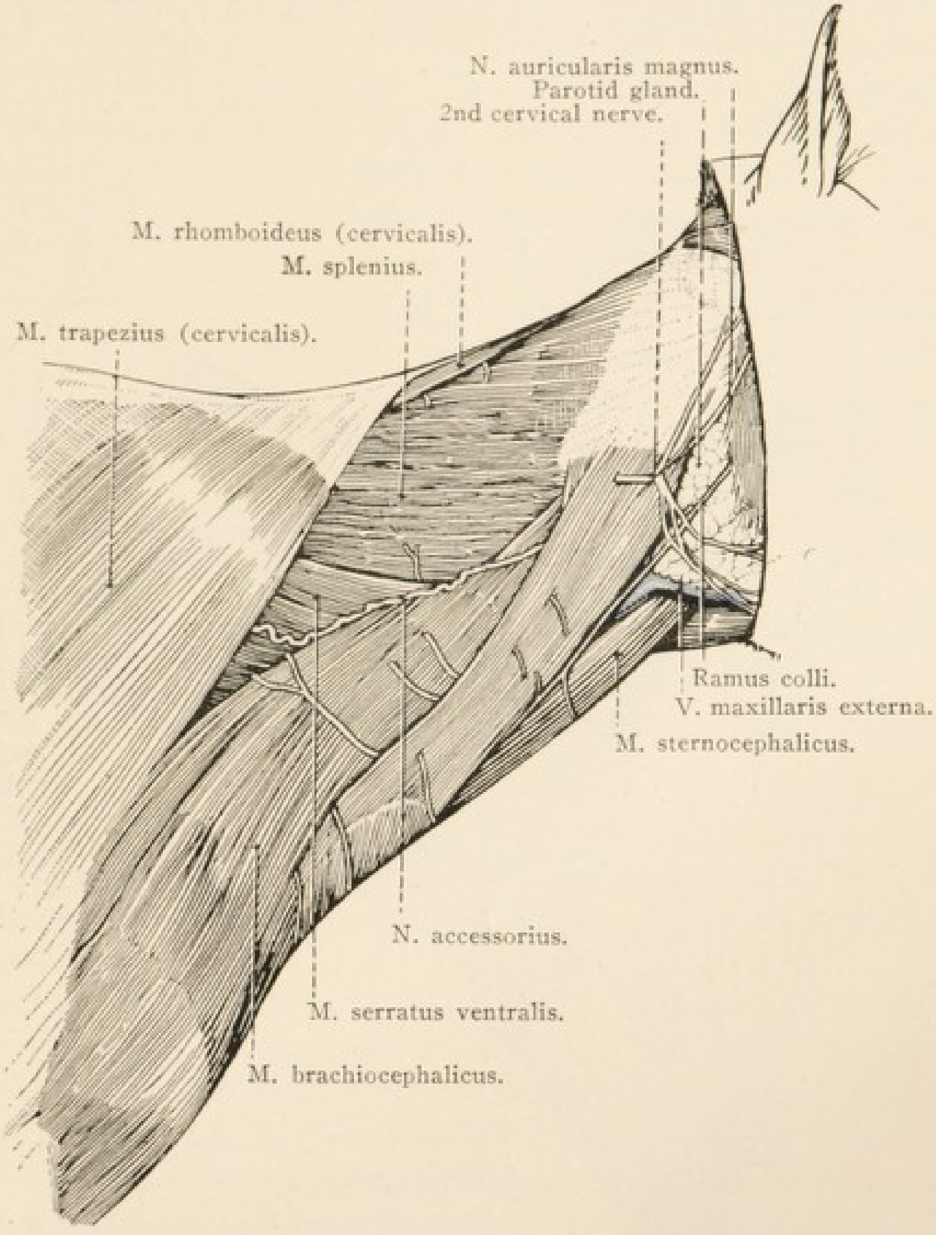


FIG. 6.—Dissection of the lateral aspect of the neck. First stage.

Dissection.—The skin must now be removed from the whole of the side of the neck. During the process a series of cutaneous nerves will be observed piercing the brachio-cephalic muscle at fairly regular intervals. These are derived from the ventral primary branches of the cervical nerves, from the second to the sixth inclusive. Other cutaneous nerves, also in series, appear nearer the mid-dorsal line of the neck. These are rami from the dorsal primary branches of the spinal nerves.

As early as possible the accessory nerve should be secured. This nerve is of some size and there will be little difficulty in finding it at the dorsal border of the brachio-cephalic muscle about the middle of the neck.

The examination of the cervical part of the trapezius and rhomboid muscles should be conducted by the dissectors of the head and neck and those of the thoracic limb working together.

M. TRAPEZIUS CERVICALIS.—The cervical part of the trapezius[1] muscle forms a thin, pale, triangular sheet with an origin from the ligamentum nuchæ, extending from the third thoracic vertebra to the level of the epistropheus. Its insertion is partly to the spine of the

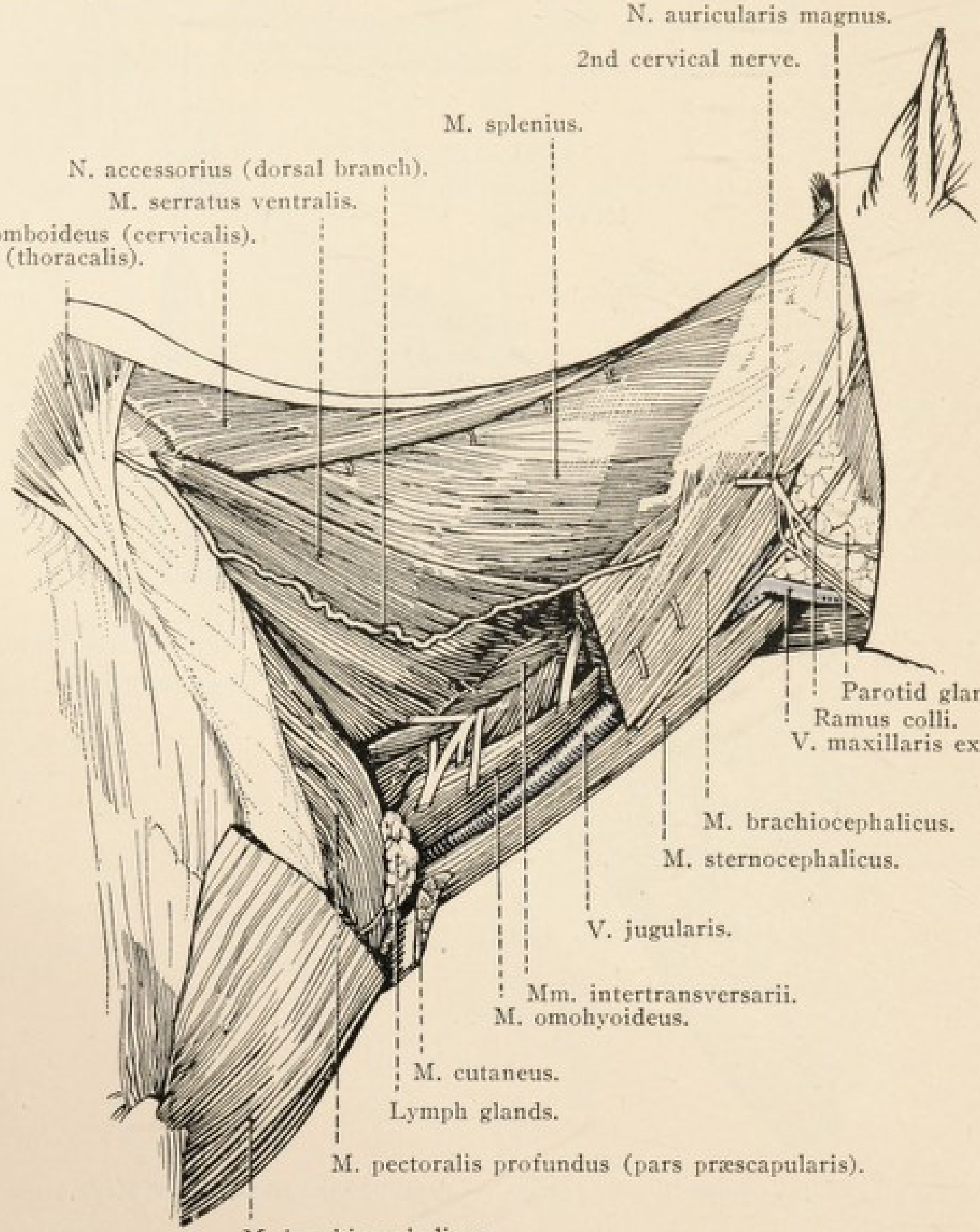


FIG. 7.—Dissection of the lateral aspect of the neck. Second stage.

scapula and partly to the scapular fascia. To clean the surface of the trapezius is a tedious task because of the firm adhesion of the cervical fascia, the fibres of which run at right angles to the direction of the fibres of the muscle.

The ventral border of the trapezius is adherent to and may slightly overlap the border of the brachio-cephalic muscle.

[1] *Trapezium* [L.], from τραπέζιον (trapezion) [Gr.], a small table; from the four-sided outline of the muscles of the two sides of the body taken together.

Dissection.—The trapezius muscle should be reflected after an incision has been made through it close to its origin from the ligamentum nuchæ.

N. ACCESSORIUS.—At a later stage in the dissection it will be found that the accessory or eleventh cerebral nerve divides into two branches ventral to the wing of the atlas. The *ramus ventralis* has already been seen to enter the sterno-cephalic muscle not far from its tendon of insertion. The *ramus dorsalis*, now being investigated, receives branches from the second and third cervical nerves in its course along the neck under cover of the brachio-cephalic muscle. It reaches the dorsal border of this muscle and travels along it for a short distance. Covered by the cervical part of the trapezius, the ramus pursues a wavy course over the ventral serrate (cervical part), deep pectoral (prescapular part) and supraspinous muscles, to end in the thoracic part of the trapezius.

M. RHOMBOIDEUS CERVICALIS.—The rounded cervical rhomboid[1] muscle arises, by short bundles of tendinous fibres, from the ligamentum nuchæ from the level of the second cervical to the second thoracic vertebra. It has a thin, narrow, pointed extremity opposite the epistropheus and increases in volume as its insertion to the medial surface of the scapular cartilage is approached.

M. BRACHIOCEPHALICUS.—It is generally accepted that the sterno-cleido-mastoid muscle of man is represented in the horse by two distinct muscles—the sterno-cephalic, already examined, and the brachio-cephalic.

Owing to degeneration of the clavicle, the clavicular part of the deltoid muscle of the human body is moreover represented in that part of the horse's brachio-cephalic[2] that extends from the level of the shoulder joint to the humeral attachment of the muscle. In this connection it should be noted that it is generally possible to find the trace of a transverse tendinous intersection, representing the clavicle, in the brachio-cephalic muscle opposite the shoulder joint.

The fact that the accessory nerve supplies the sterno-cephalic and a part of the brachio-cephalic, and that the axillary nerve supplies the humeral end of the brachio-cephalic, lends support to the view stated above.

The brachio-cephalic muscle has attachments to the ridge forming the lateral boundary of the groove on the humerus, the fascia of the arm, the transverse processes of the second, third and fourth cervical

[1] *Rhombus* [L.], ῥόμβος (rhombos) [Gr.], a rhomb. εἶδος (eidos) [Gr.], form.

[2] *Brachium* [L.], βραχίων (brachiōn) [Gr.], the arm above the elbow. *Cephalicus* [L.], κεφαλικός (cephalicos) [Gr.], pertaining to the head (κεφαλή).

vertebræ, the border of the wing of the atlas, and, by a thin aponeurotic tendon, to the mastoid portion of the temporal bone and the superior nuchal line of the occipital.

The superficial face of the muscle is cleaned with some degree of difficulty because of the close adhesion to it of the cervical fascia and the cutaneous muscle; and its deep face is adherent to the omo-hyoid muscle. The thin temporal and occipital tendon is fused with the splenius and longissimus capitis, and is connected with the tendon of insertion of the sterno-cephalic muscle by an aponeurotic sheet.

When the surface of the muscle has been divested of fascia, an imperfect division into two parts along a line indicated by the superficial rami of the ventral branches of the cervical nerves may be determined. The cleido-mastoid part (m. cleidomastoideus), attached to the temporal and occipital bones, partly overlaps the rest of the muscle (m. cleidotransversarius).

Dissection.—The brachio-cephalic muscle should be cut across at the shoulder joint and turned aside. Its close adhesion to the underlying omo-hyoid muscle renders the reflection somewhat difficult.

The *superficial cervical lymph glands* (lymphoglandulæ cervicales superficiales) occupy a triangular space bounded by the brachio-cephalic, omo-hyoid and deep pectoral muscles. They frequently reach and appear to blend with the caudal cervical glands.

A. CERVICALIS ASCENDENS.—The ascending cervical[1] artery is one of the two divisions of the omo-cervical trunk. It crosses the lateral face of the jugular vein, is related for a short distance to the border of the prescapular part of the deep pectoral muscle and the superficial cervical lymph glands, and then runs between the omo-hyoid and brachio-cephalic muscles.

M. SERRATUS VENTRALIS (CERVICIS).—Though the ventral serrate[2] muscle belongs, strictly speaking, to the thoracic limb, the dissector of the neck should examine its attachment to the transverse processes of the last four (or five) cervical vertebræ. This having been done, the remains of the muscle should be removed.

M. SPLENIUS.—The thin triangular splenius[3] muscle arises by an aponeurotic tendon from the spinous processes of the second, third and fourth thoracic vertebræ, where it is confused with the origin of the dorsal serratus muscle, and from the ligamentum nuchæ. It has fleshy insertions into the transverse processes of the fifth, fourth and third (sometimes second) cervical vertebræ. Some of its fibres blend with

1 *Cervicalis* [L.], pertaining to the neck (*cervix*).

2 *Serratus* (from *serra*, a saw) [L.], toothed or notched like the edge of a saw.

3 σπληνίον (splenion) [Gr.], a bandage.

the longissimus atlantis muscle and thus obtain insertion into the wing of the atlas. The rest of its insertion is by an aponeurotic tendon which blends with the longissimus capitis and brachio-cephalic muscles,

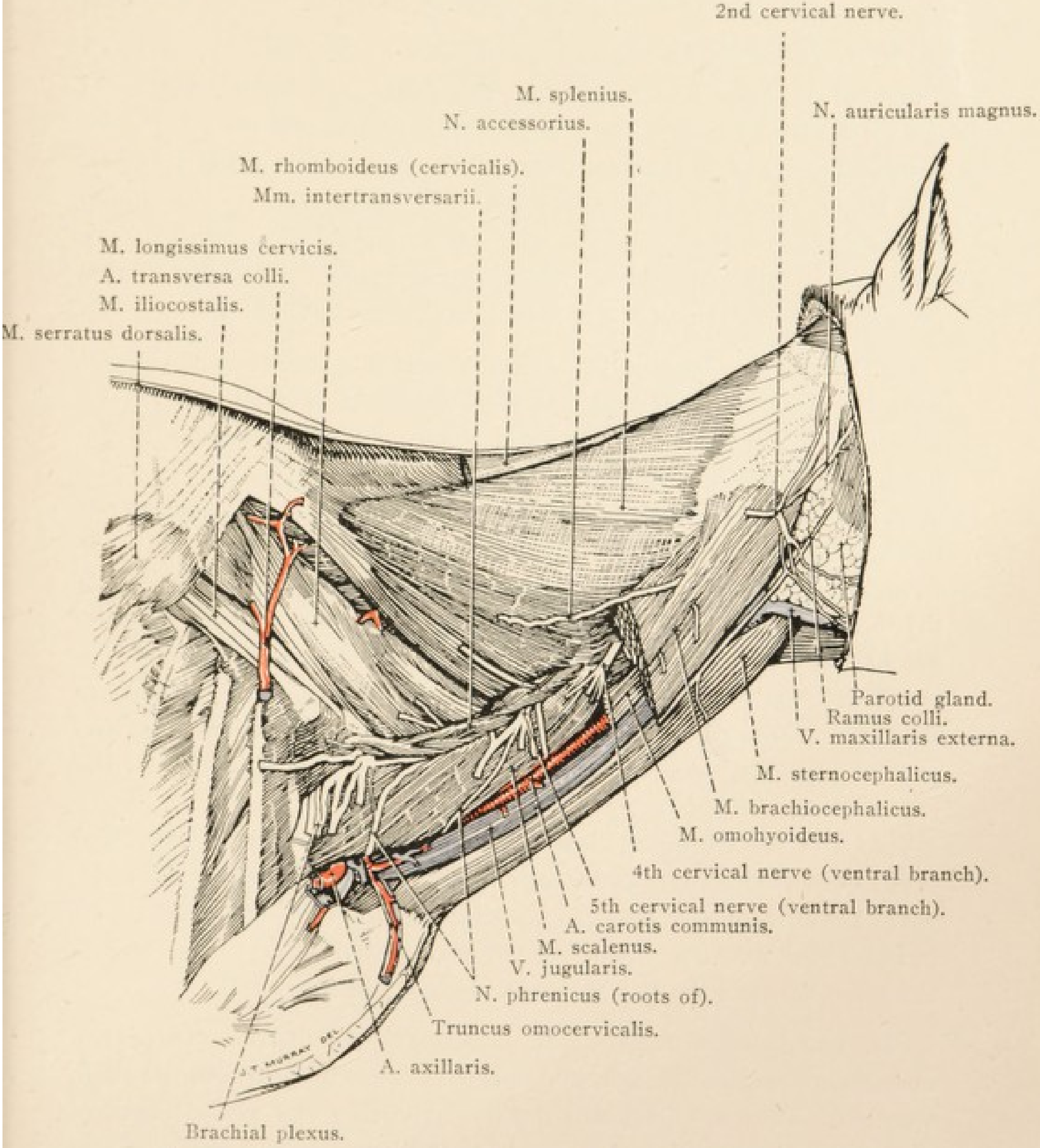


FIG. 8.—Dissection of the lateral aspect of the neck. Third stage.

and thus finds attachment to the superior nuchal line of the occipital bone and the mastoid part of the temporal.

Dissection.—Make a transverse incision through the splenius about the middle of the neck and a longitudinal incision close to the ligamentum nuchæ. Then turn the two portions of the muscle downwards.

M. LONGISSIMUS CERVICIS.—This muscle is ventral to the foregoing

—by which it is partly overlapped—and appears to be the direct continuation of the longissimus dorsi. It arises from the transverse processes of the first six or seven thoracic vertebræ, and ends on the transverse processes of the last four cervical vertebræ.

M. SCALENUS.—The brachial plexus of nerves divides the scalene [1] muscle of the horse into two parts. The dorsal and smaller portion of the muscle is attached to the cranial border of the first rib close to its vertebral end, and to the transverse process of the last cervical vertebra. The larger, ventral portion arises from the rough area on the cranial border and outer surface of the first rib proximal to a smooth groove produced by the subclavian vessels, and is inserted to the transverse processes of the sixth, fifth and fourth cervical vertebræ.

N. CERVICALIS SECUNDUS.—The present is a convenient time at which to examine the ventral branch of the second cervical nerve. The nerve appears at the lateral border of the caudal oblique muscle of the head. Underneath the brachio-cephalic muscle it communicates by anastomotic branches with the accessory nerve and with the ventral branches of the first and third cervical nerves, and is concerned in the formation of the nerve that has been noted as supplying the sterno-thyro-hyoid muscle. It then emerges between the two parts of the brachio-cephalic muscle and immediately divides into two branches.

(1) The *great auricular nerve* (n. auricularis magnus) follows the edge of the wing of the atlas and the contiguous border of the parotid gland, and ends in the skin covering the convex surface of the external ear.

(2) The *cutaneous cervical nerve* (n. cutaneus colli) is connected with the ramus colli of the seventh cerebral nerve, and the combined nerve has already been found in association with the jugular vein. As has also been noted, a part of the cutaneous cervical nerve passes into the space between the two halves of the mandible.

M. LONGISSIMUS CAPITIS. M. LONGISSIMUS ATLANTIS.—These two muscles are readily distinguished, but it is convenient to consider them together. They are long and narrow, extending the whole length of the neck, and lie medial to the splenius and longissimus cervicis. They arise in common from the transverse processes of the first two thoracic vertebræ by aponeurotic tendinous bands that are connected with the underlying semispinalis capitis muscle, and receive additional bundles of fibres from the articular processes of the last five (or six) cervical vertebræ.

[1] *Scalenus* [L.], σκαληνός (scalenos) [Gr.], uneven. The outline of the muscle is a triangle with unequal sides.

The more ventral of the two muscles, *m. longissimus atlantis*, ends in a strong tendon that joins the flattened tendon common to the brachiocephalic and splenius muscles, and is thus inserted to the wing of the atlas.

The *longissimus capitis muscle* is inserted into the mastoid part of the temporal bone in common with the splenius.

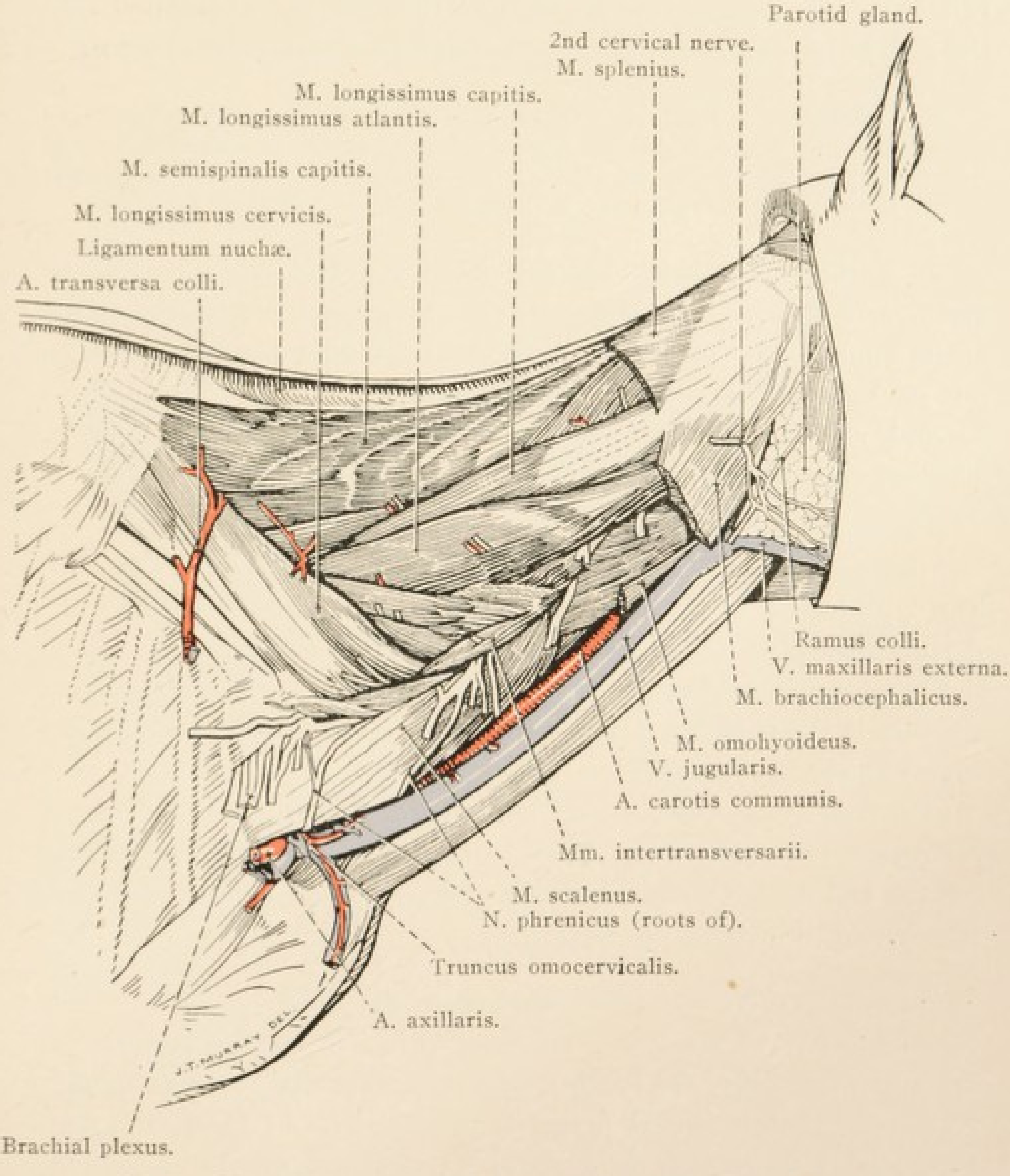


FIG. 9.—Dissection of the lateral aspect of the neck. Fourth stage.

M. SEMISPINALIS CAPITIS.[1]—Covered by the thin splenius muscle,

[1] In animals like the dog, the semispinalis capitis muscle is readily separated into two parts :—(1) *M. biventer cervicis*, the more dorsal in position, marked by tendinous intersections ; and (2) *M. complexus*. The common practice of referring to the semispinalis capitis of the horse as the "complexus" is, therefore, not without objection.

the semispinalis capitis will be easily recognised by its great size and strength and by the fact that it is crossed obliquely by four or five tendinous intersections. The origin of the muscle is from the spinous processes of the second, third and fourth thoracic vertebræ (in common with the splenius), the transverse processes of the first six or seven thoracic and the articular processes of the last five or six cervical vertebræ. A strong tendon begins over the atlas and is inserted into the occipital bone close to the attachment of the ligamentum nuchæ.

Dissection.—Make a transverse incision through the semispinalis capitis about the middle of the neck, and sever its origin from the thoracic spinous processes. This will allow the two parts of the muscle to be turned downwards, and will expose certain underlying muscles.

M. SPINALIS (ET SEMISPINALIS) CERVICIS.—The origin (from the first four thoracic spinous processes) and the greater part of the extent of the spinalis dorsi et cervicis belongs to the dissector of the thorax, but its insertion into the spinous processes of the last four or five cervical vertebræ should be examined during the present dissection. This insertion lies medial to the semispinalis capitis.

The dorsal branches of the cervical nerves from the third to the eighth should be examined before any further dissection is conducted. The branches of the third, fourth, fifth and sixth nerves form the *dorsal cervical plexus*, which lies between the semispinalis capitis and the ligamentum nuchæ. From this plexus cutaneous nerves pass to the skin in the neighbourhood of the mid-dorsal line. Other filaments supply the adjacent muscles.

The relatively small dorsal branches of the seventh and eighth cervical nerves pass in a dorsal direction between the multifidus cervicis and the longissimus cervicis, and end in the cervical rhomboid muscle and the superjacent skin.

M. MULTIFIDUS CERVICIS.—The multifidus[1] muscle of the neck consists of five or six strong bundles arising in succession from the articular processes of the last four or five cervical and the first thoracic vertebræ. Each bundle is divisible into two sets of fibres, the more superficial of which pass obliquely in a cranial and medial direction to be inserted into the spinous process of a cervical vertebra. The deeper fibres are shorter in length and straighter in direction and are inserted into the articular process of a vertebra. The last bundle is inserted into the spinous process of the epistropheus.

[1] *Multifidus* (from *multus*, many + *findere*, to cleave or split), [L.], cleft or divided into many parts.

MM. INTERTRANSVERSARII (CERVICIS).—The six intertransverse muscles of the neck consist of dorsal and ventral bundles, the dorsal of which fill the intervals between the transverse process of one vertebra and the articular process of the next. The ventral bundles run between the transverse processes of neighbouring vertebræ.

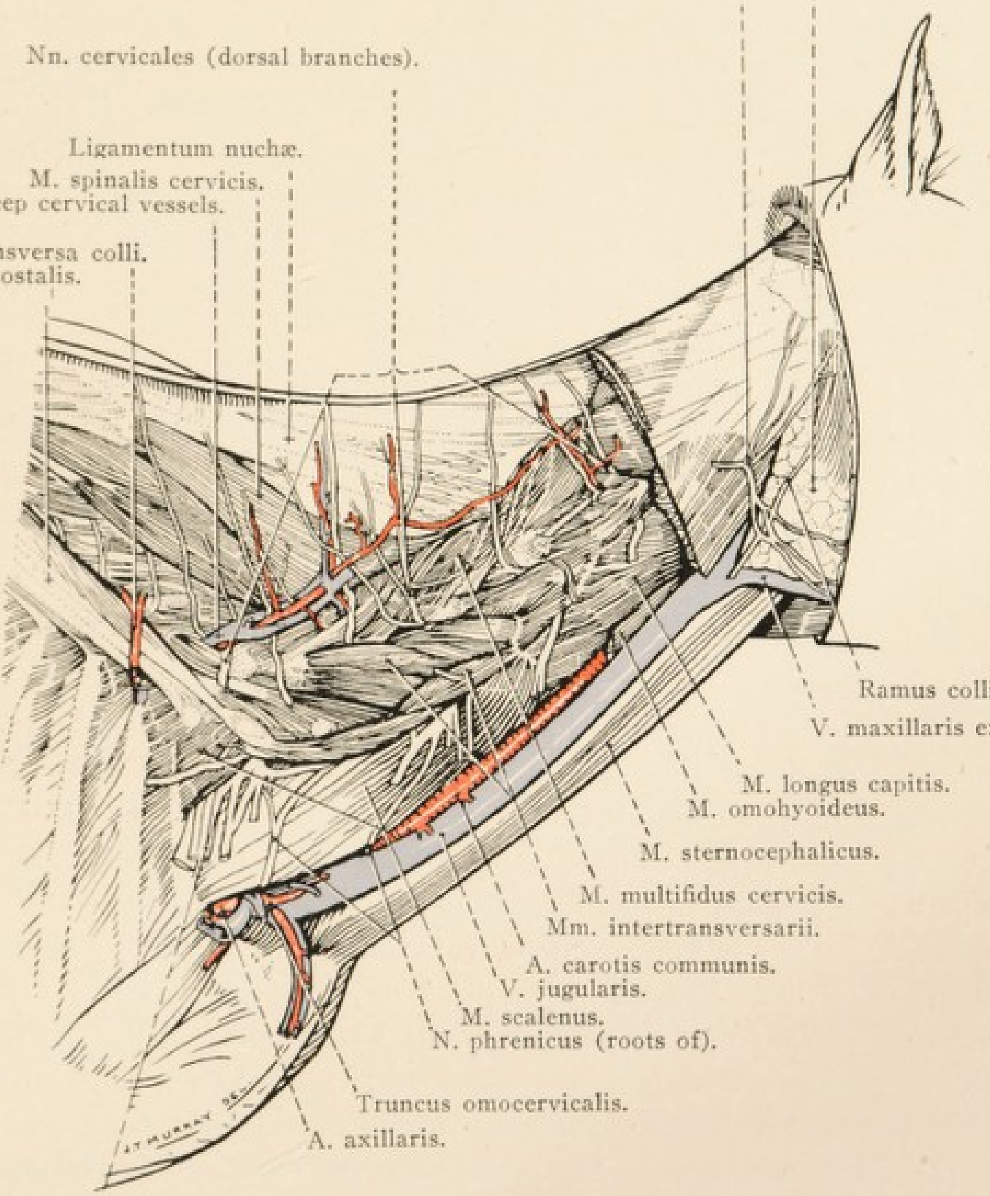


FIG. 10.—Dissection of the lateral aspect of the neck. Fifth stage.

A. CERVICALIS PROFUNDA.—The deep cervical artery of the left side of the body is a branch of the left subclavian, while the corresponding vessel of the right side springs from the costo-cervical trunk. Whichever its origin, the artery leaves the thorax by piercing the vertebral end of the first intercostal space, and sends an ascending ramus (ramus ascendens) up the neck. This ramus will be found on the deep face of the semispinalis capitis, that is, between this muscle and the ligamentum nuchæ and spinalis cervicis, and should be traceable as far as the second cervical vertebra, where it anastomoses with a branch of the occipital artery. Twigs from it join branches of the vertebral artery.

LIGAMENTUM NUCHÆ. The powerful, yellow, elastic ligament of the nape of the neck performs the function of assistant to the muscles that raise the head, and is readily divided into two parts. (1) *Pars occipitalis.*[1] — A strong, cord-like band passes from the external occipital protuberance and a shallow depression lateral thereto, to the extremity of the spinous process of the fourth thoracic vertebra, where, without any definite demarcation, it is directly continuous with the supraspinal ligament of the thoracic region of the vertebral column. With a reasonable amount of care, the dissector may satisfy himself that this portion of the ligament consists of right and left bands firmly joined together; the double character being most obvious in the upper part of the neck. Beyond the fifth cervical vertebra the two halves fuse more and more completely as they run towards the thoracic attachment of the ligament. Here, that is, at the "withers," lateral wing-like extensions of the ligament are produced and cover the surface of the trapezius and rhomboid muscles.

The dissector should notice that this part of the ligamentum nuchæ is separated from the skin from which the mane grows by a quantity of dense, elastic, fibrous and fatty tissue. He should also note the occurrence and extent of two synovial bursæ that are of importance because of their possible involvement in pathological processes. One of them occurs between the ligament and the atlas;[2] the other, of variable size, lies between the ligament and the extremity of the third (possibly also the second and fourth) thoracic spinous process. Occasionally a third bursa may be found over the spinous process of the second cervical vertebra.

(2) *Pars cervicalis.*[3]—A double reticular sheet of elastic fibres fills the triangular interval between the preceding part of the ligament and the vertebral column. As their union is by loose tissue only, the right and left halves of the sheet are easily separated. The sheet forming this part of the ligament is more complete in that portion of it that is nearer the head. As the thorax is approached the gaps in the network become larger, and the bundles of fibres

[1] Frequently termed the *funicular part* of the ligament.

[2] The occurrence and degree of development of this bursa is not constant.

[3] The so-called *lamellar part* of the ligament.

weaker. The fibres composing the pars cervicalis are attached to the occipital part of the ligament and to the spinous processes of the second and third thoracic vertebræ. Passing in a cranial and ventral direction with a varying degree of obliquity, they join the spinous processes of the last six cervical and the first thoracic vertebræ.

Dissection.—In order that the head and neck may be detached from the rest of the body, a preliminary examination of the longus colli muscle and the vertebral vessels should now be made. To expose the vertebral artery and vein the last two or three intertransverse muscles must be removed.

At the present time no attempt should be made to follow the entire course of the vertebral artery, or to disclose the final insertion of the longus colli muscle.

M. LONGUS COLLI.—This muscle is divisible into two parts and one of them belongs to the thorax, but it is well that the dissector of the neck should examine the whole of the muscle.

(1) *Pars thoracalis.*—The thoracic part arises from the lateral surface of the bodies of the first five or six thoracic vertebræ, and is inserted by tendon into the transverse processes of the last two cervical vertebræ. A synovial bursa is generally present between the tendon and the junction of the last cervical and first thoracic vertebræ.

(2) *Pars cervicalis.*—The cervical part of the longus colli consists of bundles of fibres taking origin from the transverse processes and bodies of the seventh, sixth, fifth, fourth and third cervical vertebræ. Each bundle passes in an oblique medial and cranial direction to be inserted into the mid-ventral ridge of the vertebra preceding that from which it arose. Sometimes the fibres pass over an entire vertebra before finding insertion. The final insertion to the ventral tubercle of the atlas can best be displayed at a later stage of the dissection.

A. VERTEBRALIS.—The vertebral artery begins within the thorax as a branch of the subclavian. It leaves the chest medial to the scalenus muscle, passes ventral to the transverse process of the seventh cervical vertebra, and enters the transverse foramen of the sixth vertebra. It traverses the transverse foramina of the cervical vertebræ up to and including the second, and ends by anastomosing with a branch of the occipital artery.

Between neighbouring transverse processes, the artery lies on the vertebræ underneath the intertransverse muscles. In its course up the neck it furnishes spinal and muscular branches. *Rami spinales* enter the intervertebral foramina and anastomose with the ventral artery of the spinal cord. *Rami musculares* may be grouped into a dorsal and a ventral set. The dorsal rami supply those muscles that lie along the dorsal aspect of the vertebral column, and anastomose with branches of the deep cervical artery. The ventral rami supply the scalenus, longus colli, longus capitis, and intertransverse muscles.

The vertebral vein follows the ventral border of the artery.

Accompanying the vertebral vessels through the transverse foramina is a nerve formed by the union of filaments (rami communicantes) from the second to the sixth spinal nerves. It joins the first thoracic sympathetic ganglion.

Dissection.—Subsequent dissection will be facilitated if the head and neck be now detached from the rest of the body by disarticulation between the fifth and sixth cervical vertebræ.

Before any further dissection is carried out, the external ear, as it is in the living animal, should be examined.

THE EXTERNAL EAR (Auris externa).—The freely movable *auricula* or *pinna*,[1] by which sound waves are collected, has a broad base, connected with the external acoustic meatus of the temporal bone, resting upon a bed of adipose tissue, the presence of which is an important factor in mobility. Its free extremity or apex is pointed, flattened, and gently curved so as to point forwards when the opening of the ear is directed lateralwards. The dorsum of the ear is markedly convex where it joins the head, but becomes flattened as the apex is approached. The concave surface is the counterpart of the dorsum, but carries several ridges that interrupt the smoothness of the wall of the cavity. The anterior boundary of the opening of the ear is mainly convex, though it has a shallow concavity near the apex. The lower part of this border splits into two *crura helicis*. The posterior border of the pinna is convex.

Dissection.—The skin is now to be removed from the whole of the ear and the parotid region, in order that the auricular muscles, vessels, and nerves may be examined. But before the dissector proceeds to a detailed examination of the muscles, it is well that he make himself acquainted with the form and disposition of the cartilages to which they are attached and upon which they act.

The cartilages of the ear.—The cartilages of the external ear are three in number—conchal, scutular, and annular. The *conchal*[2] *cartilage*, or cartilago auriculæ, is the largest, and forms the basis and determines the shape of the projecting, conspicuous part of the ear of the living animal. It may be said to be funnel-like or

[1] *Auricula* [L.], the external ear. *Pinna* [L.], a wing.
[2] *Concha* [L.], a shell.

trumpet-shaped, with a large, oblique, elliptical opening bounded by two free margins that meet at an angle at the apex of the pinna. The cavity within the cartilage is at first of considerable spaciousness, but, where the cartilage rests on the temporal muscle, a sudden narrowing takes place, so that the deeper part forms a short and relatively narrow tube. The lower part of the anterior free border splits into two parts that form the foundation of the crura helicis of the undissected ear. The anterior of these ends above in a pointed *spina helicis*,[1] while the posterior is the *crista helicis*. In the lower part of the posterior border there is a notch (*incisura intertragica*) that separates a small projection, the *antitragus*, from a much more

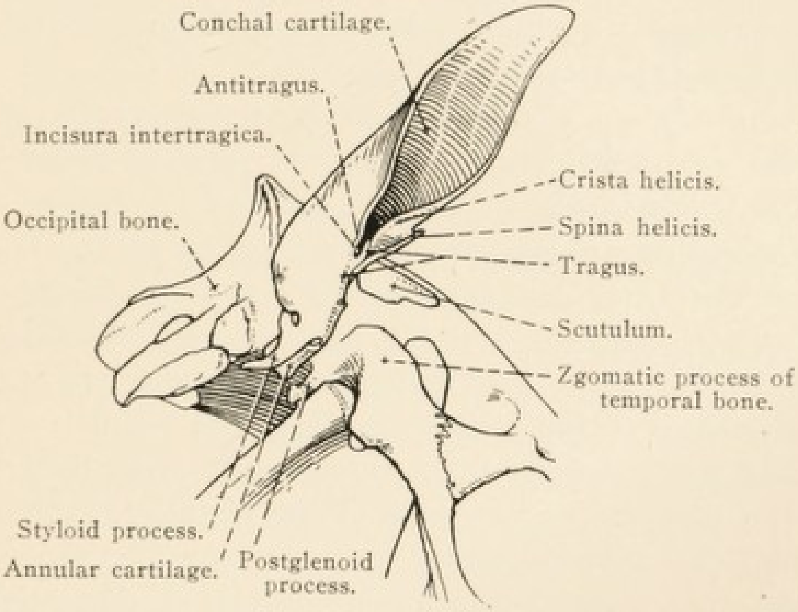


FIG. 11.—The cartilages of the ear.

definite and plate-like *tragus*.[2] From the lateral part of the deep extremity of the conchal cartilage there projects a narrow pointed styloid process. This overlies the annular cartilage, and is connected with the wall of the diverticulum of the Eustachian tube by a short band of fibrous tissue. Behind its root there is a foramen by which the auricular branch of the vagus nerve gains the interior.

The *scutular cartilage* (scutulum)[3] is a thin, curved plate, of irregularly triangular outline, lying upon the temporal muscle anterior to the broad base of the conchal cartilage.

The *annular cartilage* is in the form of a ring, incomplete medially where its borders are connected by elastic tissue. It is adherent to the margin of the external acoustic meatus of the

[1] ἕλιξ (helix) [Gr.], a coil.

[2] τράγος (tragos) [Gr.], a goat (in allusion to the hairs growing on the tragus of the human ear).

[3] *Scutulum* (dim. of *scutum*) [L.], a shield.

temporal bone, and forms a continuation of the narrower part of the conchal cartilage.

The Muscles of the Ear.

M. scutularis.—The thin scutular muscle, which lies immediately underneath the skin, is divisible into two parts. (1) The *fronto-scutular muscle* (m. frontoscutularis) consists of two bands, one of which springs from the zygomatic arch, the other from the external frontal crest of the frontal bone. (2) The *interscutular muscle* (m. interscutularis) arises from the external sagittal crest and the superior nuchal line.[1] Some of the fibres of the two interscutular muscles are continuous across the middle line.

The insertion of the scutular muscle is into the anterior, lateral and medial borders of the scutular cartilage.

Mm. auriculares anteriores.—Four short muscles, arranged about the anterior and medial part of the ear, are generally included in the group of anterior auricular or adductor muscles. Beginning with the most anterior, they are arranged in the following order. (1) A thin flat muscle arises from the zygomatic arch and the fascia over the adjacent part of the parotid, and is inserted into the concha not far from the tragus. (2) A short muscular band takes origin from the superficial surface of the scutular cartilage and is inserted into the concha near the foregoing. (3) A short muscle arises from the deep face of the posterior medial angle of the scutular cartilage and is inserted into the anterior border of the concha. (4) A narrow but fairly long muscle, apparently a continuation of the interscutular, passes from the posterior medial angle of the scutular cartilage to the medial surface of the concha.

M. auricularis inferior.—The inferior auricular muscle is thin but of some length. Its origin is from the fascia covering the ventral part of the parotid gland. The muscle narrows somewhat towards its insertion into the conchal cartilage close to the intertragic notch.

Mm. auriculares posteriores.—Three muscles fall within this group. One of them is the long levator: the others are the long and short abductors. The *long levator* arises from the ligamentum nuchæ close to its occipital attachment. It narrows and is inserted into the medial surface of the conchal cartilage. The long levator is in the same plane as the scutular muscle.

Dissection.—Reflect the scutular and long levator muscles by cutting through them close to their origins.

[1] The most posterior part of the interscutular muscle is sometimes described as a separate muscle, *M. cervicoscutularis.*

The *long abductor* arises from the ligamentum nuchæ and is inserted into the posterior and lateral part of the conchal cartilage below the level of the incisura intertragica.

The *short abductor* lies beneath the long muscle, in common with which it arises from the ligamentum nuchæ. It is inserted into the conchal cartilage close to the base of its styloid process.

Mm. auriculares superiores.—The superior group of muscles includes a short and a middle levator. The *short levator* is narrow and arises from the surface of the scutular cartilage. It crosses obliquely underneath one of the anterior auricular muscles (the fourth as described above) to be inserted into the medial surface of the conchal cartilage. The *middle levator* lies under cover of the interscutular and long levator muscles. Its origin is from the external sagittal crest, and its insertion is into the medial surface of the conchal cartilage.

Dissection.—Reflect the middle levator and the long abductor muscles.

Mm. auriculares profundi.—The deep auricular muscles are rotators—long and short—which cross each other and pass from the deep surface of the scutular cartilage to the concha.

M. tragicus.—To expose this muscle a considerable volume of fat in the region of the conchal cartilage must be removed. The muscle is small and narrow. Its origin is from the posterior aspect of the bony wall of the external acoustic meatus and the annular cartilage, and its insertion is into the basal part of the conchal cartilage.

Intrinsic muscles.—Three very rudimentary and unimportant intrinsic muscles are described. *M. antitragicus* lies on the conchal cartilage close to the point at which its free borders meet. *M. helicis* occupies a similar level on the anterior border of the cartilage and extends into the hollow between the crura helicis. The two foregoing muscles are partly continuous with the inferior auricular muscle. *M. verticalis auriculæ* consists of a few muscular and tendinous bundles on the convex surface of the conchal cartilage.

The arteries of the ear.—Only the terminal part of the vessels that furnish blood to the external ear can be examined at the present stage of the dissection. Their origin and an appreciable part of their course are hidden by the parotid gland.

A. auricularis posterior.—The main artery of the external ear is the posterior auricular, a branch of the external carotid. Beginning on a level with the great cornu of the hyoid bone, this artery runs under the parotid gland to the base of the ear, but its origin and the first part of its course must not be sought at present. Those branches of the artery that supply the ear are as follows:—

(1) *A. auricularis profunda.*—Later on the deep auricular artery will be found just behind the external acoustic meatus of the temporal bone. It gains the interior of the external ear and supplies the skin therein. A branch (the stylo-mastoid artery) from it passes into the tympanum by way of the stylo-mastoid foramen.

(2) *Ramus lateralis.*—The small lateral branch follows the posterior free border of the conchal cartilage.

(3) *Ramus intermedius.* (4) *Ramus medialis.*—These two rami arise from a common stem. The former runs along the middle of the convex surface of the concha as far as the apex of the ear. The medial ramus supplies the medial and anterior surfaces of the conchal cartilage.

The lateral, intermediate, and medial rami are connected by arciform anastomoses.

A. auricularis anterior.—The anterior auricular artery is a branch of the superficial temporal, from which it arises beneath the parotid gland and just below the condyloid process of the mandible. Its origin will be exposed later when the parotid is removed. The artery crosses the zygomatic arch behind the mandibular articulation, and is distributed to the muscles and skin anterior and medial to the base of the ear. Its most anterior branch anastomoses with the supra-orbital artery; while another branch pierces the conchal cartilage and assists in the supply of blood to the skin within the ear.

The veins of the ear are for the most part satellites of the arteries; but the posterior auricular joins the internal maxillary vein at some distance below the level of origin of the corresponding artery, and the last part of the anterior auricular vein is large since it is joined by the dorsal cerebral vein from the interior of the cranium.

The Nerves of the Ear.

N. auricularis posterior.—The entire course of the posterior auricular nerve cannot be demonstrated as yet, because it leaves the seventh cerebral close to or within the stylo-mastoid foramen. Accompanying the posterior auricular artery underneath the parotid gland, the nerve divides into branches that supply the posterior and superior auricular muscles and the skin on the convex face of the conchal cartilage.

The *internal auricular nerve,* a branch of the seventh cerebral, from which it arises close to or in common with the posterior auricular, cannot be examined at present, but may be noted as one of those concerned in the innervation of the external ear. It gains the interior of the cavity of the ear by piercing the conchal cartilage behind the base of its tapering styloid process, and terminates in the skin lining the cavity.

The auriculo-palpebral nerve (described later) supplies the anterior part of the ear. The great auricular nerve from the second cervical is distributed over the posterior part of the ear, and the occipital branch of the first cervical nerve terminates at the medial part of the base of the ear. Both of the two last-named nerves are connected with branches of the posterior auricular.

When the first part of the vagus nerve comes to be examined, it will be found that it also furnishes an auricular branch.

The dissector should now turn his attention to the face, and should begin with an examination of the external parts of the eye.

THE EYELIDS (Palpebræ).—The eyelids, using the term in the more usual sense, are two in number, upper (palpebra superior) and lower (palpebra inferior); but to these must be added a much less obvious third eyelid (palpebra tertia). The upper and lower lids may be described as membranous curtains arranged for the protection of the eyeball. The upper lid is the larger and the more movable, has the more concave free edge, and is provided with a special muscle, the *m. levator palpebræ superioris*, by which it is raised. The limits of the upper lid cannot be accurately determined by inspection merely; but an indistinct infrapalpebral groove demarcates the lower lid from the face in general. Each lid has an outer surface (facies anterior palpebræ) covered with hair-bearing skin, and an inner surface (facies posterior palpebræ) applied to the eyeball and rendered smooth by the *conjunctiva*, a membrane that is continued from the lid over the front of the eyeball. Short, fine hairs cover both lids, and in addition tactile hairs, scanty on the upper lid but numerous over the lower part of the lower lid, are present.

The free borders of the eyelids bound the *palpebral fissure* (rima[1] palpebrarum), which is in the form of a narrow slit, some 5 cm. in length when the lids are closed, but assumes an elliptical outline when the eye is open. The border of each lid is flattened in such a fashion as to make it possible to distinguish two margins, an inner and an outer. The outer margin carries the eyelashes, which are few, short, and weak on the lower lid, but much more numerous, longer and stronger on the lateral two-thirds of the upper lid. It should be noted that the upper eyelashes are arranged in

[1] *Rima* (for *rigma;* root *rig* means *to split, to cleave*) [L.], a crack, fissure, cleft, chink.

more than one row, and that they are implanted in the skin at different angles in the several rows. On the inner margin of the border of the lid are the small openings of the ducts of the tarsal glands.

The two eyelids are joined at the extremities of the palpebral fissure (the lateral and medial angles) by the lateral and medial *commissures*[1] (commissuræ palpebrarum lateralis et medialis). Both commissures are acute; but the lateral becomes rounded when the eye is widely opened, and in the neighbourhood of the medial commissure the lids circumscribe a space, the *lacus*[2] *lacrimalis*, in which is a rounded body, the *lachrymal caruncle*[3] (caruncula lacrimalis), covered with pigmented skin on which are a few small hairs. On the borders of the lids near the medial commissure are the small *puncta*[4] *lacrimalia*, upper and lower, leading into the *lachrymal ducts* (ductus lacrimales) by which the tears are drained from the eye.

Each eyelid contains a framework of fibrous tissue, the *tarsus*,[5] much better developed in the upper than in the lower lid. A sphincter muscle (m. orbicularis oculi) is associated with the lids, and can be exposed by the removal of the skin over them. In addition, the upper lid and the region of the eyebrow contain muscular fibres that corrugate the eyebrow (m. corrugator supercilii), and a very thin and variable muscle (m. malaris) passes into the lower lid from the fascia in front of the orbit.

The third eyelid consists of a pigmented semilunar fold of conjunctiva, the *membrana nictitans*,[6] easily demonstrated near the medial commissure, and a piece of cartilage (cartilago palpebræ tertiæ) that will be examined with the other contents of the orbit.

> *Dissection.*—Remove the skin from the whole of the face except about the nostrils and over the lips. This must be done with care and especially so over the eyelids, where removal is rendered difficult by close adhesion to the underlying orbicular muscle.

M. CUTANEUS (FACIEI).—The cutaneous muscle of the face is difficult to demonstrate satisfactorily except over the border of the mandible and in the region of the angle of the mouth. The most definite part of it constitutes the *risorius*[7] *muscle* (m. risorius) that

[1] *Commissura* [L.], a joining together. In anatomy, a commissure joins like parts.

[2] *Lacus* [L.], a lake. *Lacrima* [L.], a tear.

[3] *Caruncula* (dim. of *caro*, flesh) [L.], a small fleshy mass.

[4] *Punctum* [L.], a point, a minute round spot.

[5] *Tarsus* [L.], ταρσός (tarsos) [Gr.], a frame of wicker-work; a mat of reeds, such as was built into brick-work to bind it together.

[6] *Nictitare* [L.], to wink.

[7] *Risor* [L.], a laugher.

consists of a well-marked band of fibres running obliquely, immediately underneath the skin, to the angle of the mouth, where they blend with those of the buccinator and orbicular muscles.

M. ORBICULARIS OCULI.—The orbicular muscle of the eyelids consists of fibres circularly disposed so as to act as a sphincter of the palpebral fissure. The peripheral limit of the muscle is not well defined. A few fibres are attached to the oral lachrymal tubercle of the lachrymal bone, but otherwise there is no direct attachment to bone.

M. CORRUGATOR SUPERCILII.[1]—A feebly developed and thin muscle springs from the surface of the frontal bone and merges into the orbicular muscles in the upper eyelid.

At this stage the dissector should make a preliminary examination of the lips and nostrils before proceeding to the removal of the skin from these structures.

The two *lips* (labia oris) are not alike. The upper (labium superius), attached to the incisive bones, is the better developed and the more moveable. It is, moreover, marked in the middle line by a shallow and ill-defined groove, the *philtrum*. The lower lip (labium inferius) is connected with that part of the mandible that carries the incisor and canine teeth. Inferiorly it merges into the *chin* (mentum), a rounded prominence composed of muscle, fat and fibrous tissue. The opening between the lips (rima oris) terminates on each side at the *angle of the mouth* (angulus oris) where the upper and lower lips are connected by the *commissures* (commissuræ labiarum).

The *nostril* (apertura nasi externa) is a crescentic opening with medial and laterial *wings* (alæ nasi). The medial wing projects and has a basis formed by the lamina of the alar cartilage—a structure that will be exposed at a later stage of the dissection. The thinner, concave lateral wing is more flexible and consists of skin enclosing muscle and fibrous tissue. The two wings meet at a sharp upper commissure. The lower commissure, on the contrary, is rounded, its form being governed by the curved cornu of the alar cartilage. If the finger or an instrument be thrust into the upper angle of the nostril, it does not enter the nasal cavity, but finds its way into a blind *diverticulum of the nostril* (diverticulum nasi). The diverticulum, some five or six centimetres in length, extends backwards to the angle of union of the free border of the nasal bone and the nasal process of the incisive bone. Its interior is lined by a fine, pigmented skin, almost entirely devoid of hairs.

The wings of the nostril should be separated as widely as possible,

[1] *Supercilium* (=*super*, above + *cilium*, the eyelid) [L.], the eyebrow.

and the ventral wall searched for a rounded, sharply defined opening. This occurs on the skin close to its junction with the mucous membrane, and is the opening of the duct by which tears are drained from the eye.

M. ZYGOMATICUS.—The zygomatic muscle is a thin, narrow band of rather pale fibres that spring from the facial crest of the maxilla and the masseteric fascia, and blend with the buccinator muscle at the angle of the mouth.

M. NASOLABIALIS.—The naso-labial muscle is flattened and thin, and will be found immediately underneath the skin running in an oblique direction from an area medial to the eye to the side of the nose and the upper lip. Its origin is from the galea aponeurotica over the frontal and nasal bones. From this thin and not very definite origin the muscle becomes somewhat thicker, and divides into two parts. The dorsal portion ends in the upper lip and the lateral wing of the nostril under cover of the m. caninus. The ventral part, somewhat narrower, crosses the surface of the caninus muscle to end in the upper lip near the angle of the mouth, where its fibres blend with those of the orbicular and buccinator muscles.

M. CANINUS.—The canine muscle is triangular in shape, and arises by a thin, narrow tendon from the maxilla just anterior to the end of the facial crest. The muscular fibres diverge as they pass between the two parts of the naso-labial muscle, and end in the lateral ala of the nostril, the wall of the diverticulum of the nostril and the upper lip.

M. DEPRESSOR LABII INFERIORIS.—The origin (from the alveolar border of the mandible and the maxillary tuber) and a considerable part of this muscle cannot be examined as yet. Its rounded belly, however, appears at the anterior margin of the masseter muscle and ends in a rounded tendon about the level of the mental foramen of the mandible. In the lower lip the tendon divides into bundles of fibres that are connected with similar bundles of the tendon of the other side of the head.

There is a considerable amount of fusion between the belly of the depressor and the buccinator.

M. ORBICULARIS ORIS.—The sphincter muscle of the mouth consists of fibres arranged parallel to the free edge of the lips and mingled with fibres from the various muscles that end in the lips. It has no bony attachments. The skin and mucous membrane of the lips are adherent to the surface of the muscle.

M. MASSETER.—The powerful masseter muscle lies over the outer surface of the mandible below the zygomatic arch and facial crest.

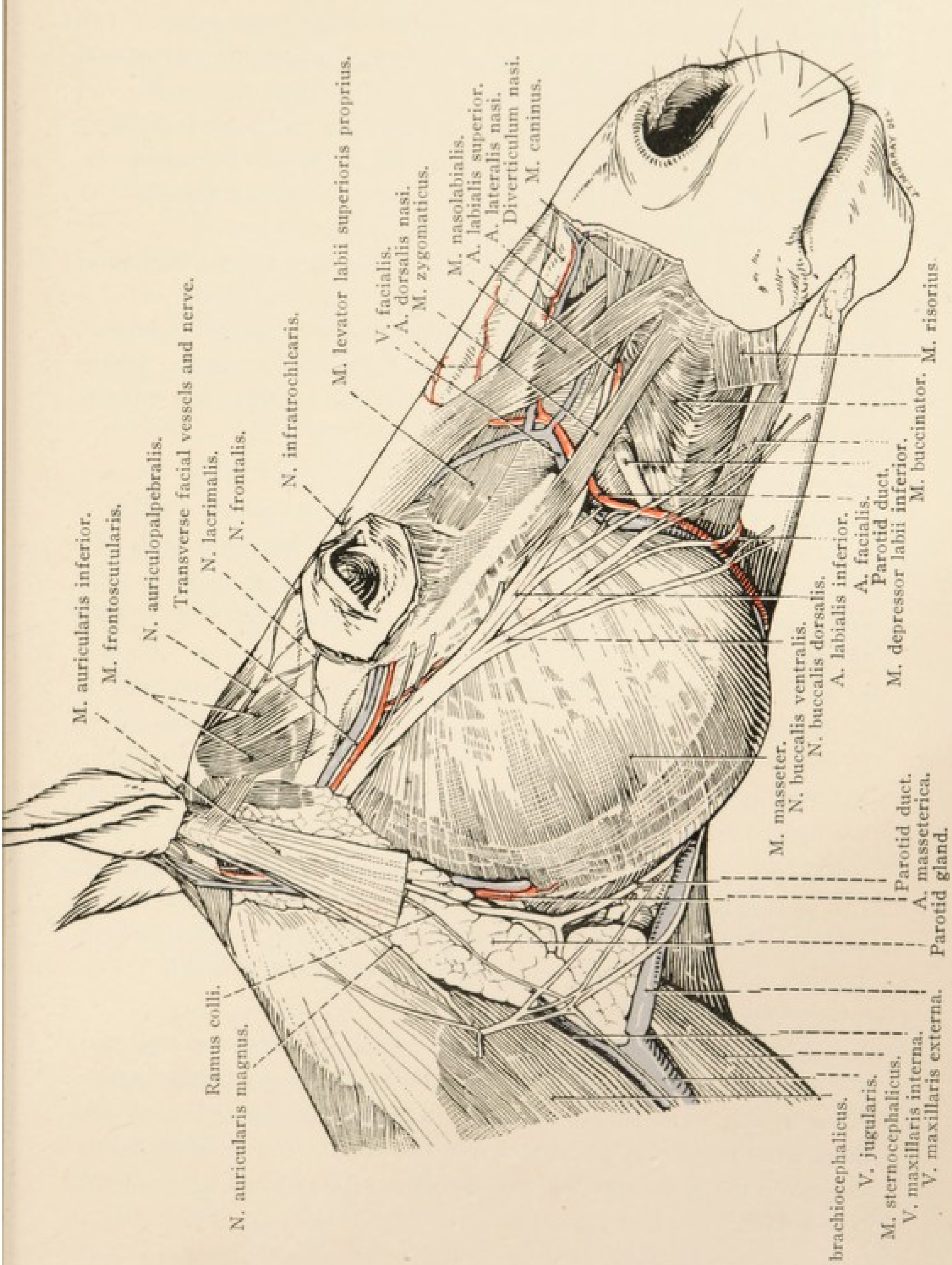


Fig. 12.—Superficial dissection of the face.

The position and extent of the muscle should be determined now, but it will be well to postpone a more complete examination.

N. AURICULOPALPEBRALIS.—The origin of the auriculopalpebral from the seventh cerebral nerve is, as yet, hidden by the parotid gland. Its distribution, however, can be determined at the present time. The nerve crosses the zygomatic arch in the neighbourhood of the mandibular joint in company with the anterior auricular vessels, and turns forwards between the temporal and scutular muscles. It becomes superficial between the origins of the two parts of the fronto-scutular muscle and thus gains the supraorbital region, where its branches are connected with the frontal and lachrymal nerves.

The auriculo-palpebral nerve supplies the orbicularis oculi, corrugator supercilii and scutular muscles. It also furnishes small *anterior auricular nerves* (nn. auriculares anteriores), which blend with branches from the fifth cerebral nerve to form the *anterior auricular plexus* (plexus auricularis anterior) and supply the anterior and inferior auricular muscles.

N. LACRIMALIS.—A branch of the lachrymal nerve (ramus zygomaticotemporalis) becomes visible close to the point of union of the zygomatic process of the frontal bone with the zygomatic arch. Its filaments form a plexus with the frontal and auriculo-palpebral nerves, and some of them travel backwards along the zygomatic arch towards the ear.

N. FRONTALIS.—The frontal, like the lachrymal, is derived from the ophthalmic nerve (a part of the fifth cerebral). It leaves the orbit by the supra-orbital foramen and, communicating with the auriculo-palpebral and lachrymal nerves, ends in the skin of the forehead and the upper eyelid.

N. INFRATROCHLEARIS.—The small infra-trochlear nerve, like the two preceding, is ultimately derived from the ophthalmic and has its origin within the orbit. In the present dissection it appears near the medial angle of the eye, and supplies branches to the skin of this neighbourhood.

NN. BUCCALES.—The two buccal[1] nerves, dorsal and ventral, may be regarded as the terminal branches of the seventh cerebral nerve. They appear as a single flattened nerve-cord between the anterior border of the parotid gland and the masseter muscle. After a short course on the surface of the masseter, the cord resolves itself into the two nerves.[2]

[1] *Bucca* [L.], the cheek.

[2] The exact disposition of the buccal nerves is liable to some variation. The description as given above may be taken as applying to the average arrangement. In the dissection from which Fig. 12 was drawn, the separation of the two nerves was late in occurring.

The *dorsal buccal nerve* (n. buccalis dorsalis) crosses the masseter muscle parallel to the facial crest, and thus gains the cheek, where, in many cases, it divides into two branches. The dorsal branch is connected with filaments from the infra-orbital nerve, and ends in the muscles of the upper lip and nostril. The lower or ventral branch is connected with the ventral buccal nerve and terminates in the muscles of the cheek and upper lip. When, as often happens, no definite division takes place, the dorsal buccal nerve can be followed forwards underneath the zygomatic, naso-labial and canine muscles, in company with the superior labial artery, to the nostril and upper lip.

The *ventral buccal nerve* (n. buccalis ventralis) crosses the masseter muscle obliquely, following a course that is nearly parallel to that of the dorsal nerve, with which it is generally connected by variable anastomoses. On the depressor muscle of the lower lip one of its branches joins twigs from the buccinator nerve. The terminal filaments of the ventral buccal nerve supply the muscles of the lower lip and the cheek.

N. TEMPORALIS SUPERFICIALIS.—The superficial temporal nerve is a comparatively small branch of the mandibular (part of the fifth cerebral nerve) and turns round the border of the ramus of the mandible in company with the transverse facial vessels. At this point the transverse facial artery separates it from the common trunk of the two buccal nerves.

The superficial temporal nerve, at a variable point, divides into two branches. The smaller and more dorsal branch (ramus transversus faciei) follows the transverse facial vessels to end in the skin of the cheek. The larger, ventral branch crosses the dorsal buccal nerve obliquely near its origin, and joins the ventral buccal which it accompanies over the masseter muscle. Its filaments supply the masseter and cutaneous muscles and the skin over them.

A. FACIALIS.—The facial artery is the continuation of the external maxillary from the border of the mandible. The external maxillary vessels and the parotid duct have been followed in the space between the two halves of the mandible ; and it has been observed that, of the three structures, the duct is most ventral and the artery most dorsal. Their facial continuations maintain the same relative positions ; consequently the parotid duct is most posterior, the facial artery is most anterior, and the facial vein lies between the duct and the artery.

The facial artery follows the anterior border of the masseter muscle until this terminates at the end of the facial crest. Thereafter the artery curves upwards and backwards to end close to the margin of the naso-labial muscle, and on the surface of the levator labii superioris proprius, by dividing into the dorsal nasal artery and the angular artery of the eye. In its course across the face the artery lies in succession upon (that is, lateral to) the depressor labii inferioris, buccinator, and levator labii superioris proprius muscles. It also crosses, very obliquely, the parotid duct which insinuates itself between the buccinator muscle and the facial vessels. Crossing the lateral aspect of the artery are the buccal nerves and the zygomatic muscle.

The following are the branches of the facial artery :—

(1) *Rami musculares* to the masseter and cutaneous muscles.

(2) *Rami cutanei* to the skin of the face.

(3) *A. labialis inferior.*—The inferior labial artery takes origin at the lower border of the buccinator muscle. It runs forwards into the lower lip under cover of the risorius, buccinator, and depressor labii inferioris muscles, and can be traced to a union with the corresponding artery of the other side of the head. A small *angular artery of the mouth* (a. angularis oris) arises from the inferior labial as this vessel reaches the border of the orbicularis muscle, and anastomoses with twigs from the superior labial artery.

(4) *A. labialis superior.*—The superior labial artery arises at the end of the facial crest. For a distance it follows the lower border of the caninus muscle, and then continues on the deep face of this muscle into the upper lip. Here its terminal branches anastomose with similar branches of the artery of the opposite side of the head, and with terminal branches of the major palatine artery.

(5) *A. lateralis nasi.*—The lateral nasal artery, as a rule, leaves the facial just before the border of the levator labii superioris proprius is reached, and passes to the side of the nose under the naso-labial muscle. Branches of the lateral nasal and superior labial arteries anastomose, and usually there is an anastomosis between the lateral nasal and the infra-orbital arteries.

Not infrequently the lateral nasal artery is double.

(6) *A. dorsalis nasi.*—The dorsal nasal artery passes under the naso-labial muscle to the dorsum of the nose. It helps to supply the wall of the diverticulum of the nostril.

(7) *A. angularis oculi.*—The angular artery of the eye continues the upward curve of the facial and reaches the medial angle of the eye. It very commonly anastomoses with the malar branch of the infra-orbital artery.

V. FACIALIS.—The facial vein follows the posterior border of the like-named artery, and receives tributaries corresponding to the branches of the artery. In addition, the transverse facial, reflex and buccinator veins communicate with the facial. At the present moment, however, no attempt should be made to follow these three vessels, but their connection with the facial may be determined by slightly raising the border of the masseter muscle.

At the border of the mandible the facial vein becomes the external maxillary.

THE PAROTID DUCT (Ductus parotideus).—The formation of the parotid duct by the union of radicles at the anterior ventral angle of the gland has already been noted, as has also its course across the tendon of the sterno-cephalic muscle into the space between the two halves of the mandible. The association of the duct with the external maxillary vein and artery—the duct being the most ventral of the three structures—has been observed. The duct leaves the space by following the margin of the mandible for a short distance, and then turns upwards on to the face. Its course up the face is at first between the edge of the masseter muscle and the facial vein; but it soon bends forwards between the buccinator muscle and the facial vessels, and disappears by piercing the muscle obliquely. Later, the opening of the duct will be found within the cheek at the summit of a low papilla (papilla salivalis) on a level with the anterior part of the third upper cheek tooth (fourth maxillary premolar).

A. TRANSVERSA FACIEI.—The transverse facial artery arises from the superficial temporal underneath the parotid gland, and, in the present dissection, appears between the gland and the border of the ramus of the mandible just below the condyloid process of the bone. The vessel runs at first on the surface of the masseter muscle close to the facial crest, but before the level of the orbit has been reached it sinks into the substance of the muscle. Terminal twigs anastomose with small branches of the facial artery.

V. TRANSVERSA FACIEI.—The transverse facial vein follows the upper border of the artery of the same name. The anterior part of the vein pierces the masseter muscle very obliquely and joins the facial vein. This union will be revealed when the masseter comes to be examined.

A. MASSETERICA.—The masseteric artery will be found at the anterior border of the parotid gland, running along the posterior border of the masseter muscle, into which it disappears. It is a branch of the external carotid artery, and reaches the face by bending round the margin of the mandible, just above the insertion of the sterno-cephalic and jugulo-mandibular muscles. Branches are furnished to the parotid gland, and the pterygoid and jugulo-mandibular muscles.

The masseteric vein follows the inferior border of the artery.

Dissection.—Reflect the naso-labial and zygomatic muscles.

