

Systemic Module

CNS

“Anatomy

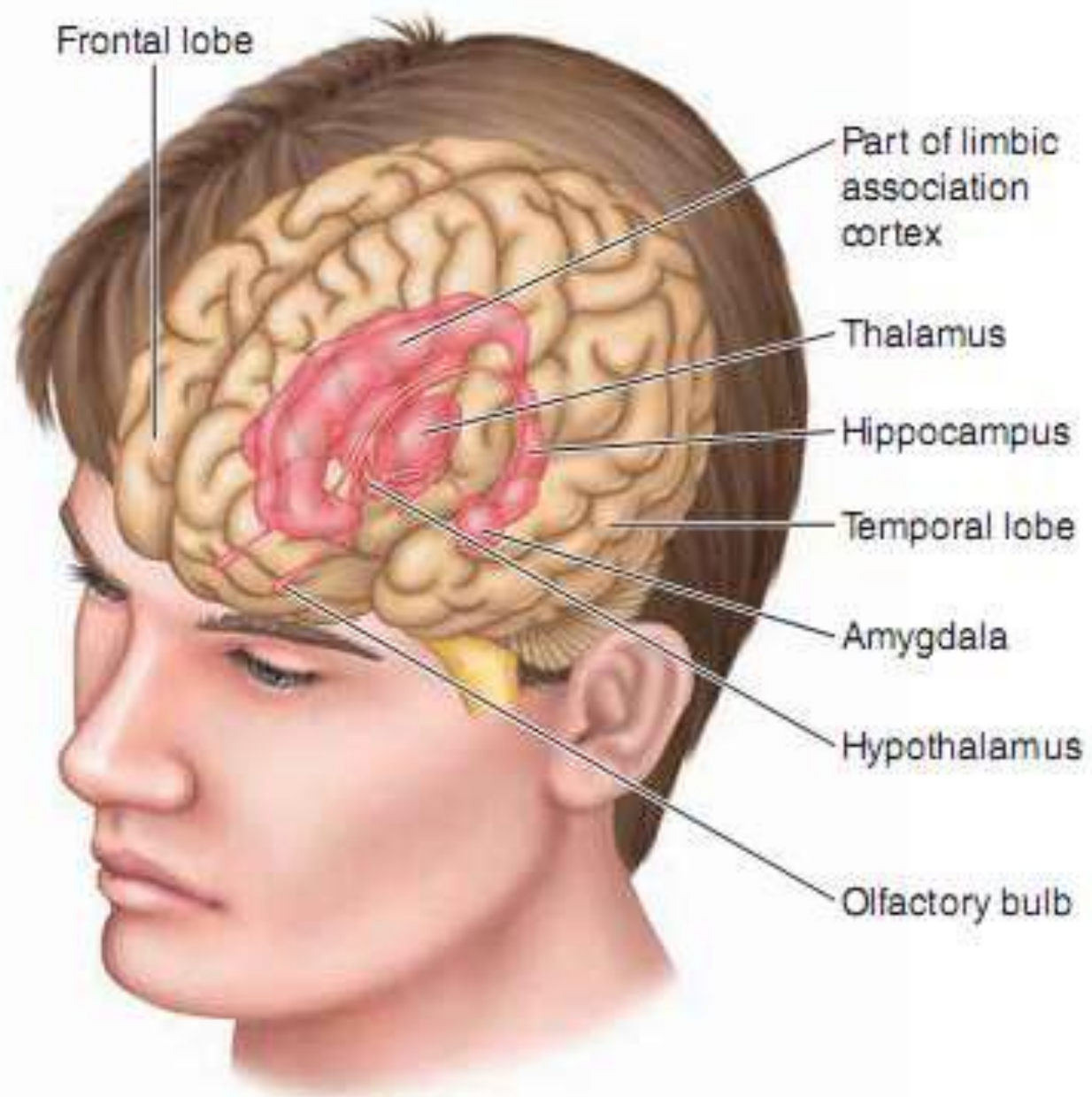
Limbic System

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Limbic System

- Functional system of interconnected **cortical** and **subcortical** structures.
- Functions:
 - Controls the expression of emotions.
 - Controls the formation of memories.
- The limbic system – also known as the **circle of Papez** (or Papez's Circuit)
- Used to include a group of structures that lie in the border zone (limbic means border) between the **cerebral cortex** and **hypothalamus**.



Types of Basic Emotions



1. Happiness



2. Sadness



3. Fear



4. Disgust



5. Anger

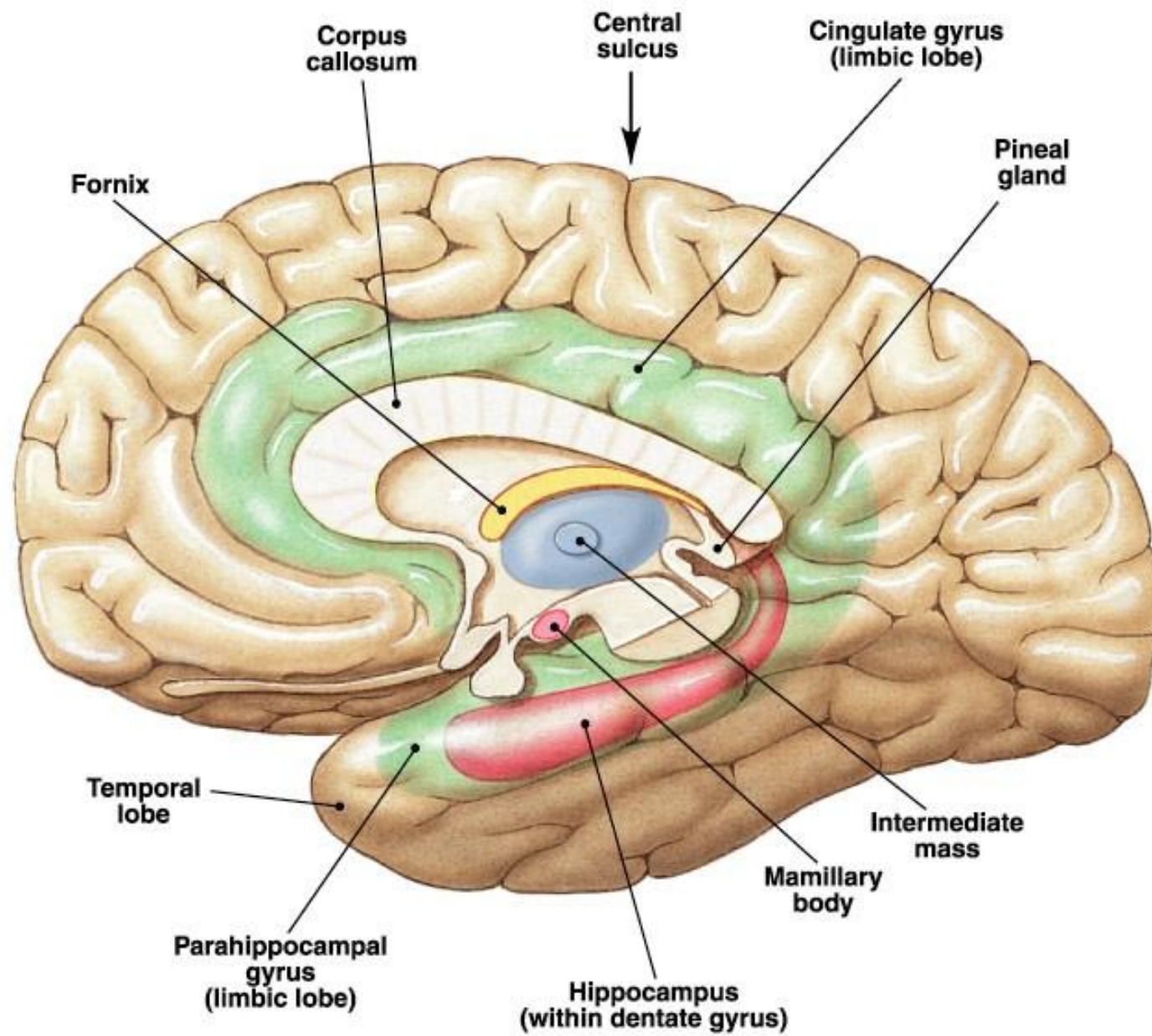


6. Surprise

The Areas of Limbic System

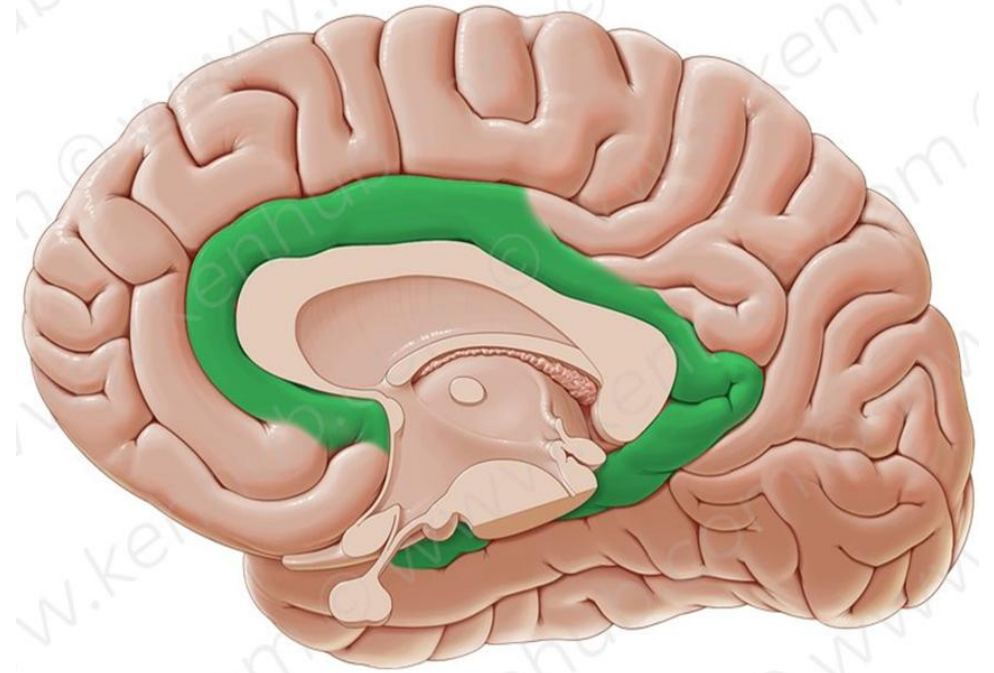
- **The cortical areas:** limbic lobe (cingulate gyrus, isthmus, parahippocampal gyrus and uncus), orbitofrontal cortex, prefrontal cortex, and insular cortex,
- **Subcortical structures:** thalamus (anterior thalamic nuclei), septal area, hippocampus, hypothalamus (mammillary bodies) and the amygdala.
- **Connecting pathways:** The alveus, the fimbria, the fornix, the mammillothalamic tract, and the stria terminalis.

