Kalpa in the Physiology

According to the research of Professor Tony Nader, in *Human Physiology: Expression of Veda and the Vedic Literature*, 4th Edition, Maharishi Vedic University, Vlodrop, Holland, 2000,
Kalpa is represented in the physiology by the various structures in the brain that together constitute the limbic system.

The following excerpts are taken from *Anatomy of the Human Body*, 20th Edition, Henry Gray and Warren Lewis, Lea & Febiger, Philadelphia, 1918, pp. 746-869.

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Part I: The Limbic System (also called the Rhinencephalon)

Limbic Lobe (Fig. 727).—The term limbic lobe was introduced by Broca, and under it he included the cingulate and hippocampal gyri, which together arch around the corpus callosum and the hippocampal fissure. These he separated on the morphological ground that they are well-developed in animals possessing a keen sense of smell (osmatic animals), such as the dog and fox. They were thus regarded as a part of the rhinencephalon, but it is now recognized that they belong to the neopallium; the cingulate gyrus is therefore sometimes described as a part of the frontal lobe, and the hippocampal as a part of the temporal lobe.

The **cingulate gyrus** (*gyrus cinguli; callosal convolution*) is an arch-shaped convolution, lying in close relation to the superficial surface of the corpus callosum, from which it is separated by a slit-like fissure, the **callosal fissure**. It commences below the rostrum of the corpus callosum, curves around in front of the genu, extends along the upper surface of the body, and finally turns downward behind the splenium, where it is connected by a narrow **isthmus** with the hippocampal

gyrus. It is separated from the medial part of the superior frontal gyrus by the cingulate sulcus, and from the precuneus by the subparietal sulcus.

The **hippocampal gyrus** (*gyrus hippocampi*) is bounded above by the hippocampal fissure, and below by the anterior part of the collateral fissure. Behind, it is continuous superiorly, through the isthmus, with the cingulate gyrus and inferiorly with the lingual gyrus. Running in the substance of the cingulate and hippocampal gyri, and connecting them together, is a tract of arched fibers, named the **cingulum** (page 843). The anterior extremity of the hippocampal gyrus is recurved in the form of a hook (**uncus**), which is separated from the apex of the temporal lobe by a slight fissure, the **incisura temporalis**. Although superficially continuous with the hippocampal gyrus, the uncus forms morphologically a part of the rhinencephalon.

The **Hippocampal Fissure** (*fissura hippocampi; dentate fissure*) begins immediately behind the splenium of the corpus callosum, and runs forward between the hippocampal and dentate gyri to end in the uncus. It is a complete fissure (page 819), and gives rise to the prominence of the hippocampus in the inferior cornu of the lateral ventricle.

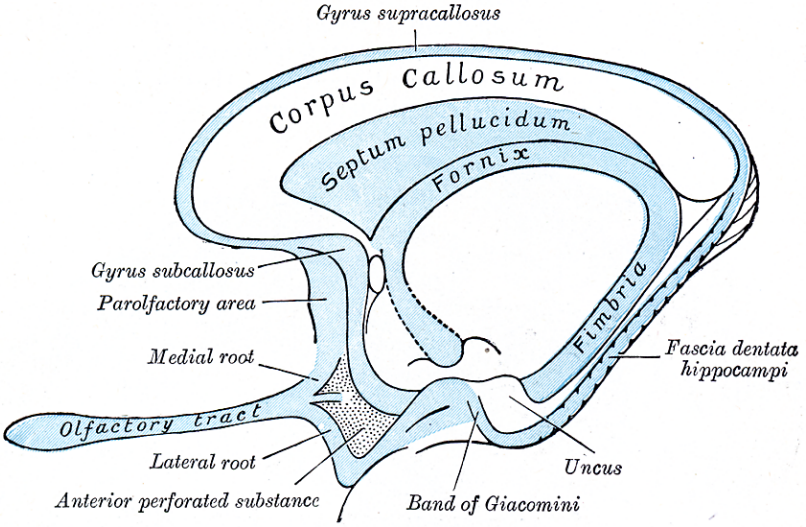

FIG. 732.—Scheme of rhinencephalon.

Rhinencephalon (Fig. 732).—The rhinencephalon comprises the **olfactory lobe**, the **uncus**, the **subcallosal** and **supracallosal gyri**, the **fascia dentata hippocampi**, the **septum pellucidum**, the **fornix**, and the **hippocampus**.

1. The **Olfactory Lobe** (*lobus olfactorius*) is situated under the inferior or orbital surface of the frontal lobe. In many vertebrates it constitutes a well-marked portion of the hemisphere and contains an extension of the lateral ventricle; but in man and some other mammals it is rudimentary. It consists of the **olfactory bulb** and **tract**, the **olfactory trigone**, the **parolfactory area of Broca**, and the **anterior perforated substance**.

(*a*) The **olfactory bulb** (*bulbus olfactorius*) is an oval, reddish-gray mass which rests on the cribriform plate of the ethmoid and forms the anterior expanded extremity of the olfactory tract. Its under surface receives the olfactory nerves, which pass upward through the cribriform plate from the olfactory region of the nasal cavity. Its minute structure is described on page 848.

(*b*) The **olfactory tract** (*tractus olfactorius*) is a narrow white band, triangular on coronal section, the apex being directed upward. It lies in the olfactory sulcus on the inferior surface of the frontal lobe, and divides posteriorly into two striæ, a medial and a lateral. The **lateral stria** is directed across the lateral part of the

anterior perforated substance and then bends abruptly medialward toward the uncus of the hippocampal gyrus. The **medial stria** turns medialward behind the parolfactory area and ends in the subcallosal gyrus; in some cases a small **intermediate stria** is seen running backward to the anterior perforated substance.

(*c*) The **olfactory trigone** (*trigonum olfactorium*) is a small triangular area in front of the anterior perforated substance. Its apex, directed forward, occupies the posterior part of the olfactory sulcus, and is brought into view by throwing back the olfactory tract.

(*d*) The **parolfactory area of Broca** (*area parolfactoria*) is a small triangular field on the medial surface of the hemisphere in front of the subcallosal gyrus, from which it is separated by the posterior parolfactory sulcus; it is continuous below with the olfactory trigone, and above and in front with the cingulate gyrus; it is limited anteriorly by the anterior parolfactory sulcus.

(*e*) The **anterior perforated substance** (*substantia perforata anterior*) is an irregularly quadrilateral area in front of the optic tract and behind the olfactory trigone, from which it is separated by the **fissure prima**; medially and in front it is continuous with the subcallosal gyrus; laterally it is bounded by the lateral stria of the olfactory tract and is continued into the uncus. Its gray substance is confluent above with that of the corpus striatum, and is perforated anteriorly by numerous small bloodvessels.

2. The **Uncus** has already been described (page 826) as the recurved, hook-like portion of the hippocampal gyrus.

3. The **Subcallosal, Supracallosal,** and **Dentate Gyri** form a rudimentary arch-shaped lamina of gray substance extending over the corpus callosum and above the hippocampal gyrus from the anterior perforated substance to the uncus.

(*a*) The **subcallosal gyrus** (*gyrus subcallosus; peduncle of the corpus callosum*) is a narrow lamina on the medial surface of the hemisphere in front of the lamina terminalis, behind the parolfactory area, and below the rostrum of the corpus callosum. It is continuous around the genu of the corpus callosum with the supra-callosal gyrus.

(*b*) The **supracallosal gyrus** (*indusium griseum; gyrus epicallosus*) consists of a thin layer of gray substance in contact with the upper surface of the corpus callosum and continuous laterally with the gray substance of the cingulate gyrus. It contains two longitudinally directed strands of fibers termed respectively the **medial** and **lateral longitudinal striæ.** The supracallosal gyrus is prolonged around the splenium of the corpus callosum as a delicate lamina, the **fasciola cinerea,** which is continuous below with the fascia dentata hippocampi.

(*c*) The **fascia dentata hippocampi** (*gyrus dentatus*) is a narrow band extending downward and forward above the hippocampal gyrus but separated from it by the hippocampal fissure; its free margin is notched and overlapped by the fimbria —the **fimbriodentate fissure** intervening. Anteriorly it is continued into the notch of the uncus, where it forms a sharp bend and is then prolonged as a delicate band, the **band of Giacomini,** over the uncus, on the lateral surface of which it is lost.

The remaining parts of the rhinencephalon, viz., the septum pellucidum, fornix, and hippocampus, will be described in connection with the lateral ventricle.

Part II: The Septum Pellucidum, Fornix, and Hippocampus in relation to the Lateral Ventricles

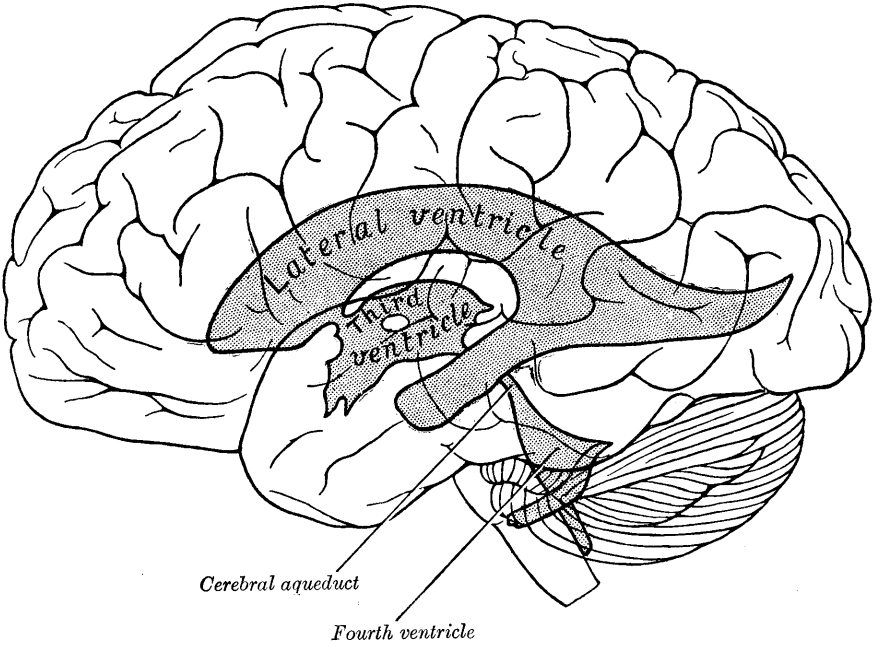

FIG. 734.—Scheme showing relations of the ventricles to the surface of the brain.

The Lateral Ventricles (*ventriculus lateralis*) (Fig. 734).—The two lateral ventricles are irregular cavities situated in the lower and medial parts of the cerebral hemispheres, one on either side of the middle line. They are separated from each other by a median vertical partition, the **septum pellucidum,** but communicate with the third ventricle and indirectly with each other through the **interventricular foramen.** They are lined by a thin, diaphanous membrane, the **ependyma,** covered by ciliated epithelium, and contain cerebrospinal fluid, which, even in health, may be secreted in considerable amount. Each lateral ventricle consists of a **central part** or **body,** and three prolongations from it, termed **cornua** (Figs. 735, 736).

The **central part** (*pars centralis ventriculi lateralis; cella*) (Fig. 737) of the lateral ventricle extends from the interventricular foramen to the splenium of the corpus

callosum. It is an irregularly curved cavity, triangular on transverse section, with a roof, a floor, and a medial wall. The roof is formed by the under surface of the corpus callosum; the floor by the following parts, enumerated in their order of position, from before backward: the caudate nucleus of the corpus striatum, the

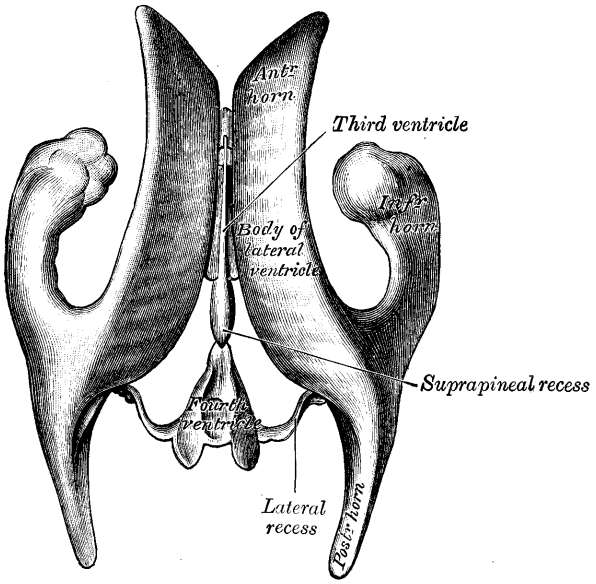

FIG. 735.—Drawing of a cast of the ventricular cavities, viewed from above. (Retzius.)

stria terminalis and the terminal vein, the lateral portion of the upper surface of the thalamus, the choroid plexus, and the lateral part of the fornix; the medial wall is the posterior part of the septum pellucidum, which separates it from the opposite ventricle.

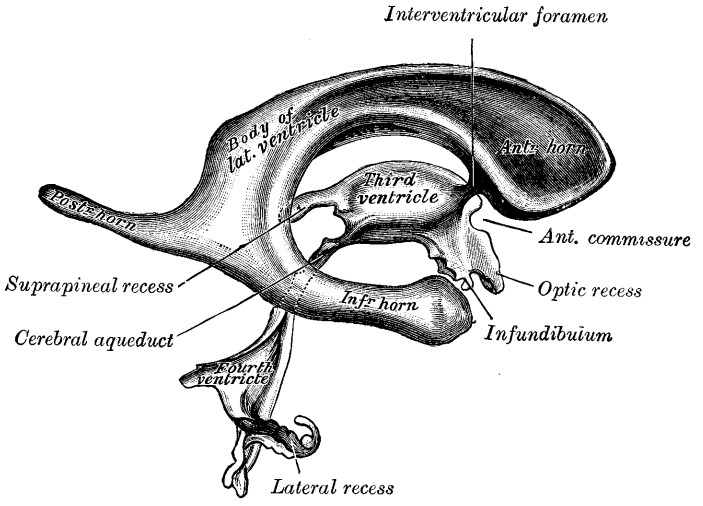

FIG 736.—Drawing of a cast of the ventricular cavities, viewed from the side. (Retzius.)

The **anterior cornu** (*cornu anterius; anterior horn; precornu*) (Fig. 736) passes forward and lateralward, with a slight inclination downward, from the interventricular foramen into the frontal lobe, curving around the anterior end of the caudate nucleus. Its floor is formed by the upper surface of the reflected portion of the

corpus callosum, the **rostrum.** It is bounded medially by the anterior portion of the septum pellucidum, and laterally by the head of the caudate nucleus. Its apex reaches the posterior surface of the genu of the corpus callosum.

The **posterior cornu** (*cornu posterius; postcornu*) (Figs. 737, 738) passes into the occipital lobe, its direction being backward and lateralward, and then medialward. Its roof is formed by the fibers of the corpus callosum passing to the temporal and occipital lobes. On its medial wall is a longitudinal eminence, the **calcar avis** (*hippocampus minor*), which is an involution of the ventricular wall produced by the calcarine fissure. Above this the forceps posterior of the corpus callosum, sweeping around to enter the occipital lobe, causes another projection, termed the **bulb of the posterior cornu.** The calcar avis and bulb of the posterior cornu are extremely variable in their degree of development; in some cases they are ill-defined, in others prominent.

FIG. 737.—Central part and anterior and posterior cornua of lateral ventricles exposed from above.