M. LEVATOR LABII SUPERIORIS PROPRIUS.—The proper levator of the upper lip is largely covered by the naso-labial muscle. It has an elongated triangular outline, the base of the triangle being formed

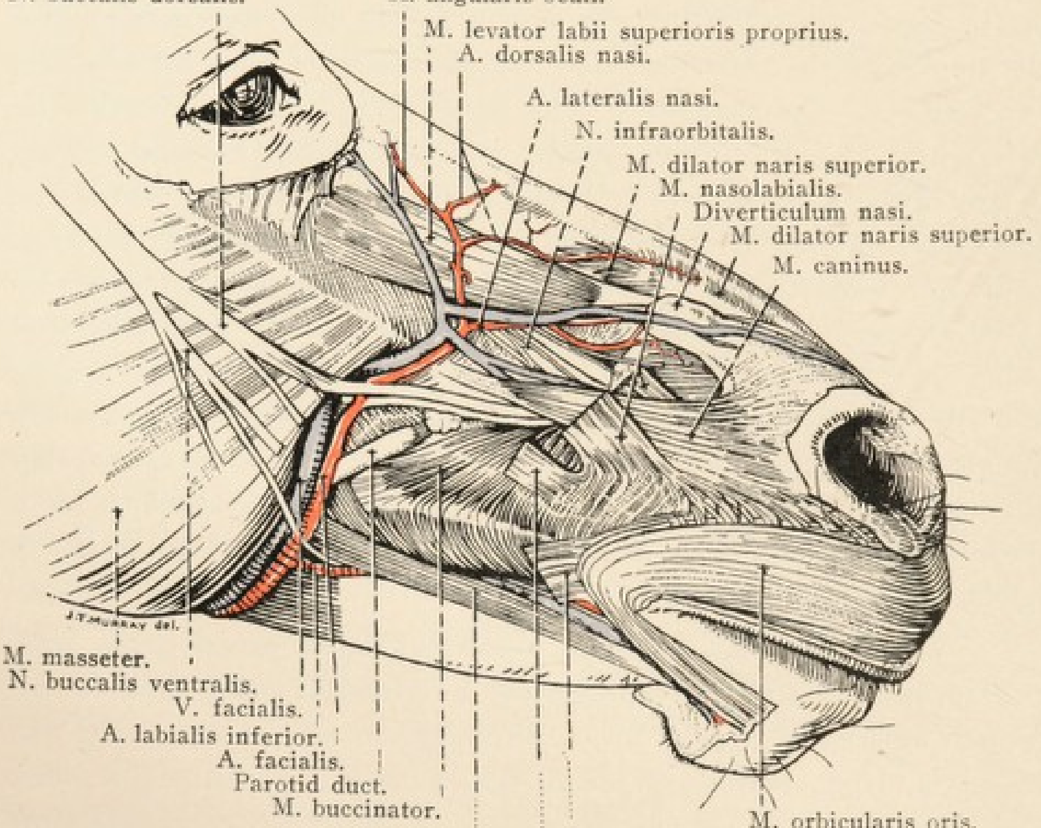


FIG. 13.—The cheek, lips and nose.

by the flattened origin from the bones of the face in the region of the union of the lachrymal, zygomatic and maxilla. A rounded tendon leaves the narrow end of the muscle and crosses the lateral face of the nose obliquely to reach the end of the nasal bone. Here the tendons of the muscles of the two sides of the head unite to form a broad, thin tendinous band that passes to the upper lip in the substance of which its fibres radiate.

M. TRANSVERSUS NASI.—The transverse nasal muscle is unpaired and consists of fibres that form a broad but short band, passing from one alar cartilage to the other. The posterior border of the muscle is definite; but the anterior border blends with the orbicular muscle of the lip.

The superficial fibres of the transverse muscle are attached to the laminæ of the alar cartilages; while the deeper fibres are connected with the cornua of the cartilages and the incisive bones.

M. LATERALIS NASI.—The lateral nasal muscle consists of diffuse, pale fibres springing from the bony boundary of the naso-maxillary notch and ending in the wall of the vestibule of the nose. From the position and direction of its fibres, the muscle may be divided into four parts. (1) The dorsal part consists of fibres arising from the free border of the nasal bone. (2) The posterior part springs from the neighbourhood of the angle formed by the union of the nasal and incisive bones. (3) The inferior part has origin from the nasal process of the incisive bone. (4) The anterior part consists of a few fibres attached to the concavity of the cornu of the alar cartilage.

N. INFRAORBITALIS.—The infra-orbital nerve is the terminal branch of the nervus maxillaris (a part of the fifth cerebral nerve) and, in the present dissection, appears at the infra-orbital foramen after having traversed the infra-orbital canal. Immediately on its emergence from the foramen, it divides into three branches.

(1) The *external nasal branch* (ramus nasalis externus) accompanies the levator labii superioris proprius and divides into two or three branches that supply the wall of the diverticulum of the nostril and the dorsum of the nose.

(2) The *anterior nasal branch* (ramus nasalis anterior), larger than the preceding, burrows between the ventral part of the lateral nasal muscle and the nasal process of the incisive bone, to end in the lining of the nostril and the skin of the upper lip.

(3) The *superior labial branch* (ramus labialis superioris) is the largest of the three divisions of the infra-orbital nerve. It runs obliquely downwards and forwards under the naso-labial muscle to reach the upper lip, in the skin and mucous membrane of which it ends. Delicate filaments are distributed to the tactile- or sinus-hairs of the lip. The superior labial branch is connected with the dorsal buccal nerve by one or two curved communicating branches, and there is frequent union between the branches of the two nerves in the substance of the lip.

Dissection.—Expose the surface of the parotid gland by the removal of the inferior auricular muscle, the very thin cutaneous muscle, and the layer of fascia covering the gland. Care must be exercised not to injure the small ramus colli of the facial (seventh cerebral) nerve, which should be found piercing the gland about its middle.

THE PAROTID GLAND (Glandula parotis).—The parotid[1] gland is the largest of the salivary glands and occupies the depression below the ear and between the wing of the atlas and the border of the ramus of the mandible. Its ventral end reaches the external maxillary vein.

In outline the gland is irregularly four-sided. The middle of its length is the narrowest part; the upper and lower ends being somewhat broader, and, not infrequently, the upper end is the broadest part.

Like the other salivary glands, the parotid is composed of lobules held together by somewhat loose fibrous tissue. Close inspection shows that the larger, primary lobules consist of collections of smaller, secondary lobules.

The lateral surface of the gland is covered by the inferior auricular and cutaneous muscles; and lying upon its lower part are the internal maxillary vein and the ramus colli of the facial nerve, which commonly pierce the gland together about its middle. The posterior auricular vein frequently lies on this surface just below the ear.

The anterior border is thin and irregular, overlaps the masseter muscle to a greater or less extent, and is related to the transverse facial vessels, the superficial temporal nerve, the common trunk of the buccal nerves, and the masseteric vessels. The posterior border is loosely connected with the adjacent muscles, and is slightly concave to fit the border of the wing of the atlas. Running along part of it is the auricular branch of the second cervical nerve.

The lower (ventral) end of the gland is in contact with the external maxillary vein, and that branch of the nervus cutaneus colli that accompanies this vessel into the space bounded by the mandible. The upper (dorsal) end is very thin and irregular, and embraces the base of the concha of the ear, spreading for a variable distance underneath the anterior auricular muscles.

The deep surface of the parotid has a large number of relations, among which are the facial nerve and a number of its branches, the external carotid artery, the digastric and jugulo-mandibular muscles, the tendon of insertion of the sterno-cephalic muscle and an aponeurotic sheet joining it to the brachio-cephalic tendon and separating the parotid and submaxillary glands.

The *parotid duct* (ductus parotideus) results from the union, about the anterior ventral angle of the gland, of a number of smaller ducts that may be readily discovered at the anterior border. The duct crosses the tendon of insertion of the sterno-cephalic muscle, and, passing medial to the jugulo-mandibular and pterygoid muscles, gains the mandibular space, where it has already been examined (pages 12 and 39).

[1] παρά (para) [Gr.], about + οὖς (ous) [Gr.], the ear.

Dissection.—The parotid gland must now be removed *bit by bit*. It is necessary to conduct the dissection in this manner in order to avoid injury to the numerous structures, some of which are small, related to the gland. It is further advisable to secure the various vessels and nerves of the region as soon as possible, and follow them under or through the gland.

A small group of lymph glands should be looked for close to the mandibular joint.

M. STERNOCEPHALICUS.—The flattened tendon of the sterno-cephalic muscle can now be completely examined. Its connection with the tendon of the brachio-cephalic muscle by an aponeurotic sheet of tissue should also be noted.

M. JUGULOMANDIBULARIS.—The strong jugulo-mandibular muscle arises from the anterior margin of the jugular process of the occipital bone, runs obliquely downwards and forwards, and is inserted to the posterior border of the ramus of the mandible.

V. MAXILLARIS INTERNA.—For the sake of convenience, the internal maxillary vein may be divided into two parts. The first part lies within the mandible, and cannot be examined as yet. The second part of the vein, now exposed, is a large vessel that makes its appearance at about the junction of the middle and upper thirds of the mandibular ramus. From this point it runs downwards and backwards, at first nearly parallel to the border of the mandible, and afterwards over the lateral surface of the jugulo-mandibular muscle. Then, by piercing the parotid gland, it gains its lateral surface along which it travels to the posterior ventral angle of the gland, where it unites with the external maxillary vein to form the jugular. The relation of the vein to the parotid is subject to considerable variation. Sometimes the passage of the vein through the gland is abrupt; at other times it is so gradual that only the very end of the vessel is visible before the parotid is removed.

The tributaries of the second part of the internal maxillary vein are as follows:—

(1) *V. temporalis superficialis*, a satellite of the superficial temporal artery, is formed by the union of the transverse facial (v. transversa faciei) and anterior auricular (v. auricularis anterior) veins. The first-named follows the dorsal border of the transverse facial artery. It has already been noted that the anterior auricular vein is a satellite of the artery of the same name, and that its terminal part is large because it is joined by the superior cerebral vein, one of the effluents of the system of venous sinuses within the cranium. The superior cerebral vein (v. cerebralis superior) traverses the temporal meatus and enters

the present dissection by the foramen that lies immediately behind the postglenoid process of the temporal bone.

(2) *V. masseterica.*—The masseteric vein is a satellite of the like-named artery. It is a large but short vessel formed by the union of

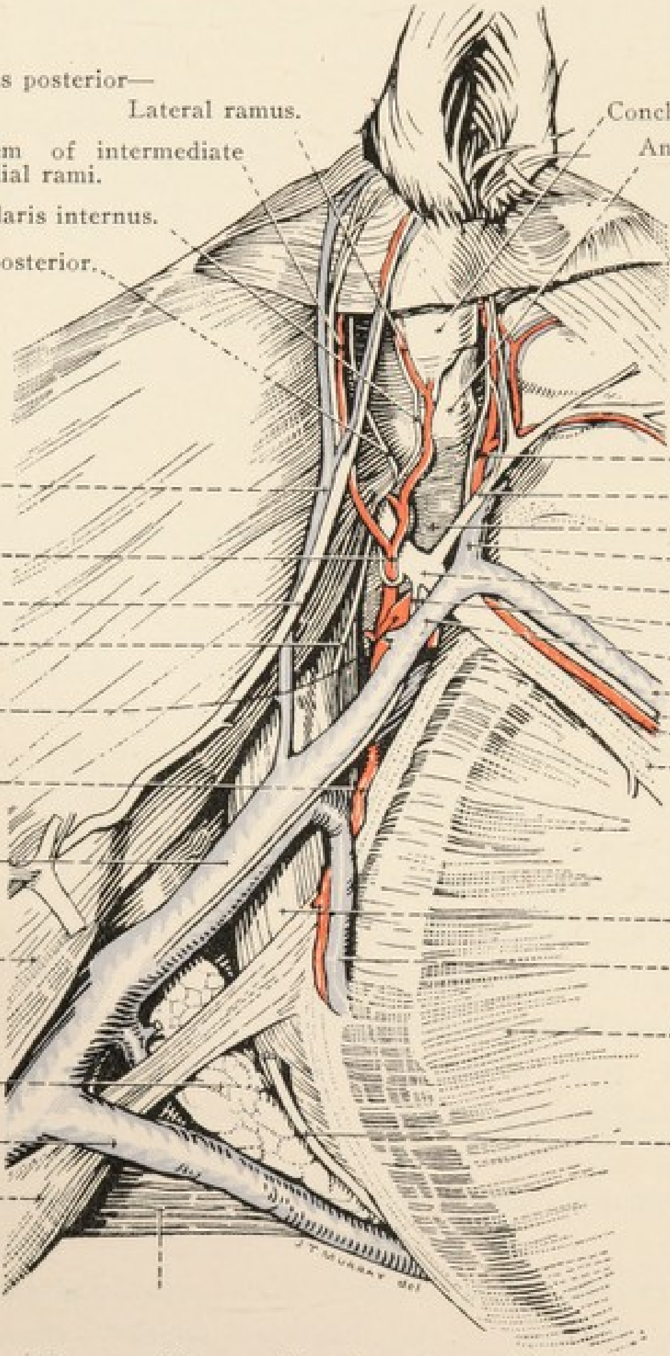


FIG. 14.—The parotid region, after removal of the parotid gland.

veins that drain the masseter and pterygoid muscles, and opens into the internal maxillary at the upper border of the sterno-cephalic tendon.

(3) *V. auricularis posterior* (*magna*), a vessel of considerable size, drains the greater part of the external ear and follows the posterior auricular artery during the initial part of its course. Later the vein leaves the artery to join the internal maxillary at a variable point.

(4) *Rami parotidei.*—Numerous small veins drain the parotid gland.

(5) *V. occipitalis.*—The origin of the occipital vein cannot be determined as yet. In a later dissection it will be found that two main radicles form the vein in the fossa atlantis. One of these is generally the result of the union of the inferior cerebral and condyloid veins; the other is produced by the confluence of cerebro-spinal and muscular branches. Occasionally the inferior cerebral vein joins the internal maxillary directly.

The point at which the occipital vein unites with the internal maxillary is variable, but usually it is close to the mergence of this vessel into the jugular. It may happen that the occipital joins the jugular itself.

A. CAROTIS EXTERNA.—The external carotid artery is the largest of the three terminal branches of the common carotid. At the present stage of the dissection not more than the terminal part of the artery is visible. This runs upwards nearly parallel to the border of the ramus of the mandible, and terminates about 5 or 6 cm. below the mandibular articulation by dividing into the superficial temporal and internal maxillary arteries. The following branches may be examined at this stage:—

(1) *A. masseterica.*—The greater part of the masseteric artery has been dissected in connection with the face, where it was found pursuing a curved course along the line of insertion of the masseter muscle. The origin of the artery is now disclosed, and it will be observed that one or possibly two branches pass within the mandible to supply the internal pterygoid muscle. It also furnishes branches to the jugulo-mandibular muscle and the parotid gland.

(2) *A. auricularis posterior (magna).*—The posterior auricular artery is of some size. It arises from the posterior border of the external carotid artery a little beyond the point of origin of the masseteric, passes upwards underneath the parotid gland to the base of the ear, and divides into four rami, the distribution of which has already been noted (page 30).

(3) *A. temporalis superficialis.*—The superficial temporal artery is much the smaller of the two terminal branches of the external carotid. After a short course underneath the parotid gland and close to the margin of the mandible, it divides into two branches. (*a*) The *transverse facial artery* has been examined in connection with the face. (*b*) The *anterior auricular artery* continues the direction of the superficial temporal. This carries it behind the mandibular joint, where it is

in contact with the joint-capsule, and over the root of the zygomatic arch. It now passes underneath the anterior auricular muscles, and is distributed over the surface of the temporal muscle. A small branch accompanies the internal auricular nerve, and another anastomoses with the supra-orbital artery.

N. FACIALIS.—The facial or seventh cerebral nerve leaves the facial canal by the stylomastoid foramen. From this point the nerve passes obliquely downwards and forwards, on the lateral face of the diverticulum of the auditory (Eustachian) tube and underneath the parotid gland, to cross the border of the mandible just below the condyloid process. Having gained the border of the masseter, the nerve—which has gradually become broader and flatter—divides into the dorsal and ventral buccal nerves, an examination of which was made during the dissection of the face (page 36).

In its course the facial nerve crosses the posterior auricular artery laterally, and, near its termination, passes between the superficial temporal artery and vein close to the point of division of the former.

The following are the branches of the facial nerve after its exit from the facial canal:—

(1) *N. auricularis posterior.*—The posterior auricular nerve arises close to or even within the stylomastoid foramen, passes upwards and backwards over the aponeurotic tendon of the splenius muscle, and ends behind the ear as has been noted previously (page 30).

(2) *N. auricularis internus.*—Arising close to the stylomastoid foramen, the small internal auricular nerve runs upwards, generally in the substance of the parotid gland, to pierce the conchal cartilage close to the base of its styloid process.

(3) *N. digastricus.* — The thin digastric nerve runs vertically downwards to end in the jugulo-hyoid and digastric (posterior belly) muscles. Close to its origin from the facial, it furnishes a small branch that, forming a loop round the posterior auricular artery, rejoins the stem of the parent nerve.

(4) *N. auriculopalpebralis.*—The auriculo-palpebral nerve is the largest collateral branch of the facial. Leaving the parent stem about two-thirds the distance between the stylomastoid foramen and the edge of the mandible, it passes upwards over the root of the zygomatic arch and crosses the anterior auricular vessels. The further continuation of the nerve between the scutular and temporal muscles, and its concern in the formation of a plexiform union with the frontal and lachrymal nerves have already been observed (page 36).

(5) *Ramus colli.*—The small cervical ramus leaves the facial at the

same level as the auriculo-palpebral but from the opposite side of the nerve trunk. It accompanies the internal maxillary vein through the parotid gland, gives filaments to the cutaneous and inferior auricular muscles, and is connected with a branch of the n. cutaneus colli of the second cervical nerve.

(6) Several small branches (rami parotidei) end in the substance of the parotid gland, where they help branches from the mandibular and superficial temporal nerves in the formation of the *parotid plexus* (plexus parotideus).

N. TEMPORALIS SUPERFICIALIS.—The small transverse facial ramus of the superficial temporal nerve was observed earlier as it lay on the surface of the masseter muscle in company with the transverse facial vessels; and a larger ventral branch has been noted as joining the ventral buccal nerve.

A deeper part of the superficial temporal nerve (a branch of the mandibular) is now exposed immediately behind the mandibular joint and in contact with the joint-capsule. Small branches to the parotid gland (rami parotidei), diverticulum of the Eustachian tube, external ear, and the inferior auricular muscle (rami auriculares) should be sought.

THE DIVERTICULUM OF THE AUDITORY TUBE.—Before any further disturbance of structures takes place, it is well to make as thorough an examination of the diverticulum of the auditory tube of Eustachius as present circumstances permit. A small opening should be made into the diverticulum close to the border of the mandible and just above the insertion of the sterno-cephalic muscle. No attempt should be made to expose the interior, but the cavity should be explored as completely as possible with the finger. In this way it may be determined that the diverticulum is a capacious sac extending from the base of the skull to the wall of the pharynx, and continued backwards under the wing of the atlas. The great cornu of the hyoid bone, sloping downwards and forwards, forms a prominent ridge in the lateral wall of the diverticulum and thus imperfectly divides the cavity into a small lateral and a large medial part.

THE SUBMAXILLARY GLAND (Glandula submaxillaris).—The posterior end of the submaxillary gland is visible in the interval between the wing of the atlas and the jugulo-mandibular muscle. Lying over this part of the gland, and separating it from the parotid, is a sheet of fibrous tissue that unites the tendons of the sterno-cephalic and brachio-cephalic muscles.

Further examination of the gland must be postponed.

M. MASSETER.—The masseter[1] muscle is powerful and very tendin-

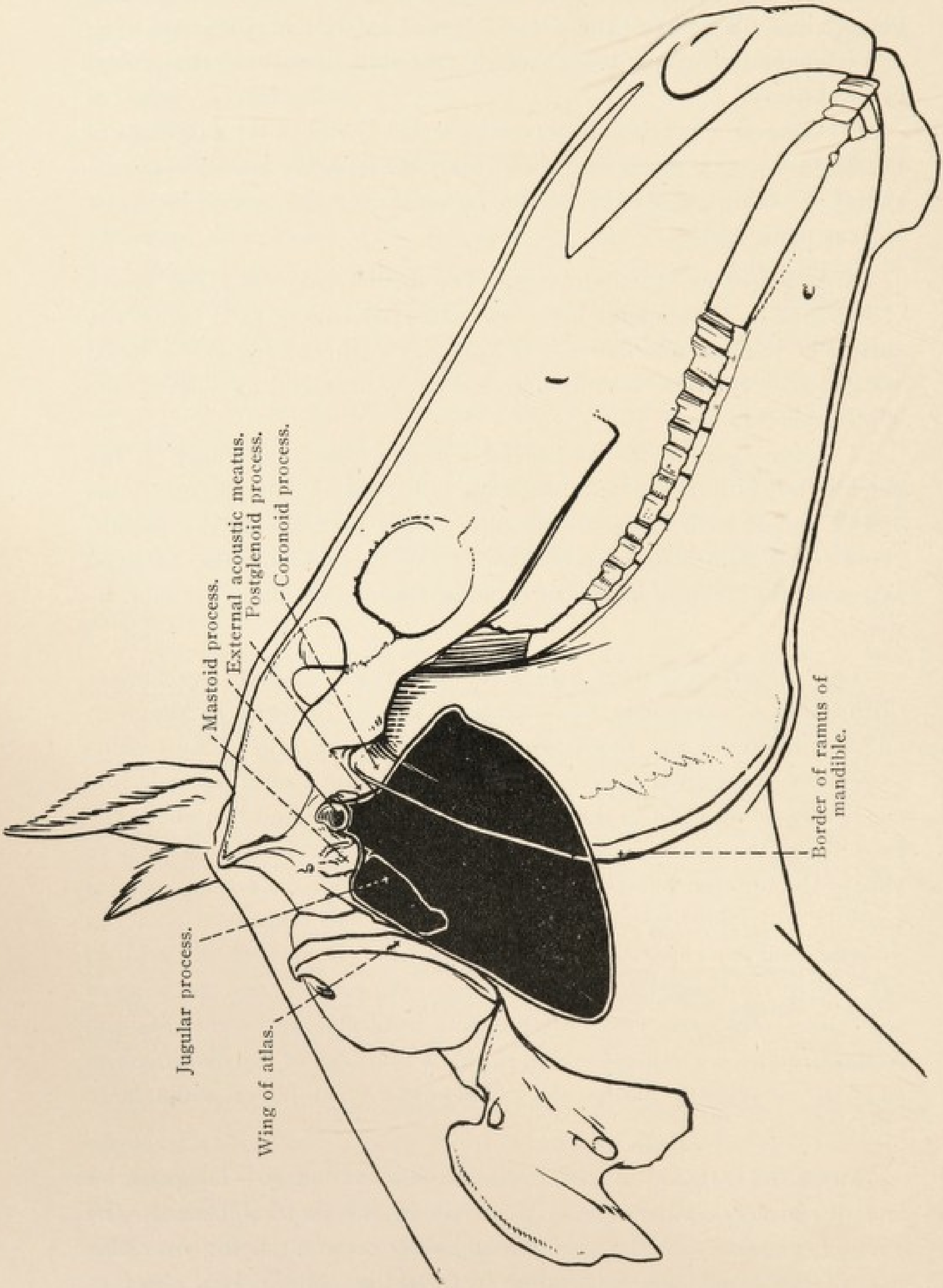


FIG. 15.—Diagram to show the relation of the diverticulum of the auditory (Eustachian) tube to the skull and the surface of the head.

ous in structure. A glistening sheet covers the surface and layers of tendinous tissue permeate the interior of the muscle. Its

[1] μασητήρ (masētēr) [Gr.], masticator.

origin is by a strong and dense tendon from the whole of the facial crest and from the zygomatic arch as far back as the mandibular joint. The insertion of the muscle is to the lateral face of the mandible. Two strata can be readily distinguished towards the origin of the muscle, but these merge into one another at the mandibular attachment. Since the superficial stratum arises from the malar bone and the maxilla only, some of the fibres of the deep stratum are visible, without dissection, near the mandibular joint; and it will be noticed further that, in direction, the fibres of the two strata cross each other.

Dissection.—The masseter muscle must now be removed completely. The transverse facial vessels should, in the first place, be traced through the substance of the muscle. Then the reflex and buccinator veins must be secured at their union with the facial vein. This permits the dissector to obtain some idea of the thickness of the muscle, and should enable him to perform its reflection without injury to underlying structures.

As the removal of the masseter proceeds, watch must be kept for its nerve, which gains the muscle by traversing the notch between the coronoid and condyloid processes of the mandible and lies close to the bone in front of the mandibular joint.

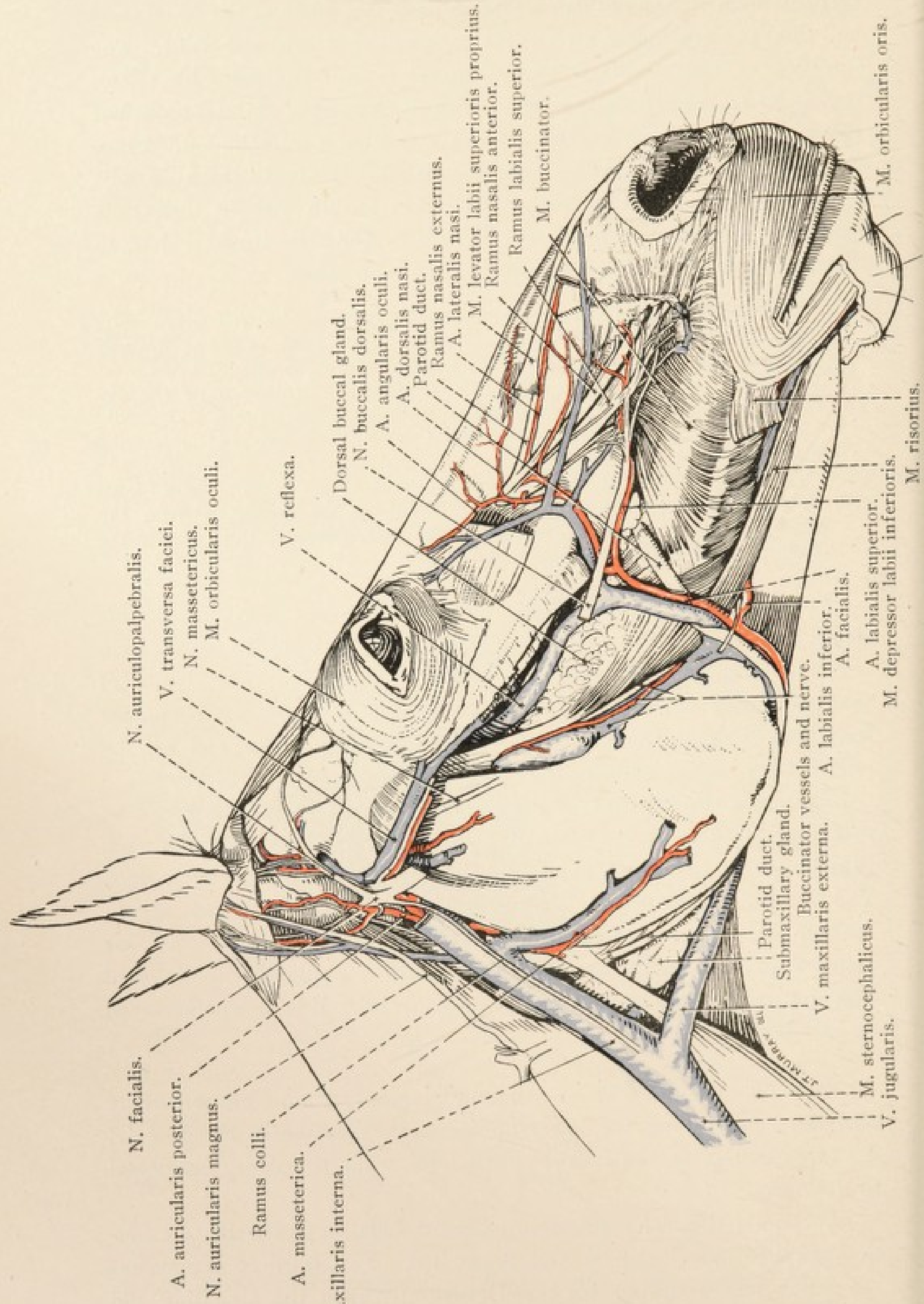
V. REFLEXA.—A portion only of the reflex vein is visible at this stage of the dissection. Traced from its union with the facial, the vein passes backwards underneath the masseter, along the upper border of the buccinator muscle and the dorsal buccul glands. It disappears from view between the mandible and the maxillary tuber, and will be followed later when the mandible has been removed.

There are two features of the reflex vein that should be noted at this time. A vein of not more than moderate size at its anterior end, it undergoes a fusiform dilatation just before it disappears from view. The second characteristic upon which the dissector should satisfy himself is the absence of valves. If the vessel be slit open for a short distance and its interior be investigated with a probe, it will be found that the passage of the instrument in either direction is unobstructed by valves.

V. BUCCINATORIA.—The buccinator vein, artery and nerve pursue a curved course along the lower border of the buccinator muscle. Of the three structures, the vein is most lateral, while the artery lies dorsal to the nerve.

Anteriorly the buccinator vein joins the facial opposite the termination of veins from the upper and lower lips. Posteriorly it approaches the reflex vein, and, like this vessel, passes between the mandible and the maxillary tuber.

The buccinator resembles the reflex vein in being without valves and


N. auriculopalpebralis.
V. transversa faciei.
N. massetericus.
M. orbicularis oculi.
V. reflexa.
Dorsal buccal gland.
N. buccalis dorsalis.
A. angularis oculi.
A. dorsalis nasi.
Parotid duct.
Ramus nasalis externus.
A. lateralis nasi.
M. levator labii superioris proprius.
Ramus nasalis anterior.
Ramus labialis superior.
M. buccinator.
M. orbicularis oris.
M. risorius.
M. depressor labii inferioris.
A. labialis superior.
A. facialis.
A. labialis inferior.
Buccinator vessels and nerve.
Submaxillary gland.
Parotid duct.
V. maxillaris externa.
M. sternocephalicus.
V. jugularis.
N. facialis.
A. auricularis posterior.
N. auricularis magnus.
Ramus colli.
A. masseterica.
V. maxillaris interna.

in undergoing a large fusiform dilatation just before it passes within the mandible.

Generally the buccinator vein is joined by a tributary from a venous network that lies between the buccinator muscle and mucous lining of the cheek, and commonly it is connected with the masseteric vein.

N. BUCCINATORIUS.—The buccinator is a nerve of some size and is derived from the n. mandibularis—a part of the trigeminal or fifth cerebral nerve. It gains the present dissection by passing between the internal pterygoid muscle and the maxillary tuber, and follows the lower border of the buccinator muscle as far as the level of the first cheek-tooth. Here it insinuates itself between the buccinator muscle and the mucous lining of the cheek, and so gains the lips in the mucous membrane of which its terminal filaments ramify. In addition numerous small branches are furnished to the mucous membrane of the cheek and to the ventral buccal glands; and a connection is established with the ventral buccal nerve.

A. BUCCINATORIA.—The relatively small buccinator artery is a branch of the internal maxillary, and gains the region of the cheek by following the dorsal border of the buccinator nerve. Branches of the artery supply blood to the pterygoid, masseter and buccinator muscles and the dorsal buccal glands.

THE BUCCAL GLANDS (Glandulæ buccales).—There are two groups of these, dorsal and ventral. The dorsal glands form an elongated flattened mass along the surface of the maxilla and the buccinator muscle, extending forwards from the anterior edge of the mandibular ramus. It is often possible to divide the group into two parts. The larger portion lies underneath the masseter muscle; while a smaller and more scattered part extends in front of the masseter to within a measurable distance from the angle of the mouth.

The smaller ventral buccal glands are at present hidden by the buccinator and the depressor muscle of the lower lip. They stretch from the margin of the masseter to the level of the angle of the mouth.

M. BUCCINATOR.—Though the whole of the buccinator[1] muscle cannot be seen until the mandible has been removed, it is necessary that that portion now visible should be examined before any further dissection is performed.

The buccinator muscle may be divided into two parts. (1) The buccal part (pars buccalis) is the more superficial and is limited to that region of the cheek that is anterior to the masseter muscle. It is

[1] *Buccinator* [L.], trumpeter.

penniform, consisting of fibres that arise from the mandible and maxilla, close to their alveolar border, and join a longitudinal tendinous raphe. Anteriorly the buccal part blends with the orbicular muscle of the lips. (2) The molar part (pars molaris) of the buccinator is partly covered by the buccal part. Its fibres are mainly longitudinal and arise from the coronoid process of the mandible and the alveolar border of the maxilla and mandible on a level with the last cheek-tooth. At the angle of the mouth they blend with the orbicular muscle.

Dissection.—A portion of the zygomatic arch must now be removed. Saw through it at two points; (1) as close to the mandibular joint as possible; and (2) as close to the orbit as can be effected without injury to the orbital rim. If now the zygomatic process of the frontal bone be sawn through at its base, a piece of bone is isolated and may be removed. During the removal of the bone, it will be observed that the temporal muscle is covered by a strong sheet of fascia that is thickest where it is attached to the margin of the zygomatic arch. Run the knife along the edge of the arch so as to free the fascia from its attachment. Then remove the fascia completely from the surface of the temporal muscle.

M. TEMPORALIS.—The strong temporal[1] muscle occupies the whole of the fossa of that name. Its origin is from the frontal crest, external sagittal crest, and the superior nuchal line, and from the parietal, occipital, temporal and sphenoid bones. In addition, some fibres arise from the deep face of the temporal fascia, and have been cut during its removal.

The converging fibres of the muscle are inserted principally into the coronoid process of the mandible, but some blend with the adjacent part of the masseter and are thus attached to that portion of the mandibular ramus from which the coronoid process springs.

Dissection.—The following dissection must be performed on one side of the head only:—With the saw separate the coronoid process from the rest of the mandible and then cut through the bone immediately behind the mental foramen. Liberate the digastric, jugulo-mandibular, and buccinator muscles from the bone, and then carefully pass the knife through the muscles, &c., attached to the medial surface of the mandible, keeping the edge of the knife as close to the bone as possible. Disarticulate the mandibular joint, bearing in mind the close relationship that exists between the joint and important vessels and nerves. Remove the piece of mandible that the foregoing operations have isolated.

This dissection involves the partial destruction of the pterygoid muscles and the inferior alveolar vessels and nerve; but the dissector will have an opportunity later of examining these on the other side of the head.

Note the presence of the mylo-hyoid nerve—a branch of the

[1] *Temporalis* [L.], pertaining to the temple (*tempus*, time, temple), where Time first shows his ravages.

mandibular—which adheres so closely to the bone that it is cut through in the removal of the mandible.

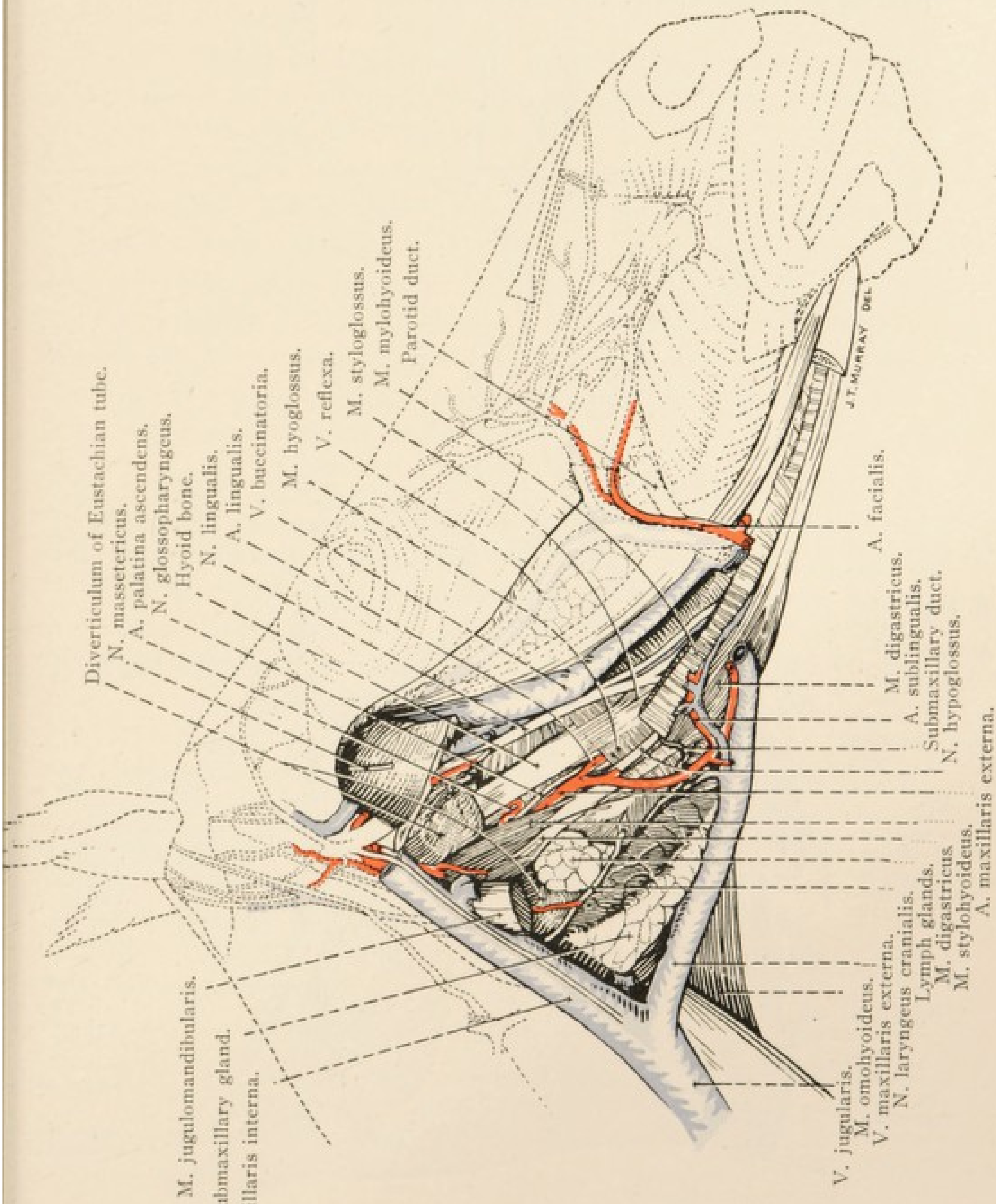


FIG. 17.—Dissection after removal of part of the mandible.

V. MAXILLARIS INTERNA.—The internal maxillary vein was partly exposed by the removal of the parotid gland. Its origin as the direct continuation of the buccinator vein (at the anterior border of the ramus of the mandible) and the first part of its course are now exposed. This part of the vein lies between the mandible and the internal pterygoid muscle, and receives the following vessels:—

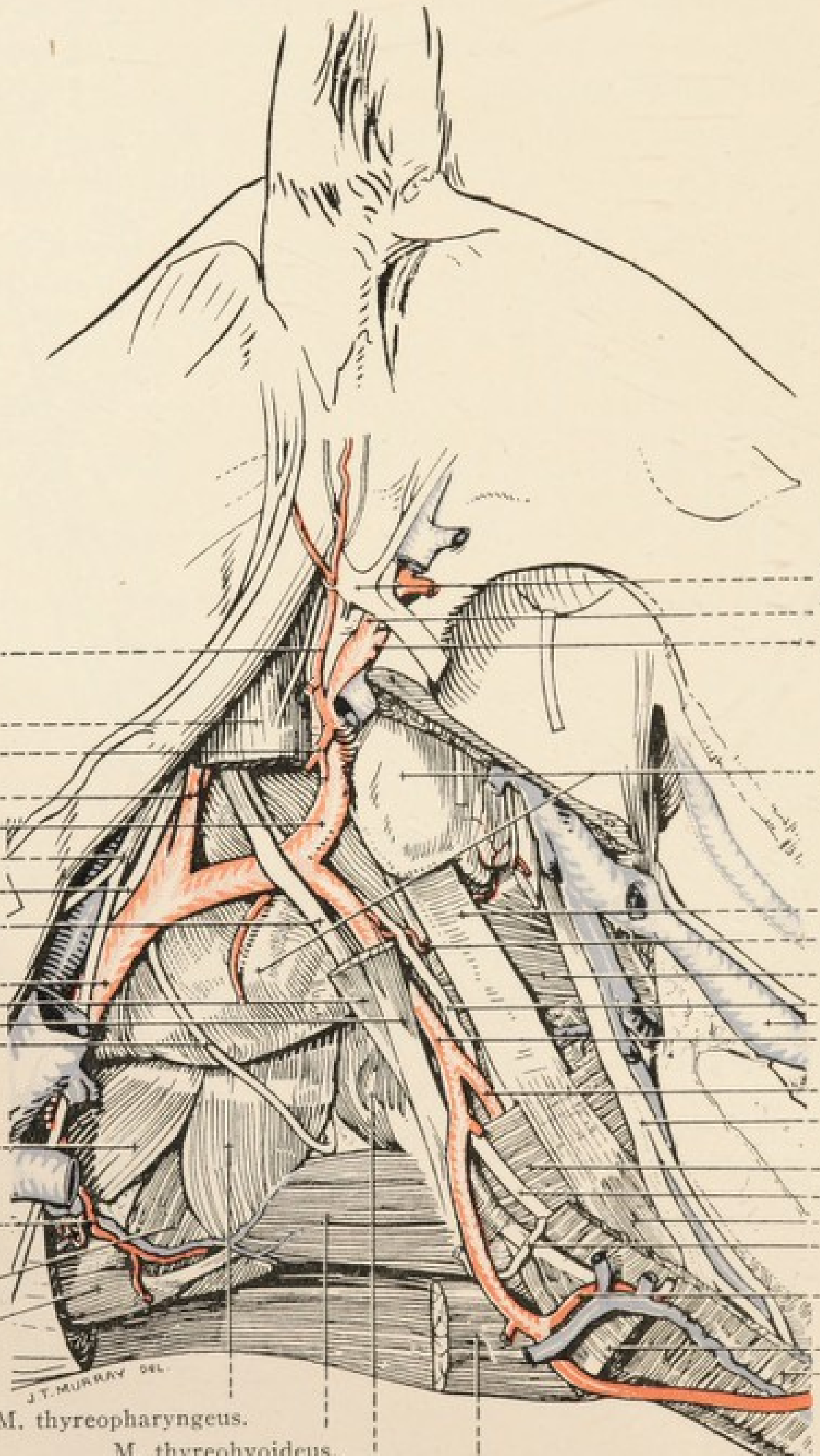


FIG. 18.—Diverticulum of the auditory (Eustachian) tube and lateral aspect of the pharynx.

(1) *V. dorsalis linguæ.*—The dorsal lingual vein drains the mucous membrane and the adjacent muscles of the posterior part of the dorsum of the tongue, and receives tributaries from the soft palate.

Within the substance of the tongue it communicates with the lingual vein.

It should be noted that the dorsal lingual vein is not the companion of any artery.

(2) *V. alveolaris inferior.*—The inferior alveolar vein lies within the mandibular canal, and joins the internal maxillary immediately on its exit from the mandibular foramen.

(3) *V. temporalis profunda.*—The deep temporal vein begins in the temporal fossa and gains the internal maxillary by crossing in front of the mandibular joint.

(4) *Rami pterygoidei* from the internal pterygoid muscle.

The vessels that join the second part of the internal maxillary vein are the superficial temporal, posterior auricular, masseteric, parotidean rami, inferior cerebral, and occipital, which have previously been examined (page 43).

THE CHEEKS (buccæ).—This is a convenient stage at which to complete the examination of the cheeks. The lips, however, should not be further dissected at the present time.

The cheeks form the lateral boundaries of the mouth, and extend backwards from the region of the commissure of the lips. Their upper and lower borders are attached to the maxilla and mandible close to the alveolar margins of these bones.

Three layers can be distinguished in the cheek. (1) The outermost of these consists of thin and very pliable skin. (2) The middle layer contains the buccal glands, of which the dorsal group was examined earlier (page 51), and certain muscles. Though the buccinator is the main muscle of the cheek, parts of the risorius, zygomaticus, nasolabialis, caninus, and depressor labii inferioris are included. Of the muscles there only remains to note the origin of the buccinator (molar part) and the depressor of the lower lip from the maxillary tuber and the coronoid process of the mandible. (3) The mucous membrane of the cheek, continuous with that forming the gums, is red in colour and about 2 mm. in thickness. A row of small papillæ will be noticed following the line of the upper teeth. Upon each papilla opens a duct of the dorsal buccal glands. A similar row of papillæ with the openings of the ducts of the ventral buccal glands may be discovered opposite the mandibular cheek-teeth towards the angle of the mouth.

The most conspicuous object on the inner surface of the cheek is an elevation of some size, the *papilla salivalis*, opposite the anterior part of the third maxillary cheek-tooth. On the summit of the papilla is the opening of the parotid duct.

The mucous membrane of the cheek should be reflected in order that the ventral buccal glands may be examined.

Dissection.—Remove the pterygoid muscles completely and clean up the underlying structures. Turn the mylo-hyoid and mylo-glossal muscles downwards as far as possible, and observe that the fibres of these two muscles cross each other obliquely.

M. STYLOHYOIDEUS.—The elongated, rounded stylo-hyoid muscle arises from the lateral aspect of the angle of the stylo-hyoid bone. The fleshy belly of the muscle tapers to a narrow tendon, which splits to permit the passage of the intermediate tendon of the digastricus, and is inserted into the lateral face of the thyroid process of the hyoid bone.

M. JUGULOHYOIDEUS. — The jugulo-hyoid muscle is sometimes described as a part of the stylo-hyoid, of which it may be regarded as the backward continuation. The muscle fills the narrow gap between the jugular process of the occipital bone and the angular projection of the stylo-hyal bone, and is attached to these bony parts. Some of its fibres blend with those of the posterior belly of the digastric muscle.

M. DIGASTRICUS.—The digastric and jugulo-mandibular muscles are inextricably blended at their common origin from the jugular process of the occipital bone. As its name indicates, the digastric possesses two fleshy bellies—posterior and anterior—between which there is an intermediate tendon that plays through the pulley formed by the splitting of the tendon of insertion of the stylo-hyoid muscle. Between the two tendons there is a small synovial bursa.

The anterior belly of the digastric, and its insertion into the medial aspect of the lower border of the molar part of the mandible, have already received attention (page 13).

It is of some morphological importance to note that the digastric muscle receives nerve fibres from two distinct sources—the posterior belly from the seventh cerebral nerve, and the anterior belly from the fifth.

THE SALIVARY GLANDS.—Although a large number of glands are concerned in the production of the saliva, the expression "salivary glands" is usually taken as indicating the three largest of these on each side of the head—the parotid, the submaxillary, and the sublingual. An examination of the parotid gland was made earlier (page 42); the submaxillary and sublingual glands are now fully revealed.

The Sublingual Gland (Glandula sublingualis).—On turning down the mylo-hyoid and mylo-glossal muscles, the pale-red, elongated and lobulated sublingual gland was exposed to view.

It is worthy of note that in the average mammal there are two sublingual glands on each side of the head. One of these is provided with a single large duct, and is therefore named the *glandula sublingualis monostomatica;* while the other, the *gl. sublingualis polystomatica,*[1] has numerous small ducts opening independently into the floor of the mouth. In the *Equidæ* the gland with the single large duct is absent, and in this respect the members of the horse tribe differ from all the other domesticated mammals.

The horse's sublingual gland is flattened laterally and extends from the symphysis of the mandible to the level of the third or fourth mandibular cheek-tooth. Its lateral surface is covered by the mylo-hyoid and mylo-glossal muscles, and along a narrow strip close to the upper border, by the mucous membrane of the mouth. The medial surface lies upon the genio-glossal and stylo-glossal muscles and is traversed longitudinally by the duct of the submaxillary gland. The lower border is in contact with the genio-hyoid muscle; while the upper border causes a linear elevation of the mucous membrane of the floor of the mouth, upon which may be observed the openings of twenty to thirty small ducts (ductus sublinguales minores) on the summits of small papillæ.

The Submaxillary Gland (Glandula submaxillaris).—The submaxillary salivary gland is elongated, laterally flattened, and gently curved with a concavity looking upwards and forwards. It extends from the fossa atlantis to the body of the hyoid bone. Its lateral face is related to the internal pterygoid, digastric and jugulo-mandibular muscles, the tendon of insertion of the sterno-cephalic and the fibrous sheet connecting this tendon with that of the brachio-cephalic muscle. The flattened tendon of the sterno-cephalic muscle, and the fibrous sheet connected therewith, separate the posterior part of the submaxillary from the overlying parotid gland.

The medial surface of the gland is in contact with the diverticulum of the auditory tube, the flexor muscles of the head, the termination of the common carotid artery, the pharynx and larynx, and the tenth and eleventh cerebral and sympathetic nerves.

The thin concave upper border of the gland is intruded between the jugulo-mandibular muscle and the diverticulum of the auditory tube, and along it the commencement of the duct of the gland will be found. The thicker convex border rests about its middle on the thyroid gland.

[1] *μόνος* (monos) [Gr.], single. *πολύς* (polys) [Gr.], many. *στόμα* (stoma) [Gr.], a mouth. Writers frequently use the terms *grandicanalaris* and *parvicanalaris* instead of *monostomatica* and *polystomatica;* but it seems preferable to employ terms that signify the number of the openings rather than the size of the ducts.

The posterior end is retained in the fossa atlantis by loose fibrous tissue. The anterior end is in contact with the anterior belly of the digastric muscle.

The *duct of the submaxillary gland* (ductus submaxillaris) begins by the union of numerous small radicles on the upper concave border of the gland. Immediately on leaving the anterior end of the gland, the duct is crossed laterally by the external maxillary artery. After crossing the digastric tendon obliquely, it passes between the mylo-hyoid and hyo-glossal muscles, in company with the hypoglossal nerve, to reach the medial surface of the sublingual gland. The last part of its course is immediately beneath the mucous membrane of the floor of the mouth, and its termination is on an elongated flattened papilla (*caruncula sublingualis*) on a level with the mandibular canine tooth.

M. STYLOGLOSSUS.—The stylo-glossal muscle is elongated, narrow, and flattened, and arises from the anterior part of the lateral surface of the great cornu of the hyoid bone. Passing along the side of the tongue, the fibres of the muscle slightly diverge and are lost in the substance of that organ towards its tip.

M. HYOGLOSSUS.—The hyo-glossal muscle is flat and four-sided, and lies to the side of the base of the tongue. It is crossed obliquely by the stylo-glossal muscle. Its fibres spring from the thyroid process, the body of the hyoid bone and its glossal process, and the lesser cornu. They run obliquely upwards and forwards, and gradually disappear in the substance of the tongue.

M. GENIOHYOIDEUS.—The genio-hyoid[1] is a fusiform muscle placed immediately within the mylo-hyoid, and running longitudinally parallel to and in contact with its fellow muscle of the opposite side of the head. Its origin is from the medial aspect of the mandible close to the symphysis, and its insertion is into the glossal process of the hyoid bone.

A. CAROTIS COMMUNIS.—The termination of the common carotid, underneath the submaxillary gland and at the level of the inferior border of the jugulo-mandibular muscle, is now exposed. The three vessels into which the common carotid divides are the occipital and the internal and external carotid arteries. Of these, the two first mentioned will not be followed until later. The external carotid artery is not only the largest of the three terminal branches: it is also that which, from its direction, might be regarded as the direct continuation of the parent vessel.

A. CAROTIS EXTERNUS.—The external carotid artery may be con-

[1] γένειον (geneion) [Gr.], the chin.

veniently divided into two parts, the line of separation being the point at

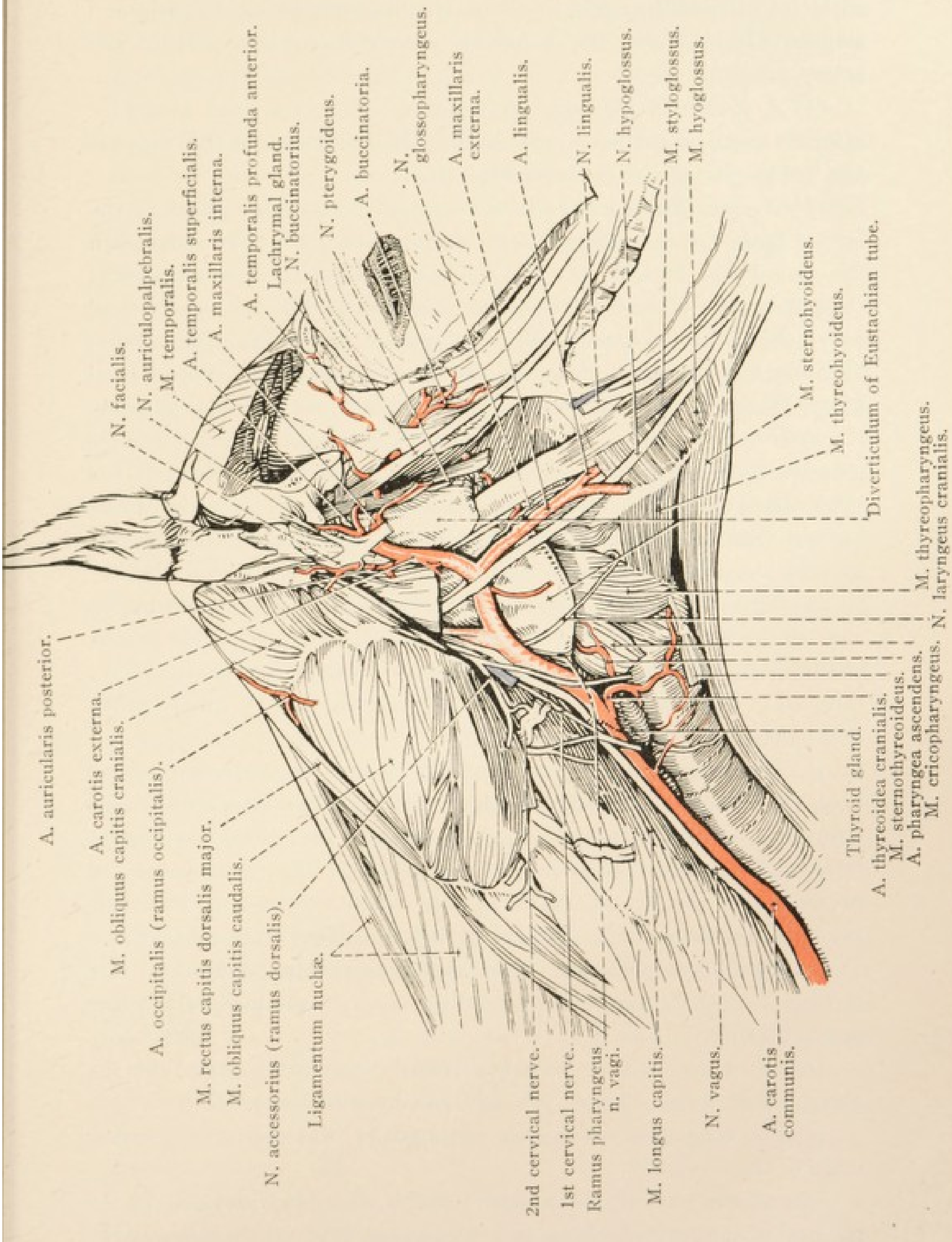


Fig. 19.—The arteries, nerves, &c., in the neighbourhood of the pharynx and larynx.

which the artery emerges from the interval between the stylo-hyoid muscle and the great cornu of the hyoid bone.

The first part of the artery lies upon the pharynx and the diverticulum of the auditory (Eustachian) tube, and is in contact laterally with the submaxillary gland and the jugulo-mandibular, digastric and stylo-hyoid muscles. The following vessels leave this part of the artery :—

(1) *A. glandulæ submaxillaris media.*—This is a small artery (or arteries) that leaves the external carotid close to its origin and supplies the middle part of the submaxillary gland.

(2) *A. maxillaris externa.*—The external maxillary artery is the largest branch of the external carotid, from which it arises underneath the stylo-hyoid muscle. At first the vessel follows the lower border of the great cornu of the hyoid bone, accompanied by the glosso-pharyngeal nerve above and the hypoglossal nerve below. Then, turning somewhat abruptly downwards, it runs on the medial surface of the internal pterygoid muscle, crossing the hyo-glossal muscle, the hypoglossal nerve, the intermediate tendon of the digastricus and the submaxillary duct, to gain the space between the two halves of the mandible where it has been already dissected (page 12). Its continuation as the facial artery has also been observed. The following are the arteries to which the external maxillary gives origin :—

(*a*) The *ascending palatine artery* (a. palatina ascendens) begins close to the border of the stylo-hyoid muscle and at once passes medial to the glosso-pharyngeal nerve and the stylo-hyal bone. It ramifies in the wall of the pharynx and ends in the soft palate. A small branch (ramus tonsillaris) supplies the tonsil.

(*b*) The *lingual artery* (a. lingualis) is the largest vessel arising from the external maxillary, which it leaves as this artery makes its downward bend. It continues the direction of the parent vessel, that is, along the lower border of the great cornu of the hyoid bone, and passes under the hyo-glossal muscle to reach the tongue, where its subsequent course will be followed during the dissection of that organ.

(*c*) Small branches (aa. glandulæ submaxillaris inferiores) are furnished to the submaxillary gland as the external maxillary artery passes its anterior end.

(*d*) Numerous small branches (rami musculares) pass into the pterygoid, digastric, sterno-hyoid and omo-hyoid muscles.

(*e*) The *sublingual artery* (a. sublingualis) was seen at an earlier stage of the dissection.

The second part of the external carotid artery was revealed by the removal of the parotid gland, and it was seen that this portion of the vessel gave origin to the masseteric, posterior auricular and superficial temporal arteries (page 45).

The internal maxillary artery is the direct continuation of the external carotid.

Lymph glands (lymphoglandulæ pharyngeales) will be found on the wall of the pharynx along the course of the external and internal carotid arteries, and possibly in the angle of divergence of these vessels.

A. MAXILLARIS INTERNA.—The internal maxillary artery is divisible into three parts:—(1) From its origin to its entrance into the alar canal; (2) the part traversing the alar canal; and (3) after its exit from the canal. The first part only is visible at the present stage of the dissection.

In its course to the alar canal, the internal maxillary artery forms a double curve. The first bend has a convexity that looks forwards and downwards; the second convexity looks backwards and upwards. The second curve also carries the vessel nearer to the median plane of the head.

The lateral relations of the artery are the external pterygoid muscle, the buccinator nerve, and the common trunk of the inferior alveolar and lingual nerves. Its medial surface is at first in contact with the diverticulum of the auditory (Eustachian) tube, and afterwards with the tensor muscle of the soft palate, and is crossed by the chorda tympani nerve.

The following branches leave the first part of the internal maxillary artery:—

(1) *A. alveolaris inferior.*—The inferior alveolar artery arises close to the upper border of the great cornu of the hyoid bone and passes at first between the pterygoid muscles and then between the internal muscle and the ramus of the mandible, to reach the mandibular foramen where it has been cut through in the process of removal of the mandible.

Before entering the mandibular canal, the artery furnishes branches to the pterygoid and mylo-hyoid muscles; and when within the canal it gives off collaterals to the cheek-teeth and gums, the bone and the periosteum. At the mental foramen it terminates by dividing into mental (*a. mentalis*) and incisive branches. The former leaves the mental foramen and anastomoses with the inferior labial artery. The incisive branch continues onwards within the bone and supplies the canine and incisor teeth.

(2) *Rami pterygoidei.*—Small branches, two or three in number, supply the pterygoid muscles and the tensor and levator of the soft palate.

(3) *A. tympanica (anterior).*—The tympanic artery is a very small

vessel that follows the auditory (Eustachian) tube and gains the middle ear by the petro-tympanic fissure.

(4) *A. meningea media.*—The middle meningeal artery is also small and arises from the internal maxillary as it is approaching the entrance to the alar canal. It at once gains the cranium by the foramen spinosum.

(5) *A. temporalis profunda posterior.*—The posterior deep temporal artery arises at the entrance to the alar canal and thence passes upwards and backwards underneath the temporal muscle. It anastomoses with the middle meningeal and superficial temporal arteries, and supplies a branch to the masseter muscle.

N. MANDIBULARIS.—The fifth cerebral, or trigeminal, nerve divides into three parts while still within the cranium, and each part leaves the cranium by a different foramen. The three nerves formed by the trigeminal are the ophthalmic, the maxillary and the mandibular; and it is the last-named that can be examined at the present time. In view of its distribution, it should be remembered that the mandibular[1] nerve differs from the ophthalmic and the maxillary in that, though mainly composed of sensory fibres, it contains motor fibres as well.

The mandibular nerve is of large size and leaves the cranium by the foramen ovale. Immediately on its exit from the foramen it divides into a number of branches of varying size.

(1) *N. massetericus.*—The masseteric nerve curves round the front of the mandibular joint in company with a tributary of the transverse facial vein, and traverses the mandibular notch to reach the masseter muscle. The terminal part of its course was seen during the removal of the masseter.

(2) *Nn. temporales profundi.*—The deep temporal nerves are generally two in number, and usually arise from the mandibular in common with the masseteric nerve. They pass upwards and forwards to enter the temporalis muscle.

(3) *N. pterygoideus.*—The pterygoid nerve is the smallest branch of the mandibular. It supplies the pterygoid muscles.

A small, flat, oval ganglion—the *otic*[2] *ganglion* (ganglion oticum)—is placed at the origin of the pterygoid nerve, where it rests upon the tensor of the soft palate. The ganglion receives motor fibres from the pterygoid nerve, sensory fibres from the facial and glosso-pharyngeal nerves by way of the lesser superficial petrosal nerve, and sympathetic filaments from the plexus about the internal maxillary artery. Delicate nerves pass from the ganglion to the tensor tympani, the tensor of the soft palate and the auditory tube.

[1] *Mandibulum* [L.], the lower jaw.
[2] ὠτικός (oticos) [Gr.], pertaining to the ear (οὖς).

(4) *N. buccinatorius.*—The relatively large buccinator nerve usually leaves the mandibular in common with the pterygoid nerve. It runs downwards and forwards across the medial aspect of the mandibular joint and over the origin of the external pterygoid muscle to gain the deep face of the masseter, where an examination of it has already been effected (page 51).

(5) *N. temporalis superficialis.*—The superficial temporal nerve bends round the back of the mandibular joint, where it lies upon the joint-capsule, to gain the face and divide into two branches, as the dissection of the face has shown (page 37).

(6) *N. alveolaris inferior.*—The inferior alveolar and lingual nerves leave the mandibular as a common nerve-cord that crosses obliquely over the lateral face of the internal maxillary artery. Thereupon the two nerves separate.

The inferior alveolar nerve passes between the two pterygoid muscles in company with the inferior alveolar vessels. The three structures then run between the internal pterygoid muscle and the mandible and enter the mandibular canal together. The nerve supplies branches to the teeth and gums and emerges from the mandibular canal by the mental foramen as the *mental nerve* (n. mentalis), which ends in a number (six or more) of branches that ramify in the lower lip and the region of the chin.

The *mylo-hyoid nerve* (n. mylohyoideus) leaves the inferior alveolar at the mandibular foramen and follows a shallow groove on the medial surface of the mandible. It supplies the mylo-hyoid and mylo-glossal muscles and the anterior belly of the digastricus.

(7) *N. lingualis.*—The lingual nerve is almost as large as the inferior alveolar. At first it lies between the internal pterygoid muscle and the mandible, and then between the mylo-hyoid and stylo-glossal muscles. Its course within the tongue will be determined later.

Close to its independent origin, or even while still in union with the inferior alveolar, the lingual nerve is joined by the chorda tympani, a branch of the seventh cerebral nerve.

N. GLOSSOPHARYNGEUS.—The glosso-pharyngeal or ninth cerebral nerve will be found between the great cornu of the hyoid bone and the external carotid artery, where it lies on the diverticulum of the auditory tube. Its pharyngeal branch (ramus pharyngeus) crosses the medial surface of the great cornu to reach the wall of the pharynx, where it comes into relation with the ascending palatine artery. Along with branches of the vagus and other nerves it assists in the formation of the pharyngeal plexus. The lingual branch (ramus lingualis) continues the line of the course of the main nerve—of which it is much the larger branch—and, consequently, follows the lower border of the hyoid bone in company with the external maxillary artery. It passes medial to the hyo-glossal muscle and ends in the mucous membrane of the posterior part of the tongue, where it is concerned in the sense of taste. Filaments are furnished to the soft palate and the tonsil, and a branch unites with a part of the lingual nerve.

N. HYPOGLOSSUS.—Though a better opportunity for the examination of the hypoglossal [1] or twelfth cerebral nerve will occur later, the dissector should note certain features of its course before the parts are further disturbed. In the present dissection the nerve appears between the external carotid artery and the stylo-hyoid muscle. It follows the lower border of the external maxillary artery as far as the origin of the lingual, where it crosses the medial face of the external maxillary to gain the surface of the hyo-glossal muscle. Continuing its course medial to the mylo-hyoid muscle and parallel to the lower border of the stylo-glossal muscle on the one hand and the submaxillary duct on the other, it gains the substance of the tongue, to the muscles of which it carries motor impulses.

Dissection.—Reflect the stylo-glossal and hyo-glossal muscles.

M. GENIOGLOSSUS.—The genio-glossal muscle is semi-penniform and flattened laterally. It lies against its fellow-muscle—from which it is separated only by loose connective tissue containing a certain amount of fat—and has a distinct tendinous lower border by which it is attached to the symphysis of the mandible. The posterior part of the muscle is fleshy and attached to the body and small cornu of the hyoid bone. From its lower border the fibres of the muscle pass upwards in a radiating manner to gain the substance of the tongue, some curving forwards into the free portion of this organ.

M. CERATOHYOIDEUS.—The cerato-hyoid is a small muscle consisting of fibres running from the thyroid cornu of the hyoid bone to the small and great cornua of the hyoid bone in the neighbourhood of their union. A better view of the muscle will be obtained later.

A. LINGUALIS.—The lingual artery has been followed to its disappearance under the edge of the hyo-glossal muscle (page 60). Its further course can now be examined.

While under (medial to) the hyo-glossal muscle, the artery lies in succession upon the cerato-hyoid muscle, the small cornu of the hyoid bone, and the genio-glossal muscle. It is continued forwards to the tip

[1] ὑπό (hypo) [Gr.], under. γλῶσσα (glossa) [Gr.], the tongue.

of the tongue as the *deep lingual artery* (a. profunda linguæ), on the lateral surface of the genio-glossal muscle. When the tongue is in the normal position of rest, the deep lingual artery is wavy; the undulations being obliterated when the organ is protruded.

The lingual artery (and its continuation, the deep lingual) gives numerous branches to the muscles and mucous membrane of the tongue. Some of these, supplying the posterior part of the dorsum and root, are known as *rami dorsales linguæ*.

M. CHONDROGLOSSUS.—A bundle of muscular fibres may sometimes be found between the hyo-glossal and genio-glossal muscles. The fibres composing the bundle arise in the neighbourhood of the joint between the great and small cornua of the hyoid bone, and run forwards in a nearly horizontal direction, to be lost among the other muscular fibres of the tongue.

Dissection.—Reflect the stylo-hyoid and the posterior belly of the digastric muscle. If the part of the great cornu of the hyoid bone that lies between the origins of the stylo-pharyngeal and stylo-glossal muscles be cut away, a better view of certain muscles of the pharynx will be obtained.

M. CHONDROPHARYNGEUS.—The chondro-pharyngeal muscle arises from the thyroid cornu of the hyoid bone near its junction with the thyroid cartilage of the larynx, a few fibres springing from the lamina of the cartilage itself. Its fibres pass upwards and inwards in the wall of the pharynx to end in the tendinous raphe that occurs in the middle line.

M. CERATOPHARYNGEUS.—The cerato-pharyngeal muscle is not constant, and, when present, is small. In the form of a narrow bundle of fibres, it arises from the medial surface of the great cornu of the hyoid bone not far from its anterior end, and terminates in the pharyngeal raphe underneath the preceding muscle.

It should be noted that the chondro- and cerato-pharyngeal muscles are sometimes described together under the common name of *m. hyopharyngeus.*

M. THYREOPHARYNGEUS.—The thyro-pharyngeal muscle is the broadest of the constrictors of the pharynx. Its origin is from the lateral surface of the lamina of the thyroid cartilage at and in the neighbourhood of its oblique line. Most of the fibres of the muscle end in the pharyngeal raphe; but some of them join a tendinous septum between this muscle and the crico-pharyngeal.

M. CRICOPHARYNGEUS.—The crico-pharyngeal is the most posterior of the constrictor muscles of the pharynx. The fibres composing it arise from the lateral surface of the arch of the cricoid cartilage of the larynx, and are inserted partly into the pharyngeal raphe and partly into the linear tendon between this and the preceding muscle.

The four muscles just described are all constrictors of the pharynx.

Dissection.—Reflect the chondro-, thyro- and crico-pharyngeal muscles. Do this by cutting through them close to their origins. This method removes the danger of injury to the deeper part of the wall of the pharynx.

M. PALATOPHARYNGEUS.—The origin of the palato-pharyngeal muscle from the border of the palatine and pterygoid bones cannot be properly displayed until the soft palate is dissected. A few fibres spring from the wall of the most anterior part of the auditory tube. The muscle itself will be found running along the lateral wall of the pharynx, to end partly in the pharyngeal raphe and partly on the anterior border of the lamina of the thyroid cartilage.

M. PTERYGOPHARYNGEUS.—The pterygo-pharyngeal muscle is thin but moderately broad and triangular, and is not very definitely separated from the palato-pharyngeus. Its origin is from the pterygoid bone, whence it sweeps round the lateral wall of the pharynx to join its fellow in the pharyngeal raphe.

M. STYLOPHARYNGEUS.—The stylo-pharyngeal is a band-like muscle that arises from the upper third of the medial surface of the great cornu of the hyoid bone, passes between the palato- and pterygo-pharyngeal muscles, and ends in the pharyngeal wall.

Dissection.—Clean up the tenth, eleventh and twelfth cerebral nerves as close to the base of the skull as possible. It is not, as yet, convenient to reveal the foramina by which they leave the cranium, but their approximate position may be determined.

N. VAGUS.— The vagus or tenth cerebral nerve leaves the cranium by the jugular foramen in company with the glosso-pharyngeal and accessory nerves. For a variable distance the vagus and accessory nerves are included in a common fibrous sheath.

The vagus runs downwards and backwards, over the wall of the diverticulum of the auditory (Eustachian) tube, to the termination of the common carotid artery, where it meets the sympathetic trunk. From this point onwards the two nerves, enclosed in the same sheath, have been examined in the neck where they follow the dorsal border of the common carotid artery (page 6).

From the part of the vagus that is now under examination arise the pharyngeal ramus and the cranial laryngeal nerve.

(1) The *ramus pharyngeus* runs downwards and forwards over the

diverticulum of the auditory tube, crosses the external carotid artery medially, and divides into two branches. The upper of these supplies the constrictor muscles and the mucous membrane of the pharynx. The lower branch ramifies in connection with the *pharyngeal plexus* (plexus pharyngeus). This plexus is formed by filaments from the glosso-pharyngeal, accessory, hypoglossal, digastric, cranial laryngeal, first cervical and sympathetic nerves; and from it slender nerves pass to the diverticulum, the soft palate, the wall of the pharynx and the commencement of the œsophagus.