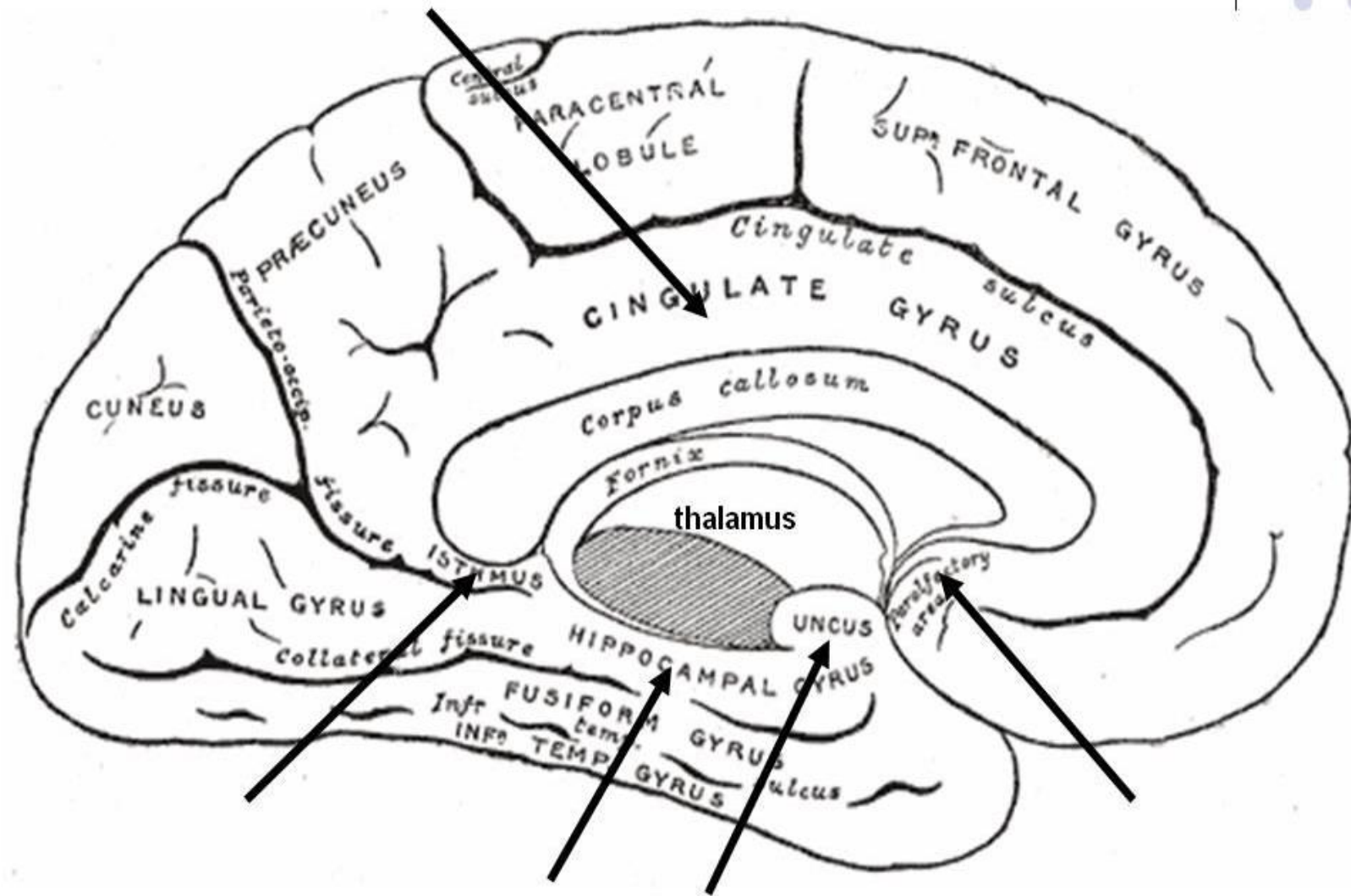
Bundles of fibers connecting the different structures of limbic system to each other and to other structures.



Limbic Lobe

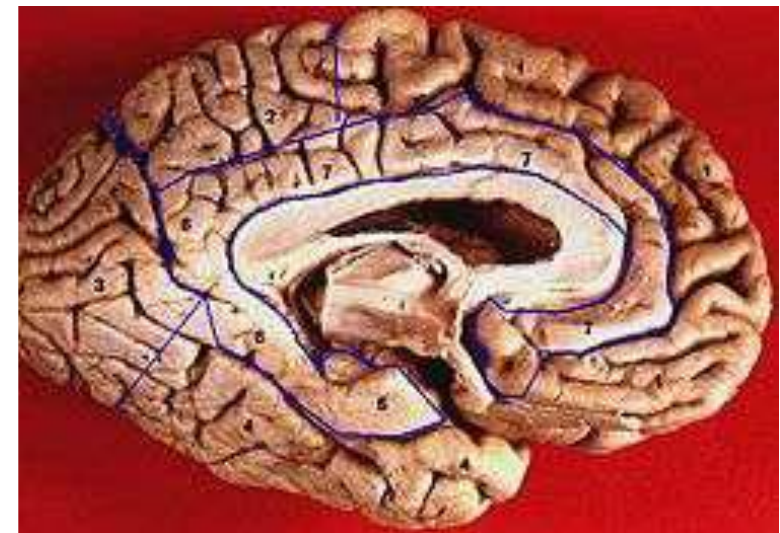
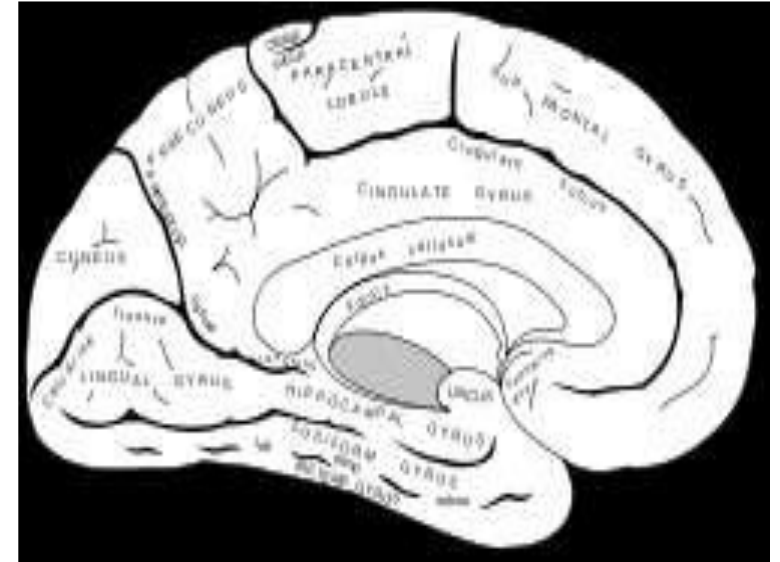
- A group of structures on the medial surface of the cerebral hemisphere forming a ring around the diencephalon.
- It consists of:
 1. **Subcallosal gyrus**
 2. **Cingulate Gyrus.**
 3. **Isthmus**
 4. **Parahippocampal Gyrus.**
 5. **Uncus.**
- The **cingulum** is a fiber bundle that runs from the cingulate gyrus to the Parahippocampal gyrus