The **inferior cornu** (*cornu inferior; descending horn; middle horn; medicornu*) (Fig. 739), the largest of the three, traverses the temporal lobe of the brain, forming in its course a curve around the posterior end of the thalamus. It passes at first backward, lateralward, and downward, and then curves forward to within 2.5 cm. of the apex of the temporal lobe, its direction being fairly well indicated on the surface of the brain by that of the superior temporal sulcus. Its roof is formed chiefly by the inferior surface of the tapetum of the corpus callosum, but the tail of the caudate nucleus and the stria terminalis also extend forward in the roof of the inferior cornu to its extremity; the tail of the caudate nucleus joins the

putamen. Its floor presents the following parts: the hippocampus, the fimbria hippocampi, the collateral eminence, and the choroid plexus. When the

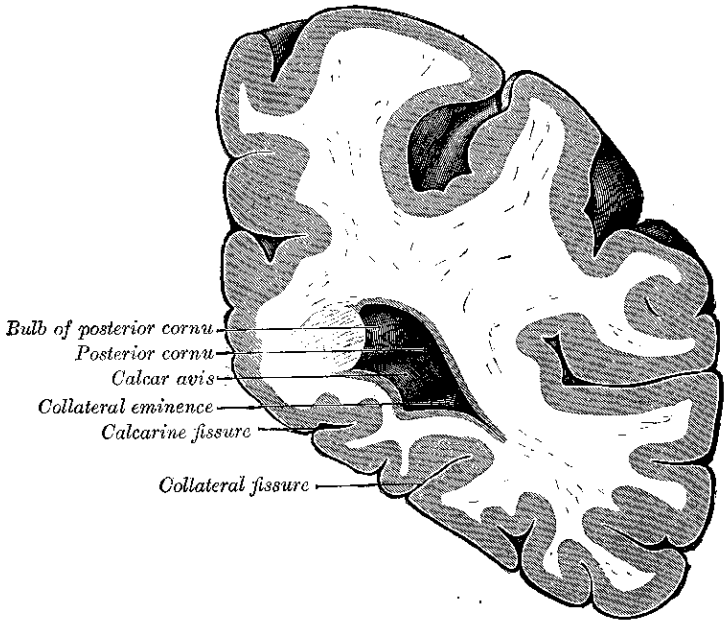

FIG. 738.—Coronal section through posterior cornua of lateral ventricle

choroid plexus is removed, a cleft-like opening is left along the medial wall of the inferior cornu; this cleft constitutes the lower part of the choroidal fissure.

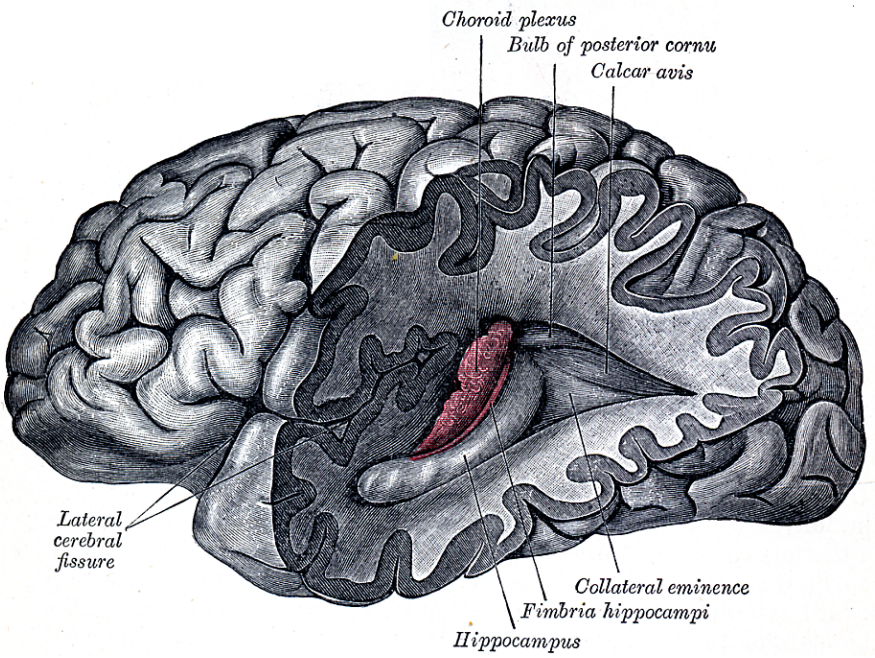

FIG. 739.—Posterior and inferior cornua of left lateral ventricle exposed from the side.

The **hippocampus** (*hippocampus major*) (Figs. 739, 740) is a curved eminence, about 5 cm. long, which extends throughout the entire length of the floor of the

inferior cornu. Its lower end is enlarged, and presents two or three rounded elevations or digitations which give it a paw-like appearance, and hence it is named the **pes hippocampi.** If a transverse section be made through the hippocampus, it will be seen that this eminence is produced by the folding of the wall of the hemisphere to form the hippocampal fissure. The main mass of the hippocampus consists of gray substance, but on its ventricular surface is a thin white layer, the **alveus,** which is continuous with the fimbria hippocampi.

The **collateral eminence** (*eminentia collateralis*) (Fig. 740) is an elongated swelling lying lateral to and parallel with the hippocampus. It corresponds with the middle part of the collateral fissure, and its size depends on the depth and direction of this fissure. It is continuous behind with a flattened triangular area, the **trigonum collaterale,** situated between the posterior and inferior cornua.

The fimbria hippocampi is a continuation of the crus of the fornix, and will be discussed with that body; a description of the choroid plexus will be found on page 840.

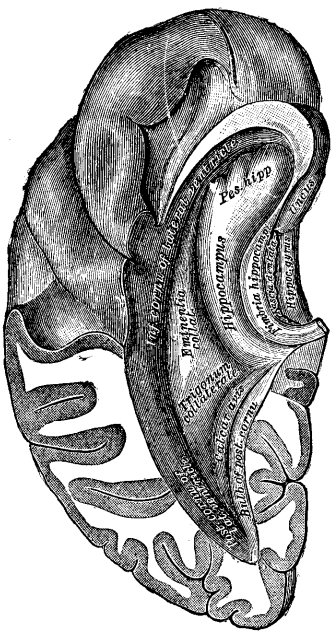

FIG. 740.—Inferior and posterior cornua, viewed from above.

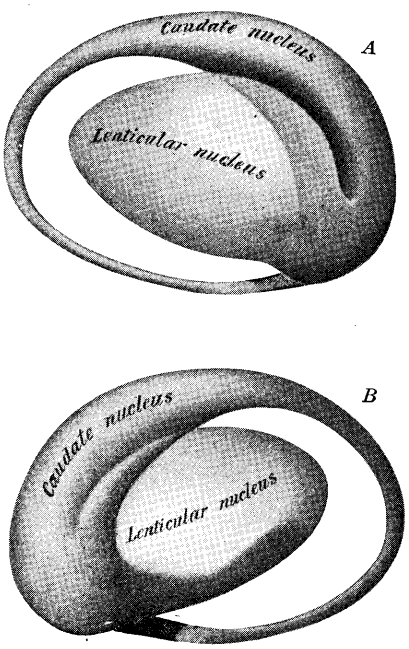

FIG. 741.—Two views of a model of the striatum: *A*, lateral aspect; *B*, mesal aspect.

The **corpus striatum** has received its name from the striped appearance which a section of its anterior part presents, in consequence of diverging white fibers being mixed with the gray substance which forms its chief mass. A part of the corpus striatum is imbedded in the white substance of the hemisphere, and is therefore external to the ventricle; it is termed the **extraventricular portion,** or the **lentiform nucleus**; the remainder, however, projects into the ventricle, and is named the **intraventricular portion,** or the **caudate nucleus** (Fig. 737).

The **caudate nucleus** (*nucleus caudatus; caudatum*) (Figs. 741, 742) is a pear-shaped, highly arched gray mass; its broad extremity, or **head,** is directed forward into the anterior cornu of the lateral ventricle, and is continuous with the anterior perforated substance and with the anterior end of the lentiform nucleus; its narrow end, **or tail,** is directed backward on the lateral side of the thalamus, from which it is

separated by the stria terminalis and the terminal vein. It is then continued downward into the roof of the inferior cornu, and ends in the putamen near the apex of the temporal lobe. It is covered by the lining of the ventricle, and crossed by some veins of considerable size. It is separated from the lentiform nucleus, in the greater part of its extent, by a thick lamina of white substance, called the **internal capsule,** but the two portions of the corpus striatum are united in front (Figs. 743, 744).

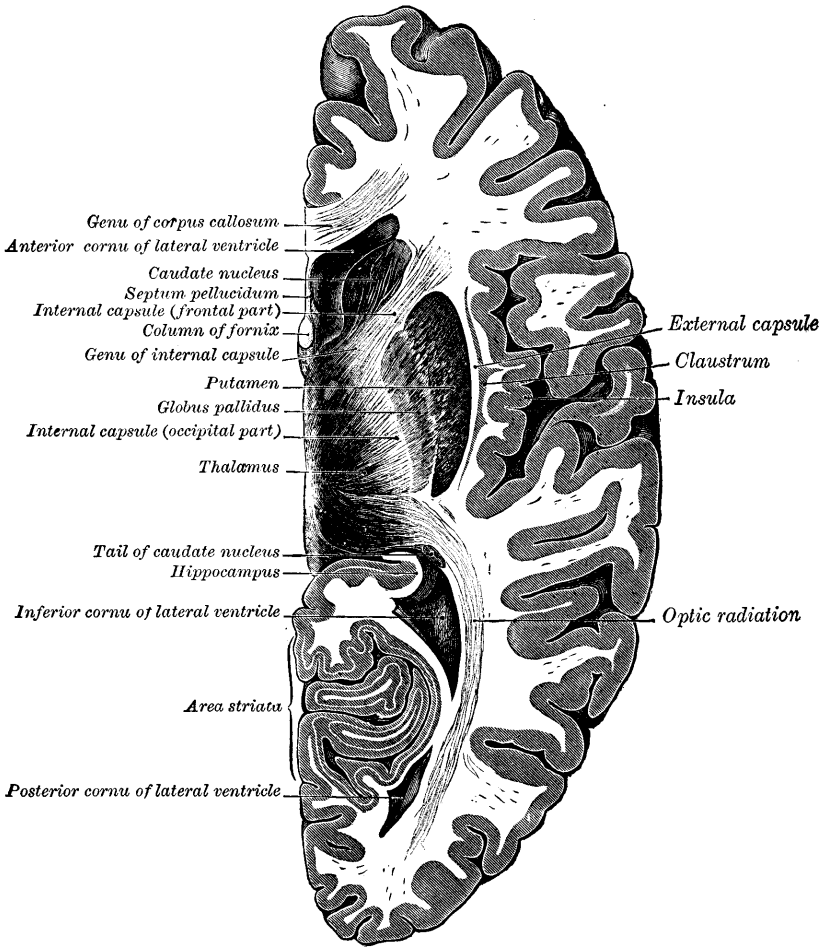

FIG. 742.—Horizontal section of right cerebral hemisphere.

The **lentiform nucleus** (*nucleus lentiformis; lenticular nucleus; lenticula*) (Fig. 741) is lateral to the caudate nucleus and thalamus, and is seen only in sections of the hemisphere. When divided horizontally, it exhibits, to some extent, the appearance of a biconvex lens (Fig. 742), while a coronal section of its central part presents a somewhat triangular outline. It is shorter than the caudate nucleus and does not extend as far forward. It is bounded laterally by a lamina of white substance called the **external capsule,** and lateral to this is a thin layer of gray substance termed the **claustrum.** Its anterior end is continuous with the lower part of the head of the caudate nucleus and with the anterior perforated substance.

In a coronal section through the middle of the lentiform nucleus, two **medullary laminæ** are seen dividing it into three parts. The lateral and largest part is of a reddish color, and is known as the **putamen,** while the medial and intermediate are of

a yellowish tint, and together constitute the **globus pallidus**; all three are marked by fine radiating white fibers, which are most distinct in the putamen (Fig. 744).

The gray substance of the corpus striatum is traversed by nerve fibers, some of which originate in it. The cells are multipolar, both large and small; those of the lentiform nucleus contain yellow pigment. The caudate and lentiform nuclei are not only directly continuous with each other anteriorly, but are connected to each other by numerous fibers. The corpus striatum is also connected: (1) to the cerebral cortex, by what are termed the **corticostriate fibers**; (2) to the thalamus, by fibers which pass through the internal capsule, and by a strand named the **ansa lentiformis**; (3) to the cerebral peduncle, by fibers which leave the lower aspect of the caudate and lentiform nuclei.

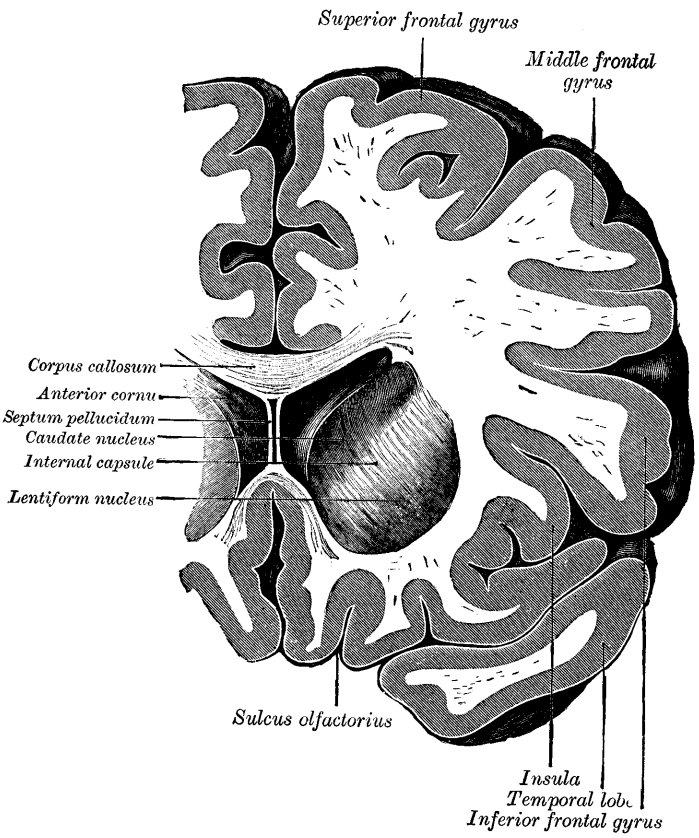

FIG. 743.—Coronal section through anterior cornua of lateral ventricles.

The **claustrum** (Figs. 742, 744) is a thin layer of gray substance, situated on the lateral surface of the external capsule. Its transverse section is triangular, with the apex directed upward. Its medial surface, contiguous to the external capsule, is smooth, but its lateral surface presents ridges and furrows corresponding with the gyri and sulci of the insula, with which it is in close relationship. The claustrum is regarded as a detached portion of the gray substance of the insula, from which it is separated by a layer of white fibers, the **capsula extrema** (*band of Baillarger*). Its cells are small and spindle-shaped, and contain yellow pigment; they are similar to those of the deepest layer of the cortex.

The **nucleus amygdalæ** (*amygdala*) (Fig. 741), is an ovoid gray mass, situated at the lower end of the roof of the inferior cornu. It is merely a localized thickening of the

gray cortex, continuous with that of the uncus; in front it is continuous with the putamen, behind with the stria terminalis and the tail of the caudate nucleus.

The **internal capsule** (*capsula interna*) (Figs. 745, 746) is a flattened band of white fibers, between the lentiform nucleus on the lateral side and the caudate nucleus and thalamus on the medial side. In horizontal section (Figs. 742) it is seen to be somewhat abruptly curved, with its convexity inward; the prominence of the curve is called the **genu,** and projects between the caudate nucleus and the thalamus. The portion in front of the genu is termed the frontal part, and separates the lentiform from the caudate nucleus; the portion behind the genu is the occipital part, and separates the lentiform nucleus from the thalamus.

