NOTES ON THE

LARYNX AND BRAIN

BY

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PREFACE.

These notes are intended to give the anatomy of the brain and larynx as given in the lectures of Dr. Huntington, the demonstration of Dr. Gallaudet and Dr. Sands. The Brain Anatomy of Gray is not always good and the recent book of Quain on the Brain is too minute and complicated for every student to work out. These notes are based upon demonstrations and upon Quain's recent Anatomy of the Brain, and are meant to include the important parts.

H. J. W.

LARYNX.

The **Larynx** is the organ of voice placed at the upper part of the air passages and situated in the upper median neck region. It is composed of cartilages connected by ligaments and moved by intrinsic muscles.

The **Cartilages** are the thyroid, cricoid, epiglottis, arytenoid, cornicula laryngis and cuneiform.

The **Thyroid** is the largest cartilage of the larynx and gives to it general shape. It consists of two quadrangular lamellae of cartilage placed vertically, united at an acute angle in front, and forming the vertical projection of Adam's apple. The **outer surface** of each lamella presents an oblique ridge running from a tubercle in front of the root of the superior cornu downward and forward to another tubercle on the inferior border. This ridge gives attachment to thyro-hyoid and sterno-thyroid muscles; the area posterior to the ridge gives attachment to a part of the inferior constrictor muscle. The **inner surface** is smooth, concave and gives attachment in the angle to epiglottis, true and false cords, thyro-arytenoid muscles and crico-thyroid membrane. The **upper border** of the thyroid cartilage is notched in the middle line, the incisura. It gives attachment throughout its whole extent to the thyro-hyoid **membrane.** The **lower border** presents the above named tubercle, which marks the division line between the straight and oblique parts of the crico-thyroid muscle. The crico-thyroid membrane does not attach to the lower border but to the inner surface at the anterior angle of the cartilage alone. The **posterior border** is thick and terminates above and below in cornua. The **superior cornua** are long, narrow processes directed upward, backward and inward, which give attachment at their extremities to the lateral thyro-hyoid ligaments. The **inferior cornua**, short and thick, are directed downward, forward

and inward, and present on their inner surfaces oval facets for articulation with the tubercles of the cricoid cartilage. The posterior border receives the insertion of the stylo-pharyngeus and palato-pharyngeus muscles.

The **cricoid cartilage** forms the lower and back part of the framework of the larynx. The cartilage may be divided into a posterior lamina and anterior ring portion with the articular tubercles on the side to mark the dividing line. The **lamina** is quite large and forms a posterior wall to the cavity. Its posterior surface is divided by a vertical ridge, the **linea eminens,** into two broad depressions, the **foveæ,** for the attachment of the crico-arytenoideus posticus muscles. Its upper border is surmounted on either side by an oval articular facet for the arytenoid cartilages. Between the facets is a slight notch giving attachment to a part of the arytenoideus muscle. The **anterior ring portion** is narrow, convex, smooth and gives attachment superiorly to crico-thyroid membrane, externally to the crico-thyroid and inferior constrictor muscles. The lower border of the two portions of the cartilage are in one horizontal plane and connected to the upper ring of the trachea by fibrous membrane, while the upper border is in a much higher plane behind than in front.

The **arytenoids** (pitcher-shaped) are two pyramidal cartilages resting on the superior border of the lamina of the cricoid. Their structure is hyaline cartilage with a point of fibro-cartilage which is not to be confused with the cartilage of Santorini. Each cartilage presents three surfaces, a base and an apex. The **antero-external** surface is convex, rough and gives attachment to the internal thyro-arytenoid muscle. In the middle of this surface is a triangular depression to which the false vocal cords are attached. Above and below this fossa are the superior and inferior tubercles. The **posterior surface** is concave for the attachment of the arytenoideus muscle. The **internal surface** is narrow, plane and

covered with mucous membrane. The **base** is broad and presents a concave articular surface which rests on the cricoid. Its external angle or **muscular process** is rounded, prominent and extends outward and backward. It received the insertion of the external thyro-arytenoid, the posterior and lateral crico-arytenoid muscles. The anterior angle or **vocal process** extends directly forward as a prominent pointed process which gives attachment to the **internal thyro-arytenoid** muscle and **true vocal cords**. The **apex** of the arytenoid is pointed, directed backward and inward and surmounted by the cartilage of Santorini.

The **Cartilages of Santorini**, or cornicula laryngis, prolong the arytenoid cartilages backward, inward and downward as conical fibro-cartilaginous nodules. They are attached to the arytenoid by fibrous tissue, rarely by an articulation.

The **Cartilages of Wrisberg** or the cuneiform are small, club-shaped nodules of cartilage, which extend obliquely downward and forward in the posterior part of the aryteno-epiglottidean fold. They are roughly parallel to the arytenoid and the large, blunt end forms above the nodule seen in the edge of the fold.

The **epiglottis** is a leaf-shaped lamella of fibro-cartilage attached by its long, narrow stalk to the receding angle of the thyroid cartilage just below the incisura. Its upper broad portion is unattached and free to close or open the superior aperture of the larynx. The **anterior surface** is curved forward toward the tongue. The reflection of mucous membrane from it to the tongue gives rise to a median and two lateral folds, the **glosso-epiglottidean ligaments** and two depressions or **valleculae** between them. The **posterior surface** is concave from side to side, convex from above downward, and studded by a number of pits for the lodgment of mucous glands. The **tubercle** is a projection on

the lower part of its posterior surface made by a pad of fat anterior to the cartilage.

The **ligaments** connecting the larynx with the hyoid bone are the thyro-hyoid membrane, the middle and two lateral thyro-hyoid ligaments and the hyo-epiglottic ligament.

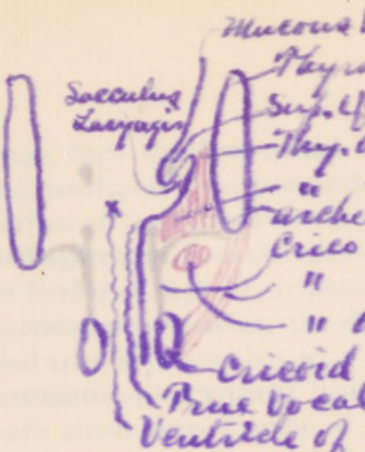
The **thyro-hyoid** membrane is a double layer of membranous tissue extending from the upper border of the thyroid cartilage below to the hyoid bone above. The external layer of this membrane is thickened cervical fascia and the internal is the mucous membrane lining the pharynx.

The **lateral thyro-hyoid** ligaments are rounded cords passing from the superior cornua of the thyroid to the apices of the greater cornua of the hyoid bone. They are included **between** the layers of thyro-hyoid membrane and are not thickened portions of it. The **cartilago triticea** is a small cartilaginous nodule that frequently forms in some part of this ligament.

The **middle thyro-hyoid ligament** is a very thick band which is attached below to the median notch in the superior border of the thyroid. It passes up behind the body of the hyoid bone, separated from it by a bursa, and attaches to the upper margin of its posterior surface. Posterior to the ligament is a fatty pad which separates it from the epiglottis and gives rise to the tubercle of the latter.

The **hyo-epiglottic** ligament is a fibrous band extending from the anterior surface of the epiglottis to the upper border of the body of the hyoid bone.

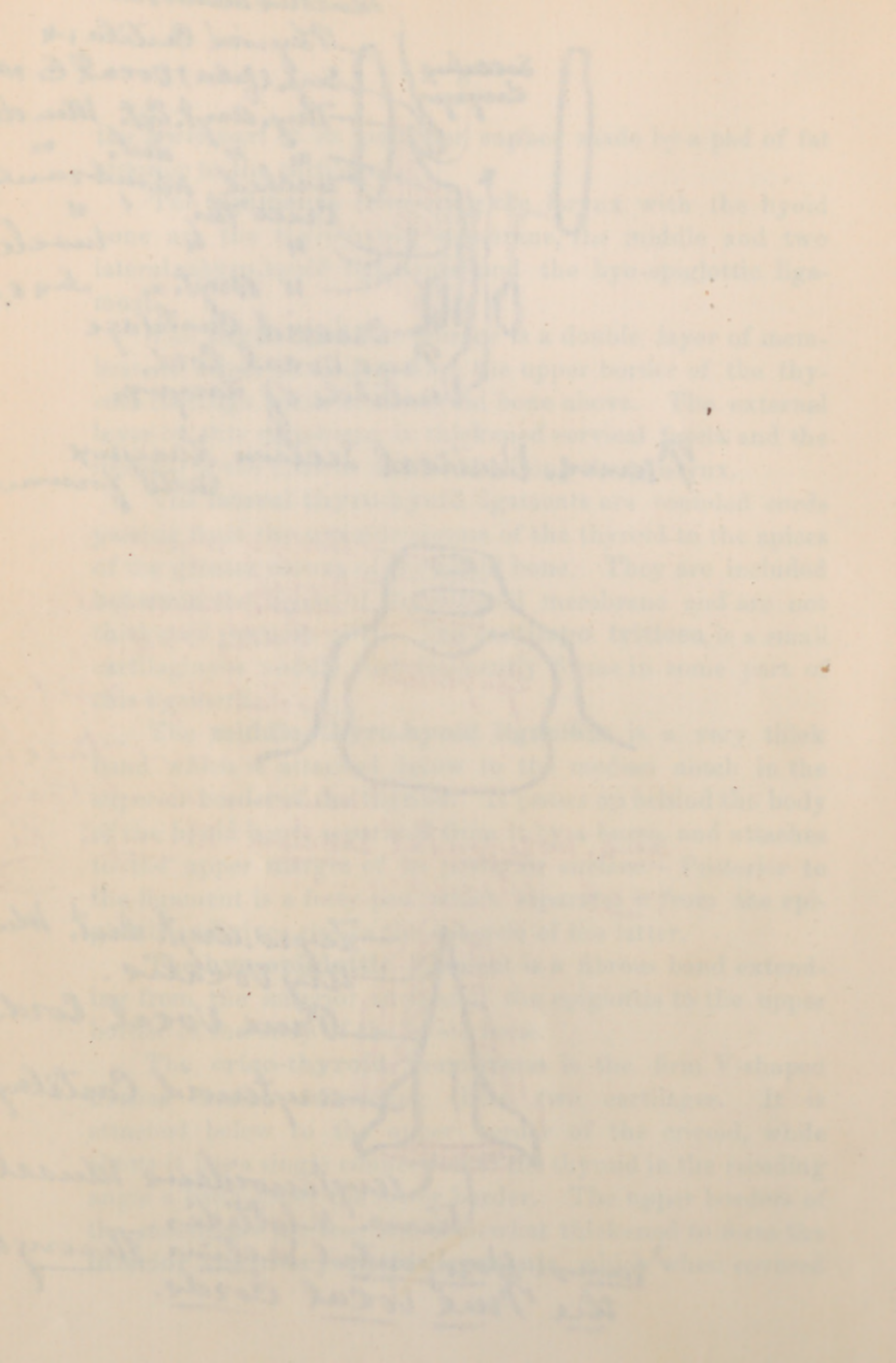
The **crico-thyroid membrane** is the firm V-shaped fibrous lamina connecting these two cartilages. It is attached below to the upper border of the cricoid, while above it has a single connection to the thyroid in the receding angle a little above the lower border. The upper borders of the membrane are free and somewhat thickened to form the **inferior thyro-arytenoid ligaments,** which when covered



Trans. Vertical Section Larynx (well formed)

ans. Horizontal Section Through Hyoid Membrane.

Trans. Horizontal Section Through the True Vocal Cords.



by mucous membrane, form the **true vocal cords**. This position of the membrane leaves a space on each side between it and the inner surface of the thyroid which is arched over by a **membranous diaphragm** from the crico-thyroid membrane to the lower border of thyroid cartilage. This **arching** membrane separates two muscles; the thyro-arytenoid above and the lateral crico-arytenoid below.

The **lateral corniculo-pharyngeal** ligaments are two small, rounded bands about three-fourths of an inch long, which start from the apex of each cornicula laryngis cartilage and run downward and inward to converge in the median line, and there terminate in the loose tissue of the pharynx. The **middle crico-pharyngeal** ligament is a single short, broad band attaching the pharynx to the linea eminens.

The **superior thyro-arytenoid** ligaments, each of which extends from the angle of the thyroid to the triangular depression on the anterior surface of the arytenoid, are not ligaments, but structures of fatty and areolar tissue covered by mucous membrane.

The **kerato-cricoid** are the articular ligaments of the crico-thyroid articulation. They are three in number. The **anterior**, narrow and long, extends downward, forward and inward from the inferior cornu of the thyroid cartilage and attaches some distance from the articular surface. The **posterior inferior**, short and broad, fuses by one edge with the preceding. It is attached to the articular edge of the thyroid above and the cricoid below. The **posterior superior** is long and runs obliquely upward and inward to the lamina of the cricoid far away from the articular surface and under cover of the posterior crico-arytenoid muscle.

The **crico-arytenoid articulation** is by a capsular ligament.