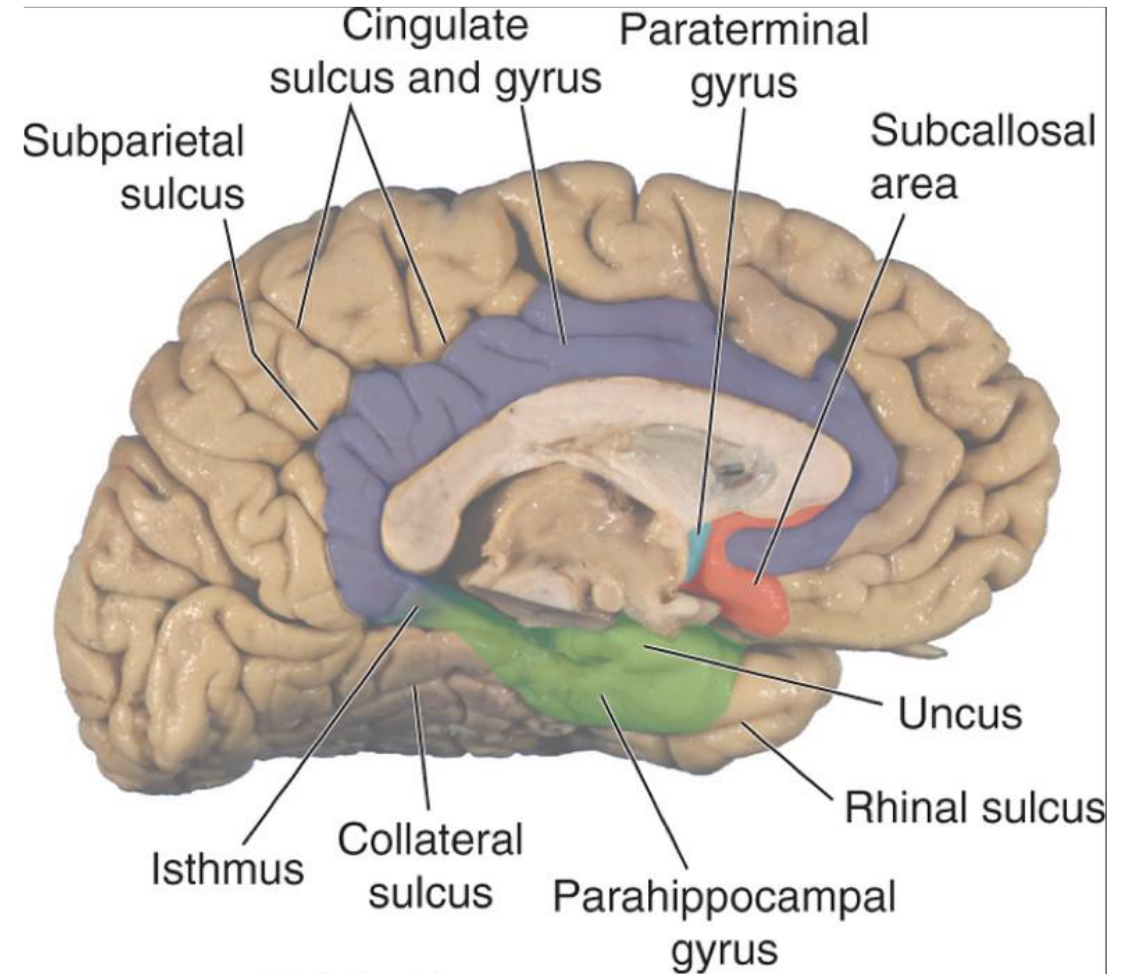
Cingulate Gyrus

- Situated dorsal to the corpus callosum
- Heavily interconnected with the association areas of the cerebral cortex. Also receives inputs from the anterior nucleus of the thalamus.
- It projects to the Parahippocampal gyrus via the cingulum.
- Involved with **emotion formation, learning, and memory**, central role in **attention, feelings of safety and security** have also been attributed to this part of the brain.



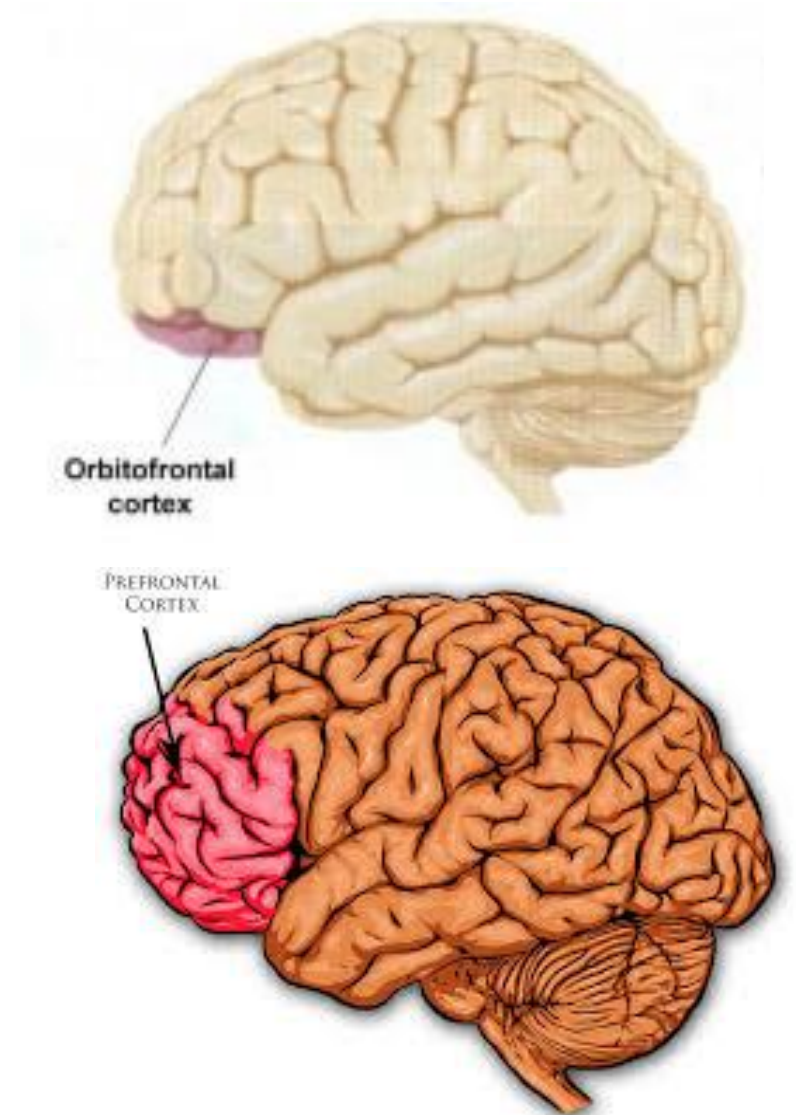
Parahippocampal Gyrus

- it lies on the inferior surface of each cerebral hemisphere medial to the collateral sulcus.
- Anteriorly continuous with the uncus. Posteriorly continuous with the cingulate gyrus.
- Involved with important role in **memory encoding and retrieval.**



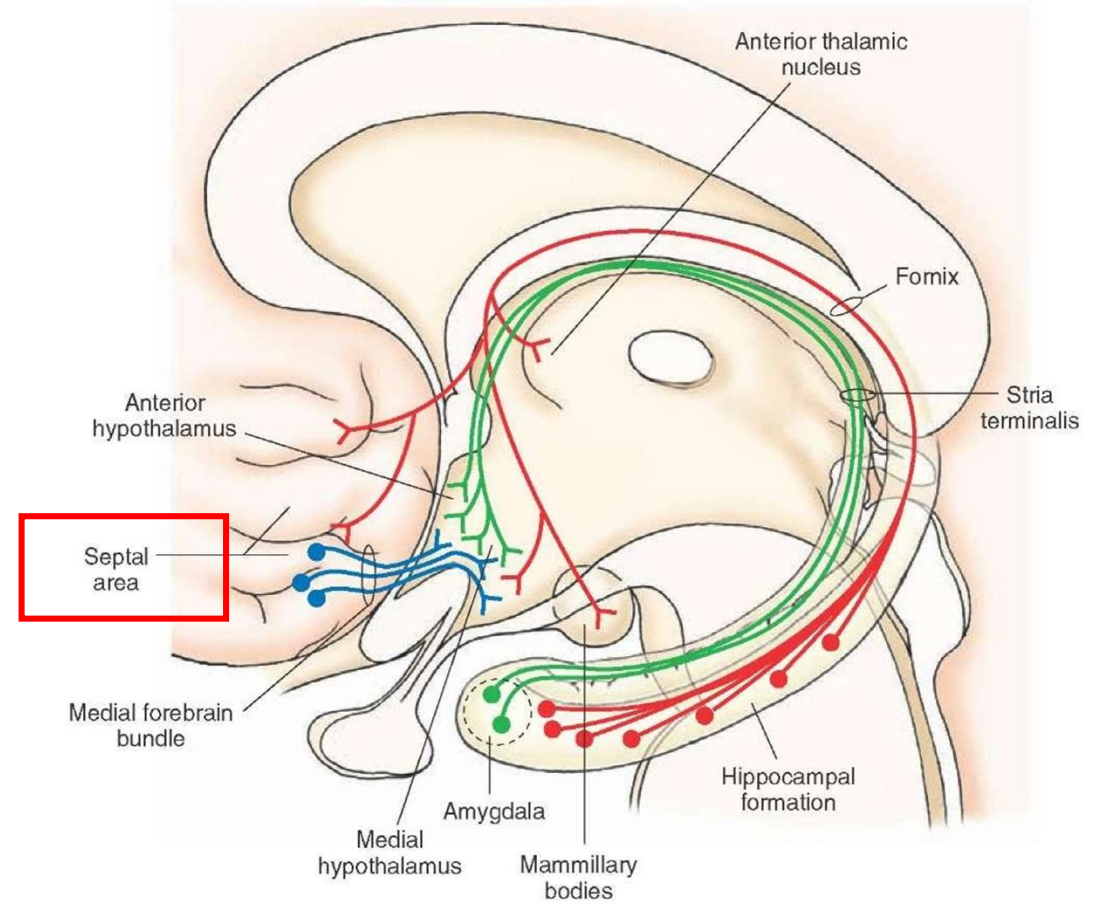
Orbitofrontal cortex and Prefrontal Cortex

- **Orbitofrontal cortex:** Located on the underside of each cerebral hemisphere (just above the bones of the eye sockets). It appears to be most directly involved in **emotions**.
- **Prefrontal Cortex:** In addition to higher mental functions, this areas appear to be involved in **memory tasks**.