(2) *N. laryngeus cranialis.*—The cranial laryngeal nerve crosses the medial face of the external carotid artery, runs over the surface of the crico- and thyro-pharyngeal muscles, and pierces a cleft between the anterior cornu and the lamina of thyroid cartilage to end in the mucous membrane of the larynx, the ventral wall of the pharynx and the commencement of the œsophagus. The terminal part of the nerve will be examined in connection with the larynx.

At the origin of the cranial laryngeal nerve, the vagus is flattened and widened to a variable degree. Sometimes an elongated grey enlargement can be determined. This is the homologue of the *nodose ganglion* (ganglion nodosum) of other mammals.

N. ACCESSORIUS.—The accessory or eleventh cerebral nerve leaves the cranium by the jugular foramen along with the vagus, with which it is included in a common sheath for a distance that varies in different subjects. After separating from the vagus, the accessory, crossing the medial aspect of the submaxillary gland and the occipital artery, passes backwards into the fossa atlantis, where it divides into dorsal and ventral branches. The dorsal branch is joined by a part of the second cervical nerve, and enters the neck between the brachio-cephalic and splenius muscles. Its subsequent course and termination were considered during the dissection of the neck (page 17). The termination of the ventral branch in the sterno-cephalic muscle has also been noted (page 2).

N. HYPOGLOSSUS.—The twelfth cerebral or hypoglossal nerve leaves the cranium by the hypoglossal foramen. Passing obliquely downwards and forwards, it runs between the vagus and accessory nerves at their angle of divergence. Its course on the lateral wall of the diverticulum of the auditory tube and onwards to the tongue has been previously revealed (page 64).

N. CERVICALIS PRIMUS.—The ventral branch of the first cervical nerve enters the fossa atlantis by the foramen alare. Branches are contributed to the sympathetic, hypoglossal and second cervical nerves, and to the pharyngeal plexus, as well as to the sterno-hyoid, omo-hyoid, sterno-thyroid and ventral straight muscles of the head.

Dissection.—Make a longitudinal incision through the lateral wall of the pharynx.

THE PHARYNX.—The pharynx[1] is a funnel-shaped muscular and membranous tube, some 15 cm. in length, extending from the choanæ and mouth, on the one hand, to the beginning of the œsophagus, on the other. Functionally, it belongs to the respiratory as well as to the digestive system, since through it pass both air and food.

By means of the muscles entering into the formation of its wall, the pharynx is attached to the pterygoid, palatine and hyoid bones, and the thyroid and cricoid cartilages of the larynx; while its mucous lining is continuous with that of the nose, mouth, larynx and œsophagus. Its relations are numerous, and among the more important the following should be noted. Dorsally it is in contact with the diverticula of the auditory tubes and a small part of the base of the cranium, while ventrally it overlies the larynx. Its lateral relations include the internal pterygoid muscle, the submaxillary gland, the great cornu of the hyoid bone, the external carotid and external maxillary arteries, and the ninth and twelfth cerebral and the cranial laryngeal nerves.

Dissection of the wall of the tube reveals four layers, namely: (1) a thin layer of pharyngeal fascia; (2) a layer of muscular tissue; (3) an aponeurotic layer; and (4) a lining of mucous membrane. The muscles of the pharynx have already been examined. The aponeurotic layer is intimately connected with the muscles, and gives attachment to some of their fibres. It is continuous with the periosteum covering the bones of the base of the skull and with the other connections of the pharynx, and it forms the raphe pharyngis.

Except where it is adherent to the bones in the neighbourhood of the choanæ, the mucous membrane is of some thickness and contains numerous small glands (glandulæ pharyngeæ), the minute openings of whose ducts can be detected on careful examination. Considerable masses of lymphoid tissue are present in the upper part of the pharynx between the openings of the auditory tubes, where they form the *pharyngeal tonsil* (tonsilla pharyngea). This is best marked in young animals. Along each lateral wall of the cavity there is a very distinct fold of mucous membrane, the *pharyngo-palatine arch* (arcus pharyngo-palatinus), that extends from the soft palate to above the entrance into the œsophagus, where it joins the corresponding fold of the other side.

[1] φάρυγξ (pharynx) [Gr.], the throat.

The cavity of the pharynx (cavum pharyngis) is divisible into dorsal and ventral portions, the plane of separation being indicated by the free edge of the soft palate and the pharyngo-palatine arch, these bound-

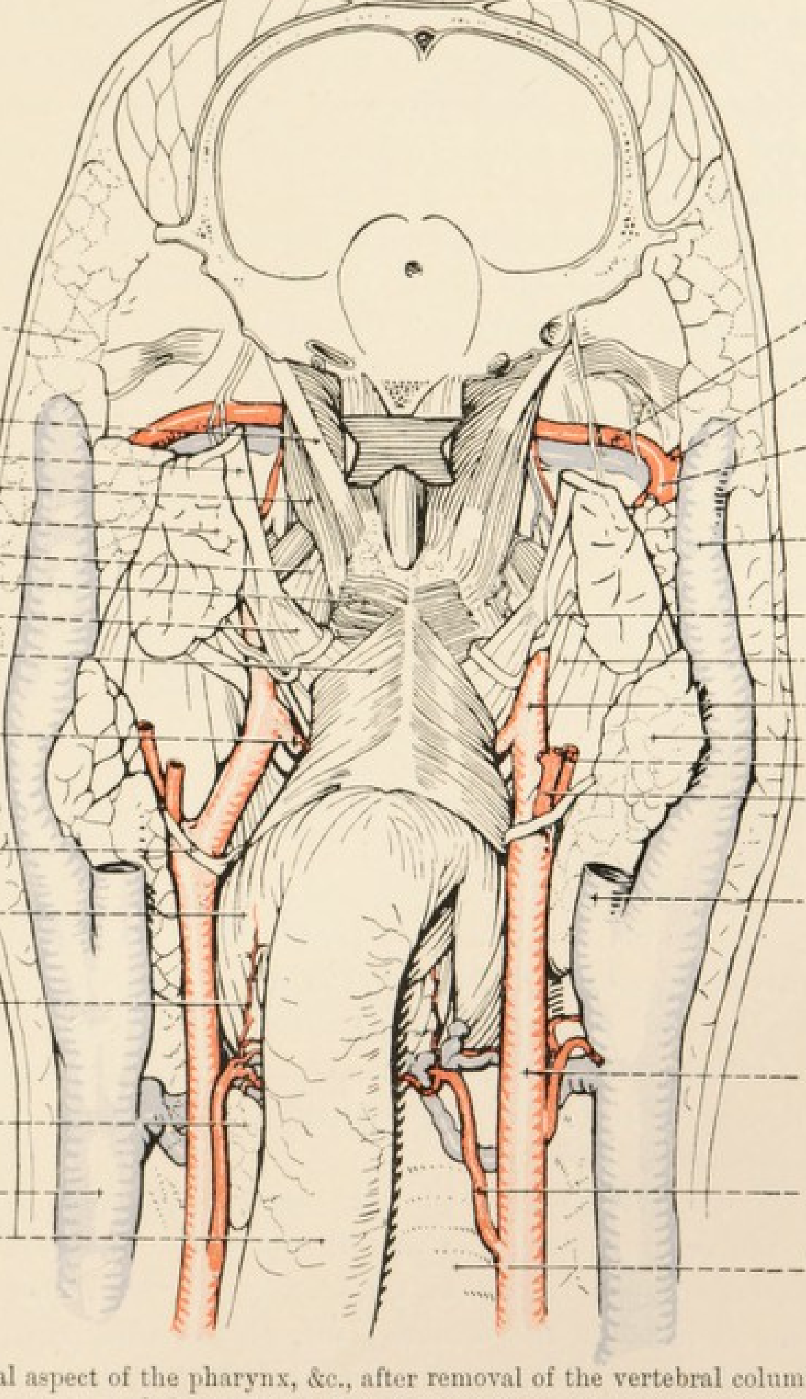


FIG. 20.—Dorsal aspect of the pharynx, &c., after removal of the vertebral column and the occipital part of the skull.

ing an oval *pharyngeal isthmus* that forms a communication between the two parts. The dorsal part (pars respiratoria) communicates with the nasal cavities by the choanæ, and is purely respiratory in function. In the middle line, behind the openings of the auditory tubes, there is a variable blind *pharyngeal recess* (recessus pharyngeus) that is protruded into a gap between the pharyngeal muscles, and is, consequently, in direct contact with the diverticulum of the auditory tube. The ventral part (pars digestoria) is both respiratory and alimentary in function, inasmuch as it communicates with the mouth and dorsal part in the one direction and with the œsophagus and larynx in the other. On each side of the entrance to the larynx there is a narrow but deep *piriform recess* (recessus piriformis). The mucous membrane of the upper part of the cavity is redder than that of the more ventral and caudal part.

There are seven openings into the cavity of the pharynx. Of these the opening from the mouth (isthmus faucium), the opening into the larynx (aditus laryngis) and the continuation of the cavity into the œsophagus, are single and median, and occur in the pars digestoria. Two paired openings, namely, from the nasal cavities (choanæ) and from the auditory tubes, are present in the dorsal part.

The openings of the auditory (Eustachian) tubes, the *ostia*[1] *pharyngea tubæ*, are slit-like apertures, covered medially by the flattened terminations of the cartilaginous wall of the tubes. A small oblique fold of mucous membrane (plica salpingopharyngea) runs downwards from each opening towards the larynx.

> *Dissection.*—The small opening that was previously made in the wall of the diverticulum of the auditory tube should be extended by a horizontal incision sufficiently large to show the whole of the interior of the cavity. Make the incision half-way between the stylo-pharyngeal muscle and the auditory tube.

THE AUDITORY (EUSTACHIAN)[2] TUBE AND ITS DIVERTICULUM—*Diverticulum tubæ auditivæ.*—The diverticulum of the auditory tube is a thin-walled sac, capable of holding some 300 cc. of fluid, formed by the extrusion of the mucous membrane of the tube out of an elongated slit in its ventral wall. Its occurrence, among domesticated mammals, is peculiar to the *Equidæ*.

The diverticulum occupies the whole of the space between the base of the cranium, the atlas and the pharynx; and (except where the ventral straight muscles of the head intervene) it comes into contact with its fellow in the median plane, where a thin partition, formed by the fusion of the mucous linings of the two diverticula, is all that separates the interior of the two cavities.

The anterior limit of the cavity is in the form of a small blind pouch immediately ventral to the body of the anterior part of the sphenoid bone and a short distance from the choanæ; or, expressed in terms of

[1] *Ostium* (dim. of *os*, a mouth) [L.], a small opening.

[2] *Bartolomeo Eustachio*, an Italian anatomist, 1520-1574.

the surface of the head, 4-5 cm. anterior to the posterior border of the ramus of the mandible. The posterior extremity reaches to the level

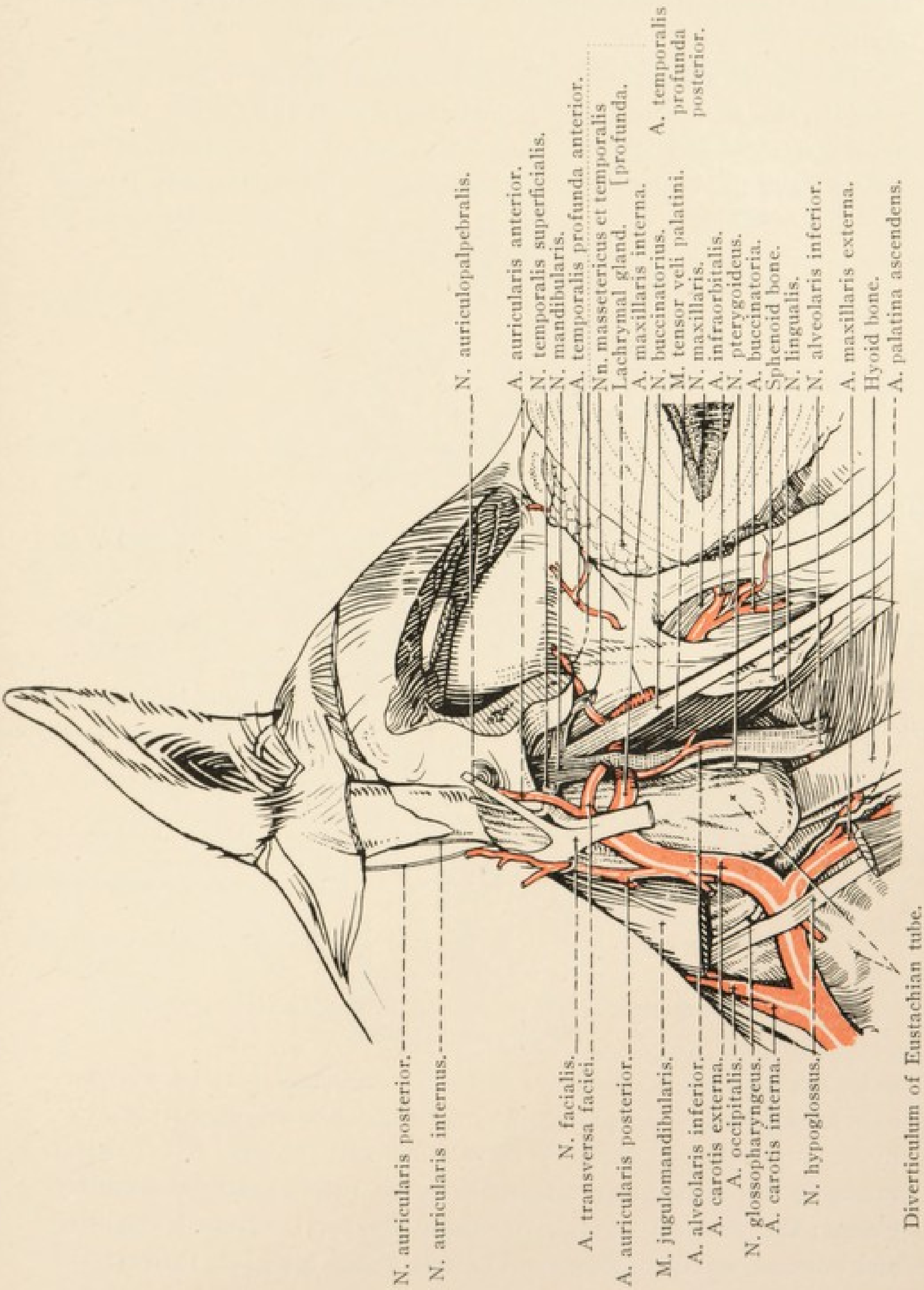


FIG. 21.—The region of the diverticulum of the auditory (Eustachian tube)

of, or possibly just beyond, the joint between the atlas and the epistropheus.

The protrusion of the upper part of the sac over the dorsal border of the great cornu of the hyoid bone, and on to its lateral face, results in a partial separation of a lateral compartment from the main cavity. The lateral compartment embraces not more than a third of the total cavity.

The dorsal relations of the diverticulum are the base of the cranium, the atlanto-occipital articulation, the longus capitis and the ventral straight muscle of the head. Ventrally it is in contact with the pharynx and the beginning of the œsophagus. The structures related

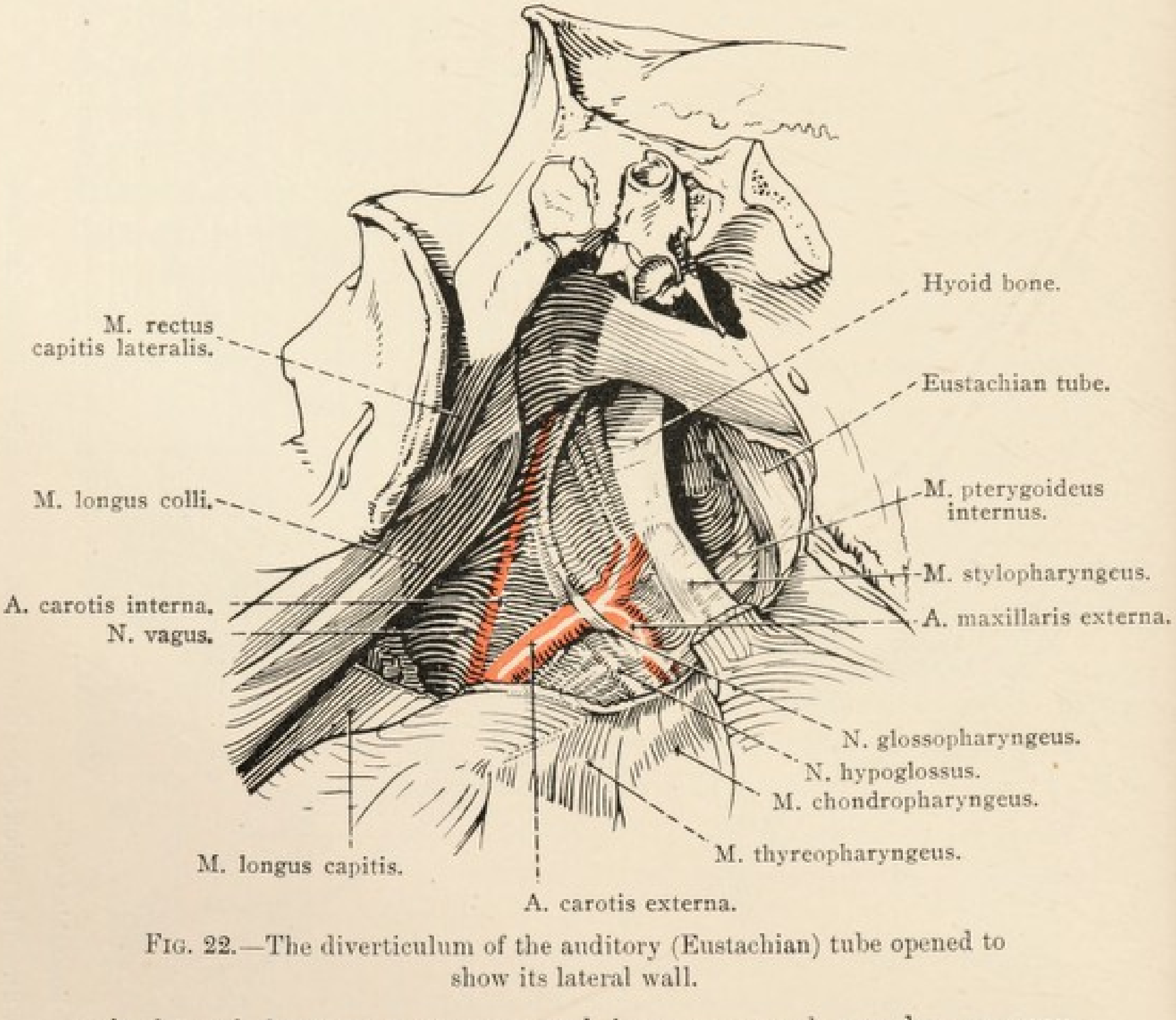


FIG. 22.—The diverticulum of the auditory (Eustachian) tube opened to show its lateral wall.

to its lateral face are numerous and important, and may be summarised as follows:—The pterygoid, jugulo-mandibular, digastric, stylohyoid, jugulo-hyoid, tensor veli palatini and levator veli palatini muscles; the mandibular articulation; the parotid and submaxillary glands; the external carotid, superficial temporal, external maxillary and internal maxillary (first part) arteries and branches thereof; the internal maxillary vein and certain of its tributaries; the facial, glossopharyngeal, hypoglossal and cranial laryngeal nerves, as well as the mandibular nerve and its main branches. The vagus and accessory nerves, the sympathetic nerve trunk and its cranial cervical ganglion, the ventral ramus of the first cervical nerve, the internal carotid and occipital arteries, and the ventral cerebral and occipital veins occupy a fold on the posterior dorsal part of the diverticulum.

The auditory tube runs along the dorsal wall of the diverticulum, and there is no difficulty in recognising the slit through which the diverticulum protrudes.

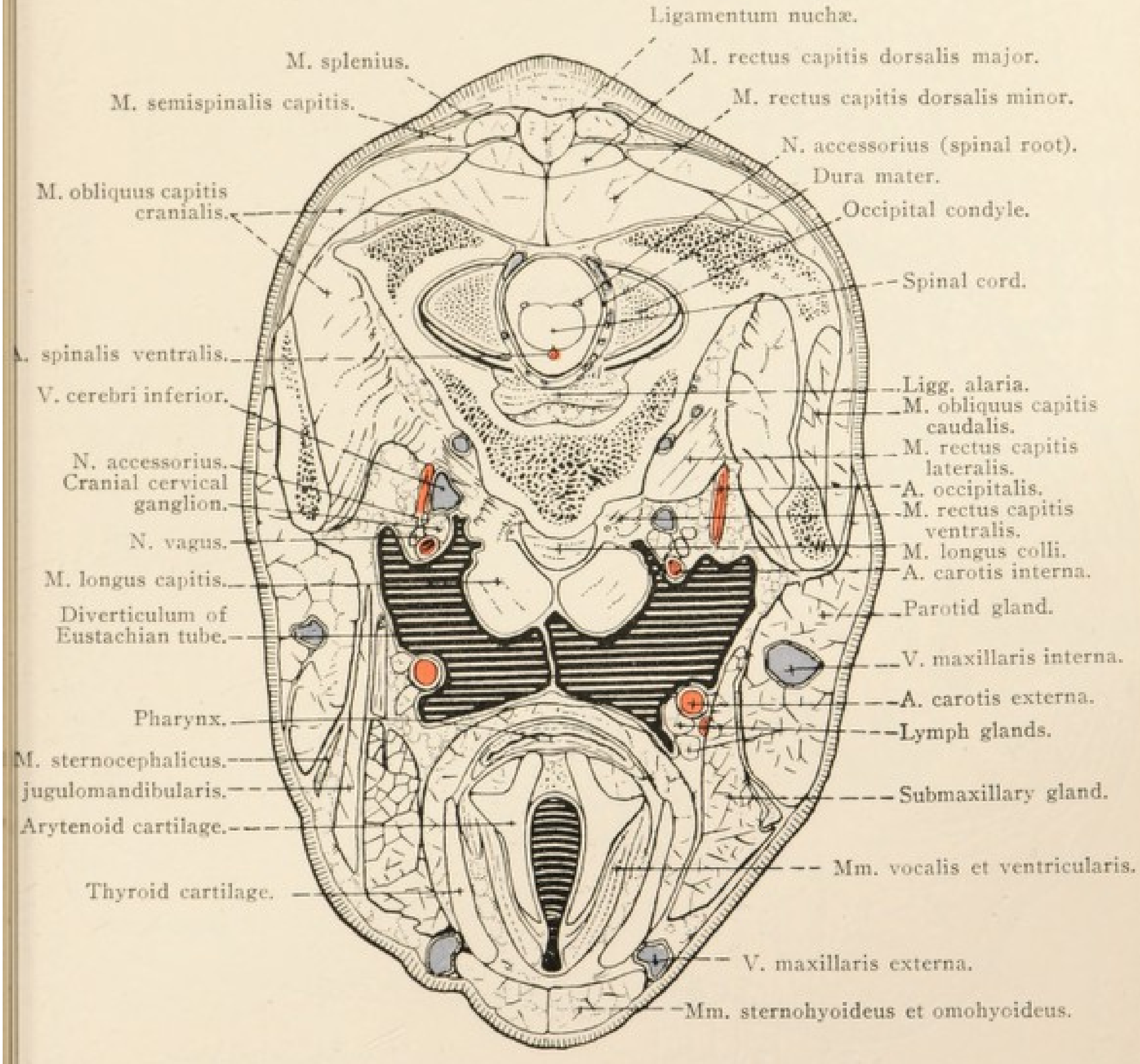
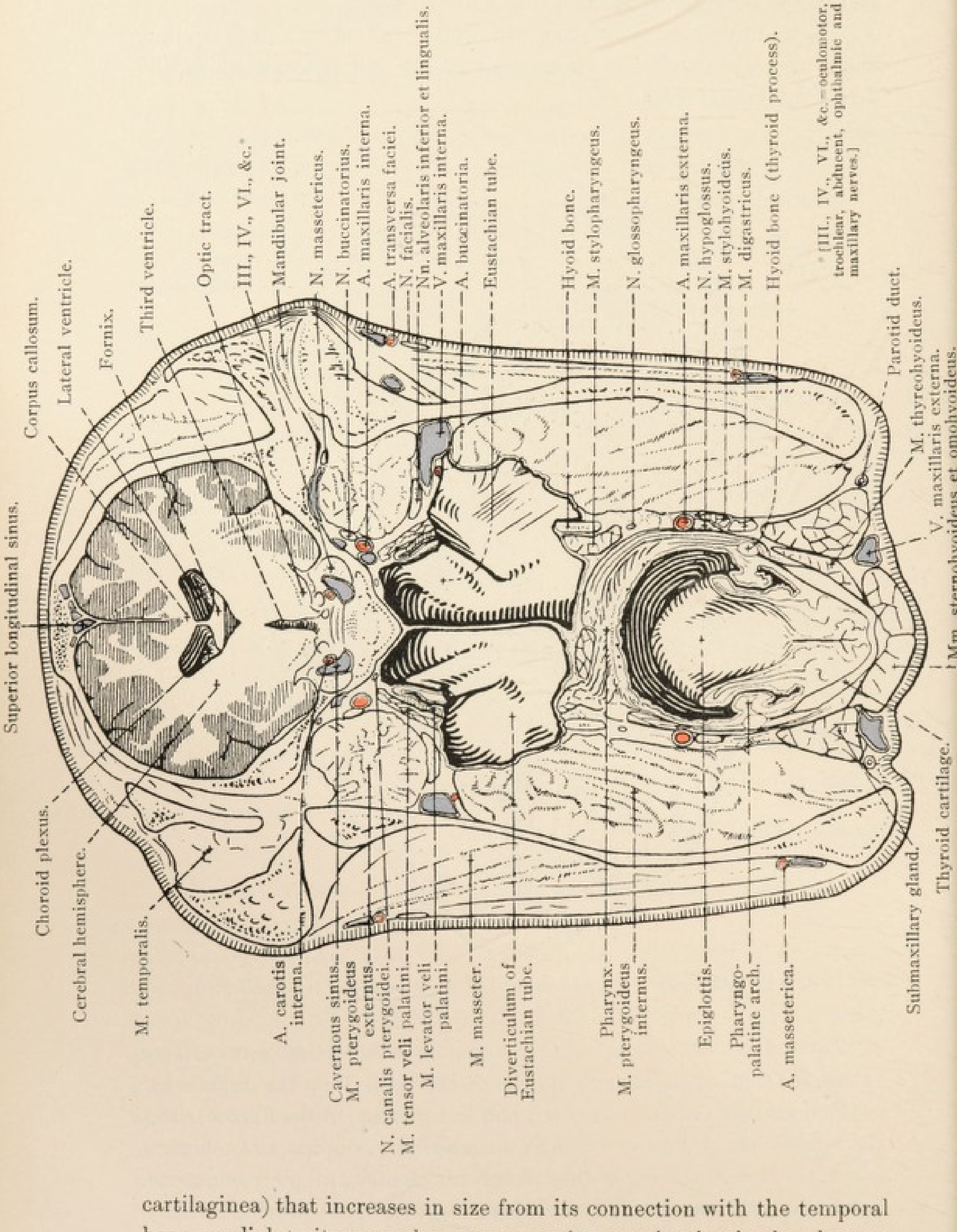


FIG. 23.—Transverse section of the occipital region at the level indicated by B in Fig. 1 (looking forward).

Tuba auditiva.—The auditory tube of Eustachius, some 10 or 11 cm. in length, runs along the base of the skull from the middle ear to the dorsal part of the pharynx; and is adherent to the fibrous sheet that closes the irregular opening between the occipital and temporal bones, the temporal wing of the sphenoid bone and the pterygoid bone. For a short distance at the tympanic end, the tube is provided with a complete bony wall (pars ossea), and this extremity of the tube opens into the middle ear at the tympanic ostium (ostium tubæ tympanicum). The greater part of the tube possesses a cartilaginous skeleton (pars



cartilaginea) that increases in size from its connection with the temporal bone, medial to its muscular process, to its termination in the pharynx at the slit-like pharyngeal ostium (ostium tubæ pharyngeum), which has been examined in association with the cavity of the pharynx. The cartilage is nowhere tubular in form, but should be regarded rather as a

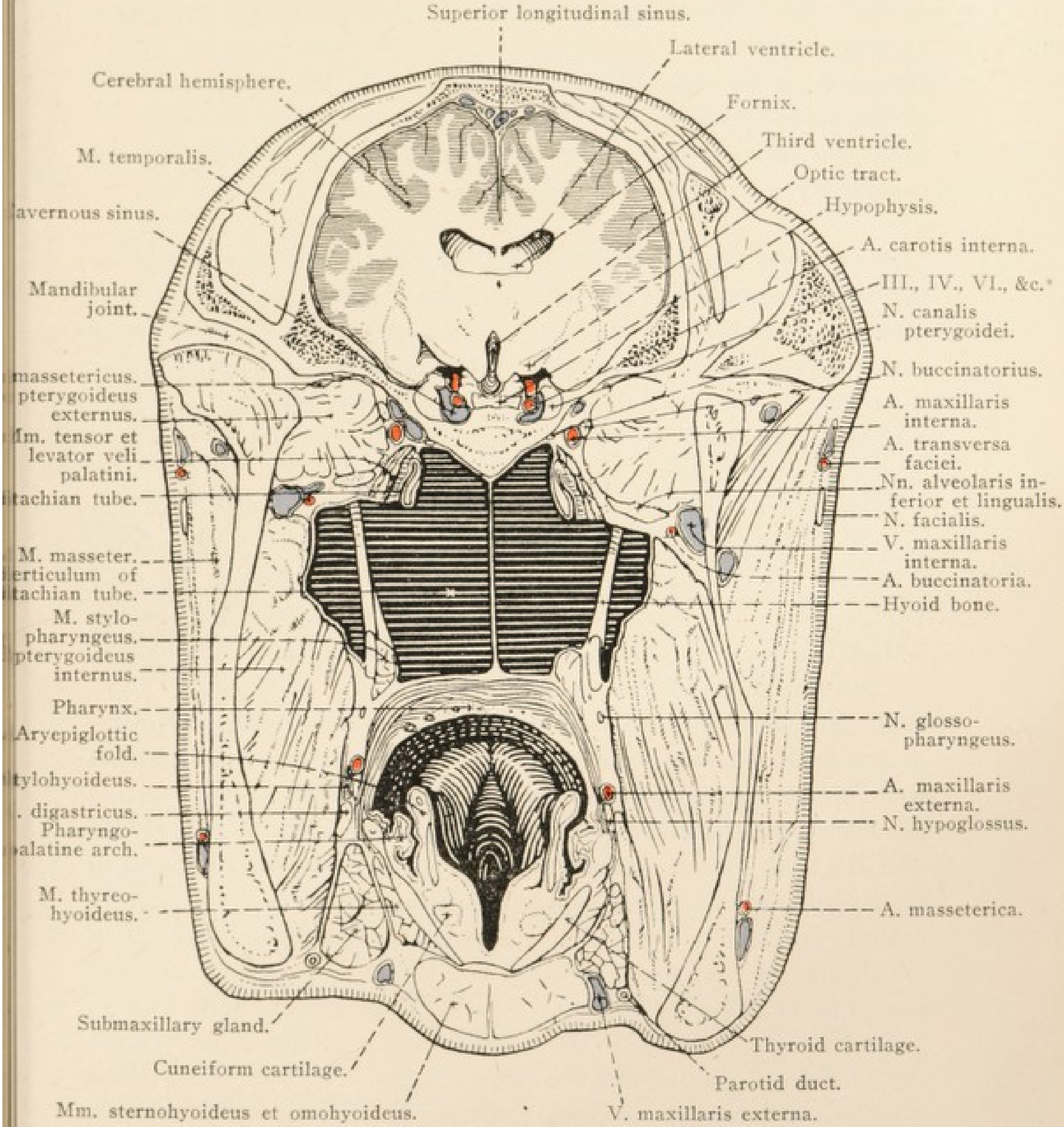


FIG. 25.—Transverse section of the head at the level indicated by C in Fig. 1 (looking backward).

* [III., IV., VI., &c. = oculomotor, trochlear, abducent, ophthalmic and maxillary nerves.]

relatively narrow strip, increasing in width from the temporal to the pharyngeal end, and folded upon itself longitudinally so that medial and lateral laminæ, united dorsally, are produced. The lateral lamina is narrow throughout, and is covered by the tensor and levator muscles of the soft palate. The medial lamina is that part of the cartilage which widens towards the pharyngeal ostium, and it is this that constitutes the basis of the broad, valve-like projection at the ostium. For a short distance close to the temporal bone the edges of the laminæ are united by fibrous tissue; but for the greater part they are separated by the elongated slit through which the diverticulum is protruded. Because of the disposition of the cartilage, the lumen of the tube is slit-like in transverse section, and its calibre increases from the tympanic to the pharyngeal ostium.

THE SOFT PALATE (Palatum molle).—The soft palate is a long (about 15 cm.) and broad, movable partition between the mouth and the pharynx. One border is attached to the posterior margin of the bony palate; while the other border is free and gently concave (arcus palatinus). When the soft palate is at rest, its free border is in contact with the glosso-epiglottic fold of mucous membrane, and is overlapped by the curved free part of the epiglottis.

The lateral borders of the soft palate are connected with the palatine and pterygoid bones. The dorsal or pharyngeal surface forms a slightly curved and oblique continuation of the floor of the nose. The ventral or oral surface, which is continuous with the hard palate, is slightly concave and in contact with the posterior part of the tongue, and is longitudinally folded.

Prolongations of the mucous membrane of the soft palate are continuous with the tongue and the wall of the pharynx in the form of folds known as the *glosso-palatine* and *pharyngo-palatine arches* (arcus glossopalatinus et arcus pharyngopalatinus). The glosso-palatine arch is a thick fold that passes from the lateral border of the tongue to the lateral part of the oral surface of the soft palate, and lies slightly behind the last cheek-tooth. The pharyngo-palatine arch is a prominent fold, continuous with the free border of the soft palate, and sweeps backwards along the lateral wall of the pharynx to unite with its fellow immediately dorsal to the opening into the œsophagus. In the angle of divergence of the two arches is the *tonsillar sinus* (sinus tonsillaris) in which the flattened *palatine tonsil* (tonsilla palatina)—a collection of lymphoid nodules and mucous glands—is readily distinguished because of the presence of small flattened elevations and numerous tonsillar crypts. In the horse, the tonsil is not sharply defined, as it is in the dog, but extends beyond the proper limits of the tonsillar sinus and is diffused over the posterior part of the tongue (lingual tonsil).

Structurally the soft palate may be described as composed of four layers:—(1) The relatively thick oral mucous membrane continuous with that of the hard palate; (2) a layer of *palatine glands;* (3) an aponeurotic and muscular layer; and (4) the pharyngeal mucous membrane continuous with that of the nasal cavity.

Dissection.—Dissect the mucous membrane from the pharyngeal surface of the soft palate. The muscular and aponeurotic layer contains the origin of the palato-pharyngeal muscle (already dissected in connection with the wall of the pharynx), the termination of the levator and tensor muscles of the palate, and the muscle of the uvula (m. uvulæ). It is convenient to dissect the whole length of the tensor and levator muscles at this stage.

M. UVULÆ.—The muscle of the uvula[1] is often described as being unpaired, but probably the best way to regard it is as a pair of muscles (right and left) blended in the middle line of the soft palate. It has a wide aponeurotic origin from the free border of the palatine bone, and ends near the free border of the soft palate.

M. TENSOR VELI PALATINI.—The tensor of the soft palate lies along the lateral surface of the auditory tube. Arising from the muscular process of the temporal bone, the lateral lamina of the cartilage of the auditory tube and the pterygoid bone, the muscle ends in a narrow, flattened tendon that bends round the hamulus of the pterygoid bone to end in the general aponeurosis of the soft palate. A small synovial bursa facilitates the play of the tendon round the pterygoid hamulus.

M. LEVATOR VELI PALATINI.—The levator of the soft palate arises from the muscular process of the temporal bone and the lateral lamina of the cartilage of the auditory tube in common with the tensor, medial to which it lies. The two levator muscles (right and left) enter the substance of the soft palate close together.

Dissection.—Reflect the muscular and aponeurotic layer of the soft palate so as to expose the glands.

The greyish-yellow *palatine glands* (glandulæ palatinæ) form a layer of 1 cm. or more in thickness. It is important to note that their ducts open only on the ventral or oral surface of the soft palate; that is, the mucous glandular secretion is poured out on that surface with which the food comes into contact during its passage from the mouth to the pharynx.

Dissection.—Make a longitudinal incision through the most lateral part of what still remains of the soft palate.

THE MOUTH (Cavum oris).—The cavity of the mouth is the initial part of the alimentary tract and extends from the lips to the isthmus

[1] *Uvula* [L.], dim. of *uva*, a grape.

faucium, by which it communicates with the pharynx. The isthmus faucium is circumscribed by the soft palate dorsally, the glosso-palatine arch laterally, and the tongue ventrally. The cavity of the mouth is bounded in front by the lips, and laterally by the cheeks. The roof is formed by the hard and soft palates, and the posterior limit is defined by the soft palate, where it lies in contact with the most posterier part of the tongue. The ventral boundary is constituted by the tongue and the "floor of the mouth" or sublingual region.

The mouth cavity comprises two parts: (1) the *vestibule* (vestibulum oris); and (2) the *mouth cavity proper* (cavum oris proprium).

The vestibule consists of a narrow space between the lips and cheeks on the one hand and the teeth and gums on the other. The mucous membrane reflected from the lips and cheeks to the incisive, maxillary and mandibular bones forms its upper and lower boundaries. In front the vestibule communicates with the exterior by an elongated opening (rima oris) between the lips. Communication between the vestibule and the mouth cavity proper is effected through the spaces between the incisor, canine and cheek-teeth, and behind the last cheek-tooth. Into the vestibule, on each side, open the ducts of the parotid and buccal glands.

The mouth cavity proper is contained within the dental arches, by which, and the gums connected therewith, it is bounded in front and on each side. Behind it communicates with the cavity of the pharynx through the isthmus faucium. The roof of the cavity is formed by the hard and soft palates, while the floor is formed by the tongue and the mucous membrane extending therefrom to the mandible. Into this part of the mouth open the ducts of the sublingual and submaxillary glands.

THE LIPS (Labia).—A preliminary inspection of the lips was made at an earlier stage (page 33). They must now be examined more thoroughly.

Each lip may be regarded as consisting of four layers:—(1) The outer surface is covered by skin that is closely adherent to the underlying muscular layer. On it two, or possibly three, kinds of hair may be distinguished. The most numerous are fine and short, and resemble those over the face in general. Sometimes much longer hairs, also moderately fine in quality, form a veritable moustache on the upper lip. Long and strong tactile hairs (sinus-hairs) are fairly abundant, these passing through the entire thickness of the skin, to be embedded in the underlying muscle. (2) A muscular layer constitutes the greater part of the whole thickness of the lip and contains a sphincter muscle

(m. orbicularis oris) and the terminations of such other muscles that converge upon the oral fissure. The orbicular, zygomatic, naso-labial and canine muscles, the depressor of the lower lip and the levator of the upper lip have been examined along with other constituents of the face. There remain the incisive and mental muscles, and these may be dissected after the mucous membrane has been examined. (3) Small collections of *labial glands*—better developed in the upper lip and more numerous towards the commissures — form an imperfect third layer. They are in the shape of small yellowish masses that elevate the mucous membrane and can be seen shining through it. (4) The mucous membrane lining the inner surface of each lip is relatively thin and continuous with that clothing the rest of the cavity of the mouth. A *frœnulum of the lip* (frænulum labii), such as is conspicuous in man, is absent in the horse. Skin and mucous membrane meet at the free border of the lip.

Mm. incisivi.—In order to expose the incisive muscles, the mucous membrane must be dissected away from the inner surface of the lips. The upper incisive muscle (m. incisivus superior) arises from the alveolar border of the incisive bone from the second incisor to the canine, or possibly a little beyond. Its fibres run into the lip and the lateral wing of the nostril. The lower incisive muscle (m. incisivus inferior) has a corresponding origin from the mandible and ends in the lower lip and the chin.

M. mentalis.—This forms the muscular component of the chin. Its fibres arise from the incisive part of the mandible and end, some in the skin of the chin, and some by blending with the orbicular muscle in the lower lip.

Vessels and nerves of the lips.—The distribution of the superior and inferior labial arteries has been noted previously. At the incisive foramen an additional artery of moderate size should be looked for—*a. nasolabialis*—formed by the union of the end of the two greater palatine arteries. After freeing itself of the incisive foramen, the vessel divides into two branches that ramify in the upper lip and anastomose with branches of the superior labial artery.

The nerves ending in the lips are derived from the dorsal and ventral buccal branches of the facial (motor) and the infraorbital and mental branches of the trigeminal nerve (sensory).

THE TONGUE (Lingua).—The tongue is an organ concerned in mastication, deglutition and taste, and consists mainly of a mass of muscular tissue covered by mucous membrane. It is placed between the two halves of the mandible, where it is supported by the mylo-glossal and mylo-hyoid muscles.

In its anterior half the tongue is flattened dorso-ventrally, but posteriorly it is so thickened that a transverse section presents a triangular outline. The broadest part is close to the anterior extremity.

It is customary to divide the tongue into three parts. The main mass is known as the *body* (corpus linguæ), the *tip* or *apex* (apex linguæ) is the blunt, free extremity, and may be separated from the body by an imaginary transverse line drawn on a level with the first premolar tooth; the *root* (radix linguæ) is the fixed part that is connected by muscles and mucous membrane to the mandible, hyoid bone, pharynx, epiglottis and soft palate. While the body of the tongue possesses three surfaces—dorsal and two lateral—separated by rounded borders, the tip, because of the aforementioned flattening, has only dorsal and ventral surfaces bounded by thick, lateral margins.

The term *dorsum*[1] *linguæ* is applied to that surface of the tongue which, when the organ is at rest, is in contact with the hard and soft palates. In some animals, *e.g.*, the dog, the dorsum is divided longitudinally into two lateral halves by a median sulcus. This groove is absent in the horse.

The whole of the dorsum and lateral borders is thickly studded with elevations of the mucous membrane, the *lingual papillæ*[2] (papillæ linguales), of which four kinds can be distinguished, namely, filiform, fungiform, vallate and foliate. The *filiform*[3] *papillæ* (papillæ filiformes) are most numerous, and occur over the whole of the dorsum and on the borders of the tip. They are small, thread-like and soft, and produce the characteristic velvety appearance of the tongue of the horse. The *fungiform*[4] *papillæ* (papillæ fungiformes), less numerous than the filiform, occur principally on the tip and borders and on the lateral surface of the body of the tongue. They are shaped somewhat like mushrooms, and can be distinguished readily by their rounded form and pale colour. The *vallate*[5] *papillæ* (papillæ vallatæ) are two in number, and occur on the posterior part of the dorsum, one on each side of the middle line, about 2·5-3 cm. apart. Each vallate papilla is large, with a slightly constricted base and a flattened tubercular crown that reaches a little above the general level of the mucous membrane Around each papilla there is a circular fossa with an outer wall known as the *vallum*. Occasionally there is a third vallate papilla, of smaller size, placed in the middle line behind the other two. The *foliate*[6]

[1] *Dorsum* [L.], the back.
[2] *Papilla* [L.], a nipple.
[3] *Filum* [L.], a thread. *Forma* [L.], form.
[4] *Fungus* [L.], a mushroom.
[5] *Vallatus* [L.], walled (*vallum*, a wall, rampart).
[6] *Foliatus* [L.], leaved (*folium*, a leaf).

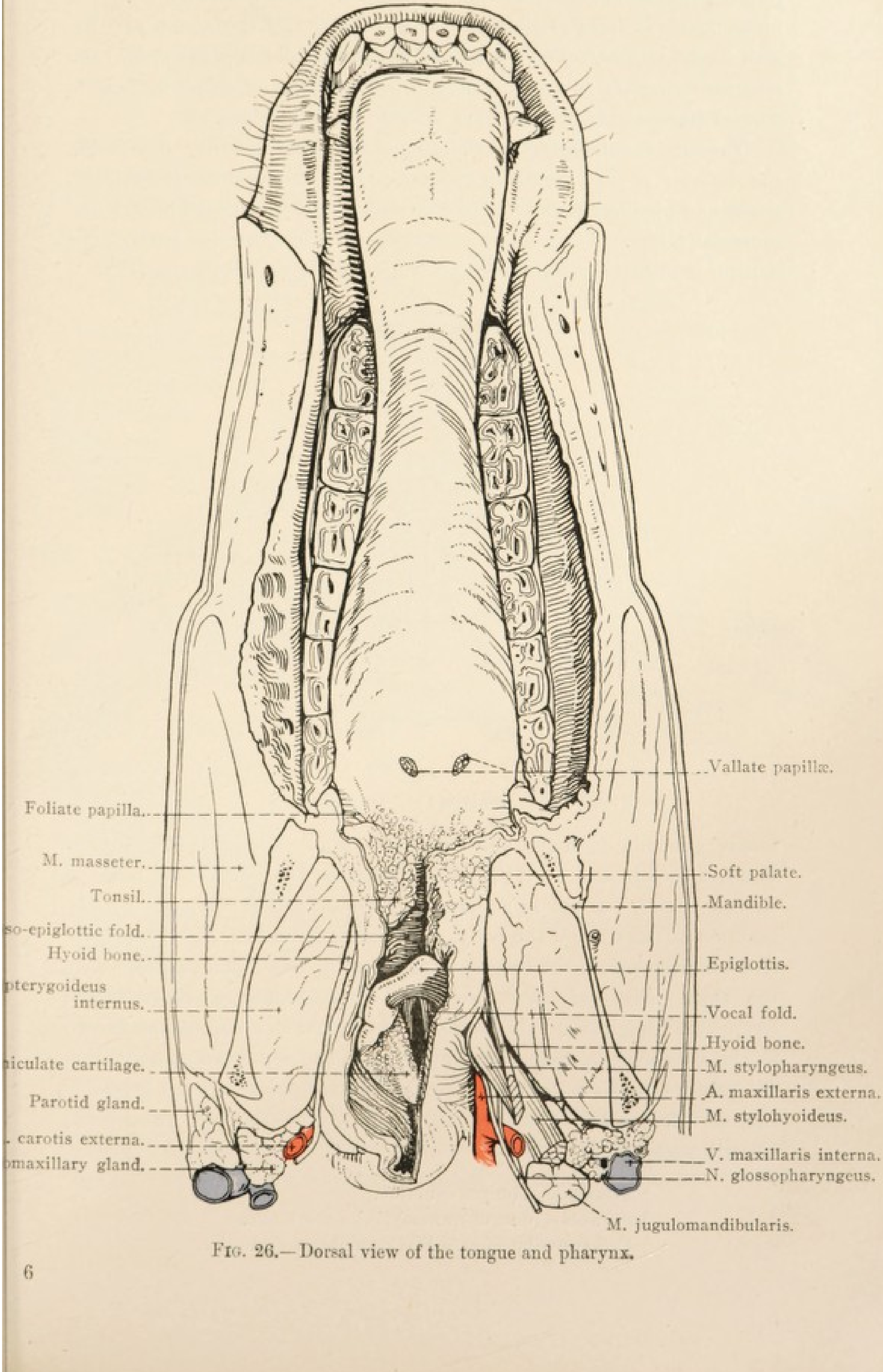


FIG. 26.—Dorsal view of the tongue and pharynx.

papillæ (papillæ foliatæ) are two in number. One occurs on each side immediately in front of the point of attachment of the glosso-palatine arch to the tongue. The term "papilla" is scarcely applicable, for each structure consists of an oval area, about 2 cm. or more in length, crossed transversely by a number of ridge-like elevations.

The mucous membrane of the tongue is continuous with that lining the interior of the mouth in general. Over the dorsum it is thick, dense and papillated, and firmly adherent to the underlying fibrous and muscular tissue. The mucous membrane of the posterior part of the dorsum is plentifully supplied with lymphoid tissue, forming a *lingual*

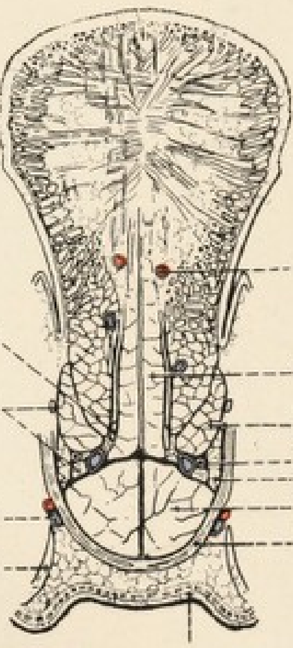


FIG. 27.—Transverse section of the tongue.

tonsil [1] (tonsilla lingualis), and tonsillar crypts are abundant and obvious. Beneath the tip and over the lateral surfaces the membrane is much thinner, softer, and not so adherent to the subjacent tissues. At the junction of the tip and the body, a median sagittal fold, the *frænulum*[2] *linguæ*, passes from the tongue to the floor of the mouth. Posteriorly the thick *glosso-epiglottic fold* (plica glossoepiglottica) connects the tongue and epiglottis. On each side of the fold is a depression, known as the *epiglottic vallecula*,[3] continuous with the depressed area in which the palatine tonsil is lodged. The thick *glosso-palatine arch*, a fold of mucous membrane connecting the tongue with the soft palate, has already been noted.

[1] *Tonsilla* [L.], (origin doubtful).

[2] *Frænulum* (dim. of *frænum*) [L.], a check-rein.

[3] *Vallecula* (dim. of *vallis*) [L.], a valley, a depression.

The muscles of the tongue (musculi linguæ).—The muscular tissue of the tongue is generally divided into that which belongs to the extrinsic muscles and that which is intrinsic to the tongue itself. The extrinsic muscles—stylo-glossal, hyo-glossal, genio-glossal and chondro-glossal—were examined at earlier stages in the dissection. The intrinsic muscular fibres are longitudinal, transverse and vertical in direction.

In the horse a very inconspicuous layer of loose connective tissue in

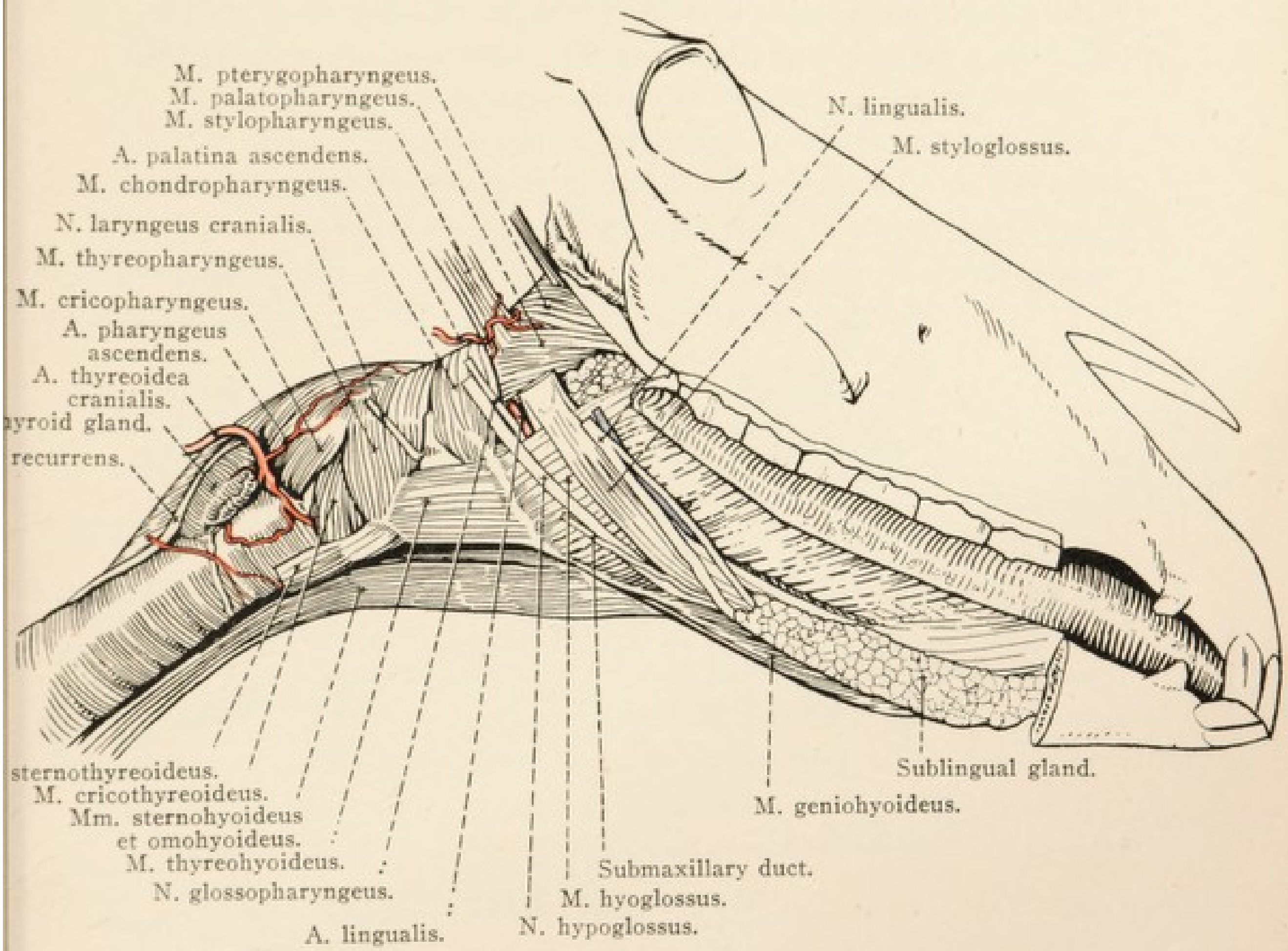


FIG. 28.—Lateral aspect of the pharynx, larynx and tongue.

the median plane, and separating the muscles of the two halves of the organ, is all that represents the *lingual septum* [1] (septum linguæ).

Arteries and nerves of the tongue.—The lingual artery has been traced into the tongue previously (page 64), and all that now remains to be done is to determine the ending of its smaller twigs in the mucous membrane, &c. The lingual ramus of the glosso-pharyngeal nerve supplies the mucous membrane of the posterior part of the tongue, and branches of the hypoglossal nerve should be found entering the various muscles.

[1] *Septum* or *sæptum* [L.], a partition.

The lingual nerve, a branch of the mandibular, has been followed between the internal pterygoid muscle and the mandible, and then between the mylo-hyoid and stylo-glossal muscles. It finally divides into two branches, superficial and deep. The superficial branch (ramus superficialis) continues forwards on the medial surface of the sublingual gland, and ends in the mucous membrane of the floor of the mouth and the adjacent part of the tongue. A recurrent branch passes towards the posterior part of the tongue and anastomoses with the lingual branch of the glosso-pharyngeal. The deep branch (ramus profundus) bends round the lower border of the stylo-glossal muscle and runs to the tip of

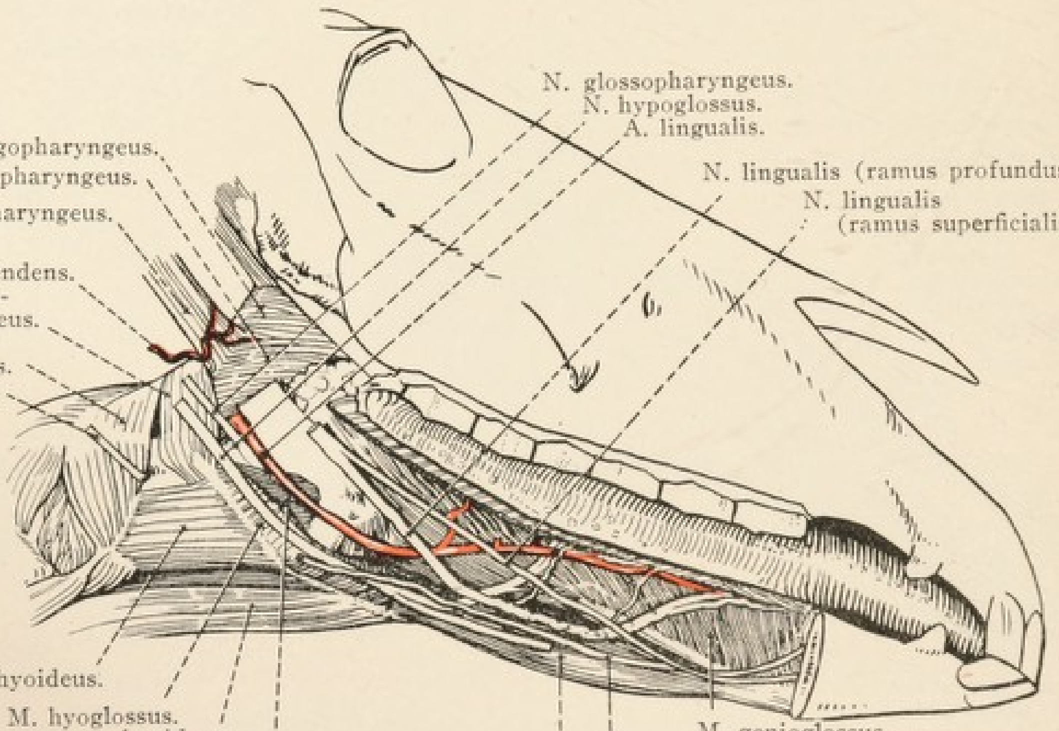


FIG. 29.—Lateral aspect of the pharynx and tongue.

the tongue on the lateral surface of the genio-glossal muscle. It supplies the mucous membrane, and its twigs unite with the superficial branch and the hypoglossal nerve.

THE TEETH (Dentes).—A tooth consists of a *crown* (corona dentis) visible above the gum, a *neck* (collum dentis) embraced by the gum, and a *root* or roots (radix [radices] dentis) embedded in the bony *tooth cavity* (alveolus [1] dentalis). The crown has a chewing surface (facies masticatoria), a surface covered by the lips or cheek (facies labialis: facies buccalis), and a surface looking towards the tongue (facies lingualis). Generally a tooth touches its neighbour by a surface of

[1] *Alveolus* (dim. of *alveus*) [L.], a small trough or cavity.

contact (facies contactus). All except old teeth contain a cavity (cavum dentis) entered by an opening at the apex of the root (foramen apicis dentis) and containing the tooth pulp (pulpa dentis).

With the naked eye it is possible to determine that there are three hard tissues entering into the composition of a tooth. *Dentine* (substantia eburnea)[1] constitutes the greater part of the structure. *Enamel* (substantia adamantina)[2] forms the porcelain-like covering of the crown; and *cement* (substantia ossea), a bone-like tissue, covers the root and, especially in the cheek-teeth of herbivora, may form a layer of considerable thickness over the enamel of the crown.

Teeth are classified from before to behind as *incisors* (dentes incisivi), *canines* (dentes canini), *premolars* (dentes præmolares) and *molars* (dentes molares). For the sake of convenience, it is customary to include the premolars and molars under the common designation of *cheek-teeth*. The number of teeth in each group may be indicated by a *dental formula*, of which the following is an example:—

$$\frac{i_3,\ c_1,\ pm_4,\ m_3}{i_3,\ c_1,\ pm_4,\ m_3} = \frac{11}{11} \times 2 = 44.$$

The above formula shows that the animal to which it applies, *e.g.*, the pig, has three incisors, one canine, four premolars, and three molars on each side of both the upper and lower rows of teeth. To save time, the initial letters of the different classes of teeth may be omitted, and the formula written $\frac{3\,1\,4\,3}{3\,1\,4\,3}$.

In mammals in general there are two sets of teeth, namely, *deciduous*, "milk," or temporary (dentes decidui), and *permanent* (dentes permanentes); and it should be noted that, of the cheek-teeth, only the premolars are represented in both sets.

The number of teeth in the foal and the adult horse may be best indicated by the following formulæ:—

$$\textit{Deciduous dentition}\ \frac{i_3,\ c_1,\ pm_4}{i_3,\ c_1,\ pm_4} = \frac{8}{8} \times 2 = 32.$$

$$\textit{Permanent dentition}\ \frac{i_3,\ c_1,\ pm_3,\ m_3}{i_3,\ c_1,\ pm_3,\ m_3} = \frac{10}{10} \times 2 = 40.$$

In the above formulæ, the rudimentary and exceedingly interesting first premolar has been counted as belonging to the deciduous dentition; but it must not be forgotten that in some instances, especially when its development is greater than usual, it persists long after the other deciduous teeth have been shed, and on this account it might be contended that it should be included in the permanent dentition. It will

[1] *Ebur* [L.], ivory.

[2] ἀδαμάντινος (adamantinos) [Gr.], very hard.

simplify subsequent description to dismiss the first premolar now, and later describe the rest of the premolars and the molars under the common and convenient name of "cheek-teeth."

From its rudimentary character as compared with its neighbours, and from its inconstancy in development, it is natural to suspect that the first premolar is in process of gradual, if slow, disappearance; and

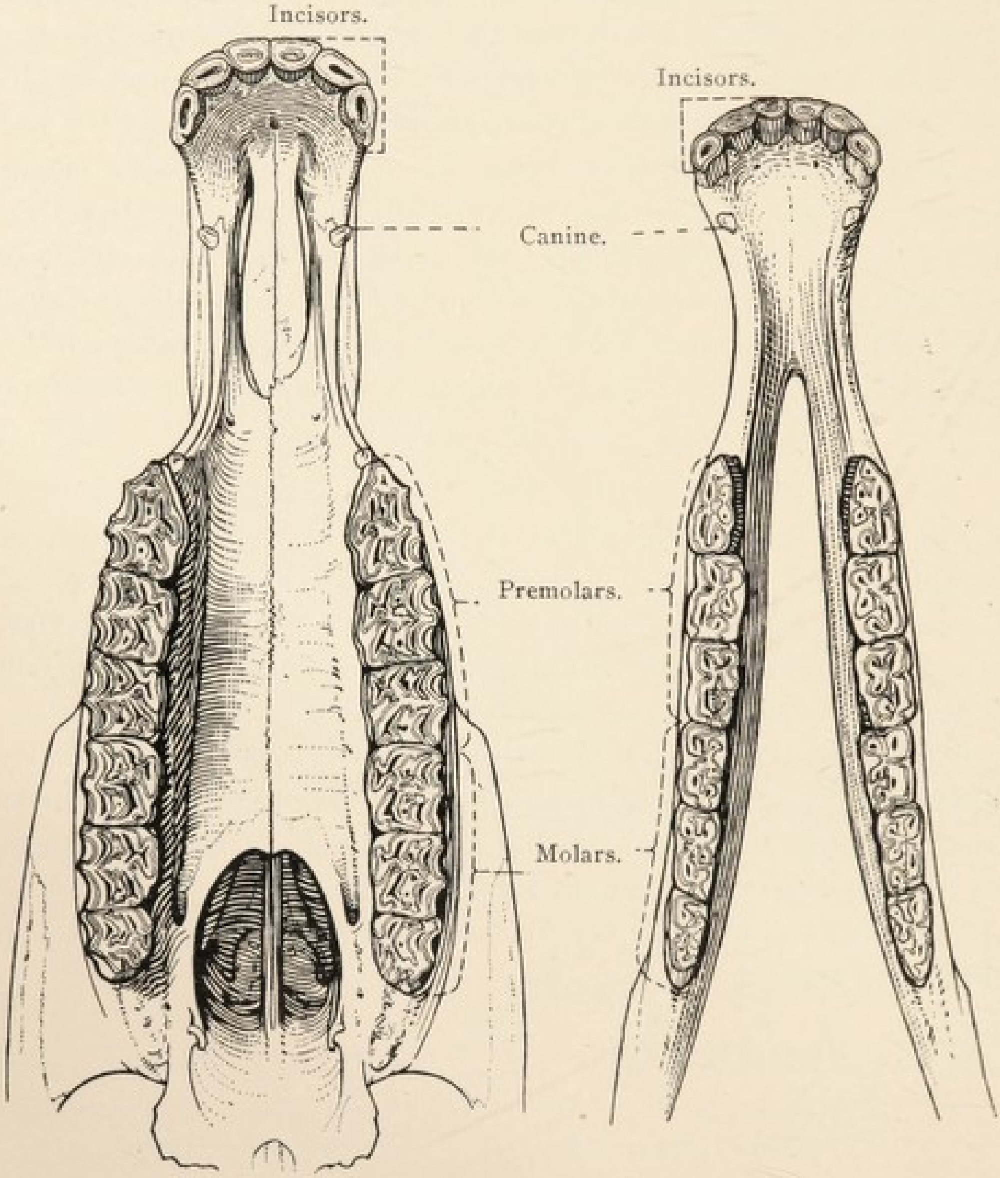


Fig. 30.—The maxillary and mandibular teeth.

that this is so is proved by the fossil remains of some of the ancestors of the modern horse, in which a first premolar was relatively large and obviously functional. In the mandible the tooth is frequently absent, and, when present, is of very small size. In the maxilla it is more commonly found, but it is variable in size. At its maximum development the crown of the tooth is small and irregularly conical, presenting some indication of the enamel-folding that is so characteristic of the other cheek-teeth of the horse. When less well developed, the crown is generally a small and simple cone. At its best the mandibular tooth is small and possessed of a simple conical crown.

In the permanent dentition the *incisor teeth* have crowns that are compressed in such a manner as to produce a labial and a lingual surface, and the chewing surfaces are oval or ovoid.[1] The crown of the first incisor is the longest and broadest, while that of the third tooth is the shortest and smallest. In none of them is there any constriction indicating the

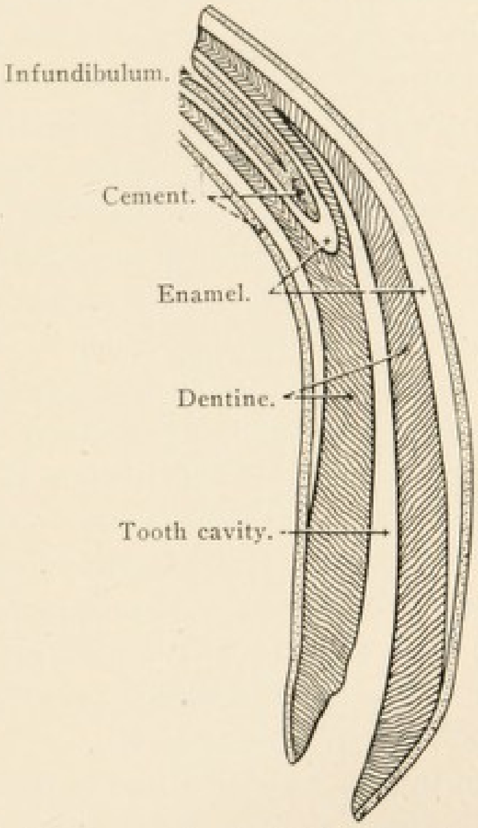


FIG. 31.—Diagram of longitudinal section of an incisor tooth.

position of the neck. The roots of all the incisors are long and curved, and so implanted in the bone that they are directed towards a common point. The root of the first tooth is somewhat longer than that of the second, while that of the third is the shortest. The curvature of the root is more marked in the maxillary than in the mandibular teeth.

[1] The description here given of the crowns of the various teeth is intended to apply to the exposed parts in young adult animals. If the term "crown" is held to include all that part of a tooth on which enamel is present, the teeth of the young adult must be described as having a considerable amount of their crowns buried beneath the gum ; for sections show that folds of enamel are carried very deeply into the interior of the tooth, with a corresponding prolongation of the surface enamel down into the tooth-socket. That is, in the young tooth there is an exposed crown, visible above the gum, and an embedded part of the crown to which it is customary to apply loosely the name root ; though the root, in the strict application of the term, is the comparatively short, enamel-free, deepest part of the tooth. As the tooth wears away the embedded part of the crown is gradually exposed.

Owing to a peculiarity in the disposition of the tissues of the teeth, the chewing surface of the horse's incisors presents a characteristic appearance. In the tooth that has not been subjected to wear, the enamel is deeply folded into what, from its funnel-like form, may conveniently be called the "infundibulum." The ridge round the infundibulum at this time consists of enamel, and is higher and thicker in front than it is behind the depression. The infundibulum contains a certain amount of cement, as do also the inequalities on the surface of the crown. When the tooth has been used to a certain extent, the enamel surrounding the infundibulum becomes worn through, and the underlying dentine is exposed. The ridge in front of the infundibulum is worn through first since it is slightly higher than that behind. In a little time the infundibulum is surrounded by three rings of alternating enamel and dentine. There is a ring of enamel that lines the infundibulum, and outside this a ring of dentine, surrounded in its turn by another ring of enamel. A certain amount of cement is present within the inner ring and outside the outer ring of enamel.

With the advance of age it is obvious that the infundibulum will gradually wear out, and, seeing that the pulp-cavity extends into the crown beyond the deepest part of the infundibulum, it is clear that the sensitive pulp will become exposed unless some provision is made to prevent this. As the tooth ages the pulp is gradually converted into a variety of dentine, with the result that, when the infundibulum has been worn away completely, the dentine that has replaced the pulp shows on the chewing surface of the incisor as a dark-coloured island in front of the place occupied formerly by the infundibulum.

With advancing age also the embedded part of the crown gradually emerges from the tooth-socket, and the outline of the chewing surface changes from an oval to a triangle. In advanced age, moreover, the incisors assume a more horizontal implantation into the jaw.

In addition to their smaller size, the *deciduous incisors* can be distinguished from those of the permanent dentition by the greater smoothness and whiteness of the crown, the presence of a constricted neck, and the small size and relative shortness and flatness of the root.

Though *canine teeth* are frequently either absent or of small size in the female, they may be quite as large in the mare as in the male. The crown of a young and comparatively unworn canine is compressed laterally so as to offer two surfaces separated by moderately sharp borders. The labial surface is simply convex and smooth. The lingual surface, on the contrary, may be described as concave, with a thick, rounded ridge occupying the greater part of the surface and arranged longitudinally. The neck of the tooth is not defined. The root (so-called) is conical, curved and well developed, being, in the young animal, two or three times the length of the exposed crown. With age the exposed crown becomes gradually converted into a blunt cone.