Movements of the arytenoid. The joint is of the reciprocal reception type, formed by two oval surfaces with

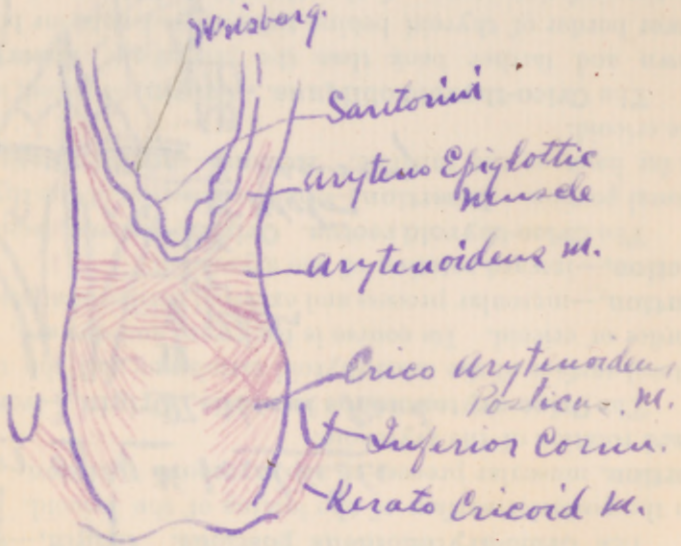
their long axes at right angles to each other, that of the cricoid being transverse in direction. It permits of motion, (1) In an antero-posterior plane; an anterior movement relaxing the cords, a posterior movement tightening them. (2) In a lateral plane; motion outward widens and motion inward narrows the rima glottis. (3) Rotation about a vertical axis; outward rotation widens the glottis and makes tense the cords; inward rotation narrows the glottis and makes the cords lax.

The **muscles** of the larynx are:

The **thyro arytenoideus externus muscle. Origin,** just external to the median line, low down in the angle of the thyroid. **Insertion,**—transverse part into the muscular process and external border of the arytenoid. The oblique part sends fibres to epiglottis, superior cord and aryteno-epiglottic fold. **Action,—transverse fibres** rotate the arytenoid inward and narrow the glottis; the **oblique fibres** depress the epiglottis, compress the sacculus laryngis, and make the cords tense.

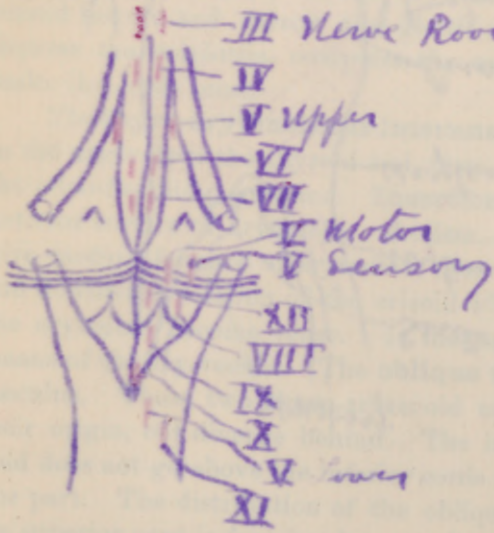
The **thyro-arytenoideus internus. Origin,**—directly in the angle from the thyroid and from the outer surface of the crico-thyroid membrane. **Insertion,**—vocal process and anterior surface of arytenoid. **Action,—transverse fibres** give motion forward of arytenoid, thus loosening the cords, and downward rotation of the cricoid when the ligaments of the arytenoid become tense. It makes the cord tense by means of the ary-vocalis. The **oblique fibres** compress the sacculus. These two thyro-arytenoid muscles are fused at their origin, but diverge behind. The inferior thyro-arytenoid does not go above the inferior cords except at the posterior part. The distribution of the oblique fibres of both to the superior cord is found only posteriorly where no sacculus exists. The ary-vocalis is a part of the internal thyro-arytenoid, best shown by diagram.

The **Arytenoideus. Origin,**—posterior surface and



Posterior View of Larynx.

Floor of 4th Ventricle



Nuclei in Floor 4th Ventricle

outer border of arytenoid. **Insertion,**—corresponding part of opposite side. **Action,** approximation of the two arytenoid cartilages, thus narrowing the glottis. It is the only single muscle of the larynx. It lies underneath the aryteno-epiglottic.

The **Aryteno-epiglottideus. Origin,**—base of posterior surface of one arytenoid and a few fibres from the apex of the opposite arytenoid as it passes around. **Insertion,** lost in the aryteno-epiglottic fold. **Action,**—motion inward of the arytenoid, depression of the epiglottis, and a narrowing of the superior aperture of the larynx. The combination of the three movements gives a sphincter action.

The **Crico-arytenoideus posticus. Origin,**—foveæ on the posterior surface of the lamina of the cricoid. **Insertion,** muscular process of the arytenoid. **Action,**—outward rotation of the arytenoid.

The **Crico-arytenoideus lateralis. Origin,**—from the lateral surface of the crico-thyroid membrane and the upper border of cricoid. Its course is backward and upward. **Insertion,**—muscular process and external border of arytenoid. **Action,**—inward rotation of the arytenoid.

The **Crico-thyroid rectus. Origin,**—cricoid, front and lateral portion. **Insertion,**—the lower border of the thyroid as far back as the tubercle. **Action,**—upward rotation of the cricoid.

The **Crico-thyroid obliquus. Origin,**—cricoid, lower down and farther back than the preceding. **Insertion,** lower border of thyroid behind tubercle and anterior border of the inferior cornu of the thyroid. **Action,**—traction backward on the cricoid. The two parts of the crico-thyroid muscles are by far the most important agents in producing tension of the vocal cords. The cricoid cartilage is always the movable, the thyroid, the fixed element.

That part of the laryngeal cavity included between the planes of the false and true cords is known as the **ventricle.**

From it a pouch is given off, the **sacculus laryngis,** which passes up behind the false cords. It exists only anteriorly. A small valve of mucous membrane guards its orifice. **Inferiorly,** the larynx communicates with the trachea by a narrow slit between the true cords known as the **rima glottidis** or the **glottis.** The rima has two portions, (1) an intraligamentous or vocal portion, and (2) a posterior intracartilaginous or respiratory portion, which is never absolutely closed.

The **superior aperture** of the larynx is made up of epiglottis, aryteno-epiglottic folds, cartilages of Wrisburg and Santorini, and the interarytenoid fold. The **aryteno-epiglottic** fold is made up of muscle fibre, areolar tissue and fat covered by a mucous membrane. The reflection of mucous membrane to the inner side of the thyroid cartilage creates a depression, the **fossa pyriformis.** The **interarytenoid** folds is of mucous membrane and muscle fibre.

MEDULLA OBLONGATA.

General shape and position—The medulla oblongata is that portion of the cerebro-spinal system which connects the cerebral system with the spinal. It is in reality an enlarged upper end of the spinal cord, and with some re-arrangements contains all the elements of the cord. Its length is one inch, its greatest breadth three-fourths of an inch, its greatest thickness rather less than three-fifths of an inch.

In shape it is pyramidal, with the **apex** downward and placed arbitrarily at the lower margin of the foramen magnum. Ventrally its upper limit or **base** is sharply marked off from the Pons by a deep groove made by the lower border of the elevated mass of transverse fibres of the Pons. Under these transverse fibres which connect the cerebellar hemispheres, the longitudinal fibres of the medulla disappear as they pass upward. **Ventrally** the medulla is rounded and rests in the basilar groove of the occipital bone. **Dorsally** it is more flattened and directly continued into the Pons, and lies in the fossa between the hemispheres of the cerebellum. From its side and anterior surface emerge certain cranial nerves, viz: VI to XII.

Surface Markings. The surface markings of the medulla are in general a series of longitudinal columns, separated by grooves, each with its counterpart in the cord. One groove expands into the fourth ventricle. At the upper end, situate laterally, is an ovoid eminence known as the **olivary body.** The anterior and posterior median fissures which partially bisect the cord are continued into similar fissures in the medulla. The **anterior fissure** extends as far as the Pons, where it ends in a depression, the **foramen caecum.** It is interrupted low down by the decussation of the pyramids. The **posterior** fissure extends only as far as the middle of the medulla, where it expands

into the fourth ventricle. Besides the longitudinal fibres of the columns, certain transverse fibres emerge from the anterior and posterior fissures—the **arcuate** and **acoustic fibres.**

The columns in order from the anterior fissure are :

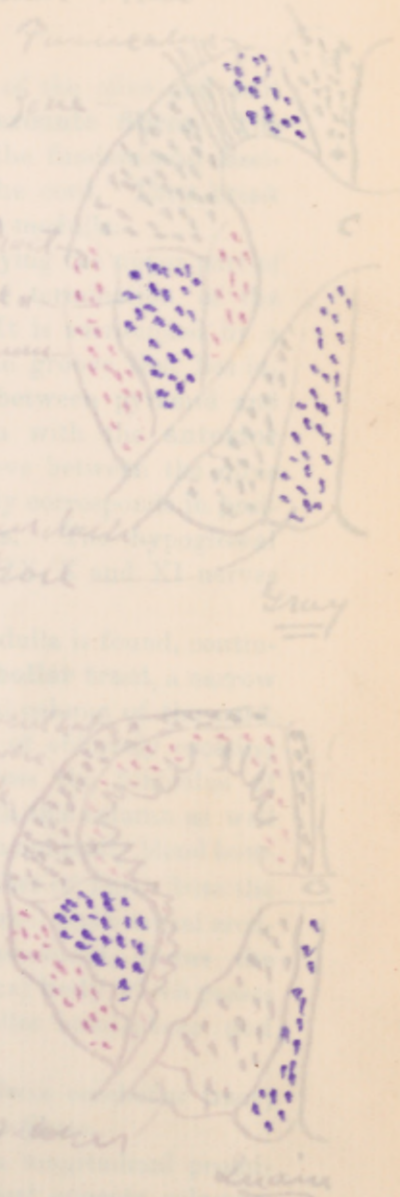
1. Pyramid.
2. Lateral Tract (and olive).
3. Direct Cerebellar tract and Restiform body.
4. Funiculus of Rolando.
5. Funiculus Cuneatus.
6. Funiculus Gracilis.

The Pyramids appear to be a direct continuation upward of the anterior columns of the cord, but this is true only of a small portion. The main mass is made up of the crossed pyramidal bundles which cross the anterior fissure from the opposite lateral column, unite with the median part of the anterior column of the cord and form the eminence on either side of the median line.

The pyramid is more marked above and is constricted at the point where it enters the pons as a single large bundle. It is **bounded** mesially by the anterior fissure, laterally by the lateral column and olivary body. From the groove between the pyramid and olive the XII nerve emerges. The pyramidal bundle soon breaks up into many smaller bundles in the Pons and is traced into the corresponding internal capsule of the cerebrum.

The **decussation** of the **pyramids** is the name given to the obliquely crossing bundles of the lateral pyramidal tract which are seen in the anterior median fissure at the lower part of the medulla oblongata. The extent of decussation visible varies much.

Lateral Tract and Olive. The lateral column of the cord appears to be directly continued upward as the **lateral tract** of the medulla which is a short, broad column just external to the pyramid, but, as was said above, a large part of this lateral column crosses over to form the pyramid.



The tract dips under the lower end of the olive and as it does so is crossed by the **external arcuate fibres.** The fibres of this tract are derived from the fundamental fasciculus and anterior radicular zone of the cord. They break up into the formatio-recticularis of the medulla.

The Olive is the eminence occupying the upper part of the lateral area and extends from the termination of the lateral column almost to the Pons. It is surrounded by a well-marked groove. The part of the groove that lies internal to it, together with the groove between pyramid and lateral tract corresponds in position with the **anterior nerve roots** of the cord. That groove between the olive and lateral tract and the restiform body corresponds in position with the **posterior nerve roots.** The hypoglossal nerve emerges from the former; the IX, X and XI nerves from the latter groove.

On the posterior region of the medulla is found, continuing around in order, the **Direct Cerebellar tract,** a narrow strand of fibres derived from the lateral column of the cord. The tract is noted in the cord as a set of obliquely crossing fibres which turn upwards as they cross the funiculus of Rolando and then appear to blend with this column as well as with the funiculus cuneatus. They do not really blend however, but are reinforced by a large number of fibres from the opposite side of the medulla—the external and internal arcuate fibres—and the whole mass so produced, forms the rounded, prominent **restiform** (rope like) **body** which passes directly into the corresponding cerebellar hemisphere and forms its **inferior peduncle.**

Restiform body consists of: Direct cerebellar tract; external arcuate fibres; internal arcuate fibres.

The **Funiculus of Rolando** is a longitudinal prominence between the direct cerebellar and cuneate columns, caused by the projection toward the surface of the grey matter of the posterior horn (or Substantia Gelatinosa of Rolan-

do.) It is narrow below and broadens as the considerable eminence of the Tubercle of Rolando is reached. It differs from the other columns in not being caused by longitudinal white fibres.

Funiculus Cuneatus. The column of Burdach, situated in the posterior region of the cord, is continued into the medulla as the funiculus cuneatus. This, like the funiculus gracilis, expands as it passes up, and opposite the **clava** of the funiculus gracilis presents an enlargement, best marked in children, the **cuneate tubercle.** From this point it diminishes in size until it reaches the upper part of the medulla, where the fibres dip down to its own nucleus **and end there.** From these nuclei, however, separate fibres start, viz.: those composing the **fillet.**

Lastly, those columns on either side of the posterior median fissure, the **funiculi Graciles,** represent the continuation upward of the tracts of Goll in the cord. Each funiculus is well marked, especially so as the fourth ventricle is reached where it broadens out into an expansion known as the **clava.** As the ventricle opens out the clavæ diverge and form the lateral boundaries of the ventricle in its lower part. Above, the clavae are tapered off and soon become no longer traceable. The fibres of this column like the cuneate, dip down to a distinct nucleus gracilis, which, together with the cuneate nucleus, sends out the **fillet. Funiculus Gracilis and Cuneatus do not enter the restiform body.** The clava and cuneate tubercle are each formed by the projection outward at this point of the considerable mass of the respective nuclei.