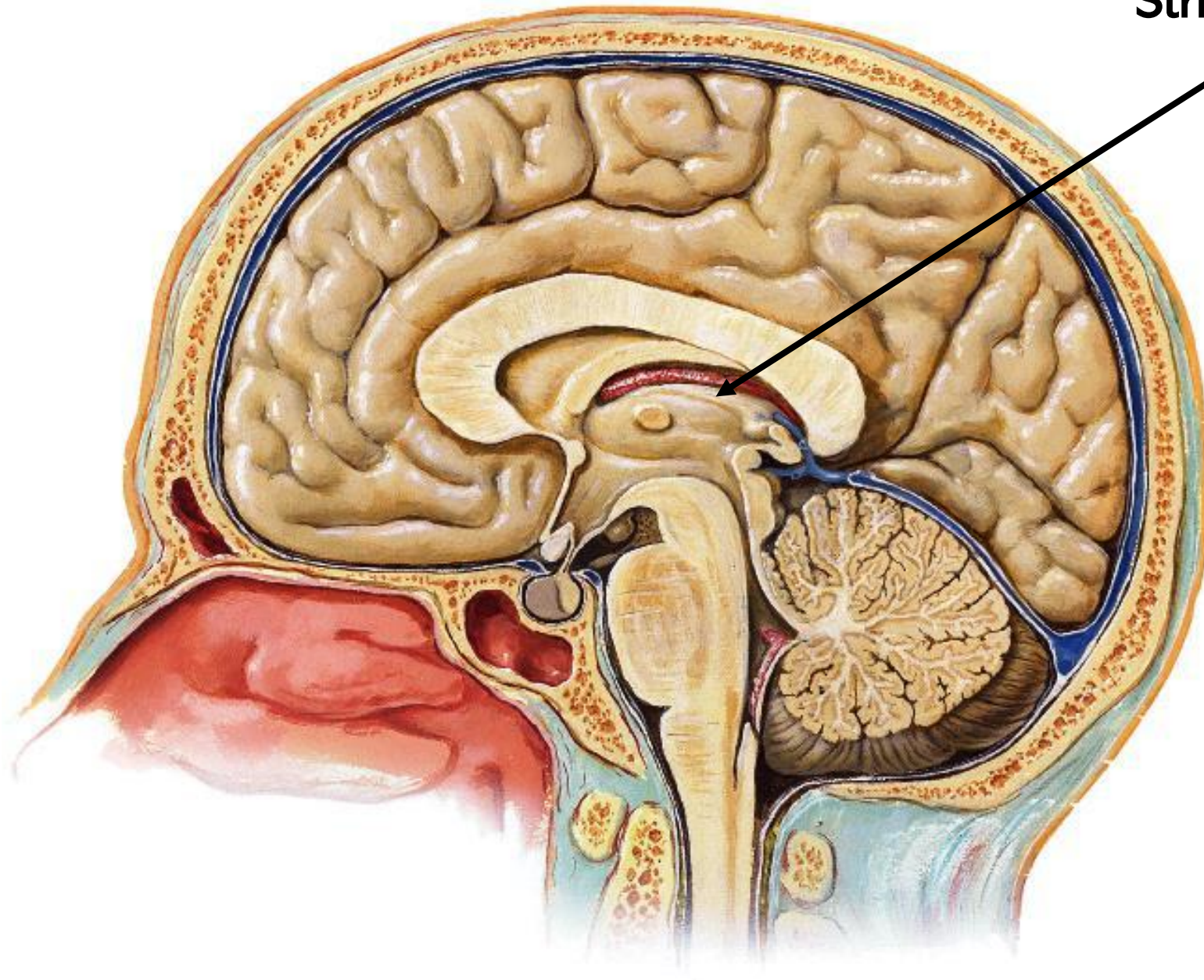


Septal Area

- It lies on the medial surface of cerebral hemisphere anterior to the lamina terminalis. It includes the **subcallosal gyrus** and **septal nuclei** (that are located anterior to anterior commissure and extend into the septum pellucidum).
- Connections:
 - With **hippocampus** via **Fornix**
 - With **hypothalamus** via **Medial Forebrain Bundle**
 - With **amygdala** via **Stria Terminalis**
 - With **habenula** via **Stria Medullaris Thalami**
- This area is considered as **pleasure center**.

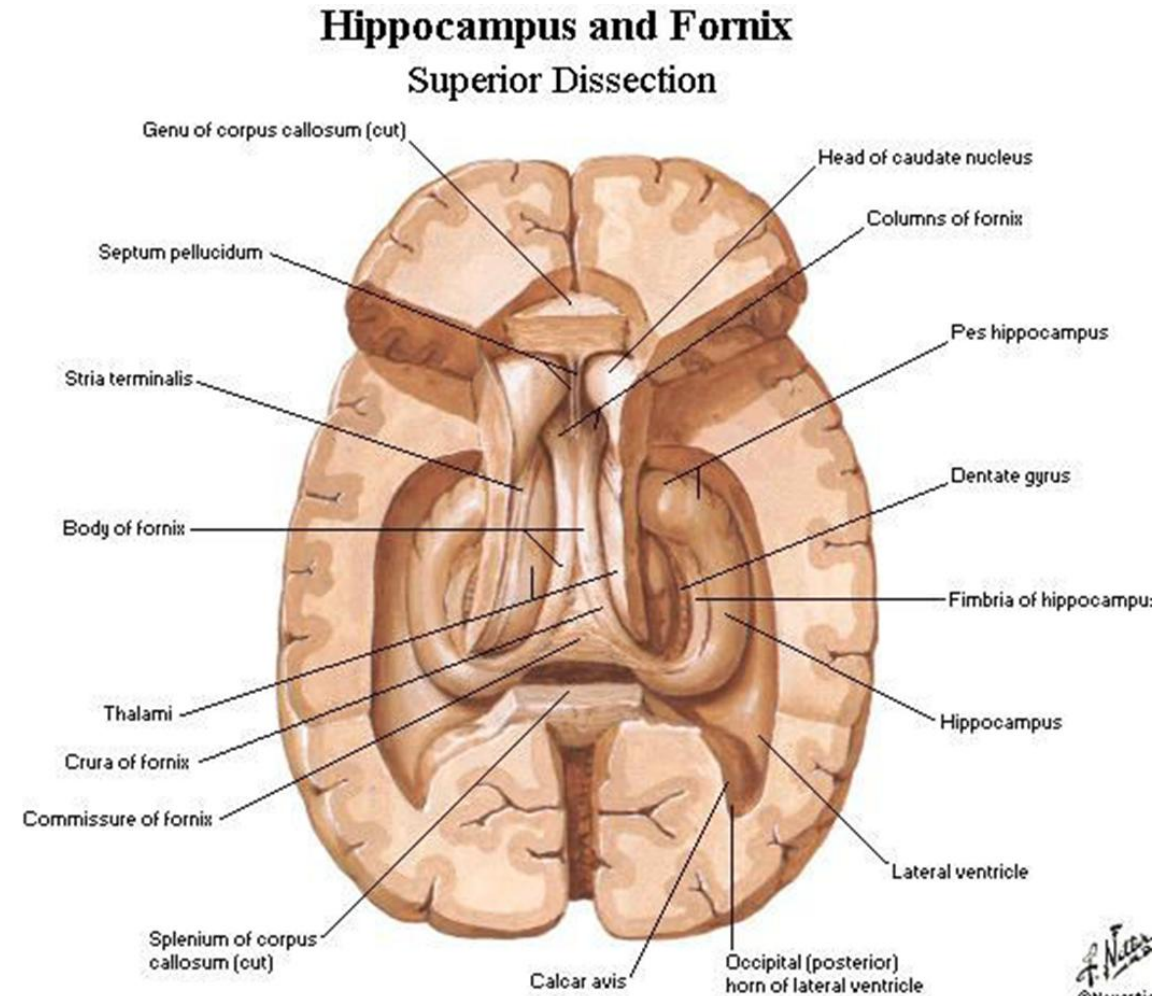


Stria Medullaris Thalami



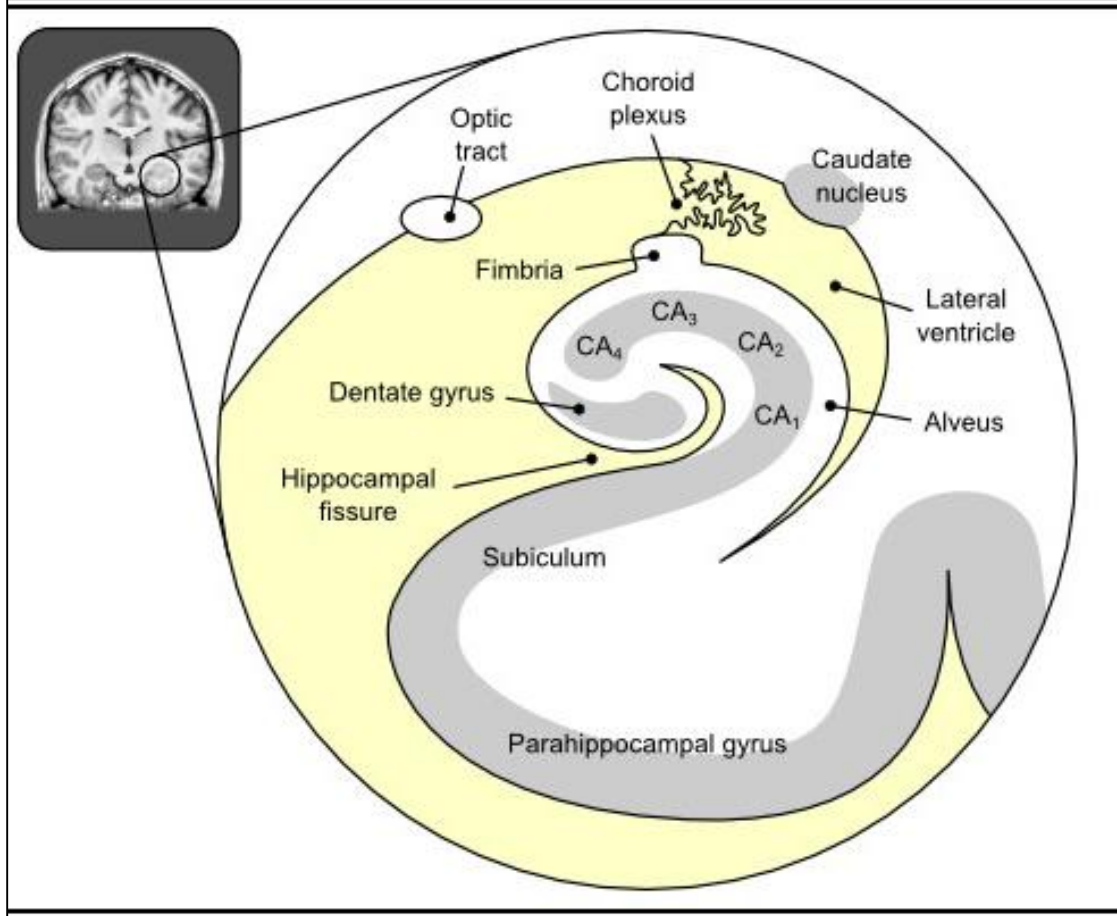
Hippocampal Formation

- Located in the temporal lobe as the floor of the inferior horn of the lateral ventricle.
- Formed of:
 - A. Hippocampus**
 - B. dentate gyrus**
 - C. Subiculum** (the transitional area between the Parahippocampal gyrus and hippocampus)

