The Limbic System

The part of the brain involved with learning, memory and emotion. It is affected in many neuropsychiatric diseases including schizophrenia, Alzheimer’s disease and some forms of epilepsy.

Identify:
- **Corpus callosum**
- **Splenium** (thick posterior end of the corpus callosum)
- **Septum pellucidum** (two thin vertical sheets of neuroglia)
- **Cavum** of the septum pellucidum (narrow space separating the SP)
- **Fornix** (fuse in the midline and, anteriorly, turn vertically downwards as the *columns of the fornix*)
- **Lamina terminalis** (forms the anterior wall of the 3rd ventricle)
- **Anterior comissure** (thick bundle of white matter crossing the midline horizontally)

On the inferior surface of the hemisphere:
- **Optic chiasm**
- **Interthalamic adhesion** (joins lobes of the thalamus)
Cingulate Gyrus

Partially wraps around the corpus callosum and is limited above by the cingulate sulcus.
- Anteriorly adjoins the subcallosal gyrus below the corpus callosum
- Subcallosal gyrus is separated from the lamina terminalis by the paraterminal gyrus (containing the septal nuclei)
- Posteriorly continues as the parahippocampal gyrus
- Parahippocampal gyrus runs into a hook-shaped region of cortex, the uncus

Hippocampal formation

The corpus callosum interconnects the bulk of the cerebral cortex on each side:
- Genu – anterior curved end
- Rostrum – anterioinferiorly, the genu leads into this
- Body – central main curve
- Spenium – rounded posterior end
Below the body of the corpus callosum lies the fornix:
- Interconnects the hippocampus with the diencephalon and the precommissural septum
- Fornices fuse below the body of the callosum in the commissure of the fornix
- The column of the fornix passes behind the anterior commissure to reach the mammillary body
- The anterior mammillary body sends fibres to the anterior nucleus of the thalamus
- These anterior nuclei in turn project to the cortex of the cingulated gyrus

Immediately in front of the fornices is the lamina terminalis, and in its superior part the anterior commissure crosses to interconnect the temporal lobes and olfactory structures on each side.

Immediately below the body of the fornix lies the choroid plexuses of the 3rd and lateral ventricles.

The hippocampus lies in the floor of the inferior horn of the lateral ventricle:
- Anteriorly, two or three shallow grooves give it a paw-like appearance, the pes hippocampi
- Beneath the ventricular surface, the alveus consists of fibres passing laterally into the fibrae

It comprises the dentate gyrus, the cornu ammonis (CA regions) and the subiculum
- Anatomically it is adjacent to the entorhinal cortex, from which it receives major inputs (via the perforant path)
- Fibres leave predominantly via area CA1 and the subiculum (many of these fibres travel in the fimbria, and then the fornix, before reaching a diverse range if cortical and subcortical targets)
Thalamus and Hypothalamus

The diencephalon (thalamus and hypothalamus) is separated into two halves by the 3rd ventricle, which is limited:
- Anteriorly – by the lamina terminalis
- Superiorly – by the invaginated ependyma forming the tela choroidea
- Inferiorly – front to back, by the optic chiasm, pituitary stalk, mammillary bodies and the tegmentum
- Posteriorly – by the cerebral aqueduct

Above the cerebral aqueduct lies the habenula on either side and the pineal body, both of which comprise the epithalamus.

Remember that the anterior group of thalamic nuclei form part of the limbic system.

The lateral wall of the 3rd ventricle is traversed by a shallow groove called the hypothalamic sulcus, which divides the diencephalon into dorsal and ventral parts:
- Ventral – hypothalamus (medially) and subthalamus (laterally)
- Dorsal – dorsal thalamus and the epithalamus

The subthalamus lies below the thalamus and lateral to the hypothalamus. It merges posteriorly with the tegmentum.

The hypothalamus extends from the lamina terminalis in front to a vertical plane immediately behind the mammillary bodies:
- It is an important centre contributing to body homeostasis and autonomic functions
- Includes the preoptic area anteriorly, adjacent to the lamina terminalis

Nucleus Accumbens and Ventral Striatum

The nucleus accumbens is found below the anterior horn of the lateral ventricle. This together with the anterior perforated substance (aka olfactory tubercle) form the ventral striatum
- Receive projections from the intralaminar/midline nuclei of the thalamus and the ventral tegmental area (adjacent to the substantia nigra)
- Project to a ventral extension of the globus pallidus, found below the anterior commissure, called the ventral pallidum, which then projects to the thalamus

Changes in the nucleus accumbens have been found in the brains of patients with schizophrenia. It also has a major role in the reward pathway that seems to be perturbed in patients suffering from an addiction.
**Amygdala**

The size and shape of an almond, it is found anterior and slightly superior to the anterior hippocampus. It performs a primary role in the processing of memory and emotional reactions

- Projections form the *stria terminalis* and the *amygdalofugal pathway*
- Receives input from the *olfactory bulb*

It is separated into three nuclear groups:

- **Corticomedial group** – projects via the stria terminalis to the hypothalamus
- **Central nuclear group** – projects via the stria terminalis and amygdalofugal pathway to reach the hypothalamus, septal nuclei and brain stem
- **Basolateral group** – projects via the amygdalofugal pathway to reach the basolateral forebrain and the thalamus

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**Lateral Ventricle**

Many of the boundaries of the lateral ventricle are major components of the limbic system (often reported to be abnormal in patients with forms of neuropsychiatric disease)
• Superior boundary – corpus callosum
• Medial boundary – septum and fornix
• Lateral boundary – head of caudate nucleus bulges into the ventricle

The thalamo-striate vein and the stria terminalis separate the caudate from the dorsal surface of the thalamus. The stria terminalis is a slender bundle of white fibres accompanying the curve of the caudate around into the temporal horn of the ventricle.

The caudate and stria terminalis, both of which follow the inner curve of the ventricle around from the ventral side of the body become continuous with the amygdala at the tip of the inferior horn (overlies the tip of the inferior horn).

Medially in the floor of the inferior horn is the convex curve of the hippocampus covered by a layer of fibres passing medially to form the fimbria.

A sheet of fibres from the callosum called the tapetum curves around the posterior horn into the inferior parts of the occipital lobe forming the roof, lateral wall and floor of this part of the ventricle.

Medially, the wall shows two ridges:
• Above, the bulb of the posterior horn (formed by fibres of the forceps major of the corpus callosum)
• Below, the calcar avis produced by the deep calcarine sulcus (contains the visual cortex)

**Corpus Callosum**

Fibres curve forwards into the frontal lobe and backwards into the occipital lobe:
• The posterior curve is called the forceps major
• The anterior curve is called the forceps minor

The horizontal fibres of the callosum interdigitate laterally with the corona radiate.

The corpus callosum is by far the largest fibre bundle interconnecting the two halves of the brain (commissural fibres), others include:
• Anterior commissure
• Commissure of the fornix
Thalamic Nuclei Associated with the Limbic System

The anterior group is part of the limbic system (anterodorsal, anteroventral, anteromedial nuclei)

- Receives fibres from the fornix and the mammillo-thalamic tract
- Projects to the cingulate cortex
- Also receives input from the amygdala