Fourth Ventricle. The fourth ventricle is the space into which the central canal of the cord expands superiorily. It is a space between the medulla and pons anteriorly, and the cerebellum behind. It is diamond shape, or may be said to be formed of two triangles with coincident bases. The lower part appears to be formed by the divergence at

an acute angle of the funiculi cuneati et graciles. Superiorly the boundaries are formed by the convergence of the superior peduncles of the cerebellum, narrowing the ventricle down again to a point in the **aqueduct of Sylvius**. To the pointed lower triangle is given the name **calamus scriptorius**, from its resemblance to the reed pen of the ancients. Opposite the middle peduncle of the cerebellum, the ventricle has obtained its greatest width, and at this point certain prolongations of the space are found. These are known as the **lateral recesses** which run out laterally, wrap around the inferior peduncles and extend on either side as far as the flocculus. The recess is **roofed** by the inferior medullary velum and tela choroidea inferior, bounded **anteriorly** by the inferior peduncle and limited **below** by the ligula. The **lateral angle** of the ventricle is the point of junction of the three peduncles, and is not to be confounded with the lateral recess.

The **Lateral Boundaries** of the fourth ventricle are formed inferiorly on either side by the clava of funiculus gracilis, funiculus cuneatus and restiform body. In the **upper half** the superior peduncles form the boundaries as they converge from a widely separated position to a point of contact. By such a course they pass gradually to the roof of the ventricle as they go upwards.

Roof.—Superiorly the triangular interval between the two peduncles is bridged over by a lamina of white matter marked across with grey streaks. This is the **superior medullary velum**, or **valve of Vieussens**, and with the peduncles, forms the roof of this part of the ventricle. On the dorsal surface of the valve are found transverse grey laminæ which together form the **lingula** of the worm. These laminæ are continued laterally into the cerebellum as the **frænula**. The white matter of the valve is directly continued into that of the cerebellum. The superior velum as a whole meets with the inferior velum from below to form the

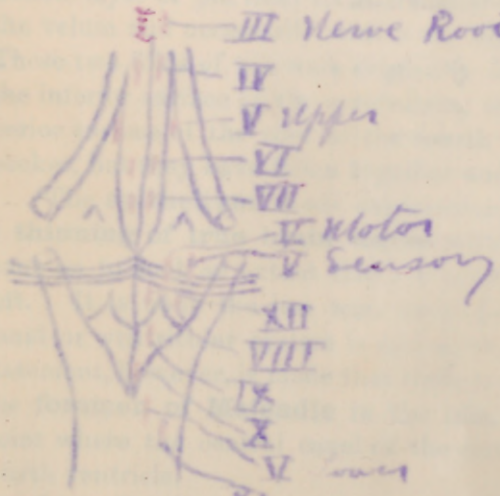
tent which may be designated as the roof of the central portion of the ventricle. In the **lower** one-half the roof is formed in part by the **inferior medullary velum,** a projection of white matter analogous to the superior velum. The velum connects the **nodule** of the cerebellar worm with the **flocculus** of the lateral hemispheres. It ends abruptly below in a thickened edge to which is attached the **tela choroidea inferior** which completes the roof of the ventricle.

Tela choroidea inferior, is a double layer of pia mater covered on its anterior or ventricular surface by a single layer of epithelium, which bridges over the triangular interval between the inferior peduncles of the cerebellum. The anatomical specimen will show the inferior medullary velum with an inferior free edge, and the fourth ventricle open. This is, however, not normal, but the result of tearing away this double layer of pia from its attachment to the lower edge of the velum and necessarily with it the **layer of epithelium.** These two folds of pia were originally separate, the one on the inferior surface of the cerebellum, the other on the superior surface of the roof of the fourth ventricle—a sort of pocket, but they have fallen together and fused to an extent.

The **epithelium** needs explanation. It is the result of a **thinning of true brain tissue,** which at this point has gone on to such an extent that but a single layer of cells is left. It is none the less true brain tissue and the central canal or ventricular system is not open at this point. The statement, however, is made that there is a small hole termed the **foramen of Majendie** in the tela, a little above the point where the central canal of the cord expands into the fourth ventricle.

Laterally, the roof epithelium is thickened by white nervous matter before becoming continuous with that of the floor, and when the roof epithelium is torn off, a ragged, slightly prominent membrane, the **ligula** (or taenia) remains attached to the surface of the medulla as a result of the

Floor of 4th Ventricle



Nuclei in Floor 4th Ventricle

thickening. The ligula commences at the apex of the clava, follows the lateral boundary of the ventricle and then turns out to form the inferior boundary of the lateral recess. Another thickening of the roof at the apex of the ventricle is known as the **Obex.**

From the roof project two longitudinal vascular infoldings of pia on either side of the median line, known as the **choroid plexus.** They are everywhere covered by epithelium. Prolongations of the plexus extend into the lateral recess, from the apex of which they emerge encircled by the ligula, which at this point is known as the **Cornucopia.**

Floor.—The floor of the fourth ventricle is made up of medulla for its lower half and pons for its upper half. The point of division between the two corresponds to the tent and to the widest part of the ventricle. This line of demarcation is indicated on the surface by the **acoustic striæ,** white fibres crossing transversely the grey matter of the floor. These fibres begin in the ventral part of the medulla, emerge from the posterior raphe, curve outward over the restiform body and pass not to the lateral root of the eighth cranial nerve as is often stated, but very largely to the **Flocculus.** An aberrant bundle often passes into the middle cerebellar peduncle.

The floor of the ventricle is bisected by a median longitudinal groove on either side of which is a ridge, the **funiculus teres,** extending throughout its whole length. The funiculus teres represents the small remaining portion of the base of the anterior cornu which in the cord was ventrolateral to the canal but now comes to the surface in the floor of the canal as it opens out. Immediately below the medullary or acoustic striæ is a triangular depression—the **inferior fovea.** From its apex at the striæ, one groove runs downward and inward to the apex of calamus scriptorius, thus cutting off a triangular prominent area with base upward (a part of funiculus teres) known as the **trigonum hypo-**

glossi. Another groove passes downward and outward to the lateral boundary of the ventricle marking off another prominent triangular area, the **trigonum acoustici.** The remaining triangular area with its apex at the inferior fovea is known as the **ala cinerea.** Its depressed upper part forms the **inferior fovea** and its lower prominent part the **eminentia cinerea.** The latter contains the nuclei of IX and X nerves. Above the acoustic striæ the floor of the ventricle is marked in the middle of each lateral half by a distinct angular depression, the **superior fovea.** The superior fovea is in a line with the inferior fovea and separated from it by an eminence over which the acoustic striæ pass. Between the fovea and the median groove is the upper part of funiculus teres. A shallow depression extends from the apex of the superior fovea up toward the aqueduct of Sylvius. This groove is known as the **locus coeruleus** and is rendered dark colored by the pigment known as the **substantia ferruginea.**

TABULATED BOUNDARIES.

	ROOF.	LATERAL.	FLOOR.
Upper Half.	Sup. Med. Velum. (or Vieussens.) Sup. Peduncles of Cerebellum.	Sup. Peduncles of Cerebellum.	Pons.
Central Part.	Tent of Cerebellum.	Lateral angle or junction of the three peduncles. Lateral Recess— (1) Inf. Velum. (2) Pia Mater. (3) Peduncle of Cerebellum. (4) Ligula.	Junction of Pons and Medulla.
Lower Half.	Tela Choroidea Inferior. Inf. Medullary Velum. Choroid Plexus.	Inf. Peduncles of Cerebellum. Upper ends of— (1) Funiculus cuneatus. (2) Clavae of gracilis.	Medulla.

Internal Structure.—The first great change in transition from cord to medulla is made by the passage of the fibres of the crossed pyramidal tract through the anterior horn of grey substance across the median line to the opposite side. By this process the grey matter is broken up and interspersed through the fibres to constitute the **formatio reticularis**. The double process of a **shifting laterally** of the posterior horns and the enlargement of the posterior columns of the cord has caused such an arrangement that viewing the system in section the horns have come to assume a position almost at right angles to the median fissure, instead of continuing, as in their position in the cord, to make an acute angle with it. The tip of the posterior horn enlarges and comes close to the surface, where it produces the projection of the funiculus of Rolando. A little higher up the horn swells into the tubercle of Rolando. Numerous collections of grey matter throughout the medulla represent the nuclei of various nerves and special bundles.

The **Formatio Reticularis** occupies the whole of the anterior and lateral mass dorsal to the olives and pyramids. The reticular appearance is given by the intersection of longitudinal and transverse bundles. The **longitudinal fibres** are made up of the fibres from the antero-lateral columns, by a special bundle from the antero-lateral column known as the posterior longitudinal bundle, and by the fillet. Or the longitudinal fibres may be said to be made up of the lateral area of the cord after the crossed pyramidal and direct cerebellar tracts have been taken out. The **transverse fibres** pass (1) obliquely from the raphe outward in rather a curved course to the nuclei of gracilis and cuneatus as the **large internal arcuate fibres**, (2) between the two olives as the **olivary peduncle**, (3) from the raphe to the restiform bodies as the **small internal arcuate fibres**. In some parts grey matter with nerve cells enters into the formatio reticu-

laris. The cells are especially large and numerous in the lateral area, and mostly absent in the antero-mesial portion.

The **Raphe** of the medulla consists of fibres running dorso-ventrally, longitudinally and across the septum more or less obliquely, intermingled with a number of nerve cells of grey matter. The **dorso-ventral fibres** are continuous ventrally with the **external arcuate fibres**, dorsally with the acoustic striæ. The **longitudinal** fibres consist of the dorso-ventral fibres that have changed direction, and the internal arcuate fibres. The **oblique fibres** comprise those internal arcuate fibres which form the fillet, the fibres of the olivary peduncle, and certain cranial nerve fibres. The raphe is continued up into the **dorsal portion** of the pons.

Nuclei.—The various cranial nerve origins are indicated in the floor of the fourth ventricle by diagram. Among the larger collections of grey matter are the nuclei of funiculus gracilis, cuneatus and the olive.

The **nuclei of funiculus gracilis and cuneatus** indicate a considerable increase in the grey matter at the base of the posterior horn of the cord as we pass upward. The nuclei are at first narrow, but as the canal opens out they become quite thick masses which produce externally the eminences of the clava and cuneate tubercle. The fibres of the corresponding columns dip down to end in these nuclei. Separate fibres, the **internal arcuate**, emanate from the nuclei, sweep forward and inward in a curved manner to the raphe. These intercross with those of the opposite side in a decussation somewhat higher up than that of the pyramids and form on either side a considerable bundle of fibres known as the **fillet** which lies just dorsal to the pyramid.

The **nucleus of the olive** is a portion of grey matter not traceable from the grey matter of the cord. The grey matter is not visible from the surface, but is covered by longitudinal and transverse white fibres in a sort of capsule. Its arrangement is that of a thin wavy lamina of grey sub-

stance forming a continuous capsule, except on its inner or median surface, where the **hilum** receives the considerable tract of white fibres of the **olivary peduncle**. This emanates from the raphe, and is derived from the opposite olive. The fibres of this peduncle diverge as they enter the hilum of the olive; some pass to the grey lamina, but the majority pass in small bundles **through** the lamina. Those which are more posterior turn backwards and course obliquely **through** the posterior part of the lateral area of the medulla to the restiform body as the **internal arcuate fibres**. These are to be distinguished by their small size from the internal arcuate fibres forming the root of the fillet. The other more anterior fibres of the olivary peduncle, after piercing the lamina reach the surface of the olive, where they form a **part** of the **external arcuate fibres** and are continued into the restiform body. Through the restiform body, arched fibres, and peduncle of the olives, the cerebellar hemisphere of one side is connected with the olive of the opposite side. The opposite olive atrophies on destruction of a cerebellar hemisphere. The olivary nucleus is connected, however, with the cerebral hemisphere of the same side. It has no direct connection with the cord.

Arcuate fibres. Of these there are three sets, one external and two deep. The **external or superficial arcuate fibres** emerge for the most part from the anterior median fissure, pass over the pyramids and olive, through the groove between the lateral tract and lower end of the olive to enter into the formation of the **restiform body**. In the region of the olive these fibres are joined by those described above, as passing through the grey lamina of the olive. Traced back into the anterior median fissure they are seen to enter the raphe, cross over in it and are then supposed to become longitudinal. Their further course is not known. Of the **internal arcuate fibres** there are two sets. **First**, those described as formed by the fibres of the olivary peduncle

which pierce the grey lamina of the olive, course through the substance of the medulla, and join the restiform body. **Second**, the larger set also described as beginning in the cuneati et graciles nuclei, coursing obliquely forwards and inwards to the raphe and then crossing over to the opposite side in a decussation to form the **fillet** of the opposite side.