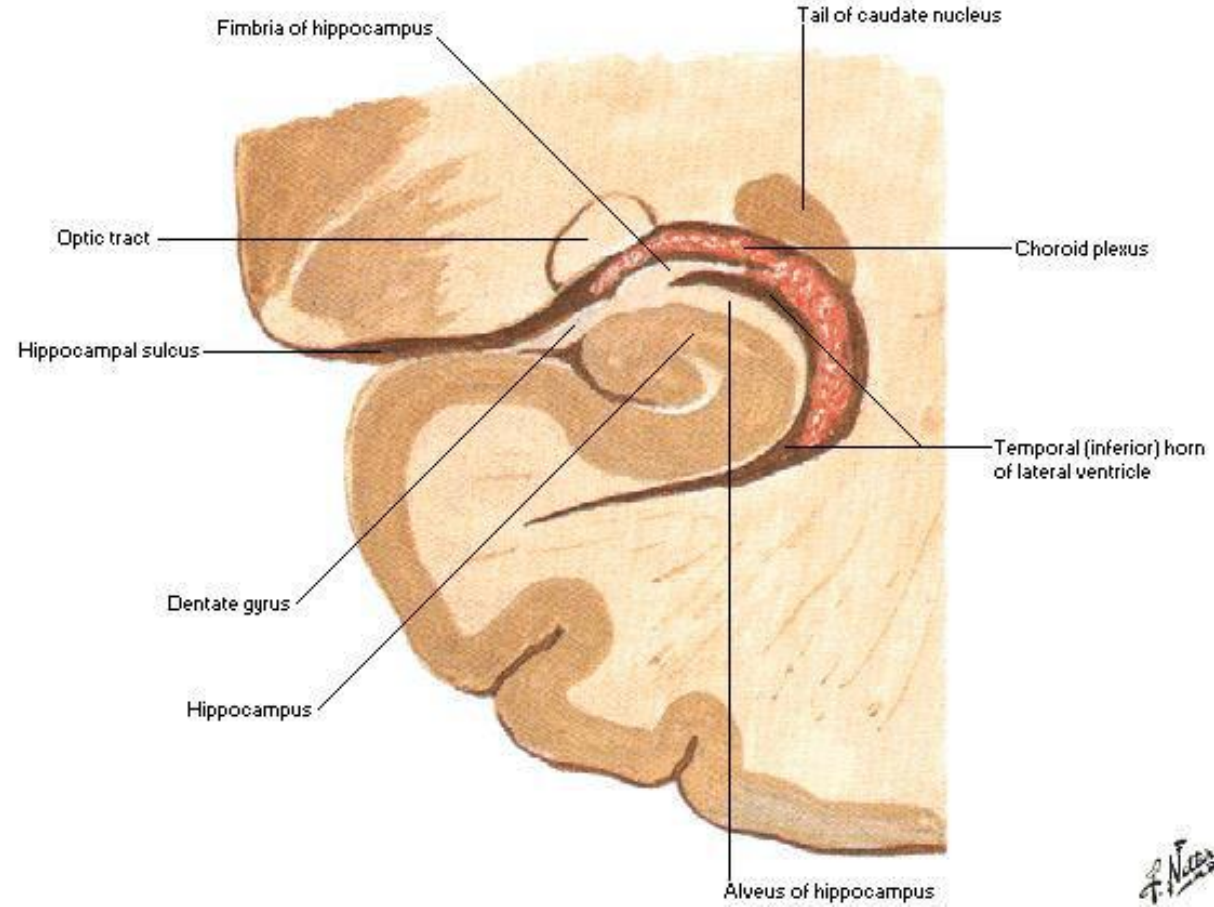


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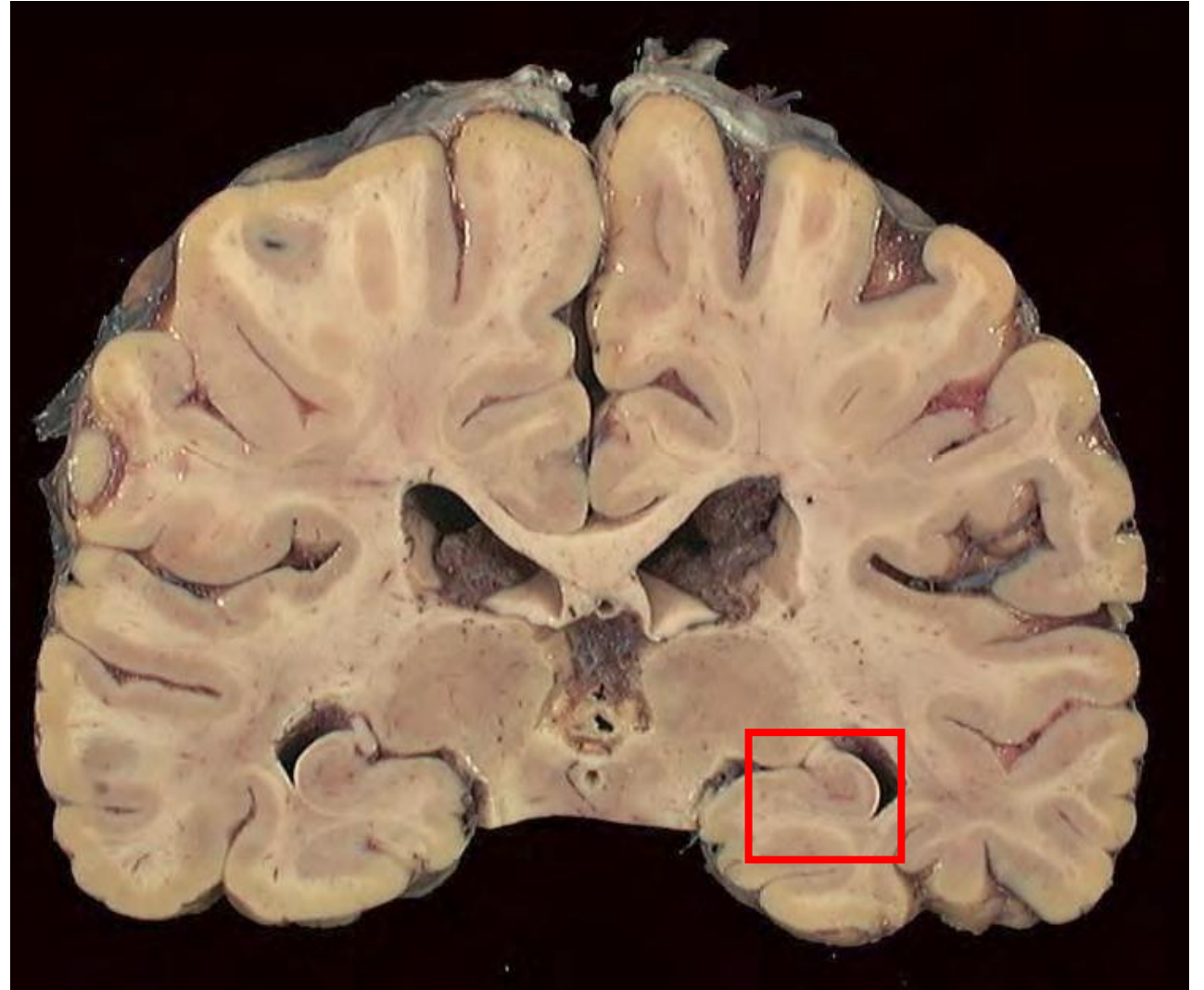
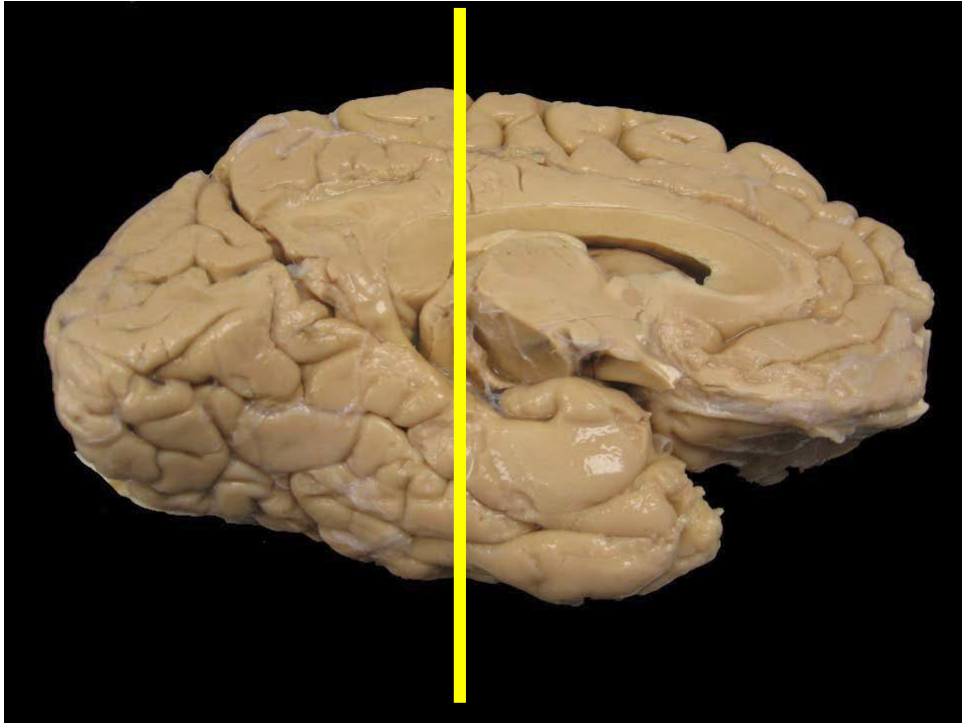
- **Hippocampus** is curved elevation of gray matter, formed by an infolding of the inferomedial part of the temporal lobe into the inferior horn of the lateral ventricle.
 - It is named hippocampus because it resembles a sea horse in coronal section.
 - Hippocampus is involved in **converting short term memory to long term memory**.
 - If damaged, patient is unable to store long term memory - **anterograde amnesia**.
- **Dentate gyrus** lies between the hippocampus and Parahippocampal gyrus.
- The **efferent fibers** arising from the hippocampus form a thin layer of white matter called the **alveus** which converge to form a bundle called the **fimbria** which becomes continuous with the crus of the **fornix**.