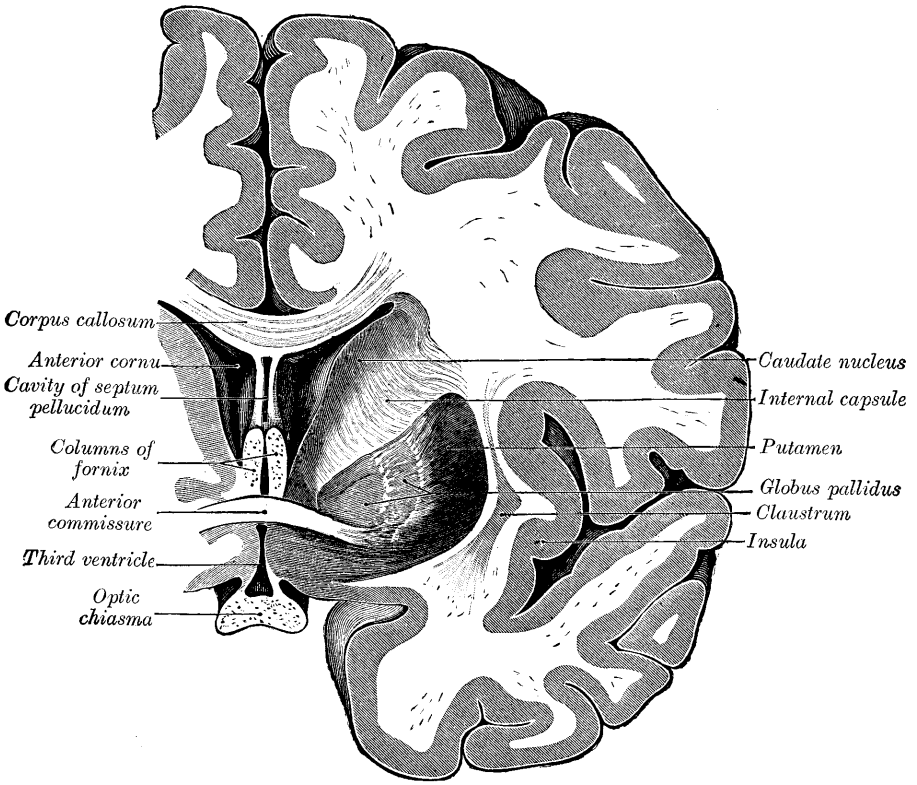

FIG. 744.—Coronal section of brain through anterior commissure.

The *frontal part* of the internal capsule contains: (1) fibers running from the thalamus to the frontal lobe; (2) fibers connecting the lentiform and caudate nuclei; (3) fibers connecting the cortex with the corpus striatum; and (4) fibers passing from the frontal lobe through the medial fifth of the base of the cerebral peduncle to the nuclei pontis. The fibers in the region of the genu are named the **geniculate fibers;** they originate in the motor part of the cerebral cortex, and, after passing downward through the base of the cerebral peduncle with the cerebrospinal fibers, undergo decussation and end in the motor nuclei of the cranial nerves of the opposite side. The anterior two-thirds of the occipital part of the internal capsule contains the **cerebrospinal fibers,** which arise in the motor area of the cerebral cortex and, passing downward through the middle three-fifths of the base of the cerebral peduncle, are continued into the pyramids of the medulla oblongata. The posterior third of the occipital part contains: (1) sensory fibers, largely derived from the thalamus, though some may be continued upward from

the medial lemniscus; (2) the fibers of optic radiation, from the lower visual centers to the cortex of the occipital lobe; (3) acoustic fibers, from the lateral lemniscus to the temporal lobe; and (4) fibers which pass from the occipital and temporal lobes to the nuclei pontis.

The fibers of the internal capsule radiate widely as they pass to and from the various parts of the cerebral cortex, forming the **corona radiata** (Fig. 745) and intermingling with the fibers of the corpus callosum.

The **external capsule** (*capsula externa*) (Fig. 742) is a lamina of white substance, situated lateral to the lentiform nucleus, between it and the claustrum, and continuous with the internal capsule below and behind the lentiform nucleus. It probably contains fibers derived from the thalamus, the anterior commissure, and the subthalamic region.

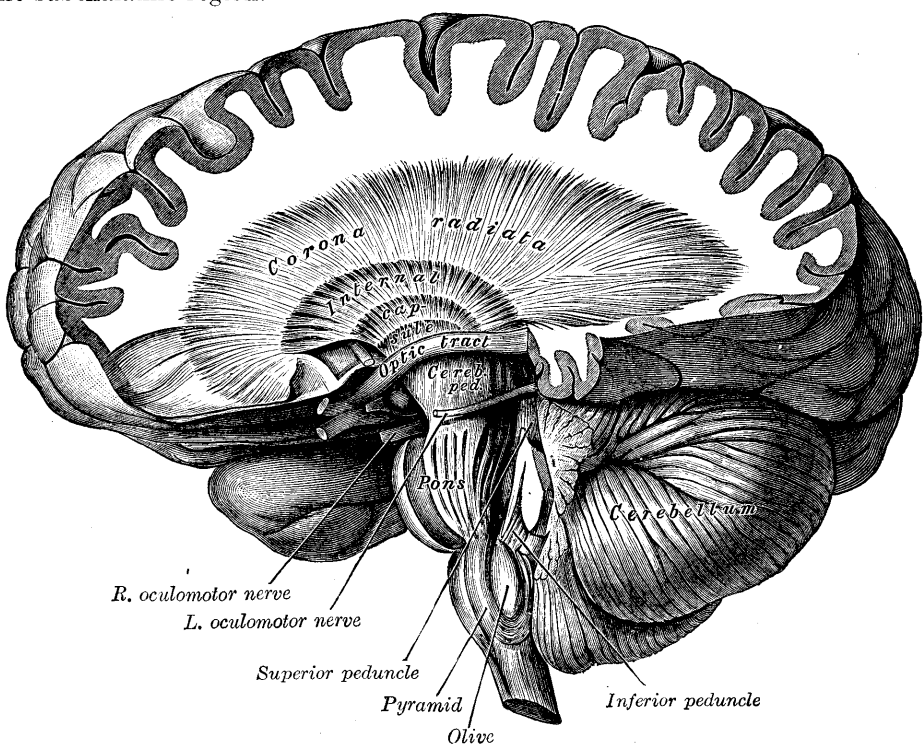

FIG. 745.—Dissection showing the course of the cerebrospinal fibers. (E. B. Jamieson.)

The **substantia innominata of Meynert** is a stratum consisting partly of gray and partly of white substance, which lies below the anterior part of the thalamus and lentiform nucleus. It consists of three layers, superior, middle, and inferior. The *superior* layer is named the **ansa lentiformis,** and its fibers, derived from the medullary lamina of the lentiform nucleus, pass medially to end in the thalamus and subthalamic region, while others are said to end in the tegmentum and red nucleus. The *middle* layer consists of nerve cells and nerve fibers; fibers enter it from the parietal lobe through the external capsule, while others are said to connect it with the medial longitudinal fasciculus. The *inferior* layer forms the main part of the inferior stalk of the thalamus, and connects this body with the temporal lobe and the insula.

The **stria terminalis** (*tænia semicircularis*) is a narrow band of white substance situated in the depression between the caudate nucleus and the thalamus. Anteriorly, its fibers are partly continued into the column of the fornix; some, however, pass over the anterior commissure to the gray substance between the caudate

nucleus and septum pellucidum, while others are said to enter the caudate nucleus. Posteriorly, it is continued into the roof of the inferior cornu of the lateral ventricle, at the extremity of which it enters the nucleus amygdalæ. Superficial to it is a large vein, the **terminal vein** (*vein of the corpus striatum*), which receives numerous tributaries from the corpus striatum and thalamus; it runs forward to the interventricular foramen and there joins with the vein of the choroid plexus to form the corresponding internal cerebral vein. On the surface of the terminal vein is a narrow white band, named the **lamina affixa**.

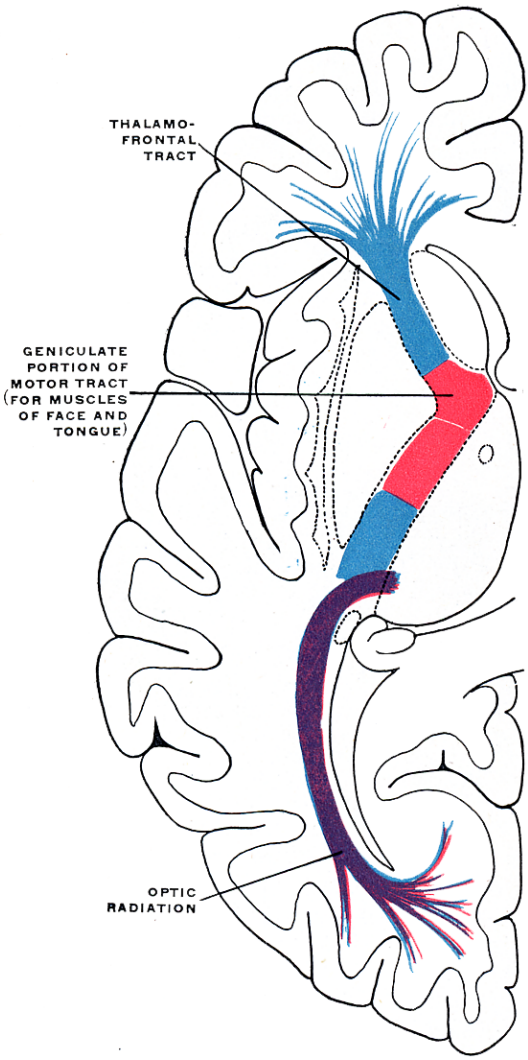

FIG. 746.—Diagram of the tracts in the internal capsule. Motor tract red. The sensory tract (blue) is not direct, but formed of neurons receiving impulses from below in the thalamus and transmitting them to the cortex. The optic radiation (occipitothalamic) is shown in violet.

The **Fornix** (Figs. 720, 747, 748) is a longitudinal, arch-shaped lamella of white substance, situated below the corpus callosum, and continuous with it behind, but separated from it in front by the septum pellucidum. It may be described as consisting of two symmetrical bands, one for either hemisphere. The two portions are not united to each other in front and behind, but their central parts are joined together in the middle line. The anterior parts are called the **columns** of the fornix; the intermediate united portions, the **body**; and the posterior parts, the **crura**.

The **body** (*corpus fornicis*) of the fornix is triangular, narrow in front, and broad behind. The medial part of its upper surface is connected to the septum pellucidum in front and to the corpus callosum behind. The lateral portion of this surface forms part of the floor of the lateral ventricle, and is covered by the ventricular epithelium. Its lateral edge overlaps the choroid plexus, and is continuous with the epithelial covering of this structure. The under surface rests upon the tela choroidea of the third ventricle, which separates it from the epithelial roof of that cavity, and from the medial portions of the upper surfaces of the thalami. Below, the lateral portions of the body of the fornix are joined by a thin triangular lamina, named the **psalterium** (*lyra*). This lamina contains some transverse fibers which connect the two hippocampi across the middle line and constitute the **hippocampal commissure**. Between the psalterium and the corpus callosum a horizontal cleft, the so-called **ventricle of the fornix** (*ventricle of Verga*), is sometimes found.

The **columns** (*columna fornicis; anterior pillars; fornicolumns*) of the fornix arch downward in front of the interventricular foramen and behind the anterior commis-

sure, and each descends through the gray substance in the lateral wall of the third ventricle to the base of the brain, where it ends in the corpus mammillare. From the cells of the corpus mammillare the **thalamomammillary fasciculus** (*bundle of Vicq*

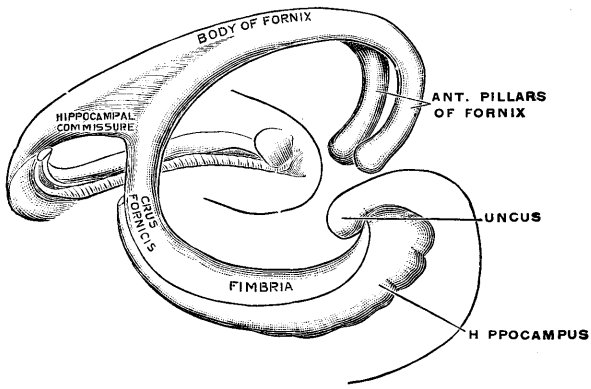

FIG. 747.—Diagram of the fornix. (Spitzka.)

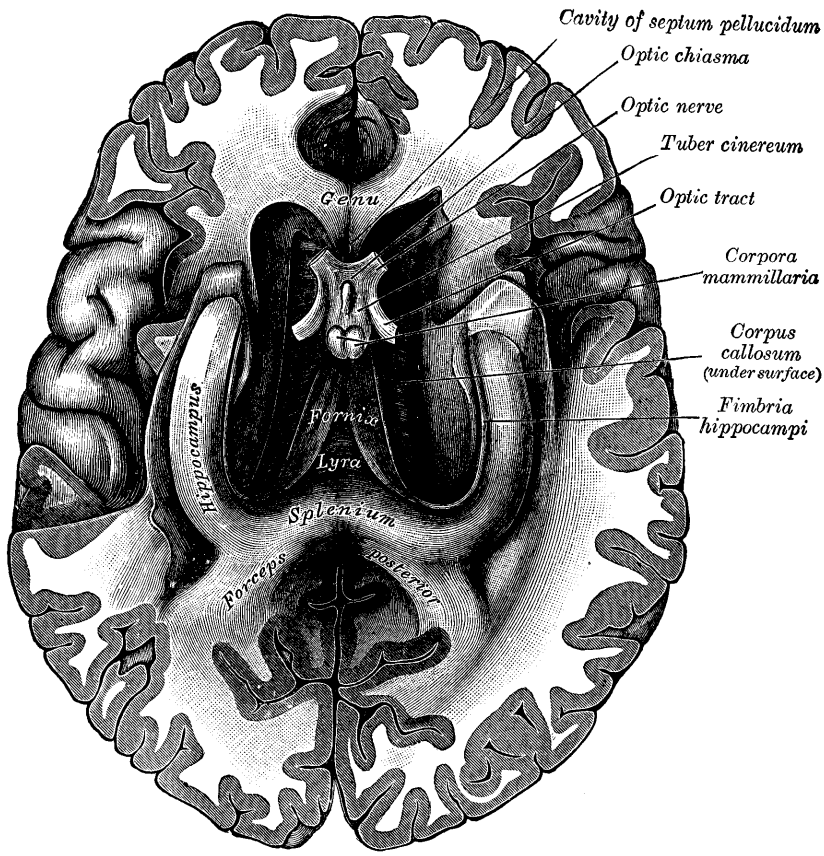

FIG. 748.—The fornix and corpus callosum from below. (From a specimen in the Department of Human Anatomy of the University of Oxford.)

d'Azyr) takes origin and is prolonged into the anterior nucleus of the thalamus. The column of the fornix and the thalamomammillary fasciculus together form a loop resembling the figure 8, but the continuity of the loop is broken in the corpus

mammillare. The column of the fornix is joined by the stria medullaris of the pineal body and by the superficial fibers of the stria terminalis, and is said to receive also fibers from the septum pellucidum. Zuckerkandl describes an **olfactory fasciculus** which becomes detached from the main portion of the column of the fornix, and passes downward in front of the anterior commissure to the base of the brain, where it divides into two bundles, one joining the medial stria of the olfactory tract; the other joins the subcallosal gyrus, and through it reaches the hippocampal gyrus.

The **crura** (*crus fornicis; posterior pillars*) of the fornix are prolonged backward from the body. They are flattened bands, and at their commencement are intimately connected with the under surface of the corpus callosum. Diverging from one another, each curves around the posterior end of the thalamus, and passes downward and forward into the inferior cornu of the lateral ventricle (Fig. 750). Here it lies along the concavity of the hippocampus, on the surface of which some of its fibers are spread out to form the **alveus**, while the remainder are continued as a narrow white band, the **fimbria hippocampi**, which is prolonged into the uncus of the hippocampal gyrus. The inner edge of the fimbria overlaps the **fascia dentata hippocampi** (*dentate gyrus*) (page 827), from which it is separated by the **fimbriodentate fissure**; from its lateral margin, which is thin and ragged, the ventricular epithelium is reflected over the choroid plexus as the latter projects into the chorioidal fissure.

Interventricular Foramen (*foramen of Monro*).—Between the columns of the fornix and the anterior ends of the thalami, an oval aperture is present on either side: this is the interventricular foramen, and through it the lateral ventricles communicate with the third ventricle. Behind the epithelial lining of the foramen the choroid plexuses of the lateral ventricles are joined across the middle line.

The **Anterior Commissure** (*precommissure*) is a bundle of white fibers, connecting the two cerebral hemispheres across the middle line, and placed in front of the columns of the fornix. On sagittal section it is oval in shape, its long diameter being vertical and measuring about 5 mm. Its fibers can be traced lateralward and backward on either side beneath the corpus striatum into the substance of the temporal lobe. It serves in this way to connect the two temporal lobes, but it also contains decussating fibers from the olfactory tracts.