PONS.

Pons.—The Pons Varolii forms a prominence marked by transverse fibres, above and in front of the medulla and between the hemispheres of the cerebellum. At the sides the transverse fibres are collected into a compact mass which enters the cerebellum as its **middle peduncle**. The **ventral** surface of the pons projects beyond the level of the other parts, is of quadrilateral form, and rests upon the sphenoid and basilar process of the occipital bone. The surface is marked by a longitudinal median groove which receives the basilar artery. This groove is in a measure due to the passage upward of the fibres of the pyramids of the medulla on either side of the median line and covered in by the transverse fibres of the pons. The **dorsal** surface forms a part of the floor of the fourth ventricle.

Internal Structure.—The ventral portion consists of longitudinal and transverse fibres interlacing and arranged in layers. The posterior or **dorsal portion** is a continuation upward of the reticular formation and grey matter of the medulla. There exists in the pons a **median raphe** or septum similar in structure to that of the medulla, but which does not extend through the ventral half because of the transverse and oblique fibres in this region.

Besides the grey matter freely interspersed through its formatio recticularis, the pons has two main collections, viz: the **superior olivary nucleus** and **nucleus** of the **seventh**

cranial nerve. Minor collections represent a part of fifth cranial nerve nucleus. The **superior olivary nucleus** is a collection of grey nerve cells situated in the lower part of the pons near the medula, and lying dorsal to the pyramidal fibres. Their connections are little understood at present, but enclosing and in definite connection with some of its cells is a transverse bundle of fibres, the **trapezium.** This bundle curves around these nuclei, runs out over the seventh nerve roots and is connected with the **accessory auditory nucleus** and **ventral root** of the **eighth nerve.** Therefore the trapezium forms a cerebral commissure for the nuclei of the VIII nerves.

Fibres of Cord Traced.

The **Posterior columns** form in the medulla the funiculi cuneati et graciles which terminate in their own nuclei. From these nuclei emerge certain deep arched fibres which pass to the raphe, cross over and pass up as fillet to end partly in corpora quadrigemina, partly in cerebrum. Some fibres, especially from cuneate nucleus, pass directly into the restiform body of the same side.

The **Lateral column** of the cord in large part, namely, the **crossed pyramidal** tract, passes over to form the opposite pyramid of the medulla. From here it proceeds in the ventral part of the medulla and pons to the middle third of the crusta, and reaches the cerebral cortex through the internal capsule. Some fibres of the pyramid emerge from the anterior median fissure of the medulla as the external arcuate fibres and then pass to the cerebellum in the restiform body. The **direct cerebellar tract** passes upward at about the middle of the medulla, to form a part of the restiform body, and terminates in the cerebellar worm. The **ascending antero-lateral tract** passes into the upper part of the pons and then turning at about the level of the point of emer-

gence of the fifth nerve, curves backward and enters the cerebellum in the superior peduncles and in the valve of Vieussens.

The rest of the **lateral column** enters into the structure of formatio reticularis. Some of its fibres also contribute to the fillet, because this is not wholly made up of the fibres from the nuclei of the posterior columns, the accession being of fibres from the posterior horn of the cord that have crossed over in the anterior commissure of the cord, and then ascended in the antero-lateral column.

The **anterior column** of the cord is in part continued into the corresponding pyramid of the medulla, but the major part of it dips under the pyramid and forms the longitudinal fibres of the formatio reticularis. One bundle of these fibres appears quite distinct and definite in the pons, and is known as the **posterior longitudinal bundle.** Other fibres of the column join the fillet.

CEREBELLUM.

The Cerebellum occupies the posterior fossa of the cranium, and consists of two lateral hemispheres joined together by a median portion called the **worm.** The worm appears as a well marked prominence in a deep hollow and divided by the great transverse fissure into a superior and an inferior worm (the latter the most marked). In birds and animals of a lower type the worm alone exists. The median portion lies behind the fourth ventricle and below and behind the corpora quadrigemina from which it seems to be suspended by the superior peduncles of the cerebellum. Below the cerebellum receives its inferior peduncles from the medulla, while in front and at the sides the mass of the middle peduncle passes from the pons to the hemispheres. **Superiorly** the hemispheres are somewhat flattened with a ridge in

the middle from which it slopes laterally and backward. **Inferiorly** the hemispheres are rounded and separated by a deep groove, the **vallecula,** which receives the medulla.

The cerebellum is characterized by its **laminated appearance** being everywhere marked by deep, closely set transverse or curved fissures. Its structure is best demonstrated by sagittal sections.

The **great horizontal fissure** is the most conspicuous fissure. It divides the cerebellum into an upper and lower portion, corresponding to the upper and lower surfaces, each portion being again subdivided by fissures into lobes. The fissure begins on either side at the middle peduncles, extends around the outer and posterior border of either hemisphere and dips down into the posterior notch.

The Upper Surface is composed of worm and hemisphere, each subdivided into lobes by transverse fissures and each part of the worm having a corresponding part in the hemisphere with which it is definitely connected. Thus we have in order from before backwards:

Worm.	Hemisphere.
Lingula,	Fraenulum,
Lobulus Centralis,	Ala,
Culmen,	Anterior Crescentic,
Declive,	Posterior Crescentic,
Folium Cacuminis.	Posterior Superior or Sup. Semilunar.

Lingula.—The **lingula** is the most anterior lobe of the worm and is generally not extended to the hemispheres. It consists of a tongue-shaped group of four or five transverse laminae which lie directly on the dorsal surface of the **valve** of **Vieussens.** If the other lobes may be called bipenniform this will be penniform and the white stalk will correspond to the valve of Vieussens. When the lobe extends laterally to the hemisphere it is known as the **fraenulum.**

The **Lobulus Centralis,** the next lobe in order, is concealed by the culmen. In the natural position of parts the primary branch of the arbor vitae to it passes forward and upward. The lobe is prolonged into the hemisphere as the **ala,**—a narrow, wing-like strip along the upper and anterior part of the hemisphere.

The **Culmen** occupies rather more than one-half of the upper surface of the worm and constitutes its most prominent part. It is marked by several secondary transverse laminae and is separated from the declive by a very deep sulcus extending to the middle of the organ. The lateral prolongation, the **anterior crescentic** lobe, likewise makes the main subdivision of the upper surface of the hemisphere. It is marked off by well defined sulci. The culmen receives a single stem of the arbor vitae, while the anterior crescentic lobe receives three branches from the medullary centre of the hemisphere.

The **Declive** is another considerable group of well marked laminae which form the descending slope of the upper surface. The lateral extension of the lobe in the hemisphere is known as the **posterior crescentic** lobe which together with the anterior crescentic forms the **quadrate lobe.**

The **Folium Cacuminis** is formed by the apex of the main horizontal stem of the arbor vitae, as a single primary folium. It is limited behind by the **great transverse fissure.** As the folium passes into the hemisphere it rapidly expands with the divergence of the limiting fissures and the development of numerous secondary and tertiary folia into the **posterior superior lobe.** Its expansion occurs mainly above the horizontal plane and occupies the posterior one-third of the upper surface.

Under surface. The under surface of the cerebellum presents more complexity and the correspondence of parts in

Sagittal Section of Cerebellar Worm.

the worm and hemispheres is less definite and regular than in the superior worm. From before backward we have:

Worm.	Hemisphere.
Nodulus,	Flocculus,
Uvula,	Tonsil,
Pyramid,	Digastric,
Tuber Valvulae.	Slender and Inf'r Semilunar.

It is sufficient to say that each lobe is marked off by deep fissures.

The **Nodulus** occupies much the same position relatively to the inferior medullary velum and tent that the lingula occupies with respect to the superior velum. It is, however, better developed as a distinct prominence with a separate branch from the arbor vitae. In the natural position of the parts it is concealed by the uvula and can not be seen. The nodulus is connected with the **flocculus**, its corresponding part in the hemisphere, by the inferior medullary velum. This lobe, the **flocculus**, consists of a collection of lamellae diverging from a stalk and situated in the groove between the digastric lobe and the middle peduncle of the cerebellum.

The **Uvula** forms a considerable portion of the inferior worm. It is elongated from before backward, least prominent next the nodule and increasingly so up to the pyramid. It is purely a mesial structure, separated from the hemispheres by deep grooves. At the bottom of the groove is a low, corrugated, grayish ridge, the **furrowed band**, which connects the uvula with the stalk of the **tonsil**, its corresponding part in the hemisphere. The **tonsil** is a rounded mass of sagittal laminae lodged in a depression at the front of the **vallecula**. It is bounded mesially by the uvula, laterally by the digastric lobe.

The **Pyramid** forms the most marked prominence of the lower worm, as a long, clavate projection attached to the stem of the arbor vitae by a very narrow stalk. It is separated

from the uvula and tuber valvulae by deep fissures and connected to its large corresponding lobe of the hemisphere by a **low narrow ridge** analogous to the furrowed band. The **digastric lobe** is triangular in shape, with the apex of the triangle pointing backward and inward to the pyramid. It is generally subdivided by a sulcus.

The **Tuber Valvulae** is the hindermost division of the worm, between the pyramid in front and folium cacuminus behind. It is separated from the latter by the **great transverse fissure**. The lateral prolongation broadens out rapidly and is represented by two well marked lobes. The **semilunar lobe** appears to be in direct continuity. The **slender** lobe next to the great transverse fissure seems to be interpolated with no corresponding part in the worm. These two lobes occupy two-thirds of the inferior surface of the hemisphere, the greater part of the remaining area being taken up by the digastric lobe.

Arbor Vitae. This term is applied to the appearance presented by a sagittal section **through the worm**. The tree-like appearance is due to the fact that we have primary laminae giving off secondary, and these in turn beset by tertiary laminae, the whole covered by a uniform layer of grey matter. The **stem** or **corpus trapezoides**, is formed by the fusion of the superior and inferior medullary velum at the apex of the tent. The term arbor vitae applies strictly only to the worm. The **white matter of the hemispheres** is much less regularly arranged and forms a central white mass, the result of the entrance of the three peduncles. Enclosed within its substance is the **dentate nucleus** a plicated capsule of compact, yellowish-brown substance, enclosing white matter in its interior. The nucleus is open at its anterior and mesial part, where it receives the superior peduncles of the cerebellum.

The **peduncles of the cerebellum** are bundles of fibres connecting this with the other parts of the brain. They con-

verge from three directions at the anterior termination of the great transverse fissure to make up the medullary white portion of the hemisphere and ultimately reach the grey cortical cells.

The **Superior Peduncles**, from which the cerebellum seems suspended, emerge from the upper and central part of each hemisphere, run forward first on the side, then in the roof of the fourth ventricle, and disappear under the corpora quadrigemina. The fibres of the superior peduncle emerge almost entirely from the hilum of the dentate nucleus. Some are traced to the grey lamina of the nucleus, others through it to the cortex. Those fibres that do not enter the hilum curve around the nucleus. Traced forwards the fibres decussate under the posterior pair of corpora quadrigemina and form a distinct white longitudinal bundle of the tegmentum. This bundle encloses a collection of pigmented cells known as the **red nucleus**, receives accessions from these cells and is continued into the ventral part of the optic thalamus. Certain fibres pass around the optic thalamus into the cerebrum while certain other fibres do not decussate but pass into the red nucleus of the same side.

The **Middle Peduncle** consists of transverse fibres of the pons entering laterally the cerebellar hemispheres in two thick masses. Some of the fibres traced ventrally end in the grey cells of the pons; others take a longitudinal direction in the raphe, or in the fillet and the posterior longitudinal bundle of the same side; a few pass to the opposite cerebellar hemisphere. After extirpation of one cerebellar hemisphere the degenerations are in the middle peduncle as far as the median line, the grey matter of the pons of the same side, the fillet and posterior longitudinal bundle of the same side.

The **Inferior Peduncle** issues from the lateral hemisphere between the other two and passes forward immediately outside the superior peduncles to reach the lateral wall of

the fourth ventricle. Here it suddenly turns downward at right angles, to become the **restiform body** of the medulla.

The peduncle is made up of (1) the direct cerebellar tract of the cord (2) the external arcuate fibres (3) the internal arcuate fibres (4) the fibres of the descending cerebellar tract.

MID-BRAIN.

The parts of the brain included under this division are all covered by the hemispheres. They are the corpora quadrigemina, aqueduct of Sylvius, crusta, tegmentum, brachia, substantia nigra and internal geniculate body. It serves as the connecting band between the cerebral and cerebellar hemispheres. In general shape it is a very short and chunky rhomboid, with very thick walls as compared to the cavity. Nearer its lower surface the rhomb is divided by a lamina of grey matter, convex downwards — the **substantia nigra.** All above the lamina is known as **tegmentum**, all below as **crusta.**

The **superior surface** of the mid-brain presents at its back part two pairs of rounded bodies, the **corpora quadrigemina.** Each body is marked off by grooves, the pineal gland resting in the groove between the anterior pair. On the **lateral surface** of the mid-brain is seen a well-marked groove, the **lateral sulcus,** which indicates the line of division between tegmentum and crusta—the line of outcrop of substantia nigra. Crossing obliquely from above downwards and forwards, with the corpora quadrigemina as an origin, are distinct bands, the **anterior** and **posterior brachia.** The **posterior brachium** passes to the **internal geniculate** body, a prominence of the mid-brain located a little farther forward, while the **anterior brachium** passes between this body and the external geniculate, which is adjacent to it, but belongs to the optic thalamus and joins

the **optic tract**. The posterior brachium in its course marks off a **triangular area**, bounded by brachium, lateral groove and anterior border of pons, where alone the fillet (lower) appears on the surface of the brain. **Inferiorly** the crusta are seen as rounded bundles of white matter, which rapidly diverge and soon disappear under the cerebral hemispheres. They include between them the interpeduncular space, filled in posteriorly by the out-cropping of the substantia nigra, known here as the **posterior perforated lamina**, and by the corpora albicantia. At the point of divergence is seen the emergence of the third cranial nerve.