In both the upper and lower jaw there is an interdental space between the incisors and the canines, but the interval is less in the mandible than in the upper jaw. Thus the mandibular canine bites in front of the maxillary tooth, as is the arrangement in mammalia in general.

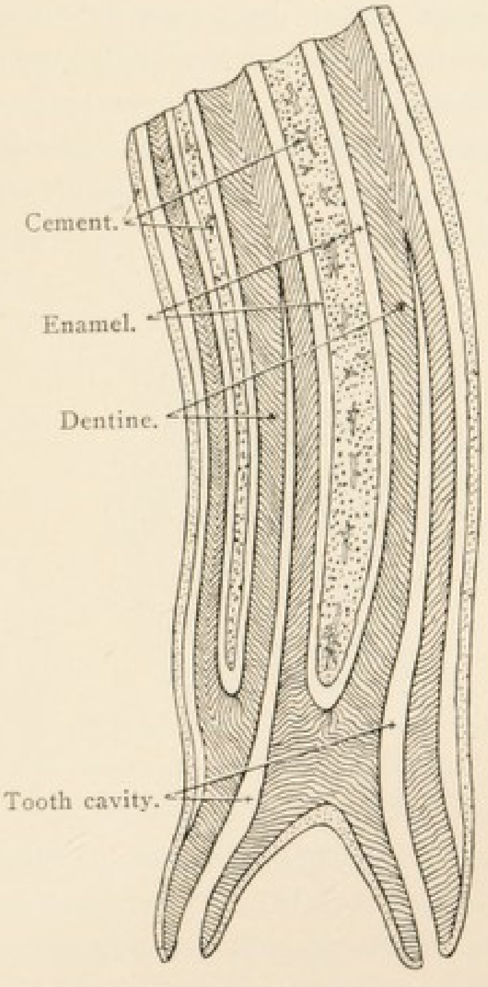


FIG. 32.—Diagram of a longitudinal section of a maxillary cheek-tooth.

Deciduous canines occur in both the male and the female, but they are always rudimentary and do not erupt.

The *maxillary cheek-teeth* [1] are large and possessed of long crowns, the major part of which, in the young tooth, is embedded in the jaw. As wear proceeds the embedded part of the crown emerges, and thus ensures the preservation of a uniform length of tooth above the gum. With the exception of the first, each tooth is in the form of a slightly bent four-sided prism, the first being three-sided in consequence of the

[1] Since the first premolar was described earlier (page 86), it is not included in the above description. What are here named the first, second and third "cheek-teeth" are, therefore, the second, third and fourth premolars.

possession of an anterior border instead of a surface of contact. The first tooth also differs in the character of its buccal surface. In the second to the sixth tooth, this surface carries a longitudinal, rounded ridge that separates two grooves. In the first tooth there are two such ridges, the anterior being somewhat the less prominent. The lingual surface of the crown of each tooth is marked by a longitudinal ridge, agreeing in position with a column or pillar, presently to be noted in connection with the chewing surface, defined by a groove on each side.

It will be readily observed that the crowns of the maxillary cheek-teeth are taller towards the buccal surface than they are on that side which is in contact with the tongue. In other words, the chewing surface is not at right angles to the longitudinal or vertical plane of the tooth, but is set obliquely thereto. A similar feature will also be noted in connection with the mandibular teeth.

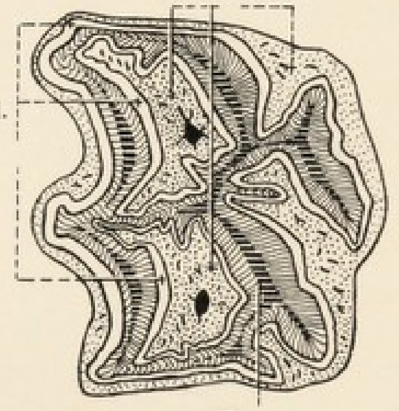


Fig. 33.—Diagram of the chewing surface of a maxillary cheek-tooth.

The chewing surface is very characteristic. Owing to deep and complicated folding of the enamel, the unworn tooth presents a surface on which there are two undulating and narrow ridges—one lateral and the other medial—to the anterior and lingual side of the medial of which an extra hillock (column or pillar) is added. The central portion of the surface is indented by two depressions (anterior and posterior) comparable to, but much deeper than, the infundibula of the incisor teeth. When the teeth have been subjected to wear, the enamel clothing the ridges is worn through, and the underlying dentine appears on the surface. The result is that after a time the chewing surface displays a complicated pattern that may be likened to the outline of an ornamental and ornate capital letter B, to the upper curve of which an appendix (the extra column above referred to) has been added. It will be observed that both in the infundibula and on the surface of the crown cement is abundant.

The true roots of the cheek-teeth are short compared with the total length of the teeth, and are generally three in number—one large and medial, and two smaller and lateral. In all, except the first and last of the series, a fourth root may be present.

In connection with dental operations, it is necessary to observe carefully the direction of implantation of the maxillary cheek-teeth. When the entire skull rests with the mandible on a horizontal surface, the first tooth is implanted in the jaw with a slope in an upward and forward direction. The next three teeth are implanted practically at right angles to the long axis of the skull ; while the last two slope upwards and backwards, the slope in the sixth being more pronounced than that of the fifth. It should also be noted that the anterior end of the facial or zygomatic crest is slightly in front of the line of contact of the crowns of the third and fourth teeth.

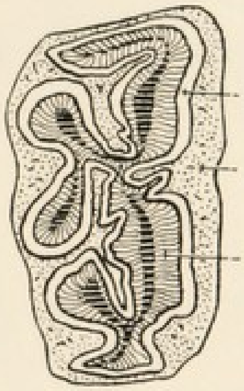


FIG. 34.—Diagram of the chewing surface of a mandibular cheek-tooth.

The relation of the teeth to the maxillary sinus is also of surgical importance, though this varies at different ages and even in different individuals of the same age. Generally speaking, the last three teeth produce elevations on the floor of the sinus, but it may happen that the third tooth also is associated with the sinus if this cavity is continued farther forwards than usual. The relation of the teeth to the sinus will form the subject of inquiry for the dissector when he is examining the interior of the cavity at a later stage.

Though the *mandibular cheek-teeth* are, on the whole, about as long as the maxillary, their transverse measurement is much less, and consequently they have oblong instead of approximately square chewing surfaces. On the buccal surface of the first five teeth there is a longitudinal groove : on the last tooth there are two grooves. The lingual surface is irregularly grooved longitudinally. The exposed part of the crown is taller on the inner or lingual side, with the result that, as in the maxillary teeth, the chewing surface is set obliquely to the longitudinal plane of the tooth. Apart altogether from any structural arrangement, the maintenance of the slope on the chewing surfaces of the maxillary and mandibular teeth can be associated with the fact that the maxillary teeth of the two sides of the head are farther apart than are the two rows of mandibular teeth.

The pattern assumed by the worn dental tissues on the mandibular teeth is different from and simpler than that of the maxillary teeth; for, while there are two infundibula, these are not closed on the lingual side until cement has been extensively developed. The consequence is that in the worn tooth the enamel fold lingual to each infundibulum is incomplete.

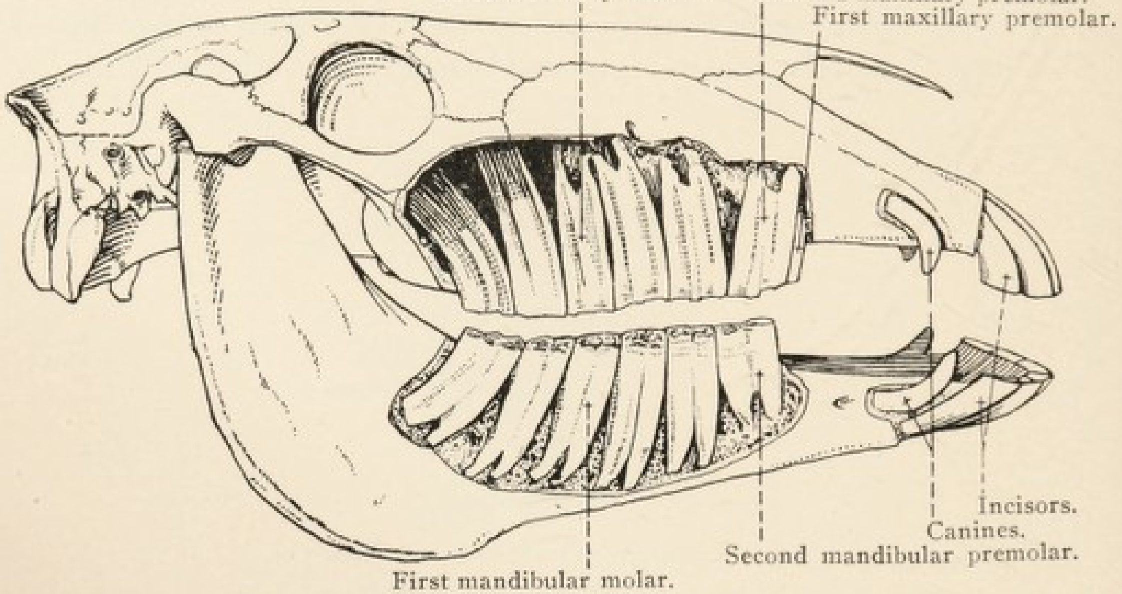


FIG. 35.—The teeth after their embedded parts have been exposed by removal of the surrounding bone.

With the exception of the last, which has usually three, each of the mandibular cheek-teeth has two relatively short roots.

The first mandibular tooth is implanted in the jaw at right angles to the lower border of the mandible. The implantation of the rest of the teeth is oblique (downwards and backwards), the obliquity gradually increasing from the second to the last.

The *deciduous premolars* are smaller than their representatives in the permanent dentition, their crowns are shorter, and a neck may be recognised.

Dissection.—The tongue, pharynx and larynx should now be removed, in order that an examination of the last-named may be proceeded with. In the first place, the thyro-hyoid and transverse hyoid muscles must be cleaned and defined.

M. THYREOHYOIDEUS.—The thyro-hyoid is a broad, flat muscle arising from the body and thyroid process of the hyoid bone, and inserted into the oblique line on the lateral surface of the lamina of the thyroid cartilage.

M. HYOIDEUS TRANSVERSUS.—The transverse hyoid muscle is small and single, pale in colour, and runs across from one lesser cornu of the hyoid bone to the other on the opposite side of the head.

THE LARYNX.—The larynx[1] is a tubular organ situated immediately behind the root of the tongue and ventral to the pharynx and the beginning of the œsophagus. Laterally and dorsally it is related to the constrictor muscles of the pharynx, while laterally and ventrally it is covered by the thyro-hyoid, sterno-thyroid and sterno-hyoid muscles. Its function is to produce voice, guard against the entrance of foreign bodies into the trachea, and regulate the amount of air respired. The organ is provided with a skeleton of cartilages, upon which muscles act in such a way as to cause variation in the character of the interior of the tube. The interior itself is lined by mucous membrane continuous, on the one hand, with that of the pharynx, and, on the other, with the lining of the trachea.

Seeing that it is well nigh impossible to obtain an intelligent grasp of the arrangement of the muscles, &c., without knowing something of the parts with which they are connected, an account of the laryngeal cartilages is given here instead of later; and it will be well that the dissector procure a set of disarticulated cartilages in order that he may familiarise himself with their form and parts before beginning the actual dissection of the larynx.

THE CARTILAGES OF THE LARYNX (Cartilagines laryngis).—The larynx contains nine cartilages, of which three are single—thyroid, cricoid and epiglottis—and the rest are in pairs—arytenoid, corniculate and cuneiform. In the horse the corniculate cartilages are fused with the arytenoids, and the cuneiform with the epiglottis.

The *thyroid cartilage* (cartilago thyreoidea) is the largest, and consists of two quadrilateral *laminæ*[2] meeting and fused in the mid-ventral line at a narrow isthmus, that forms a slightly projecting *laryngeal prominence* (prominentia laryngis). The dorsal border of each lamina is nearly straight, and terminates at each end in a process or *cornu*,[3] the anterior of which (cornu craniale) is connected with the end of the thyroid process of the hyoid bone, while the posterior (cornu caudale) articulates by a moveable joint with the cricoid cartilage. The cranial cornu is much the more slender, and is separated from the rest of

[1] λάρυγξ (larynx) [Gr.], a crier or bawler.
[2] *Lamina* [L.], a plate.
[3] *Cornu* [L.], a horn.

the lamina by a narrow *thyroid fissure* (fissura thyreoidea), which is converted into a foramen by a membranous ligament continuous with the hyo-thyroid membrane. By means of this foramen the cranial laryngeal nerve gains the interior of the larynx. The cranial or anterior borders of the two laminæ are connected with the hyoid bone by the *hyo-thyroid membrane* (membrana hyothyreoidea). The ventral borders meet at the laryngeal prominence only. Behind this they are separated by a deep triangular *caudal thyroid notch* (incisura thyreoidea caudale), which is filled by the *crico-thyroid ligament* (ligamentum crico-thyreoideum). The caudal border of each lamina overhangs the arch of the cricoid cartilage, and affords attachment to the crico-thyroid muscle. The lateral surface of the lamina is slightly convex, and is crossed by a

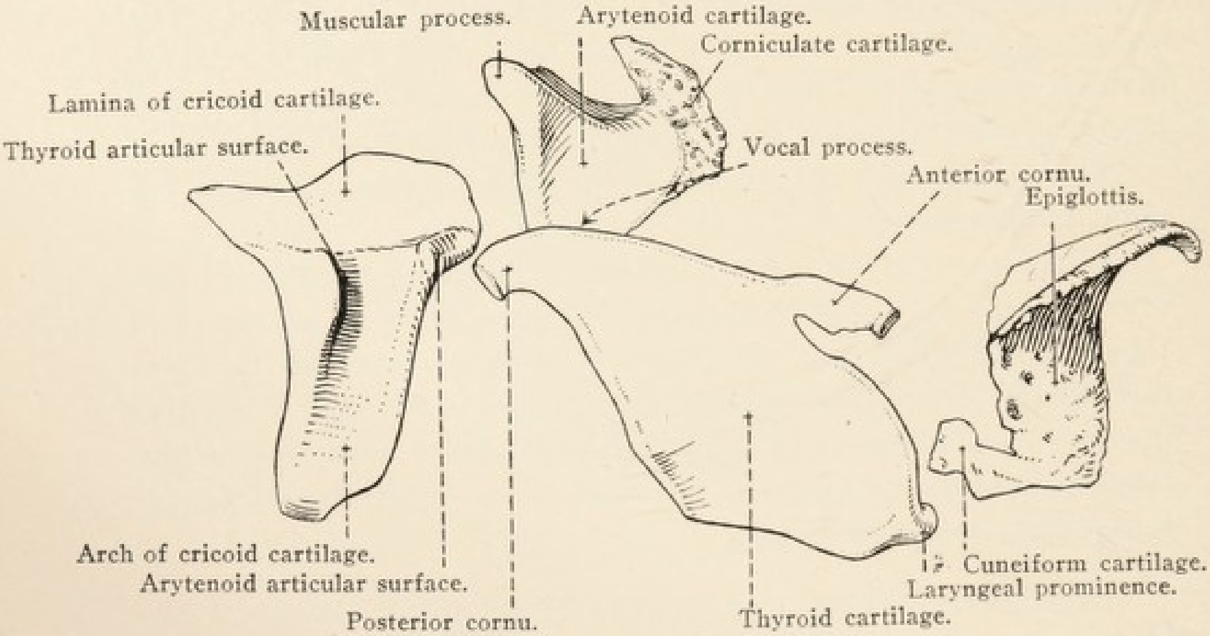


FIG. 36.—The laryngeal cartilages.

faint *oblique line* (linea obliqua), to which the thyro-hyoid muscle is inserted. The concave medial surface is smooth, and partly covered by the mucous membrane that lines the interior of the larynx.

The *cricoid*[1] *cartilage* (cartilago cricoidea) is placed behind the thyroid, by the laminæ of which it is partially covered laterally. In form it has a resemblance to a signet ring, and is, therefore, divisible into a narrow *arch*, ventral and lateral in position, and a broader dorsal portion or *lamina*. The arch is narrowest in its most ventral part where its cranial border forms a wide and shallow notch. Its caudal border is connected with the first ring of the trachea, and its lateral surface is grooved for the reception of the crico-thyroid muscle. In the middle of the cranial border of the lamina there is a shallow notch, and on each side of this an oval, convex facet for articulation with one of

[1] κρίκος (krikos) [Gr.], a finger-ring. εἶδος (eidos) [Gr.], form.

the arytenoid cartilages (facies articularis arytænoidea). The caudal border of the lamina is thin and irregular, and overhangs the first ring of the trachea. The dorsal or outer surface of the lamina carries a median ridge-like *muscular process* (processus muscularis). On each side, at the junction of the arch and the lamina, there is a projecting, bracket-like articular surface for the reception of the caudal cornu of the thyroid (facies articularis thyreoidea). The whole of the internal surface of the cricoid cartilage is smooth and covered by the laryngeal mucous membrane.

The two *arytenoid*[1] *cartilages* (cartilagines arytænoideæ), irregularly pyramidal in shape, rest on the cranial border of the lamina of the cricoid. The apex of each cartilage is directed towards the mouth, and is continued by a curved and sharply pointed *corniculate cartilage* (cartilago corniculata), which is yellow and elastic and pitted with depressions, while the arytenoid itself, like the thyroid and cricoid, is bluish in colour, rigid and smooth. The pointed tips of the corniculate cartilages curve upwards and backwards, and approach each other in the median plane, where, covered by mucous membrane, they form a characteristic projection in the undissected larynx. The triangular base of each arytenoid cartilage has a prominent ventral angle, the *vocal process* (processus vocalis) to which the vocal fold is attached, and a blunt lateral angle, the *muscular process* (processus muscularis), on which certain muscles terminate. The lateral part of the base carries an oval concave surface (facies articularis) for articulation with the cricoid cartilage. The lateral and dorsal surfaces of the arytenoid are concave, while the medial surface, larger than the other two, is flattened and covered by the laryngeal mucous membrane.

The *epiglottis*[2] (cartilago epiglottica) has the form of a sessile leaf, resting within the laryngeal prominence of the thyroid by a broad base, from each corner of which an irregular rod of cartilage—the *cuneiform*[3] *cartilage* (cartilago cuneiforme) projects towards the arytenoid. The anterior angle or apex of the epiglottis is free and sharply curved, projects towards the base of the tongue, and rests on the edge of the soft palate. Of the two surfaces, the dorsal is entirely free and saddle-shaped (convex longitudinally and concave transversely), and is covered by firmly adherent mucous membrane. The ventral surface is also saddle-shaped (in the reverse direction) and partly free, but it affords attachment to the glosso-epiglottic mucous fold and the hyo-epiglottic muscle and ligament. The borders are thin and irregular.

[1] ἀρύταινα (arytaina) [Gr.], a pitcher, a ladle. εἶδος (eidos) [Gr.], form.

[2] ἐπί (epi) [Gr.], upon. γλωττίς (glottis) [Gr.], the mouth of the windpipe (Galen), the mouthpiece of a flute.

[3] *Cuneus* [L.], a wedge.

The cavity of the larynx (Cavum laryngis).—If the interior of the larynx be examined it will be observed that the lumen of the cavity is constricted opposite two lateral folds of mucous membrane. These are the *vocal folds* (plicæ vocales), and they form sharp and prominent ridges running from the angle of convergence of the two thyroid laminæ to the vocal processes of the arytenoid cartilages. The folds are close together at their ventral ends, but diverge dorsally; and it must be noted that they are not disposed at right angles to the long axis of the larynx, but run downwards and forwards. The interval between the folds is the inter-membranous part (pars intermembranacea) of the *glottis* (rima glottidis); its continuation between the arytenoid cartilages being the intercartilaginous part (pars intercartilaginea) of this opening. Anterior to the vocal folds the cavity of the larynx is relatively spacious and is distinguished as the *vestibule* (vestibulum laryngis). Its boundaries are formed mainly by the epiglottic and arytenoid cartilages and the folds of mucous membrane that connect these with each other.

Immediately lateral to each vocal fold there is a slitlike depression, the *lateral ventricle* of the larynx (ventriculus laryngis lateralis), bounded by two lips, one of which is formed by the vocal fold, the other by a very inconspicuous *ventricular fold* (plica ventricularis). If the depths of the ventricle be explored, it will be found that the cavity is continued into a relatively spacious *appendix of the ventricle* (appendix ventriculi), of which a complete examination will be more easily possible after the removal of a lamina of the thyroid cartilage at a later stage of the dissection.

At the base of the epiglottis there is a small *middle ventricle* (ventriculus laryngis medianus), trilocular in character.

The oval entrance to the larynx (aditus laryngis) from the pharynx should receive attention. The prominent epiglottis, which forms the anterior boundary of the aditus, is connected with the tongue by the thick and obvious *glosso-epiglottic fold* (plica glossoepiglottica) of mucous membrane, to the side of which is the *epiglottic vallecula* (vallecula epiglottica), a deep and somewhat triangular depression. Joining the margins of the epiglottis to the apices of the arytenoid and corniculate cartilages are the two *aryepiglottic folds* (plicæ aryepiglotticæ). Between each aryepiglottic fold and the lamina of the thyroid cartilage is the *piriform recess*[1] (recessus piriformis), the roof of which is formed by the pharyngo-palatine arch.

Beyond the vocal folds the cavity of the larynx is roomy and directly continuous with the lumen of the trachea.

The mucous membrane (tunica mucosa laryngis) lining the cavity of

[1] *Pirus* [L.], a pear.

the larynx is firmly adherent to the dorsal surface of the epiglottis, the medial surfaces of the arytenoid cartilages and over the vocal folds, where it is thin. Elsewhere in the vestibule and about the aditus it is thicker and loosely adherent to the subjacent structures.

Dissection.—Remove the remains of the pharyngeal, sterno-thyroid, sterno-hyoid and thyro-hyoid muscles. Take care to preserve the laryngeal nerves and vessels.

Now examine the structures on the ventral and lateral aspects of the larynx.

The connection of the hyoid bone and the thyroid cartilage is established by the articulation of the extremities of the thyroid processes of the bone with the cranial cornua of the thyroid, and by the presence of the *hyo-thyroid membrane* (membrana hyothyreoidea), which fills the gap between the hyoid bone and the thyroid cartilage, and is attached to the body and thyroid processes of the hyoid and to the anterior border of the thyroid laminæ.

The joint between the bone and the thyroid cornu (articulatio hyothyreoidea) is a diarthrosis and is provided with a thick joint capsule. The movement in the joint is of the nature of a rotation about a transverse axis passing through the joints on the two sides of the larynx.

M. CRICOTHYREOIDEUS.—The crico-thyroid muscle lies in the groove on the cricoid arch, from the lateral surface of which cartilage it takes its origin. Its insertion is into the caudal border and immediately adjacent part of the lateral surface of the thyroid lamina. By rotation of the cricoid cartilage about a transverse axis passing through the right and left cricothyroid joints, the muscle moves the anterior border of the cricoid lamina—and the bases of the arytenoid cartilages situated thereon—upwards and backwards, and thus tenses the vocal folds.

The thin and membranous *crico-thyroid ligament* (ligamentum cricothyreoideum) is visible between the two crico-thyroid muscles, and fills the triangular interval between the thyroid and cricoid cartilages. The joint between the caudal thyroid cornu and the cricoid cartilage should be looked at now, but its complete examination may be deferred until the dissection of the larynx nears completion. The joint is a diarthrosis provided with the usual joint capsule attached round the articular margins of the two cartilages.

Dissection.—Now turn to the dorsal aspect of the larynx. Remove the mucous membrane from the outer surface of the cricoid, arytenoid and corniculate cartilages, taking care not to destroy the cranial laryngeal and recurrent nerves. The origin of longitudinal muscular fibres of the œsophagus from the interval between the cricoid and arytenoid cartilages should be noted. The lateral layer of the aryepiglottic fold of mucous membrane should also be removed. Define the dorsal crico-arytenoid and the transverse arytenoid muscles.

M. CRICOARYTÆNOIDEUS DORSALIS.—The dorsal crico-arytenoid muscle arises from the dorsal surface and median ridge of the cricoid lamina. From this extensive origin the muscular fibres converge and are inserted into the muscular process of the arytenoid cartilage. It follows that all the fibres will not have a like degree of obliquity, nor

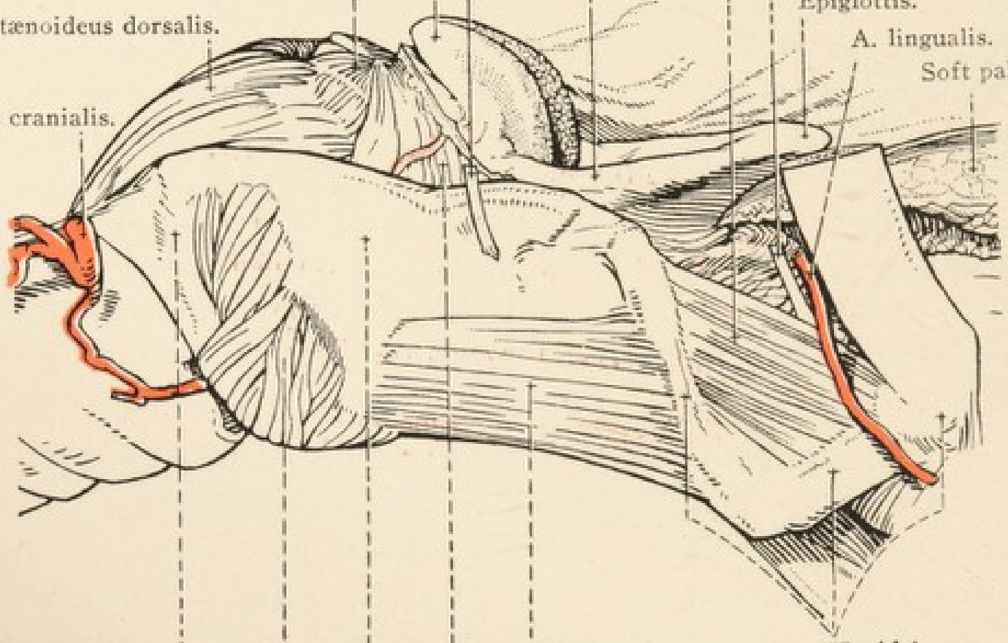


FIG. 37.—Lateral aspect of the larynx.

will they all be of the same length. The most anterior are the most nearly transverse and are the shortest; the posterior fibres are the longest and most nearly longitudinal; whereas the intermediate fibres are oblique. The muscle rotates the arytenoid cartilage so that its vocal process is carried away from the median plane, and thus the vocal fold is abducted.

M. ARYTÆNOIDEUS TRANSVERSUS. — The transverse arytenoid muscle is small and not very clearly defined. Its fibres spring from the arytenoid cartilage in the region of its muscular process, and join a tendinous raphe in the middle line that is common to fibres from both sides of the larynx. Hence the muscle is generally described as unpaired. In its action, the muscle draws the two arytenoid cartilages nearer together and so narrows the intercartilaginous part of the rima glottidis; but it doubtless also causes some rotation of the cartilages that results in the abduction of the vocal folds.

Dissection.—The dissection of the remaining muscles should be confined, for the time being, to one side of the larynx; the other side being reserved for later examination.

Disarticulate one thyroid cornu from the hyoid bone, and cut through the hyo-thyroid membrane on the same side as far as the middle line. Cut through the thyroid lamina just where it joins the laryngeal prominence.

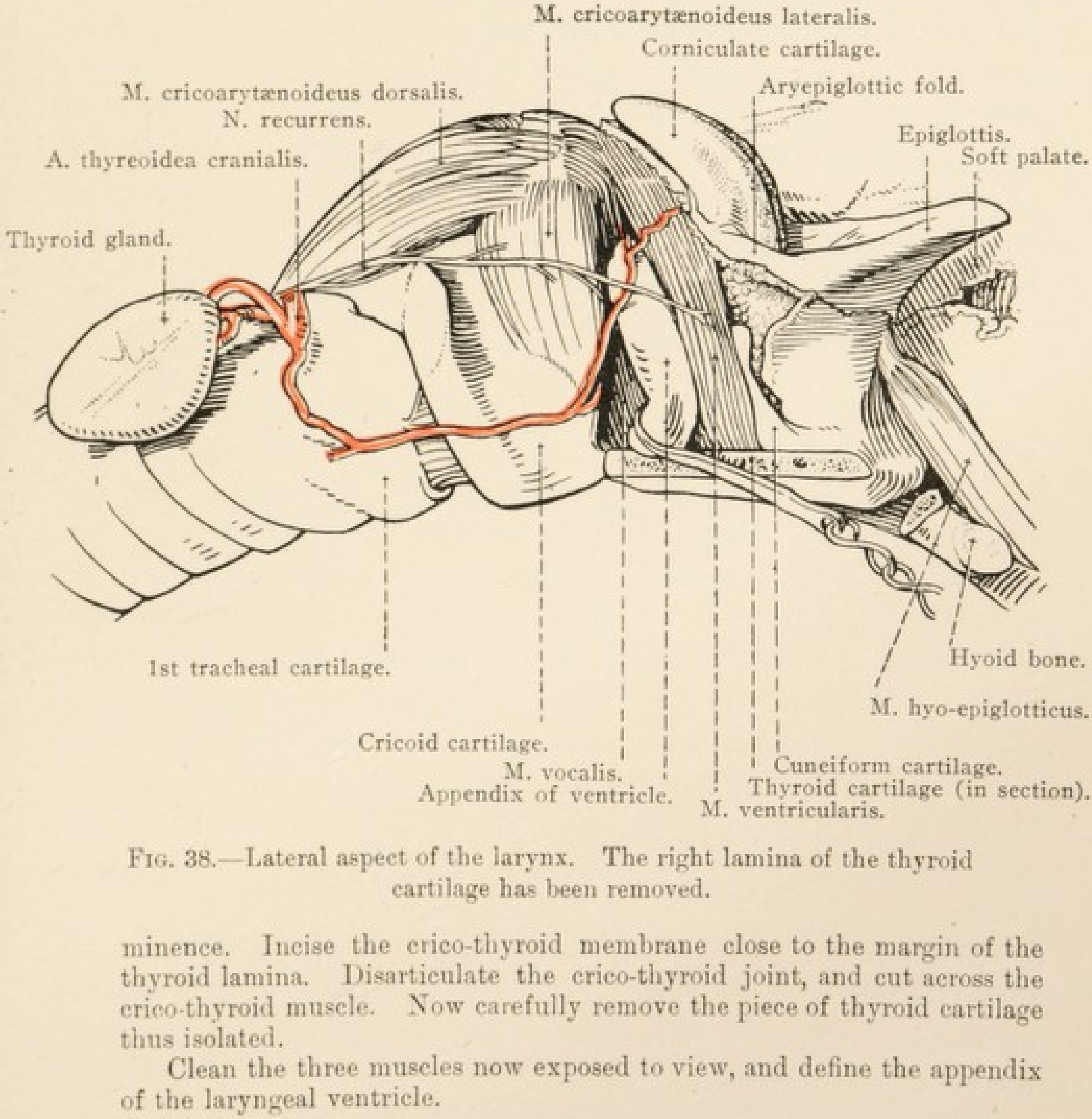


FIG. 38.—Lateral aspect of the larynx. The right lamina of the thyroid cartilage has been removed.

Incise the crico-thyroid membrane close to the margin of the thyroid lamina. Disarticulate the crico-thyroid joint, and cut across the crico-thyroid muscle. Now carefully remove the piece of thyroid cartilage thus isolated.

Clean the three muscles now exposed to view, and define the appendix of the laryngeal ventricle.

M. CRICOARYTÆNOIDEUS LATERALIS.—The lateral crico-arytenoid muscle is much smaller than the dorsal muscle of the same name. Its origin is from the anterior border of the cricoid arch, and its insertion is into the muscular process of the arytenoid cartilage. Through rotation of the arytenoid cartilage, contraction of this muscle results in adduction of the vocal fold.

Dissection.—Release the lateral crico-arytenoid muscle from its cricoid attachment in order that an uninterrupted view of the vocal muscle may be obtained.

M. VOCALIS: M. VENTRICULARIS.—Because of their intimate connection at their origin and insertion, these two muscles are better studied together. Their middle parts are separated by the intrusion of the appendix of the ventricle of the larynx. They have a blended origin from the ventral border of the thyroid lamina near the laryngeal prominence and from the adjacent part of the crico-thyroid ligament. Their insertion is partly into the neighbourhood of the muscular process of the arytenoid cartilage; but some fibres (the more superficial) are continued towards the middle line and blend with the transverse arytenoid muscle. The superficial fibres are often not strictly speaking part of the main muscular mass, but arise independently by a thin aponeurosis from within the thyroid lamina close to its dorsal border.

Dissection.—Remove the vocal muscle.

The Vocal and Ventricular Ligaments.—Immediately within the vocal muscle is a thin membrane connected with the cranial border of the arch of the cricoid cartilage, ventrally continuous with the crico-thyroid ligament, and dorsally attached to the vocal process of the arytenoid cartilage. The cranial edge of the membrane blends with the *vocal ligament* (ligamentum vocale), a definite and elastic band stretching from the laryngeal prominence and crico-thyroid ligament to the vocal process of the arytenoid cartilage. Each vocal ligament is covered by one of the vocal folds of mucous membrane already examined in connection with the interior of the larynx; and, like the folds, the ligaments are close together at their ventral ends, but diverge towards their arytenoid attachments.

The *ventricular ligament* (ligamentum ventriculare) is an ill-defined band of fibres, covered by the ventricular fold of mucous membrane, extending from the cuneiform cartilage to the vocal process of the arytenoid.

The Laryngeal Ventricle and its Appendix.—The ventricle (lateral) of the larynx is an elongated depression, the anterior boundary of which is mainly formed by the cuneiform cartilage and completed dorsally by the ventricular fold. The posterior boundary of the ventricle is formed by the vocal fold.

The appendix of the ventricle is a spacious blind diverticulum covered laterally by the lamina of the thyroid cartilage. Anteriorly it is related to the ventricular muscle, while in the opposite direction it is in contact with the vocal and lateral crico-arytenoid muscles. The cavity of the appendix should be explored, and its communication with the cavity of the larynx through the ventricle determined.

Dissection.—If the glosso-epiglottic fold of mucous membrane be removed, the under-lying hyo-epiglottic muscle will be revealed. At the same time the hyoid attachment of the genio-glossal muscle will be made more clear than was previously possible.

M. HYO-EPIGLOTTICUS.—The right and left hyo-epiglottic muscles lie so close together, and are so ill defined medially, that they are

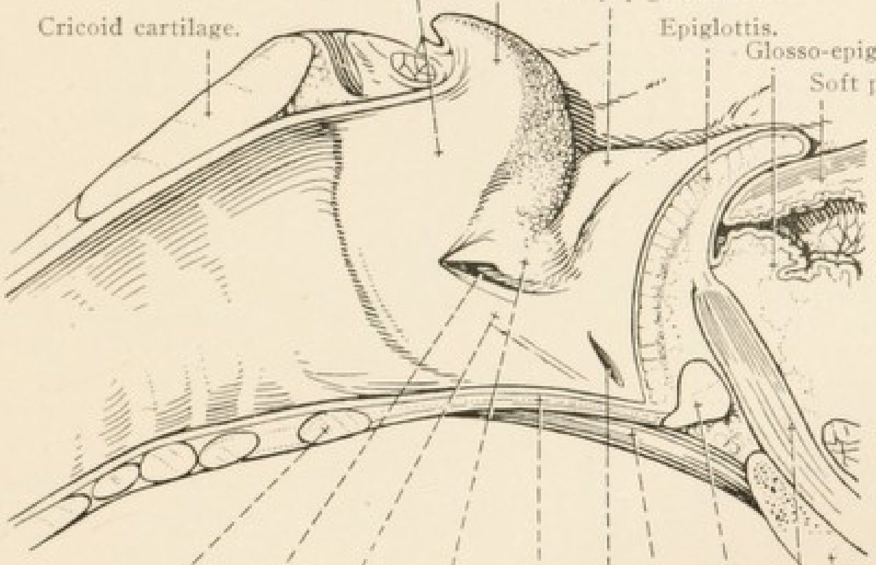


FIG. 39.—The larynx in median section, to show its lateral wall from within.

often described as one muscle. They are covered by the elastic hyo-epiglottic ligament. Pale in colour and plentifully intermixed with fat, the muscular fibres arise mainly from the body of the hyoid bone, though a few of them may be traced into the root of the tongue. Their insertion is into the lingual surface of the base of the epiglottis.

Dissection.—Clean the nerves and vessels on the intact side of the larynx.

The Nerves and Vessels of the Larynx.—The nerves that supply the larynx are the cranial laryngeal and the recurrent, both branches of the vagus. The former enters the larynx by the thyroid notch and is distributed mainly to the mucous membrane of the larynx, but one of its branches (ramus externus) supplies the crico-thyroid muscle.

The recurrent nerve has been followed up the neck along the dorsal border of the trachea (page 6). Its termination furnishes branches to all the intrinsic muscles of the larynx except the crico-thyroid. Fine anastomotic branches (rami anastomotici) connect the cranial laryngeal and recurrent nerves.

The laryngeal artery has been noted as a stout branch of the

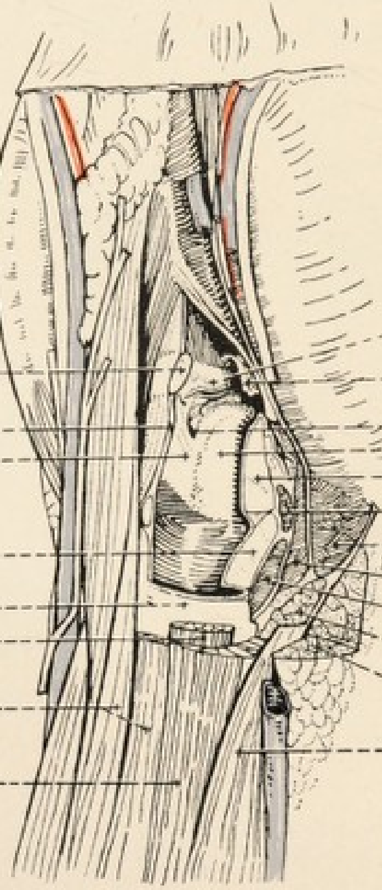


FIG. 40.—Dissection of the laryngeal region. The left wall of the larynx has been partially removed to show the interior.

cranial thyroid (page 6). It can now be followed between the cricoid and thyroid cartilages to its termination in the laryngeal mucous membrane.

Dissection.—Strip the mucous membrane from the interior of the larynx and remove the remains of the muscles. Care must be exercised in the removal of the membrane from the epiglottis, cuneiform and corniculate cartilages, as these are readily torn.

The description of the laryngeal cartilages, already given (page 93), should be read again.

The connections of most of the cartilages of the larynx have been described as the dissection proceeded, but there still remains to be examined the attachment of the epiglottis to the thyroid.

The character of the articulation between other cartilages, and the union of the two arytenoid cartilages, may now be more easily determined.

The base of the epiglottis is attached to the thyroid cartilage by the thick and elastic *thyro-epiglottic ligament* (ligamentum thyreo-epiglotticum), which, in conjunction with the elasticity of the epiglottis itself, permits of free movement.

Now that the restraining muscles have been removed, it is easy to demonstrate that the movement between the thyroid cornua and

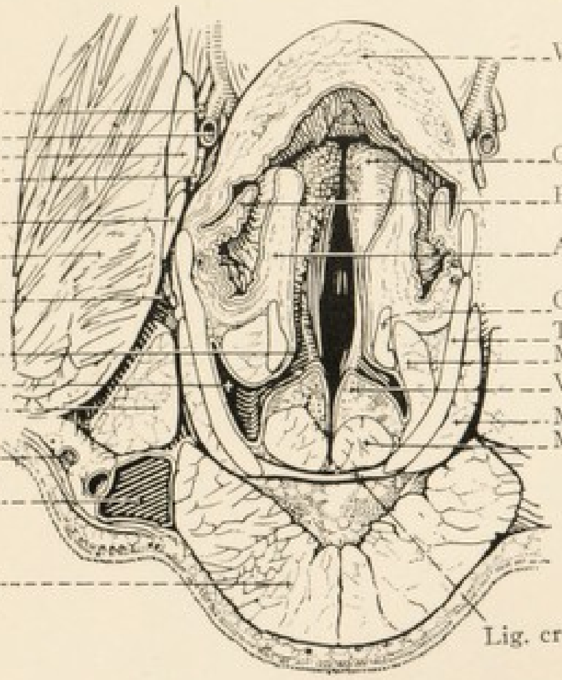


FIG. 41.—Transverse section of the larynx and pharynx.

the cricoid cartilage is rotatory about a transverse axis running through the joints of opposite sides of the larynx.

The crico-arytenoid joint is also diarthrodial. Its movements are gliding in various directions, and (more important because of the adduction and abduction of the vocal folds thus produced) rotatory about a longitudinal axis. It should be noted that the capsule of the joint is strengthened medially.

The medial angles of the two arytenoid cartilages are united by a narrow band of fibrous tissue (ligamentum arytænoideum transversum) that is sufficiently loose to allow of the necessary rotation in the crico-arytenoid joint.

Dissection.—The dissector should now transfer his attention to the occipital region. The occipital and temporal attachment of the brachio-cephalic and splenius muscles must be liberated from the bone, and the short muscles dorsal to the atlas and epistropheus cleaned and defined.

M. RECTUS CAPITIS DORSALIS MAJOR.—The greater dorsal straight muscle of the head is flattened and narrow. Its origin is from the border of the spinous process of the epistropheus, and its insertion is into the occipital bone in company with the m. semispinalis capitis. A very little care in dissection will show that, at its origin, the muscle consists of two strata, a long superficial part more or less blended with the semispinal muscle, and a shorter deep portion.

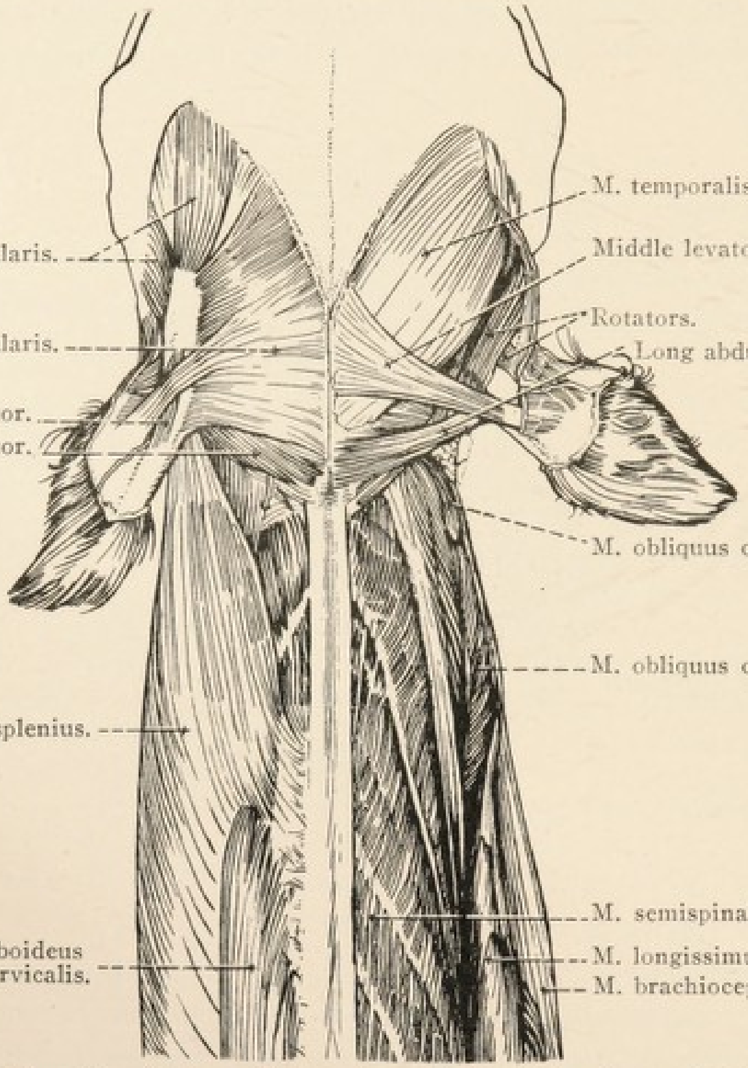


FIG. 42.—Dissection of the occipital region. First (left) and second (right) stages.

M. OBLIQUUS CAPITIS CAUDALIS.—The caudal oblique muscle is strongly developed. Its fibres arise from the lateral aspect of the spinous process and the caudal articular process of the epistropheus, and run in an oblique cranio-lateral direction to be inserted into the dorsal surface of the wing of the atlas.

M. OBLIQUUS CAPITIS CRANIALIS. — The cranial oblique muscle is very much shorter, merely filling the narrow interval between the atlas and the skull. The muscle arises from the cranial edge of the wing of the atlas and the adjacent part of fossa atlantis. Its insertion is to the superior nuchal line of the occipital bone and the base of the jugular process.

Dissection.—Remove the caudal oblique muscle entirely. Cut across the cranial oblique muscle close to the wing of the atlas, and turn it forwards as much as possible.

M. RECTUS CAPITIS DORSALIS MINOR.—The smaller dorsal straight muscle lies close upon the capsule of the occipito-atlantal joint, with

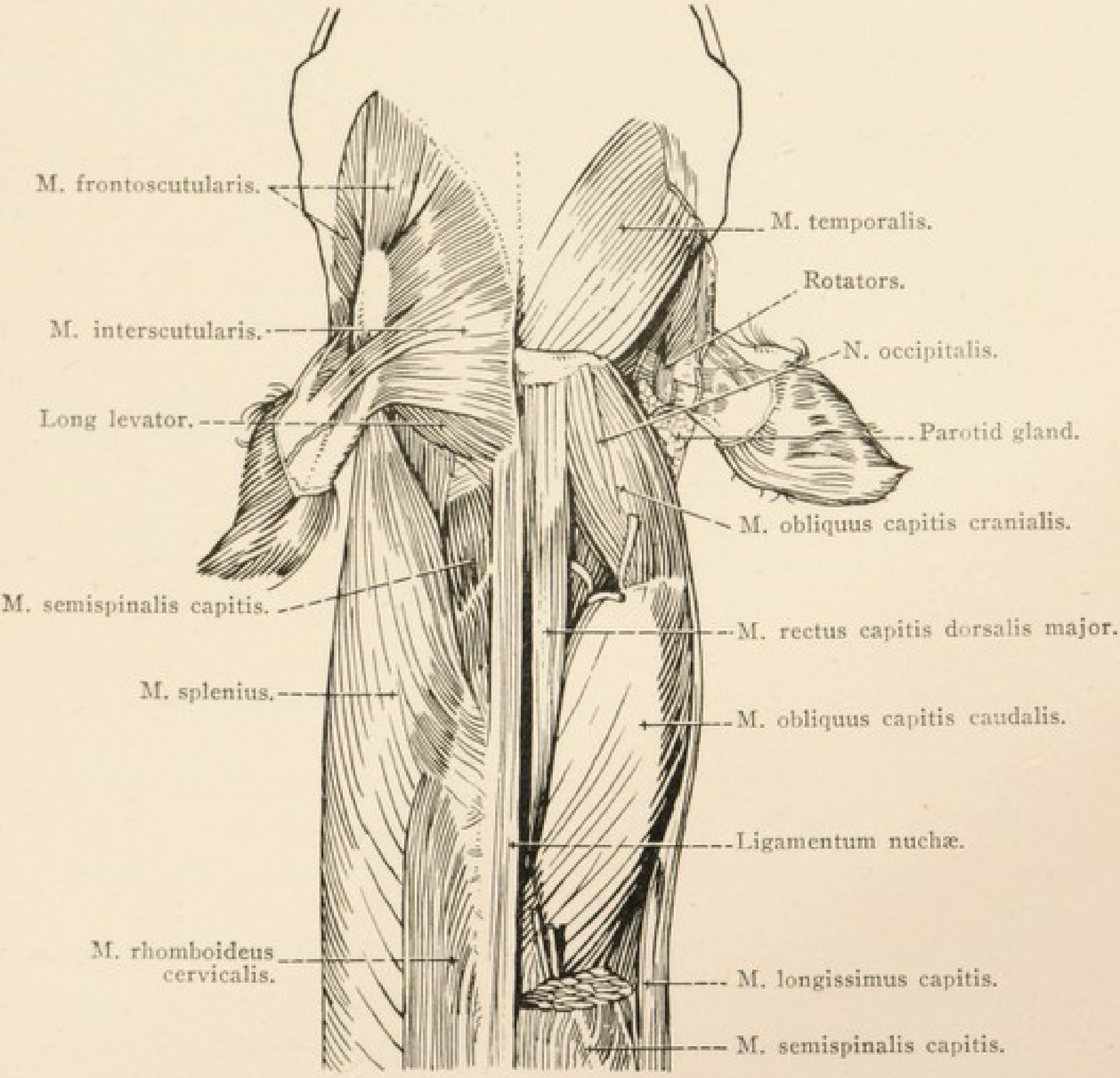


FIG. 43.—Dissection of the occipital region. First (left) and third (right) stages.

which its deeper surface is connected. It springs from the dorsal arch of the atlas, and is inserted near the occipital attachment of the ligamentum nuchæ.

A. OCCIPITALIS.—The removal of the caudal oblique muscle has revealed the two terminal branches of the occipital [1] artery, both of which have origin in the fossa atlantis.

The *descending branch* (ramus descendens) is the smaller of the

[1] *Occiput* (= *ob* + *caput*, the head) [L.], the back of the head.

two, and appears in the present dissection by emerging from the transverse foramen of the atlas. It crosses the atlanto-epistrophic joint to unite with the terminal portion of the vertebral artery. Twigs are contributed to the caudal oblique muscle.

The *occipital branch* (ramus occipitalis) of the occipital artery is a large vessel that leaves the fossa atlantis by the alar foramen. Dorsal to the atlas and epistropheus, it supplies branches to the two oblique and the two straight muscles of the head, the semispinalis capitis, the

FIG. 44.—Dissection of the occipital region. First (left) and fourth (right) stages.

splenius, and the posterior auricular muscles and superjacent skin of the ear. It anastomoses with the deep cervical and posterior meningeal arteries and its fellow of the opposite side of the body. During its passage through the alar foramen, the occipital ramus gives off the small *cerebro-spinal artery* (a cerebrospinalis) which at once enters the vertebral canal by the intervertebral foramen of the atlas.

N. OCCIPITALIS.—The occipital nerve is the dorsal branch of the first cervical nerve. Appearing between the greater straight and the caudal oblique muscles, it supplies the occipital group of muscles, as well as those behind the ear, and ends in the skin of the occipital region.

Dissection.—Remove the temporal muscle. Saw across the zygomatic process of the frontal bone, immediately lateral to the supra-orbital foramen, and the zygomatic bone on a level with the maxillary tuber.

Observe the considerable collection of fat—varying in amount with age—that lies between the border of the temporal muscle and the periorbita.

THE ORBIT (Orbita).—Although the orbit is usually described as a funnel-shaped cavity, with its apex at the optic foramen and its base at the rim of bone formed by the frontal, lachrymal and zygomatic, in the macerated skull its boundaries are far from definite; for, except for a medial wall and a ring of bone in front, the cavity is undefined and communicates freely with the temporal and pterygo-palatine fossæ.

The dissector will find it profitable to make an examination of the orbit of a macerated skull before proceeding to the dissection of the contents of the cavity. The base or inlet of the orbit (aditus orbitæ) is circumscribed by the zygomatic process of the frontal, the zygomatic process of the temporal, the temporal process of the zygomatic, and the lachrymal bone. The apex is at the optic foramen. The axis of the orbit (axis orbitæ), taken as passing from the optic foramen to the central point of the inlet, runs in a forward, lateral and slightly upward direction. The superior wall (paries superior) is formed mainly by the frontal bone, and to a certain extent by the lachrymal also. The medial wall (paries medialis) is the only one that is completely formed by bone, and the frontal, lachrymal, and orbital wing of the sphenoid enter into its formation. Close to the rim of the orbit, and in the lachrymal bone, there is a fossa (leading into a foramen) for the reception of the lachrymal sac; and immediately behind this is a rounded depression from which the inferior oblique muscle of the eyeball arises. The inferior wall (paries inferior) is very incomplete, and is formed by the zygomatic process of the temporal, the temporal process of the zygomatic, and a small part of the maxilla. The lateral wall (paries lateralis) consists of the zygomatic process of the frontal bone. The superior and lateral walls are smoothly continuous, and a shallow depression in which the lachrymal gland is lodged (fossa glandulæ lacrimalis) occurs on the under surface of the zygomatic process of the frontal.

Though the bony boundaries of the orbit are so incomplete, the definition of the cavity in the recent state is rendered precise by the presence of the periorbita.

The *periorbita* is a stout, inelastic, fibrous sheath of conical form, with an apex adherent to the bone around the optic foramen and the orbital fissure, and a base that merges partly into the periosteum of the bones that bound the orbital inlet and partly into the fibrous tissue of the eyelids. In thickness the sheath is far from uniform. Thickest

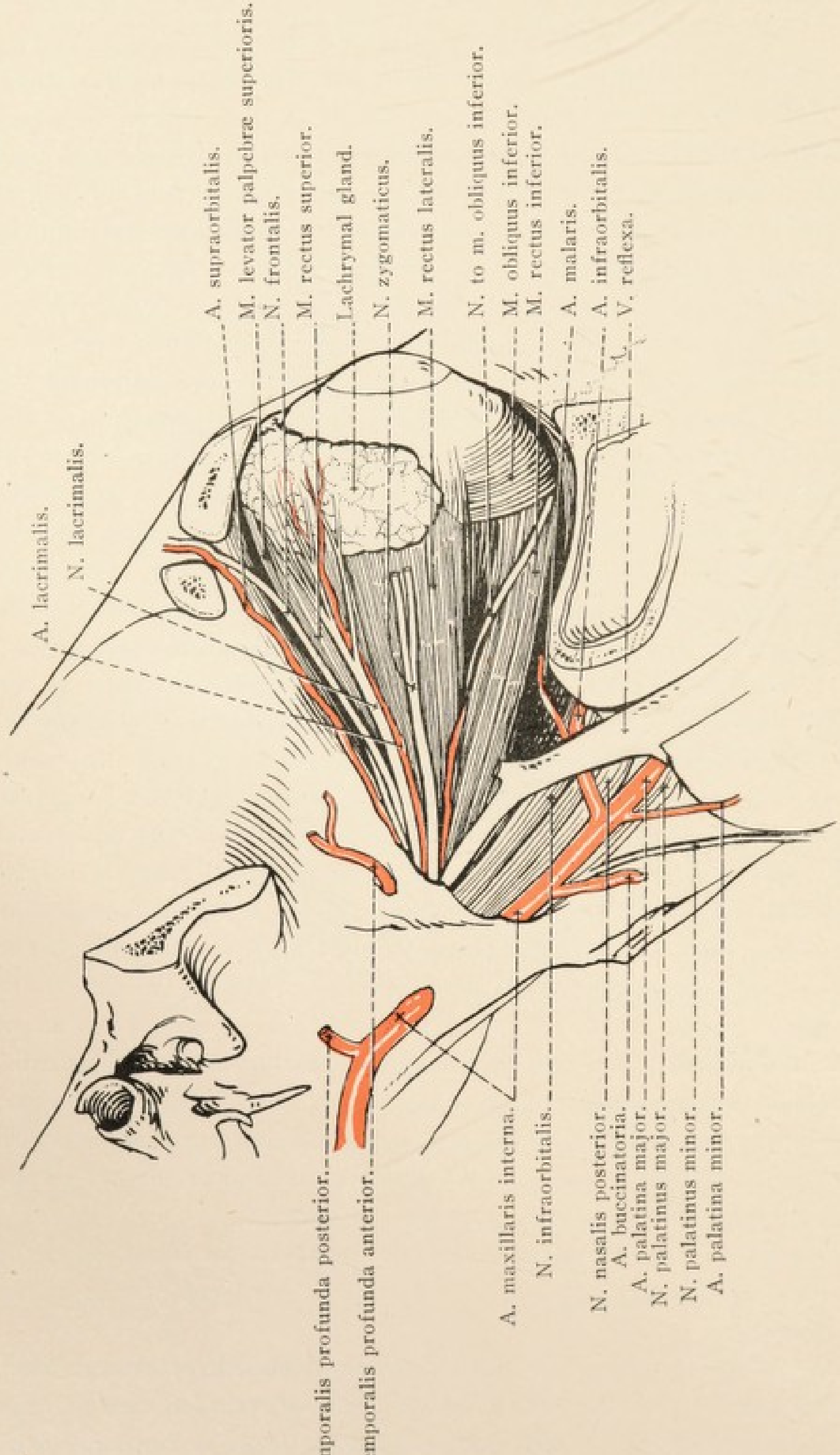


FIG. 45.—Dissection of the orbit. First stage.

and stoutest laterally, where it is reinforced by an elastic band attached to the pterygoid crest, it is thin where it lies against the medial wall of the orbit. In connection with the medial portion of the membrane, and just below the root of the zygomatic process of the frontal bone, there is a flattened rod of cartilage concerned in the formation of a pully through which the superior oblique muscle of the eyeball plays.

Dissection.—The periorbita must now be slit open, and, if considered necessary, a portion of it may be removed. In doing this, care must be exercised not to injure the structures lying close to its deep surface.

In cleaning the contents of the orbit, the accumulation of fat (corpus adiposum infraorbitale) that fills all the interstices between the muscles and around the eyeball, must be removed with constant regard to the fact that nerves and vessels of small size are embedded in it.

The *lachrymal apparatus* (apparatus lacrimalis) consists of the lachrymal gland with its excretory ducts, the two lachrymal ducts, the lachrymal sac, and the naso-lachrymal duct. Of these, the gland is now visible.

The *lachrymal gland* (glandula lacrimalis) lies under cover of the zygomatic process of the frontal bone and over the dorso-lateral face of the eyeball. Oval in outline and flattened in form, it is curved in conformity with the shape of the orbit and the surface of the eyeball. It is pale red in colour and distinctly lobulated. Twelve to fifteen or sixteen small ducts (ductuli excretorii) open into the lateral half of the upper fornix of the conjunctiva.

The terminations of the frontal, lachrymal and zygomatic nerves have been examined in connection with the dissection of the face (page 36). The middle part of the course of these nerves is now exposed. The lachrymal and zygomatic nerves follow an almost parallel course within the periorbita and lateral to the muscles of the eyeball.

N. ZYGOMATICUS.—The zygomatic nerve is a branch of the maxillary, from which it arises close to the orbital fissure. Piercing the periorbita, it runs along the surface of the lateral straight muscle of the eyeball, divides into two or three branches and reaches the lower eyelid, in which it ramifies. Small filaments from the nerve are connected with similar twigs from the lachrymal.

N. OPHTHALMICUS.—The ophthalmic[1] nerve is one of the three divisions of the fifth cerebral or trigeminal nerve. Leaving the cranium by the orbital fissure it immediately divides into the lachrymal, frontal and naso-ciliary nerves. Two of these—the lachrymal

[1] ὀφθαλμός (ophthalmos) [Gr.], the eye.

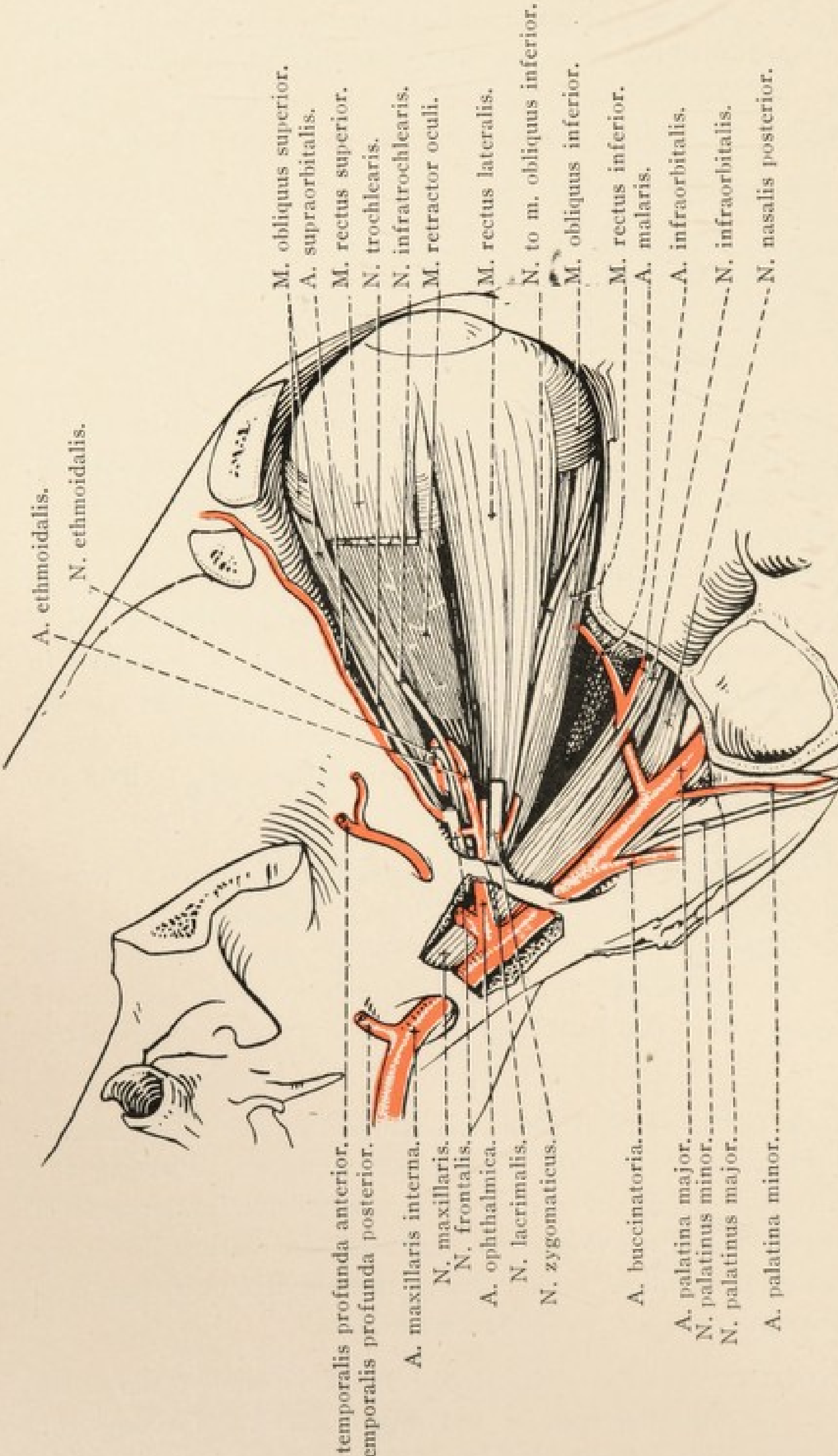


Fig. 46.—Dissection of the orbit. Second stage.

and the frontal—may be examined at once: the naso-ciliary should be dissected after the examination of the levator of the upper eyelid and the superior straight muscle of the eyeball.

N. lacrimalis.—The lachrymal nerve passes to the lachrymal gland by traversing the surface of the superior rectus muscle. Its terminal filaments supply the gland and the upper eyelid. A small branch (ramus zygomaticotemporalis) anastomoses with a similar branch from the zygomatic nerve, pierces the periorbita and appears on the forehead immediately behind the zygomatic process of the frontal bone, where it joins the plexus formed by the auriculo-palpebral and frontal nerves.

N. frontalis.—The frontal nerve follows the margin of the superior oblique muscle for a distance, then pierces the periorbita, and finally gains the supra-orbital foramen by which it reaches the forehead, where it assists in the formation of a plexus in which the auriculo-palpebral and lachrymal nerves are also concerned.

In cleaning the muscles of the eyeball, an endeavour should be made to determine the arrangement of the fascia connected with them. A thin, superficial fascia surrounds the various structures contained within the orbit. It is attached to the sphenoid bone around the optic foramen; while anteriorly it blends with the fibrous tissue of the eyelids. The deep fascia forms sheaths for the various muscles, vessels and nerves, and can be resolved anteriorly into two layers. One of these merges into the fibrous tissue of the eyelids; the other is attached to the eyeball in the neighbourhood of the corneo-scleral junction. It may be remarked here that the posterior part of the eyeball is surrounded by its own sheath of fascia (fascia bulbi), between which and the eyeball there is a lymph space that communicates with a prolongation of the subdural space surrounding the optic nerve.

M. LEVATOR PALPEBRÆ SUPERIORIS.—The thin, narrow levator muscle of the upper eyelid is dorsal to the eyeball and immediately underneath the periorbita. Its origin is from the vicinity of the ethmoidal foramen, and its expanded insertion is into the upper eyelid.

M. OBLIQUUS SUPERIOR.—Of the two oblique muscles of the eyeball the long and narrow superior one arises near the ethmoidal foramen. Passing towards the anterior part of the orbit medial to the medial rectus, it reaches the cartilaginous trochlea underneath the root of the zygomatic process of the frontal bone. After traversing the trochlea, the muscle is reflected, at almost a right angle, outwards and very slightly forwards, so that its thin tendon, insinuating itself between the superior rectus and the eyeball, is finally inserted into the sclera between the superior and lateral recti muscles. A small synovial bursa surrounds the muscle as it plays through the trochlea.

MM. RECTI OCULI.—The four straight muscles of the eyeball, namely, superior, inferior, medial and lateral, all arise in the neighbourhood of the optic foramen, and pass forwards to be inserted by thin tendons into the sclera of the eyeball in front of the equator.

M. OBLIQUUS INFERIOR.—The inferior oblique differs from all the other ocular muscles in that its origin is from the anterior part of

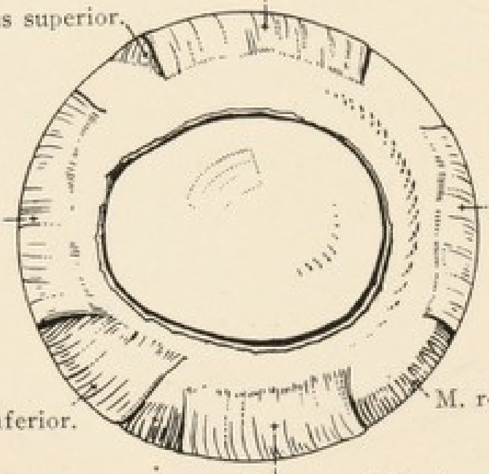


FIG. 47.—Diagram of the front of the right eyeball to show the insertions of the muscles.

the orbit. It is also broader than the others, and much shorter. Its origin is from a depression in the lachrymal bone just behind the lachrymal fossa. From this point the muscle passes outwards under (ventral to) the inferior rectus, and is inserted into the sclera beneath the tendon of the lateral rectus.

M. RETRACTOR OCULI.—Composed of a variable number of indistinctly separated parts, which all arise from the margin of the optic foramen, the retractor of the eyeball lies within the straight muscles, and is inserted into the sclera immediately behind them.

N. TROCHLEARIS.—The trochlear or fourth cerebral nerve, purely motor in function, leaves the cranium by the trochlear foramen and runs forwards on the surface of the superior oblique muscle, into which it sinks about midway between the ethmoidal foramen and the trochlea through which the muscle plays.

N. NASOCILIARIS.—The naso-ciliary nerve, a branch of the ophthalmic, should be found at the apex of the orbit between the superior rectus muscle and the retractor. Its main continuation is the *ethmoidal nerve* (n. ethmoidalis), which, making a sharp backward bend, enters the cranium by the ethmoidal foramen and thus leaves the present dissection. The collateral branches of the naso-ciliary are the infratrochlear nerve and the long root to the ciliary ganglion. The *infratrochlear nerve* (n. infratrochlearis) runs forwards along the border of the superior oblique muscle as far as the trochlea, and then follows the medial wall of the orbit to the medial canthus of the eye, where it ends in the skin of this region. Small filaments are furnished to the third eyelid, the lachrymal ducts and sac, the conjunctiva and the lachrymal caruncle.

N. OCULOMOTORIUS.—The oculomotor or third cerebral nerve enters the orbit along with the ophthalmic and abducens nerves, and divides into two main branches. The superior branch (ramus superior) supplies twigs to the levator of the upper eyelid and the superior rectus muscle of the eyeball. The larger inferior branch (ramus inferior) supplies the medial and inferior rectus muscles, and its terminal branch enters the inferior oblique muscle after crossing the surface of the inferior rectus obliquely. In addition motor fibres are furnished to the ciliary ganglion.

The small *ciliary*[1] *ganglion* (ganglion ciliare) lies on the inferior branch of the oculomotor nerve close to its point of origin from the parent trunk. The ganglion may be easily overlooked, and is most readily found by tracing the nerve of the inferior oblique muscle to its origin from the oculomotor. Small though the ganglion is, it is of great importance because of the circumstance that through it fibres from the oculomotor nerve reach the circular muscle of the iris and the ciliary muscle, and sympathetic fibres gain the dilator muscle of the pupil. The ganglion receives motor fibres from the oculomotor, sensory fibres (long root) from the naso-ciliary, and sympathetic fibres from the spheno-palatine plexus. From it thin filaments proceed to the ciliary plexus, in the formation of which twigs from the ophthalmic and maxillary nerves and the spheno-palatine ganglion are also concerned. From the ciliary plexus a variable number (6 to 8) of small nerves (nn. ciliares breves) follow the optic nerve, pierce the sclera and run between this coat of the eye and the choroid to end in a plexus at the circumference of the iris. It is from this plexus that fine filaments pass to the iris, ciliary body and the cornea.

N. ABDUCENS.—The abducent or sixth cerebral nerve enters the

[1] *Cilium* [L.], an eyelid, an eyelash. The adjective is applied to several structures connected with the eye.

orbit through the orbital fissure along with the ophthalmic and oculomotor. It divides into two branches which supply the lateral rectus and retractor muscles.