The **Septum Pellucidum** (*septum lucidum*) (Fig. 720) is a thin, vertically placed partition consisting of two laminæ, separated in the greater part of their extent by a narrow chink or interval, the **cavity of the septum pellucidum**. It is attached, above, to the under surface of the corpus callosum; below, to the anterior part of the fornix behind, and the reflected portion of the corpus callosum in front. It is triangular in form, broad in front and narrow behind; its inferior angle corresponds with the upper part of the anterior commissure. The lateral surface of each lamina is directed toward the body and anterior cornu of the lateral ventricle, and is covered by the ependyma of that cavity.

The **cavity of the septum pellucidum** (*cavum septi pellucidi; pseudocele; fifth ventricle*) is generally regarded as part of the longitudinal cerebral fissure, which has become shut off by the union of the hemispheres in the formation of the corpus callosum above and the fornix below. Each half of the septum therefore forms part of the medial wall of the hemisphere, and consists of a medial layer of gray substance, derived from that of the cortex, and a lateral layer of white substance continuous with that of the cerebral hemispheres. This cavity is not developed from the cavity of the cerebral vesicles, and never communicates with the ventricles of the brain.

The **Choroid Plexus of the Lateral Ventricle** (*plexus chorioideus ventriculus lateralis; paraplexus*) (Fig. 750) is a highly vascular, fringe-like process of pia mater, which projects into the ventricular cavity. The plexus, however, is everywhere

covered by a layer of epithelium continuous with the epithelial lining of the ventricle. It extends from the interventricular foramen, where it is joined with the plexus of the opposite ventricle, to the end of the inferior cornu. The part in relation to the body of the ventricle forms the vascular fringed margin of a triangular process of pia mater, named the **tela chorioidea of the third ventricle,** and projects from under cover of the lateral edge of the fornix. It lies upon the upper surface of the thalamus, from which the epithelium is reflected over the plexus on to the edge of the fornix (Fig. 723). The portion in relation to the inferior cornu lies in the concavity of the hippocampus and overlaps the fimbria hippocampi: from the lateral edge of the fimbria the epithelium is reflected over the plexus on to the roof of the cornu (Fig. 749). It consists of minute and highly vascular villous processes, each with an afferent and an efferent vessel. The *arteries* of the plexus are: (*a*) the anterior choroidal, a branch of the internal carotid, which enters the plexus at the end of the inferior cornu; and (*b*) the posterior choroidal, one or two small branches of the posterior cerebral, which pass forward under the splenium. The *veins* of the choroid plexus unite to form a tortuous vein, which courses from behind forward to the interventricular foramen and there joins with the terminal vein to form the corresponding internal cerebral vein.

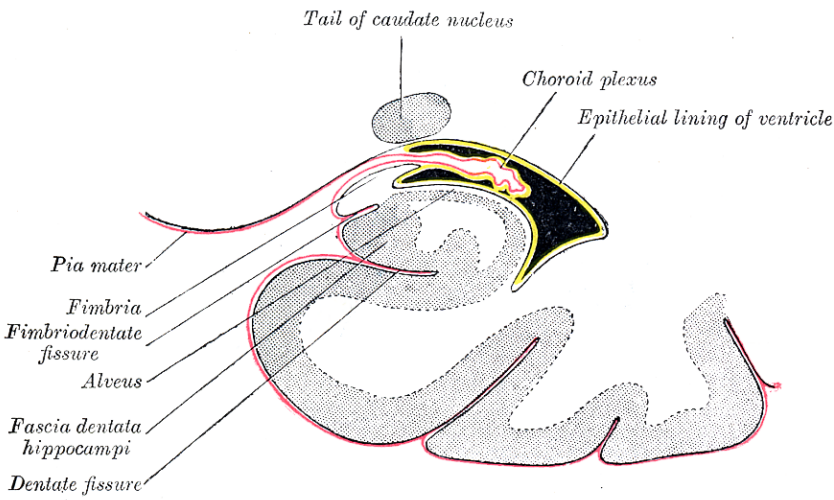

FIG. 749.—Coronal section of inferior horn of lateral ventricle. (Diagrammatic.)

When the choroid plexus is pulled away, the continuity between its epithelial covering and the epithelial lining of the ventricle is severed, and a cleft-like space is produced. This is named the **choroidal fissure**; like the plexus, it extends from the interventricular foramen to the end of the inferior cornu. The upper part of the fissure, *i. e.*, the part nearest the interventricular foramen is situated between the lateral edge of the fornix and the upper surface of the thalamus; farther back at the beginning of the inferior cornu it is between the commencement of the fimbria hippocampi and the posterior end of the thalamus, while in the inferior cornu it lies between the fimbria in the floor and the stria terminalis in the roof of the cornu.

The **tela chorioidea of the third ventricle** (*tela chorioidea ventriculi tertii; velum interpositum*) (Fig. 750) is a double fold of pia mater, triangular in shape, which lies beneath the fornix. The lateral portions of its lower surface rest upon the thalami, while its medial portion is in contact with the epithelial roof of the third ventricle. Its apex is situated at the interventricular foramen; its base corresponds with the splenium of the corpus callosum, and occupies the interval between that structure above and the corpora quadrigemina and pineal body below. This

interval, together with the lower portions of the choroidal fissures, is sometimes spoken of as the **transverse fissure of the brain.** At its base the two layers of the velum separate from each other, and are continuous with the pia mater investing the brain in this region. Its lateral margins are modified to form the highly vascular choroid plexuses of the lateral ventricles. It is supplied by the anterior and posterior choroidal arteries already described. The veins of the tela chorioidea are named the **internal cerebral veins** (*venæ Galeni*); they are two in number, and run backward between its layers, each being formed at the interventricular foramen by the union of the terminal vein with the choroidal vein. The internal cerebral veins unite posteriorly in a single trunk, the **great cerebral vein** (*vena magna Galeni*), which passes backward beneath the splenium and ends in the straight sinus.

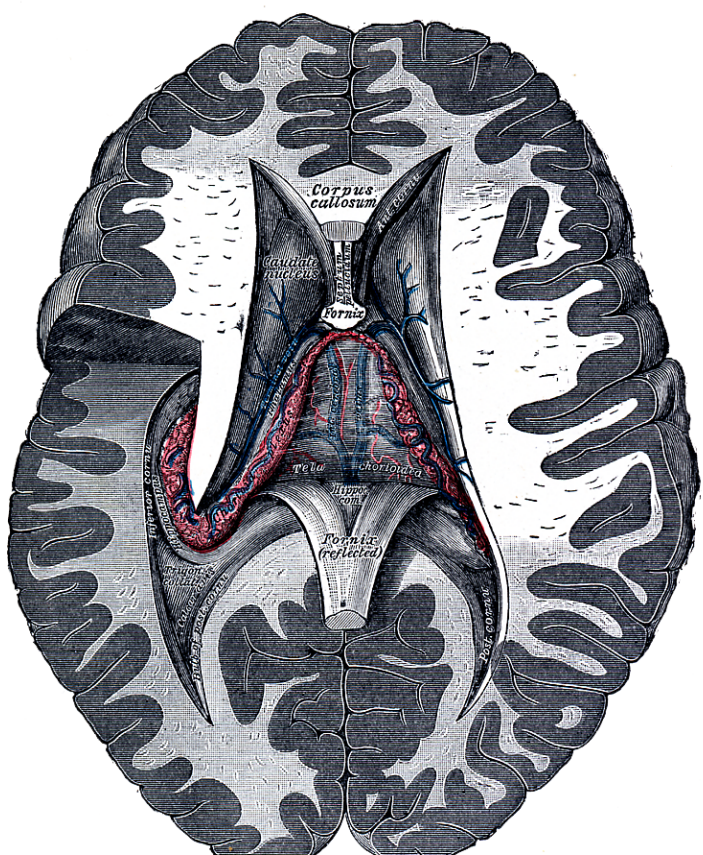

FIG. 750.—Tela chorioidea of the third ventricle, and the choroid plexus of the left lateral ventricle, exposed from above.

3. In the hippocampus the molecular layer is very thick and contains a large number of Golgi cells. It has been divided into three strata: (*a*) *s. convolutum* or *s. granulosum*, containing many tangential fibers; (*b*) *s. lacunosum*, presenting numerous vascular spaces; (*c*) *s. radiatum*, exhibiting a rich plexus of fibrils. The two layers of pyramidal cells are condensed into one, and the cells are mostly of large size. The axons of the cells in the polymorphous layer may run in an ascending, a descending, or a horizontal direction. Between the polymorphous layer and the ventricular ependyma is the white substance of the alveus.

4. In the fascia dentata hippocampi or dentate gyrus the molecular layer contains some pyramidal cells, while the layer of pyramidal cells is almost entirely represented by small ovoid cells.

5. *The Olfactory Bulb.*—In many of the lower animals this contains a cavity which communicates through the olfactory tract with the lateral ventricle. In man the original cavity is filled up by neuroglia and its wall becomes thickened, but much more so on its ventral than on its dorsal aspect. Its dorsal part contains a small amount of gray and white substance, but it is scanty and ill-defined. A section through the ventral part (Fig. 755) shows it to consist of the following layers from without inward:

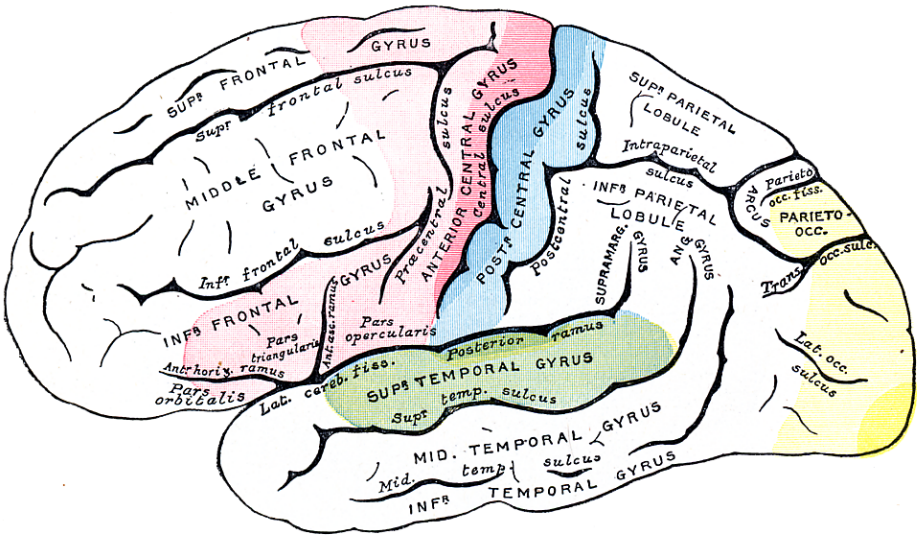

FIG. 756.—Areas of localization on lateral surface of hemisphere. Motor area in red. Area of general sensations in blue. Auditory area in green. Visual area in yellow. The psychic portions are in lighter tints.

1. A layer of olfactory nerve fibers, which are the non-medullated axons prolonged from the olfactory cells of the nasal cavity, and reach the bulb by passing through the cribriform plate of the ethmoid bone. At first they cover the bulb, and then penetrate it to end by forming synapses with the dendrites of the mitral cells, presently to be described.

2. *Glomerular Layer.*—This contains numerous spheroidal reticulated enlargements, termed **glomeruli,** produced by the branching and arborization of the processes of the olfactory nerve fibres with the descending dendrites of the mitral cells.

3. *Molecular Layer.*—This is formed of a matrix of neuroglia, imbedded in which are the *mitral cells.* These cells are pyramidal in shape, and the basal part of each gives off a thick dendrite which descends into the glomerular layer, where it arborizes as indicated above, and others which interlace with similar dendrites of neighboring mitral cells. The axons pass through the next layer into the white matter of the bulb, and after becoming bent on themselves at a right angle, are continued into the olfactory tract.

4. *Nerve Fiber Layer.*—This lies next the central core of neuroglia, and its fibers consist of the axons or afferent processes of the mitral cells passing to the brain; some efferent fibers are, however, also present, and end in the molecular layer, but nothing is known as to their exact origin.

Weight of the Encephalon.—The average weight of the brain, in the adult male, is about 1380 gms.; that of the female, about 1250 gms. In the male, the maximum weight out of 278 cases was 1840 gms. and the minimum weight 964 gms. The maximum weight of the adult female brain, out of 191 cases, was 1585 gms. and the minimum weight 879 gms. The brain increases rapidly during the first four years of life, and reaches its maximum weight by about the twentieth year. As age advances, the brain decreases slowly in weight; in old age the decrease takes place more rapidly, to the extent of about 28 gms.

The human brain is heavier than that of any of the lower animals, except the elephant and whale. The brain of the former weighs from 3.5 to 5.4 kilogm., and that of a whale, in a specimen 19 metres long, weighed rather more than 6.7 kilogm.

Cerebral Localization.—Physiological and pathological research have now gone far to prove that a considerable part of the surface of the brain may be mapped out into a series of more or less definite areas, each of which is intimately connected with some well-defined function.

The chief areas are indicated in Figs. 756 and 757.

Motor Areas.—The motor area occupies the anterior central and frontal gyri and the paracentral lobule. The centers for the lower limb are located on the uppermost part of the anterior central gyrus and its continuation on to the paracentral lobule; those for the trunk are on the upper portion, and those for the upper limb on the middle portion of the anterior central gyrus. The facial centers are situated on the lower part of the anterior central gyrus, those for the tongue, larynx, muscles of mastication, and pharynx on the frontal operculum, while those for the head and neck occupy the posterior end of the middle frontal gyrus.

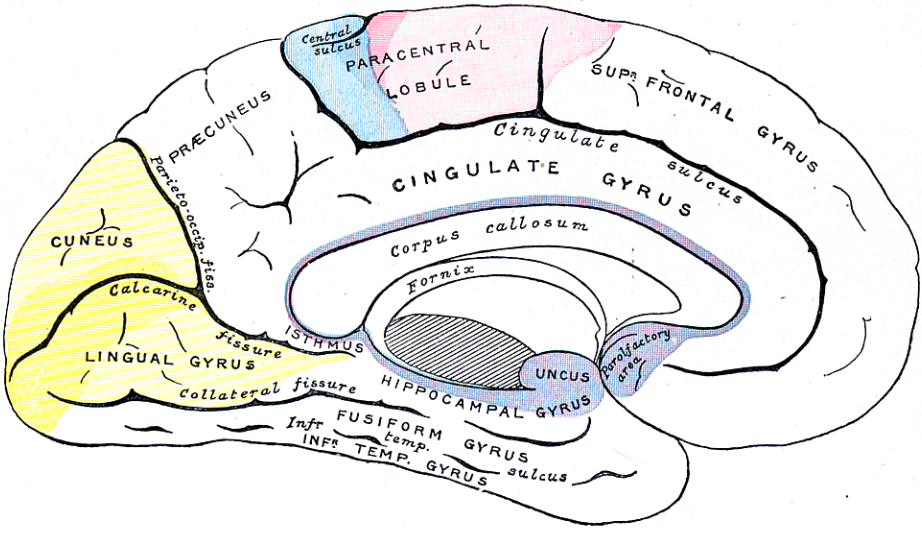

FIG. 757.—Areas of localization on medial surface of hemisphere. Motor area in red. Area of general sensations in blue. Visual area in yellow. Olfactory area in purple. The psychic portions are in lighter tints.

Sensory Areas.—Tactile and temperature senses are located on the posterior central gyrus, while the sense of form and solidity is on the superior parietal lobule and precuneus. With regard to the special senses, the area for the sense of taste is probably related to the uncus and hippocampal gyrus. The auditory area occupies the middle third of the superior temporal gyrus and the adjacent gyri in the lateral fissure; the visual area, the calcarine fissure and cuneus; the olfactory area, the rhinencephalon. As special centers of much importance may be noted: the emissive center for speech on the left inferior frontal and anterior central gyri (Broca); the auditory receptive center on the transverse and superior temporal gyri, and the visual receptive center on the lingual gyrus and cuneus.