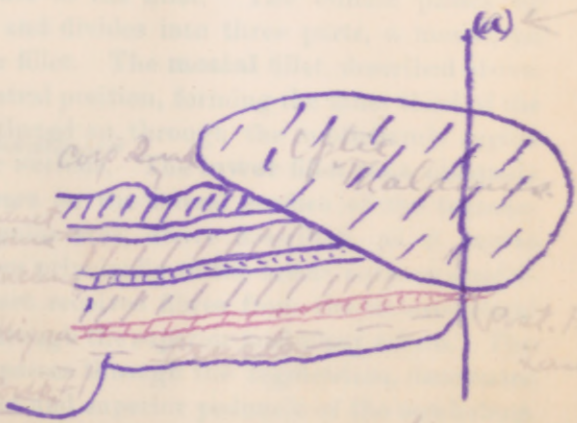
The **aqueduct of Sylvius** is the central cavity of this part of the brain, continuous below with the fourth ventricle, above with the third ventricle. Its length is rather more than one-half inch. Its shape varies in different parts; T-shaped on section below, triangular above and an elongated oval in the intermediary portion. Wholly within the tegmentum and near its upper surface, it forms a narrow canal, lined by a ciliated epithelium and surrounded by a layer of grey matter two or three *mm.* thick, which is a prolongation upward of the grey matter of the floor of the fourth ventricle and gives origin to important nerves, viz., third, fourth, fifth.

The **crura cerebri** correspond to tegmentum + crusta + substantia nigra, i. e., another name for the mid-brain.

The **Crusta** are seen on the ventral surface of the mid-brain as two longitudinal bundles of fibres, which emerge from beneath the transverse fibres of the pons, pass forward and outward around the outer side of the optic thalamus, and in a large measure enter into the formation of the internal capsule. On section they are semilunar in shape and receive in their substance the projections of the substantia nigra on the concave surface. They consist in the main of the prolongation of the longitudinal fibres found in the pons and medulla. The crusta may be roughly divided into three

parts, viz., an outer, middle and inner third. The pyramidal tract of the medulla and pons occupies the **middle third**, passes on through the middle portion of the internal capsule to the fronto-Rolandic region. This is, therefore, the **motor** element of the crusta. The **outer third** is sensory, and appears in a prominent ridge, laterally known as the **curved sensory tract**. The fibres are traceable downwards to the lateral longitudinal bundles of the pons, where they end perhaps in grey nuclei, upwards to the posterior part of the internal capsule and, consequently, to the occipito-temporal cortex. The **inner third** contains (1) fibres passing to the prefrontal cortex through the anterior part of the internal capsule, not traceable downwards, and (2) the fibres of the mesial fillet, traceable to the corpus striatum and lenticular nucleus.

The **Tegmentum** includes the corpora quadrigemina, posterior longitudinal bundle, fillet, red nucleus and aqueduct of Sylvius. It is a continuation upward of formatio reticularis, with the addition of much grey matter and white fibres. A cross section shows its general shape. As it passes forward it gets thinner (well shown in longitudinal section) and finally divides into two lateral parts, which pass into the ventral portion of each optic thalamus and form the **subthalamic region.** The **posterior longitudinal bundle** is made up of certain longitudinal fibres of the anterior area of the cord, which instead of breaking up into the reticular formation of the medulla, remain distinct, and become collected in the upper part of the medulla into a compact bundle. This bundle passes through the pons as a distinct fasciculus, and receives here some of those fibres of the middle peduncle of the cerebellum which have become longitudinal. It is connected with the nucleus of the third nerve of the same and of the opposite side in passing through the mid-brain, and forms, at the posterior part of the third ventricle, the greater


(a)

part of the posterior commissure. It finally passes through the optic thalamus into the white matter of the cerebrum.

The **Fillet** takes origin in the medulla, principally from the nucleus cuneatus and gracilis of the opposite side. From these nuclei the fibres under the name of the **internal arcuate fibres** curve forward and inward to the median raphe, decussate with the fibres of the opposite side and form a considerable bundle on either side of the median line just dorsal to the pyramids. It is here, after the decussation, that the fibres take the name, **fillet.** A few fibres derived from the posterior horn, and traced through the antero-lateral tract of the cord, contribute to the fillet. The bundle passes up through the pons and divides into three parts, a mesial, an upper and a lower fillet. The **mesial** fillet, described above, remains in the ventral position, forming the inner third of the crusta, and is continued on through the subthalamic region into the lenticular nucleus. The **lower** fillet runs obliquely outward and appears on the lateral surface of the tegmentum in the triangular area, above described, as it curves upward, then passes principally to the lower corpora quadrigemina. This part receives fibres from the antero-lateral tract of the cord through the superior medullary velum. The **upper** fillet, as it passes through the tegmentum, decussates with the lower fillet and superior peduncle of the cerebellum in the roof of the aqueduct of Sylvius to form the **white lamina.** It passes principally to the upper corpus, but some fibres extend through the subthalamic region to the occipital region of the cerebrum.

The **Red Nucleus** is a cylindrical tract of grey matter on either side, located ventrally in the tegmentum. It consists, essentially, of a number of large, pigmented, grey cells, enclosed in the tract of the superior cerebellar peduncle.

The **Substantia Nigra** is a curved lamina of grey matter, characterized by very darkly pigmented nerve cells, which separates the crusta from the tegmentum. It is thicker

mesially than laterally; convex downward, and from the convex side sends projections into the crusta. Commencing at the upper margin of the pons, it extends only as far as the corpora albicantia. When the crusta diverge this lamina continues complete, except for small perforations, and bridges over the space intervening between them as the **posterior perforated lamina.**

The **Corpora Quadrigemina** are two pairs of rounded eminences, composed mainly of grey matter, situated on the dorsal surface of the mid-brain. The upper pair are broader, longer and darker in color, but less prominent than the lower. Laterally they are not bounded by distinct grooves, but are continued as distinct white tracts known as the **brachia.** The **anterior brachium** from the upper corpus passes outward and forward between the two corpora geniculata as a narrow, twisted band to form one root of the optic tract. The **posterior brachium** from the lower corpus loses itself under the internal geniculate body on the side of the mid-brain. Some of its fibres pass on under the geniculate body to join the optic tract as the commissural fibres of Gudden, but they are strictly commissural with the corresponding body of the other side and have nothing to do with sight, because: (1), after extirpation of an eye the anterior brachium atrophies, but the posterior does not; (2), in the mole the posterior brachium is present, but the anterior is not.

The **lower corpora** are made up entirely of grey matter, forming two nuclei connected by commissural fibres. They are separated from the aqueduct of Sylvius by the white lamina alone. The bodies seem to be the termination of the fibres of the lower fillet, and as these fibres become continuous in part with those of the trapezium, which again is connected to the principal auditory nuclei, we must believe a close connection between the lower corpora and the auditory nerve.

The **upper corpora** are larger and less prominent, and have a much more complicated structure. In a general way,

we may say that the fibres of the upper fillet end here, and that fibres concerned in vision leave by the anterior brachium.

The **internal geniculate body** is an oval prominence situated on the antero-lateral part of the mid-brain in close relation with the optic thalamus. It receives the posterior brachium and sends out fibres to the optic tract, as stated, but has nothing to do with sight.

THALAMENCEPHALON.

The thalamencephalon includes optic thalamus, third ventricle, posterior perforated lamina, corpora albicantia, tuber cinereum, infundibulum, pituitary body, lamina cinerea, middle and posterior commissures, pineal gland, optic tracts, external geniculate body.

This part of the brain is deeply placed and covered in at every point except a small area inferiorly, the interpeduncular space. It is a true part of the primary tube, but the fore brain, confined to a limited cavity in its extreme development, has folded back on top of this portion of the tube, "in fact slid all over it." Another example is given here of thickenings and thinnings of the original tube, the walls becoming greatly thickened to form the optic thalami, while the floor is quite thin and the roof, reduced to a single layer of cells, adheres to the velum interpositum.

The **Optic Thalami** are large oblong masses of grey matter situated between the caudate nuclei of the corpora striata and resting on the crusta. Its **dorsal surface** presents a groove, better marked behind, which runs from the anterior part of the internal border obliquely backward and outward. The groove corresponds to the thickened margin of the fornix and divides the dorsal surface into an outer one-fourth and an inner three-fourths. The fourth external to the groove enters into the floor of the lateral ventricle and is limited

externally by a band of white fibres the **taenia semicircularis.** It is broader in front where it presents a prominence, the **anterior tubercle.** The internal three-fourths of the dorsal surface is limited internally by the sharp edge separating the dorsal from the mesial surface. It is broader behind and projects into neither of the ventricles. It has resting upon it for the whole extent the **velum interpositum.** The **posterior extremity** of the thalamus is a rounded prominence known as the **pulvinar,** which projects over and partially conceals the brachia of the corpora quadrigemina. It lies partly in the descending horn of the lateral ventricle and is entirely external to the third ventricle. Below and external to the pulvinar is the **outer geniculate** body, placed just above the **internal geniculate** body (belonging to mid-brain) and separated from the latter by the anterior brachium. **Inferiorly** the optic thalamus rests mainly on the tegmentum. The posterior portion, including the pulvinar and external geniculate body, is free, while the anterior portion rests upon the white matter of the frontal lobe. The corpora albicantia and lateral parts of the tuber cinereum also bear an inferior relation to the thalamus. **Externally** the optic thalamus is closely united to the **internal capsule** by a free interchange of fibres. The **internal surface** is plane and forms the lateral wall of the third ventricle. The **main structure** is of white and grey matter. The main elements of white matter are (1) the tegmentum, entering posteriorly, (2) an anterior tract to the frontal lobe, (3) a lower tract to the hemispheres, and (4) a tract to the lenticular nucleus. The grey matter is divided into a large **lateral nucleus** extending into the pulvinar, a **mesial nucleus,** and an **anterior nucleus** located within the anterior tubercle. The nuclei are divided off by white laminae.

The **Third Ventricle** is the portion of the central canal belonging to the thalamencephalon. It is a perpendicular slit-like expansion of the aqueduct of Sylvius between the

optic thalami, deeper in front than behind and presenting two conical depressions in its floor. One of these lies over the optic commissure in the angle of the lamina cinerea, the **optic recess**; the other lies just behind it over the pituitary body, the **infundibulum**. At its posterior extremity beneath the posterior commissure is the entrance of the aqueduct of Sylvius, while anteriorly we find a communication with each lateral ventricle by the **foramen of Monroe**,—a small opening between the anterior pillar of the fornix and the anterior extremity of optic thalamus. The boundaries of the ventricle are: **Roof**,—the under surface of velum interpositum and choroid plexus, covered by a **single layer of epithelium**, and the posterior commissure. **Laterally** are the inner surfaces of the optic thalamus, which are almost in contact in the median line. Each surface is marked anteriorly by a white curved band, convex forward, representing the buried anterior pillars of the fornix. On the **Floor**, in order from behind forward are the posterior perforated lamina, tegmentum, tuber cinereum, infundibulum, pituitary body, and lamina cinerea covering the optic commissure. The corpora albicantia do not enter into the floor. **Anteriorly** we have the main limb of the lamina cinerea, the anterior pillars of the fornix, and a single layer of epithelium covering the anterior commissure. **Posteriorly** the aqueduct of Sylvius.

The **posterior perforated lamina** is the triangular lamina of grey matter, in reality a continuation of substantia nigra, bridging over the area between the diverging crusta. It extends as far forward as the corpora albicantia, where it becomes continuous with the tuber cinereum. The numerous perforations transmit small vessels.

The **tuber cinereum** is a lamina of grey matter forming a part of the floor of the third ventricle. It is continuous with the posterior perforated lamina behind, opposite the corpora albicantia, and with the lamina cinerea in front, opposite the optic commissure. It extends beneath the optic thalamus

on either side and in the middle is prolonged downwards and forwards as the conical **infundibulum**, to which is attached the pituitary body.