Hippocampus and Fornix Coronal Section - Posterior View

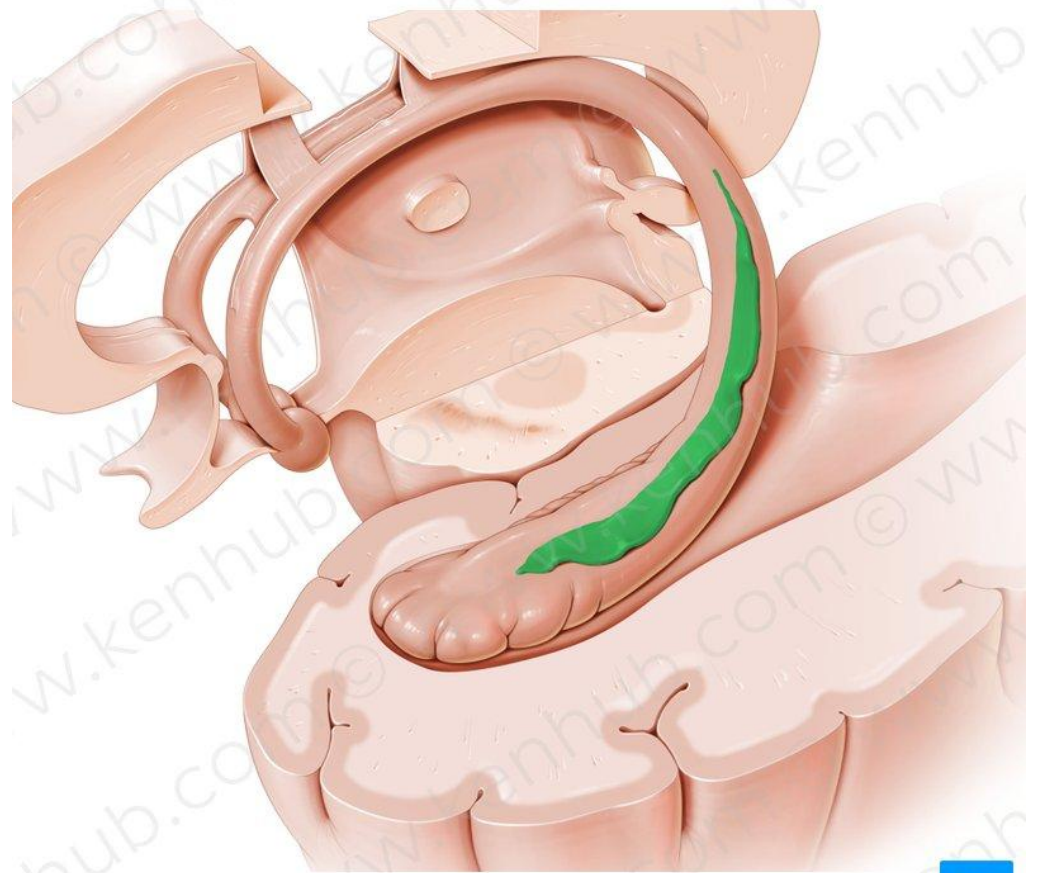
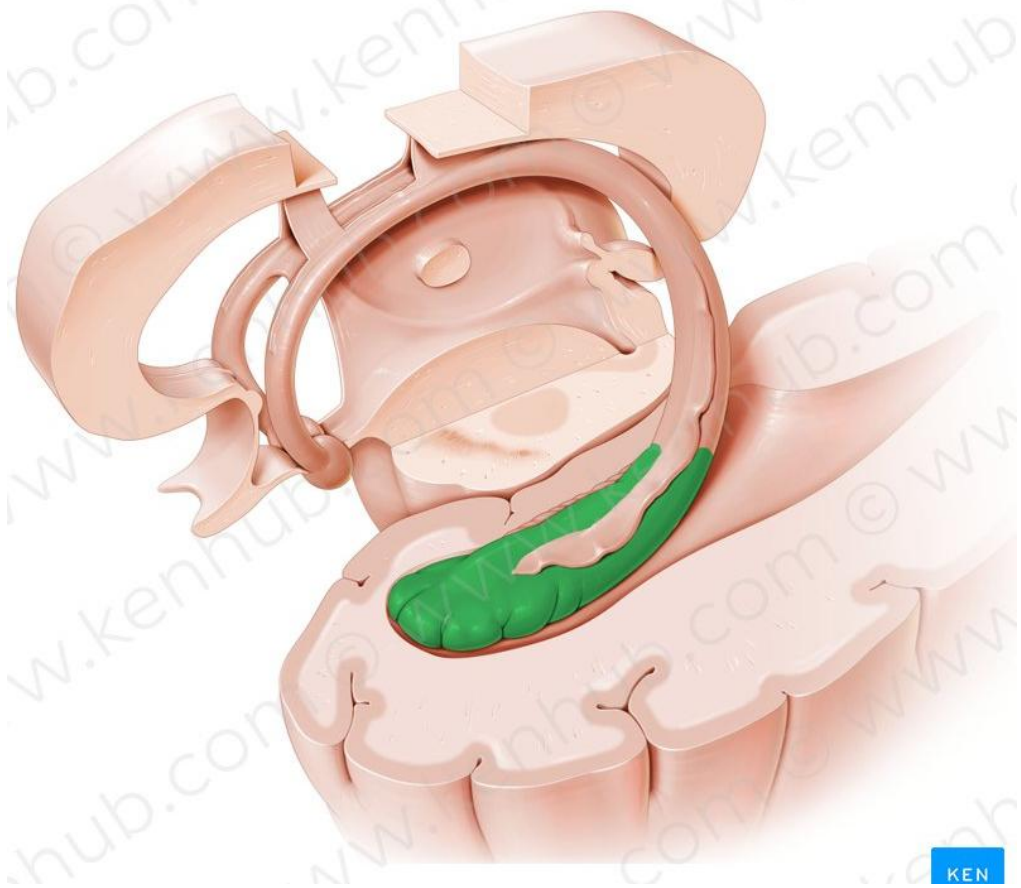