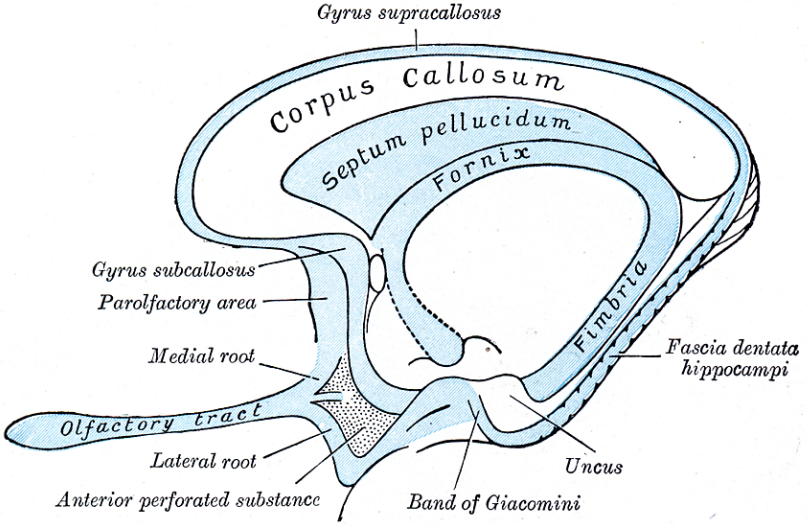

FIG. 732.—Scheme of rhinencephalon.

Part IV: Fimbria correlated with Āshvalāyana Gṛihya Sūtra

The **crura** (*crus fornicis; posterior pillars*) of the fornix are prolonged backward from the body. They are flattened bands, and at their commencement are intimately connected with the under surface of the corpus callosum. Diverging from one another, each curves around the posterior end of the thalamus, and passes downward and forward into the inferior cornu of the lateral ventricle (Fig. 750). Here it lies along the concavity of the hippocampus, on the surface of which some of its fibers are spread out to form the **alveus,** while the remainder are continued as a narrow white band, the **fimbria hippocampi,** which is prolonged into the uncus of the hippocampal gyrus. The inner edge of the fimbria overlaps the **fascia dentata hippocampi** (*dentate gyrus*) (page 827), from which it is separated by the **fimbriodentate fissure;** from its lateral margin, which is thin and ragged, the ventricular epithelium is reflected over the choroid plexus as the latter projects into the chorioidal fissure.

Part V: Prosubiculum, Subiculum, and Presubiculum
correlated to Khadira, Kāthaka and Kaushītaka Gṛihya Sūtras

(Initially called the subiculum, it is now subdivided into parasubiculum, presubiculum, and subiculum proper. (Miller and Burack))

"The subiculum constitutes the major synaptic relay for the majority of hippocampal area CA1 neurons, making the subiculum the last relay of the hippocampal formation prior to the cortex. The hippocampal formation is composed of the hippocampus proper (dentate gyrus; areas CA1 & CA3), entorhinal cortex (EC) and the subicular complex (subiculum, parasubiculum and presubiculum). The subiculum and entorhinal cortex process and transmit information between the neocortex and hippocampus." Michael Anderson, home page, "Current Research", Department of Psychology, Trinity College, Dublin. http://www.tcd.ie/Psychology/Michael_Anderson/research.html

Part 6: Parahippocampal Gyrus correlated with Mānava Gṛihya Sūtra

Parahippocampal gyrus is the name given the most medially placed gyrus of the temporal lobe.

Part 7: Hippocampal Gyrus correlated with Pāraskara Gṛihya Sūtra

The **hippocampal gyrus** (*gyrus hippocampi*) is bounded above by the hippocampal fissure, and below by the anterior part of the collateral fissure. Behind, it is continuous superiorly, through the isthmus, with the cingulate gyrus and inferiorly with the lingual gyrus. Running in the substance of the cingulate and hippocampal gyri, and connecting them together, is a tract of arched fibers, named the **cingulum** (page 843). The anterior extremity of the hippocampal gyrus is recurved in the form of a hook (**uncus**), which is separated from the apex of the temporal lobe by a slight fissure, the **incisura temporalis**. Although superficially continuous with the hippocampal gyrus, the uncus forms morphologically a part of the rhinencephalon.

The **Hippocampal Fissure** (*fissura hippocampi; dentate fissure*) begins immediately behind the splenium of the corpus callosum, and runs forward between the hippocampal and dentate gyri to end in the uncus. It is a complete fissure (page 819), and gives rise to the prominence of the hippocampus in the inferior cornu of the lateral ventricle.

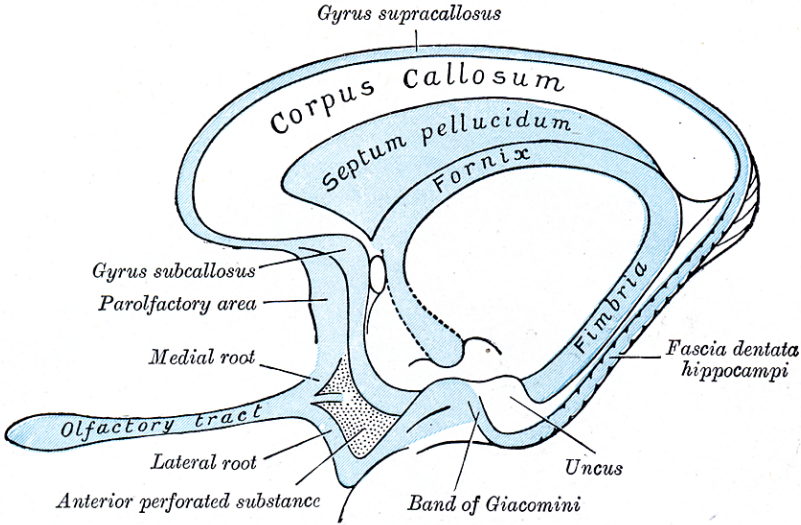

FIG. 732.—Scheme of rhinencephalon.

Part 8: Dentate gyrus correlated with the Baudhāyana Gṛihya Sūtra

3. The **Subcallosal, Supracallosal,** and **Dentate Gyri** form a rudimentary arch-shaped lamina of gray substance extending over the corpus callosum and above the hippocampal gyrus from the anterior perforated substance to the uncus.

(*a*) The **subcallosal gyrus** (*gyrus subcallosus; peduncle of the corpus callosum*) is a narrow lamina on the medial surface of the hemisphere in front of the lamina terminalis, behind the parolfactory area, and below the rostrum of the corpus callosum. It is continuous around the genu of the corpus callosum with the supra-callosal gyrus.

(*b*) The **supracallosal gyrus** (*indusium griseum; gyrus epicallosus*) consists of a thin layer of gray substance in contact with the upper surface of the corpus callosum and continuous laterally with the gray substance of the cingulate gyrus. It contains two longitudinally directed strands of fibers termed respectively the **medial** and **lateral longitudinal striæ.** The supracallosal gyrus is prolonged around the splenium of the corpus callosum as a delicate lamina, the **fasciola cinerea,** which is continuous below with the fascia dentata hippocampi.

(*c*) The **fascia dentata hippocampi** (*gyrus dentatus*) is a narrow band extending downward and forward above the hippocampal gyrus but separated from it by the hippocampal fissure; its free margin is notched and overlapped by the fimbria —the **fimbriodentate fissure** intervening. Anteriorly it is continued into the notch of the uncus, where it forms a sharp bend and is then prolonged as a delicate band, the **band of Giacomini,** over the uncus, on the lateral surface of which it is lost.

The remaining parts of the rhinencephalon, viz., the septum pellucidum, fornix, and hippocampus, will be described in connection with the lateral ventricle.

The **dentate gyrus** which may be considered as a modified part of the hippo-campus is partially separated from the gyrus hippocampus by the hippocampal fis-sure and from the fimbria by the fimbrio-dentate sulcus; it is intimately connected with the hippocampal gyrus and the hippocampus. When followed backward the dentate gyrus separates from the fimbria at the splenium, loses its incisions and knobs, and as the fasciola cinerea passes over the splenium onto the dorsal surface of the corpus callosum and spreads out into a thin layer of gray substance known as the **indusium,** which can be traced forward around the genu of the corpus callosum into the gyrus subcallosus. The white matter of the indusium known as the **medial longitudinal striæ** (*nerves of Lancisi*) and the **lateral longitudinal striæ,** are related to the indusium somewhat as the cingulum is to the gyrus cinguli. Axons from the indusium pass into the longitudinal striæ, some running forward and others backward while some after entering the medial longitudinal stria, pierce the corpus callosum to join the fornix. Some of the fibers which pass forward extend around the front of the corpus callosum and the anterior commissure, then curve downward, according to Cajal, to enter the corpus striatum where they join the olfactory projection-path. Other fibers are said to arise in the parolfactory area, the **gyrus subcallosus** and the **anterior perforated substance** (*diagonal band of Broca*) and course backward in the longitudinal striæ to the dentate gyrus and the hippocampal region. The indusium is usually considered as a rudimentary part of the rhinencephalon.

Part 9: Alveus correlated with the Kaushika Gṛihya Sūtra

The main mass of the hippocampus consists of gray substance, but on its ventricular surface is a thin white layer, the **alveus,** which is continuous with the fimbria hippocampi.

The **crura** (*crus fornicis; posterior pillars*) of the fornix are prolonged backward from the body. They are flattened bands, and at their commencement are intimately connected with the under surface of the corpus callosum. Diverging from one another, each curves around the posterior end of the thalamus, and passes downward and forward into the inferior cornu of the lateral ventricle (Fig. 750). Here it lies along the concavity of the hippocampus, on the surface of which some of its fibers are spread out to form the **alveus,** while the remainder are continued as a narrow white band, the **fimbria hippocampi,** which is prolonged into the uncus of the hippocampal gyrus. The inner edge of the fimbria overlaps the **fascia dentata hippocampi** (*dentate gyrus*) (page 827), from which it is separated by the **fimbriodentate fissure;** from its lateral margin, which is thin and ragged, the ventricular epithelium is reflected over the choroid plexus as the latter projects into the chorioidal fissure.

Part 10: Fasciolar Gyrus (called fasciola cinerea in the book) correlated with the Hiraṇyakeshīya Gṛihya Sūtra

3. The **Subcallosal, Supracallosal,** and **Dentate Gyri** form a rudimentary arch-shaped lamina of gray substance extending over the corpus callosum and above the hippocampal gyrus from the anterior perforated substance to the uncus.

(*a*) The **subcallosal gyrus** (*gyrus subcallosus; peduncle of the corpus callosum*) is a narrow lamina on the medial surface of the hemisphere in front of the lamina terminalis, behind the parolfactory area, and below the rostrum of the corpus callosum. It is continuous around the genu of the corpus callosum with the supra-callosal gyrus.

(*b*) The **supracallosal gyrus** (*indusium griseum; gyrus epicallosus*) consists of a thin layer of gray substance in contact with the upper surface of the corpus callosum and continuous laterally with the gray substance of the cingulate gyrus. It contains two longitudinally directed strands of fibers termed respectively the **medial** and **lateral longitudinal striæ.** The supracallosal gyrus is prolonged around the splenium of the corpus callosum as a delicate lamina, the **fasciola cinerea,** which is continuous below with the fascia dentata hippocampi.

(*c*) The **fascia dentata hippocampi** (*gyrus dentatus*) is a narrow band extending downward and forward above the hippocampal gyrus but separated from it by the hippocampal fissure; its free margin is notched and overlapped by the fimbria —the **fimbriodentate fissure** intervening. Anteriorly it is continued into the notch of the uncus, where it forms a sharp bend and is then prolonged as a delicate band, the **band of Giacomini,** over the uncus, on the lateral surface of which it is lost.

The remaining parts of the rhinencephalon, viz., the septum pellucidum, fornix, and hippocampus, will be described in connection with the lateral ventricle.

Part 11: Entorhinal cortex correlated with the Vārāha Gṛihya Sūtra

The entorhinal cortex (EC) is both the primary source of neocortical input to the hippocampus and the primary target of hippocampal outputs to the neocortex. The entorhinal area is the area of cortex between prorhinal area and parasubiculum.

Part 12: Prorhinal cortex correlated with the Gobhila Gṛihya Sūtra

The prorhinal cortex is an area of cortex adjacent to the parasubiculum and entorhinal cortex.

Part 13: Periamygdaloid cortex correlated with the Agniveshya Gṛihya Sūtra

The periamygdaloid cortex is a region of the pyriform lobe; the pyriform lobe consists of the lateral olfactory stria, the uncus and the anterior part of the parahippocampal gyrus. The periamygdaloid area is a small region dorsal and rostral to the amygdaloid nuclear complex; it is intimately related to the prepyriform area.(Carpenter and Sutin). The amygdaloid nuclear complex is a gray mass in the dorsomedial part of the temporal lobe which underlies the uncus.

Part 14: Mossy fibre pathway, Schaeffer collateral pathway and perforant fibre pathways correlated to Shānkhāyana, Vādhūla and Jaiminī Gṛihya Sūtra.

The hippocampus has three major afferent pathways running from the subiculum (cortex) to the Ca1 region: The perforant pathway, the mossy fibre pathway, and the Schaeffer collateral pathway. (Athene.mit.csu.edu).

Part 15: The alvear pathway correlated to the Bhāradvāja Gṛihya Sūtra

The alvear pathway runs from the entorhinal cortex to the CA1 area of the hippocampus.

Part 16: Indusium griseum (or supracallosal gyrus) correlated to the Āpastamba Gṛihya Sūtra

(*b*) The **supracallosal gyrus** (*indusium griseum; gyrus epicallosus*) consists of a thin layer of gray substance in contact with the upper surface of the corpus callosum and continuous laterally with the gray substance of the cingulate gyrus. It contains two longitudinally directed strands of fibers termed respectively the **medial** and **lateral longitudinal striæ.** The supracallosal gyrus is prolonged around the splenium of the corpus callosum as a delicate lamina, the **fasciola cinerea,** which is continuous below with the fascia dentata hippocampi.

The **dentate gyrus** which may be considered as a modified part of the hippocampus is partially separated from the gyrus hippocampus by the hippocampal fissure and from the fimbria by the fimbrio-dentate sulcus; it is intimately connected with the hippocampal gyrus and the hippocampus. When followed backward the dentate gyrus separates from the fimbria at the splenium, loses its incisions and knobs, and as the fasciola cinerea passes over the splenium onto the dorsal surface of the corpus callosum and spreads out into a thin layer of gray substance known as the **indusium,** which can be traced forward around the genu of the corpus callosum into the gyrus subcallosus. The white matter of the indusium known as the **medial longitudinal striæ** (*nerves of Lancisi*) and the **lateral longitudinal striæ,** are related to the indusium somewhat as the cingulum is to the gyrus cinguli. Axons from the indusium pass into the longitudinal striæ, some running forward and others backward while some after entering the medial longitudinal stria, pierce the corpus callosum to join the fornix. Some of the fibers which pass forward extend around the front of the corpus callosum and the anterior commissure, then curve downward, according to Cajal, to enter the corpus striatum where they join the olfactory projection-path. Other fibers are said to arise in the parolfactory area, the **gyrus subcallosus** and the **anterior perforated substance** (*diagonal band of Broca*) and course backward in the longitudinal striæ to the dentate gyrus and the hippocampal region. The indusium is usually considered as a rudimentary part of the rhinencephalon.

Part 17: The medial and longitudinal striae correlated to the Vaikhānasa and Kauthuma Gṛihya Sūtra

(*b*) The **supracallosal gyrus** (*indusium griseum; gyrus epicallosus*) consists of a thin layer of gray substance in contact with the upper surface of the corpus callosum and continuous laterally with the gray substance of the cingulate gyrus. It contains two longitudinally directed strands of fibers termed respectively the **medial** and **lateral longitudinal striæ.**

The white matter of the indusium known as the **medial longitudinal striæ** (*nerves of Lancisi*) and the **lateral longitudinal striæ,** are related to the indusium somewhat as the cingulum is to the gyrus cinguli. Axons from the indusium pass into the longitudinal striæ, some running forward and others backward while some after entering the medial longitudinal stria, pierce the corpus callosum to join the fornix. Some of the fibers which pass forward extend around the front of the corpus callosum and the anterior commissure, then curve downward, according to Cajal, to enter the corpus striatum where they join the olfactory projection-path. Other fibers are said to arise in the parolfactory area, the **gyrus subcallosus** and the **anterior perforated substance** (*diagonal band of Broca*) and course backward in the longitudinal striæ to the dentate gyrus and the hippocampal region. The indusium is usually considered as a rudimentary part of the rhinencephalon.