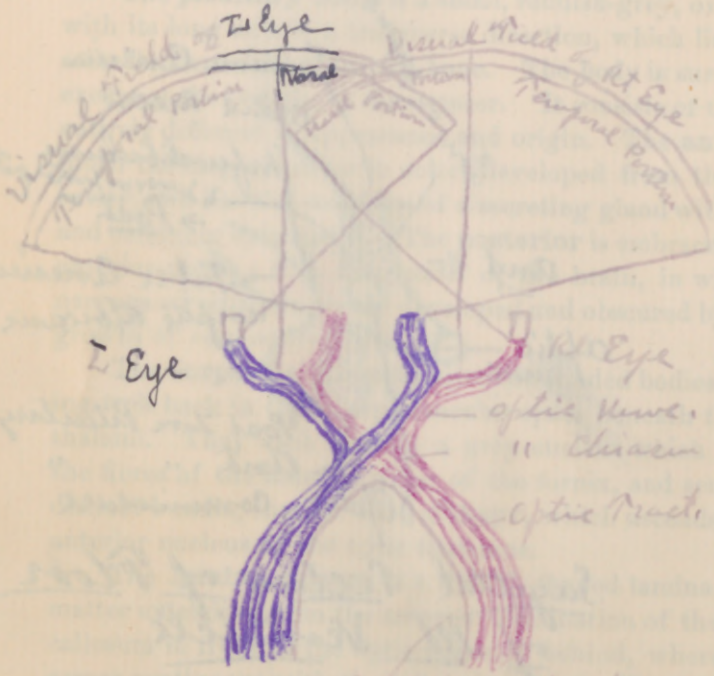
The **pituitary body** is a small, reddish-grey, ovoid mass with its long axis in a transverse direction, which lies in the sella Turcica of the sphenoid bone. The body is surrounded, except at the pedicle, by dura mater. It consists of two lobes entirely different in appearance and origin. The **anterior** is much the larger, darker in color, developed from the buccal cavity, and has the structure of a secreting gland with alveoli and columnar epithelium. The **posterior** is embraced by the anterior and is a true outgrowth of the brain, in which the nervous structure is poorly developed and obscured by the ingrowth of connective tissue.

The **corpora albicantia** are two rounded bodies appearing well back in the interpeduncular space beneath the optic thalami. They each contain a grey nucleus which receives the fibres of the anterior pillar of the fornix, and send out a distinct bundle, that of **Vicq d'Azyr**, which ascends to the anterior nucleus of the optic thalamus.

The **lamina cinerea** is a thin, L-shaped lamina of grey matter extending from the anterior termination of the corpus callosum in front to the optic chiasma behind, where it becomes continuous with the tuber cinereum. The **long arm** is perpendicular and forms the anterior wall of the third ventricle, while the **short arm** is horizontal and lies directly on top of the chiasma. The angle so made forms the anterior or **optic recess** on the floor of the third ventricle. On either side the lamina is continuous with the grey matter of the anterior perforated laminae.

The **anterior perforated lamina** is an outcropping of the slight connecting band of grey matter between the two parts of the corpus striatum. It is a triangular area, bounded posteriorly by the optic tract, internally and externally by the diverging roots of the olfactory nerve. The apex externally

Sagittal Section of Floor of III Ventricle



Optic Tracts showing the Portion of the Visual Field supplied by E

corresponds to the beginning of the fissure of Sylvius, while it is continuous at the base internally with the lamina cinerea. It is crossed by the peduncle of the corpus collosum, an indistinct, white band. The perforating vessels supply the corpus striatum.

Optic tracts and commissure. The optic tracts curve around the crusta on either side, come together just in front of the tuber cinereum, decussate and pass on as optic nerves to the eye. The optic tract has two roots. The **outer** has an apparent and real origin in the external geniculate body. The **inner** is made up of fibres from the optic thalamus which emerge from the sulcus in front of the internal geniculate body; and of the fibres of the anterior brachium, which pass between the two geniculate bodies as a twisted band to join the others. The fibres of the posterior brachium are only commissural, and are not concerned in sight. Only a part of the fibres of each optic tract decussate, the arrangement being such that each tract supplies the corresponding half of each eye.

The **Commissures.** The **anterior commissure** is a rounded cord of white fibres placed transversely in front of the anterior pillars of the fornix, the epithelial wall of the third ventricle and the lamina cinerea. Laterally, the ends pass through the lenticular nucleus to the substance of the hemisphere.

The **middle commissure** is a connecting band of grey matter between the middle nuclei of the optic thalami. It is a free cord, frequently broken, and placed a little in advance of the middle of the ventricle where the walls come nearest together. The **posterior commissure** is a flattened band of white fibres which overlies the entrance of the aqueduct of Sylvius into the third ventricle. Its fibres in part connect the optic thalami, in part are made up of the fibres of the posterior longitudinal bundle and of fibres from the nuclei of the III nerves. It is placed in front of the pineal gland

and furnishes a lamina which contributes to the stalk of this body. The prolongation of the ventricle between this and the lamina formed by the union of the peduncles of the gland, is known as the **pineal recess.**

The **pineal gland** is a conical body resting in the groove between the upper corpora. It is attached by a broad stalk which is formed by the union of the lamina of the posterior commissure with the lamina formed by the convergence of the two peduncles of the pineal gland. The **peduncles** of the gland are two bands of white fibres which pass forward along the optic thalami, in the upper angles of the ventricle, and join the pillars of the fornix about the region of the foramen of Monroe. Traced backwards, the peduncles converge and at the same time expand into a lamina. The triangular area included between the peduncle, pulvinar and upper corpus, is known as **trigonum habenulae** (triangle of the bridle). The pineal gland is composed of a number of hollow follicles, containing gritty, calcareous matter, and separated by ingrowths of connective tissue. It is a true outgrowth of the brain. In some animals the stalk is much elongated and passes to the surface of the skull, in which case the gland has been supposed to be an eye, capable of receiving impressions, and the stalk an optic nerve.

PROSENCEPHALON.

Under the prosencephalon we include the lateral ventricle, corpus callosum, fornix, septum lucidum, corpora striata, taenia semicircularis, velum interpositum, internal capsule, etc.

The **lateral ventricle** is the central canal of this part of the brain, much distorted by the complex development. It may be described as consisting of a body, anterior, posterior and descending horn. The **body** extends from the foramen of Monroe to the extremity of the pulvinar. In the normal condition the ventricle would appear as a transverse slit with its roof and floor in contact. The **anterior cornu** runs forward, downward and outward from the foramen of Monroe into the frontal lobe. It is separated from its fellow of the opposite side by the **septum lucidum** alone. The **posterior cornu** passes backward, in a curve which is convex outward, into the occipital lobe. The **descending** horn is the part of the ventricle taken along with the temporosphenoidal bud in development, but it is not in the center of its mass, because, internally, we find only a single layer of the epithelium, while the whole mass of the lobe lies external to it. The boundaries of each part of the ventricle are best expressed in tabulated form:

	ROOF.	ANT. WALL.	INNER WALL.	FLOOR.	OUTER WALL.
Anterior Cornu.	Corpus Callosum.	Genu of Corpus Callosum.	Septum Lucidum.	1. The angle of junction of caudate n. and Septum Lucidum. 2. Rostrum of Corpus Callosum.	Caudate nucleus.
Body.	Corpus Callosum. (tapetum)		1. Septum Lucidum, 2. Junction of fornix and Corp. Call.	1. Caudate n. 2. Taenia Semicircularis. 3. Optic Thalamus. 4. Choroid plexus. 5. Fornix— (*a*) body. (*b*) post. pillar.	No outer wall. An angle of junction between Corp. Call. and white matter.
Descendi'g Cornu.	(1) Corp. Call. (2) Pulvinar. (3) Int. Capsule. (4) Taenia Semicircularis. (*b*) Surcingle.		Transverse fissure.	(1) Eminentia collateralis. (2) Hippocampus major. (3) Pes hippocampi. (4) Corpus Fimbriatum. (5) Choroid plexus.	White matter of Temporo-Sphenoidal lobe.
Posterior Cornu.	Corpus Callosum.		Bulb caused by forceps major.	Hippocampus minor.	White matter of occipital lobe.

The optic thalamus does not in reality form a part of the floor of the body of the lateral ventricle. The floor of the ventricle, between the edge of the fornix and the taenia semicircularis, has become thinned to a single layer of cells, but this layer is, nevertheless, still the true floor. The optic thalamus merely **happens to lie under this part**, and, practically, when we see the floor of the ventricle we see the optic thalamus **through** the single layer of cells. In other words, the optic thalamus never formed a part of the prosencephalon, and therefore cannot form a wall to its cavity.

The **taenia semicircularis** is a narrow band of white fibres, which lies in the groove separating the caudate nucleus

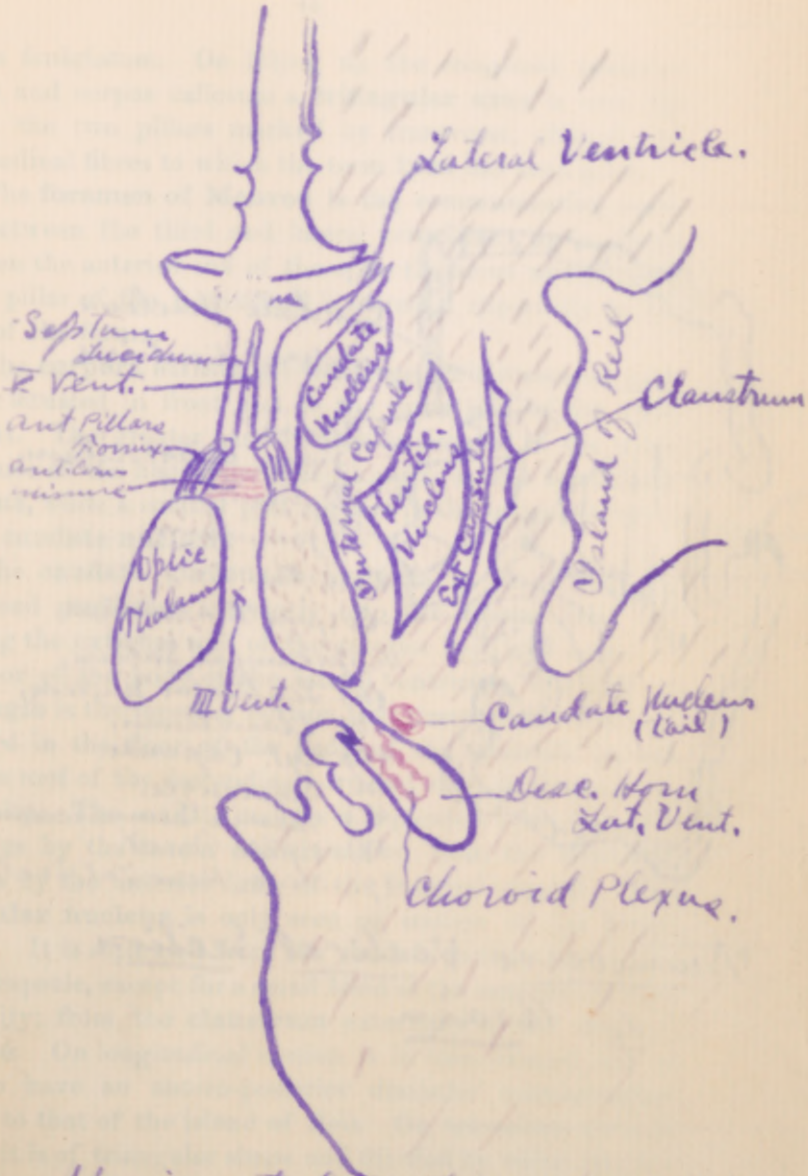
from the optic thalamus. It takes its origin in the nucleus amygdala, at the apex of the descending horn of the ventricle, passes up in the roof of the cornu and curves around into the floor of the body of the ventricle. A part, at least, of its fibres join the anterior pillar of the fornix near the foramen of Monroe; the rest are uncertain.

The **corpus callosum**, or great commissure, is the connecting band between the two cerebral hemispheres seen at the bottom of the great longitudinal fissure. It connects the hemispheres throughout nearly half their length, approaches closer to the front than the back, and has a thickness considerable in all parts but greatest at the ends. The upper surface is principally marked by transverse striae, but presents on either side of the median line longitudinal white bundles, the nerves of Lancisi. On each side, near the margin, are seen other longitudinal striae. Both sets are traced posteriorly into the gyrus dentatus (fascia dentata). In front the corpus callosum is reflected downward and backward, forming a bend named the **genu**. The reflected portion, termed the **rostrum**, becomes gradually narrower as it descends and is connected with the lamina cinerea by a thin white layer. It gives off also two bands of substance, the **peduncles of the corpus callosum**, which diverge from one another, run across the anterior perforated space to the tip of the temporal lobe. Traced upwards around the genu these peduncles are found to be continuous with the nerves of Lancisi. Behind, the corpus callosum terminates in a free thickened border named the **splenium**. The mesial part of the **under surface** of corpus callosum is connected with the fornix behind and in the rest of its length with the **septum lucidum**. On the sides it forms the roof of the anterior horn and body of the lateral ventricle. The fibres pass in a radiating manner, interlacing with those of the **internal capsule**, through the medullary substance to the cortex. Those fibres which sweep round into the prefrontal region form the **forceps**

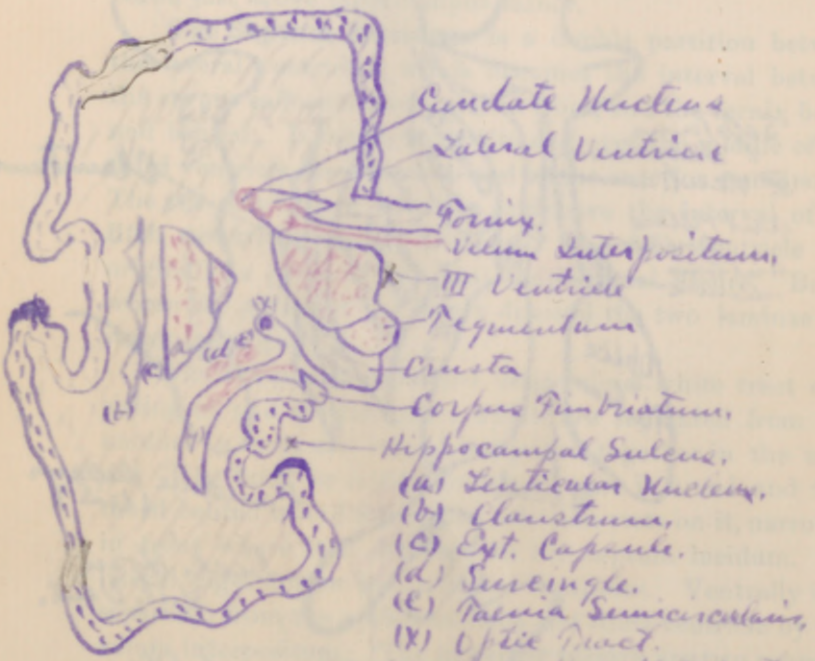
minor, those curving over the lateral ventricle take the name of **tapetum,** while the large mass of fibres of the splenium curves round into the occipital lobe as the **forceps major,** making the prominence of the **bulb** in the posterior cornu just above hippocampus minor.