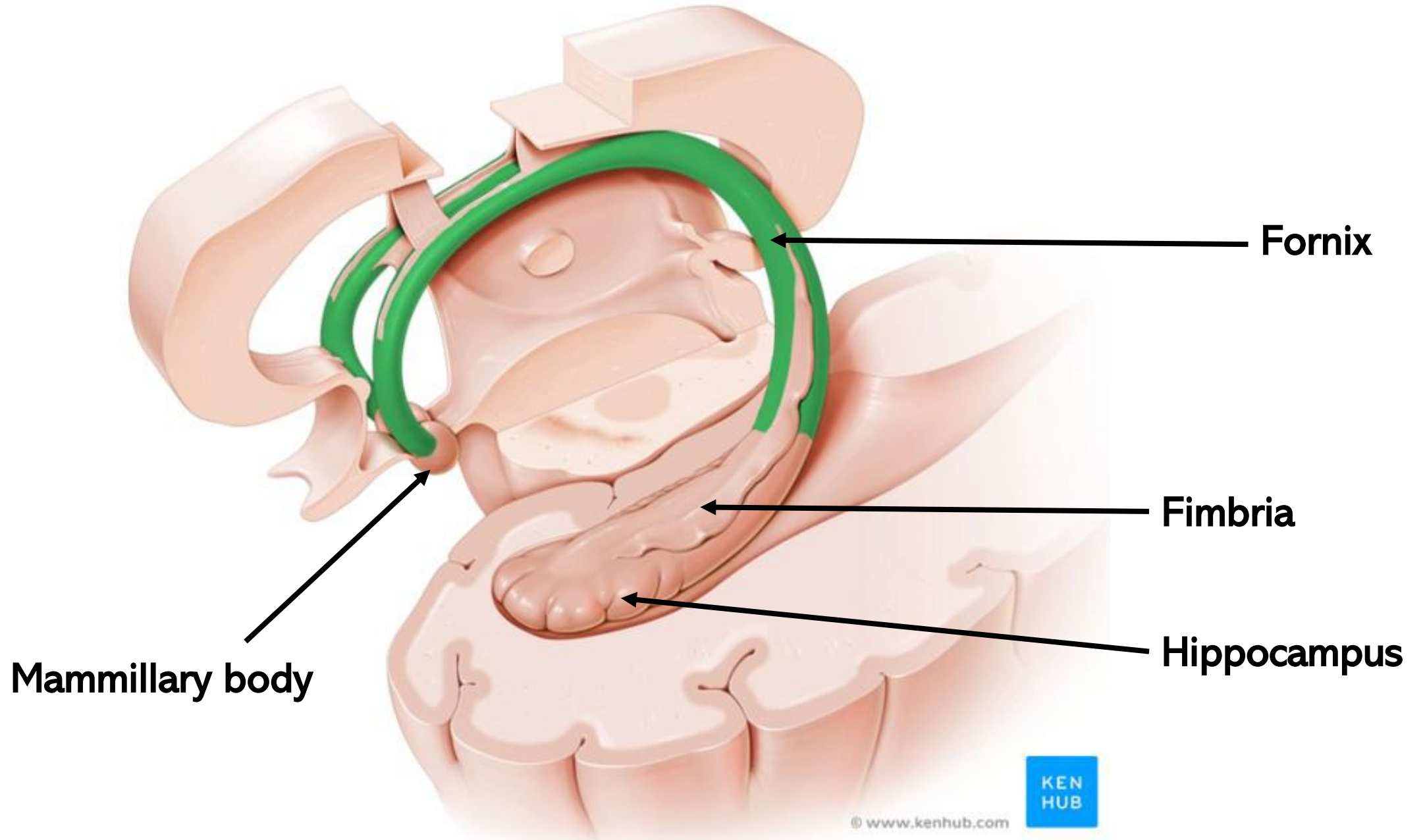
Exploring the Hippocampus



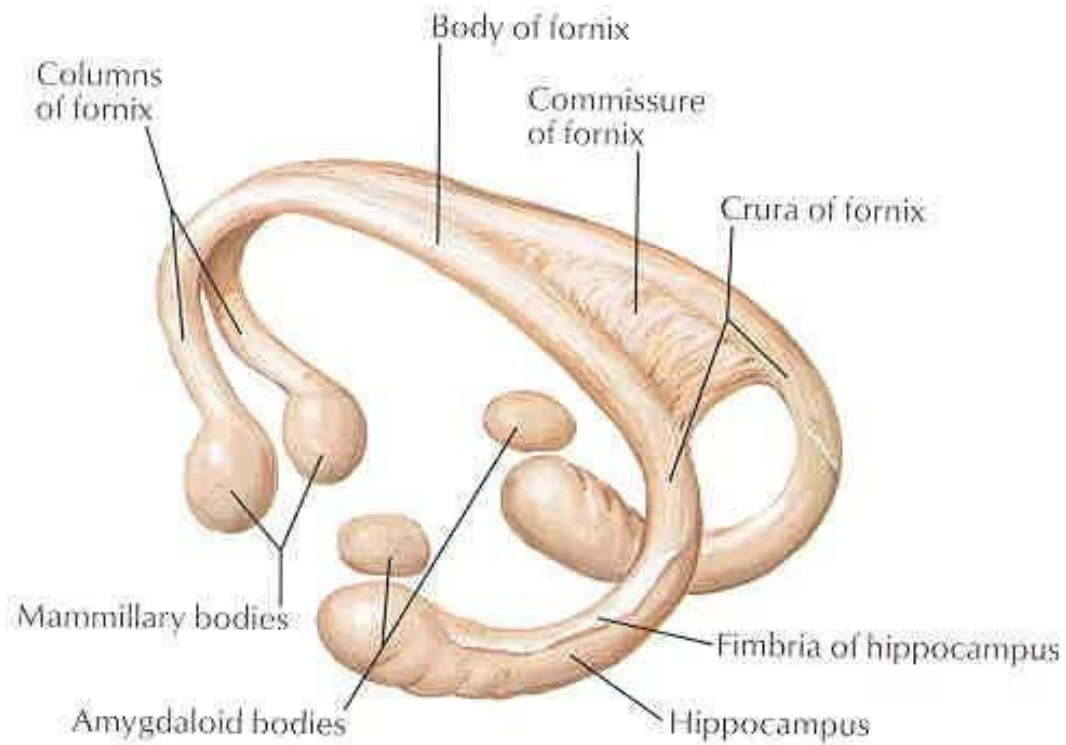
Fornix

- It is an arching band of white matter that **connects the hippocampus to hypothalamus (mammillary bodies)**. It is formed of two posterior columns (crura) that begin from the fimbria of hippocampus.
- They arch around the thalamus, below the corpus callosum, where they come close together in the midline to form the **body of fornix**. Behind the body is the commissure of fornix (hippocampal commissure) where fibers cross the midline from one side to the other.
- The body of fornix is connected to the under surface of the corpus callosum by the septum pellucidum then splits anteriorly into **two anterior columns** of the fornix, each dips in the lateral wall of the hypothalamus to end in a **mammillary body**.