Part 18: Mammillary body correlated to the Shānkhāyana Shrauta Sūtra

The **olfactory projection fibers** which arise from the pyramid cells of the uncus and hippocampus and from the polymorphic cells of the dentate gyrus form a dense stratum on the ventricular surface, especially on the hippocampus, called the **alveus.** These fibers pass over into the fimbria and are continued into the **fornix.** About one-fourth of all the fibers of the fimbria are large projection fibers, the other three-fourths consist of fine commissural fibers which pass from the hippocampus of one side through the fimbria and **hippocampal commissure** (*ventral psalterium or lyre*), to the fimbria and hippocampus of the opposite side where they penetrate the pyramidal layer and terminate in the stratum radiatum. The fibers which course in the fornix pass forward and downward into the corpora mammillare where numerous collaterals are given off and a few terminate. Most of the fibers in the fornix, however, pass through the corpora, cross the middle line and turn downward in the reticular formation in which they are said to be traceable as far as the pons and possibly farther. As the fornix passes beneath the corpus callosum it receives fibers from the longitudinal striæ of the indusium and from the cingulum; these are the perforating fibers of the fornix which pass through the corpus callosum and course in the fornix toward the mammillary body. As the fornix passes the anterior end of the thalamus a few fibers are given off to the stria medullaris of the thalamus and turn back in the stria to the habenular ganglion of the same and the opposite side, having probably the same relation that the reflex fibers have which arise from the primary centers and course in the stria medullaris of the thalamus. Aside from the fibers of the fornix which pass through the mammillary body to decussate and descend (as the mammillo-mesencephalic fasciculus), many fibers are said to pass into the **bundle of Vicq d'Azyr,** and one bundle of fibers is said to pass from the fornix to the tuber cinereum.

The mammillary bodies receive collaterals and terminals then from the cortical centers via the fornix and probably other collaterals and terminals are received directly from the primary centers through the tractus olfactomesencephalicus. According to Cajal fibers also reach the mammillary body through the peduncle of the corpus mammillare from the arcuate fibers of the tegmentum and from the main fillet. The fornix probably brings the cortical centers into relation with the reflex path that runs from the primary centers to the mammillary body and the tuber cinereum.

The **bundle of Vicq d'Azyr** (*mammillo-thalamic fasciculus*) arises from cells in both the medial and lateral nuclei of the mammillary body and by fibers that are directly continued from the fornix. There axons divide within the gray matter; the coarser branches pass into the anterior nucleus of the thalamus as the bundle of Vicq d'Azyr, the finer branches pass downward as the mammillo-tegmental bundle of Gudden. The bundle of Vicq d'Azyr spreads out fan-like as it terminates in the anterior or dorsal nucleus of the thalamus. A few of the fibers pass through the dorsal nucleus to the angular nucleus of the thalamus. The axons from these nuclei are supposed to form part of the thalamocortical system.

The mammillo-tegmental bundle has already been considered under the olfactory reflex paths.

Part 19: Diagonal band correlated to the Āpastamba Shrauta Sūtra

"At the point of division of the olfactory tract into lateral and medial olfactory striae, there is a rhomboid-shaped region, bounded by the olfactory trigone and the optic tract, known as the anterior perforated substance. This region is studded with numerous perforations made by entering blood vessels. The posterior border of this region, near the optic tract, has a smooth appearance and forms an oblique band, the diagonal band of Broca." p617, Carpenter and Sutin, *Human Neuroanatomy*, Baltimore: Williams and Wilkins, 1983.

Part 20: Amygdaloid complex correlated with Mashaka Shrauta Sūtra.

The Amygdaloid complex is a gray mass in the dorsomedial part of the temporal lobe which underlies the uncus. This complex lies dorsal to the hippocampal formation and rostral to the tip of the interior horn of the lateral ventricle." P. 40, Carpenter and Sutin, Human Neuroanatomy, Baltimore: Williams and Wilkins, 1983.

Part 21: Medial and lateral septal nuclei
correlated with Kaushika and Vaitāna Shrauta Sūtra.

"The subcallosal area and the paraterminal gyrus together constitute the septal area (paraterminal body). The term septal area referes to the cortical part of this region. The subcortical part of the septal region consists of the medial and lateral septal nuclei, which are found rostral to the anterior commissure. The medial septal nucleus becomes continuous with the nucleus and tract of the diagonal band and thus establishes connections with the amygdaloid nuclear complex." Carpenter and Sutin, Human Neuroanatomy, Baltimore: Williams and Wilkins, 1983.

Part 22: Anterior commissure correlated with the Hiraṇyakeshīya Shrauta Sūtra

The **Anterior Commissure** (*precommissure*) is a bundle of white fibers, connecting the two cerebral hemispheres across the middle line, and placed in front of the columns of the fornix. On sagittal section it is oval in shape, its long diameter being vertical and measuring about 5 mm. Its fibers can be traced lateralward and backward on either side beneath the corpus striatum into the substance of the temporal lobe. It serves in this way to connect the two temporal lobes, but it also contains decussating fibers from the olfactory tracts.

Part 23: Medial Forebrain bundle correlated with the Vādhūla Shrauta Sūtra

"The medial septal nucleus also receives fibers from the medial midbrain reticular formation; these fibers ascend in the mammillary peduncle and continue rostyrally in the medial forebrain bundle. Efferent fibres from the septal nuclei enter the medial part of the stria medullaris and pass to the habenular nuceus. In addition, axons from these nuclei enter the medial forebrain bundle to be distributed caudally to the entire lateral extend of the hypothalamic region."" Carpenter and Sutin, Human Neuroanatomy, Baltimore: Williams and Wilkins, 1983.

Part 24: Anterior nucleus of thalamus correlated with Mānava Shrauta Sūtra

The anterior nuclear group lies beneath the dorsal surface of the most rostral part of the thalamus, where it forms a distinct swelling, the anterior tubercle. . . . The anterior nuclei receive the mammillothalamic tract and may send some fibers to the mammillary body. . . In addition the anterior nuclei of the thalamus receive as many direct fibers from the fornix as from the mammillothalamic tract." Carpenter and Sutin, Human Neuroanatomy, Baltimore, Williams and Wilkins, 1983.

Part 25: Stria medullaris correlated with Bhāradvāja Shrauta Sūtra

"Transversely coursing fibers of the striae medullares run from the region of the lateral recess toward the midline and disappear in the median sulcus." Carpenter and Sutin, Human Neuroanatomy, Baltimore: Williams and Wilkins, 1983.

Part 26: Habenular nucleus correlated with Drāhyāyaṇa Shrauta Sūtra

The **Epithalamus** comprises the **trigonum habenulæ**, the **pineal body**, and the **posterior commissure.**

The **trigonum habenulæ** is a small depressed triangular area situated in front of the superior colliculus and on the lateral aspect of the posterior part of the tænia thalami. It contains a group of nerve cells termed the **ganglion habenulæ.** Fibers enter it from the stalk of the pineal body, and others, forming what is termed the **habenular commissure,** pass across the middle line to the corresponding ganglion of the opposite side. Most of its fibers are, however, directed downward and form a bundle, the **fasciculus retroflexus** of Meynert, which passes medial to the red nucleus, and, after decussating with the corresponding fasciculus of the opposite side, ends in the interpeduncular ganglion.

Part 27: Stria terminalis correlated with Bhāradvāja Shrauta Sūtra

The **stria terminalis** (*tænia semicircularis*) is a narrow band of white substance situated in the depression between the caudate nucleus and the thalamus. Anteriorly, its fibers are partly continued into the column of the fornix; some, however, pass over the anterior commissure to the gray substance between the caudate nucleus and septum pellucidum, while others are said to enter the caudate nucleus. Posteriorly, it is continued into the roof of the inferior cornu of the lateral ventricle, at the extremity of which it enters the nucleus amygdalæ. Superficial to it is a large vein, the **terminal vein** (*vein of the corpus striatum*), which receives numerous tributaries from the corpus striatum and thalamus; it runs forward to the interventricular foramen and there joins with the vein of the choroid plexus to form the corresponding internal cerebral vein. On the surface of the terminal vein is a narrow white band, named the **lamina affixa.**

Part 28: Interpeduncular nuclei (called interpeduncular ganglion in the book) correlated with Vārāha Shrauta Sūtra

The **cerebral peduncles** (*pedunculus cerebri; crus cerebri*) are two cylindrical masses situated at the base of the brain, and largely hidden by the temporal lobes of the cerebrum, which must be drawn aside or removed in order to expose them. They emerge from the upper surface of the pons, one on either side of the middle line, and, diverging as they pass upward and forward, disappear into the substance of the cerebral hemispheres. The depressed area between the crura is termed the **interpeduncular fossa,** and consists of a layer of grayish substance, the **posterior perforated substance,** which is pierced by small apertures for the transmission of bloodvessels; its lower part lies on the ventral aspect of the medial portions of the tegmenta, and contains a nucleus named the **interpeduncular ganglion** (page 802); its upper part assists in forming the floor of the third ventricle. The ventral sur-

face of each peduncle is crossed from the medial to the lateral side by the superior cerebellar and posterior cerebral arteries; its lateral surface is in relation to the gyrus hippocampi of the cerebral hemisphere and is crossed from behind forward by the trochlear nerve. Close to the point of disappearance of the peduncle into the cerebral hemisphere, the optic tract winds forward around its ventro-lateral

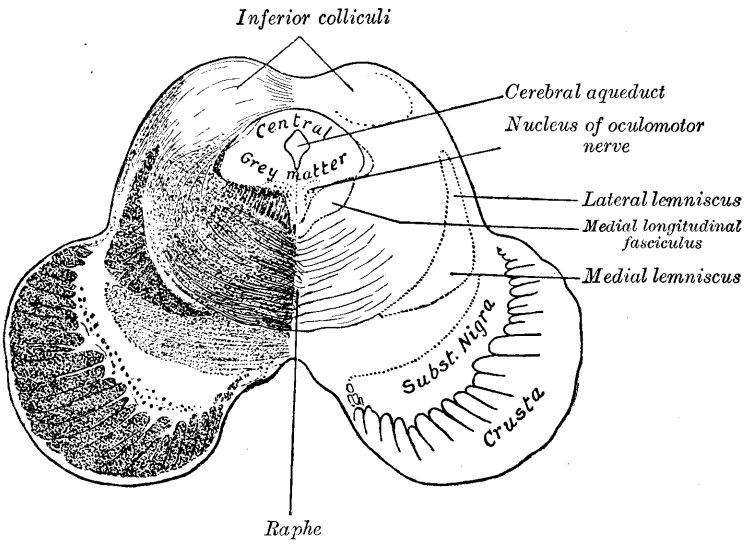

FIG. 711.—Transverse section of mid-brain at level of inferior colliculi.

surface. The medial surface of the peduncle forms the lateral boundary of the interpeduncular fossa, and is marked by a longitudinal furrow, the **oculomotor sulcus**, from which the roots of the oculomotor nerve emerge. On the lateral surface of each peduncle there is a second longitudinal furrow, termed the **lateral sulcus**; the fibers of the lateral lemniscus come to the surface in this sulcus, and pass backward and upward, to disappear under the inferior colliculus.

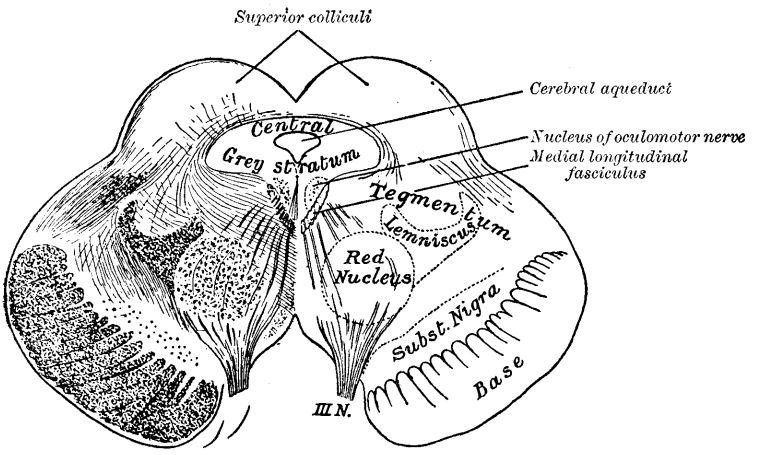

FIG. 712.—Transverse section of mid-brain at level of superior colliculi.

Structure of the Cerebral Peduncles (Figs. 711, 712).—On transverse section, each peduncle is seen to consist of a dorsal and a ventral part, separated by a deeply pigmented lamina of gray substance, termed the **substantia nigra.** The dorsal part

is named the **tegmentum**; the ventral, the **base** or **crusta**; the two bases are separated from each other, but the tegmenta are joined in the median plane by a forward prolongation of the raphé of the pons. Laterally, the tegmenta are free; dorsally, they blend with the corpora quadrigemina.

The **interpeduncular ganglion** is a median collection of nerve cells situated in the ventral part of the tegmentum. The fibers of the fasciculus retroflexus of Meynert, which have their origin in the cells of the ganglion habenulæ (page 812), end in it.

Besides the two nuclei mentioned, there are small collections of cells which form the dorsal and ventral nuclei and the central nucleus or nucleus of the raphé.

[1] A band of fibers, the *tractus peduncularis transversus*, is sometimes seen emerging from in front of the superior colliculus; it passes around the ventral aspect of the peduncle about midway between the pons and the optic tract, and dips into the oculomotor sulcus. This band is a constant structure in many mammals, but is only present in about 30 per cent. of human brains. Since it undergoes atrophy after enucleation of the eyeballs, it may be considered as forming a path for visual sensations.

The ganglion of the habenulæ located in the trigonum habenulæ just in front of the superior colliculus contains a mesial nucleus with small cells and a lateral nucleus with larger cells. The axons of these cells are grouped together in a bundle, the **fasciculus retroflexus of Meynert,** which passes ventrally medial to the red nucleus and terminates in a small medial ganglion in the substantia perforata posterior, immediately in front of the pons, called the **interpeduncular ganglion.**

The **interpeduncular ganglion** has rather large nerve cells whose axons curve backward and downward as the **tegmental bundle of Gudden,** to end partly in the dorsal tegmental nucleus and surrounding gray substance where they come into relation with association neurons and the dorsal longitudinal bundle of Schütz.

Part 29: Mammilothalamic Tract (called the bundle of Vicq d'Azyr in the book) correlated with Kātyāyana Shrauta Sūtra

Aside from the fibers of the fornix which pass through the mammillary body to decussate and descend (as the mammillo-mesencephalic fasciculus), many fibers are said to pass into the **bundle of Vicq d'Azyr,** and one bundle of fibers is said to pass from the fornix to the tuber cinereum.

The mammillary bodies receive collaterals and terminals then from the cortical centers via the fornix and probably other collaterals and terminals are received directly from the primary centers through the tractus olfactomesencephalicus. According to Cajal fibers also reach the mammillary body through the peduncle of the corpus mammillare from the arcuate fibers of the tegmentum and from the main fillet. The fornix probably brings the cortical centers into relation with the reflex path that runs from the primary centers to the mammillary body and the tuber cinereum.

The **bundle of Vicq d'Azyr** (*mammillo-thalamic fasciculus*) arises from cells in both the medial and lateral nuclei of the mammillary body and by fibers that are directly continued from the fornix. There axons divide within the gray matter; the coarser branches pass into the anterior nucleus of the thalamus as the bundle of Vicq d'Azyr, the finer branches pass downward as the mammillo-tegmental bundle of Gudden. The bundle of Vicq d'Azyr spreads out fan-like as it terminates in the anterior or dorsal nucleus of the thalamus. A few of the fibers pass through the dorsal nucleus to the angular nucleus of the thalamus. The axons from these nuclei are supposed to form part of the thalamocortical system.

The mammillo-tegmental bundle has already been considered under the olfactory reflex paths.