N. OPTICUS.—The optic nerve forms a conspicuous, rounded and slightly flexuous cord surrounded by the retractor muscle and extending from the optic foramen, by which it emerges from the cranium, to the back of the eyeball.[1] The nerve pierces the sclera below and lateral to the posterior pole of the eyeball.

A. OPHTHALMICA.—The ophthalmic artery is a branch of the internal maxillary, from which it arises within the alar canal. Leaving the canal by its anterior opening, the artery at once enters the orbit (at the apex of the cavity bounded by the periorbita), where it is related to the naso-ciliary nerve, curves in a medial direction underneath the superior rectus muscle, and is continued through the ethmoidal foramen as the ethmoidal artery.

The collateral branches of the ophthalmic artery are as follows:—

(1) *Rami musculares.*—These supply not only the muscles within the orbit but also the periorbita, the fat of the orbit, the third eyelid and the conjunctiva.

(2) *A. lacrimalis.*—The lachrymal artery follows the like-named nerve and terminates in the lachrymal gland and the upper eyelid.

(3) *Aa. ciliares anteriores.*—The anterior ciliary arteries are slender vessels that pierce the sclera in front of the equator of the eyeball and terminate in the iris and the ciliary body.

(4) *Aa. ciliares posteriores.*—The posterior ciliary arteries are also small vessels. They penetrate the sclera at the back of the eyeball, and most of them (the short ciliary arteries) end in the choroid. Two of them (the long ciliary arteries), however, pass forwards between the sclera and the choroid to end at the periphery of the iris.

(5) *A. centralis retinæ.*—The central artery of the retina is a slender vessel that may take origin from one of the posterior ciliary arteries. It enters the optic nerve within which it gains the interior of the eyeball to ramify over the surface of the posterior part of the retina.

(6) *A. supraorbitalis.*—The supraorbital artery follows the frontal nerve along the medial wall of the orbit, traverses the supra-orbital foramen, and is distributed in the muscles and skin of the supra-orbital region, where it anastomoses with branches of the anterior auricular artery.

[1] Strictly speaking the optic nerve should be described as passing in the opposite direction, for its fibres have their origin in the retina.

(7) *A. ethmoidalis.*—The ethmoidal artery is the direct continuation of the ophthalmic, and gains the interior of the cranium by doubling back through the ethmoidal foramen. Its ultimate division into meningeal and nasal branches will be determined later.

The Third Eyelid (Palpebra tertia).—When the eye of a living horse is examined, a prominent semilunar fold of conjunctiva is noticeable medial to the eyeball. This is the *membrana nictitans*, which covers the thin anterior part of a curved plate of cartilage that forms the basis of the third eyelid. The cartilage is roughly quadrilateral in outline, with a thin, broad, anterior margin, and a narrower and thicker posterior part surrounded by fat and associated with a gland (glandula palpebræ tertiæ) that has a structural resemblance to the lachrymal gland. When the eyeball is retracted, pressure is exerted upon the orbital fat at the posterior part of the cartilage. The cartilage is thus thrust forwards, and the membrana nictitans is protruded over the front of the eyeball.

Dissection.—The dissection of the eyeball may be made more thorough if several specimens are secured. If eyes of the horse cannot be obtained, those of the ox will serve the purpose almost equally well. Failing specimens from either the horse or the ox, eyes of the sheep may be used. Some of the specimens are to be examined in the fresh condition: others should be hardened in a solution of formol before dissection. From all the specimens the muscles must be removed. While doing this, notice the exit of the vorticose veins about the equator of the eyeball, and the entrance of the optic nerve and the posterior ciliary arteries. The optic nerve pierces the sclera below and lateral to the posterior pole of the ocular bulb.

In the first place the dissector should gain some idea of the general structure of the eyeball from ***sections*** of at least two specimens. One of these should be cut in a vertical antero-posterior direction: the other in the plane of the equator.

The eyeball (Bulbus oculi).—The eyeball is lodged in the anterior part of the orbit, and is protected in front by the eyelids and the conjunctiva. The bony ring formed by the frontal, lachrymal, zygomatic and temporal bones forms a protection for the middle zone of the organ; while posteriorly it is covered by the periorbita, orbital fascia and fat, and the orbital muscles.

Although it is customary to describe the eyeball as having the form of an oblate spheroid, this does not give a sufficiently accurate notion of the degree of the characteristic antero-posterior flattening; nor does it take into account the fact that the cornea, being a segment of a smaller sphere than the sclera, causes a bulging of the front of the eyeball and thus adds to the antero-posterior diameter. In actual figures, the average transverse, vertical and antero-posterior diameters and the distance from the anterior pole to the entrance of the optic nerve may be expressed as being in the proportion of 5 : 4·5 : 4·25 : 3. Though the curves of the cornea and sclera are not the same in every direction or in every part, the difference between them may be indicated by saying that, on the average, the radius of the curvature of the cornea is about 17 mm., while that of the sclera is about 25 mm. Where the cornea and sclera meet there is a shallow *sulcus scleræ* on the surface of the eyeball.

For descriptive purposes it is found convenient to employ certain terms. the *anterior* and *posterior poles* of the eyeball (polus anterior : polus posterior) are the central points of the anterior and posterior curvatures respectively. They are joined by an imaginary line, the *optic axis* (axis optica), the shortest distance between the two poles,

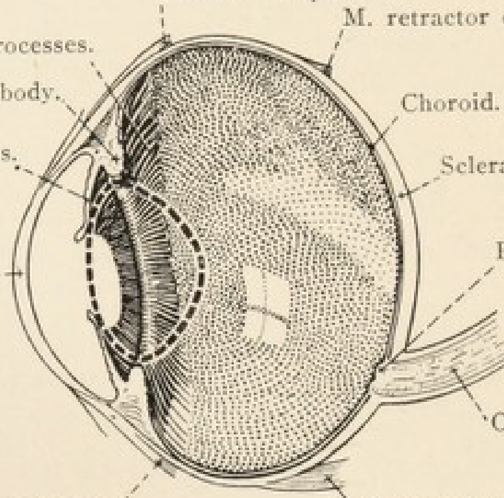


FIG. 48.—Sagittal section of the eyeball.

and by *meridians* (meridiani) that lie evenly on the surface of the eyeball and cut the equator at right angles. The *equator* (æquator) is a line drawn on the surface equidistant between the two poles. The optic axes of the two eyes diverge at an angle of about 137 degrees.

The eyeball is composed of three concentric tunics enclosing three refracting media. The tunics are:—(1) An outer, dense, fibrous coat (tunica fibrosa oculi) consisting of the opaque *sclera* posteriorly and the transparent *cornea* anteriorly; (2) a middle vascular and pigmented envelope (tunica vasculosa oculi) comprising a posterior and more extensive portion, the *choroid* (chorioidea), an intermediate *ciliary body* (corpus ciliare), and an anterior diaphragm or *iris;* and (3) an internal and thin nervous tunic, the *retina*. The refracting media are:—(1) The most posterior and most voluminous, the *vitreous body* (corpus vitreum), of jelly-like consistence; (2) the *crystalline lens* (lens crystallina), the most dense of the media; and (3) an *aqueous humour* that occupies the most anterior part of the eyeball.

Dissection.—The dissection should begin with a separation of the sclera and cornea from the structures that lie within them. With great care, make a short incision with the knife through the sclera at the equator. The underlying choroid must not be injured: therefore the incision must stop immediately pigment becomes visible. Now complete the incision round the equator by means of scissors. The separation of the sclera can be effected readily, except on a level with the junction of the cornea and sclera and at the entrance of the optic nerve. In the first-named position resistance is offered by the attachment of the ciliary muscle, and can be overcome by using a pair of closed forceps or a similar blunt instrument. The optic nerve must be severed immediately it has pierced the sclera. The fibrous tunic of the eyeball is now divided into two parts. The rest of the specimen must be preserved for later examination.

The *sclera*[1] is a dense, resisting, white tunic, composed of interlacing meridional and circular bundles of fibres, and forming some four-fifths of the whole tunica fibrosa. It is of considerable thickness in the region of the posterior pole, and fairly thick close to the margin of the cornea. The intermediate part, however, is relatively thin and may have a bluish tinge from the underlying pigment. The relative thickness of the different parts may be expressed in figures as follows: In the region of the corneo-scleral junction the sclera is about 1·3 mm. in thickness; at the equator the thickness is reduced to 0·4 or 0·5 mm.; while at the posterior pole it attains a thickness of 1·5 to 2 mm.

The external surface of the sclera gives attachment to the various ocular muscles, and is partly covered (anteriorly) by conjunctiva. The anterior margin circumscribes an oval opening, with a transverse long axis, into which the cornea fits in much the same manner as does a watchglass into its metal rim. The point of entrance of the optic nerve, as has been previously noted, is below and lateral to the posterior pole. Here the fibrous sheath of the nerve—derived from the dura mater of the brain—is continuous with the sclera. The bundles of fibres of the nerve pass through small orifices, the area containing them being the *lamina cribrosa*[2] *scleræ*.

Between the sclera and the choroid there is a perichoroidal lymph space (spatium perichorioidale) crossed by fine ciliary vessels and nerves and a loose network of pigmented connective tissue that constitutes the *lamina fusca*.[3]

The sclera is poorly supplied with blood by the ciliary arteries. Relatively large veins—*venæ vorticosæ*—pierce it about the equator, and into these the small veins of the tunic open. A circular venous sinus (*sinus venosus scleræ*), which communicates with the scleral

[1] *Sclera* [L.], σκληρός (sklēros) [Gr.], hard.

[2] *Cribrum* [L.], a sieve.

[3] *Fuscus* [L.], brown.

veins and with the anterior chamber of the eyeball, is present near the corneo-scleral junction.

The *cornea*[1] is transparent, non-vascular, of great density and of ovoid outline, and forms approximately one-fifth of the whole fibrous tunic of the eyeball. Owing to the greater amount of overlap by the sclera above and below, the cornea presents a more markedly ovoid configuration when viewed from the front than it does when seen from behind. The broader end of the outline is medial.

The curvature of the cornea is different in different directions and in different regions. It is greater in the vertical than in the horizontal direction, and the highest point of the curvature (*vertex corneæ*) is below and medial to the mid-point of the transverse diameter. The anterior surface (facies anterior) is covered by conjunctiva reduced to its epithelial elements only. The posterior surface (facies posterior) is bathed by the aqueous humour of the anterior chamber.

The cornea contains the following layers:—(1) The *anterior epithelium*, stratified in character and continuous with the conjunctiva; (2) the *substantia propria*, forming almost the whole of the thickness of the cornea and consisting of lamellæ of connective fibres; (3) the *posterior elastic lamina;* and (4) the *endothelium* of the anterior chamber, a single layer of low, polyhedral cells continued on to the anterior surface of the iris. At the periphery of the cornea the posterior elastic lamina divides into three sets of fibres. The most superficial blend with the sclera; the middle fibres give attachment to the ciliary muscle; and the deepest fibres radiate into the iris as the *ligamentum pectinatum*[2] *iridis*, between the bundles of which are the *spatia anguli iridis* that communicate with the anterior chamber of the eyeball and the sinus venosus scleræ.[3]

The *choroid*[4] (chorioidea), a thin, pigmented membrane that lies between the sclera and the retina, forms the greater part of the middle or vascular tunic of the eyeball, and is thickest in the region of the posterior pole and the entrance of the optic nerve. As has been demonstrated by dissection, the connection between the choroid and the sclera is loose, except at the entrance of the optic nerve. In general, the colour of the membrane is a deep brown verging upon black, but if it be viewed from the front, a shining, iridescent, crescentic or roughly triangular area is conspicuous above the optic papilla.

[1] *Corneus* [L.], horny.

[2] *Pecten* [L.], a comb.

[3] The brief details of structure given herein must be amplified by reference to one of the standard textbooks on microscopic anatomy.

[4] *Chorioideus* [L.], χοριοειδής (chorioeides) [Gr.], skin-like. *Corium* [L.], χόριον (chorion), [Gr.], skin.

This is the *tapetum*,[1] and the characteristic appearance of the choroid in this region is due to the presence of a layer of fibrous tissue.[2] The colour of the tapetum varies somewhat in different specimens, but is mostly composed of shades of green and blue merging into yellow.

The choroid is composed of four layers:—(1) The outermost, the *lamina suprachorioidea*, having a close resemblance to the lamina fusca of the sclera; (2) the *lamina vasculosa*, consisting of a superficial stratum containing whorls of veins that drain into the venæ vorticosæ, and a deeper layer in which are branches of the short posterior ciliary arteries; (3) the *lamina choriocapillaris*, consisting mainly of a very rich meshwork of capillary vessels; and (4) a transparent *lamina basalis*. The tapetum occurs between the lamina vasculosa and the lamina choriocapillaris.

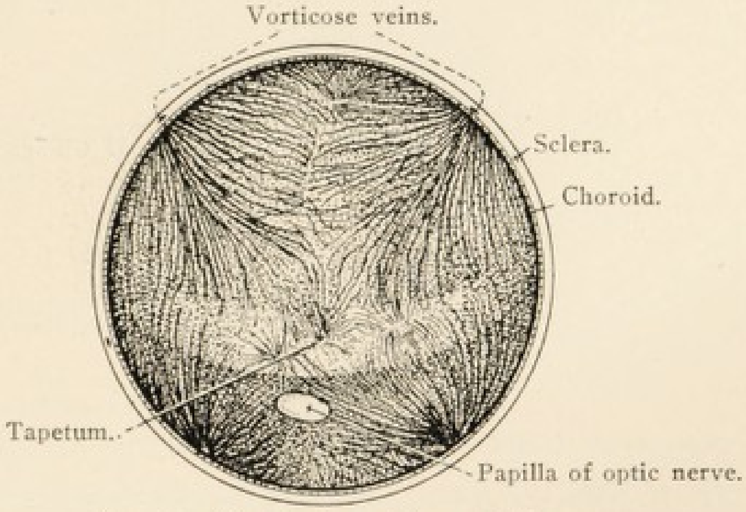


Fig. 49.—The fundus of the eyeball.

Dissection.—To display the ciliary body, cut an eyeball across a little distance in front of the equator, and remove the vitreous body and the crystalline lens from the anterior segment.

The *ciliary body* (corpus ciliare) connects the choroid to the periphery of the iris and consists of the ciliary processes internally and the ciliary muscle externally. In a longitudinal section of the eyeball it has the form of an elongated, curved triangle, the base of which is directed towards the iris. The *ciliary processes* (processus ciliares), over a hundred in number, are radially arranged ridge-like thickenings of the ciliary body; each ridge becoming taller from the periphery centralwards and ending abruptly as a slightly expanded prominence. The length of the ridges, that is, the breadth of the zone formed by the ciliary processes, is less on the medial side of the

[1] *Tapetum* [L.], a carpet.

[2] The tapetum varies structurally in different mammals. For example, in the horse, as above stated, it is composed of fibrous tissue (tapetum fibrosum); while in the dog it consists of polyhedral cells (tapetum cellulosum).

eyeball than it is elsewhere. A portion of the hyaloid membrane that surrounds the vitreous body is applied to the ciliary processes, and is radially thickened and folded so as to present grooves and elevations that are adherent to the processes and the depressions between them.

Immediately behind the ciliary processes there is a circular area, almost entirely smooth, known as the *orbiculus ciliaris.* This is directly continuous with the choroid, of which it might be considered a part, and from which it is distinguishable only by its greater thickness and the absence of a lamina choriocapillaris.

The *ciliary muscle* (m. ciliaris) consists of involuntary fibres arranged, for the most part, in a meridional or radiating manner. There is, however, some admixture of oblique and circular fibres.

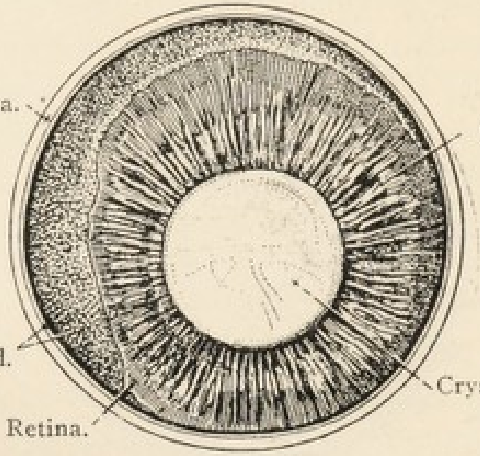


FIG. 50.—The ciliary body and crystalline lens viewed from behind.

The radiating fibres arise from the corneo-scleral junction and the ligamentum pectinatum iridis, and are attached to the ciliary processes and orbiculus ciliaris.

Dissection.—The posterior surface of the iris can be studied in the preparation made to show the ciliary body; but to reveal the anterior surface it is necessary to remove the cornea from another eyeball.

The *iris*[1] is a muscular diaphragm placed immediately in front of the crystalline lens. About its centre is an elliptical opening, the *pupil* (pupilla), which during life is capable of variation in size to regulate the amount of light entering the eye. When the pupil is fully dilated it approaches the circular in outline; but when strongly contracted it is little more than a narrow linear opening. These variations in size are governed by muscular fibres in the substance of the iris. Some of them are arranged in a circular manner around the pupil (*m. sphincter pupillæ*), and to them motor impulses are

[1] ἶρις (iris) [Gr.], a rainbow, a bright-coloured circle surrounding another body. Gālen was apparently the first to apply the name to the iris of the eye.

carried by fibres derived from the oculomotor through the short ciliary nerves. Radially arranged fibres (*m. dilatator pupillæ*) diverge from the circular sphincter to the periphery of the iris, and are governed by fibres from the sympathetic nervous system through the short ciliary nerves.

The iris has two margins. One (margo pupillaris) circumscribes the pupil, and carries darkly pigmented masses (*granula iridis*), varying in number and size, along both margins of the pupil. Those of the upper margin are much the larger. The ciliary border (margo ciliaris) is connected with the ciliary body and, by the ligamentum pectinatum iridis, with the posterior lamina of the cornea and the corneo-scleral junction.

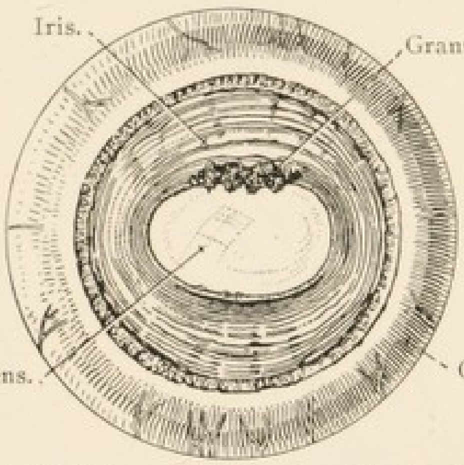


FIG. 51.—Iris and adjoining part of the choroid viewed from the front.

The iris is supplied with blood by the long and anterior ciliary arteries. The two long ciliary vessels (page 114) pierce the sclera close to the entrance of the optic nerve, and run forwards between the sclera and the choroid. Near the periphery of the iris each divides into two branches, which, by anastomoses of their subdivisions with each other and with twigs from the anterior ciliary arteries, form the *circulus arteriosus major*. Branches from this circle supply the ciliary body, while others pass towards the pupillary border of the iris, and there form a *circulus arteriosus minor*.

Dissection.—The retina may be demonstrated in several ways. By carefully removing the vitreous body from the eyeballs that have been sectioned, a good view of the retina from within may be obtained. It may also be studied in the specimen in which the sclera and cornea have been removed for the exhibition of the vascular tunic. In this specimen, the choroid, ciliary body and iris must be cautiously removed bit by bit.

The pigmentary (outermost) layer of the *retina*[1] is so closely adherent to the deep face of the choroid that it is removed along with

[1] *Rete* [L.], a net; *retina* [low L.], something to hold fast, to keep; (in the retina images are captured).

this tunic. The rest of the very delicate membrane consists of nervous and connective tissue. It is in the nervous layers of the retina that the fibres of the optic nerve have their origin, a circumstance that accounts for the gradual increase in the thickness of the membrane as its point of connection with the nerve is approached. That part of the retina that contains nervous elements is distinguished by the name *pars optica retinae.* At an indistinct line, the *ora*[1] *serrata*, close to the edge of the ciliary body, the nerve elements cease and the retina suddenly becomes thinner. From this line the membrane is continued over the ciliary body as the *pars ciliaris retinae*, and thence on to the posterior surface of the iris as the *pars iridica retinae.*

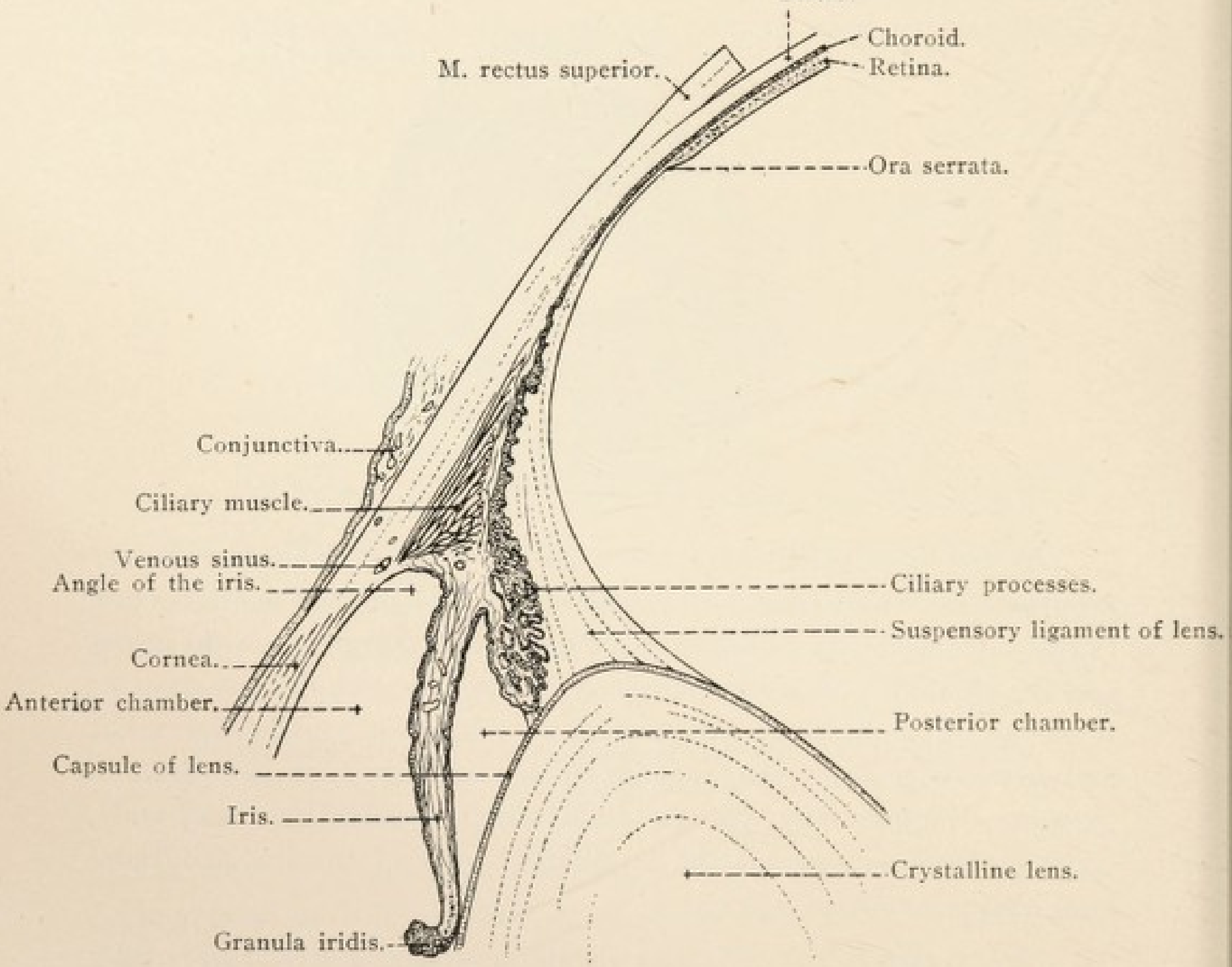


Fig. 52.—Section through the ciliary body and iris of the eye.

When the retina is viewed from within, the entrance of the optic nerve is distinguishable as a well-defined, pale, oval area, the *optic papilla* (papilla optica), below and lateral to the posterior pole of the eyeball. The transverse diameter of the papilla is the greater, being about 6-7 mm., while the vertical diameter is 4-5 mm. The central part of

[1] *Ora* (from *os*, a mouth) [L.], a border, edge, boundary, &c. *Serratus* [L.], toothed like the edge of a saw, notched at the edge.

the papilla is pitted by the *excavatio papillæ nervi optici.* It should be remembered that the optic papilla, having no nerve elements except nerve fibres, is the "blind spot." Thirty or forty small arteries, branches of the central artery of the retina, with their satellite veins, radiate from the papilla.

Dissection.—To obtain the isolated vitreous body and crystalline lens, the method suggested by Anderson Stuart should be followed. An eyeball is allowed to lie untouched for some time—one to three days, according to the season. An incision is then made along the equator through the three tunics, and the two halves of the eyeball are gently separated. If this is properly done, the vitreous body and lens may be allowed to drop entire into water, or, still better, into a stain in which they may remain for some minutes. If stained, the specimen should be well washed before examination.

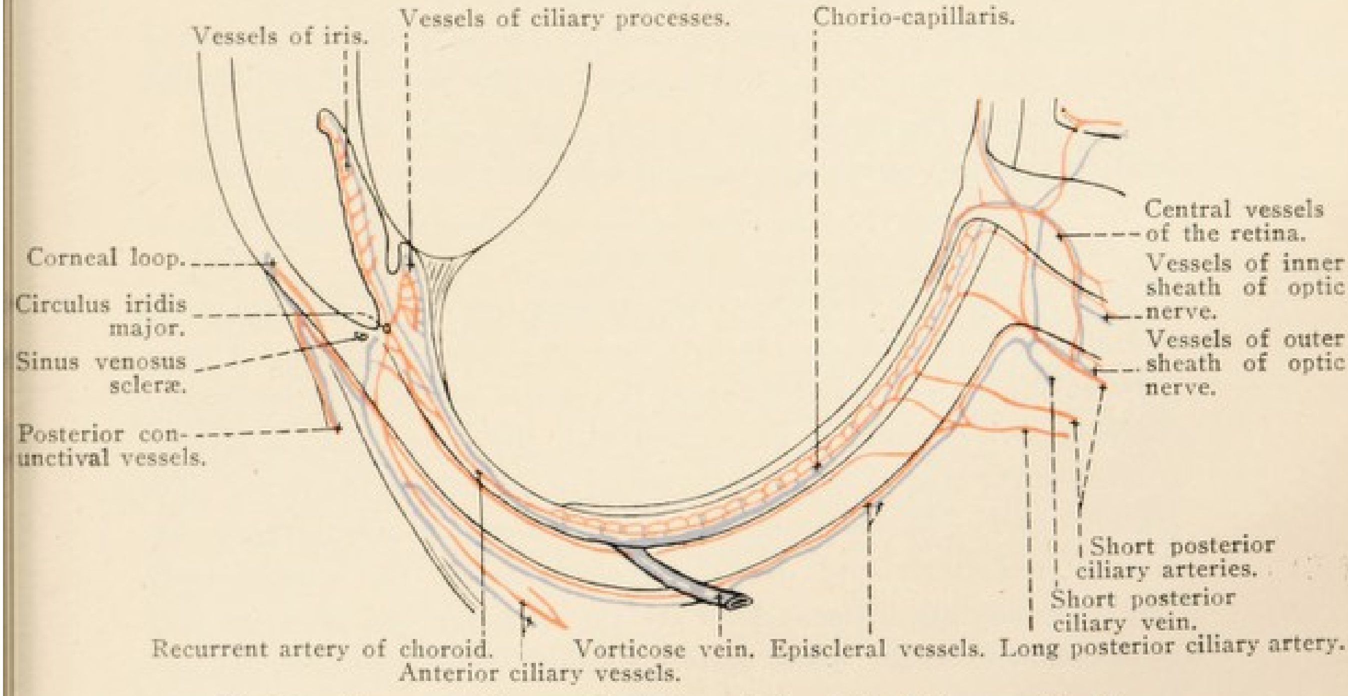


FIG. 53.—Diagram of the vessels of the eyeball. (After Leber, modified.)

The *vitreous body*[1] (corpus vitreum) is a transparent, jelly-like substance occupying the posterior part of the cavity of the eyeball, and intervening between the crystalline lens and the retina. In front, adaptation to the lens produces the *hyaloid fossa* (fossa hyaloidea). The rest of the surface of the body is convex and applied to the optic and ciliary parts of the retina, but is not in any way connected with this membrane except at the entrance of the optic nerve.

The surface of the vitreous body is covered by a delicate *hyaloid*[2] *membrane* (membrana hyaloidea), which, over the ciliary body, is thickened by the accession of radial fibres. The thickened part of the membrane is the *ciliary zonule* (zonula ciliaris), which is firmly adherent to the ciliary processes to which it is adapted by a series of

[1] *Vitreus* [L.], glassy.
[2] ὕαλος (hyalos) [Gr.], glass.

radial folds and grooves. Close to the margin of the crystalline lens the zonule splits into two layers: The thinner of these lines the hyaloid fossa; while the thicker and more anterior layer is connected with the capsule of the lens, and thus forms the *suspensory ligament.* A very loose and delicate fibrous *stroma vitreum*, with a *humor vitreus* filling its spaces, is enclosed by the hyaloid membrane and forms the substance of the vitreous body.

Running through the vitreous body from the optic papilla to the back of the lens is a minute *hyaloid canal* (canalis hyaloideus) marking the line of the embryonic hyaloid artery (a. hyaloidea), a branch of the central artery of the retina. The canal cannot be detected in the adult eye unless the vitreous body has been stained.

If a blow-pipe be introduced through the suspensory ligament, a varicose canal surrounding the equator of the lens can be inflated. This is formed by the *zonular spaces* (spatia zonularia), bounded in front by the suspensory ligament and behind by the hyaloid membrane.

Dissection.—The lens must be separated from the vitreous body by cutting through the suspensory ligament.

The transparent, nearly circular and biconvex *crystalline lens* (lens crystallina), lies between the iris and the vitreous body. A zone between the extreme periphery and the centre of the anterior surface (facies anterior lentis) is in contact with the iris; while a variable amount of the central part of the surface coincides with the pupil. The posterior surface (facies posterior lentis) has a greater curvature than the anterior, and is received into the hyaloid fossa of the vitreous body. The central points of the surfaces are the *anterior* and *posterior poles* (polus anterior lentis: polus posterior lentis). Joining the two poles is the *axis* of the lens (axis lentis). The periphery or *equator* (æquator lentis) is in close contact with the ciliary processes.

If the lens be held up to the light, three fine radiating lines may be detected spreading out from the central point of each surface. These indicate the planes of contact of the ends of the fibres (fibræ lentis) that compose the intimate structure of the lens. When viewed from the anterior surface, one of these lines runs vertically upwards from the anterior pole; the other two diverge downwards. On the posterior surface one of the lines runs vertically downwards from the pole; the others diverge upwards.

Covering the surface of the lens is a homogeneous membrane, the *capsule* (capsula lentis), much thicker over the anterior than over the posterior surface.

If a fresh lens be crushed between the fingers, it will be easy to demonstrate the presence of a softer *cortical substance* (substantia corticalis) that gradually merges into the much denser *nucleus* or central part (nucleus lentis). A hardened lens should be broken and teased in order to show the concentric disposition of laminæ and the fibres that compose them.

Between the cornea and the iris and central part of the lens there is a space known as the *anterior chamber of the eye* (camera oculi anterior). In the angle formed by the cornea and the iris, the *angulus iridis*, the aqueous humour finds its way into the spatia anguli iridis. The *posterior chamber of the eye* (camera oculi posterior) is the circular interval bounded by the iris, the suspensory ligament, the peripheral part of the anterior surface of the lens and the projection formed by the extremities of the ciliary processes. The anterior and posterior chambers are filled with the *aqueous humour*, and communicate with each other through the pupil.

Dissection.—The blood-vessels and nerves that lie immediately below the orbit, that is, in the pterygo-palatine fossa, must be cleaned and examined.

V. REFLEXA.—The reflex vein, which communicates anteriorly with the facial, has previously been traced under the masseter muscle and between the mandible and the maxillary tuber into the pterygo-palatine fossa (page 49). In the present dissection it is seen to pierce the periorbita and enter the cranium by the orbital fissure. The connection of the vein with the cavernous venous sinus within the cranium will be revealed at a later stage of the dissection. The following are its tributaries:—

(1) *V. palatina major.*—The greater palatine vein drains the blood from the hard palate, where its radicles spring from an exceedingly rich submucous plexus, and is now found between the maxillary tuber and the perpendicular part of the palatine bone, where it is joined by veins from the soft palate. It should be noted that the vein, inasmuch as it does not traverse the palatine canal, is not a close companion of the artery of the same name.

(2) *V. sphenopalatina.*—The spheno-palatine vein begins in a rich plexus of vessels in the mucous membrane of the nasal cavity, and gains the pterygo-palatine fossa by the spheno-palatine foramen.

(3) *V. infraorbitalis.*—The infraorbital vein, after traversing the infraorbital canal, generally joins the reflex in company with the spheno-palatine vein.

(4) *V. ophthalmica.*—The short ophthalmic vein is formed by the union of the ethmoidal, ciliary, muscular and lachrymal veins and the central vein of the retina.

A. MAXILLARIS INTERNA.—The first part of the internal maxillary artery, that is, from its origin to its entrance into the alar canal, has

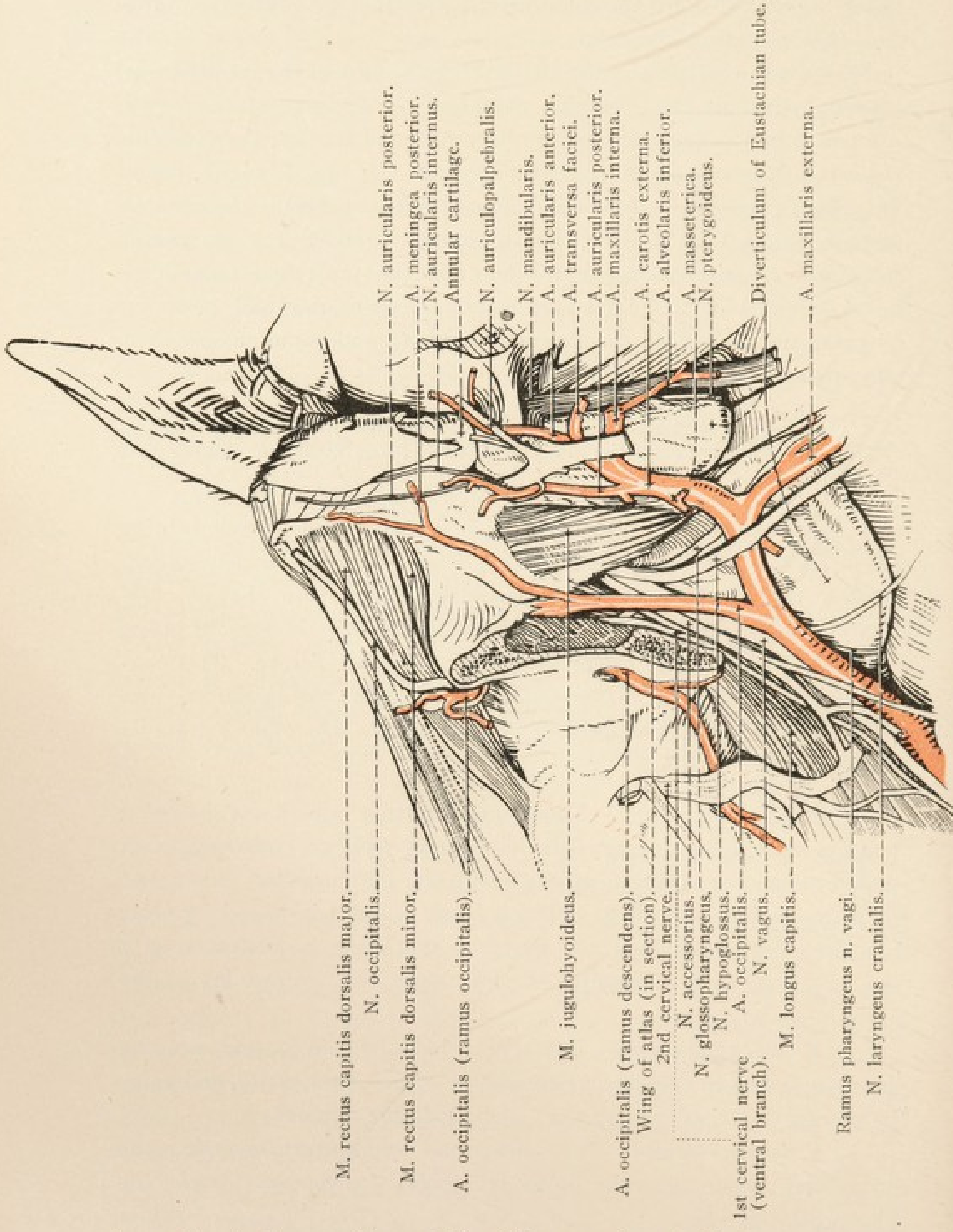


FIG. 54.—The diverticulum of the auditory (Eustachian) tube, with the related arteries and nerves.

been already dissected (page 61). The second and third parts, namely, that part within the canal and the terminal stretch after the canal has been left, must be examined now.

While within the alar canal, the internal maxillary furnishes two branches, the anterior deep temporal and the ophthalmic arteries, which very commonly arise by a common stem.

(1) *A. temporalis profunda anterior.*—The anterior deep, temporal artery leaves the alar canal by the small alar foramen, and at once buries itself underneath the temporal muscle, where its branches anastomose with those of the posterior artery of the same name.

(2) *A. ophthalmica.*—The ophthalmic artery leaves the canal in company with the parent vessel, and thus gains the orbit, where its course and distribution have been examined (page 114).

The third part of the internal maxillary artery passes along the pterygo-palatine fossa from the anterior alar foramen to the vicinity of the posterior palatine foramen, into which it is continued as the greater palatine artery. This part of the vessel is very intimately related to the maxillary nerve and its branches. It supplies the following branches:—

(1) *A. buccinatoria.*—The buccinator artery rises close to the anterior alar foramen, and runs to the cheek on the lateral face of the maxillary tuber. It furnishes branches to the masseter and pterygoid muscles, and, as has been already noted, to the component structures of the cheek (page 51).

(2) *A. infraorbitalis.*—The infraorbital artery runs direct to the maxillary foramen, by which it enters the infraorbital canal. Its subsequent course and distribution will be considered later. Usually the infraorbital gives origin to the *malar artery* (a. malaris), though occasionally this leaves the internal maxillary itself. Whichever may be its origin, the malar artery passes along the ventral wall of the orbit (outside the periorbita), crosses the orbital rim and ends on the face by anastomosing with the angular artery of the eye. Small branches are supplied to the inferior oblique muscle, the lachrymal sac and the lower eyelid.

(3) *A. palatina minor.*—The lesser palatine artery is a small vessel that gains the soft palate by crossing the medial surface of the maxillary tuber.

(4) *A. sphenopalatina.* — The spheno-palatine artery enters the spheno-palatine foramen immediately, in order to gain the cavity of the nose.

(5) *A. palatina major.*—The greater palatine artery, the direct continuation of the internal maxillary, traverses the palatine canal and supplies the hard palate.

N. MAXILLARIS.—The maxillary nerve is one of the divisions of the fifth cerebral, or trigeminal, and leaves the cranium by the foramen rotundum. The close relation of the branches of this nerve and the internal maxillary artery in the pterygo-palatine fossa has already been remarked. The branches of the nerve are as follows :—

(1) *N. zygomaticus.*—The slender zygomatic nerve was encountered in the orbit which it gains by piercing the periorbita. It has been seen to follow the lateral rectus muscle and end in the skin of the lower eyelid.

(2) *N. infraorbitalis.*—From its size and direction, the infraorbital nerve might be regarded as the main continuation of the maxillary. It enters the infraorbital canal in company with the artery of the same name.

(3) *N. sphenopalatinus.*—The spheno-palatine nerve is broad and flat, and will be found crossing the pterygoid process of the sphenoid bone and the perpendicular part of the palatine, where it divides into the lesser and greater palatine and posterior nasal nerves. (*a*) The *lesser palatine nerve* (n. palatinus minor) accompanies the artery of the same name into the soft palate. (*b*) The *greater palatine nerve* (n. palatinus major) also follows the artery that bears a like name. (*c*) The *posterior nasal nerve* (n. nasalis posterior) enters the nasal cavity by the spheno-palatine foramen.

Spheno-palatine plexus and ganglia.—If the maxillary nerve be raised from the surface of the bone on which it lies, the spheno-palatine plexus (plexus sphenopalatinus), in which several small ganglia are entangled, will be exposed. Afferent fibres to the ganglia are derived from the spheno-palatine nerve (sensory) and the nerve (Vidian) of the pterygoid canal (motor and sympathetic). Efferent fibres supply the periorbita and form a network around the branches of the internal maxillary artery.

Dissection.—Clear away the remains of the diverticulum of the auditory tube and examine the structures ventral to the epistropheus and the base of the skull.

M. LONGUS CAPITIS.—The long muscle of the head arises from the transverse processes of the fourth and third and the body of the second cervical vertebræ, and ends on the tubercles at the junction of the occipital and sphenoid bones, in a tendinous insertion common to the muscles of the two sides of the body. The terminal part of the muscle is in contact with its fellow, and between the diverticula of the auditory tubes.

M. RECTUS CAPITIS VENTRALIS.—The ventral straight muscle of the head is small, fleshy and short. Its fibres arise from the ventral arch of the atlas, and are inserted into the basilar part of the occipital bone.

M. RECTUS CAPITIS LATERALIS.—The lateral straight muscle is also small and fleshy, and runs between the wing of the atlas and the jugular process of the occipital bone.

N. CERVICALIS PRIMUS.—The ventral branch of the first cervical nerve pierces the alar foramen of the atlas to gain the fossa atlantis, and will now be observed to emerge from the interval between the lateral straight and the caudal oblique muscles. Its division into two branches has already been remarked.

Dissection.—Detach the origin of the stylo-glossal muscle from the hyoid bone. Remove the jugulo-hyoid muscle, and cut through the cartilaginous connection between the hyoid and temporal bones. Then clean the occipital artery and the last few cerebral nerves at their exit from the cranium.

N. GLOSSOPHARYNGEUS: N. VAGUS: N. ACCESSORIUS: N. HYPOGLOSSUS.—The first three of these nerves leave the cranium together by the jugular foramen. For a certain distance the tenth and eleventh nerves are enclosed in a common fibrous sheath, after which they diverge at an acute angle.

On the glosso-pharyngeal nerve, immediately at its exit, there is an elongated, greyish *petrosal*[1] *ganglion* (ganglion petrosum). The small *tympanic nerve* (n. tympanicus) leaves the ganglion, and at once turns upwards between the tympanic and petrous parts of the temporal bone to gain the interior of the tympanum. Fine filaments also connect the ganglion with the jugular ganglion of the vagus and the cranial cervical ganglion of the sympathetic. Two other branches of the glosso-pharyngeal nerve should be sought. One of these crosses the surface of the diverticulum of the Eustachian tube, gives twigs to the pharyngeal plexus, and assists in the formation of the carotid plexus. The other branch is small, and terminates in the stylo-pharyngeal muscle.

The hypoglossal nerve leaves the cranium by the hypoglossal foramen, runs for a short distance between the diverticulum of the auditory tube and the capsule of the atlanto-occipital joint, and then traverses the angle of divergence of the vagus and accessory nerves.

GANGLION CERVICALE CRANIALE.—The fusiform, greyish cranial cervical ganglion of the sympathetic nervous system, lies on the dorsal posterior part of the diverticulum of the Eustachian tube close

[1] Petrosus [L.], rocky, stony (the ganglion is named from the bone with which it is associated).

to the atlanto-occipital joint. Communicating fibres connect it with the last four cerebral nerves and the ventral branch of the first cervical nerve. Numerous fine filaments pass from the ganglion to the pharyngeal plexus; and two or three nerves from it form the *internal carotid plexus* (plexus caroticus internus), which accompanies the internal carotid artery into the cranium. An *external carotid plexus* (plexus caroticus externus) is also formed around the artery of this name. From the caudal end of the ganglion proceeds a nerve-cord that soon enters a connective tissue sheath common to it and the vagus nerve. The two nerves were dissected in the neck (page 6).

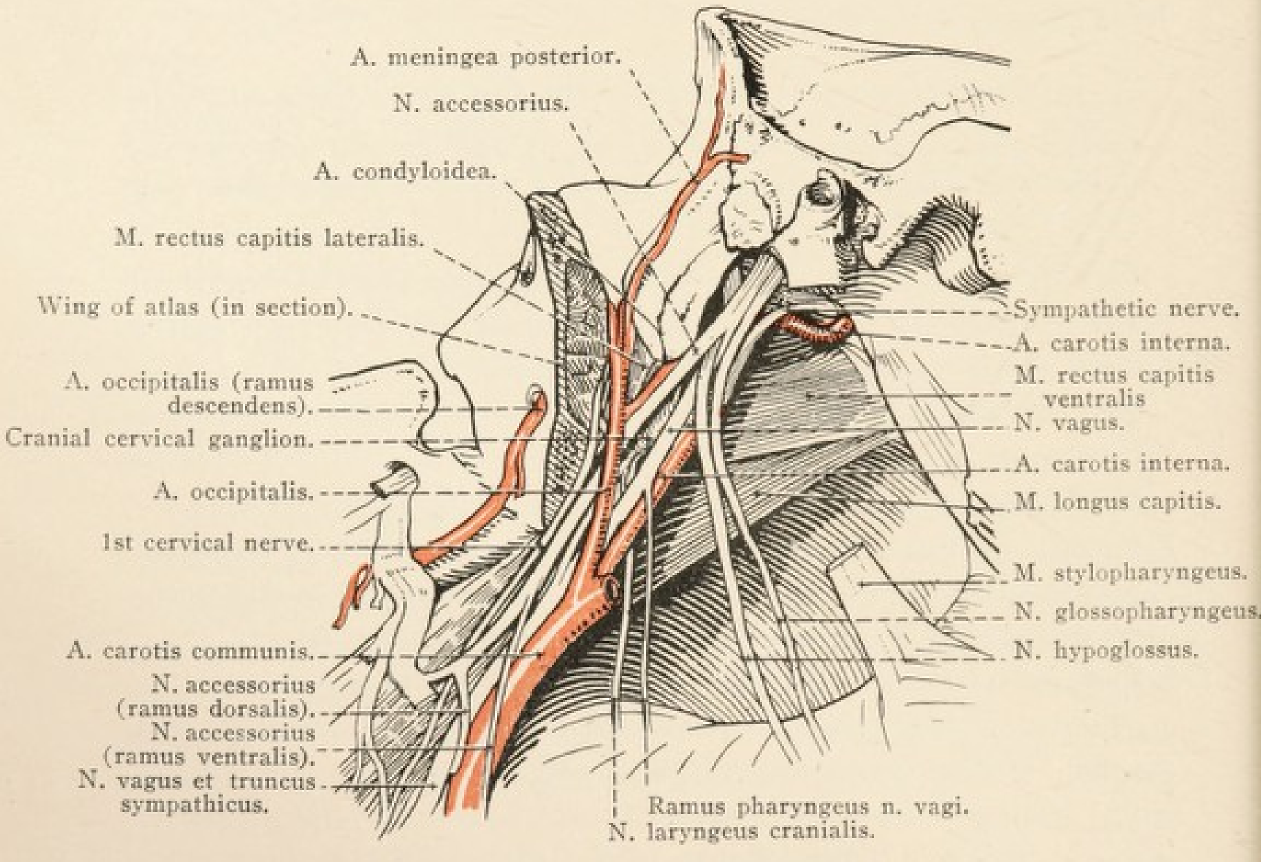


FIG. 55.—The arteries and nerves in the region of the atlanto-occipital and atlanto-epistrophic articulations.

A. OCCIPITALIS.—The whole length of the occipital artery is now open to examination. One of the smaller terminal branches of the common carotid artery, the occipital runs upwards and backwards into the fossa atlantis, crossing the lateral face of the vagus and accessory nerves. In the fossa, it divides into descending and occipital branches, which were dissected with the other structures dorsal to the atlas (page 105).

The following are the collateral branches of the occipital artery:—

(1) *A. glandulæ submaxillaris superior.*—This is a small vessel that supplies blood to the caudal end of the submaxillary gland.

Though usually derived from the occipital, it may arise from the external carotid, or from the posterior meningeal, or from the termination of the common carotid artery.

(2) *A. condyloidea*.—The condyloid artery is also small. After running obliquely across the surface of the diverticulum of the Eustachian tube, it divides into branches, some of which are muscular in distribution, while others enter the cranium by the hypoglossal and jugular foramina and are expended in the dura mater of the brain.

(3) *A. meningea posterior*.—The posterior meningeal artery is the largest collateral branch of the occipital. Following the posterior border of the jugular process of the occipital bone underneath the cranial oblique muscle, it reaches a transverse and sinuous groove on the mastoid part of the temporal bone. The groove leads the artery between the squamous and mastoid parts of the temporal bone and so into the temporal meatus, by which it gains the interior of the cranium where it supplies the dura mater. On its way to the cranium, the meningeal artery contributes branches to the cranial oblique muscle of the head and the joint between the atlas and the skull.

V. OCCIPITALIS.—The occipital vein begins by the union of radicles equivalent to the descending and occipital rami of the artery, and receives the inferior cerebral vein. It ends by joining the internal maxillary vein.

A. CAROTIS INTERNUS.—One of the three terminal branches of the common carotid artery, the internal carotid arises immediately behind the point of origin of the occipital (the deep face of which it crosses), ascends on the diverticulum of the auditory tube, and enters the cranium by the carotid foramen. It is related to the vagus nerve and the cranial cervical ganglion, and is crossed laterally by the glosso-pharyngeal and hypoglossal nerves and the pharyngeal branch of the vagus.

M. LONGUS COLLI.—The whole extent of the cervical part of the longus colli muscle is now exposed. The muscle should be revised (see page 25), and its terminal insertion into the ventral tubercle of the atlas noted.

Dissection.—All the muscles must now be cleared away from the cervical vertebræ, and the joints of the neck—including that between the atlas and the occipital bone—must be examined.

THE CERVICAL ARTICULATIONS.—The joints between the last six cervical vertebræ are similar in their component parts to the articulations between the thoracic vertebræ,[1] with the difference that there is no ventral longitudinal ligament and supraspinal ligaments are absent. *Intervertebral fibro-cartilages* (fibrocartilagines intervertebrales), each consisting of a fibrous ring and a pulpy nucleus, connect the bodies of the vertebræ. *Interarcual ligaments* (ligamenta flava) pass between the adjacent arches and are well developed and distinctly elastic. *Interspinal ligaments* (ligamenta interspinalia) are developed proportionate to the size of the spinous processes, and are elastic. *Intertransverse ligaments* are absent.

The joints between the articular processes of adjacent vertebræ are provided with *joint capsules* (capsulæ articulares), which are more roomy in the neck than in other parts of the vertebral column in accordance with the greater range of movement in this region.

A *dorsal longitudinal ligament* will be exposed when the spinal cord is removed from the vertebral canal.

The special movements in the joints between the epistropheus and the atlas and between the atlas and the occipital bone, and the concomitant peculiarities of the opposed bony surfaces, necessitates a special arrangement of ligaments.

THE ATLANTO-EPISTROPHIC ARTICULATION (articulatio atlanto-epistrophica).—This joint has an arrangement of bony surfaces and ligaments that permits of a rotation of the atlas[2] (and, with it, the head), about an axis formed by the dens of the epistropheus.[3] The comparative looseness of adaptation of the bony surfaces, and the elasticity of the interspinal ligament, render possible considerable freedom of movement.

The dissector should refresh his memory by referring to the bony surfaces of the separated and macerated bones. The atlas carries two saddle-shaped surfaces, separated by a wide dorsal and a narrow ventral notch. In addition, the hinder part of the ventral half of the vertebral foramen is hollowed from side to side to accommodate the dens of the epistropheus. The epistropheus also has two saddle-shaped surfaces, and the ventral face of the dens is smooth and convex from side to side. If the bones be placed in apposition, it will be observed that the amount of actual contact between them is very limited; and, if the normal movements of the joint be imitated, it will be noted that the points of contact undergo a continuous series of changes.

[1] See *The Topographical Anatomy of the Thorax and Abdomen.*

[2] Ἄτλας (Atlas) [Gr.]. In Greek mythology, Atlas was one of the Titans and bore the heavens on his shoulders, as the human atlas bone bears the skull.

[3] ἐπιστροφεύς (epistropheus) [Gr.], the pivot. ἐπιστρέφω (epistrepho), to turn back the head, to look back.

A roomy *joint capsule* surrounds and encloses the opposed articular surfaces. The *tectorial*[1] *membrane* (membrana tectoria) plays the part of an interarcual ligament running from the arch of the epistropheus to the margin of the dorsal arch of the atlas, and filling in the considerable interarcual space between these bones. An *interspinal ligament* can readily be distinguished as a double elastic band,

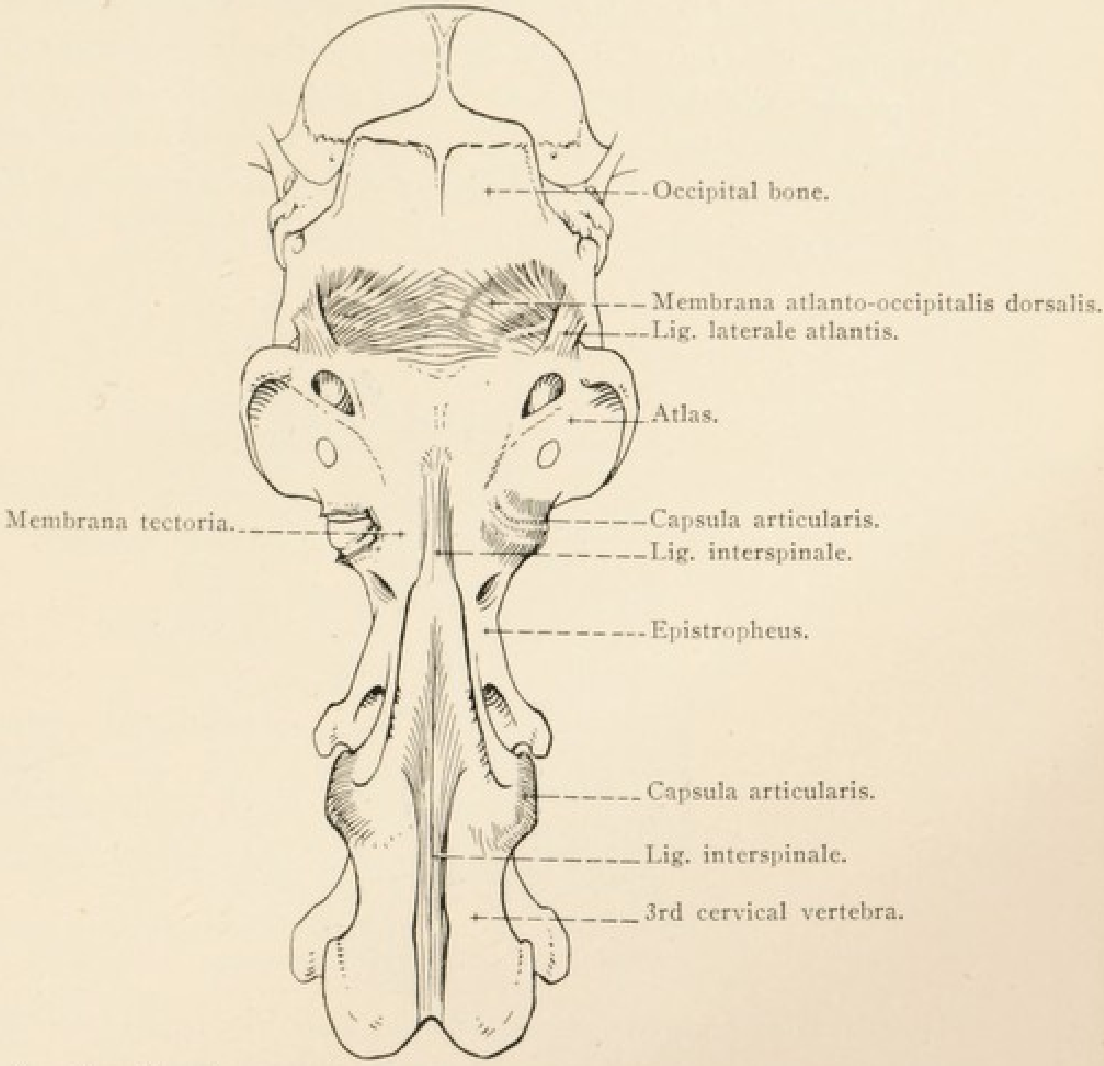


Fig. 56.—The atlanto-occipital and atlanto-epistrophic articulations. Dorsal aspect.

but it is with difficulty separated from the tectorial membrane. A *ventral ligament* connects the mid-ventral ridge of the epistropheus with the ventral tubercle of the atlas. A single flat band, corresponding to the *alar ligaments* (ligamenta alaria) of the dog, cat and pig, will be found when the vertebral canal is opened at a later stage in the dissection.

The atlanto-occipital articulation (Articulatio atlanto-occipitalis).—The occipital condyles and the foveæ of the atlas are so

[1] *Tectum* [L.], a roof.

adapted as to permit of free movements by which the head is flexed and extended on the neck. There are two joint cavities—right and left—corresponding to the two occipital condyles. Each is enclosed by a loose *joint capsule.* The interarcual ligament of the other vertebral articulations is here represented by the strong *dorsal atlanto-occipital membrane* (membrana atlanto-occipitalis dorsalis), which is attached to the dorsal arch of the atlas and the dorsal margin of the occipital foramen magnum. The *ventral atlanto-occipital membrane* (membrana atlanto-occipitalis ventralis) is not so strong, and fills the narrow interval between the ventral arch of the atlas and the intercondyloid notch of the occipital bone. Both dorsal and ventral membranes are blended with the joint capsules. A *lateral atlantal ligament* (ligamentum

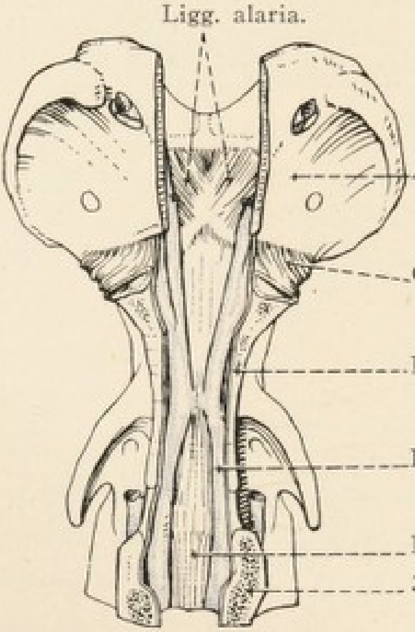


FIG. 57.—The atlanto-epistrophic articulation, after removal of the arches of the vertebræ.

laterale atlantis) is connected with the joint capsule on each side, and runs from the margin of the wing of the atlas to the jugular process of the occipital bone.

Dissection.—Remove the arches of all the cervical vertebræ, and then remove the spinal cord by cutting across it at the foramen magnum. The roots of the spinal nerves must also be cut.

The spinal cord should be laid aside for later examination.

Two ligaments are now revealed, namely, the dorsal longitudinal and the alar.

Branches of the vertebral and the cerebro-spinal artery (a branch of the occipital) should be noted as they enter the vertebral canal by the intervertebral foramina.

A large vein or venous sinus (*sinus vertebralis longitudinalis*) should also be observed on each side of the dorsal longitudinal ligament. The right and left sinuses are connected by transverse anastomoses that run underneath the narrow portions of the ligament. The sinuses are connected with the basilar plexus in the cranium, and into them drain vessels from the spinal cord and its meninges and from the bodies of the vertebræ.

The *dorsal longitudinal ligament* (ligamentum longitudinale dorsale) is continuous throughout most of the vertebral canal. Its commencement at the dens of the epistropheus can now be determined.

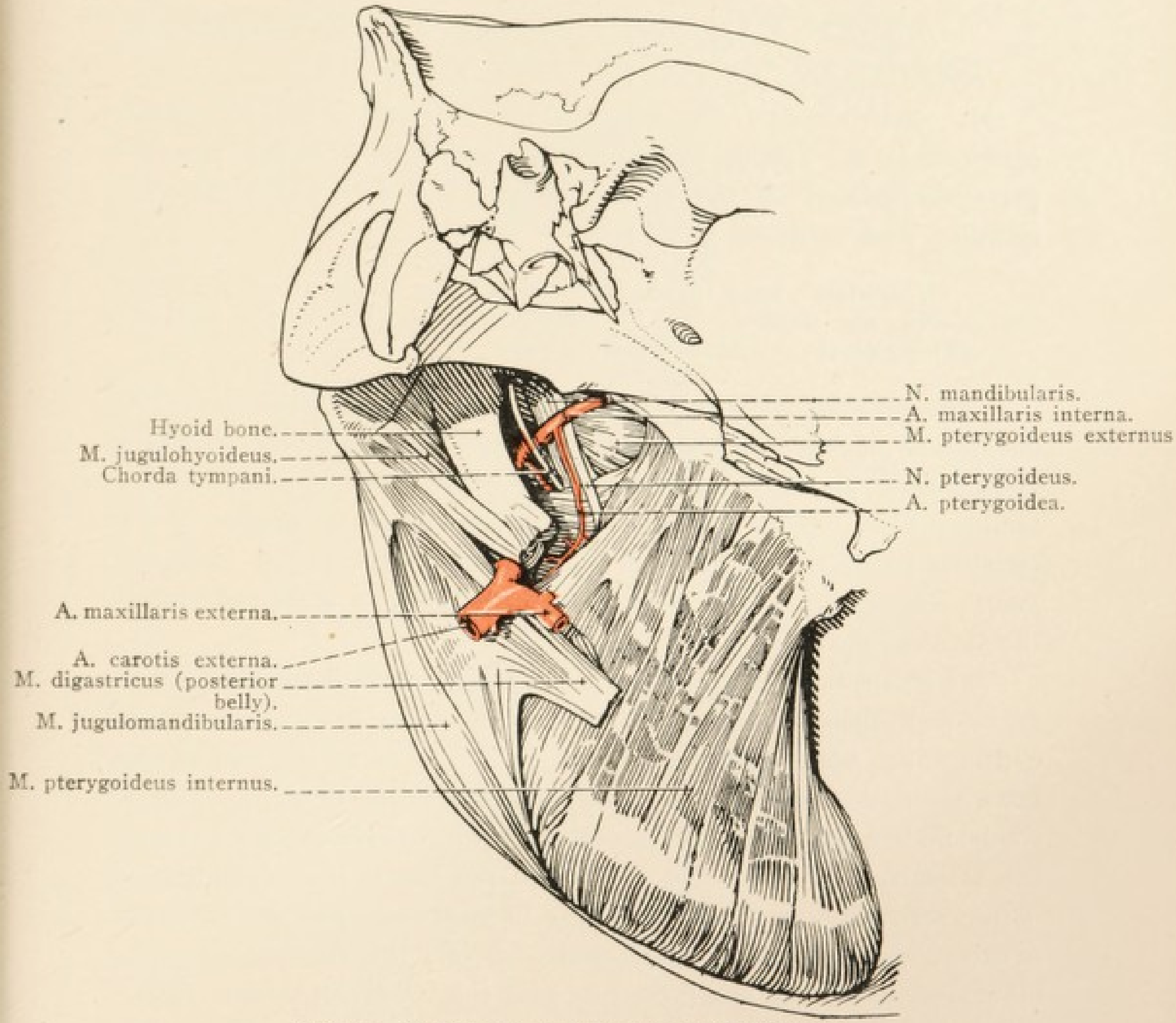


FIG. 58.—Medial aspect of the left pterygoid region.

In the horse the markedly divergent *alar ligaments* (ligamenta alaria) of the dog, cat and pig are represented by a single short and strong band of slightly divergent fibres, stretching from the dorsal surface of the dens to the interior of the atlas immediately cranial to the fossa dentis.

Dissection.—Disarticulate the cervical vertebræ from the skull.

The present is a favourable time for examining the pterygoid muscles and their associated structures on that side of the head upon which the mandible is still intact. The inferior alveolar nerve and blood-vessels and the mylo-hyoid nerve should be revised.

M. PTERYGOIDEUS INTERNUS.—The internal pterygoid[1] muscle is large and strong, being possessed of a considerable admixture of tendinous tissue. Arising from the rough ridge formed by the pterygoid process of the sphenoid and the neighbouring part of the palatine bone, it spreads out in a fan-like manner and is inserted into the medial surface of the mandible.

Dissection.—The internal pterygoid muscle should be removed in order that the external muscle of the same name may be examined.

M. PTERYGOIDEUS EXTERNUS.—The external pterygoid, much smaller than the internal muscle of that name, takes origin from the pterygoid process of the sphenoid bone and is inserted into the mandible close to its condyloid process.

Dissection.—Remove all the muscles, &c., from about the joint between the mandible and the temporal bone on that side of the head upon which the articulation is still intact.

THE MANDIBULAR ARTICULATION (Articulatio mandibularis).—The mandibular joint occurs between the condyloid process of the mandible and the articular tuber, mandibular fossa and postglenoid process of the temporal bone. When the joint is at rest, the condyloid process of the mandible lies in the mandibular fossa of the temporal; but when the mouth is opened, it glides forwards on to the articular tuber and carries the articular disc with it.

The component bony surfaces of the joint are not in actual contact, for between them there is an *articular disc* (discus articularis) of fibro-cartilage, the upper surface of which is convex to fit the mandibular fossa, while its lower surface is concave for adaptation to the mandibular condyloid process. The joint is enclosed by a *capsule* attached around the articular surfaces of the two bones and also to the circumference of the articular disc. Thus it comes to pass that there are two joint cavities; one between the temporal bone and the articular disc; the other, less roomy, between the disc and the condyloid process of the mandible. In general, the capsule is strong, but the presence of a *temporo-mandibular ligament* (ligamentum temporomandibulare) makes it especially so laterally. A *posterior ligament* (ligamentum posticum), composed of elastic fibres, runs from the post-glenoid process of the temporal bone to the posterior border of the mandible just below the condyloid process.

Naturally, the freest movements in the mandibular joint are such as result in depression and elevation of the mandible. In addition, how-

[1] πτέρυξ (pteryx) [Gr.], a wing (referring to the origin of the muscle from the pterygoid process of the sphenoid).

ever, there is an important side-to-side movement associated with the extensive flattened grinding surfaces of the cheek-teeth. During this movement one condyloid process undergoes little more than a small amount of rotation. The other condyloid process moves backwards and forwards in the short arc of a circle, the centre of which is in the opposite condyloid process. Protrusion and retraction of the jaw, without any rotation or lateral movement, may also take place.

Dissection.—Remove the mandible and examine the hard palate.

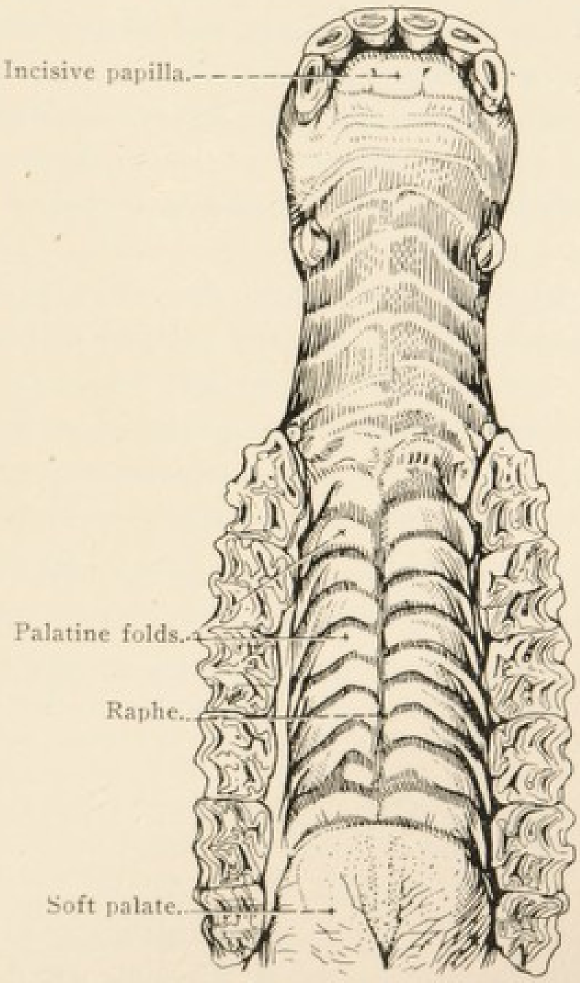


FIG. 59.—The hard palate.

THE HARD PALATE (Palatum durum).—The hard palate consists of a dense mucous membrane, with a very vascular deep layer (especially well developed in the anterior part), attached to the periosteum of the palatine, maxillary and incisive bones. Laterally and anteriorly it is continuous with the gums, while on a level with the last cheek-tooth it merges into the soft palate.

A median longitudinal groove (raphe palati), which ends in front at a flattened four-sided *incisor papilla* (papilla incisiva), divides the surface of the palate into right and left halves. Each half carries from 17 to 19 curved *transverse palatine folds* (plicæ palatinæ transversæ) each with its convexity turned forwards. The anterior ridges differ from the most posterior in having the posterior slope much more abrupt than the anterior. The anterior ridges are also better developed and farther apart than the posterior.

Dissection.—Dissect the hard palate from the bones upon which it lies. Preserve carefully the greater palatine arteries and nerves, which should be secured early as they emerge from the great palatine foramina.

This dissection discloses the highly vascular deeper layer of the palate.