The **Septum Lucidum** is a double partition between the lateral ventricles, which occupies the interval between the corpus callosum above and in front, and the fornix below and behind. It tapers behind to end over the middle of the third ventricle, and below to end at the anterior commissure. The two laminae are distinct and have the interval of the **fifth ventricle** between them. The fifth ventricle was originally a part of the great longitudinal fissure. Below where the pillars of the fornix descend the two laminae are separated slightly.

The **Fornix** is an arched longitudinal white tract consisting of two lateral halves which are separated from one another in front and behind but joined together in the middle. The **body** or middle conjoined part is broad and flattened behind where the corpus callosum rests on it, narrower in front where it is attached to the septum lucidum. Its lateral edges appear in the lateral ventricles. Ventrally it is separated from the optic thalamus and third ventricle by the velum interpositum. The **anterior pillars** are two rounded cords, slightly separated, which pass down in front of the foramen of Monroe and through the grey matter of the walls of the third ventricle to the **corpora albicantia** where they end. Each pillar is connected near the foramen of Monroe with the fibres of the peduncles of the pineal gland and a part of the fibres of the taenia semicircularis. The **posterior pillars** are the two flat posterior prolongations, which diverge rapidly and pass down over the pulvinar into the descending horns of the lateral ventricles. Here some of the fibres are distributed to the surface of the hippocampus major, and the remainder are continued into the



Horizontal Section Hemispheres



Transverse Vertical Section

of Brain

corpus fimbriatum. On lifting up the conjoined posterior pillars and corpus callosum a **triangular area** is seen between the two pillars marked by transverse, oblique and longitudinal fibres to which the term **lyra** has been given.

The **foramen of Monroe** is the communicating aperture between the third and lateral ventricles. It is placed between the anterior end of the optic thalamus and the anterior pillar of the fornix, and is bounded superiorly by the body of the fornix.

The **corpora striata** are two large ovoid masses of grey matter situated in front and to the outer side of the optic thalami. The greater part of each is situated in the white substance of the hemispheres and known as the **lenticular nucleus,** while a smaller part appears in the lateral ventricle as the **caudate nucleus.**

The **caudate nucleus** is pyriform in shape with its large end projecting anteriorly into the frontal lobe and forming the external wall of the anterior horn and a part of the floor of the body of the lateral ventricle. The **tail** or **surcingle** is the tapering portion that passes backward and outward in the floor of the body of the ventricle, curves into the roof of the descending horn and extends almost to its extremity. The caudate nucleus is separated from the optic thalamus by the taenia semicircularis; from the lenticular nucleus by the anterior limb of the internal capsule. The **lenticular nucleus** is only seen on section of the hemisphere. It is separated from the caudate nucleus by the internal capsule, except for a small band at the anterior inferior extremity; from the **claustrum** externally by the external **capsule.** On longitudinal section it is lense-shaped and is seen to have an antero-posterior diameter corresponding closely to that of the island of Reil. On transverse vertical section it is of triangular shape and divided by white laminæ into an outer striated zone, the **putamen,** and two inner zones known conjointly as the **globus pallidus.**

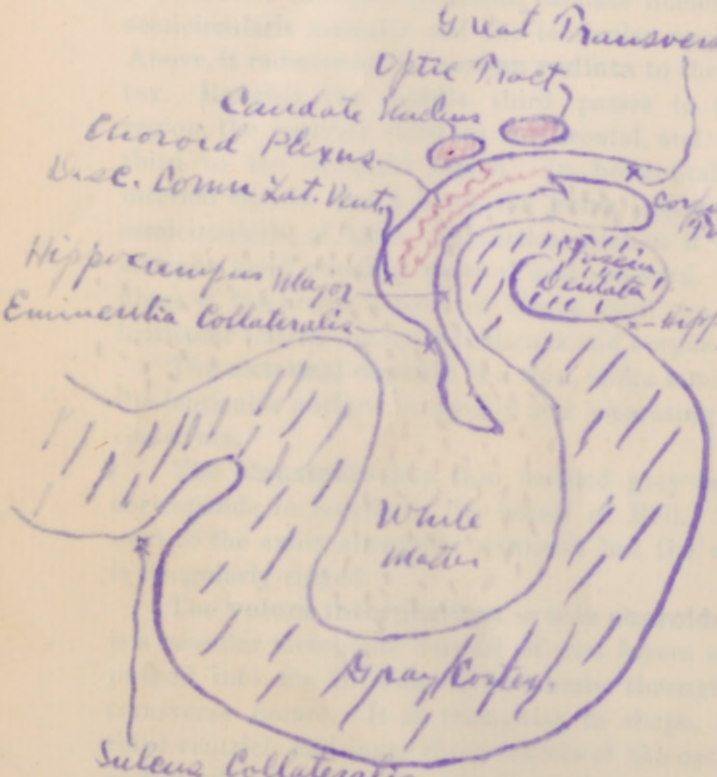
The **internal capsule** is a lamellated tract of white fibres, the direct continuation upward of the crusta, which lies between the optic thalamus, caudate nucleus and taenia semicircularis mesially and the lenticular nucleus laterally. Above, it radiates as the **corona radiata** to the cerebral cortex. Roughly the middle third passes to the Rolandic region, the anterior third to the frontal, and the posterior third to the occipital region. In horizontal section the internal capsule has a bend, the **genu,** opposite the taenia semicircularis, of 120°. In vertical section it appears as a straight band running upward and outward. Besides the fibres of the crusta it receives others from the caudate and lenticular nuclei, the optic thalamus and corpus callosum.

The **external capsule** is a thin, white lamina bounding the lenticular nucleus externally and separating it from the claustrum.

The **claustrum** is a thin isolated grey lamina, which corresponds in length to the island of Reil. The surface next to the external capsule is smooth but the outer surface is irregularly ridged.

The **velum interpositum** or **tela choroidea superior** is a vascular membrane formed of two layers of pia mater pushed into the interior of the brain through the great transverse fissure. It is triangular in shape, overlies the third ventricle and inner three-fourths of the optic thalamus, and is placed directly under the body of the fornix. Its **apex** is bifid at the foramen of Monroe, its **sides** project into the lateral ventricles as the **choroid plexus** from underneath the fornix, and the **base** is continuous with the general pia mater. Large veins, the Vanae Geleni, run between its layers.

The **hippocampus minor** is the prominence in the floor of the posterior cornu of the lateral ventricle caused by the pushing inward of the brain substance by the **calcarine** fissure on the mesial surface of the hemisphere.



Section Through Left Hippocampal Region.

The **hippocampus major** which occupies the whole length of the floor of the descending cornu, is in a like manner formed by the **hippocampal** or **dentate fissure.** This and the eminentia collateralis are best understood by reference to the diagrams. The lower end of the hippocampus major is enlarged, has notched edges and is known as the **pes hippocampi.**

The **eminentia collateralis** is a rounded prominence situated in the angle of divergence of the hippocampus major and minor and running down into the descending cornu parallel to the hippocampus major. It is caused by **collateral fissure** protruding inward.

The **corpus fimbriatum** is the prolongation downward of the posterior pillar of the fornix which passes along the concave edge of the hippocampus major to end in the white matter of the **uncus.** It represents the white matter of the hemisphere which here comes to the surface along the edge of the dentate gyrus. It exists only in the descending horn.

The **fascia dentata** is the name given to the peculiarly toothed and notched free edge of the dentate gyrus, where its grey matter stops short at the surface just below the great transverse fissure. It does not enter into the lateral ventricle as the figure will show. It begins posteriorly just above and behind the splenium in the nerves of Lancisi, passes down along the upper border of the hippocampal gyrus to the uncus where it becomes lost.

The **great transverse fissure** is a line of a horseshoe shape along which is found only a single layer of epithelium between the lateral ventricle and the external surface of the brain. Beginning forward beneath the lateral edge of the body of the fornix it follows the plane of the body and posterior pillar of the fornix down into the descending cornu of the ventricle to its apex. The fissure, then, would lie between the body of the fornix and the optic thalamus, above: between the posterior pillar of the fornix and the pulvinar a

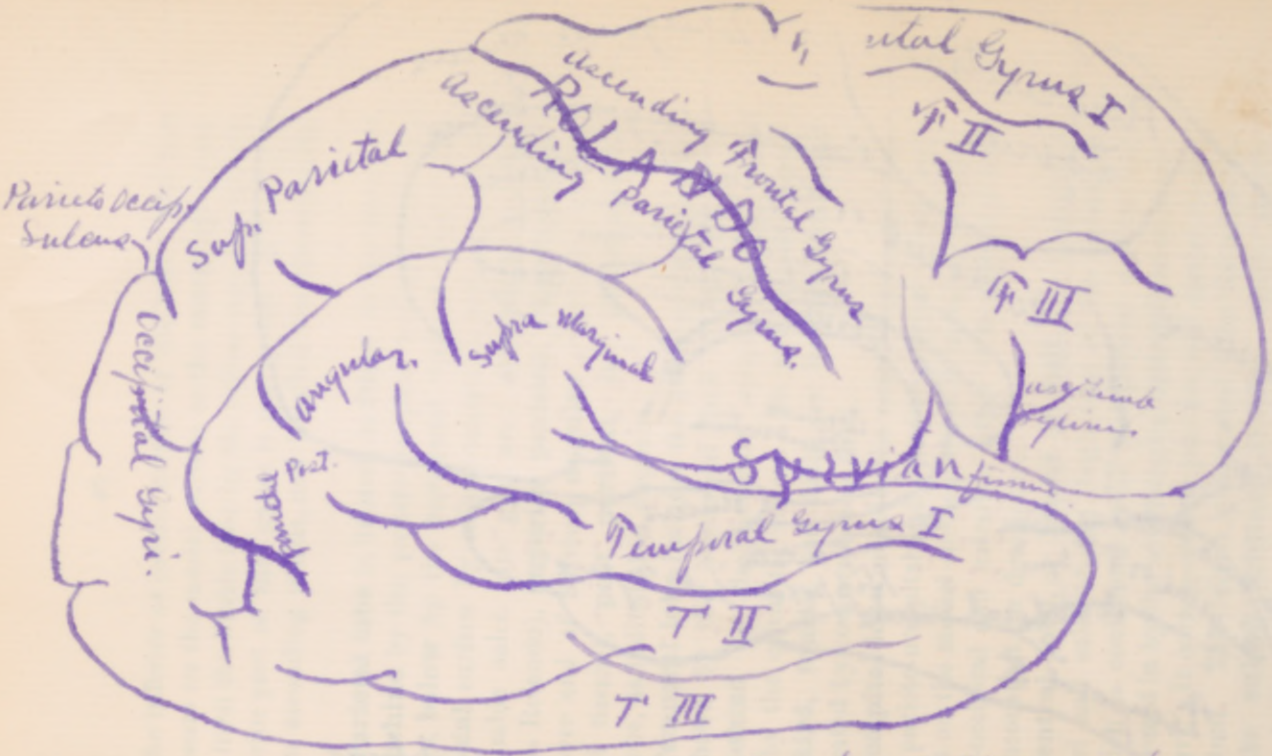
little further back; between the under surface of the pulvinar and the corpus fimbriatum in the first part of the descending cornu; and finally between the white matter of the cerebrum and the corpus fimbriatum nearer the apex. Throughout the whole length of the fissure the pia mater pushes into the ventricle to form the many convolutions of the choroid plexus, and pushes ahead of it a single layer of cells. This single layer of cells represents the primary wall of the ventricular canal thinned down to this degree in the course of development. Throughout the whole course the layer of cells extends, as a bridge of tissue following every convolution of the choroid plexus, between the edge of the fornix on the one side and the taenia semicircularis on the other. If the pia mater is pulled away from this region the single layer of cells is torn away and the lateral ventricle is open for the whole length of the great transverse fissure.

Cerebral Lobes and Convolutions.