Part 30: Substantia innominata correlated with Laugākshi Shrauta Sūtra

The **substantia innominata of Meynert** is a stratum consisting partly of gray and partly of white substance, which lies below the anterior part of the thalamus and lentiform nucleus. It consists of three layers, superior, middle, and inferior. The *superior* layer is named the **ansa lentiformis,** and its fibers, derived from the medullary lamina of the lentiform nucleus, pass medially to end in the thalamus and subthalamic region, while others are said to end in the tegmentum and red nucleus. The *middle* layer consists of nerve cells and nerve fibers; fibers enter it from the parietal lobe through the external capsule, while others are said to connect it with the medial longitudinal fasciculus. The *inferior* layer forms the main part of the inferior stalk of the thalamus, and connects this body with the temporal lobe and the insula.

Part 31: Fornix correlated with Āshwalāyana Shrauta Sūtra

The **Fornix** (Figs. 720, 747, 748) is a longitudinal, arch-shaped lamella of white substance, situated below the corpus callosum, and continuous with it behind, but separated from it in front by the septum pellucidum. It may be described as consisting of two symmetrical bands, one for either hemisphere. The two portions are not united to each other in front and behind, but their central parts are joined together in the middle line. The anterior parts are called the **columns** of the fornix; the intermediate united portions, the **body**; and the posterior parts, the **crura.**

The **body** (*corpus fornicis*) of the fornix is triangular, narrow in front, and broad behind. The medial part of its upper surface is connected to the septum pellucidum in front and to the corpus callosum behind. The lateral portion of this surface forms part of the floor of the lateral ventricle, and is covered by the ventricular epithelium. Its lateral edge overlaps the choroid plexus, and is continuous with the epithelial covering of this structure. The under surface rests upon the tela chorioidea of the third ventricle, which separates it from the epithelial roof of that cavity, and from the medial portions of the upper surfaces of the thalami. Below, the lateral portions of the body of the fornix are joined by a thin triangular lamina, named the **psalterium** (*lyra*). This lamina contains some transverse fibers which connect the two hippocampi across the middle line and constitute the **hippocampal commissure.** Between the psalterium and the corpus callosum a horizontal cleft, the so-called **ventricle of the fornix** (*ventricle of Verga*), is sometimes found.

The **columns** (*columna fornicis; anterior pillars; fornicolumns*) of the fornix arch downward in front of the interventricular foramen and behind the anterior commis-

sure, and each descends through the gray substance in the lateral wall of the third ventricle to the base of the brain, where it ends in the corpus mammillare. From the cells of the corpus mammillare the **thalamomammillary fasciculus** (*bundle of Vicq*

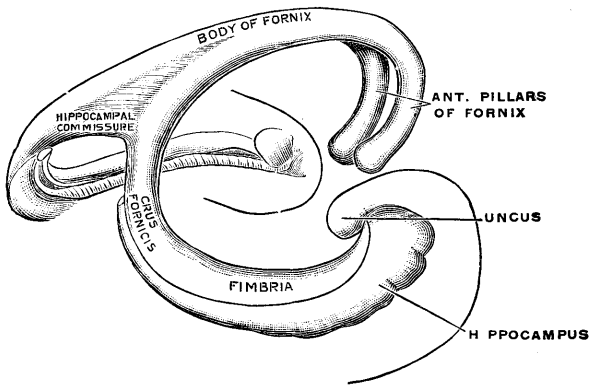

FIG. 747.—Diagram of the fornix. (Spitzka.)

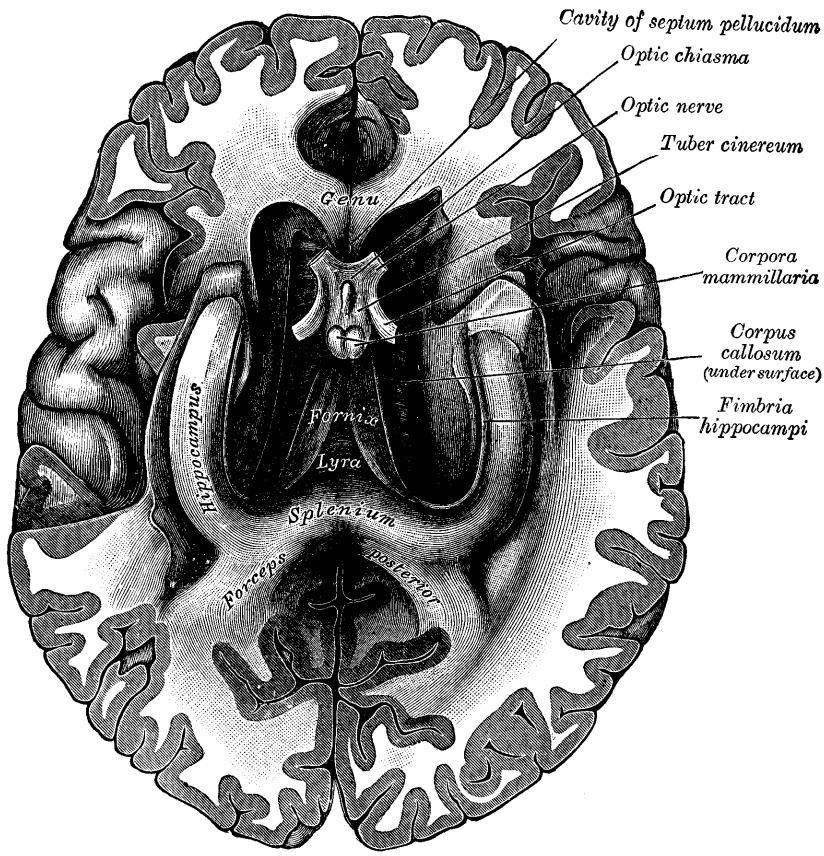

FIG. 748.—The fornix and corpus callosum from below. (From a specimen in the Department of Human Anatomy of the University of Oxford.)

d'Azyr) takes origin and is prolonged into the anterior nucleus of the thalamus. The column of the fornix and the thalamomammillary fasciculus together form a loop resembling the figure 8, but the continuity of the loop is broken in the corpus

mammillare. The column of the fornix is joined by the stria medullaris of the pineal body and by the superficial fibers of the stria terminalis, and is said to receive also fibers from the septum pellucidum. Zuckerkandl describes an **olfactory fasciculus** which becomes detached from the main portion of the column of the fornix, and passes downward in front of the anterior commissure to the base of the brain, where it divides into two bundles, one joining the medial stria of the olfactory tract; the other joins the subcallosal gyrus, and through it reaches the hippocampal gyrus.

The **crura** (*crus fornicis; posterior pillars*) of the fornix are prolonged backward from the body. They are flattened bands, and at their commencement are intimately connected with the under surface of the corpus callosum. Diverging from one another, each curves around the posterior end of the thalamus, and passes downward and forward into the inferior cornu of the lateral ventricle (Fig. 750). Here it lies along the concavity of the hippocampus, on the surface of which some of its fibers are spread out to form the **alveus,** while the remainder are continued as a narrow white band, the **fimbria hippocampi,** which is prolonged into the uncus of the hippocampal gyrus. The inner edge of the fimbria overlaps the **fascia dentata hippocampi** (*dentate gyrus*) (page 827), from which it is separated by the **fimbriodentate fissure**; from its lateral margin, which is thin and ragged, the ventricular epithelium is reflected over the choroid plexus as the latter projects into the chorioidal fissure.

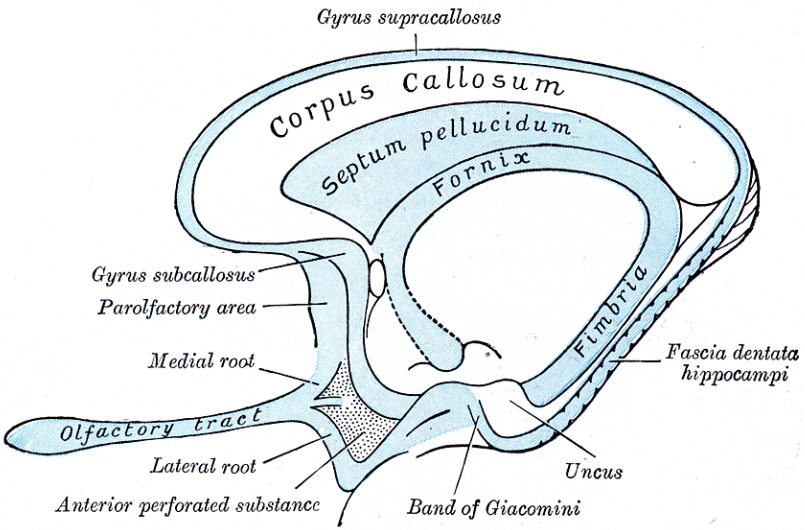

FIG. 732.—Scheme of rhinencephalon.

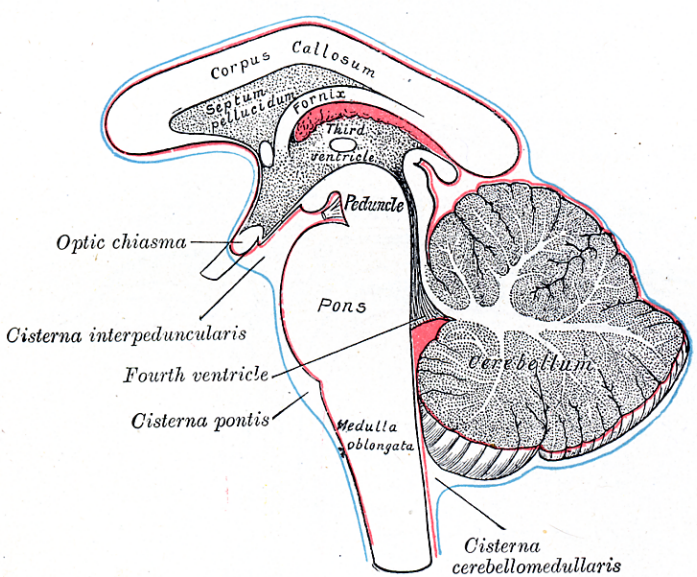

FIG. 768.—Diagram showing the positions of the three principal subarachnoid cisternæ.

Part 32: Medial and lateral dorsal nuclei
correlated with the Jaiminīya Shrauta Sūtra and the Nidāna Sūtra

"The dorsal thalamus is divided into anterior, medial and lateral nuclear groups by a band of myelinated fibers, the internal medullary lamina of the thalamus." (P.501, Carpenter and Sutin, Human Neuroanatomy, Baltimore: Williams and Wilkins, 1983.)

Part 33: Hypothalamic nuclei correlated with Baudhāyana Shrauta Sūtra

The **Hypothalamus** (Fig. 720) includes the **subthalamic tegmental region** and the structures forming the greater part of the floor of the third ventricle, viz., the **corpora mammillaria, tuber cinereum, infundibulum, hypophysis,** and **optic chiasma.**

The **subthalamic tegmental region** consists of the upward continuation of the tegmentum; it lies on the ventro-lateral aspect of the thalamus and separates it from the fibers of the internal capsule. The red nucleus and the substantia nigra are prolonged into its lower part; in front it is continuous with the substantia innominata of Meynert, medially with the gray substance of the floor of the third ventricle.

It consists from above downward of three strata: (1) **stratum dorsale,** directly applied to the under surface of the thalamus and consisting of fine longitudinal fibers; (2) **zona incerta,** a continuation forward of the formatio reticularis of the tegmentum; and (3) the **corpus subthalamicum** (*nucleus of Luys*), a brownish mass presenting a lenticular shape on transverse section, and situated on the dorsal aspect of the fibers of the base of the cerebral peduncle; it is encapsuled by a lamina

of nerve fibers and contains numerous medium-sized nerve cells, the connections of which are as yet not fully determined.

The **corpora mammillaria** (*corpus albicantia*) are two round white masses, each about the size of a small pea, placed side by side below the gray substance of the floor of the third ventricle in front of the posterior perforated substance. They consist of white substance externally and of gray substance internally, the cells of the latter forming two nuclei, a **medial** of smaller and a **lateral** of larger cells. The white substance is mainly formed by the fibers of the columns of the fornix, which descend to the base of the brain and end partly in the corpora mammillaria. From the cells of the gray substance of each mammillary body two fasciculi arise: one, the **thalamomammillary fasciculus** (*bundle of Vicq d'Azyr*), passes upward into the anterior nucleus of the thalamus; the other is directed downward into the tegmentum. Afferent fibers are believed to reach the corpus mammillare from the medial lemniscus and from the tegmentum.

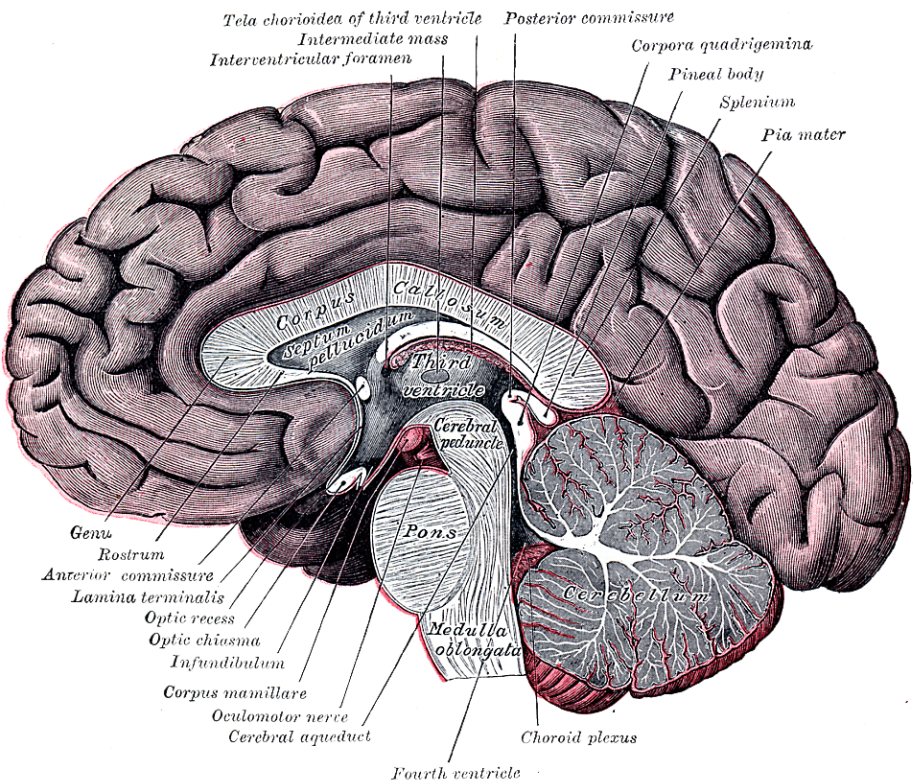

FIG. 720.—Median sagittal section of brain. The relations of the pia mater are indicated by the red color.

The **tuber cinereum** is a hollow eminence of gray substance situated between the corpora mammillaria behind, and the optic chiasma in front. Laterally it is continuous with the anterior perforated substances and anteriorly with a thin lamina, the **lamina terminalis.** From the under surface of the tuber cinereum a hollow conical process, the **infundibulum,** projects downward and forward and is attached to the posterior lobe of the hypophysis.

In the lateral part of the tuber cinereum is a nucleus of nerve cells, the **basal optic nucleus of Meynert,** while close to the cavity of the third ventricle are three additional nuclei. Between the tuber cinereum and the corpora mammillaria a small elevation, with a corresponding depression in the third ventricle, is sometimes seen. Retzius has named it the **eminentia saccularis,** and regards it as a representative of the saccus vasculosus found in this situation in some of the lower vertebrates.

The **hypophysis** (*pituitary body*) (Fig. 721) is a reddish-gray, somewhat oval mass, measuring about 12.5 mm. in its transverse, and about 8 mm. in its antero-posterior diameter. It is attached to the end of the infundibulum, and is situated in the fossa hypophyseos of the sphenoidal bone, where it is retained by a circular fold of dura mater, the **diaphragma sella**; this fold almost completely roofs in the fossa, leaving only a small central aperture through which the infundibulum passes.