A. PALATINA MAJOR.—The origin of the greater palatine artery from the third part of the internal maxillary, and its entrance into the palatine canal, were observed during the dissection of the structures in the pterygo-palatine fossa (page 127). The artery, accompanied by a nerve (but not by the greater palatine vein), leaves the canal by the great palatine foramen, and proceeds forwards in a shallow groove on the palatine process of the maxilla.

Near the level of the third incisor tooth, the artery bends round a small projection of the cartilage that fills the palatine fissure. Thence it pursues a curved course to the middle line, where it meets and anastomoses with its fellow artery. The *naso-labial artery* (a. naso-labialis) thus produced traverses the incisor foramen and so gains the upper lip, where it divides into right and left main branches.

N. PALATINUS MAJOR.—The greater palatine nerve has been noted previously as the largest of the three terminal branches of the maxillary (page 128). It traverses the palatine canal and groove, in company with the homonymous artery, and supplies branches to the hard palate and gums.

Dissection.—Preparatory to the removal of the brain, the remains of muscles, &c., should be cleared from the cranial bones. The intact zygomatic arch must be removed with the saw, and the cranial bones are then to be cut away piecemeal with bone forceps down to the level of the root of the zygomatic arches. The removal of the cranial bones must be done very cautiously, so that injury to the dura mater, the fibrous membrane covering the brain, may be avoided. The dura mater is closely applied to the inner surface of the bones, and is particularly adherent along the lines of the sutures and at the base of the cranium, and to projections such as the osseous tentorium and the ridge produced by the intruding border of the petrous temporal bone. There may be some difficulty in removing the osseous tentorium, but this should be overcome by gradually stripping the membrane from the bone.

The occipital bone must be cut away down to the level of the condyles; that is, the dorsal boundary of the foramen magnum must be removed. It will be found that the dura mater is firmly adherent to the margins of the foramen.

DURA MATER ENCEPHALI.—The brain is enclosed in three membranes or meninges, of which the outermost, thickest and strongest is the *dura* *mater*.[1] This membrane has a double function. It affords protection to the brain, which it completely surrounds, and it constitutes the periosteum of the inner surface of the cranial bones. The latter function is indicated by the character of the outer surface of the stripped dura, which presents a more or less ragged appearance, due to the presence of stumps of vessels that have been torn across during the separation of the bone from the membrane. It is, therefore, customary to regard the dura mater of the cranium as composed of two layers: (1) an endocranial or periosteal layer; and (2) an inner layer applied to the brain and forming supporting folds between certain parts of this organ. In some regions the two layers are separated by venous channels, the blood-sinuses of the dura mater. These will be examined later, but the position of some of them should be noted at the present time. One is easily recognised as it runs in a longitudinal direction in the middle line. This is the *dorsal sagittal sinus*[2] (sinus sagittalis), which passes backwards to near the osseous tentorium and there joins the *straight sinus* (sinus rectus) at the *confluence of the sinuses* (confluens sinuum). Right and left *transverse sinuses* (sinus transversi) are also visible now as they run in a transverse direction into the temporal meatus on each side of the skull. From their association with the cranial bones they have suffered injury during the removal of bone. The relatively small and plexiform *occipital sinuses* (sinus occipitales) lie over the cerebellum behind the osseous tentorium.

Dissection.—Raise the dura mater from the underlying brain with a pair of forceps and make as long an incision as possible through it on each side of and parallel to the sagittal and occipital sinuses. At right angles to the first incisions, and from about the middle of their length, make an incision on each side as far as the cut edge of the cranial bones. These incisions open into the subdural cavity and make possible an examination of the falx cerebri.

The *subdural cavity* (cavum subdurale) is a potential space between the dura and the arachnoid mater. The opposed surfaces of the two membranes are smooth and glistening, and moistened by a small quantity of serous fluid.

The *falx*[3] *cerebri* is one of the folds of the supporting layer of the dura mater. It lies in the median plane between the two hemispheres of the cerebrum, and is in the form of a sickle with its point at the crista galli of the ethmoid and its base at the osseous tentorium. The thick convex border of the fold is attached to the middle line of the

[1] *Durus* [L.], hard, tough. *Mater* [L.], mother.

[2] *Sagitta* [L.], an arrow (sagittal, in the line of an arrow shot from a bow). *Sinus* [L.], a curved surface, a bay, a gulf.

[3] *Falx* [L.], a sickle, a reaping-hook.

cranial vault from the crista galli to the osseous tentorium, and contains the dorsal sagittal blood-sinus. The concave border is free and very thin. Sometimes, indeed, it presents defects in the shape of small holes.

Dissection.—Cut across the falx cerebri as close as possible to its anterior end and turn it backwards. Veins from the interior of the brain will be noted joining the system of blood-sinuses in the region of the osseous tentorium. Deep veins unite to form the straight sinus, and this in turn joins the sagittal sinus at the confluence of the sinuses.

Next cut through the tentorium cerebelli—a fold of the dura mater inserted into the cleft between the cerebral hemispheres and the cerebellum—on one side of the head a little distance from the median plane.

Now proceed to remove the brain. This is facilitated by placing the head in a vertical position with the nose resting on the table. Introduce the handle of a knife under the medulla oblongata and gently raise the brain from the base of the cranium. The nerves and vessels associated with the base of the brain are thus put on the stretch, and must be severed one by one. In cutting the cerebral nerves it is well to divide them close to the brain on one side and close to the dura mater on the other. The last eight cerebral nerves are fairly close together, but may be distinguished by differences in size and mode of exit from the cranium. The twelfth nerve leaves alone by the hypoglossal foramen. Then comes a group formed by the eleventh, tenth and ninth, which leave the cranium together by the jugular foramen. The eighth and seventh enter the internal acoustic meatus in company. The sixth, a small nerve, and the fifth, the largest of all the cerebral nerves, pierce the dura mater close together at the projecting edge of the temporal bone. The fourth, the smallest cerebral nerve, winds round the lateral border of the cerebral peduncle; and the third nerve leaves the ventral surface of the peduncle.

The next structure that interferes with the removal of the brain is the infundibulum, a hollow, median connection between the tuber cinereum and the hypophysis. As it is not advisable to attempt the removal of the hypophysis from the sella turcica in which it is lodged, the infundibulum should be cut through.

Just about the same level as the infundibulum, and at no great distance from the median plane, are the two internal carotid arteries. A little farther forwards, and also not far from the median plane, are the optic or second cerebral nerves.

The last connection of the brain with the wall of the cranium is that produced by the olfactory nerves as they pierce the ethmoid bone. It is generally very difficult to extract the olfactory bulbs, from which the nerves arise, without injury.

If the brain, when removed, is not sufficiently well hardened to allow of satisfactory dissection, it should be placed in a 5 per cent. solution of formaldehyde. In any case its dissection is better postponed.

The dura mater and other structures at the base of the cranium should now be examined. The dura mater where it covers the basal bones of the cranium, is removed with difficulty. Not only is it adherent to the bones: it also forms sheaths for the various cerebral nerves, and is continuous, through the foramina of the skull, with the periosteum of the exterior. The falx cerebri, one of the three folds of the dura, already having been examined, there remain the other two, namely, the tentorium cerebelli and the diaphragma sellæ turcicæ.

The *tentorium*[1] *cerebelli* is interposed between the cerebellum and the hemispheres of the cerebrum. Its central portion is attached to the lateral margins of the osseous tentorium, while its lateral parts are adherent to the projecting ridge produced by the border of the temporal bone. The free ventral edge of the fold is concave and thin, and bounds an opening (*incisura tentorii*), triangular in outline, by which the

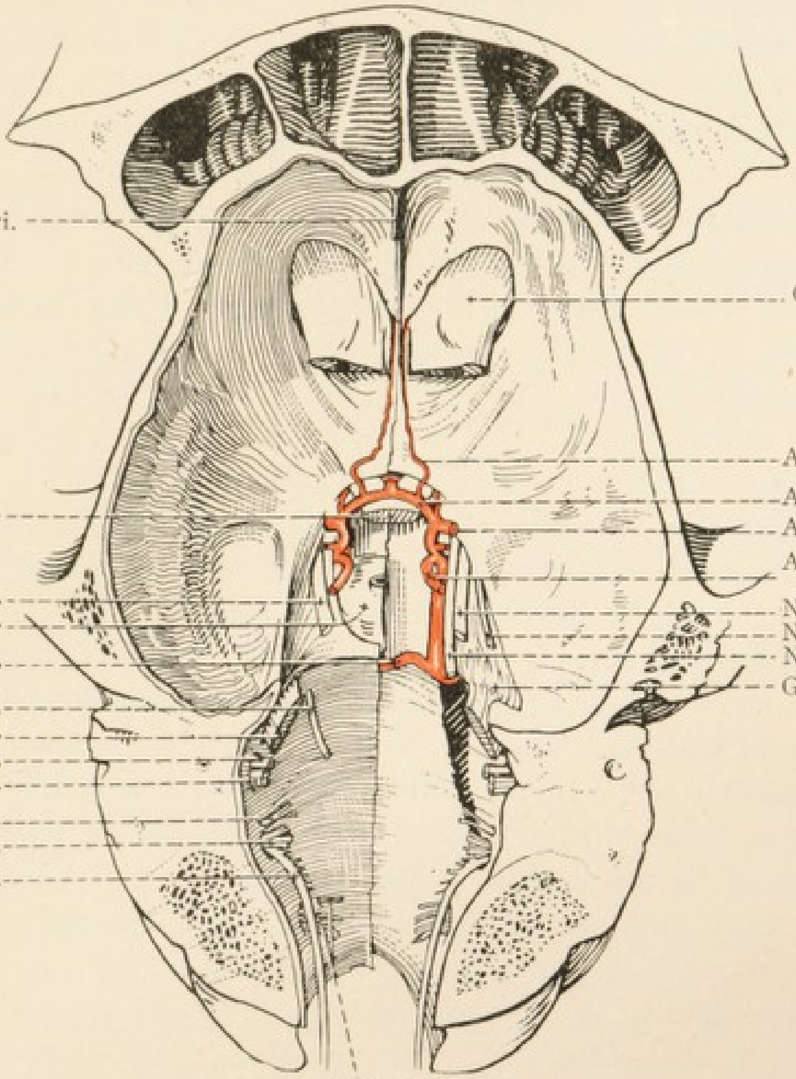


Fig. 60.—The floor of the cranial cavity. On the right side the dura mater has been removed.

middle and posterior cranial fossæ communicate with each other. The opening is occupied by the mid-brain.

The *diaphragma sellæ*[2] is a circular thickening of the dura mater that surrounds and in a manner defines the sella turcica. A central opening in the fold accommodates the infundibulum. The diaphragm forms a resisting roof to the cavernous and intercavernous blood sinuses, and is applied to part of the upper surface of the hypophysis. It is

[1] *Tentorium* [L.], a tent (literally something stretched out).
[2] διάφραγμα (diaphragma) [Gr.], a partition wall. *Sella* [L.], a seat (a saddle).

owing to the presence of the diaphragm that the hypophysis is usually left in the cranium during the removal of the brain.

NERVI CEREBRALES.—As much of the cerebral nerves as is left behind in the cranium after the removal of the brain must be examined at this stage.

Each cerebral nerve, on its exit from the cranium, is provided with a sheath derived from all three cranial meninges. With the exception of those around the optic nerve, however, the identity of the three membranes is soon lost, because of the disappearance of the arachnoid and the subsequent blending of the dura and pia mater.

The numerous small olfactory nerves [1] leave the cranium at once by the foramina in the cribriform plate of the ethmoid bone. The optic nerve [1] also makes a rapid exit by the foramen that bears its name. The oculomotor nerve, on the contrary, travels for some distance within the substance of the dura mater before it reaches its point of exit, the orbital fissure. Its intra-dural course is somewhat oblique (with a forward and lateral inclination) in the dural roof of the cavernous blood sinus. The trochlear nerve also follows an oblique course after piercing the tentorium cerebelli. It leaves the cranium by the trochlear foramen, or, if this be absent, by the orbital fissure.

The trigeminal nerve is more deeply seated than the oculomotor and trochlear, and a certain amount of dissection is necessary to display its intra-cranial anatomy. The nerve has two roots: a large *sensory root* (portio major), and a much smaller *motor root* (portio minor). The sensory root passes through a notch on the lower part of the projecting ridge formed by the margin of the temporal bone and immediately expands to join the *semilunar ganglion* (ganglion semilunare). The ganglion, as its name indicates, is roughly crescentic in form, and is partly embedded in the fibrous tissue that occludes the irregular and composite foramen bounded by the sphenoid, temporal and occipital bones. Some difficulty will be experienced in exposing the ganglion owing to the intimate adherence of the dura mater. From the convex anterior border of the ganglion arise the three main divisions of the trigeminal nerve, namely, the ophthalmic, maxillary and mandibular nerves. The relatively small ophthalmic nerve (n. ophthalmicus) has an intra-cranial course along the lateral border of the cavernous blood sinus to the orbital fissure, by which it leaves the cranium in company with the oculomotor and abducent nerves. The maxillary nerve (n. maxil-

[1] The olfactory and optic nerves should be described as *entering* the cranium, since their fibres are processes of cells located at a distance from the brain. For the purposes of the present dissection, however, it is more convenient to consider that they leave the cranium.

laris) passes to the foramen rotundum along a well-marked groove close to the line of junction of the temporal wing and the body of the sphenoid bone. Like the ophthalmic, the maxillary nerve lies along the side of the cavernous blood sinus, but at a lower level. The mandibular nerve (n. mandibularis) immediately on leaving the semilunar ganglion, traverses the foramen ovale and thus gains the exterior of the cranium. The small compact motor root of the trigeminal joins the mandibular nerve, and will be found underneath the sensory root and the semilunar ganglion.

The abducent nerve runs to the orbital fissure medial to the oculomotor and ophthalmic nerves.

The exits of the remaining cerebral nerves were noted during the removal of the brain. A closer inspection of them may profitably be made at this time.

The sinuses of the dura mater (Sinus duræ matris).—The blood sinuses of the dura mater may be conveniently arranged in two groups, a dorsal and a ventral, as follows :—

Dorsal group.
- Dorsal sagittal or longitudinal sinus (sinus sagittalis dorsalis).
- Ventral sagittal or longitudinal sinus (sinus sagittalis ventralis).
- Straight sinus (sinus rectus).
- Occipital sinuses (sinus occipitales).
- Transverse sinuses (sinus transversi).
- Dorsal petrosal sinuses (sinus petrosi dorsales).

Ventral group.
- Cavernous sinuses (sinus cavernosi).
- Intercavernous sinus (sinus intercavernosus).
- Ventral petrosal sinuses (sinus petrosi ventrales).
- Basilar plexus (plexus basilaris).

When the falx cerebri was examined, the *dorsal sagittal sinus* was found in its attached or convex border, extending from the crista galli of the ethmoid to near the osseous tentorium, where it joins the straight sinus at the confluence of the sinuses. The lumen of the sinus is irregular, the wall being beset with small diverticuli (*lacunæ*[1] *laterales*) into which the veins from the upper part of the cerebral hemisphere open. Irregular bands cross from one side of the sinus to the other. The *ventral sagittal sinus* is very small. It runs in the concave border of the falx cerebri and is joined on a level with the splenium of the corpus callosum by the great cerebral vein. The *straight sinus* is formed by the union of the great cerebral vein and the ventral sagittal sinus. Passing backwards and upwards in the falx cerebri, it unites with the dorsal sagittal sinus at the confluens sinuum. The right and left *transverse sinuses* lie in the grooves running on the parietal bones

[1] *Lacuna* [L.], a pool, a pond, a gap or void.

from the osseous tentorium, where they are connected with the confluens sinuum, to the inner end of the temporal meatus. Each sinus leaves the cranium by the temporal meatus and is continued as the dorsal cerebral vein, which unites with the superficial temporal. A communicating sinus links the right and left sinuses together. The *occipital sinuses* occupy that portion of the dura mater which coincides in position with the grooves between the vermis and the hemispheres of the cerebellum. In front they open into the communicating sinus between the two transverse sinuses. Behind they are connected with a vein that runs backwards into the vertebral canal dorsal to the medulla oblongata. There are numerous intercommunications between the right and left sinuses. The *dorsal petrosal sinuses* run in the tentorium cerebelli close to the projecting edge of the temporal bone, and open into the transverse sinuses near the inner end of the temporal meatus. Each petrosal sinus receives a rhinal vein at its anterior end.

The right and left *cavernous sinuses* occupy groove-like depressions at the junction of the body and temporal wings of the sphenoid bone, immediately lateral to the sella turcica. Behind the sella turcica an *intercavernous sinus* places the two cavernous sinuses in free communication with each other. Occasionally, a very much smaller intercavernous sinus occurs in front of the sella. Anteriorly each cavernous sinus is continuous with a reflex vein, which places the sinus in communication with the exterior of the cranium. The floor of each sinus is connected by a wide oval opening with the ventral petrosal sinus of that side. As has been previously noted, the oculomotor, abducent, ophthalmic and maxillary nerves are related to the wall of the cavernous sinus. Each *ventral petrosal sinus* is enclosed in the dense fibrous tissue (dura mater) that occludes the irregular composite foramen bounded by the occipital, temporal and sphenoid bones. The posterior end of each sinus is dilated and lies in the condyloid fossa, where it receives the condyloid vein and communicates with the ventral cerebral vein. The main part of the sinus follows the margin of the basilar part of the occipital bone and extends for a short distance under the temporal wing of the sphenoid bone. Anteriorly it communicates with veins in the pterygo-palatine fossa. The *basilar plexus* lies on the inner face of the basilar part of the occipital bone. Anteriorly it has narrow communications with the cavernous and intercavernous sinuses, and posteriorly it is continuous with veins within the atlas. The condyloid vein forms a connection between the basilar plexus and the ventral petrosal sinus.

A. CAROTIS INTERNA.—The origin and extra-cranial course of the internal carotid artery have been noted at earlier stages of the dissection (page 131). To reach the brain, in which it is finally distributed, the artery passes through the ventral petrosal and cavernous sinuses and through the connecting link between them. While traversing these sinuses, the artery forms an S-shaped curve, after which it pierces the dura mater on a level with the infundibulum. A transverse vessel (a. intercarotica) lies within the intercavernous sinus and connects the internal carotid arteries of the two sides of the head.

The termination and distribution of the internal carotid artery will be examined in connection with the dissection of the brain.

Meningeal arteries.—The dura mater is supplied with blood by the anterior, middle and posterior meningeal and the condyloid arteries. The *middle meningeal artery* (a. meningea media) arises from the first part of the internal maxillary, and enters the cranium by the foramen spinosum. Its branches occupy grooves on the cerebral surface of the parietal and temporal bones. The *posterior meningeal artery* (a. meningea posterior) is the branch of the occipital that follows the sinuous groove on the mastoid part of the temporal bone and enters the cranium by traversing part of the temporal meatus. Slender anastomoses occur between this artery and the preceding. The *anterior meningeal artery* (a. meningea anterior) is a small branch of the anterior cerebral. In addition to supplying the dura mater of the anterior cerebral fossa, it assists in the formation of a network of vessels in the ethmoidal fossa. The *condyloid artery* (a. condyloidea) furnishes meningeal branches that enter the cranium by the jugular and hypoglossal foramina.

Dissection.—The cavity of the nose must next be examined. In order to expose the interior of the cavity, the skull should be sawn across on a level with the sella turcica, and a sagittal section then made by sawing parallel to and slightly to the side of the median plane. Thus the septum of the nose will be preserved on one side of the head.

The nasal cavity (Cavum nasi).—The nasal cavities are elongated passages extending from the nostrils to the choanæ (posterior nares), by which they communicate with the pharynx. All the facial bones, with the exception of the mandible and the hyoid, take part in the formation of their boundaries; and the palatine, maxilla and incisive bones separate them from the mouth.

Cartilages of the Nose (Cartilagines nasi).—The cartilaginous skeleton of the nose consists of the *cartilage of the nasal septum* (cartilago septi nasi), and certain smaller cartilages. The septal cartilage is a wide, elongated plate that may be regarded as an unossified anterior prolongation of the perpendicular plate of the ethmoid. Its thick and rounded lower border fits into the groove of the vomer and its anterior continuation formed by the palatine processes of the incisive bones. A process from this border almost completely fills the palatine fissure and forms the projection in the hard palate round which the greater palatine artery curves. The upper border of the septal cartilage is attached to the inner face of the interfrontal and the internasal sutures, and extends for about 5 cm. beyond the end of the nasal bones. The border is produced on each side into a thin, narrow *parietal*[1] *cartilage* (cartilago parietalis) that widens anteriorly and projects beyond the free border of the nasal bone.

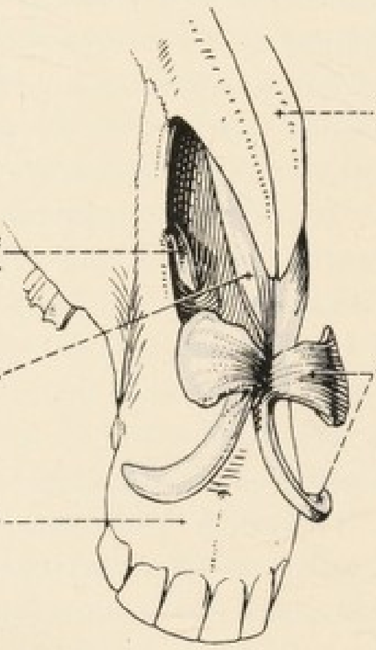


FIG. 61.—The cartilages of the nostril.

The *alar*[2] *cartilages* (cartilagines alares), which should be completely exposed by the removal of the muscles of the nostrils, are conspicuous and important appendages to the cartilage of the nasal septum. Each of these cartilages is shaped like a comma and consists of a broad *lamina*, which is dorsal in position, and forms the resisting basis of the medial wing of the nostril, and a curved, flattened rod, the *cornu*, that sweeps downwards and outwards from the lamina, and can be detected before dissection by manipulation of the rounded lower angle of the nostril. The alar cartilages are united to the end of the septal cartilage by stout fibrous tissue that allows of a certain amount of movement, the union taking place in the region of the junction of the lamina and cornu.

Other cartilages connected with the nose are the *vomero-nasal cartilage* (better examined at a later stage), and a small, curved and grooved rod of cartilage that continues the ventral turbinated bone and

[1] *Paries* [L], a wall. [2] *Ala* [L], a wing.

is included in a fold of mucous membrane, the plica alaris, that runs to the lateral wing of the nostril.

Dissection.—The constitution of the septum (septum nasi) between the two nasal cavities should be determined by stripping the mucous membrane from the surface at present exposed. A part of the septum—the bony septum—is formed by the perpendicular plate of the ethmoid and the vomer. The rest is cartilaginous, and formed by the cartilage above described.

By the exercise of a reasonable amount of care, the septum may be removed bit by bit in such a manner that the mucous membrane clothing its other side is left intact. This permits the dissector to examine the blood vessels and nerves of the partition.

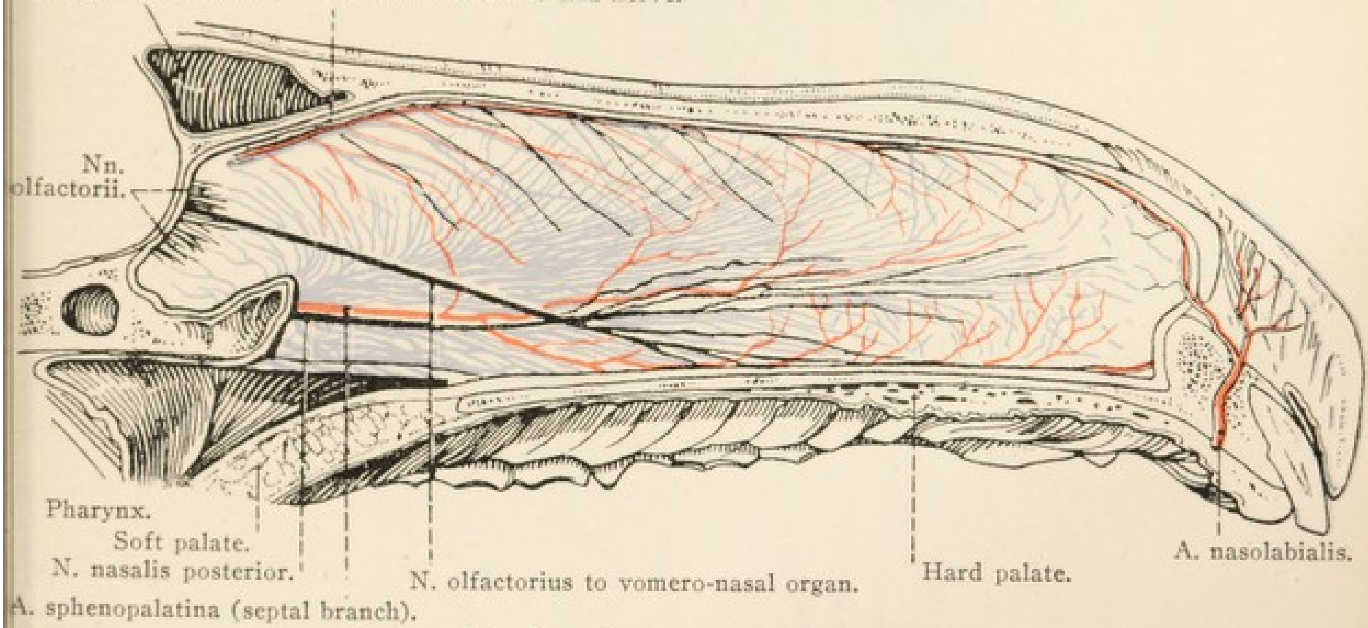


FIG. 62.—Vessels and nerves of the nasal septum.

In common with that of the nasal cavity in general, the mucous membrane covering the septum is richly supplied with both blood vessels and nerves. The vessels are derived from the ethmoidal branch of the ophthalmic artery, which ramifies over the upper part of the septum, and the nasal branch of the sphenopalatine artery, which supplies the lower region. The veins begin in very rich plexuses that are remarkably thick in some regions.

The nerves are derived from two sources:—(1) The olfactory nerves are distributed over the posterior dorsal part of the septum (and also supply the vomero-nasal organ). (2) The trigeminal nerve contributes branches from both its ophthalmic and its maxillary divisions. The ethmoidal branch of the ophthalmic nerve terminates over the dorsal part of the septum, and the nasal branch of the sphenopalatine nerve supplies the lower part.

Dissection.—With a pair of scissors, cut along the upper border of the septal mucous membrane, and so obtain a view of the interior of the nasal cavity.

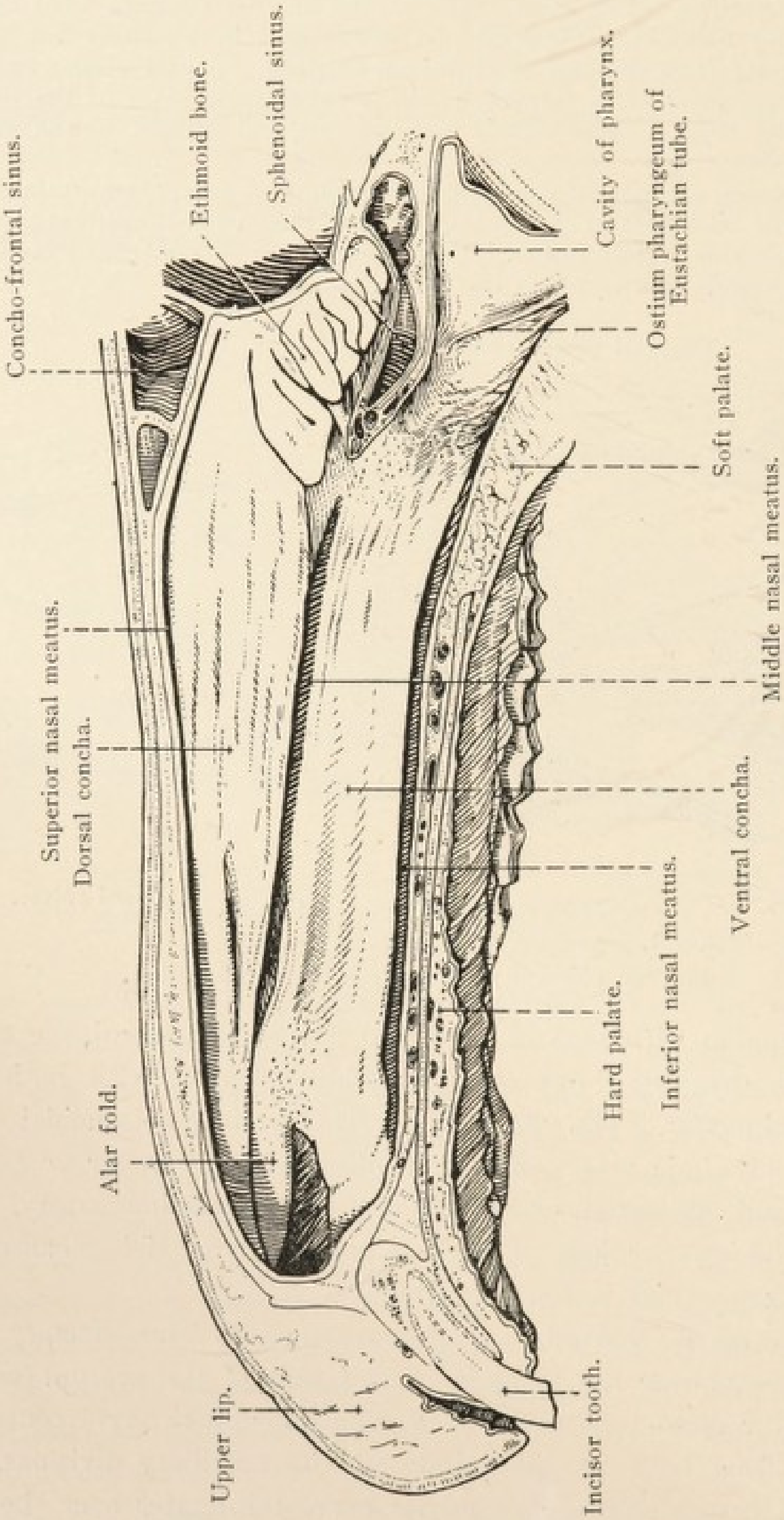


Fig. 63.—The lateral wall of the nasal cavity.

Each nasal cavity is narrow and elongated, with a dorsal boundary or roof formed by the nasal and frontal bones; while the palatine, maxillary and incisive bones enter into the composition of the somewhat wider floor. The nasal septum constitutes the medial wall. The lateral wall is very uneven as the result of the projection of the turbinated bones and the labyrinth of the ethmoid into the cavity. The dorsal turbinated bone (concha nasalis superior) is broader at its posterior end and more tapering anteriorly than the ventral turbinated

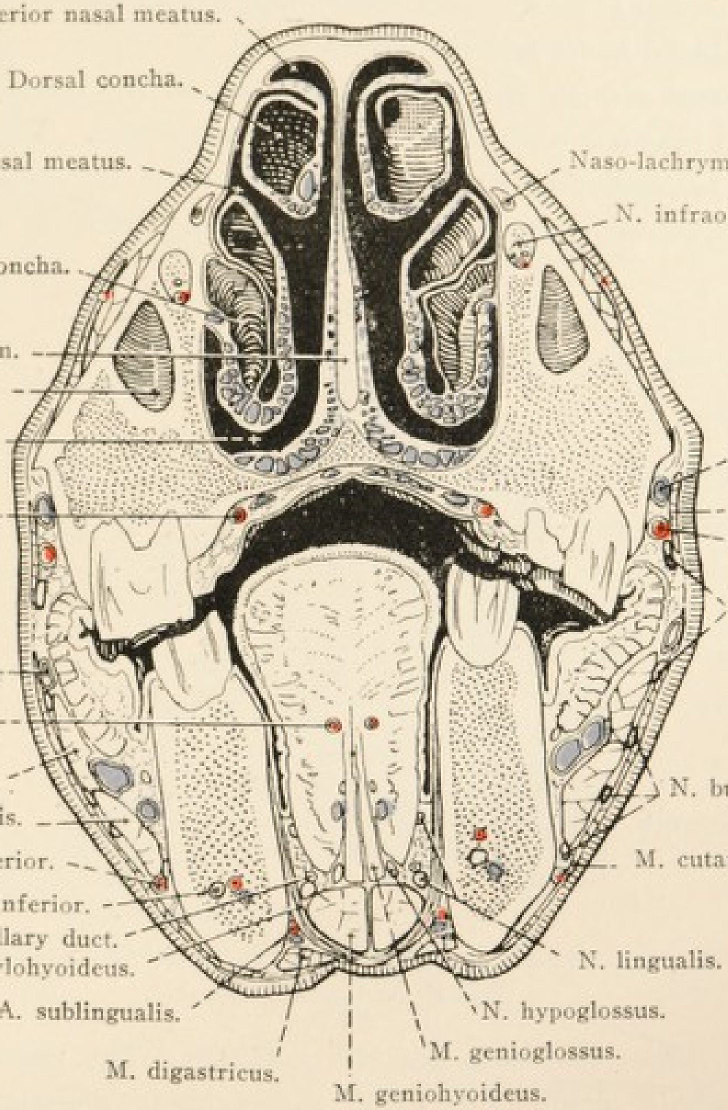


FIG. 64.—Transverse section of the face at the level indicated by E in Fig. 1 (looking forward).

bone (concha nasalis inferior). The labyrinth of the ethmoid forms an irregularly conical mass insinuated between the posterior ends of the two turbinated bones.

The intrusion of the turbinated bones divides the nasal cavity into passages, the *meatus*[1] *nasi*. The *superior meatus* (meatus nasi superior) is narrow, and bounded by the superior concha and the nasal and frontal bones. The *middle meatus* (meatus nasi medius), bounded by the two conchæ and the maxilla, is slightly wider and does not extend so far back as the upper meatus. It is into the posterior part

[1] *Meatus* [L], a going or passing, a passage.

of this meatus that the maxillary sinus opens by a narrow, slit-like orifice. The *inferior meatus* (meatus nasi inferior) is placed between the inferior concha and the floor of the nose, is the widest of the nasal passages, and forms a direct line of communication between the nostril and the pharynx. The three passages are put into continuity by the *common meatus* (meatus nasi communis), a cleft-like channel between the turbinated bones and the nasal septum.

The most anterior part of the lateral wall of the nasal cavity carries elongated prominences or folds of mucous membrane. The most dorsal of these is continuous with the anterior end of the upper turbinated bone, and, on being traced backwards, will be found to begin as two

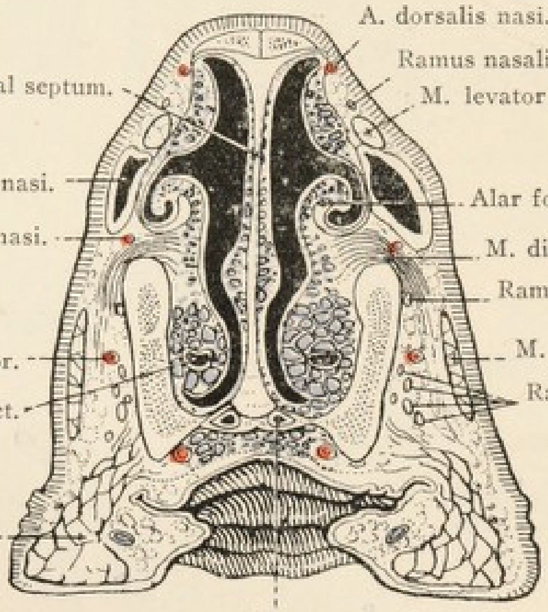


FIG. 65.—Transverse section of the nose at the level indicated by F in Fig. 1 (looking forward).

rounded ridges that soon become confluent. The upper of the two ridges usually contains a small cartilaginous prolongation of the turbinated bone. A second fold is appended to the inferior turbinated bone, and, from its connection with the ala of the nostril, is distinguished as the *alar fold* (plica alaris). It is in this fold that the curved cartilaginous continuation of the lower turbinated bone is contained. A third ridge of mucous membrane lies still more ventral, and is produced by a thick venous plexus that extends backwards on to the lower turbinated bone. In it is to be found the *naso-lachrymal duct* (ductus nasolacrimalis), by which the tears reach the nostril.

Naso-palatine Duct and Vomero-Nasal Organ.—If search be made on the floor of the nose opposite the palatine fissure, a small, slit-like opening should be found. A probe introduced into the opening enters the short *naso-palatine duct* (ductus nasopalatinus) that, in the majority of domestic mammals, opens into the mouth at the side of the incisor papilla. In the horse, however, the duct ends blindly in the cartilage that occludes the palatine fissure.

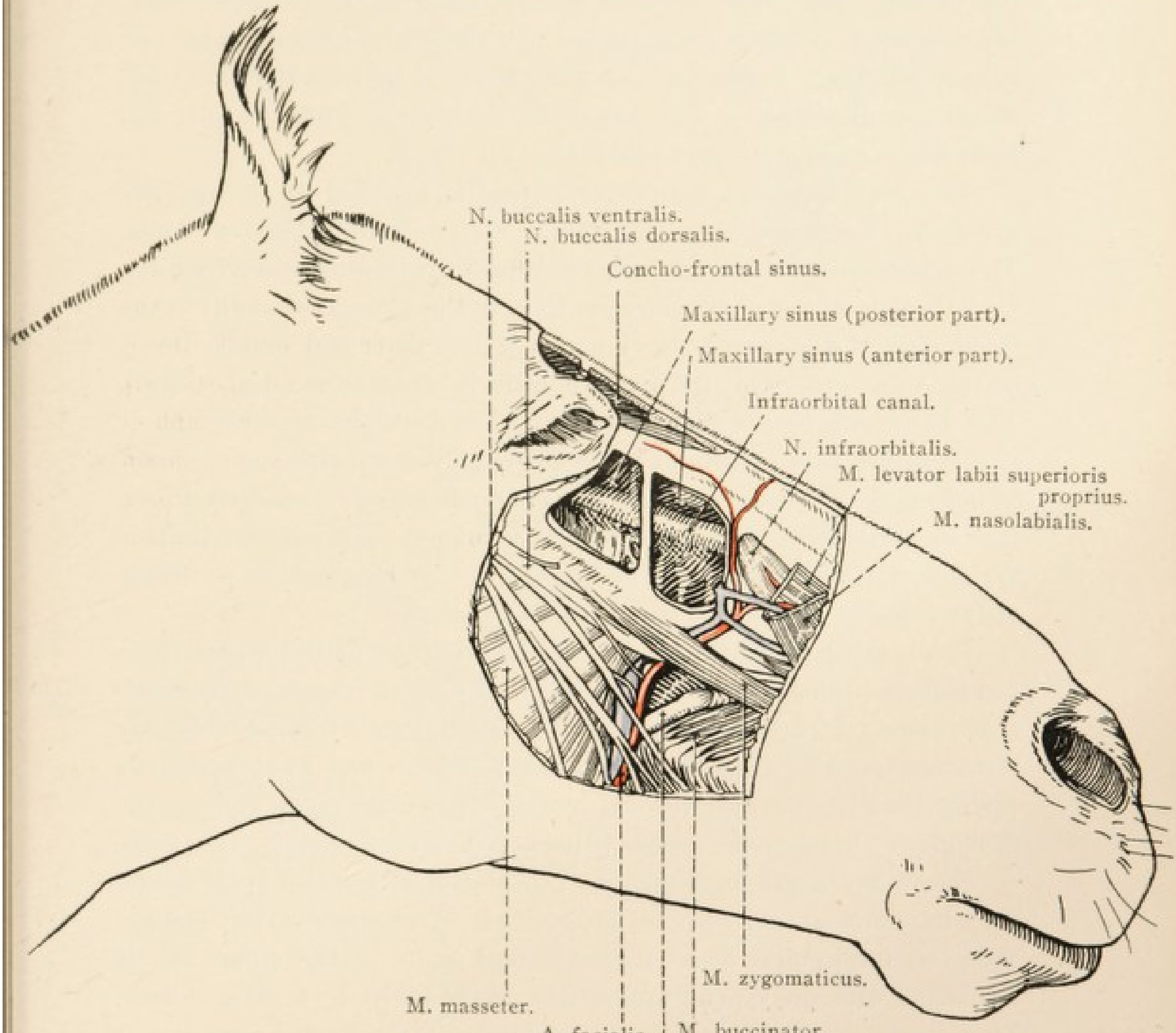


FIG. 66.—Lateral aspect of the maxillary paranasal sinus.

Into the nasal end of the naso-palatine duct opens the tubular *vomero-nasal organ* (organon vomeronasale), which, enclosed in the *vomero-nasal cartilage* (cartilago vomeronasalis) at the base of the nasal septum, extends backwards as far as the level of the third or fourth cheek-tooth.

THE PARANASAL SINUSES (Sinus paranasales).—The paranasal sinuses, or air sinuses of the skull, are irregular cavities produced by the separation of the two compact plates that, in all the bones of the skull, are separated by a stratum of looser bone. The sinuses communicate with the nasal cavity, either directly or indirectly. They, therefore, contain air and are lined by a thin, mucous membrane continuous with that of the nose. Such cavities, or cells, occur in the ethmoid bone; but the most important sinuses are the maxillary, concho-frontal and spheno-palatine. Before beginning the study of these in the head upon which the dissection is now being conducted, it is useful to plot out their limits upon an intact macerated skull.

The *maxillary sinus* (sinus maxillaris) is bounded by the maxilla, zygomatic, lachrymal, ethmoid, frontal and ventral turbinated bones. The upper limit of the sinus may be defined by drawing a line from the medial angle of the eye (lachrymal fossa in the macerated skull) to the lower angle of the nostril (the junction of the lower and middle thirds of the nasal process of the incisive bone in the macerated specimen). The line should have a slight curve, with the convexity upwards, and it should be remembered that it indicates roughly the position of the naso-lachrymal duct. Posteriorly the sinus extends into the maxillary tuber, that is, to the level of the lateral angle of the eye. Its anterior limit is variable, but, in the majority of horses, may be regarded as occurring about 5 cm. in front of the end of the facial crest.

The maxillary sinus is divided into anterior and posterior parts by a complete septum, the position of which is variable, as is also the angle that it forms with the transverse plane. In all horses it slopes obliquely downwards and forwards, and its average position may be indicated by saying that it coincides with an oblique transverse plane cutting the face midway between the margin of the orbit and the end of the facial crest.

If now the sinus be opened by the piecemeal removal of its lateral wall, its exact extent may be determined. The dissector will observe that the infraorbital canal traverses both parts of the sinus, and is connected with the ventral wall or floor of the cavity by a plate of bone. Thus it comes to pass that the sinus is imperfectly divided into medial and lateral compartments, communication between which is over the infraorbital canal. For surgical reasons it is important to remember, moreover, that the roots of the last three or four cheek-teeth are associated with the lateral compartment of the sinus, a thin, irregular layer of bone being all that separates them from the interior of the cavity. The septum between the anterior and posterior parts of the sinus occurs, in the average animal, on a level with the second last tooth.

The dimensions of the sinus vary in different individuals: they also undergo very marked changes in the same individual at different ages.

In the foal the cavity is very largely encroached upon by developing teeth. In the young adult the lower part of the sinus contains the long,

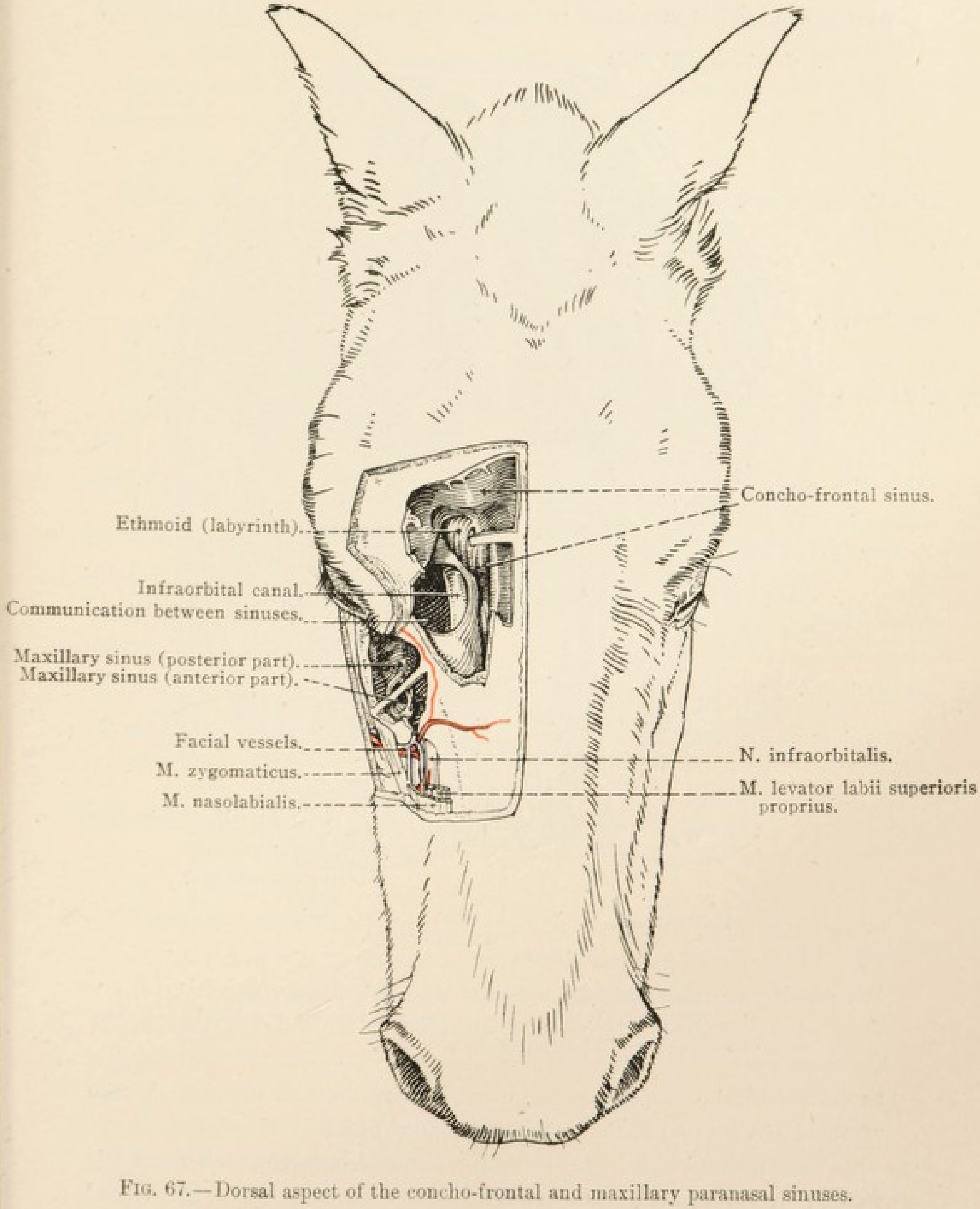


FIG. 67.—Dorsal aspect of the concho-frontal and maxillary paranasal sinuses.

embedded part of the cheek-teeth (covered by a thin layer of bone), which become gradually shorter as age advances and the embedded part of the teeth is extruded to compensate wear of the crown.

The communication between the maxillary sinus and the nasal cavity (aditus nasomaxillaris) is in the form of an elongated opening, about the level of the last cheek-tooth, which leads into the posterior part of the middle meatus of the nose. The aditus is above the level of

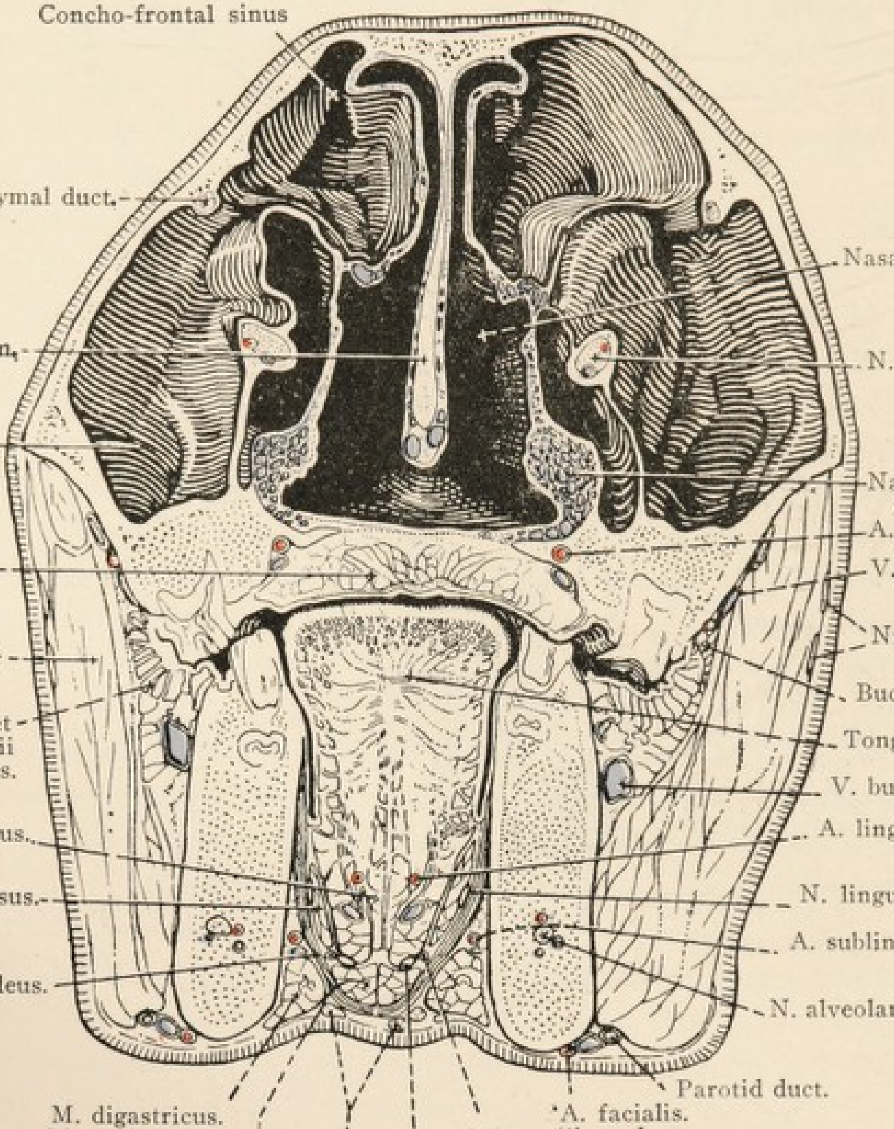


Fig. 68.—Transverse section of the face at the level indicated by D in Fig. 1 (looking forward). The section strikes the communication between the concho-frontal and maxillary sinuses.

the infraorbital canal, and is only rendered visible from the nose by the removal of a portion of the upper turbinated bone.

The *concho-frontal* (or *frontal*) *sinus* (sinus conchofrontalis) is formed by the frontal, nasal, ethmoid, lachrymal and upper turbinated bones. Its posterior limit is slightly behind a transverse plane taken on a level with the posterior border of the zygomatic process of the frontal bone (in the macerated skull, about midway between this plane and the coronal suture). The anterior limit reaches a transverse plane midway between the edge of the orbit and the end of the facial crest. Medially the two concho-frontal sinuses are only separated by a thinnish plate of bone. Laterally the sinus extends to within a short distance of the margin of the orbit, and, in front of the orbit, is separated from the maxillary sinus by little more than the width of the naso-lachrymal bony canal.

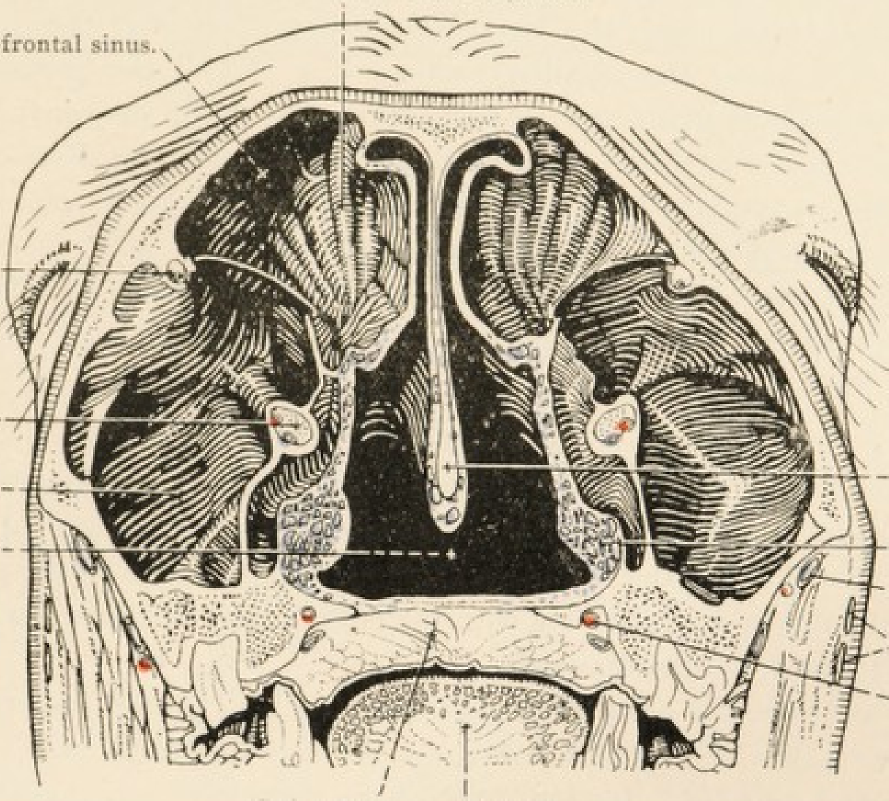


FIG. 69.—Transverse section of the face in the same plane (D in Fig. 1) as Fig. 68, but looking backward. The section strikes the communication between the concho-frontal and maxillary sinuses.

The sinus must be opened by gradually snipping away the frontal bone. In doing this, it should be noted that a curved partition of bone extends from the median septum towards the ethmoidal labyrinth, and imperfectly divides the sinus into anterior and posterior parts. It should also be observed that the most anterior part of the cavity is contained in the dorsal turbinated bone, the thin plate of which alone serves to separate it from the nasal cavity.

The concho-frontal communicates with the maxillary sinus by a large, oval opening between the labyrinth of the ethmoid and the bony naso-lachrymal canal.

The *spheno-palatine sinus* (sinus sphenopalatinus) is the smallest of the cavities of the skull, and occurs in the body of the sphenoid bone and the perpendicular part of the palatine. It communicates with the maxillary sinus by a large opening immediately below the labyrinth of the ethmoid.

Dissection.—If the lateral wall of the infraorbital canal be removed, the branches of the infraorbital nerve and the arteries to the teeth may be examined.

N. INFRAORBITALIS.—Just before it enters the infraorbital canal the nerve furnishes several small branches that, piercing the wall of the maxillary tuber, supply the last cheek-tooth and part of the mucous membrane lining the maxillary sinus. The rest of the cheek-teeth receive branches that leave the nerve while it is within the canal. The canine and incisor teeth are supplied by *anterior alveolar rami*, which gain the roots of the teeth by the narrow anterior alveolar canal that leaves the infraorbital canal near its anterior end.

The nerve, after it has left the canal by the infraorbital foramen, was examined in connection with the other structures of the face (page 41).

A. INFRAORBITALIS.—The infraorbital artery, a branch of the internal maxillary, has been noted as entering the infraorbital canal by the maxillary foramen, after contributing a malar branch that runs along the floor of the orbit. A small branch that leaves the infraorbital foramen to anastomose with the lateral nasal and superior labial arteries, has also been dissected.

Small *posterior alveolar arteries* (aa. alveolares posteriores), for the supply of the cheek-teeth, leave the infraorbital artery within the canal, and *anterior alveolar arteries* (aa. alveolares anteriores) gain the canine and incisor teeth by the anterior alveolar canal.

THE ORGAN OF HEARING (Organon auditus).—The organ of hearing is susceptible of a natural division into three parts: The external ear or auricle (auricula), the middle ear or cavity of the tympanum, and the internal ear. The external ear is provided with a skeleton of cartilages, which, with the muscles that move them, have been examined at a previous stage of the dissection (page 26). The canal contained in the external ear is the *external acoustic meatus* (meatus acusticus externus), and is continued beyond the limit of the cartilaginous skeleton into the temporal bone. The meatus ends at the membrana tympani, by which its cavity is separated from that of the tympanum.

Dissection.—To make a satisfactory examination of the tympanum and internal ear it is necessary to have several specimens, so that sections across some of them may be made with a fine saw, while one at least is to be examined after piecemeal removal of parts of the bone. From all the specimens the auricular cartilages must be removed, and the bone should be cleaned as far as possible.

In order to examine the cavity of the tympanum, the lower part of the osseous bulla should be snipped away bit by bit. It will be observed that the cavities of the osseous bulla and the tympanum communicate freely with each other; indeed, the cavity of the bulla must be regarded as a recess or extension of the tympanic cavity.

THE CAVITY OF THE TYMPANUM (Cavum tympani).—The cavity of the tympanum[1] is a narrow chamber within the temporal bone, between the deep end of the external acoustic meatus and the internal ear. Its lateral wall (paries membranacea) is formed almost entirely by

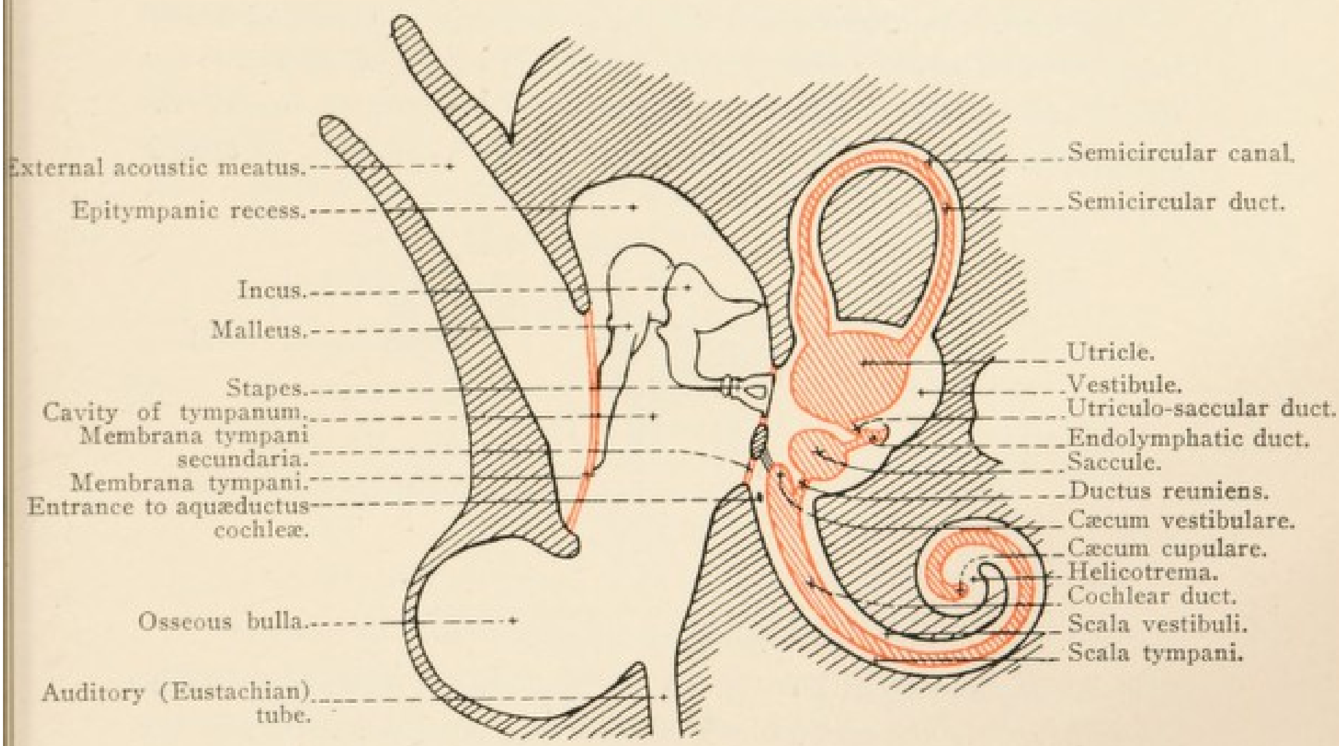


FIG. 70.—Diagram of the tympanum and internal ear.

the thin, translucent membrana tympani. On the medial wall (paries labyrinthica), which separates the cavity from the labyrinth of the internal ear, there is a well-marked projection, the *promontory* (promontorium), formed by the first coil of the cochlea of the internal ear, above and slightly in front of which is the *fenestra*[2] *vestibuli* closed by the base of the stapes. Below the promontory is the *fenestra cochleæ,* occluded by the secondary tympanic membrane (membrana tympani secundaria). Leading from the anterior and lower part of the cavity is the narrow opening of the auditory tube of Eustachius, by which air enters the tympanum.

The roof (paries tegmentalis) of the tympanic cavity is crossed by

[1] *Tympanum* [L.], a drum.
[2] *Fenestra* [L.], a window.

the facial canal, the bony wall of which is here usually more or less defective; while the floor, formed by the osseous bulla, is concave and thin, and crossed by curved plates of bone radiating from the bony ring to which the membrana tympani is attached. The posterior wall (paries mastoidea) of the horse's tympanum presents no noteworthy features.

Dissection.—Snip all round the outer wall of tympanum, so that it may be removed. In the process of the operation an irregular space, the *epitympanic recess* (recessus epitympanicus), containing the incus and the head of the malleus, will be revealed in connection with the roof of the cavity.

The *membrana tympani* is the thin membrane, composed of fibrous tissue covered laterally with skin, and medially with mucous membrane, that separates the external acoustic meatus from the cavity of the tympanum. It is oval in outline, and is placed obliquely, so that it

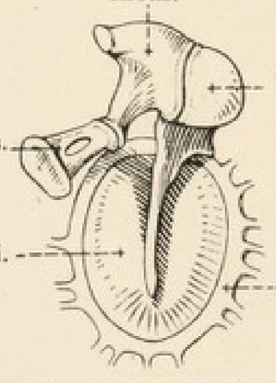


FIG. 71.—The auditory ossicles and the membrana tympani.

forms an angle of about 30° with the inferior wall of the meatus. The circumference of the membrane is slightly thickened and attached to a ring of bone, the *annulus tympanicus.* The handle of the malleus is attached to the membrane, and draws it inwards, so that the lateral surface is concave and the medial correspondingly convex.

The *auditory ossicles* (ossicula auditus), three in number, namely the malleus, the incus and the stapes, cross the cavity of the tympanum from the membrana tympani to the fenestra vestibuli. The *malleus*[1] is the outermost and the largest of the three bones, and consists of a large upper part or *head* (capitulum mallei), below which is a *neck* (collum mallei), and a *manubrium* (manubrium mallei)[2] and two processes. The head carries a diarthrodial articular surface for contact with the incus. The neck is crossed medially by the chorda tympani nerve. The long manubrium is attached to the membrana tympani, as is also the short *lateral process* (processus lateralis). The *anterior*

[1] *Malleus* [L.], a hammer.
[2] *Manubrium* [L.], a handle.

process (processus anterior) springs from the neck, is very slender, and is attached by ligament to the wall of the tympanic cavity.

The *incus*[1] bears some resemblance to a human bicuspid tooth with widely divergent roots, and possesses a body and two crura. The *body* (corpus incudis) carries a saddle-shaped surface for articulation with the head of the malleus. The *short crus*[2] (crus breve) is movably connected with the wall of tympanum; while the *long crus* (crus longum) ends in a nodule of bone (lenticular process), frequently separable, that articulates with the head of the stapes by a diarthrodial joint.

The *stapes*,[3] a stirrup-shaped bone, consists of a *head* (capitulum stapedis), two *crura* (crus anterius et crus posterius), and a base. The *base* (basis stapedis) is connected with the ends of the crura and is in the form of an oval plate that is lodged in the fenestra vestibuli, and connected with the margin of the opening by an annular ligament in such a manner that some amount of movement is possible.

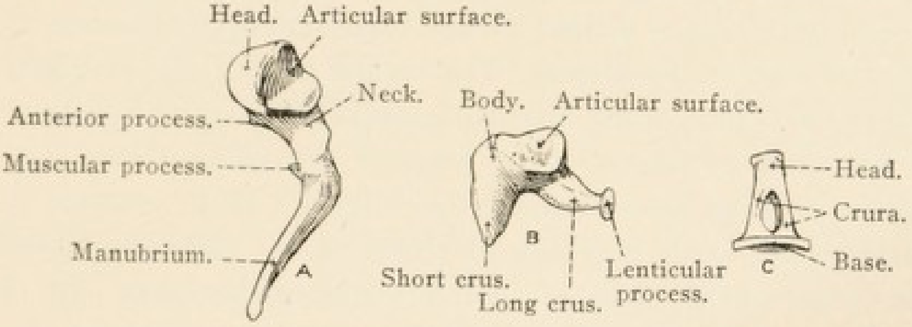


FIG. 72.—The auditory ossicles (×3). A = malleus; B = incus; C = stapes.

Connected with the auditory ossicles are two small muscles (musculi ossiculorum auditus). The *tensor of the tympanum* (m. tensor tympani) is short and conical, with an origin from the bone just above the opening into the auditory tube. A slender tendon connects the muscle with the manubrium of the malleus close to its root. The *stapedius muscle* (m. stapedius) arises from an eminence on the posterior wall of the tympanic cavity, and is inserted into the head of the stapes.

The whole of the tympanic cavity, including its recesses, is lined by mucous membrane (tunica mucosa tympanica), which is continuous with that of the pharynx through the auditory tube. It is closely adherent to the periosteum of the bone, covers the auditory ossicles and their muscles and the chorda tympani nerve, and closes the defect in the floor of the facial canal.

The dissector should open up the whole length of the *facial canal* (canalis facialis), beginning at the stylomastoid foramen and working towards the internal acoustic meatus. He will then find that the canal curves round the base of the cochlea and the posterior part of the

[1] *Incus* [L.], an anvil. [2] *Crus* [L.], a leg, a limb. [3] *Stapes* [L.], a stirrup.

internal wall of the tympanum, and crosses the roof of this cavity. The main structure contained in the canal is the seventh cerebral or facial nerve. In addition there is the small *auricular branch* (ramus auricularis) of the vagus nerve, which, arising from the jugular ganglion, gains the canal, gives filaments to the facial nerve, along with which it leaves the canal by the stylomastoid foramen to ascend behind the external acoustic meatus and end in the skin within the meatus.

THE INTERNAL EAR (Auris interna).—The internal ear consists of spaces and canals tunnelled out of the temporal bone, to which the collective name of osseous labyrinth is applied, and in which membranous sacs and tubes—the membranous labyrinth—are contained.

The Osseous Labyrinth (labyrinthus osseus).—The central space of the osseous labyrinth, the *vestibule* (vestibulum), has a lateral wall formed by part of the medial wall of the tympanum, and in the dried skull communicates with this cavity by the fenestra vestibuli. In the fresh state and in the living animal, as has been stated, the fenestra is occluded by the base of the stapes. The medial wall of the vestibule corresponds to the depths of the internal acoustic meatus, and is crossed by an oblique *crista vestibuli.* In front of the crista there is a depression, the *recessus sphæricus*, for the lodgment of the saccule of the membranous labyrinth, to which filaments of the vestibular nerve gain access by a number (12-15) of small foramina in the lower part of the recess. A larger oval *recessus ellipticus*, for the utricle of the membranous labyrinth, occurs behind the crista vestibuli. In this recess, and in the upper part of the crista, are numerous foramina for the transmission of filaments of the vestibular nerve to the utricle and the ampullæ of the superior and lateral semicircular ducts. The posterior-inferior end of the crista splits to enclose the *recessus cochlearis*, which is perforated by small foramina for nerve filaments that pass to the cochlear duct. Below the recessus ellipticus is the small, slit-like entrance to the *aquæductus vestibuli*, which passes through the temporal bone to open on its cerebral surface, and transmits the endolymphatic duct and minute vessels.

In the posterior part of the vestibule are openings leading into the three osseous semicircular canals—superior, posterior and lateral; while in the lower and anterior part of the cavity is an opening into the spiral canal of the cochlea. Each of the *semicircular canals* (canales semicirculares ossei) forms about two-thirds of a circle, and is enlarged at one end into an *ampulla.*[1] The superior canal is vertical, with its ampulla anterior and lateral. The more posterior non-ampullated end

[1] *Ampulla* [L.], a globular vessel for holding liquids, a flask.

joins the corresponding part of the posterior canal to form a *crus commune* that opens into the medial part of the vestibule. The posterior canal is also vertical. Its non-ampullated end joins the crus commune; while its lower and ampullated end opens into the lower and posterior part of the vestibule. The lateral canal is horizontal, with an ampulla, lateral in position, opening into the vestibule close to that of the superior canal. The non-ampullated end opens above the ampulla of the posterior canal.