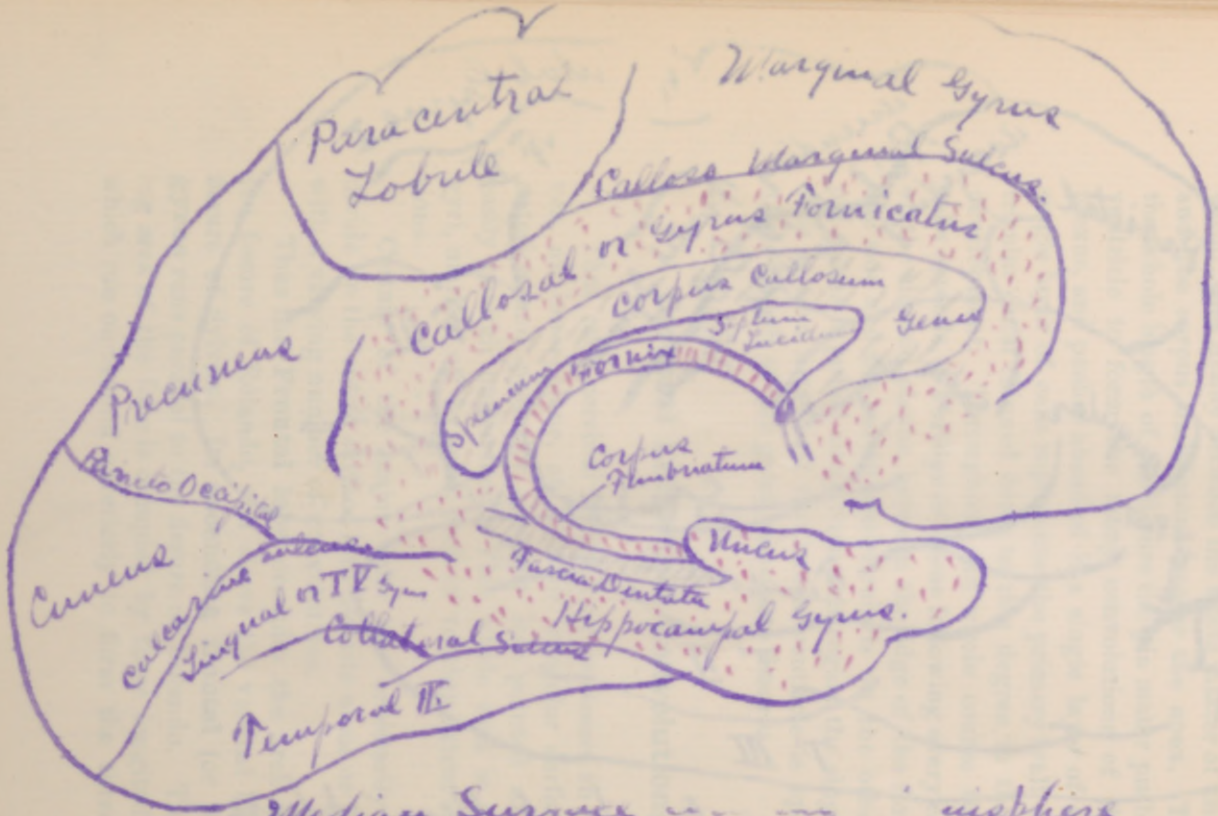
That each cerebral hemisphere possesses an outer convex, an inner plane, an inferior irregular surface, and an anterior and posterior more or less pointed extremity is easily enough understood. This whole area is made up of gyri, marked off by sulci, each of varying extent and dimensions.

Certain of the major sulci are arbitrarily taken to divide up the entire surface into definite areas or **lobes** each with a varying number of convolutions.

Thus the **Frontal lobe** occupies the area in front of the fissure of Rolando, and above the vertical limb of the fissure of Sylvius. Its **ascending frontal** (or precentral) **gyrus** runs parallel to the fissure of Rolando. The remaining area of the lobe is occupied by three longitudinal gyri, which run on around anteriorly to form the three **orbital**



External Surface of Cerebral Hemisphere.



Median Surface of the hemisphere

gyri on the inferior or orbital surface of the lobe. The first gyrus appears on the mesial surface as the **marginal** gyrus, separated from the limbic lobe by the calloso-marginal fissure. The posterior part of this gyrus is nearly cut off from the rest by an ascending sulcus, and is called the **paracentral lobule.**

The **Parietal lobe** is limited, in **front** by the fissure of Rolando, **behind** by the parieto-occipital and anterior occipital sulcus, **below** by the horizontal limb of Sylvius, and on the **mesial** surface by calloso-marginal, parieto-occipital and post-limbic sulci. Its gyri are: **ascending parietal** (parallel to Rolando), **superior parietal, supramarginal** (curving over end of Sylvius), **angular** (curving over end of parallel fissure), **post parietal**, and **precuneus** or quadrate lobe, as indicated in diagram.

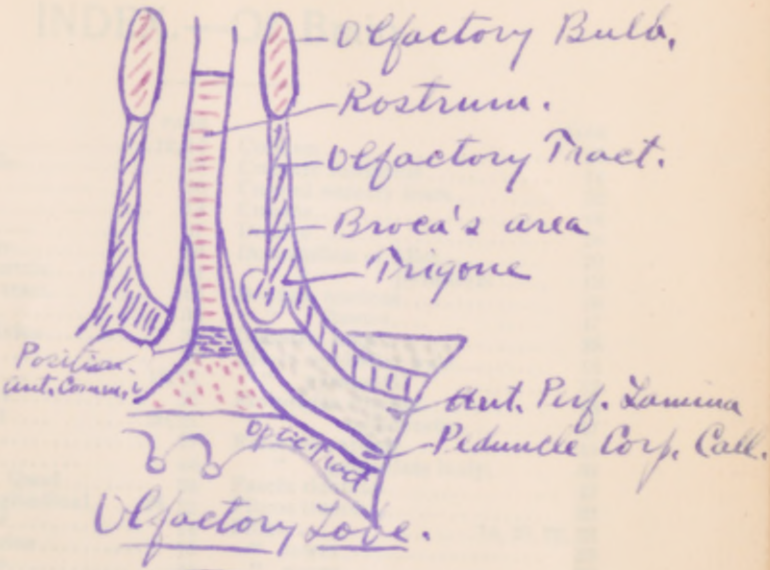
The **Temporal lobe** includes the lower prominent area, limited **above** by the horizontal limb of the fissure of Sylvius, **behind** by the anterior occipital sulcus, and **mesially** by the calcarine sulcus. Its gyri are the **first, second, third, fourth** and **fifth** (or lingual) **temporal gyri**, separated by corresponding sulci.

The **Occipital lobe** includes the remaining limited area behind the parieto-occipital and anterior occipital sulcus, and the **cuneus** on the mesial surface which is included between the parieto-occipital and calcarine sulci. The gyri are too small and inconstant for description.

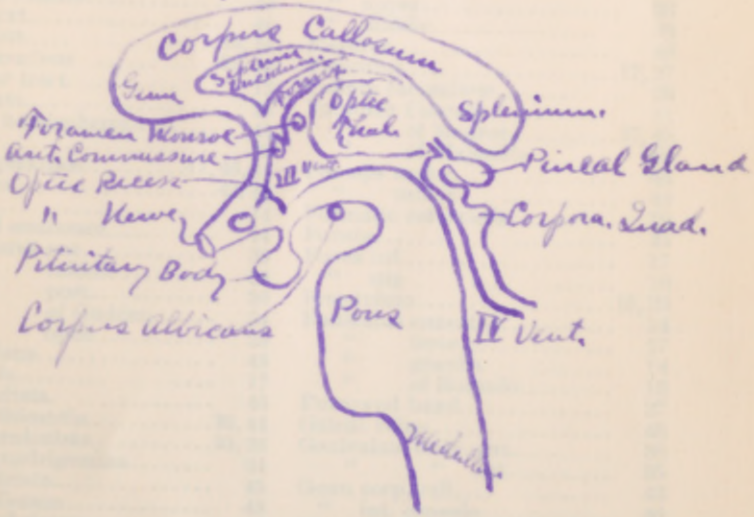
The **Central lobe**, or **Island of Reil** is a triangular area of gyri and sulci at the beginning of the fissure of Sylvius, which is continuous with the general surface, but has been covered in by the overhanging **operculum** and surrounding gyri. It corresponds in position and extent to the corpus striatum. The Island is separated from the adjacent parts by the **sulcus limitans insulae** which almost entirely surrounds it.

The **Limbic lobe** (a morphological lobe) is a long, rather narrow area, making almost a complete oval on the mesial surface of the hemisphere. It is arranged, as indicated by the dotted area in the diagram, about the corpus callosum and descending horn of the lateral ventricle. It includes **gyrus fornicatus, dentate gyrus** (or fascia), **corpus fimbriatum, hippocampal gyrus** and **sulcus.**

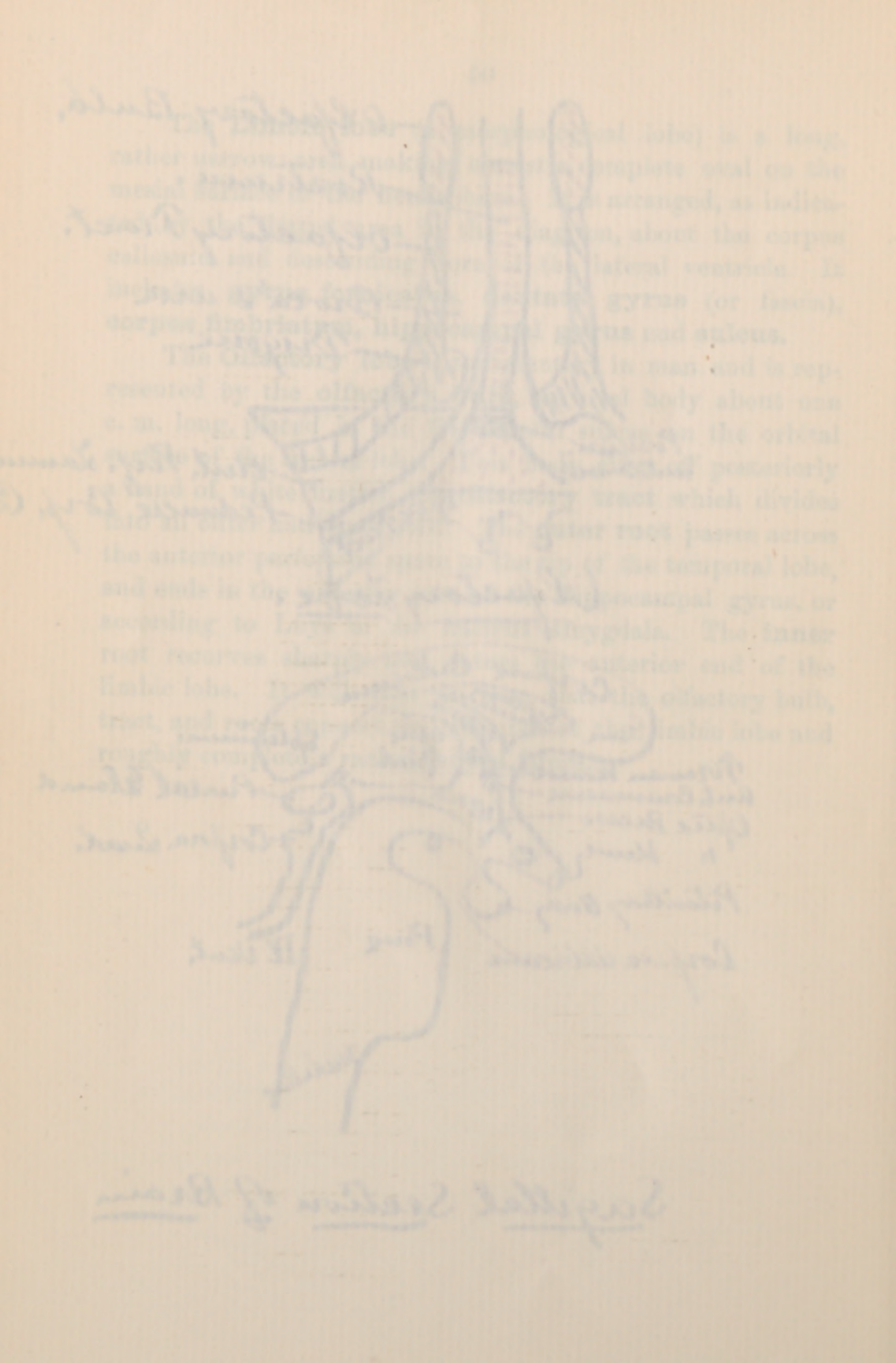
The **Olfactory lobe** is rudimentary in man and is represented by the **olfactory bulb,** an oval body about one c. m. long, placed in the first frontal sulcus on the orbital surface of the frontal lobe. This body gives off posteriorly a band of white matter, the **olfactory tract** which divides into an outer and inner root. The **outer root** passes across the anterior perforated space to the tip of the temporal lobe, and ends in the anterior part of the hippocampal gyrus, or according to Luys in the nucleus amygdala. The **inner** root recurves sharply and enters the anterior end of the limbic lobe. It will thus be seen that the olfactory bulb, tract, and roots connect the two ends of the limbic lobe and roughly complete a racket shaped figure.



Olfactory Lobe.



Sagittal Section of Brain



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