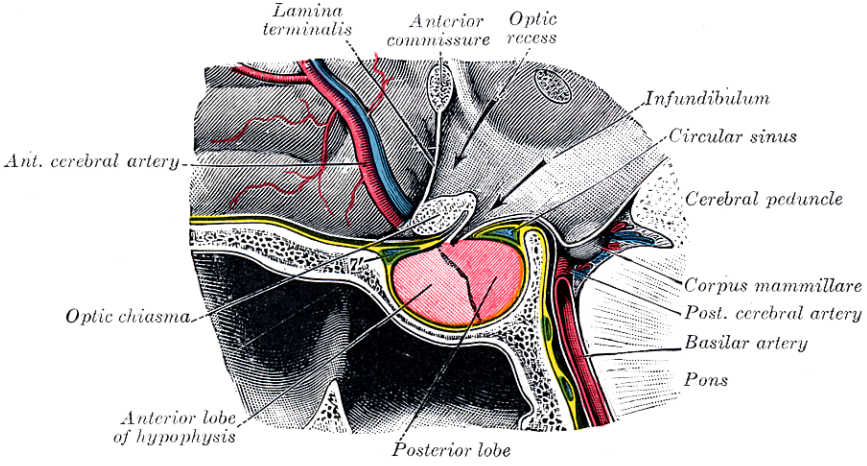

FIG. 721.—The hypophysis cerebri, in position. Shown in sagittal section.

Optic Chiasma (*chiasma opticum; optic commissure*).—The optic chiasma is a flattened, somewhat quadrilateral band of fibers, situated at the junction of the floor and anterior wall of the third ventricle. Most of its fibers have their origins in the retina, and reach the chiasma through the optic nerves, which are continuous with its antero-lateral angles. In the chiasma, they undergo a partial decussation (Fig. 722); the fibers from the nasal half of the retina decussate and enter the optic tract of the opposite side, while the fibers from the temporal half of the retina do not undergo decussation, but pass back into the optic tract of the same side. Occupying the posterior part of the commissure, however, is a strand of fibers, the **commissure of Gudden,** which is not derived from the optic nerves; it forms a connecting link between the medial geniculate bodies.

Part 34: Fasciculus retroflexus correlated with the Vaikhānasa Shrauta Sūtra

The **Epithalamus** comprises the **trigonum habenulæ**, the **pineal body**, and the **posterior commissure.**

The **trigonum habenulæ** is a small depressed triangular area situated in front of the superior colliculus and on the lateral aspect of the posterior part of the tænia thalami. It contains a group of nerve cells termed the **ganglion habenulæ.** Fibers enter it from the stalk of the pineal body, and others, forming what is termed the **habenular commissure,** pass across the middle line to the corresponding ganglion of the opposite side. Most of its fibers are, however, directed downward and form a bundle, the **fasciculus retroflexus** of Meynert, which passes medial to the red nucleus, and, after decussating with the corresponding fasciculus of the opposite side, ends in the interpeduncular ganglion.

Part 35: Mammillotegmental tract correlated to the Anupāda Shrauta Sūtra

Mammillary efferent fibres, arising from the medial mammillary nucleus and to a lesser extent from the lateral and intermediate mammillary nuclei, form a well defined bundle, the fasciculus mammillaris princeps. This bundle passes dorsally for a short distance and divides into two components: the mammillothalamic tract and the mammillotegmental tract. . . . The mamillotegmental tract curves caudally into the midbrain tegmentum. Fibers of this tract terminate in the dorsal and ventral tegmental nuclei." Pp. 564-565 Carpenter and Sutin, Human Neuroanatomy, Baltimore: Williams and Wilkins, 1983. Page 867, "The pathways from these centers to lower centers in the brain stem and spinal cord are . . . to end of paragraph."

Part 36: Subcallosal gyrus correlated to the Kāthaka Shulba Sūtra

3. The **Subcallosal, Supracallosal,** and **Dentate Gyri** form a rudimentary arch-shaped lamina of gray substance extending over the corpus callosum and above the hippocampal gyrus from the anterior perforated substance to the uncus.

(*a*) The **subcallosal gyrus** (*gyrus subcallosus; peduncle of the corpus callosum*) is a narrow lamina on the medial surface of the hemisphere in front of the lamina terminalis, behind the parolfactory area, and below the rostrum of the corpus callosum. It is continuous around the genu of the corpus callosum with the supra-callosal gyrus.

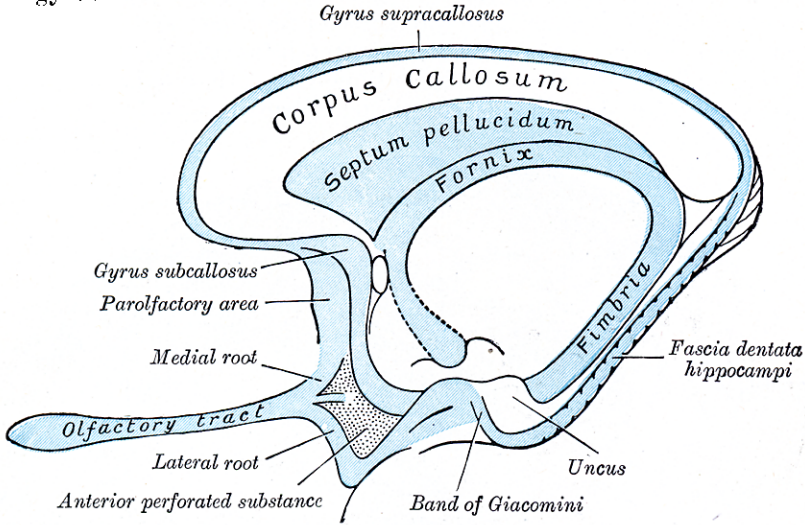

FIG. 732.—Scheme of rhinencephalon.

Part 37: Paraterminal gyrus correlated to the Hiranyakeshīya Shulba Sūtra

"The medial olfactory stria extends toward the medial hemispheric surface and becomes continuous with a small cortical field known as the subcallosal area (parolfactory area), located beneath the rostrum of the corpus callosum. This area is limited in front by the anterior parolfactory sulcus, while behind it is separated by the posterior parolfactory sulcus from another strip of cortex, the paraterminal gyrus, which is closely applied to the rostral lamina of the corpus callosum. The subcallosal area and the paraterminal gyrus together constitute the septal area (paraterminal body)." Carpenter and Sutin, Human Neuroanatomy, Baltimore: Williams and Wilkins, 1983, pages 617 and 618.

Part 38: Cingulate gyrus correlated to the Baudhāyana Shulba Sūtra

Limbic Lobe (Fig. 727).—The term limbic lobe was introduced by Broca, and under it he included the cingulate and hippocampal gyri, which together arch around the corpus callosum and the hippocampal fissure. These he separated on the morphological ground that they are well-developed in animals possessing a keen sense of smell (osmatic animals), such as the dog and fox. They were thus regarded as a part of the rhinencephalon, but it is now recognized that they belong to the neopallium; the cingulate gyrus is therefore sometimes described as a part of the frontal lobe, and the hippocampal as a part of the temporal lobe.

The **cingulate gyrus** (*gyrus cinguli; callosal convolution*) is an arch-shaped convolution, lying in close relation to the superficial surface of the corpus callosum, from which it is separated by a slit-like fissure, the **callosal fissure.** It commences below the rostrum of the corpus callosum, curves around in front of the genu, extends along the upper surface of the body, and finally turns downward behind the splenium, where it is connected by a narrow **isthmus** with the hippocampal gyrus. It is separated from the medial part of the superior frontal gyrus by the cingulate sulcus, and from the precuneus by the subparietal sulcus.

Part 39: Orbito-frontal gyrus 1, 2 and 3 correlated to Vārāha, Vādhūla and Mānava Shulba Sūtras

The **inferior frontal gyrus** (*gyrus frontalis inferior; subfrontal gyre*) lies below the inferior frontal sulcus, and extends forward from the lower part of the precentral sulcus; it is continuous with the lateral and posterior orbital gyri on the under surface of the lobe. It is subdivided by the anterior horizontal and ascending rami of the lateral fissure into three parts, viz., (1) the **orbital part,** below the anterior horizontal ramus of the fissure; (2) the **triangular part** (*cap of Broca*), between the ascending and horizontal rami; and (3) the **basilar part,** behind the anterior ascending ramus. The left inferior frontal gyrus is, as a rule, more highly developed than the right, and is named the **gyrus of Broca,** from the fact that Broca described it as the center for articulate speech.

The **inferior** or **orbital surface** of the frontal lobe is concave, and rests on the orbital plate of the frontal bone (Fig. 729). It is divided into four orbital gyri by a well-marked H-shaped **orbital sulcus.** These are named, from their position, the **medial, anterior, lateral,** and **posterior orbital gyri.** The medial orbital gyrus presents a well-marked antero-posterior sulcus, the **olfactory sulcus,** for the olfactory tract; the portion medial to this is named the **straight gyrus,** and is continuous with the superior frontal gyrus on the medial surface.

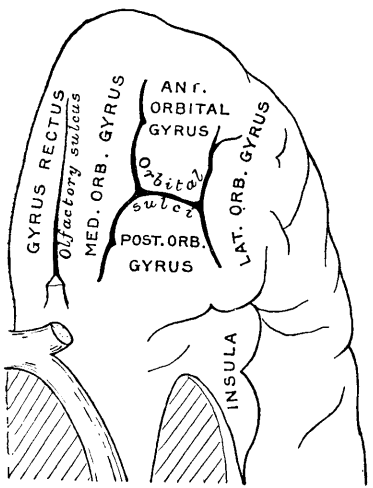

FIG. 729.—Orbital surface of left frontal lobe.

The **medial surface** of the frontal lobe is occupied by the medial part of the superior frontal gyrus (*marginal gyrus*) (Fig. 727). It lies between the cingulate sulcus and the supero-medial margin of the hemisphere. The posterior part of this gyrus is sometimes marked off by a vertical sulcus, and is distinguished as the **paracentral lobule,** because it is continuous with the anterior and posterior central gyri.

Part 40: Gyrus rectus correlated to Āpastamba Shulba Sūtra

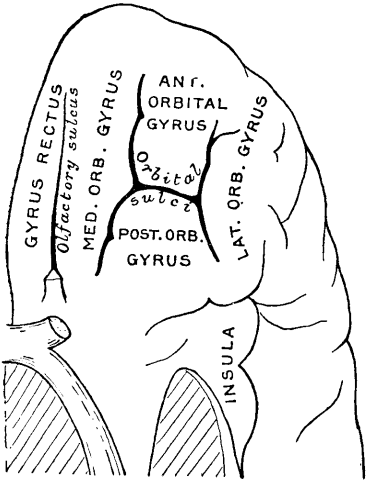

FIG. 729.—Orbital surface of left frontal lobe.

Part 41: Anterior perforated substance correlated to Kātyāyana Shulba Sūtra

(*e*) The **anterior perforated substance** (*substantia perforata anterior*) is an irregularly quadrilateral area in front of the optic tract and behind the olfactory trigone, from which it is separated by the **fissure prima**; medially and in front it is continuous with the subcallosal gyrus; laterally it is bounded by the lateral stria of the olfactory tract and is continued into the uncus. Its gray substance is confluent above with that of the corpus striatum, and is perforated anteriorly by numerous small bloodvessels.

Part 42: Pyriform cortex of parahippocampal gyrus correlated to Vishṇu Dharma Sūtra

Pyriform cortex is the rostral region of five-layered cortex curled up rostrally and medially in the parahippocampal gyrus. Limbic System Lab, psy.jhu.edu.

Part 43: Anterior olfactory nucleus correlated to Vasishtha Dharma Sūtra

"Caudal to the olfactory bulb are scattered groups of neurons, intermediate in size between mitral and granule cells, that form the anterior olfactory nucleus."

Part 44: Olfactory tract correlated to Āpastamba Dharma Sūtra

(*b*) The **olfactory tract** (*tractus olfactorius*) is a narrow white band, triangular on coronal section, the apex being directed upward. It lies in the olfactory sulcus on the inferior surface of the frontal lobe, and divides posteriorly into two striæ, a medial and a lateral. The **lateral stria** is directed across the lateral part of the anterior perforated substance and then bends abruptly medialward toward the uncus of the hippocampal gyrus. The **medial stria** turns medialward behind the parolfactory area and ends in the subcallosal gyrus; in some cases a small **intermediate stria** is seen running backward to the anterior perforated substance.

Part 45: Olfactory bulb correlated to Hiranyakeshīya Dharma Sūtra

(*a*) The **olfactory bulb** (*bulbus olfactorius*) is an oval, reddish-gray mass which rests on the cribriform plate of the ethmoid and forms the anterior expanded extremity of the olfactory tract. Its under surface receives the olfactory nerves, which pass upward through the cribriform plate from the olfactory region of the nasal cavity. Its minute structure is described on page 848.

5. *The Olfactory Bulb.*—In many of the lower animals this contains a cavity which communicates through the olfactory tract with the lateral ventricle. In man the original cavity is filled up by neuroglia and its wall becomes thickened, but much more so on its ventral than on its dorsal aspect. Its dorsal part contains a small amount of gray and white substance, but it is scanty and ill-defined. A section through the ventral part (Fig. 755) shows it to consist of the following layers from without inward:

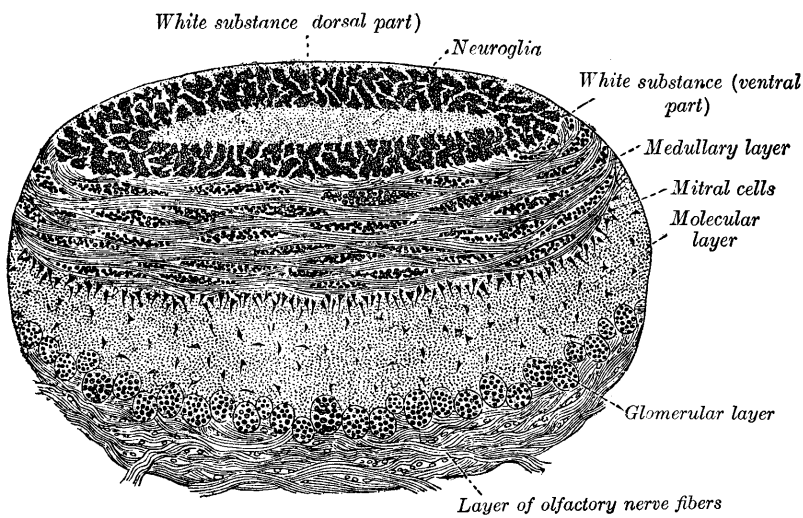

FIG. 755.—Coronal section of olfactory bulb. (Schwalbe.)

Part 46: Olfactory tubercule correlated to Gautama Dharma Sūtra

"At the point of division of the olfactory tract into lateral and medial olfactory striae, there is a rhomboid-shaped region, bounded by the olfactory trigone and the optic tract, known as the anterior perforated substance. This region is studded with numerous perforations made by entering blood vessels. The posterior border of this region, near the optic tract, has a smooth appearance and forms an oblique band, the diagonal band of Broca. In macrosmatic animals, especially those with well developed snouts or muzzles, the rostral portion of the area is marked by a prominent elevation, the olfactory tubercle." Carpenter and Sutin, Human Neuroanatomy, Baltimore: Williams and Wilkins, 1983, pages 617.

Part 47: Olfactory striae correlated to Vaikhānasa Dharma Sūtra

(*b*) The **olfactory tract** (*tractus olfactorius*) is a narrow white band, triangular on coronal section, the apex being directed upward. It lies in the olfactory sulcus on the inferior surface of the frontal lobe, and divides posteriorly into two striæ, a medial and a lateral. The **lateral stria** is directed across the lateral part of the anterior perforated substance and then bends abruptly medialward toward the uncus of the hippocampal gyrus. The **medial stria** turns medialward behind the parolfactory area and ends in the subcallosal gyrus; in some cases a small **intermediate stria** is seen running backward to the anterior perforated substance.

Part 48: Parts of the amygdaloid complex correlated to the Baudhāyana Dharma Sūtra

"The amygdaloid nuclear complex is a gray mass situated in the dorsomedial portion of the temporal lobe, in front of, and partly above the tip of the inferior horn of the lateral ventricle. It is covered by a rudimentary cortex and caudally is continuous with the uncus of the parahippocampal gyrus." Page 634 Carpenter and Sutin, Human Neuroanatomy, Baltimore: Williams and Wilkins, 1983.