The *cochlea*[1] forms the most anterior part of the bony labyrinth, and consists essentially of a *spiral canal* (canalis spiralis cochleæ) wound round a central column of bone known as the *modiolus*.[2] The

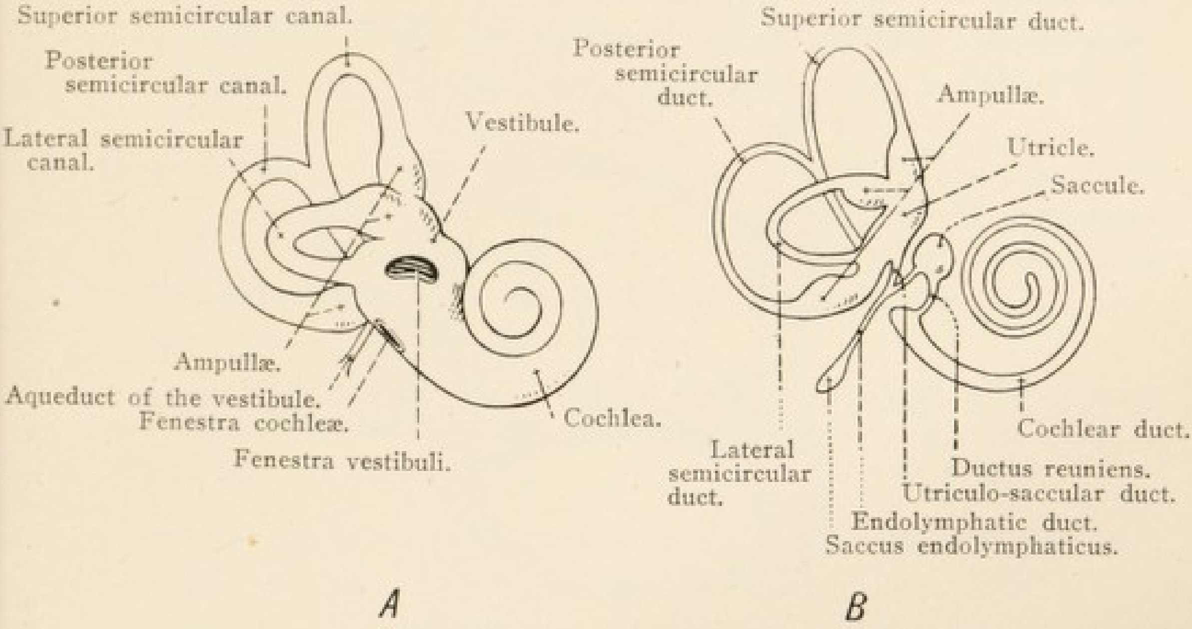


FIG. 73.—The osseous (*A*) and membranous (*B*) labyrinths of the internal ear.

canal ends blindly at the apex of the cochlea, where it forms the *cupula*. Into the canal a *spiral lamina* of bone (lamina spiralis ossea) projects for some distance from the inner (modiolar) wall, and thus partially divides the canal into two compartments. One of these, the *scala*[3] *vestibuli*, communicates with the vestibule; while the other, the *scala tympani*, in the macerated bone, opens by the fenestra cochleæ into the cavity of the tympanum. In the fresh condition the fenestra is closed by the membrana tympani secundaria. The spiral lamina begins at the floor of the vestibule, and ends close to the cupula in a hook-like process, the *hamulus*,[4] which assists in the formation of an opening, the

[1] *Cochlea* [L.], κοχλίας (cochlias) [Gr.], a snail; in a borrowed sense, anything twisted spirally.

[2] *Modiolus* [L.], the nave or hub.

[3] *Scala* [L.], a staircase.

[4] *Hamulus* (dim. of *hamus*) [L.], a hook.

helicotrema,[1] through which the scala vestibuli and scala tympani communicate with each other.

Close to the fenestra cochleæ there is a small opening leading into the *aquæductus cochleæ*, which traverses the temporal bone to open on its cerebral surface posterior to the internal acoustic meatus. The aqueduct places the scala tympani in communication with the subarachnoid space.

The Membranous Labyrinth (labyrinthus membranaceus).—The membranous labyrinth consists of the utricle, the saccule, three semicircular ducts and the cochlear duct. The *utricle*[2] (utriculus) lies in the upper and posterior part of the vestibule, part of it being accommodated in the recessus ellipticus. The *saccule* (sacculus), smaller than the utricle, occupies the recessus sphæricus of the vestibule. The

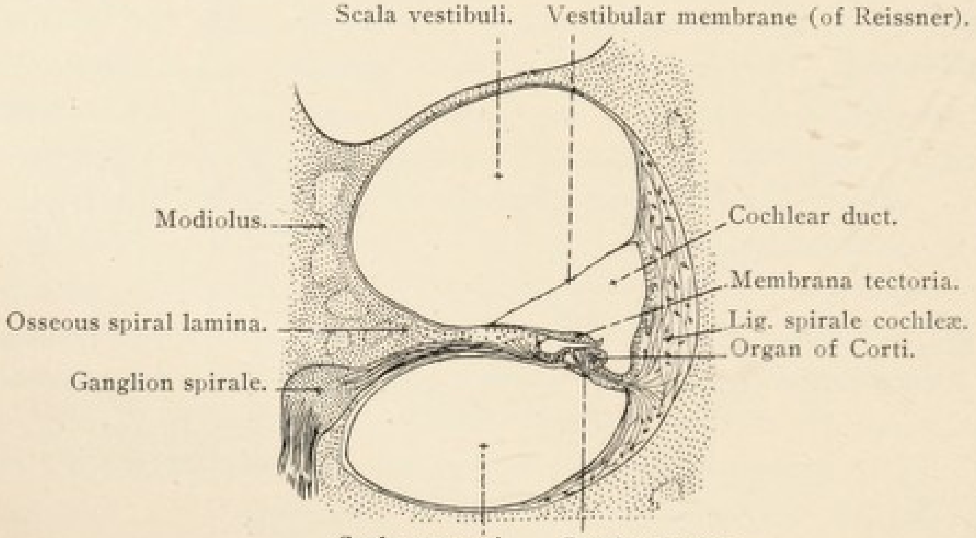


FIG. 74.—Section across the cochlea.

ductus endolymphaticus leaves its posterior part, and is joined by the *ductus utriculosaccularis* from the utricle. The endolymphatic duct traverses the aquæductus vestibuli of the temporal bone, and ends under the dura mater as a dilatation, the *saccus endolymphaticus*.

The *semicircular ducts* (ductus semicirculares) lie within the osseous semicircular canals, to the walls of which they are attached by their convex borders. Each duct is ampullated at one end, in agreement with the canal containing it. The non-ampullated ends of the superior and posterior ducts are united, and consequently the three ducts open into the utricle by five openings.

The *cochlear duct* (ductus cochlearis) is attached on one side to the

[1] ἕλιξ (helix) [Gr.], a spiral, anything that assumes a spiral shape. τρῆμα (trēma) [Gr.], a hole.

[2] *Utriculus* (dim. of *uter*) [L.], a small bag or bottle made of hide, a skin for wine, &c.

outer wall of the spiral canal of the cochlea, and on the other to and about the edge of the bony spiral lamina. Both ends of the duct are blind. One, the *cæcum* [1] *vestibulare*, lies in the recessus cochlearis of the vestibule; while the other, the *cæcum cupulare*, is attached to the cupula and helps to bound the helicotrema. Near its vestibular end, the duct is joined by the *ductus reuniens* from the lower part of the saccule.

In section, the cochlear duct is triangular. The roof or vestibular wall, between the cavity of the duct and the scala vestibuli, is formed by the *membrana vestibularis* (of Reissner) that stretches from the periosteum on the apical side of the lamina spiralis to the outer wall of the cochlea. The outer wall is formed by the *ligamentum spirale cochleæ*, a thickening of the periosteum of the cochlea. The basal or tympanic wall, separating the cavity of the duct from the scala tympani is formed by the *limbus* [2] *lamina spiralis* and the *lamina basilaris*. The limbus is a grooved thickening of the periosteum at, and near, the border of the bony spiral lamina. The lamina basilaris stretches across from the tympanic (lower) lip of the groove to the outer wall of the cochlea, and supports the essential end-organ of hearing, the *spiral organ of Corti* [3] (organon spirale Cortii).

The term *perilymph* is applied to a watery fluid between the osseous and membranous labyrinths, and the membranous labyrinth is filled with *endolymph*.

There still remain for examination the spinal cord and brain that were laid aside at an earlier stage of the dissection.

THE SPINAL MENINGES.—Surrounding the spinal cord there are three membranous envelopes—the meninges [4]—continuous with those that cover the brain. A certain amount of fat covers the outermost of these and must be removed before a satisfactory examination of the dura mater can be made.

The *spinal dura mater* (dura mater spinalis) is in the form of a dense, fibrous tube, continuous with the cranial dura mater at the foramen magnum, and extending into the sacrum. Close to the foramen magnum it is connected with the ventral occipito-atlantal membrane. The tube is uneven in calibre. Wide in the cervical and lumbar regions (and especially so opposite the atlas), it is narrower and much more closely applied to the spinal cord in the thoracic region. Posteriorly it tapers to its sacral termination. Along each side the

[1] *Cæcus* [L.], blind.

[2] *Limbus* [L.], a border or edge.

[3] Alfonso Corti, an Italian anatomist, 1822-1876.

[4] μῆνιγξ (meninx) (Gr.), any membrane, but especially of the brain (Hippocrates).

bundles of fibres forming the roots of the spinal nerves pierce the wall of the tube, and in doing so derive a thin fibrous sheath therefrom.

Dissection.—The dura mater must now be carefully slit along the middle line. This having been done, the smooth nature of its interior will be manifest. The interval between the dura mater and the arachnoid is known as the *subdural space* (cavum subdurale).

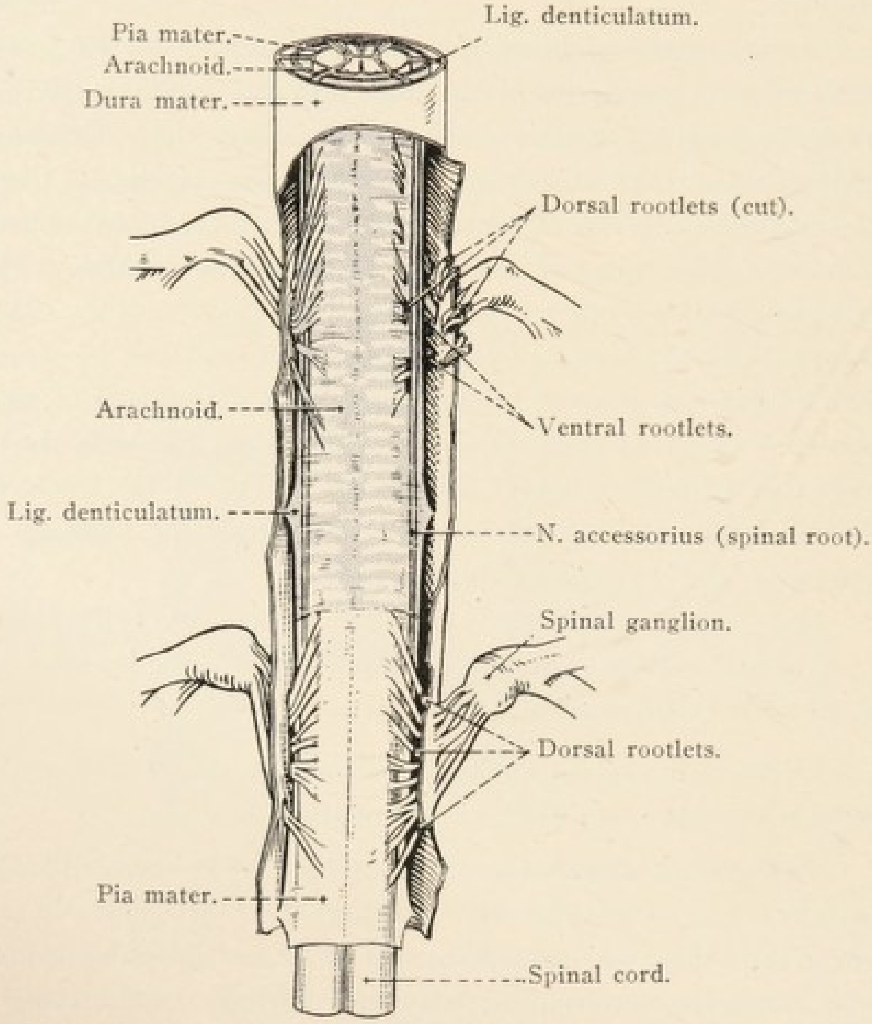


FIG. 75.—The spinal meninges. The fourth and fifth cervical segments of the spinal cord are illustrated.

On comparison, it is obvious that marked differences exist between the dura mater covering the brain and its continuation over the spinal cord. The cranial dura mater is closely adherent to, and forms the internal periosteum of, the cranial bones; the spinal dura mater is separated from the vertebræ by a space (cavum epidurale) in which there is a certain amount of fatty tissue. The cranial dura mater consists of two layers, from one of which membranous partitions are formed; the spinal dura mater corresponds to the inner of these two layers only. Venous sinuses are present in the cranial dura mater; the corresponding membrane of the spinal cord is devoid of them.

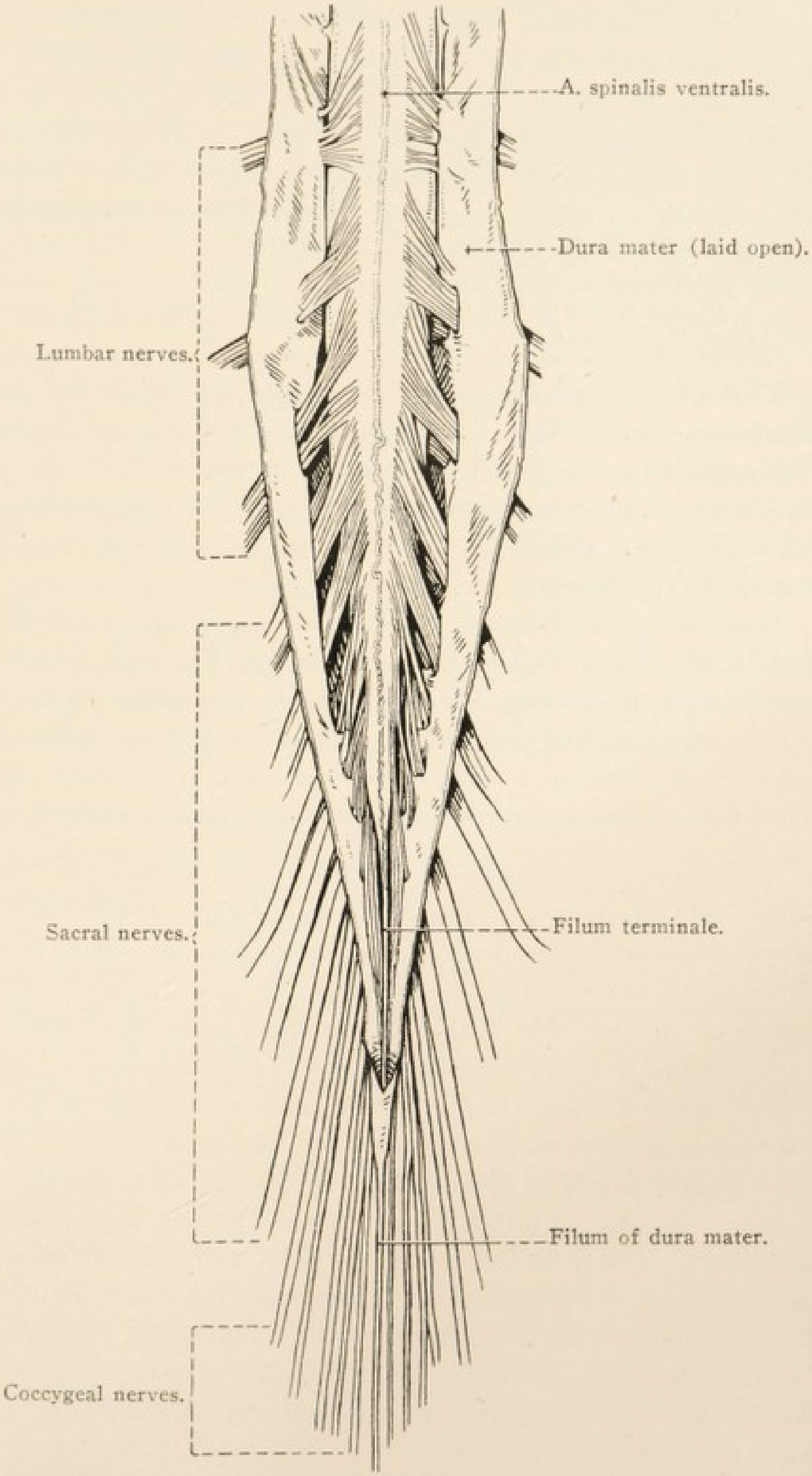


FIG. 76.—The cauda equina.

The *spinal arachnoid*[1] (arachnoidea spinalis), the second tubular investment of the spinal cord, is very delicate and transparent. Continuous anteriorly with the arachnoid of the brain, posteriorly it forms a loose covering for the cauda equina, and ends by joining the other meninges. Between the arachnoid and the underlying pia mater is the *subarachnoid space* (cavum subarachnoideale), which is imperfectly subdivided by a dorsal longitudinal septum (septum subarachnoideale) and the right and left ligamenta denticulata.

Dissection.—Remove the arachnoid from a length of the cord and so expose the pia mater.

The *spinal pia mater*[2] (pia mater spinalis) is a tough vascular membrane—thicker than the corresponding covering of the brain—closely applied to the surface of the cord and continued into the ventral median fissure, opposite which it is thickened into a longitudinal band called the *linea splendens.* Thin sheets of pia are provided for the roots of the spinal nerves.

Connecting the pia mater with the dura mater, and suspending the cord in the dural sheath, the *denticulate ligament* (ligamentum denticulatum) is attached continuously along the lateral border of the spinal cord. Its connection with the dura mater, however, is interrupted, and is in the form of a series of pointed teeth, which reach the dura mater between the apertures of exit of successive spinal nerves.

THE SPINAL CORD (Medulla spinalis).—The spinal cord, weighing about 250 grammes, is a bilaterally symmetrical cylindrical mass of nerve matter extending from the foramen magnum, where it is continuous with the medulla oblongata of the brain, to the third sacral vertebra. Its posterior extremity rapidly tapers, thus forming the *conus medullaris,* beyond which is the *filum*[3] *terminale.* The last named is a thin, thread-like structure, mainly composed of pia mater, but containing some small amount of nervous tissue.

A certain degree of dorso-ventral flattening is observable in most of the spinal cord, but this is least in the thoracic region and conus medullaris. The thickness of the cord is not uniform. Those parts are thickest from which spring the nerves that form the limb-plexuses. Thus it comes to pass that there are two enlargements, a *cervical swelling* (intumescentia cervicalis) and a *lumbar swelling* (intumescentia lumbalis). The longest stretch with a uniform diameter is the thoracic part of the cord.

[1] ἀραχνοειδής (arachnœides) [Gr.], like a cobweb (ἀράχνη).
[2] *Pius* [L.], tender; *Mater* [L.], mother.
[3] *Filum* [L.], a thread.

Leaving each side of the spinal cord are forty-two spinal nerves (nervi spinales), classified according to the vertebræ behind which they leave the vertebral canal. The number of nerves agrees with the number of the vertebræ in the thoracic, lumbar and sacral regions; but in the cervical region there are eight nerves, the first leaving the vertebral canal by the intervertebral foramen of the atlas. The number of coccygeal nerves is generally five.

Each spinal nerve is formed by the union of two roots, a dorsal and a ventral. Each root in its turn is compounded of a number of rootlets that leave the lateral aspect of the spinal cord. The rootlets of the dorsal root leave along a definite line (the dorsal lateral groove); but those of the ventral root emerge from a narrow longitudinal area (area radicularis ventralis). The two roots pierce the dura mater separately, though close together, and join to form the mixed spinal nerve within the intervertebral foramen, except in the sacral and coccygeal part of the cord, where union takes place within the vertebral canal. Immediately before union is effected, the dorsal root expands into an oval grey swelling, the *spinal ganglion* (ganglion spinale).

It is customary to regard as a "segment" of the spinal cord the length with which a pair of spinal nerves is connected. The whole cord is therefore divided into as many segments as there are pairs of spinal nerves.

Up to a certain stage of embryonic development, the spinal cord is co-extensive with the vertebral canal, and the various nerves arise from the cord opposite their foramina of exit from the canal. But, owing to disparity in the rate of growth in length of the two structures, the cord is displaced, and it becomes necessary for many of the nerves to travel for a longer or shorter distance before gaining egress from the vertebral canal. To such a degree is this carried in the terminal part of the spinal cord that it is surrounded by a cluster of nerve roots, known as the *cauda equina.*

Dissection.—Remove the membranes from the cord so that its exterior may be studied.

By examination of the exterior of the spinal cord the dissector may readily satisfy himself of its bilateral symmetry. A deep *ventral median fissure* (fissura mediana ventralis) runs the full length of the ventral aspect and, in conjunction with a faint *dorsal median groove* (sulcus medianus dorsalis), divides the surface into two symmetrical halves. Each half is subdivided into three *funiculi* (ventral, lateral and dorsal) by the emergence of the ventral rootlets of spinal nerves and by the *dorsal lateral groove* (sulcus lateralis dorsalis). In the cervical region and the first part of the thoracic region a *dorsal inter-*

mediate groove (sulcus intermedius dorsalis) subdivides the dorsal funiculus into a medial *fasciculus*[1] *gracilis* of Goll and a lateral *fasciculus cuneatus* of Burdach. Goll's fasciculus is much the narrower.

Sections across the spinal cord (sectiones medullæ spinalis) should be made in different regions. In these the bilateral character of the structure is confirmed. The ventral median fissure cuts into the cord to near the middle of its dorso-ventral diamater, and a *dorsal median septum* (septum medianum dorsale) continues the dorsal median groove into the interior. Each half contains grey and white matter; the former more deeply placed and in the form of a curved or comma-

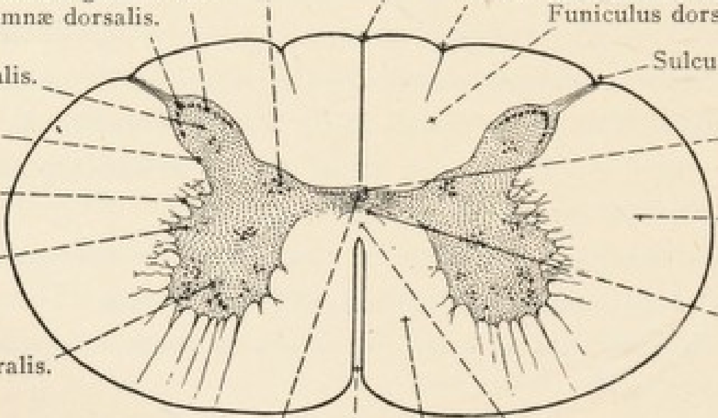


FIG. 77.—Diagram of a transverse section of the spinal cord.

shaped mass (in section). The grey matter of one side of the cord is connected with that of the other by the *dorsal* and *ventral grey commissures* (commissura dorsalis grisea: commissura ventralis grisea), between which is the *central canal* (canalis centralis) of the cord surrounded by the *central grey matter*.

The exact shape of the sectional area of the grey matter varies considerably in different regions, but in the main it may be indicated by saying that it resembles the capital letter H, the cross-bar of the letter being represented by the grey commissures; and the study of a series of sections shows that each half of the cord contains a *dorsal* and a *ventral column* of grey matter, of which the ventral is the larger and thicker, and is separated from the surface of the cord by a considerable layer of white matter. The dorsal column approaches the surface very nearly, and terminates in sections in a pointed apex, which is covered by a particular kind of grey matter, the *substantia*

[1] *Fasciculus* (dim. of *fascis*) [L.], a little bundle.

gelatinosa (Rolandi), so called from its semitransparent character. Occasionally a slight constriction, or *neck* (cervix columnæ dorsalis), marks off the dorsal column from the rest of the grey matter.

In some regions of the cord a projection—the *lateral column* (columna lateralis)—may be observed opposite the grey commissures; and it is often difficult to clearly define the boundary of the grey matter in the concavity formed by the dorsal and ventral columns, owing to an admixture of grey and white matter known as the *formatio reticularis*.

The grey columns are largest in the cervical and sacral regions, and particularly so on a level with the origin of those nerves that form the limb-plexuses; while they are smallest in the thoracic and early lumbar regions.

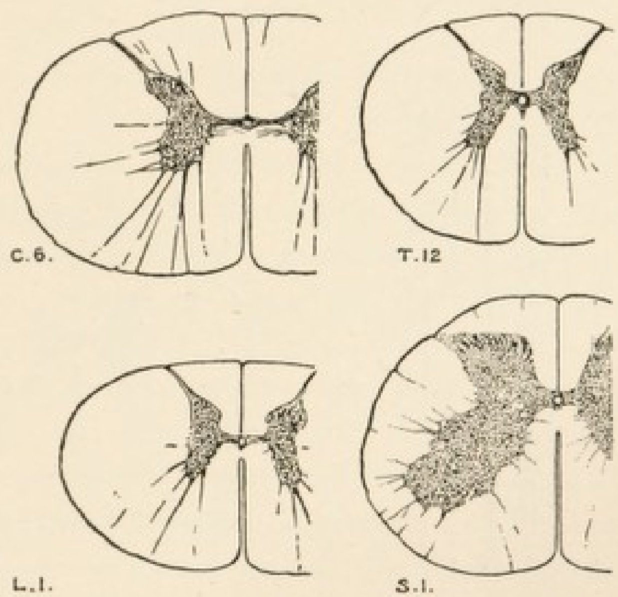


FIG. 78.—Transverse sections of the spinal cord at different levels.

The white matter of the cord is disposed external to the grey columns, and consequently is divided into the three funiculi previously mentioned. A *dorsal funiculus*[1] (funiculus dorsalis), triangular in section, lies between the dorsal grey column and the dorsal median septum. A *lateral funiculus* (funiculus lateralis) occupies the concavity lateral to the grey columns. A *ventral funiculus* (funiculus ventralis) fills the interval between the grey column and the ventral median fissure. The two ventral funiculi are connected across the bottom of the fissure by the *white commissure* (commissura ventralis alba). From the circumstance that the ventral grey column does not reach the surface of the cord, it is obvious that the lateral and ventral funiculi are only imperfectly separated. For this reason they are sometimes taken together as the ventro-lateral funiculus. As previously stated, in

[1] *Funiculus* (dim. of *funis*) [L.], a little cord.

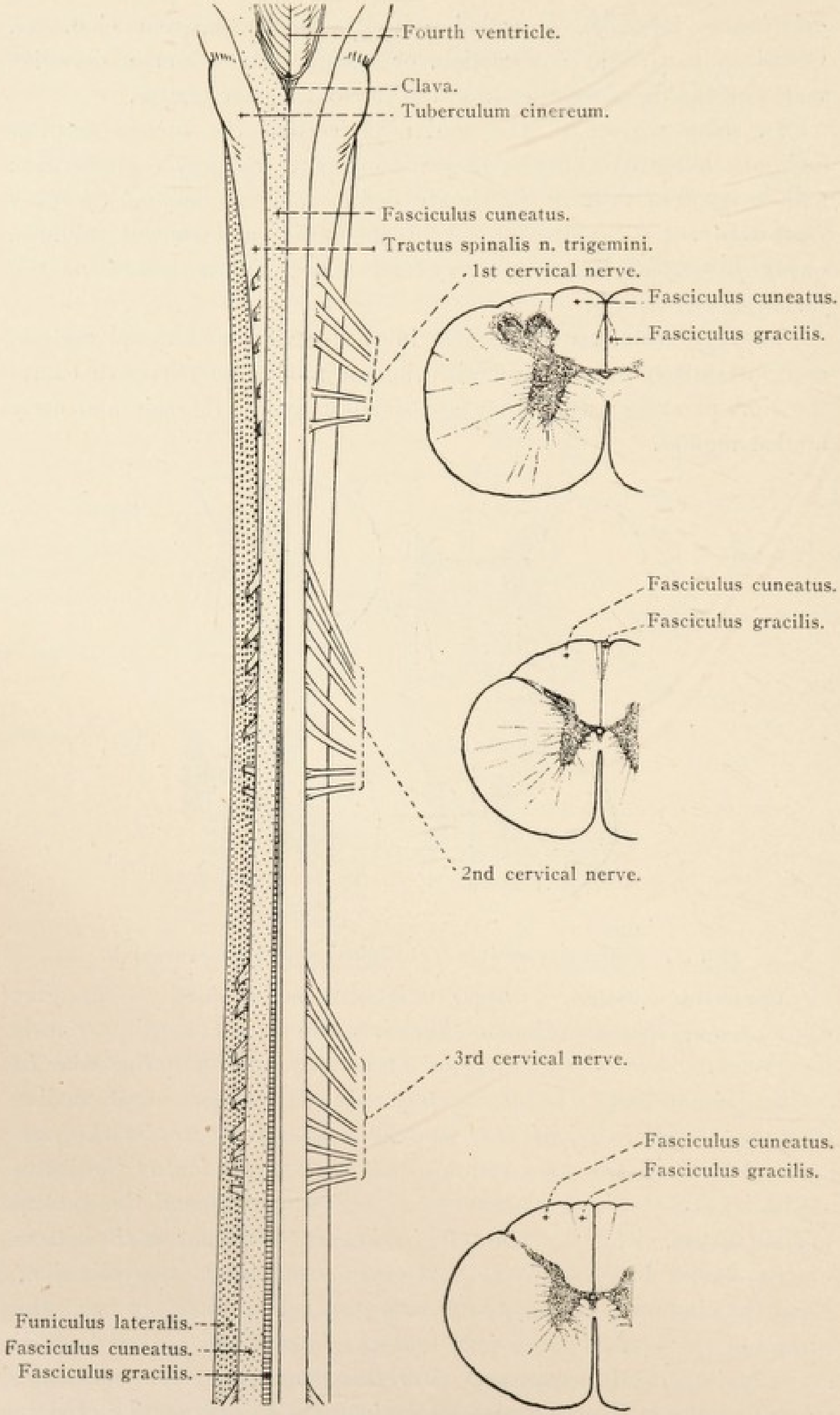


FIG. 79.—The dorsal funiculus of the spinal cord in the cervical region. The three figures on the right of the diagram illustrate the appearance of transverse sections at different levels.

the cervical region and the first part of the thoracic region, the dorsal funiculus is subdivided into a fasciculus gracilis and a fasciculus cuneatus by the dorsal intermediate groove. The fasciculus gracilis, always narrow on the surface of the cord, disappears entirely about the middle of the second cervical segment, and often does not appear again. Occasionally, however, a glimpse of it may be obtained in the medulla oblongata of the brain, at the posterior angle of the fourth ventricle. At the point of disappearance of the fasciculus gracilis, an additional ridge-like area (*tractus spinalis nervi trigemini*) appears on the surface of the cord, narrow at first, but gradually widening. This is formed by the substantia gelatinosa covered by fibres of the spinal root of the trigeminal cerebral nerve, and later, during the examination of the brain, will be found to end at the tuberculum cinereum of the medulla oblongata.

THE BRAIN (Encephalon).—Before beginning the actual dissection of the brain, it will be profitable to make a general survey of its external conformation. The whole organ has an irregularly ovoid shape, in conformity with the cranial cavity in which it is lodged. In weight it averages some 650 grammes. Its posterior end is formed mainly by the medulla oblongata and the cerebellum, but partly also by the hemispheres of the cerebrum. The anterior ends of the hemispheres, capped by the olfactory bulbs, form the narrow extremity of the ovoid. Of the various component parts of the organ, the cerebral hemispheres constitute by far the greater proportion of its entire bulk, and it is these that contribute the greatest transverse diameter.

Viewed from the dorsal aspect, the cerebral hemispheres are the most conspicuous objects, though part of the cerebellum and a short length of the medulla oblongata may also be seen. The two cerebral hemispheres are separated from each other by a *longitudinal fissure* (fissura longitudinalis cerebri), and a *transverse fissure* (fissura transversa) divides them from the cerebellum. The surface of each hemisphere is marked by grooves and convolutions arranged in what appears at first glance to be an inextricably confused pattern; but a closer examination at a later stage of the dissection will show that all the grooves are not of the same depth nor of equal morphological value. The surface of the cerebellum is also covered by grooves and ridges, but here they run mainly in a transverse direction; those of the cerebrum being chiefly longitudinal or oblique. The cerebellum, moreover, is divided by rather shallow and ill-defined antero-posterior depressions into a middle *vermis*[1] and two lateral *hemispheres*.

[1] *Vermis* [L.], a worm; from the resemblance of this part of the human cerebellum to a caterpillar.

An inspection of the lateral aspect of the brain emphasises the preponderating size of the cerebrum, and affords partial views of the cerebellum, pons and medulla oblongata.

On regarding the brain from its ventral aspect, a considerable number of structures are visible. At the present moment it will suffice to recognise only the most conspicuous of these. The most posterior is the *medulla oblongata*, a dorso-ventrally flattened column somewhat similar to the spinal cord in appearance, and continuous therewith without any definite line of demarcation. The artificial limits of the two structures may be taken as occurring at a transverse plane on a level with the foramen magnum. Immediately in front of the medulla there is a rounded, transverse band, the *pons*,[1] which can be readily followed laterally into the hemispheres of the cerebellum. Appearing from underneath the pons are two thick, rounded cords or columns, the *cerebral peduncles*,[2] which, after a diverging course, disappear into the ventral face of the cerebral hemispheres.

Crossing the anterior end of each cerebral peduncle obliquely is a strongly marked white cord, the *optic tract*, which approaches and meets the tract from the other side and unites therewith at the *optic chiasma*.[3] The rest of the ventral view is occupied by parts of the cerebral hemispheres, separated by a continuation of the longitudinal fissure.

THE CRANIAL MENINGES.—Of the three membranous coverings of the brain, the dura mater has already been examined (page 138).

Continuous with, and structurally similar to, the corresponding membrane of the spinal cord, the *arachnoid* of the brain (arachnoidea encephali) is, for the most part, intimately related to the pia mater. Over the summits of the convolutions of the brain the two membranes are so inter-related as to constitute a single membranous covering;[4] but in other situations they are separated by a *subarachnoid space* (cavum subarachnoidale) of variable depth, across which passes a fine felt-work of fibres. In some places, for example at the base of the brain, the subarachnoid space is of considerable dimensions and forms the *subarachnoid cisterns* (cisternæ subarachnoidales). A cistern of some size exists between the medulla and the cerebellum (cisterna cerebello-medullaris), and communicates with the interior of the fourth ventricle by openings in the lateral recesses of the ventricle. A much smaller

[1] *Pons* [L.], a bridge.

[2] *Pedunculus* (dim. of *pes*) [L.], a little foot.

[3] χίασμα (chiasma) [Gr.], the mark or figure Χ, two crossing lines.

[4] There are those who hold that only two meninges should be recognised—a *leptomeninx* (comprising the arachnoid and pia mater together) and a *pachymeninx* (dura mater). λεπτός (leptos) [Gr.], thin, delicate. παχύς (pachys) [Gr.], thick, stout.

space (cisterna pontis) occurs where the basilar artery crosses the ventral surface of the pons. Another coincides with the interpeduncular fossa (cisterna interpeduncularis), and is connected with a fourth about the optic chiasma (cisterna chiasmatis). The latter, in its turn, is continuous on each side with a cistern in the lower part of the Sylvian fissure (cisterna fossæ lateralis).

Sheaths of the arachnoid are continued along the cerebral nerves for a short distance, except in the case of the optic nerve, where the sheath extends to the eyeball.

At the attached edge of the falx cerebri, rounded and sometimes pedunculated *arachnoidal granulations* (granulationes arachnoideales) may often be found invaginating the dura mater and projecting into the dorsal sagittal sinus and its lateral lacunæ. They consist of outgrowths of the arachnoid enclosing subarachnoid tissue, and are more obvious in old animals.

The thin *pia mater* of the brain (pia mater encephali) follows all the inequalities of its surface, sinking into the sulci of both the cerebrum and the cerebellum, and forming sheaths for the small blood vessels that penetrate the substance of the brain. The membrane is highly vascular since the smaller branches of the chief cerebral arteries ramify in it preparatory to their entry into the brain-tissue. When the membrane is raised from the surface of the brain, its deep face is rough and shaggy from the presence of minute ruptured vessels.

Later it will be seen that folds of the pia mater are included in the transverse fissure between the cerebrum and the cerebellum, and between the cerebellum and the medulla oblongata.

Dissection.—Cautiously strip the arachnoid from the base of the brain, and follow the arteries thus exposed as far as possible without causing injury to the brain-tissue.

THE ARTERIES OF THE BRAIN.—The larger blood vessels that supply the brain are contained within the subarachnoid space, and are derived from three main sources, namely, the single basilar artery and the two internal carotid arteries.

A. basilaris.—After the cerebro-spinal artery—a branch of the occipital—has entered the vertebral canal by the intervertebral foramen of the atlas (page 106), and has pierced the dura mater, it divides into spinal and cerebral branches. The spinal branch (ramus spinalis) unites with that of the opposite side of the body to form the ventral spinal artery. In like manner the basilar artery is produced by the union of the cerebral branch (ramus cerebralis) with its fellow.

The single, median basilar artery enters the cranium by the foramen magnum, and runs ventral to the medulla and pons to end, ventral to the interpeduncular fossa, by dividing into the right and left posterior cerebral arteries. In its course the basilar artery contributes numerous small branches to the medulla (rami medullares) and pons, and at its termination a multitude of fine branches leave it (and the first part of the posterior cerebral arteries) to enter the posterior perforated substance between the cerebral peduncles.

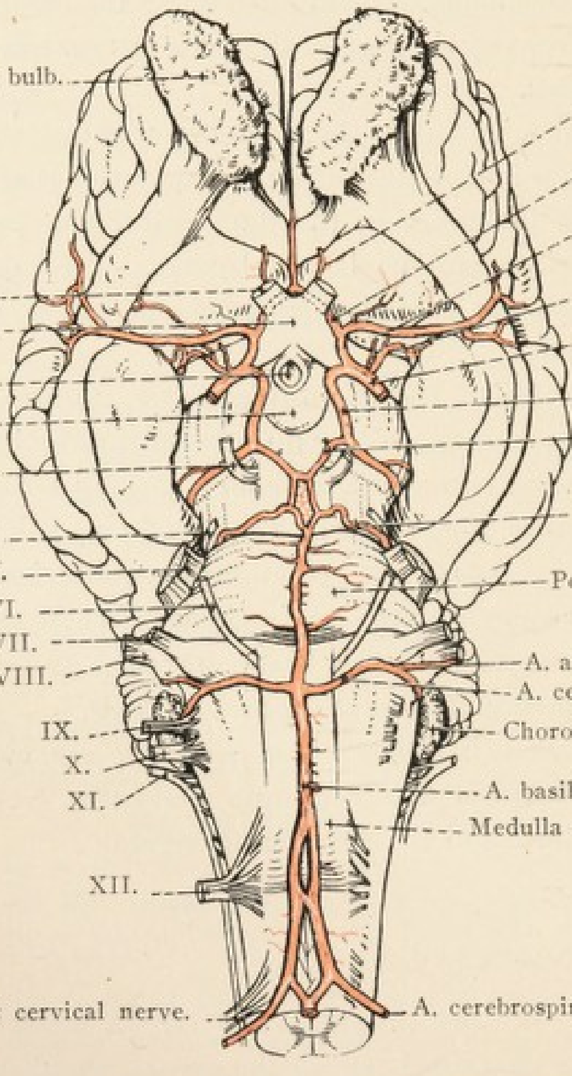


FIG. 80.—The arteries of the brain. The Roman numerals refer to the cerebral nerves.

The larger branches of the basilar are the following:—(1) The *posterior cerebellar arteries* (aa. cerebelli posteriores), right and left, run round the lateral margins of the medulla, to be expended mainly in the posterior part of the cerebellum and the choroid plexuses of the fourth ventricle. (2) The small *internal auditory arteries* (aa. auditivæ internæ) are branches either of the basilar or of the posterior cerebellar arteries. Each enters the temporal bone of its own side along with the auditory nerve, and ends in the tympanum. (3) The *anterior cerebellar arteries* (aa. cerebelli anteriores) are variable in number and point of origin. There may be only one on each side of the brain, but very frequently there are two or three, one or more of which may arise from the posterior cerebral artery. Bending round the lateral border of the mid-brain and following the brachium pontis, they terminate mainly on the anterior surface of the cerebellum. (4) The *posterior cerebral arteries* (aa. cerebri posteriores) leave the termination of the basilar at an acute angle, and each is soon joined by a posterior communicating branch of internal carotid artery. The vessel then disappears from the present dissection by passing into the narrow chink between the cerebral hemisphere and the cerebral peduncle. The posterior cerebral arteries are chiefly concerned in supplying the posterior part of the cerebral hemispheres.

A. carotis interna.—After traversing the cavernous venous sinus and piercing the dura mater, the internal carotid artery terminates immediately lateral to the optic chiasma by dividing into middle and anterior cerebral arteries. A collateral branch, the posterior communicating artery, leaves the internal carotid as soon as it has penetrated the dura mater.

The *posterior communicating artery* (a. communicans posterior) runs backwards on the cerebral peduncle and joins the posterior cerebral. A small and inconstant *deep cerebral artery* (a. cerebri profunda) bends round the border of the peduncle and ends in the mid-brain.

The *middle cerebral artery* (a. cerebri media) gains the lateral cerebral (Sylvian) fissure by traversing the depression anterior to the piriform lobe, and is distributed over almost the whole of the lateral surface of the cerebral hemisphere.

A small *choroidal artery* (a. chorioidea) leaves either the middle cerebral close to its commencement or the internal carotid near its termination, and follows the optic tract to end in the choroid plexus of the lateral ventricle.

The *anterior cerebral artery* (a. cerebri anterior), converging upon the median plane, passes dorsal to the optic nerve and unites with its fellow of the opposite side. The single vessel thus produced enters the longitudinal fissure and bends round the genu of the corpus callosum. It then divides into right and left branches and ramifies over the medial surface of the cerebral hemisphere. A small *anterior meningeal artery* (a. meningea anterior) arises from the anterior cerebral and supplies blood to the anterior part of the dura mater, anastomosing with branches of the ethmoidal artery to form a network in the ethmoidal fossa. It is often also possible to demonstrate another small branch of the anterior cerebral artery, which follows the optic nerve and anastomoses with a branch of the ophthalmic artery.

Circulus arteriosus.—The anastomoses of the chief cerebral arteries results in the production of a polygonal *arterial circle* (of Willis), which lies in the depressed area in front of the pons, and surrounds the hypophysis and optic chiasma. Anteriorly the circle is closed by the union of the two anterior cerebral arteries. Laterally the posterior communicating arteries link the anterior to the posterior part of the circle by establishing a connection between the internal carotid and posterior cerebral arteries. The circle is completed behind by the diverging posterior cerebral arteries.

Dissection.—Remove the vessels and pia mater from the base of the brain. This must be done with the utmost care to avoid injury to the brain tissue generally, but especially to prevent tearing away the roots of the several cerebral nerves. The pia mater forms sheaths to the various nerve roots. The relation of the membrane to the nerves is consequently so intimate that it is probably safest to cut the membrane with scissors around each root.

Before proceeding with a detailed examination of the brain, the dissector should amplify somewhat the brief general survey already made of the structures at its base.

A *ventral median fissure*, continuous with the ventral fissure of the spinal cord, divides the medulla oblongata into two lateral halves, and terminates abruptly at the *foramen cæcum*, a blind depression close to the pons. The fissure is bounded on each side by a prominent white strand, the *pyramid*, which disappears under the pons. Lateral to the pyramid, and separated from it by a shallow groove, is the flattened, oval *facial tubercle*. Immediately in front of this is the transverse prominence, the *corpus trapezoideum*.[1]

The salient *pons* forms a convex transverse elevation that can be traced laterally into the hemisphere of the cerebellum. The broad and rounded *cerebral peduncles* appear from underneath the anterior border of the pons and, diverging somewhat, disappear into the cerebral hemisphere dorsal to the optic tracts and chiasma. The divergence of the peduncles produces the *interpeduncular fossa*, the anterior boundary of which is formed by the *optic tracts*—definite white cords that appear between the piriform lobe of the cerebrum and the cerebral peduncle—and the *optic chiasma* that results from the union of the tracts. The posterior part of the interpeduncular fossa is formed mainly by the *posterior perforated* substance, which derives its name from the numerous small openings by which blood vessels gain the deeper brain tissue. The anterior part of the fossa is occupied by the *mammillary*[2] *body* and the *tuber cinereum*.[3] The mammillary body is a prominent

[1] *Corpus* [L.], body. τρâπεζοειδής (trapezœides) [Gr.]; trapezium-shaped (τρâπέζιον (trapezion), a small table or counter).

[2] *Mammilla* (dim. of *mamma*) [L.], a nipple.

[3] *Cinereus* [L.], ashy, grey.

white object that subsequent dissection will show to be connected with the columns of the fornix. The tuber cinereum is a less prominent grey elevation, between the mammillary body and the optic chiasma, connected by a hollow stalk, the *infundibulum*, with the *hypophysis*.[1]

On a level with the interpeduncular fossa, the cerebral hemisphere is raised into the *piriform lobe*, a small anterior continuation of which is separated from the main mass by a deep transverse depression occupied by the middle cerebral artery. In front of the depression is the *olfactory*[2] *lobe*, consisting of the *olfactory bulb*, from which arises a flattened white band, the *olfactory tract*. At its posterior end the tract divides into *medial* and *lateral striæ*,[3] the former disappearing into the fissure between the two cerebral hemispheres, the latter coursing, as a white band, across the surface of the anterior prolonga-

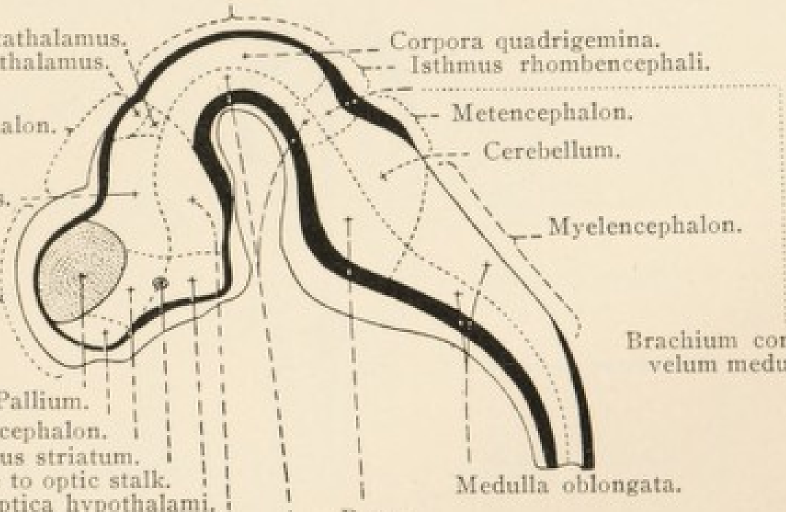


FIG. 81.—Diagram of the alar and basal laminæ of the embryonic brain.

tion of the piriform lobe, and finally disappearing in the prominent part of this lobe. Between the two striæ is a grey eminence, the *olfactory trigone*, the greater part of which is pitted with holes, thus forming the so-called *anterior perforated substance*.

Development of the Brain.—The whole of the central nervous system—spinal cord and brain—develops from an embryonic *neural tube*, the right and left halves of which are divisible into a ventral zone or *basal lamina*, and a dorsal zone or *alar lamina*, united by a dorsal *roof plate* and a ventral *floor plate*. The development of the spinal cord is comparatively simple, since it consists essentially of a gradually increasing thickening of the right and left walls of the neural tube by the formation of nervous tissue, the original lumen of the tube remaining as the definitive central canal of the spinal cord.

The development of the brain is, naturally, more complicated. The anterior

[1] ὑπόφυσις (hypophysis) [Gr.], an undergrowth.

[2] *Olfacio* [L.], to smell.

[3] *Stria* [L.], a furrow, groove, channel.

part of the neural tube is expanded, and, early in embryonic life, is marked off by two constrictions into the three *primary cerebral vesicles*—the hind-brain or rhombencephalon, the mid-brain or mesencephalon, and the fore-brain or prosencephalon. Certain flexures also occur in this part of the neural tube. The first to appear is the *cephalic flexure*, in the region of the mid-brain, produced by the fore-brain and the anterior part of the head being bent round the anterior end of the foregut and the notochord. A forward bending of the whole head leads to the formation of the *cervical flexure*, which marks the junction of the hind-brain with the spinal cord. This flexure is indifferently marked in the embryos of domestic mammals, and does not persist after birth. A third bend, with its convexity in a direction opposite to that of the other two, namely, downwards instead of upwards, forms in the region of the future pons, and is therefore known as the *pontine flexure*.

The *rhombencephalon* or *hind-brain* is the largest of the three primary cerebral vesicles, and is usually held to be divisible into two parts—metencephalon and myelencephalon. From the *myelencephalon*—the posterior segment—the medulla

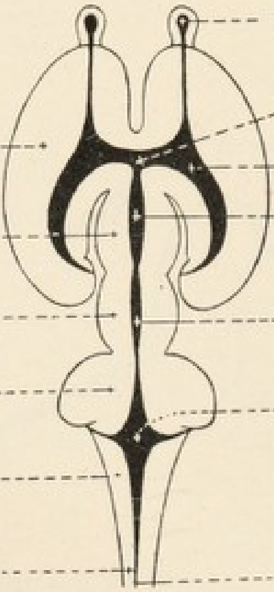


FIG. 82.—Diagram of the ventricular system of the brain.

oblongata is formed, largely by a thickening of its lateral walls, but also by the development of decussating nerve-fibres in the floor plate. The roof plate, from a falling apart of the lateral walls, becomes greatly expanded, remains chiefly ependymal, and forms the thin posterior part of the roof of the fourth ventricle. From the *metencephalon* are developed the pons and cerebellum.

That part of the hind-brain which joins the mid-brain is narrower than the rest, and to it the name of *isthmus rhombencephali* is given.

The *mesencephalon* or *mid-brain* remains undivided, and, though comparatively large in the early embryo, forms only a small part of the fully developed brain. From the circumstance that nerve tissue is developed in every part of the wall of this vesicle, its cavity—the aquæductus cerebri—is very restricted in comparison with the ventricles that represent the cavities of the other cerebral vesicles. The dorsal (alar) zone of the mid-brain becomes the corpora quadrigemina, while the ventral (basal) zone develops into the cerebral peduncles.

The *prosencephalon* or *fore-brain* at an early stage is particularly wide opposite lateral diverticula—the *optic vesicles*—which are responsible for the formation of the retinæ and the optic nerves. Changes in the form of the fore-brain are numerous and complicated, but it may be stated briefly that they result in a division of this part of the embryonic brain into an anterior *telencephalon* and a posterior *diencephalon.* From the former the hollow cerebral hemispheres rapidly grow, and, because of their extension in a backward direction, soon override the diencephalon and, later, the mesencephalon. The cavities of the hemispheres become the lateral ventricles, connected with the rest of the cavity of the fore-brain by a wide opening that gradually narrows to the dimensions of the interventricular foramen of the adult brain.

The lateral walls of the diencephalon form the thalami, while the ventral wall thickens into part of the cerebral peduncles and the structures that occupy the interpeduncular fossa. It is noteworthy that the roof plate of the diencephalon, like that of the myelencephalon, remains thin and membranous.

The following table indicates generally the parts of the adult brain that develop from the primary embryonic vesicles :—

ENCEPHALON.	Rhombencephalon or Hind-brain	Myelencephalon	Medulla oblongata. Posterior part of 4th ventricle.
		Metencephalon	Cerebellum. Pons. Anterior part of 4th ventricle.
		Isthmus rhombencephali	Brachia conjunctiva. Anterior medullary velum. Cerebral peduncles (in part).
	Mesencephalon or Mid-brain	Mesencephalon	Corpora quadrigemina. Cerebral peduncles (in part). Aquæductus cerebri (of Sylvius).
	Prosencephalon or Fore-brain	Diencephalon	Thalami. Hypo-thalamic tegmental region. Mammillary bodies. Tuber cinereum. Hypophysis. Pineal body. Optic nerves and retinæ. Posterior part of 3rd ventricle.
		Telencephalon	Cerebral hemispheres (Pallium, rhinencephalon and corpora striata). Lateral ventricle. Interventricular foramen. Anterior part of 3rd ventricle.

THE CEREBRAL NERVES (Nervi cerebrales).—Twelve pairs of nerves arise from each half of the brain. These are either named numerically,

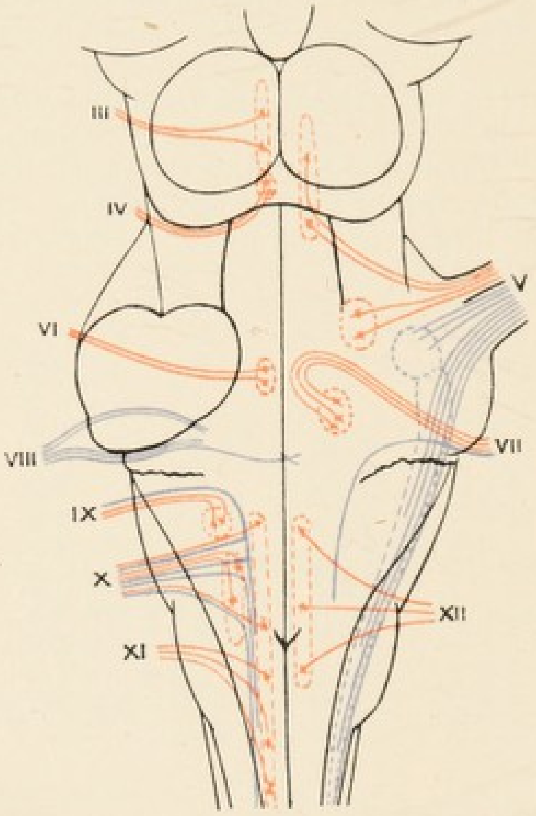


FIG. 83.—Diagram of the origin and relations of the root-fibres of the cerebral nerves.

or are given designations that signify their function, distribution or some notable characteristic :—

First cerebral nerve	. .	*Nervus olfactorius.*
Second ,,	. .	,, *opticus.*
Third ,,	. .	,, *oculomotorius.*
Fourth ,,	. .	,, *trochlearis.*
Fifth ,,	. .	,, *trigeminus.*
Sixth ,,	. .	,, *abducens.*
Seventh ,,	. .	,, *facialis.*
Eighth ,,	. .	,, *acusticus.*
Ninth ,,	. .	,, *glossopharyngeus.*
Tenth ,,	. .	,, *vagus.*
Eleventh ,,	. .	,, *accessorius.*
Twelfth ,,	. .	,, *hypoglossus.*

The intracranial course of the cerebral nerves, and their mode of exit from the cranium, have been previously determined (page 142). Each nerve is associated with cells in the interior of the brain, from which it can be traced to some definite point on the surface where it has what is generally called its "superficial origin." This is the best time at which the superficial origins of the various nerves may be determined.

Numerous small *olfactory nerves* leave the olfactory bulb and immediately enter the foramina of the ethmoid bone to gain the cavity of the nose. They are generally left behind when the brain is removed. The *optic nerve* is a large rounded cord connected with the optic chiasma, through which its fibres are continued into the optic tracts. The *oculomotor nerve* has origin from the cerebral peduncle about the middle of its length and towards its medial border. The origin of the *trochlear nerve* from the anterior medullary velum cannot be seen at present; but the nerve itself will be found curving round the lateral border of the cerebral peduncle, in the cleft between this and the cerebrum and cerebellum. The trochlear is the smallest of the cerebral nerves. The *trigeminal*[1] *nerve* is the largest of the cerebral group and arises by two roots from the lateral part of the pons. The larger root (portio major) is sensory in function, while the much smaller medial root (portio minor) is motor. The *abducent nerve* has its origin from the most anterior part of the groove that forms the lateral boundary of the pyramid of the medulla oblongata. The *facial* and *acoustic nerves* arise together from the lateral extremity of the corpus trapezoideum; the facial being the more medial and slightly the smaller. The *glossopharyngeal, vagus* and *accessory nerves* are formed by the union of a series of nerve rootlets that leave the lateral border of the ventral surface of the medulla oblongata. The accessory nerve, in addition to its fine medullary roots, contains fibres derived from the first five cervical segments of the spinal cord. These unite into a single cord that enters the cranium by the foramen magnum and joins the medullary roots to form the complete nerve. The *hypoglossal nerve* arises by several rootlets from the posterior part of groove lateral to the pyramid.

Dissection.—As a preliminary to the examination of the surface of the cerebral hemispheres, they must be carefully denuded of the covering formed by the pia mater and arachnoid. Since the whole of their surface cannot be examined without the separation of the two hemispheres, two brains should be procured, if possible. One of these should be left intact; while the cerebellum, medulla oblongata and pons of the other should be separated from the cerebrum by a transverse incision made just in front of the pons. The two hemispheres of this specimen may now be isolated by an incision in the plane of the great longitudinal fissure.

THE CEREBRAL HEMISPHERES (Hemisphæria cerebri).—The two cerebral hemispheres form the greater part of the bulk of the brain. Each is flattened laterally in a certain degree, and so possesses surfaces that are generally described as three in number—dorso-lateral, medial and ventral—though there is no clear line of distinction between the

[1] *Trigeminus* [L.], three born at a birth, a triplet. (From the three primary divisions of the nerve.)

dorso-lateral and ventral surfaces. The dorso-lateral surface (facies convexa), for the most part convex, is applied to the walls of the cranium. The medial surface (facies medialis), on the contrary, is flattened, and much of it faces the corresponding surface of the opposite hemisphere: the more posterior portion, however, faintly concave, joins the rest at an angle and faces the cerebellum, from which it is separated by the tentorium only. The ventral surface (basis cerebri) is irregular and is formed by the olfactory and piriform lobes.

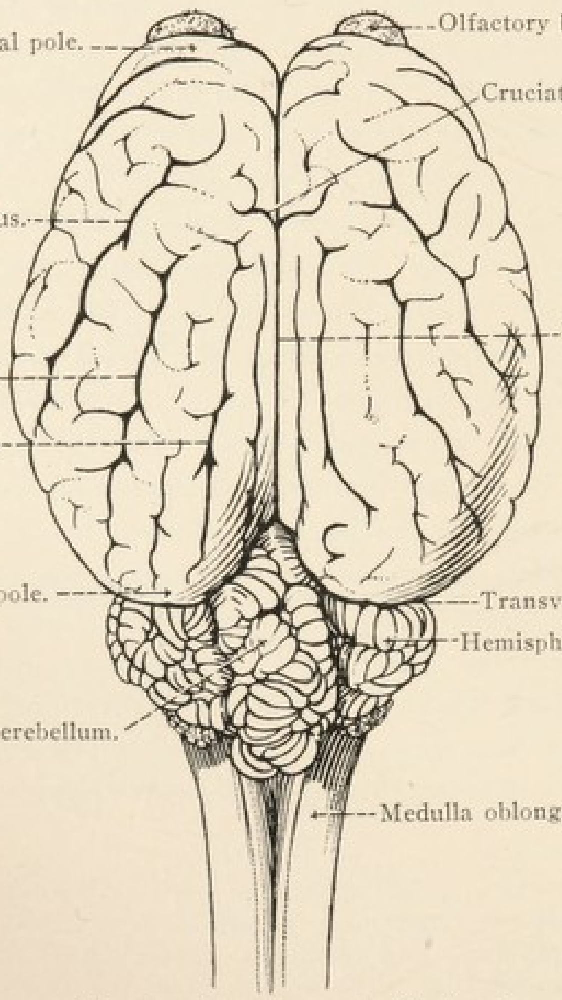


Fig. 84.—Dorsal aspect of the brain.

The extremities of the hemisphere are known as the frontal and occipital poles (polus frontalis: polus occipitalis), of which the anterior is laterally flattened, and the posterior is bluntly pointed.

If, in the intact specimen, the hemispheres are separated as far as possible by opening the longitudinal fissure, it will be found that they are connected by a broad, white, commissural band, the *corpus callosum*. It will be observed, moreover, that the commissure does not extend to either the frontal or the occipital pole of the hemisphere, and that it is not placed in a horizontal plane, but slopes downwards and forwards.

The surface of the hemisphere is sculptured by lines, known as *fissures* (fissuræ) and *sulci*, which separate winding ridges referred to generally as *convolutions* (gyri). The shallower sulci and the smaller convolutions are of little anatomical importance, but the deeper grooves and the main convolutions must be regarded as of morphological moment. A landmark of fundamental importance is the undulating *rhinal fissure* (fissura rhinalis) that divides the *rhinencephalon*[1] form the much larger and more dorsal *pallium*[2] of the hemisphere.

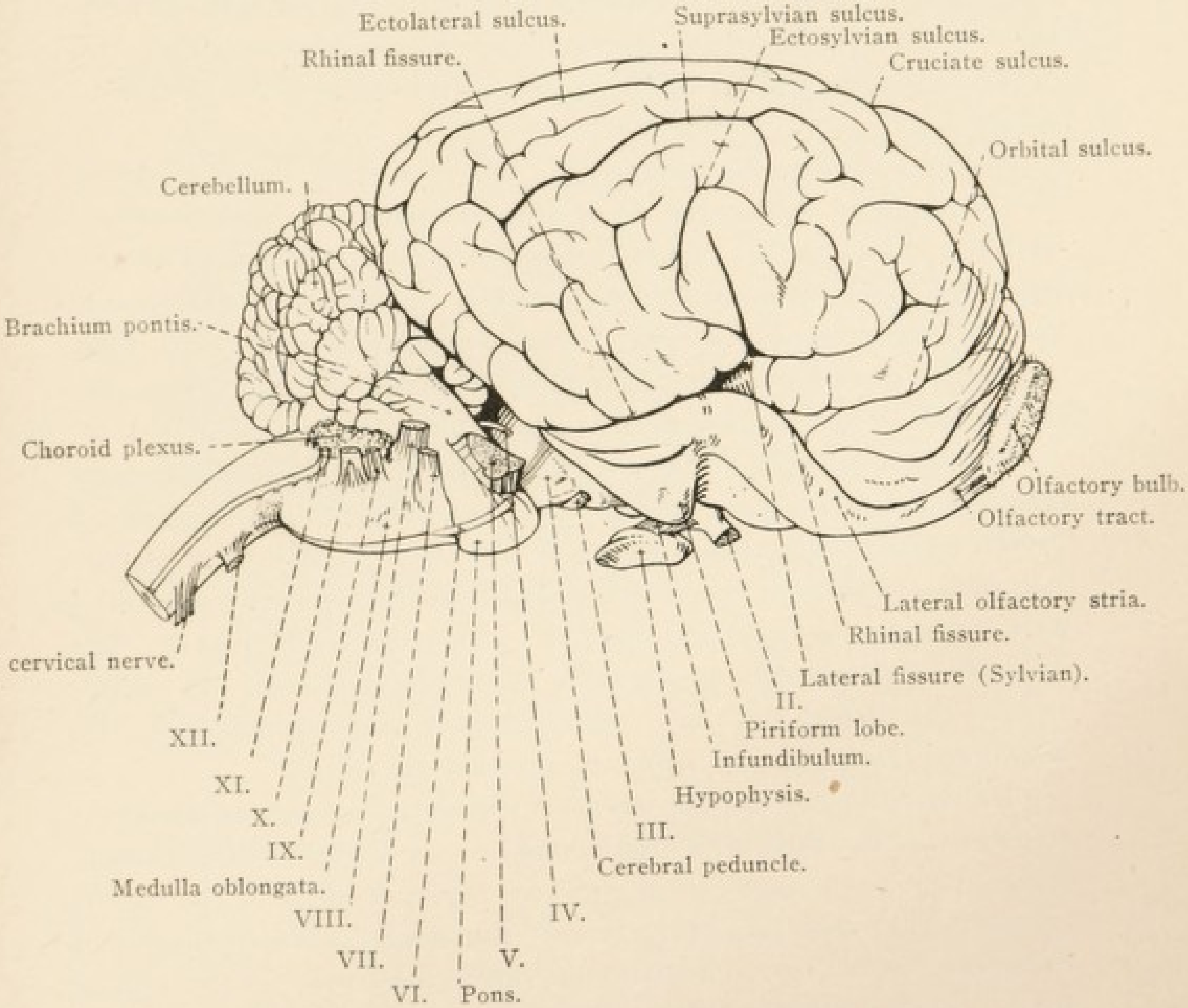


FIG. 85.—Lateral aspect of the brain. The Roman numerals refer to the cerebral nerves.

Pallium. Dorso-lateral surface.—The dorso-lateral surface of the pallium is covered by convolutions that, for the most part, rise tier above tier, and are arranged in a curved manner relative to a fissure of considerable depth, the *lateral cerebral fissure* (fissura cerebri lateralis) or fissure of Sylvius.[3] This occurs on a level with the deep transverse depression that forms the anterior boundary of the most prominent and

[1] ῥίς (rhis) [Gr.], the nose. ἐγκάφαλος (encephalos) [Gr.], the brain.

[2] *Pallium* [L.], mantle.

[3] Franciscus Sylvius (François Dubois), French anatomist, 1614-1672.

conical part of the piriform lobe, and consists of a short stem from which three branches—anterior, middle and posterior—usually radiate. In the depths of the fissure, and most frequently partly or completely hidden from view, are several short convolutions composing the *insula*.

Bent round the middle or ascending branch of the Sylvian fissure is a convolution bounded above by the *ectosylvian sulcus* (sulcus ectosylvius). Above this is a convolution, generally complex in formation, limited dorsally by one of the deepest of the cerebral sulci, the *suprasylvian sulcus* (sulcus suprasylvius), which is commonly connected in front with the cruciate sulcus, and sometimes also with the orbital sulcus.

The area between the suprasylvian sulcus and the dorsal margin of the hemisphere is indented by a longitudinal *lateral sulcus* (sulcus lateralis). Between the suprasylvian and lateral sulci there is a subsidiary *ectolateral sulcus* (sulcus ectolateralis) that may be broken into two or more segments. The lateral and suprasylvian sulci most commonly extend over the occipital pole of the hemisphere to the surface that is in contact with the tentorium cerebelli.

Two other constant sulci, the orbital and the cruciate, are demonstrable on the dorso-lateral surface of the hemisphere. The long, curved *orbital sulcus* (sulcus orbitalis) begins not far from, or even in connection with, the anterior end of the suprasylvian sulcus, cuts the anterior part of the hemisphere, and ends by joining the rhinal fissure. The *cruciate*[1] *sulcus* (sulcus cruciatus) is of considerable depth and belongs to both the medial and dorso-lateral surfaces of the hemisphere. Its lateral end most commonly joins the suprasylvian sulcus.

Medial Surface.—As has just been stated, the cruciate sulcus is prolonged round the margin of the hemisphere on to the medial surface, where it joins a long, curved groove, roughly parallel to the corpus callosum, that may possibly represent the combined *intercalary* and *calcarine*[2] *sulci* (sulcus intercalaris: sulcus calcarinus) of the human brain. Between this groove and the corpus callosum there is a long and generally subdivided convolution that is considered by some to be the homologue of the gyrus fornicatus of man. The *callosal sulcus* (sulcus corporis callosi) separates the gyrus from the corpus callosum.

If the specimen in which as much as possible of the brain-stem has been removed be examined, the *hippocampal fissure* (fissura hippocampi) will be seen as a curved groove extending from the posterior end of the callosal sulcus to the prominent part of the piriform lobe, of which it forms the medial boundary. Along the convexity of the

[1] *Crux* [L], a cross.
[2] *Calcar* [L.], a spur.

fissure is the hippocampal gyrus, continuous below with the piriform lobe.

Rhinencephalon.—A considerable number of structures are usually included under this term. They are:—Olfactory lobe, substantia perforata anterior, piriform lobe, gyrus fornicatus, subcallosal and supracallosal gyri, fascia dentata, fornix, septum pellucidum, hippocampus, cingulum, mammillary body, fasciculus thalamomammillaris, and a part of the anterior commissure. Many of these are examined in connection

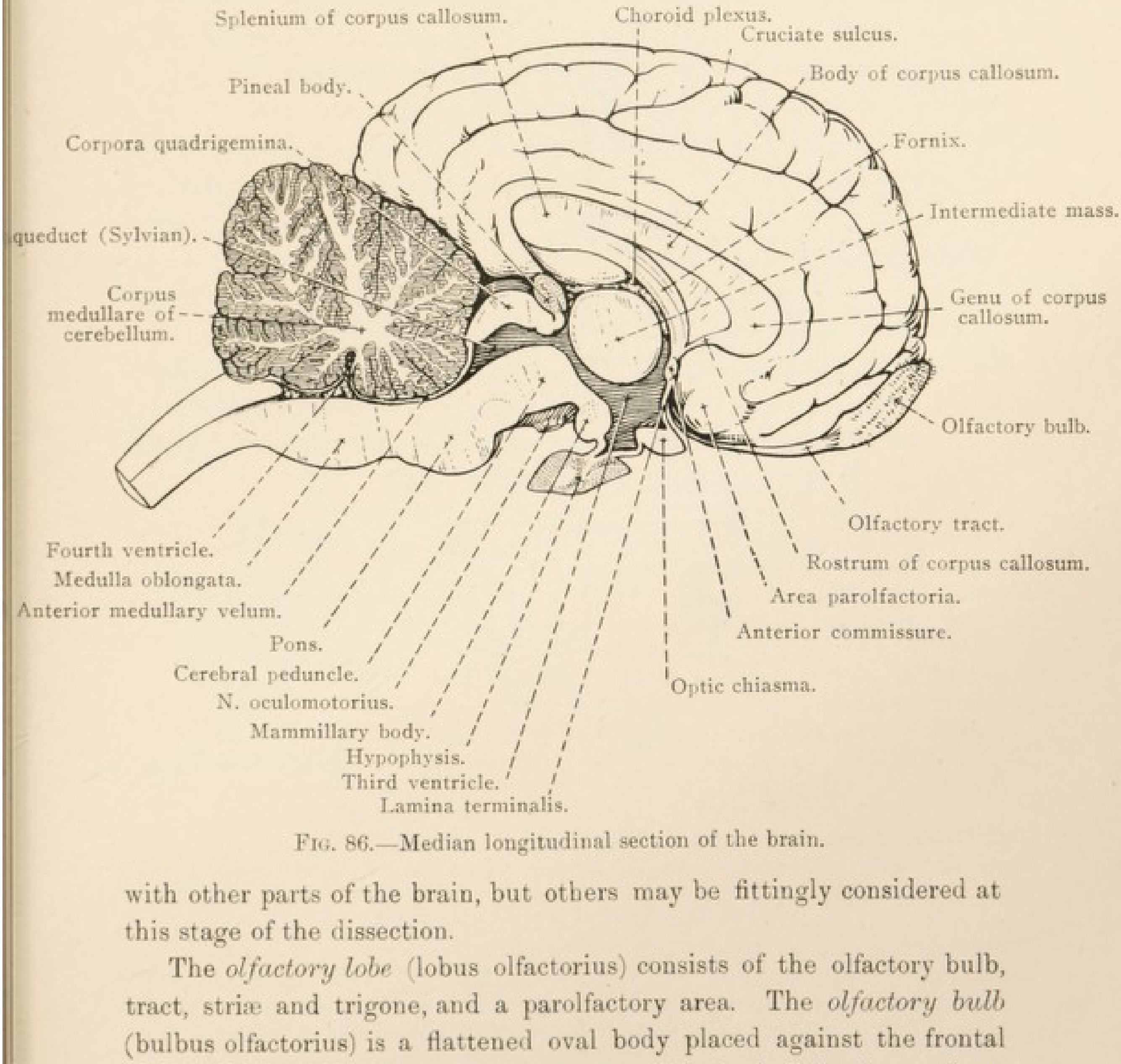


Fig. 86.—Median longitudinal section of the brain.

with other parts of the brain, but others may be fittingly considered at this stage of the dissection.

The *olfactory lobe* (lobus olfactorius) consists of the olfactory bulb, tract, striæ and trigone, and a parolfactory area. The *olfactory bulb* (bulbus olfactorius) is a flattened oval body placed against the frontal pole of the cerebral hemisphere, and, when the brain is in the cranium, fitted to the deep fossa of the ethmoid bone. Its convex surface receives the numerous olfactory nerves that pierce the foramina of the cribriform plate of the ethmoid. From the posterior part of the bulb a short, broad, white band, the *olfactory tract* (tractus olfactorius) passes backwards on the ventral aspect of the hemisphere, and divides into the two *olfactory striæ* (striæ olfactorii). The lateral stria is much the more distinct, and runs in a lateral, dorsal and backward direction forming the medial lip of the rhinal fissure. Posteriorly it is lost in the piriform lobe. The much less definite and shorter medial stria curves towards the middle line, and disappears into the longitudinal fissure between the two hemispheres.

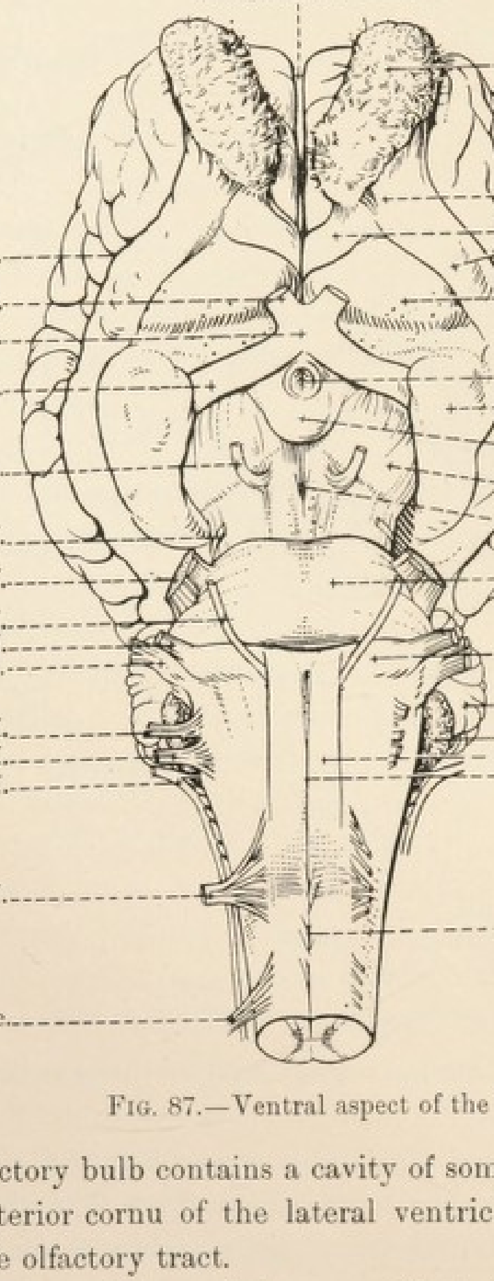


FIG. 87.—Ventral aspect of the brain.

The olfactory bulb contains a cavity of some size, which is connected with the anterior cornu of the lateral ventricle by a narrow canal that traverses the olfactory tract.

The *olfactory trigone* (trigonum olfactorium) is an elevated grey area between the olfactory striæ. It is continuous with an ill-defined area (area parolfactoria) on the medial surface of the hemisphere.

The *piriform lobe* (lobus piriformis) forms a conspicuous pear-shaped elevation, indented by one or two shallow grooves, immediately lateral to the optic tract and cerebral peduncle, and medial to the posterior part of the rhinal fissure. In front of its most prominent part is a steep declivity that may be mistaken for the anterior limit of the lobe. It is stated, however, that a small continuation reaches to the olfactory trigone. Posteriorly the piriform lobe is continuous with the hippocampal gyrus.

The term *substantia perforata anterior* is applied to an area in front of the most prominent part of the piriform lobe, in which there are numerous small openings for the admission of vessels to the deeper part of the brain.

The *subcallosal gyrus* (gyrus subcallosus) is a vague area of the cerebral cortex ventral to the rostrum of the corpus callosum; and the *supracallosal gyrus* (indusium griseum) consists of a very thin layer of grey matter covering the dorsal surface of the corpus callosum and containing the longitudinal striæ of this commissure.

The *fascia dentata* is a narrow and slightly crenated ridge separated from the hippocampal gyrus by the hippocampal fissure.

The *cingulum*[1] is contained in the gyrus fornicatus, and consists of association fibres that begin at the anterior perforated substance, run round the genu and over the trunk of the corpus callosum, curve round the splenium, and end in the hippocampal gyrus and piriform lobe.

Dissection.—Part of one cerebral hemisphere should be removed down to the level of the corpus callosum. This must be done by making a succession of slices in planes parallel to the commissure. The specimen in which the two hemispheres have been separated by a longitudinal incision is of service as a guide to the direction and depth to which the slices may be removed. As soon as the corpus callosum is plainly visible, it is well to remove the remains of the convolution immediately dorsal to it by tearing rather than by cutting. This is necessary because the lateral ventricle, a cavity roofed over by the corpus callosum, projects above the level of the medial part of the commissure. There is, therefore, danger of opening the ventricle prematurely if the slicing process is continued.

When sufficient of one hemisphere has been removed, the other should be treated in the same way.

During this dissection some features of the inner structure of the cerebrum will be revealed. The depth of some of the sulci will be demonstrated, and the fact that the convolutions are composed of an outer rind of grey matter enclosing a core of white matter will be disclosed. In the deeper sections the white cores of the convolutions become confluent; and finally a large island of white matter, connected by the corpus callosum with a similar island in the other hemisphere, occupies the central part of the section of each hemisphere.

The study of the corpus callosum should be carried out by an examination of the hemi-sected brain concurrently with that of the specimen just prepared.

CORPUS CALLOSUM.—The corpus callosum[2] is a broad, transverse

[1] *Cingulum* [L.], a girdle, belt.
[2] *Corpus* [L.], body. *Callosus* [L.], thick, hard, solid.

band mainly concerned in connecting the two hemispheres with each other. It is not co-extensive with the hemispheres, but coincides with the middle two-fourths of these structures.

The dorsal surface of the corpus callosum has a slight convexity longitudinally, but is concave from side to side. Numerous transverse lines (striæ transversæ) show that it is mainly composed of commissural fibres, though faint longitudinal markings, corresponding to the striæ longitudinales of the human brain, may be detected. The ventral surface forms the roof of the lateral ventricles, and in the median plane is connected with the septum pellucidum, a partition separating the cavities of the two ventricles. The lateral boundaries of the corpus callosum are lost in the white substance of the hemispheres.

The main part of the corpus callosum is known as the *truncus corporis callosi*. Its posterior end is thickened and forms the *splenium*[1] *corporis callosi;* while the anterior end, as an examination of the sagittal median section will show, is abruptly bent at the *genu*[2] *corporis callosi*, from which is continued a recurved, tapering (in section) *rostrum*[3] *corporis callosi* connected in its turn with the *lamina terminalis*, a thin sheet of grey matter that lies dorsal to the optic chiasma and is continuous with the tuber cinereum.

Dissection.—The interior of the lateral ventricle must now be exposed. Make a longitudinal incision through the corpus callosum some three or four mm. from the middle line, and then remove that part of the body which is lateral to the incision by tearing it away with either forceps or the end of the handle of the scalpel. When both ventricles have thus been opened, a narrow strip of corpus callosum will be left undisturbed.

Two cornua proceed from the main part of the ventricle now exposed. One of these is anterior in position and can be followed without much difficulty. The course of the other (inferior) cornu must be disclosed by the piecemeal removal of portions of the hemisphere; and in doing this it is well to remember that the cornu curves at first in a lateral, backward and ventral direction, and that later its course is medialwards and forwards.

A proper understanding of the lateral ventricle and its boundaries will be aided by the dissection of the cavity from the medial aspect. To do this, remove the corpus callosum and the immediately adjoining part of the hemisphere from the hemi-sected brain. Though the anterior cornu may be completely investigated in this specimen, it is better to do no more than expose the first part of the inferior cornu.

THE LATERAL VENTRICLE (Ventriculus lateralis).—The lateral ventricle represents the cavity of the vesicle from which the hemisphere originally developed, and is in communication with the third

[1] *Splenium* [L.], a plaster or patch; σπλήνιον (splenion) [Gr.], a bandage, compress of linen.

[2] *Genu* [L.], knee.

[3] *Rostrum* [L.], the bill or beak of a bird.

ventricle by the *interventricular foramen* (of Monro[1]) (foramen interventriculare), a small opening immediately beneath the fornix. In general, the cavity of the ventricle is not spacious, since the roof and floor are usually more or less in contact with each other. Occasionally, however, the dimensions of the cavity, even in a healthy specimen, may be considerable.

For descriptive purposes the ventricle is divided into a central part, an anterior cornu and an inferior cornu. The *central part* (pars centralis), extending from the interventricular foramen to the splenium

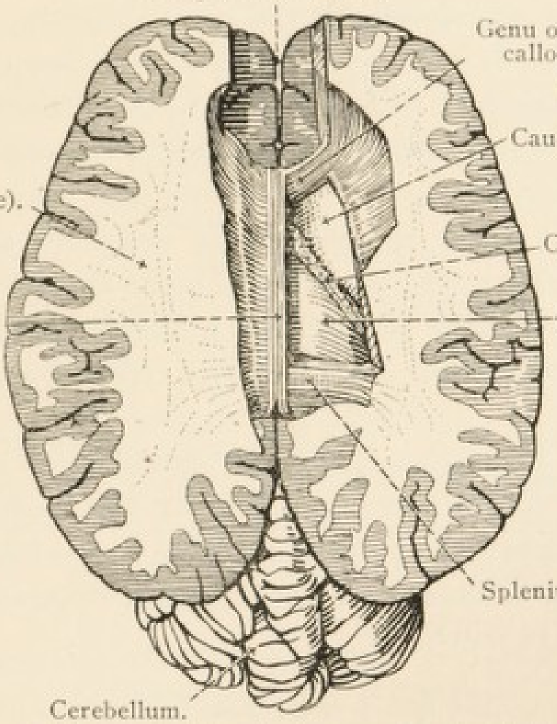


FIG. 88.—Horizontal section of the cerebral hemispheres. On the right side, the corpus callosum has been removed to show the interior of the lateral ventricle.

of the corpus callosum, has a roof formed by the corpus callosum, and a medial wall, by which it is separated from the ventricle on the opposite side of the brain, consisting of the septum pellucidum. There is no lateral wall, because the roof and floor meet and thus form the lateral boundary. The floor of the central part of the ventricle is formed by several important objects. Of these, the most anterior is a pear-shaped grey eminence, the *caudate nucleus* (nucleus caudatus), the narrow posterior end of which is continued into the inferior cornu. Along the medial border of the caudate nucleus runs a vascular fringe, the *choroid*[2] *plexus* (plexus chorioideus ventriculi lateralis), the appearance of which might lead to the assumption that it is actually within the ventricle. It is, however, excluded from the cavity by a thin, cellular

[1] Alexander Monro *primus*, an Edinburgh anatomist, 1697–1767.
[2] *Chorioideus* [L.], χοριοειδής (chorioeides) [Gr.], skinlike.

investment, the *ependyma*,[1] continuous with that lining the whole of the interior of the ventricle. Parallel to, and partially covered by, the choroid plexus is the edge of the *fornix* and its backward continuation, the *fimbria hippocampi*. The last named is a white hem applied to the rounded, elongated eminence, the *hippocampus*,[2] which extends from the floor of the central part of the ventricle down the inferior cornu to the piriform lobe. The deeper part of the hippocampus is grey in colour, but its ventricular surface is covered by a layer of white fibres, the *alveus*,[3] derived from the crus of the fornix.

The *anterior cornu* (cornu anterius) of the ventricle is, strictly speaking, merely an extension of the central part beyond the interventricular foramen. It inclines in a ventral direction and is continuous, through a narrow canal, with the cavity of the olfactory bulb.

The *inferior cornu* (cornu inferius) is a tapering and curved prolongation of the ventricle into the piriform lobe, where it ends on a level with the point at which the optic tract makes its appearance on the surface of the brain. The cornu contains the tail of the caudate nucleus (cauda nuclei caudati) reduced to a slender grey ridge, and the diminished continuations of the choroid plexus, fimbria and hippocampus.

The *septum pellucidum* is a thin, medial partition that separates the anterior part of the pars centralis of the two ventricles, and fills the triangular gap between the corpus callosum and the fornix. It is composed of two thin laminæ in contact with each other, and is thickest near the columns of the fornix.

Dissection.—The fornix must now be exposed as completely as the present stage of the dissection permits. Cut across the remains of the corpus callosum about the genu, and remove it from this point to the splenium. Its connection with the septum pellucidum is necessarily destroyed in the operation.

The hemi-sected brain affords much assistance in the study of the fornix, which there appears as a curved white band, ventral to the corpus callosum.

FORNIX.—The fornix[4] consists of two bands of fibres pursuing an arched course and intimately connected with each other at one place. The fibres are mainly longitudinal in direction and connect structures on the same side of the median plane; but there are also some commissural fibres that unite the two hippocampi (commissura hippocampi).

The *body of the fornix* (corpus fornicis) consists of the fused right

[1] ἐπένδυμα (ependyma) [Gr.], an outer garment.

[2] ἱπποκάμπος (hippocampos) [Gr.], a monster, with a horse's body and a fish's tail, on which the sea-gods rode (named from its shape in the human brain).

[3] *Alveus* [L.], a hollow vessel, a tub, a tray.

[4] *Fornix* [L.], an arch or vault.

and left bands, and is connected with the corpus callosum and the septum pellucidum. It is triangular in outline, and is related ventrally to the third ventricle and thalami, the choroid tela intervening. At each end of the body the right and left constituent parts of the fornix separate. At the anterior end the amount of divergence is not very great and results in the production of the *columnæ fornicis,* two rounded cords that curve ventralwards, in front of the interventricular foramen and behind the anterior commissure, to end at the base of the brain in the prominent mammillary body. A few fibres of the columns pass in front of the anterior commissure to end in the medial striæ of the olfactory lobe; and some run backwards as the striæ medullares attached to the thalami.

From the posterior end of the body of the fornix arise the two widely-diverging *crura fornicis.* These are at first connected with the

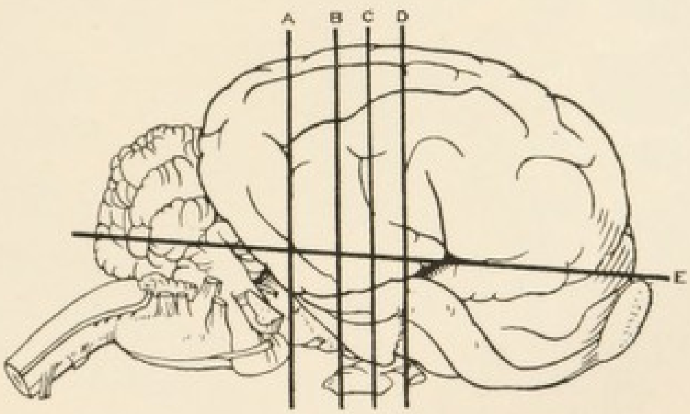


FIG. 89—Key-outline of the brain to indicate the plane of the sections illustrated in subsequent figures.

corpus callosum; but each soon forms the white hem—*fimbria*[1] *hippocampi*—that is adherent to the hippocampus of its own side, and, as such, is continued down the inferior cornu of the lateral ventricle. Some fibres of each crus are spread out as the white layer (alveus) on the surface of the hippocampus.

Dissection.—Cut across the fornix about the point where the crura are leaving the body. Then, with the utmost care, remove the isolated posterior part of the cerebral hemisphere, that is, the hippocampus and the adjacent part of the wall of the inferior cornu of the ventricle.

This is a convenient time to revise the examination of the hippocampal fissure and determine its associations. Between the fissure and the fimbria hippocampi there is a narrow and somewhat corrugated strip, the *fascia dentata hippocampi.*

The removal of the posterior part of the hemisphere has revealed the choroid tela of the third ventricle.

The *choroid tela of the third ventricle* (tela chorioidea ventriculi

[1] *Fimbræ* [L.], the extremity of anything, a border, edge, fringe.

tertii) is a triangular double fold of pia mater enclosing a layer of arachnoid and some blood vessels. It is interposed between the fornix and part of the hippocampus on the one hand, and the thalami and the third ventricle on the other. The apex of the triangle lies at the interventricular foramen of Monro. Each of its sides is bounded by the choroid plexus of the central part of the lateral ventricle, and at its base it divides into its two component sheets of pia mater that are here continuous with the pia covering the surface of the brain generally. The ventral face of the tela carries a linear longitudinal ridge that bulges towards the cavity of the third ventricle, and is produced by the choroid plexus of this ventricle (plexus chorioidea ventriculi tertii).

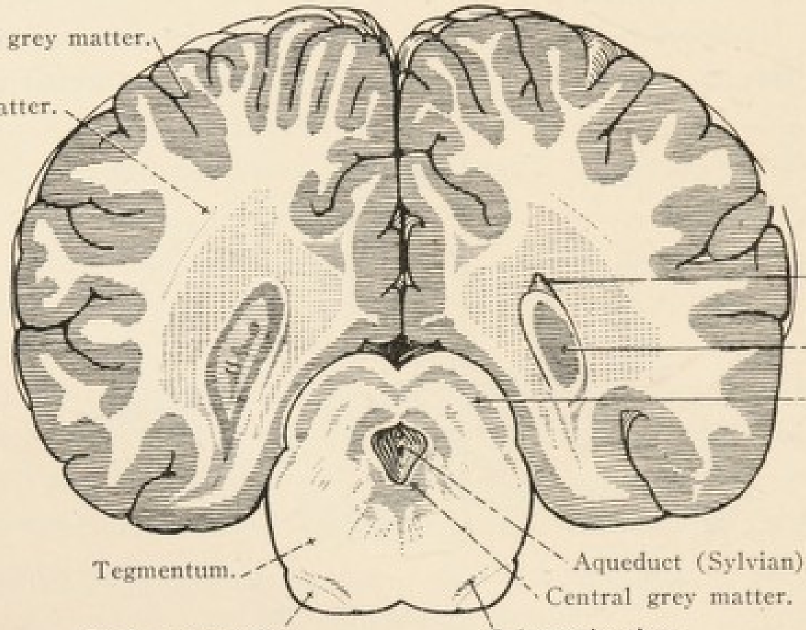


FIG. 90.—Transverse section of the brain at the level indicated by A in Fig. 89 (looking forward.)

The cleft into which the choroid tela and the choroid plexuses of the inferior cornua of the lateral ventricles are insinuated is the *transverse cerebral fissure* (fissura transversa cerebri).

Dissection.—Seize the apex of the choroid tela with forceps and strip it from the surface of the thalami upon which it rests. As this is done, the narrow cleft-like third ventricle comes into view.

THALAMUS.—The thalamus[1] is an oval mass of grey matter separated from the caudate nucleus by an oblique groove containing a narrow white band, the *stria terminalis.* When the choroid tela was removed its attachment along the stria terminalis was torn, with the result that a ragged edge, the *tænia chorioidea,* was left. Anteriorly the stria is

[1] *Thalamus* [L.], θάλαμος (thalamos) [Gr.], bedchamber (where the optic nerve is born).

connected with one of the columns of the fornix, while its posterior extremity is associated with the amygdaloid nucleus.

The dorsal surface of the thalamus is convex in the main, with a slightly more prominent elevation, the *anterior tubercle*, in front. The surface is bounded medially by a prominent border formed by a longitudinal ridge, white in colour, known as the *medullary stria* (stria medullaris), the anterior end of which joins one of the columns of the fornix. The posterior end of the stria is at the base of the pineal body, where some fibres join the nucleus habenulæ,[1] while others cross to the

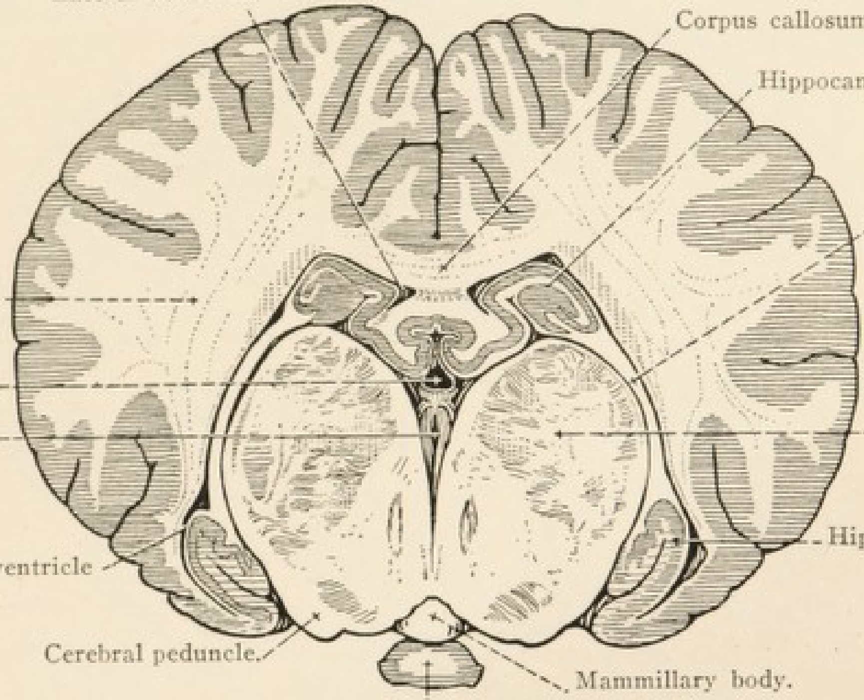


Fig. 91.—Transverse section of the brain at the level indicated by B in Fig. 89 (looking forward).

opposite nucleus in the *commissura habenularum*. The choroid tela of the third ventricle is attached along each stria medullaris, and when the tela is removed an irregular *tænia*[2] *thalami* is left.

The medial surface of each thalamus is flattened, and forms one of the lateral walls of the third ventricle. Crossing the ventricle and uniting the two thalami is a thick, rounded grey bridge of tissue, the *intermediate mass* (massa intermedia).

The lateral and ventral surface of the thalamus cannot be demonstrated at present, since they are connected with other parts of the brain. The lateral surface is in contact with the internal capsule, and the ventral surface rests on the dorsal or tegmental part of the cerebral

[1] *Habenula* (dim. of *habena*) [L.], a thong or strap, a rein.
[2] *Tænia* [L.], a flat band, tape, ribbon.

peduncle (the hypo-thalamic tegmental region). The posterior end of the thalamus, corresponding to the pulvinar of the human brain, cannot be precisely determined, because the lateral geniculate body is closely applied to this part.

In the middle line and in a depression bounded by the two thalami and the anterior colliculi of the quadrigeminal bodies, the conical and small but variable *pineal*[1] *body* (corpus pineale) will be found.

It should be noted that the pineal body, nucleus habenulæ, striæ

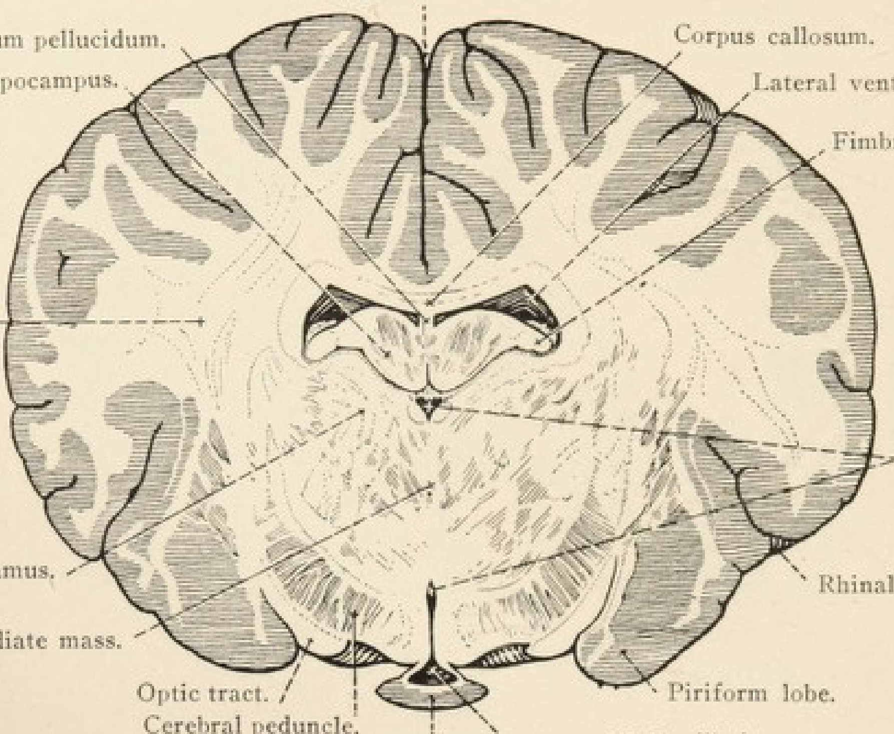


Fig. 92.—Transverse section of the brain at the level indicated by C in Fig. 89 (looking forward).

medullares and the posterior commissure (presently to be examined), constitute the *epithalamus*.

The *geniculate bodies*, medial and lateral, are intimately related to the thalamus, and are generally referred to as forming the *metathalamus*. The *lateral geniculate*[2] *body* (corpus geniculatum laterale) is closely applied to the posterior part (pulvinar)[3] of the thalamus, and from it the optic tract appears to arise. The more definite and oval *medial geniculate body* (corpus geniculatum mediale) lies between the optic tract and the brachium of the posterior colliculus of the corpora quadrigemina.

[1] *Pineus* [L.], pertaining to the pine (from the resemblance, in shape, of the body to a pine cone.)

[2] *Geniculatus* [L.], with knee-joints, bent like the knee (*genu*).

[3] *Pulvinar* [L.], a cushioned couch.

It is the custom to group together, under the common term *hypo-thalamus*, a number of structures that lie ventral to the thalamus. These are—the optic tracts and chiasma, the hypo-thalamic tegmental region, the mammillary body, the tuber cinereum, the hypophysis and the lamina terminalis.

Each *optic tract* (tractus opticus), in the form of a conspicuous white band, curves round the lateral part of the cerebral peduncle to meet its fellow at the *optic chiasma* on the ventral aspect of the brain. To the naked eye it appears to commence in the lateral and medial geniculate bodies; but microscopically its fibres are connected with the anterior colliculus and the thalamus, as well as with the geniculate

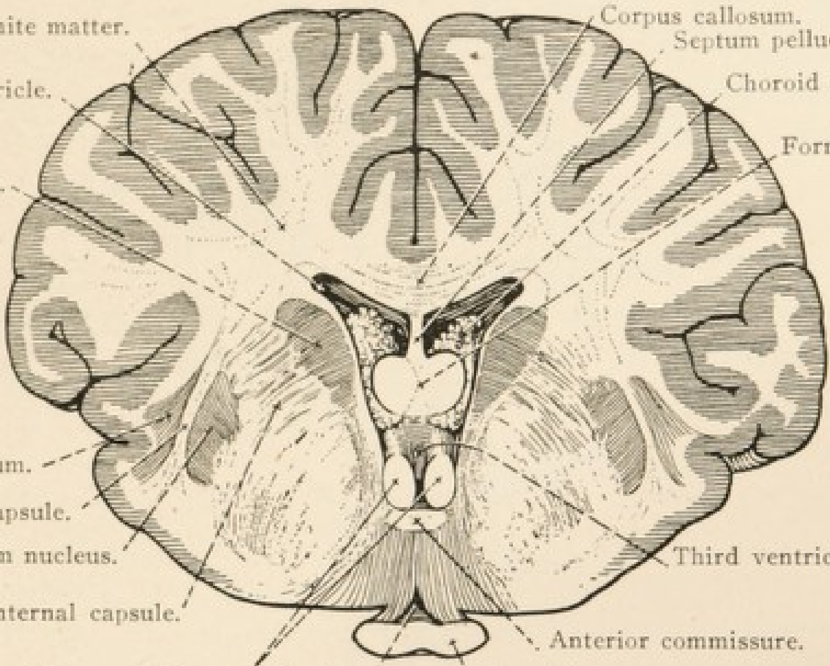


FIG. 93.—Transverse section of the brain at the level indicated by D in Fig. 89 (looking forward).

bodies. It is, indeed, the custom to regard the tract as having two roots—a medial root connected with the medial geniculate body, and a lateral root ending in the thalamus, lateral geniculate body and the anterior colliculus. The fibres of the medial root are commissural, inasmuch as they cross in the optic chiasma and become continuous with the fibres of the medial root of the opposite side of the brain. The fibres of the lateral root, on the other hand, are partly continued into the optic nerve of the same side, and partly cross at the chiasma into the nerve of the opposite side.

The term *hypo-thalamic tegmental region* is applied to that part of the tegmentum of the cerebral peduncle upon which the thalamus rests.

The *mammillary body* (corpus mammillare) is a small but prominent white elevation at the anterior end of the inter-peduncular fossa, and contains a nucleus of grey matter. The columns of the fornix end in it, and from it arise the *fasciculus thalamomammillaris*, which passes to the anterior part of the thalamus, and the *fasciculus*

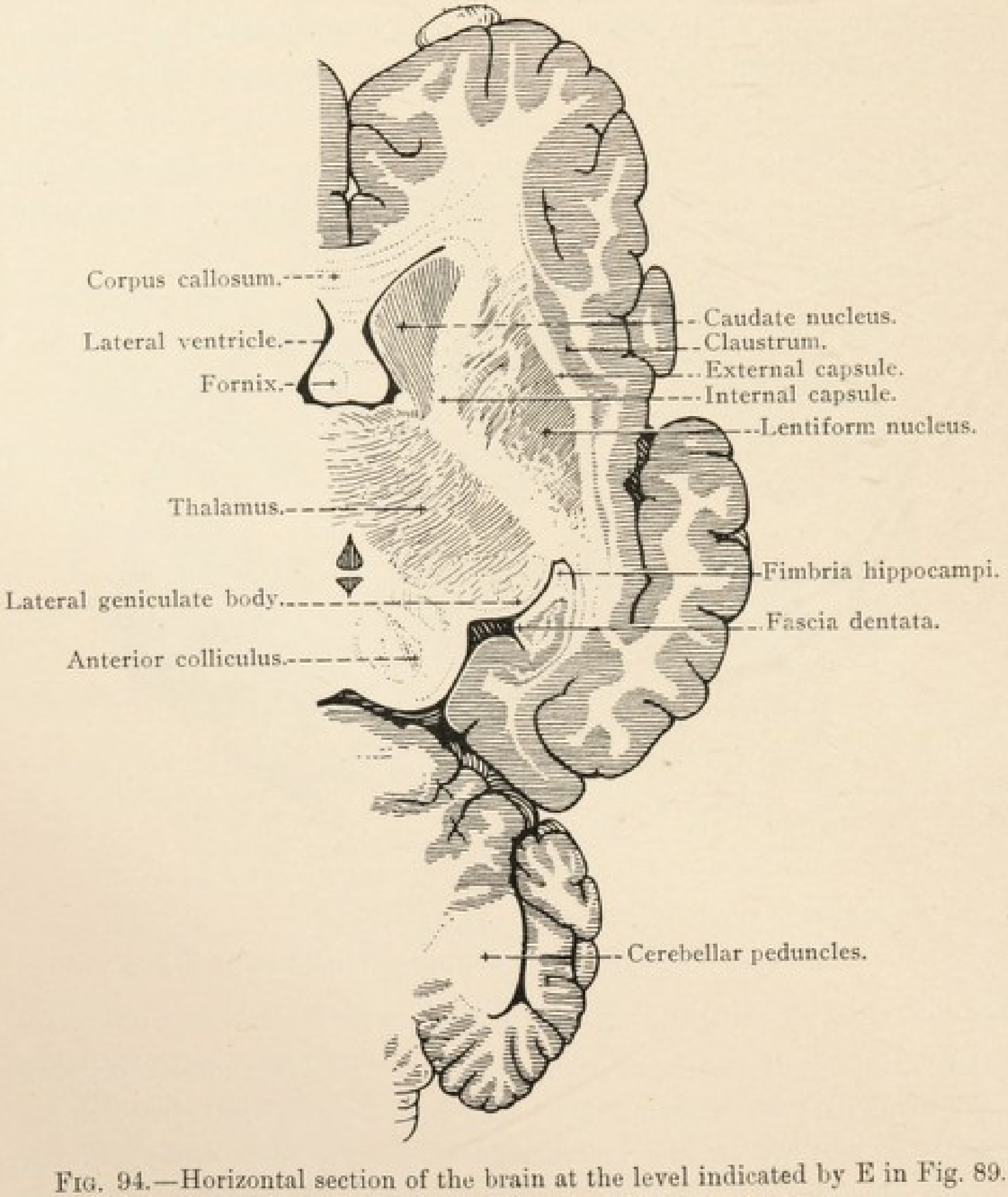


Fig. 94.—Horizontal section of the brain at the level indicated by E in Fig. 89.

pedunculomammillaris that runs along the floor of the third ventricle to the tegmentum.

The *tuber cinereum* is an elevation of grey matter between the mammillary body and the optic chiasma. It is continuous with the lamina terminalis and the anterior perforated substance, and is connected with the hypophysis by a hollow stalk, the *infundibulum*.

The *hypophysis cerebri*, rounded or oval in outline and flattened dorso-ventrally, occupies the sella turcica of the sphenoid bone. It consists of a pale and relatively small central part (homologous with the posterior lobe of the human hypophysis), connected with the brain by the infundibulum, and a much larger and darker glandular part (anterior lobe), developed originally from the upper part of the primitive buccal cavity.

The connections of the *lamina terminalis* have already been noted (page 188).

THE THIRD VENTRICLE (Ventriculus tertius).—The third ventricle is the laterally restricted space between the two thalami. The choroid tela forms its roof, while its floor corresponds to the optic chiasma, tuber cinereum, mammillary body, posterior perforated substance and the tegmenta. Anteriorly the cavity is bounded by the lamina terminalis, the columns of the fornix and the anterior commissure. It communicates with the lateral ventricles through the inter-ventricular foramen of Monro, and posteriorly an *aditus*[1] (aditus ad aquæductum cerebri) gives access to the aqueduct of Sylvius.

The thick intermediate mass, passing across the ventricle from thalamus to thalamus, reduces the cavity to an annular space, the regularity of the contour of which is broken by several recesses. The *recess of the infundibulum* (recessus infundibuli) extends into the hypophysis. The *optic recess* (recessus opticus) is just dorsal to the optic chiasma. In the base of the pineal body is a small *pineal recess* (recessus pinealis), and above it is a much more extensive *suprapineal recess* (recessus suprapinealis).

Associated with the third ventricle are the anterior and posterior commissures. The *anterior commissure* (commissura anterior) is a transverse band of fibres, largely concerned in connecting the olfactory and piriform lobes of opposite sides, readily demonstrable in the hemisected brain, where it appears as a small, oval, white object immediately in front of the columns of the fornix. In the specimen from which the structures overlying the thalami have been removed, a glimpse of the commissure may be obtained between the slightly diverging columns of the fornix. The *posterior commissure* (commissura posterior) consists of a small white strand crossing the brain at the base of the pineal body and dorsal to the entrance to the aqueduct. It is best demonstrated in a median longitudinal section of the brain The connections of its fibres are still obscure.

Dissection.—It is now possible to make a complete examination of the mid-brain. Strip the membranes from the corpora quadrigemina that lie immediately behind the thalami, and from the adjacent part of the cerebellum. Be careful to preserve the small trochlear nerve that

[1] *Aditus* [L.], an approach, an access, an entrance.

lies deep in the depression between the cerebellum and the corpora quadrigemina.

THE MID-BRAIN (Mesencephalon).—The mid-brain is the short and relatively narrow segment joining the pons and cerebellum on the one hand with the cerebrum on the other. It has a dorsal part formed by the *corpora quadrigemina*, and a larger ventral portion consisting of the *cerebral peduncles*. Running through the mid-brain is a constricted passage, the *aquæductus cerebri*, which connects the third and fourth ventricles.

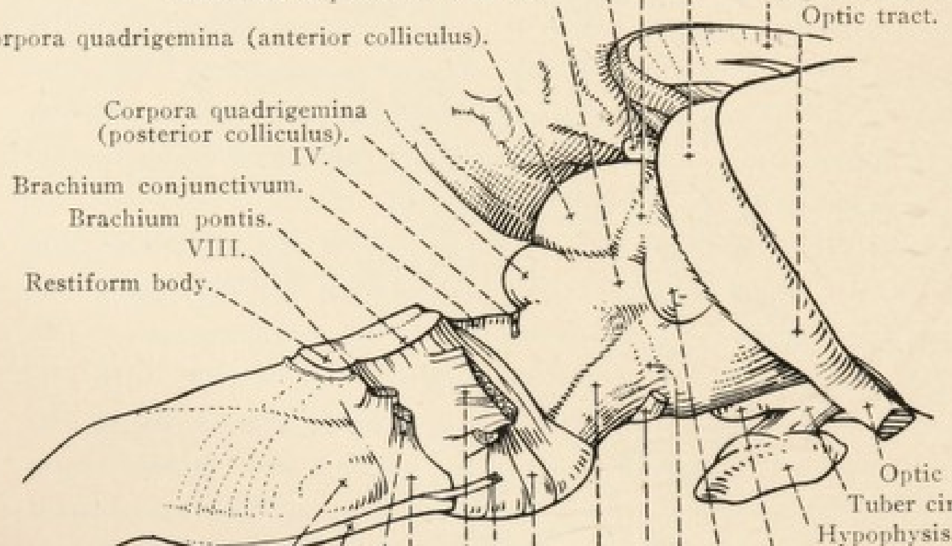


FIG. 95.—Lateral aspect of the hind-brain and mid-brain, after removal of the cerebellum. The Roman numerals apply to cerebral nerves.

Corpora quadrigemina.[1]—In the intact brain these bodies are completely hidden by the cerebral hemispheres, but at the present stage of the dissection they are revealed as four rounded elevations, arranged in pairs, between the thalami and the cerebellum. The anterior elevations (colliculi anteriores) are larger and more clearly defined, and are closer together than the posterior colliculi. The latter are separated from each other by a wide and shallow groove. The two colliculi of the same side are separated by a narrow but not very deep transverse groove. Laterally each colliculus[2] is continued by a

[1] *Corpus* [L.], body. *Quadri* [L.], four + *geminus* [L.], twin.
[2] *Colliculus* (dim. of *collis*) [L.], a mound.

brachium,[1] of which the anterior (brachium quadrigeminum anterius) is scarcely demonstrable, since it becomes buried immediately on leaving the colliculus. The brachium of the posterior colliculus (brachium quadrigeminum posterius), on the contrary, is easily traced as a rounded ridge running in a ventral and anterior direction to disappear under the medial geniculate body.

The *Cerebral Peduncles* (Pedunculi cerebri).—Each cerebral peduncle forms the ventral part of its own half of the mid-brain, and is divisible into two strata—the *tegmentum* [2] and the *basis pedunculi*. Of these, the basis pedunculi is the smaller and the more ventral, and is separated from its fellow by the *interpeduncular fossa* (fossa interpeduncularis) in the posterior part of which (*substantia perforata posterior*) there are numerous small openings for the passage of arteries into the brain tissue. The superficial distinction between the two parts of the peduncle is indicated by two grooves. The *lateral groove* (sulcus lateralis) is visible when the mid-brain is viewed from the lateral aspect, and runs from the pons to the medial geniculate body. The extent of the basis pedunculi in a medial direction is marked by the shallow groove from which the roots of the oculomotor nerve take their superficial origin, the *sulcus nervi oculomotorii*.

An indistinct strip of fibres winds round the cerebral peduncle beginning at the brachium of the anterior colliculus and ending vaguely about the mammillary body. This is the *transverse peduncular fasciculus* (fasciculus peduncularis transversus).

Dissection.—Cut across the mid-brain, making the section through the anterior colliculus, but not so far forward as to injure the geniculate bodies.

An examination of the cut surface of the mid-brain reveals the *aquæductus cerebri* (aqueduct of Sylvius), which represents the cavity of the original embryonic vesicle from which the mid-brain develops, and, in the adult, places the third and fourth ventricles in communication with each other. In general, the outline of the aqueduct in section is lozenge-shaped, and around it is a collection of grey nerve matter from which the fibres of the third and fourth and the mesencephalic motor root of the fifth cerebral nerve take their real origin.

The differentiation of the tegmentum and basis pedunculi can be readily made by an observation of the position of the two grooves already noted on the surface. In addition, a stratum of nerve tissue, the *substantia nigra*, of somewhat darker colour, lies between the two structures.

[1] *Brachium* [L.], βραχίων (brachion) [Gr.], an arm.

[2] *Tegmentum* [L.], a covering.

Dissection.—By a median incision separate the halves of what remains of the cerebrum. Of one half make a series of horizontal sections about four or five millimetres thick. The other half should be cut into similar slices by vertical transverse incisions. In making these sections it is well to use a long, broad-bladed knife or a razor.

THE CORPUS STRIATUM, ETC.—The so-called basal ganglia of the cerebral hemisphere consist of masses of grey matter separated by intervening strata of white matter. The ganglia are the caudate and lentiform nuclei of the corpus striatum, the claustrum and the amygdaloid nucleus.

A partial examination of the *caudate*[1] *nucleus* (nucleus caudatus) was made after the lateral ventricle had been opened (page 189). The nucleus consists of a mass of grey matter of curved, pear-shaped form, with a *head* (caput nuclei caudati) that is thick and forms a projection in the anterior part of the ventricle. From the head the nucleus tapers somewhat rapidly to a *tail* (cauda nuclei caudati) that follows the inferior cornu of the ventricle to end in the *amygdaloid*[2] *nucleus* (nucleus amygdalæ) in the roof of the extremity of the cornu. From what has been seen, and from the sections now under examination, it is manifest that the caudate nucleus may be described as having two surfaces. A free ventricular surface is covered by the ependyma of the ventricle. A deeper face is embedded in the substance of the cerebral hemisphere, and is mainly in contact with the internal capsule.

The *lentiform nucleus*[3] (nucleus lentiformis) is an irregularly lens-shaped mass of grey matter placed lateral and ventral to the caudate nucleus and the thalamus. Smaller than the caudate nucleus, it is connected with it by strands of grey matter that cross the intervening white stratum. In addition, the two nuclei are continuous with each other and with the grey matter of the surface of the hemisphere at the olfactory tubercle.

The *claustrum*[4] is a thin layer of grey matter lateral to the corpus striatum and very nearly co-extensive with the insula, that is, with the convolutions hidden in the Sylvian fissure.

The term *internal capsule* (capsula interna) is applied to the white matter separating the caudate nucleus and the thalamus on the one side from the lentiform nucleus on the other. The continuity of the capsule is much interfered with anteriorly by the grey strands that cross from one nucleus to the other. In horizontal sections, the capsule is bent opposite the stria terminalis at what is known as

[1] *Cauda* [L.], a tail.
[2] ἀμυγδαλοειδής (amygdalœides) [Gr.], like the almond.
[3] *Lens* [L.], a lentil, lens. *Forma* [L.], form. *Nucleus* [L.], a kernel, a nut.
[4] *Claustra* [L.], a barrier, a barricade, a bulwark.

the *genu* (genu capsulæ internæ). The limb in front of the genu may be named the *frontal part* (pars frontalis capsulæ internæ), and the limb behind the genu the *occipital part* of the capsule (pars occipitalis capsulæ internæ).

The internal capsule is of great importance since it contains fibres derived from or passing to various parts of the cerebral cortex. The

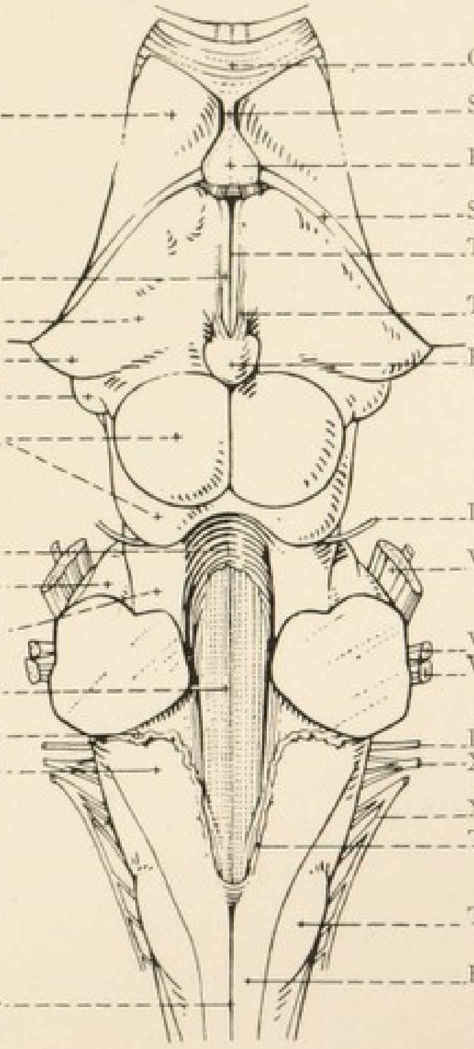


FIG. 96.—Dorsal aspect of the hind- and mid-brain and thalami. The cerebellum has been removed. The Roman numerals refer to cerebral nerves.

divergence of the fibres dorsal to the capsule forms the *corona radiata*[1]: below the capsule the fibres are continued into the basis pedunculi.

The so-called *external capsule* (capsula externa) is the layer of white matter between the lentiform nucleus and the claustrum.

Dissection.—If this has not already been done, the pia-arachnoid must be removed from the surface of the hind-brain. The membrane must *not* be disturbed where it lies between the medulla oblongata and the cere-

[1] *Corona* [L.], a crown. *Radiatus* [L.], irradiated, furnished with rays, like a wheel with spokes.

bellum, nor in the neighbourhood of the choroid plexuses of the fourth ventricle, vascular fringes that project from the groove between the medulla oblongata and the cerebellum immediately behind the pons.

The HIND-BRAIN (Rhombencephalon).—The hind-brain consists of the medulla oblongata, the pons and the cerebellum.

Medulla oblongata.—The spinal cord and the medulla oblongata are directly continuous with each other, and when the brain and cord have been removed from the cranium and the vertebral canal, it is impossible to set a precise limit to the two structures. For descriptive purposes, however, the medulla is held to extend from the level of the foramen magnum to the pons. At first it has the same general form as the spinal cord, but soon it becomes dorso-ventrally flattened and expanded laterally; a change of form associated with the opening out of the central canal into the fourth ventricle.

The bilateral character of the medulla oblongata is made manifest on the surface by the presence of ventral and dorsal median fissures, continuous with corresponding landmarks on the spinal cord. While the *ventral median fissure* (fissura mediana ventralis) can be traced as far as the pons, where it ends abruptly at the *foramen cæcum*, its depth is not uniform throughout. Near the posterior end of the medulla numerous fibres pass from one side to the other (the decussation of the pyramids) and cause the fissure to be very shallow in this region. The *dorsal median fissure* (fissura mediana dorsalis) is not so extensive. It is continued only to the extremity of the fourth ventricle, where it apparently widens out in conformity with the lateral divergence of the two halves of the dorsal portion of the medulla oblongata.

Along each side of the ventral median fissure is a very definite strand of nerve fibres known as the *pyramid* of the medulla oblongata (pyramis medullæ oblongatæ). Followed towards the cerebrum, the pyramid disappears beneath the pons. The fibres composing it are derived from nerve cells in the grey matter of that part of the cerebral cortex that lies in neighbourhood of the cruciate sulcus. From their origin these fibres, which are motor in function, pass by way of the corona radiata and internal capsule into the basis pedunculi and so through the pons into the medulla oblongata, where, close to the foramen magnum, they cross over from one side to the other (decussatio pyramidum) to travel along the crossed pyramidal tract of the opposite half of the spinal cord.

Lateral to the pyramid is a groove, of no great depth, from which the rootlets of the abducent and hypoglossal nerves arise. The groove separates the pyramid from an elevation known as the *facial tubercle* (tuberculum faciale). In the adult the tubercle is not very conspicuous, because its surface is crossed by the *external arcuate fibres* (fibræ arcuatæ externæ) that traverse the lateral border of the medulla oblongata obliquely. Behind the facial tubercle the medulla resembles the lateral part of the spinal cord, and to the naked eye it appears as if the lateral columns of the cord were merely prolonged into the medulla. This appearance, however, is contrary to fact; for the lateral column of the cord contains fibres not present in a similar position in the medulla (*e.g.* the crossed pyramidal tract).

On each side of the dorsal median fissure there is a very conspicuous *funiculus cuneatus*,[1] continuous with the like-named fasciculus of the spinal cord. At the posterior end of the fourth ventricle the funiculus diverges from the middle line, and appears to join the restiform body. In reality, however, it ends at what is often called the *cuneate tubercle*, though it is generally quite impossible to detect any specific elevation that would justify the use of the term. By the divergence of the cuneate funicles a glimpse of the *clava*[2] is usually permitted. This is the termination of the *funiculus gracilis*[3] that is not elsewhere visible on the surface of the medulla, because the fasciculus gracilis of the spinal cord, of which it is the continuation, disappeared from the surface at the second cervical segment. The "cuneate tubercle" and the clava contain collections of nerve cells (nucleus funiculi cuneati: nucleus funiculi gracilis).

Immediately behind the level of the posterior end of the ventricle, and lateral to the funiculus cuneatus, there is an elevation to which the name of *tuberculum cinereum* is given. This is associated with the *tractus spinalis nervi trigemini* that begins to form a low ridge on the spinal cord at the second cervical segment. The tract gradually increases in width as it is followed forwards into the medulla, and is produced by an enlargement of the substantia gelatinosa covered by the spinal root of the trigeminal nerve.

The *restiform*[4] *body* (corpus restiforme) is a thick strand that, after forming the floor of the lateral recess of the fourth ventricle, turns abruptly dorsalwards and enters the hemisphere of the cerebellum. It will be observed that the external arcuate fibres enter largely into its formation.

The Pons.—The pons is a transverse prominence between the medulla oblongata and the cerebral peduncles. Its ventral surface is convex from side to side with a very shallow antero-posterior groove (sulcus basilaris) in the middle line. The dorsal surface assists in the

[1] *Cuneatus* [L.], wedge-shaped.

[2] *Clava* [L.], a knotted branch, a club. [3] *Gracilis* [L.], thin, slender.

[4] *Restis* [L.], a rope or cord. *Forma* [L.], form.

formation of the floor of the fourth ventricle, and will be examined later. On each side the pons is associated with the superficial origin of the trigeminal nerve, and beyond this is continued into the cerebellum as the *brachium pontis.*

A superficial examination of the pons suffices to show that it is composed largely of transverse fibres. The greater part of these are superficial to the pyramids ; but some cross the dorsal aspect of these bundles and, since they are more posterior than the superficial fibres, form an elongated transverse area, the *trapezoid body* (corpus trapezoideum), on the surface of the brain. From the lateral part of this body the facial and acoustic nerves have their superficial origin.

Dissection.—With a very little dissection the course of the pyramids through the pons can be demonstrated. Make a longitudinal incision across the middle of the pons, and a similar incision just medial to the origin of the trigeminal nerve. Then, with a pair of forceps, tear away the superficial transverse fibres of the pons until the pyramid is exposed. In this way the continuity of the pyramid with the basis pedunculi can be determined.

The Cerebellum.—The cerebellum, a transversely elongated rounded mass, forms the dorsal and more bulky part of the hind-brain. For descriptive purposes three parts may be distinguished—namely, a central vermis and two hemispheres. The *vermis* is the most prominent part of the organ, and projects beyond the level of the hemispheres as a rounded ridge, more sharply defined in its posterior and ventral parts than elsewhere. The *hemisphere,* lateral in position, is narrow anteriorly but rapidly widens as it is followed backwards. Since the restiform body, the brachium pontis and the brachium conjunctivum—generally designated collectively the *cerebellar peduncles*—are connected with the hemisphere and not with the vermis, it is clear that the only mode of access of fibres to the cerebellum is through the hemisphere. The restiform body and the brachium pontis have been noted in connection with the medulla oblongata and the pons respectively. The whole of the *brachium conjunctivum*[1] cannot be seen at present, but a glimpse of it may be obtained between the brachium pontis and the posterior colliculus of the corpora quadrigemina.

The surface of the cerebellum is beset with narrow ridges or *folia,* separated by *fissures.* Deeper fissures cut the organ into *lobes,* which can be more easily studied in sections, as will be done presently. It should be observed, however, that the most lateral part of the hemisphere is isolated from the rest by a fissure running in a sagittal direction. The portion so defined is composed of the paraflocculus and flocculus.

[1] *Conjunctio* [L.], a joining together, a union.

The *paraflocculus*[1] consists of a double row of folia, and into the depths of the fissure separating it from the main mass of the hemisphere the brachium pontis disappears. Between the paraflocculus and the origins of the facial and acoustic nerves is the *flocculus*, a small collection of folia separated from the paraflocculus by a fissure of some depth.

Dissection.—Make a median sagittal section through the vermis of the cerebellum and the two medullary vela (thin membranous structures forming the roof of the fourth ventricle). By separating the two halves of the cerebellum a view of the floor of the ventricle may be obtained. The cut surface of the vermis should be examined, and the arrangement of the lobes and fissures noted.

A sagittal section of the vermis of the cerebellum reveals in a very striking manner the peculiar arrangement of grey and white matter. The grey matter forms a continuous layer on the surface of the organ, while the white matter within, as a consequence of the presence of numerous fissures, presents a tree-like appearance in section, and therefore goes by the name of *arbor vitæ*.[2] From the central mass of white matter (corpus medullare) various branches (laminæ medullares) radiate. Of these, two are conspicuously large and form the core of the two largest lobes separated by the deepest of the cerebellar fissures.

Two of the connections of the cerebellum—namely, the restiform body and the brachium pontis, have previously been examined, but up to the present, the third connection—the *brachium conjunctivum*—could not be seen in its whole length. If now the two halves of the cerebellum be separated as much as possible, the brachium will be disclosed at its connection with the hemisphere immediately within the brachium pontis. Followed towards the mid-brain, each brachium runs in a slightly medial direction to disappear under the posterior colliculus of the corpora quadrigemina. At the point of their disappearance, the superficial origins of the trochlear nerves should be noted.

Ventral to the cerebellum, and connected round the ends of the vermis with the white matter of this organ, are two thin, nervous membranes that form the greater part of the roof of the fourth ventricle. The *anterior medullary velum*[3] (velum medullare anterius) is a triangular membrane that fills the gap between the two brachia conjunctiva. The base of the triangle bends round the end of the vermis and is continuous with its white core. The *posterior medullary velum* (velum medullare posterius) is somewhat more complicated. Its cerebellar connection stretches from the median plane—where it has

[1] παρά (para) [Gr.], beside. *Flocculus* (dim. of *floccus*) [L.], a little tuft or flock of wool.

[2] *Arbor* [L.], a tree. *Vita* [L.], life.

[3] *Velum* [L.], a covering, an awning, a veil.

a continuity with the white matter of the vermis comparable to that of the anterior velum—to the flocculus. The velum, however, soon loses its nervous elements and gives place to a very thin translucent membrane composed of pia mater lined with ependyma. This completes the posterior part of the roof of the ventricle, and is attached to the margins of this cavity.

The Fourth Ventricle (Ventriculus quartus).—The fourth ventricle represents the cavity of the original vesicle from which the hind-brain developed. Consequently it is in communication with the central canal of the spinal cord at one end and with the cavity of the mid-brain (aquæductus cerebri) at the other. The opening of the central canal into the ventricle has already been commented upon; and, if the anterior medullary velum be raised, the communication with the aqueduct—and, through this with the third ventricle—will be revealed.

In outline the cavity is rhomboidal; hence the name *fossa rhomboidea* [1] as applied to its floor. From the narrow posterior end—*calamus scriptorius* [2]—it widens to the level of the place where the restiform bodies turn up into the cerebellum. Here the transverse diameter is materially increased by the presence of *lateral recesses* (recessus laterales), which curve round the posterior aspect of the restiform bodies. In front of the recesses the ventricle narrows to the entrance of the aqueduct of the mid-brain.

The roof or dorsal boundary of the ventricle is formed by the two medullary vela and the thin pial continuation of the posterior velum. Seen in sagittal section, it is somewhat tent-like, being prolonged into a recess between the vermis attachments of the two vela. The roof, moreover, is rendered irregular on a level with the lateral recesses by an invagination produced by the *choroid plexus* (plexus chorioideus ventriculi quarti) of the *choroid tela* [3] (tela chorioidea ventriculi quarti) of pia mater. That part of the plexus that is related to the lateral recess is conspicuous in the intact brain as a vascular tuft occupying an angular depression formed by the cerebellum and the medulla oblongata.

The membranous roof is defective at the extremity of the lateral recess, where a small, irregular opening, the *lateral aperture* (apertura lateralis ventriculi quarti), places the cavity of the ventricle in communication with the subarachnoid space. At the extreme posterior end of the ventricle the roof forms a small blind recess that overlies the entrance to the central canal of the spinal cord.

[1] *Fossa* [L.], a ditch, a trench, a fosse. ῥομβοειδής (rhombœides) [Gr.], shaped like a rhomb.

[2] *Calamus* [L.], a reed, a reed-pen. *Scriptor* [L.], a writer.

[3] *Tela* [L.], a web.

The floor of the ventricle is formed by the medulla oblongata and the pons. Divided into two lateral halves by a median longitudinal groove, the floor is further subdivided into areas. A longitudinal *limiting groove* (sulcus limitans) forms the lateral boundary of an elongated medial area. The limiting groove is shallow, but becomes a little deeper at the *anterior fovea* [1] in the anterior half of the ventricle. The elongated and slightly raised and rounded ridge between the median and limiting grooves is the *medial eminence* (eminentia medialis), which is most prominent on a level with the anterior fovea, where it forms the *colliculus facialis*, so named from its association with part of the root of the facial nerve.

In the posterior part of the ventricle the limiting groove divides at what is the equivalent to the *posterior fovea* of the human brain. Thus the floor in this region is divided into three areas. (1) The *hypoglossal trigone* (trigonum nervi hypoglossi) is the area between the fovea and the median groove, and overlies the nucleus of the hypoglossal nerve. (2) The *ala cinerea*, a triangular area between the two diverging limbs of the limiting groove, is associated with the nucleus of the glosso-pharyngeal and vagus nerves. (3) Lateral to the limiting groove is the *acoustic area* (area acustica), which is continued into the floor of the lateral recess of the ventricle.

[1] *Fovea* [L.], a small pit.

Cerebral Nerves and their Branches.

Nerve	Division	Foramen of Exit from Cranium.	Branches.		
1st. N. olfactorius		Ethmoidal.			
2nd. N. opticus		Optic.			
3rd. N. oculomotorius		Orbital fissure	Ramus superior.		
			Ramus inferior.		
4th. N. trochlearis		Trochlear.			
5th. N. trigeminus	N. ophthalmicus	Orbital fissure	N. lacrimalis.—Ramus zygomaticotemporalis.		
			N. frontalis.		
			N. nasociliaris	N. ethmoidalis.	
				N. infratrochlearis.	
				Radix longa to ciliary ganglion.	
	N. maxillaris	Foramen rotundum	N. zygomaticus.		
			N. sphenopalatinus	N. nasalis posterior.	
				N. palatinus major.	
				N. palatinus minor.	
			N. infraorbitalis	Rami alveolares superiores.	
				Ramus nasalis externus.	
				Ramus nasalis anterior.	
				Ramus labialis superior.	
	N. mandibularis	Foramen ovale	N. massetericus.		
			Nn. temporales profundi.		
			N. buccinatorius.		
			N. pterygoideus.		
			N. temporalis superficialis	Rami parotidei.	
				Rami auriculares.	
				Ramus transversus faciei.	
			N. alveolaris inferior.	N. mylohyoideus.	
				N. mentalis.	
			N. lingualis	Ramus superficialis.	
				Ramus profundus.	
6th. N. abducens		Orbital fissure.			

7th. N. facialis	Facial canal (stylomastoid foramen)	N. petrosus superficialis major.	
		Ramus anastomoticus to tympanic plexus.	
		N. stapedius.	
		Chorda tympani.	
		Ramus anastomoticus with auricular branch of the vagus.	
		N. auricularis posterior.	
		N. auricularis internus.	
		N. digastricus.	
		N. auriculopalpebralis.—Nn. auriculares anteriores.	
		Ramus colli.	
		Ramus parotidea.	
		N. buccalis superior.	
		N. buccalis inferior.	
8th. N. acusticus	Internal acoustic meatus	N. vestibuli.	
		N. cochleæ.	
9th. N. glossopharyngeus	Jugular foramen	N. tympanicus.	
		Rami to pharyngeal plexus.	
		Ramus pharyngeus.	
		Ramus lingualis.	
10th. N. vagus	Jugular foramen	Ramus auricularis.	
		Ramus pharyngeus.	
		N. laryngeus cranialis.	
		N. recurrens	Rami cardiaci.
			Rami tracheales.
			Rami œsophagei.
			N. laryngeus caudalis.
		Rami cardiaci.	
		Rami tracheales.	
		Rami œsophagei.	
		Rami bronchiales.	
		Ramus dorsalis.	Truncus œsophageus dorsalis.
		Ramus ventralis	Truncus œsophageus ventralis.
11th. N. accessorius	Jugular foramen	Ramus dorsalis.	
		Ramus ventralis.	
12th. N. hypoglossus	Hypoglossal foramen.		

ARTERIES OF THE HEAD AND NECK.

A. CAROTIS COMMUNIS.

- Rami musculares.
- Rami tracheales.
- Rami œsophagei.
- Rami lymphoglandulares.
- A. parotidea.
- A. thyreoidea cranialis
  - A. laryngea.
  - A. pharyngea ascendens.
- *A. carotis externa*
  - A. glandulæ submaxillaris media.
  - A. masseterica
  - A. maxillaris externa
    - A. palatina ascendens.
    - A. lingualis.—A. profunda linguæ.
    - Aa. glandulæ submaxillaris inferiores.
    - Rami musculares.
    - A. subligualis.—A. submentalis.
    - A. facialis,
      - Rami musculares.
      - Rami cutanei.
      - A. labialis inferior.—A. angularis oris.
      - A. labialis superior.
      - A. lateralis nasi.
      - A. dorsalis nasi.
      - A. angularis oculi.
  - A. auricularis posterior
    - Ramus intermedius.
    - Ramus medialis.
    - Ramus lateralis.
    - A. auricularis profunda.—A. stylomastoidea.
  - A. temporalis superficialis
    - A. auricularis anterior.
    - A. transversus faciei.
  - *A. maxillaris interna*
    - A. alveolaris inferior.—A. mentalis.
    - Rami pterygoidei.
    - A. tympanica.
    - A. meningea media.
    - A. temporalis profunda posterior.
    - A. temporalis profunda anterior.
    - A. ophthalmica
      - A. supraorbitalis.
      - A. lacrimalis.
      - Rami musculares.
      - Aa. ciliares anteriores.
      - Aa. ciliares posteriores.
      - A. centralis retinæ.
      - A. ethmoidalis.
    - A. buccinatoria.
    - A. infraorbitalis
      - A. malaris.
      - Aa. alveolares posteriores.
      - Aa. alveolares anteriores.
    - A. palatina minor.
    - A. sphenopalatina.
    - *A. palatina major.—A. nasolabialis.*
- A. carotis interna
  - A. communicans posterior.—A cerebri profunda.
  - A. cerebri anterior.—A. meningea anterior.
  - A. cerebri media.
  - A. chorioidea.
- A. occipitalis
  - A. glandulæ submaxillaris superior.
  - A. condyloidea.
  - A. meningea posterior.
  - Ramus descendens.
  - Ramus occipitalis.—A. cerebrospinalis
    - A. basilaris cerebri
      - Rami medullares.
      - Aa. cerebelli posteriores.
      - Aa. auditivæ internæ.
      - Aa. cerebelli anteriores.
      - Aa. cerebri posteriores.
    - A. spinalis ventralis.

Nerve and Blood Supply of the Muscles of the Head and Neck.

Nerve Supply.		*Blood Supply.*
Accessory, cervical and axillary	M. brachiocephalicus.	Ascending cervical, common carotid and vertebral.
Accessory	M. sternocephalicus.	Common carotid.
	M. trapezius (cervicalis).	Deep cervical.
6th cervical	M. rhomboideus (cervicalis).	Deep cervical.
1st cervical	M. sternohyoideus.	Common carotid.
	M. thyreohyoideus.	
	M. omohyoideus.	Ascending cervical, common carotid.
Cervical (4-8)	M. scalenus.	Common carotid, ascending cervical and vertebral.
Cervical (3-8)	M. splenius.	Deep cervical and transverse artery of the neck.
	M. longissimus cervicis.	Vertebral.
	M. longissimus atlantis.	Deep cervical and vertebral.
	M. longissimus capitis.	
	M. semispinalis capitis.	Deep cervical, vertebral and occipital.
	M. multifidus cervicis.	Deep cervical and vertebral.
Cervical	Mm. intertransversarii cervicis.	Vertebral.
	M. longus capitis.	Common carotid, vertebral and occipital.
Cervical and thoracic	M. spinalis cervicis.	Deep cervical and transverse artery of the neck.
	M. longus colli.	Supreme intercostal and vertebral.

NERVE AND BLOOD SUPPLY OF THE MUSCLES OF THE HEAD AND NECK—*continued.*

Nerve Supply.		*Blood Supply.*
1st cervical	M. rectus capitis ventralis. M. rectus capitis lateralis. M. obliquus capitis cranialis. M. rectus capitis dorsalis major. M. rectus capitis dorsalis minor.	Occipital.
2nd cervical	M. obliquus capitis caudalis.	Occipital and vertebral.
Facial and 1st and 2nd cervical	M. auricularis inferior. Mm. auriculares anteriores. Mm. auriculares superiores. Mm. auriculares posteriores. Mm. auriculares profundi.	Anterior and posterior auricular and occipital.
Facial	M. risorius.	Inferior labial and angular of the mouth.
	M. orbicularis oris.	Naso-labial, superior and inferior labial, and mental.
	M. nasolabialis.	Superior labial, lateral and dorsal nasal.
	M. zygomaticus.	Superior labial and angular of the mouth.
	M. levator labii superioris proprius.	Facial and lateral and dorsal nasal.
	M. incisivus superior.	Superior labial.
	M. incisivus inferior.	Inferior labial.
	M. depressor labii inferioris.	Inferior labial.
	M. buccinator.	Facial, superior and inferior labial, and buccinator.
	M. caninus.	Superior labial and lateral nasal.
	M. dilator naris transversus.	Naso-labial.
	M. dilator naris superior.	Lateral nasal.
	M. dilator naris inferior.	Superior labial and lateral nasal.
	M. orbicularis oculi. M. corrugator supercilii. M. malaris.	Transverse facial, supraorbital, malar and angular of the eye.

NERVE AND BLOOD SUPPLY OF THE MUSCLES OF THE HEAD AND NECK—*continued.*

Nerve Supply.		*Blood Supply.*
Oculomotor	M. levator palpebræ superioris. M. rectus superior. M. rectus inferior. M. rectus medialis. M. obliquus inferior.	Ophthalmic.
Trochlear	M. obliquus superior.	
Abducent	M. rectus lateralis. M. retractor oculi.	
Trigeminal	M. masseter.	Masseteric and transverse facial.
	M. temporalis.	Deep temporal, superficial temporal and posterior meningeal.
	M. pterygoideus internus.	Internal maxillary, inferior alveolar and masseteric.
	M. pterygoideus externus.	Internal maxillary and inferior alveolar.
	M. mylohyoideus. M. myloglossus.	Sublingual.
Trigeminal and facial	M. digastricus.	External carotid and sublingual.
Facial	M. jugulomandibularis.	External carotid.
	M. jugulohyoideus.	Occipital.
	M. stylohyoideus.	External carotid.
Glossopharyngeal	M. keratohyoideus. M. hyoideus transversus.	Lingual.
Hypoglossal	M. geniohyoideus. M. styloglossus. M. hyoglossus. M. genioglossus.	Lingual and sublingual.
Trigeminal (through otic ganglion)	M. tensor veli palatini.	Internal maxillary and ascending palatine.
Accessory (through pharyngeal plexus)	M. levator veli palatini. M. uvulæ.	

NERVE AND BLOOD SUPPLY OF THE MUSCLES OF THE HEAD AND NECK—*continued.*

Nerve Supply.		*Blood Supply.*
Glossopharyngeal .	M. stylopharyngeus.	External carotid, external maxillary, laryngeal and ascending pharyngeal.
Accessory (through pharyngeal plexus) .	M. palatopharyngeus. M. pterygopharyngeus. M. keratopharyngeus. M. chondropharyngeus. M. thyreopharyngeus.	
Vagus (cranial laryngeal)	M. cricopharyngeus. M. cricothyreoideus.	
Vagus (recurrent) .	M. cricoarytænoideus dorsalis. M. cricoarytænoideus lateralis. M. arytænoideus transversus. M. vocalis. M. ventricularis.	Laryngeal.

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