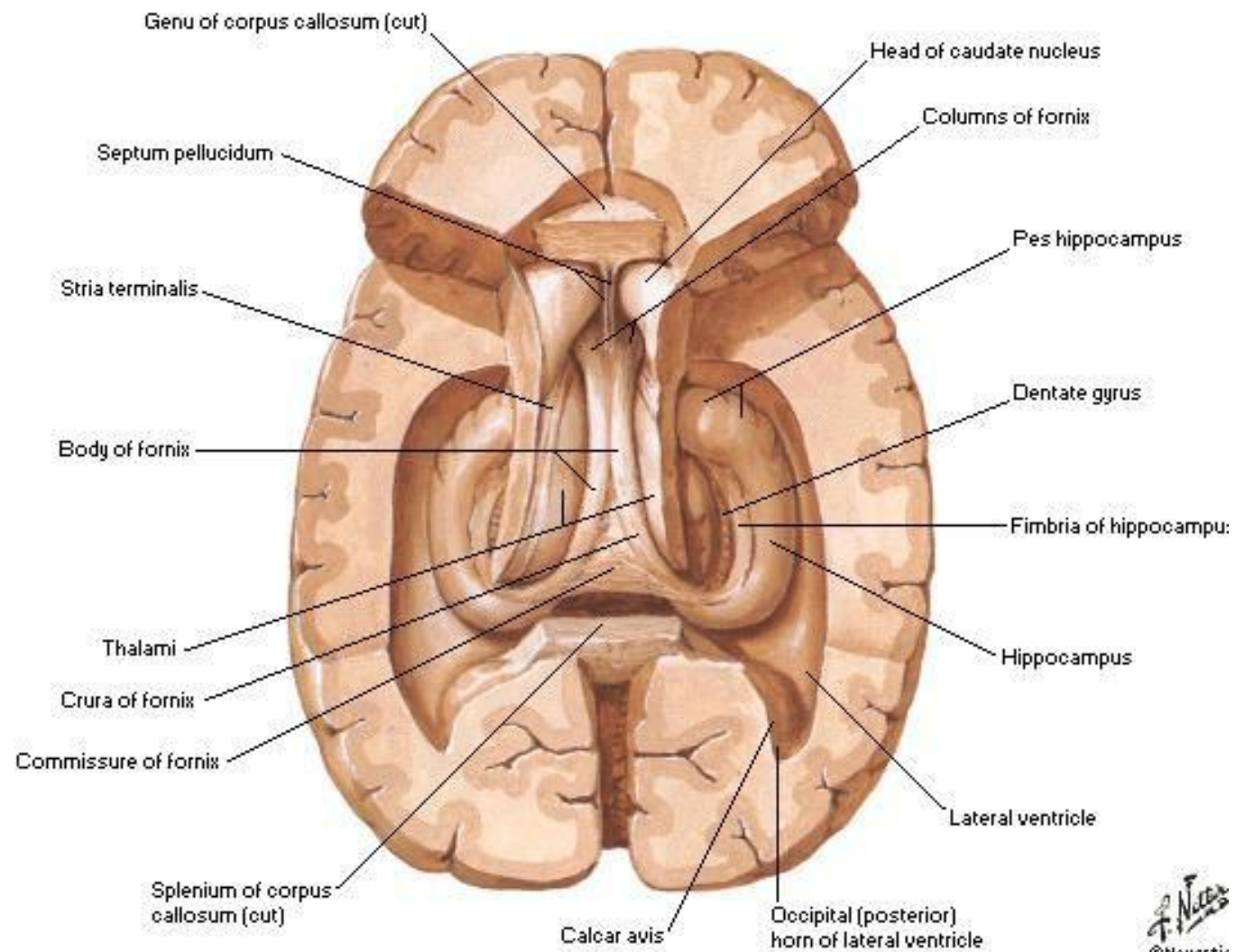


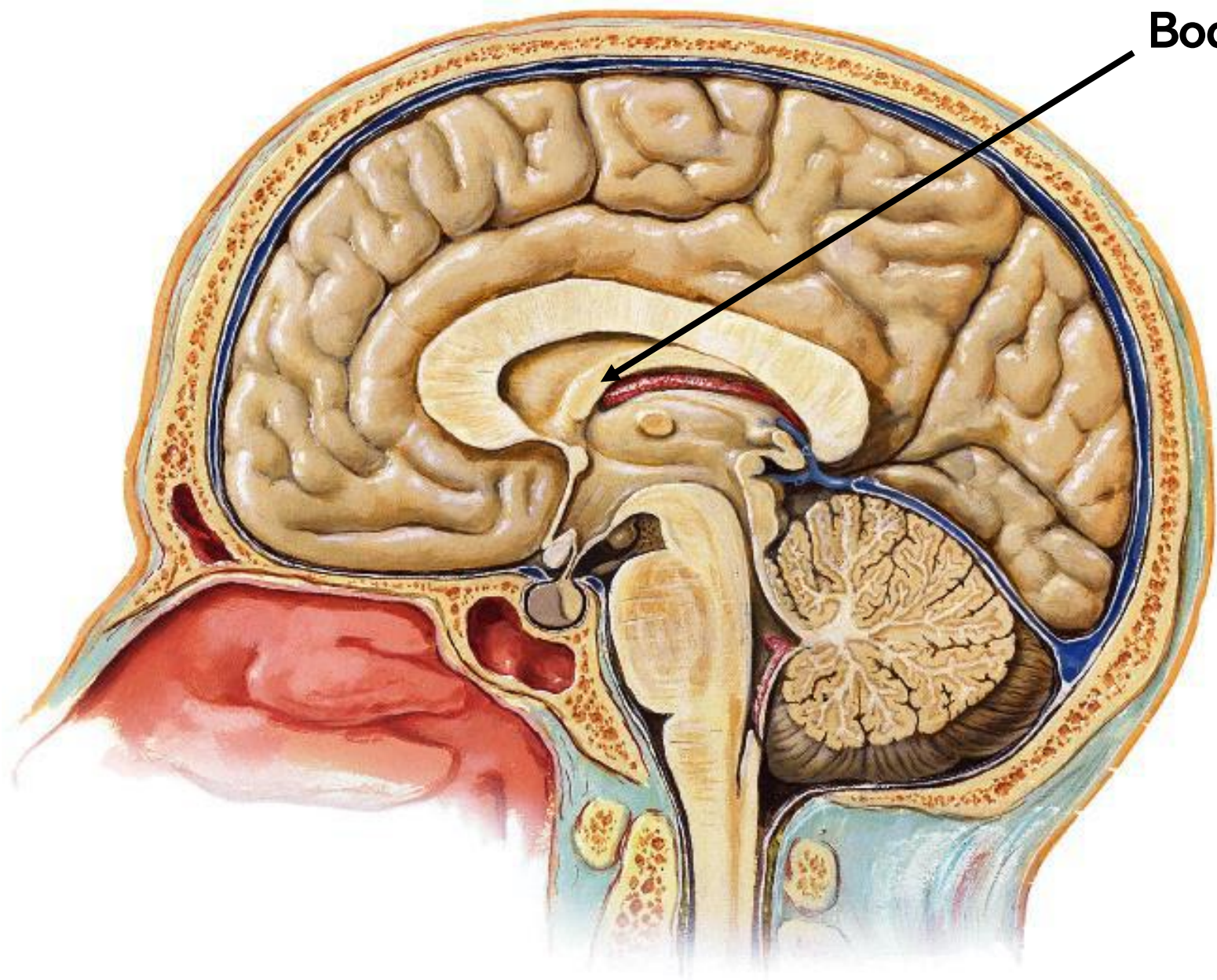


Hippocampus and Fornix Superior Dissection



Fornix: schema

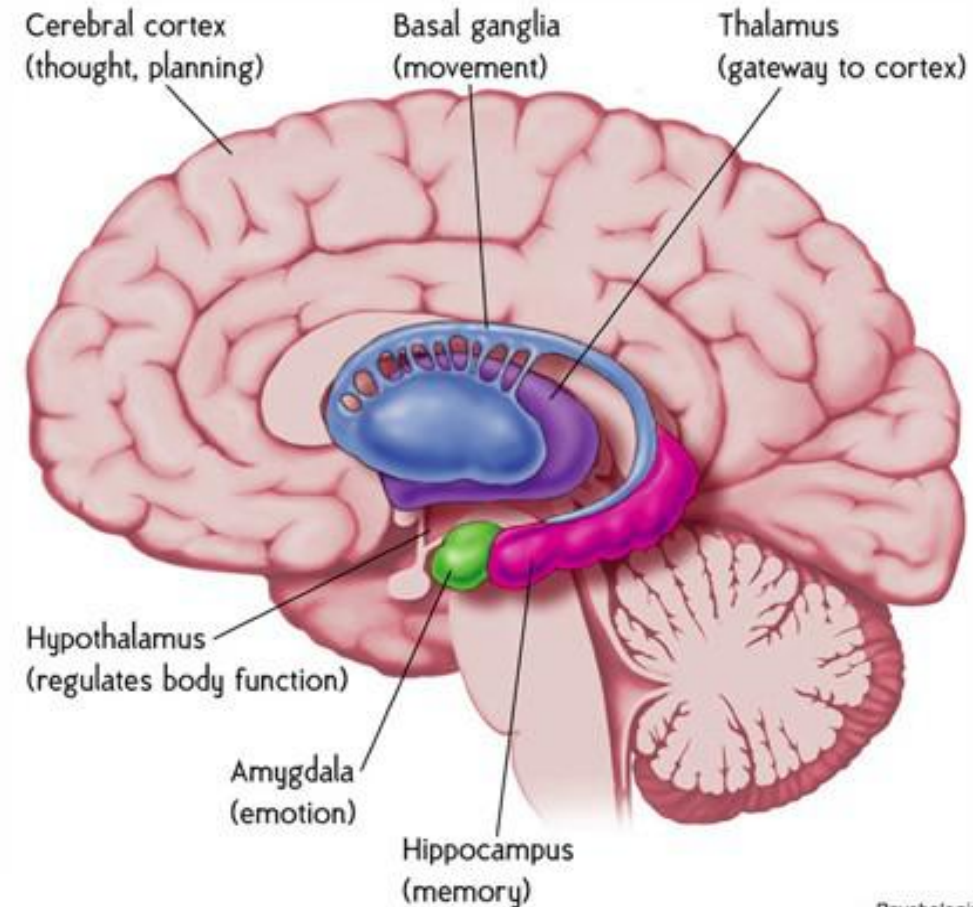


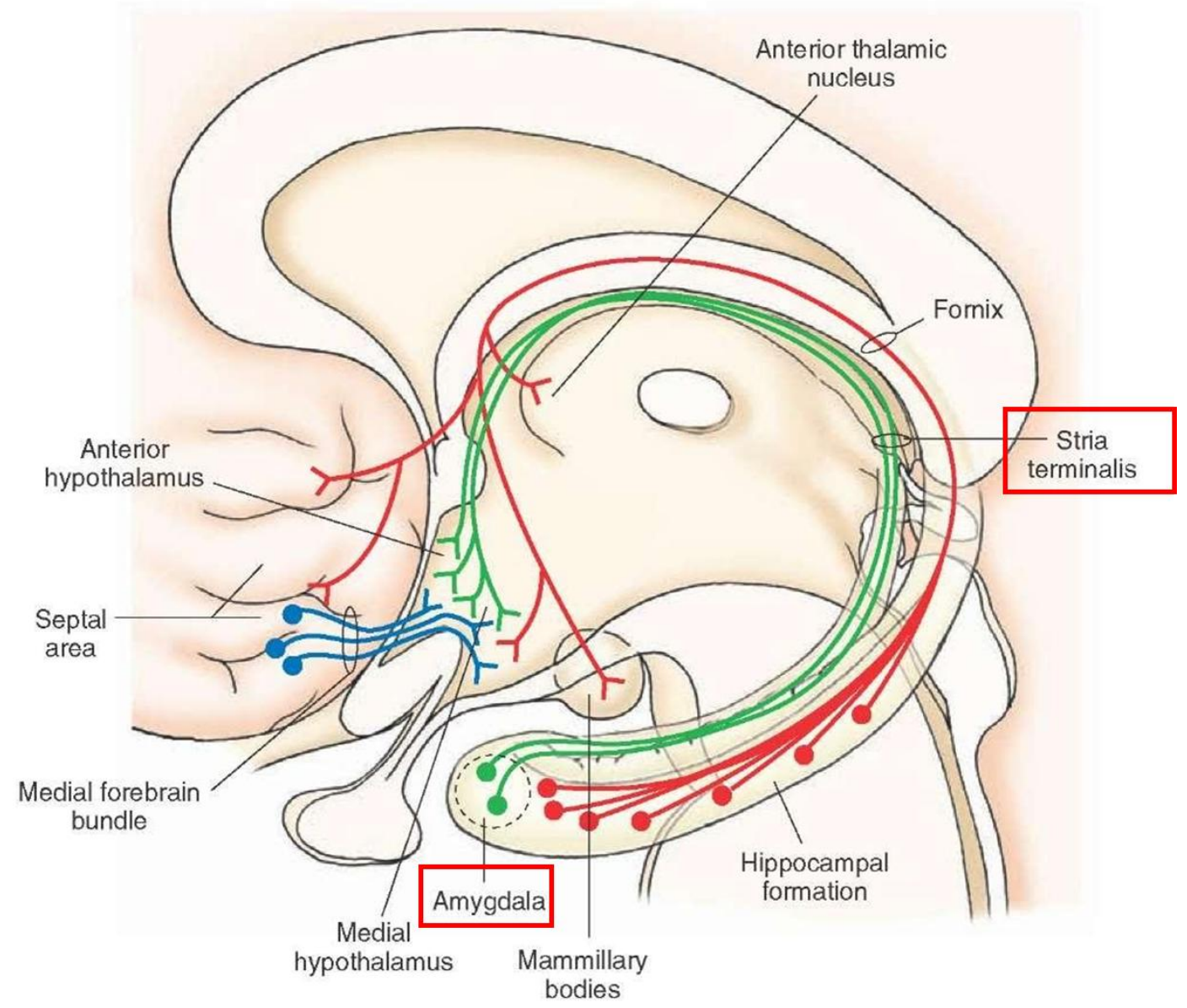
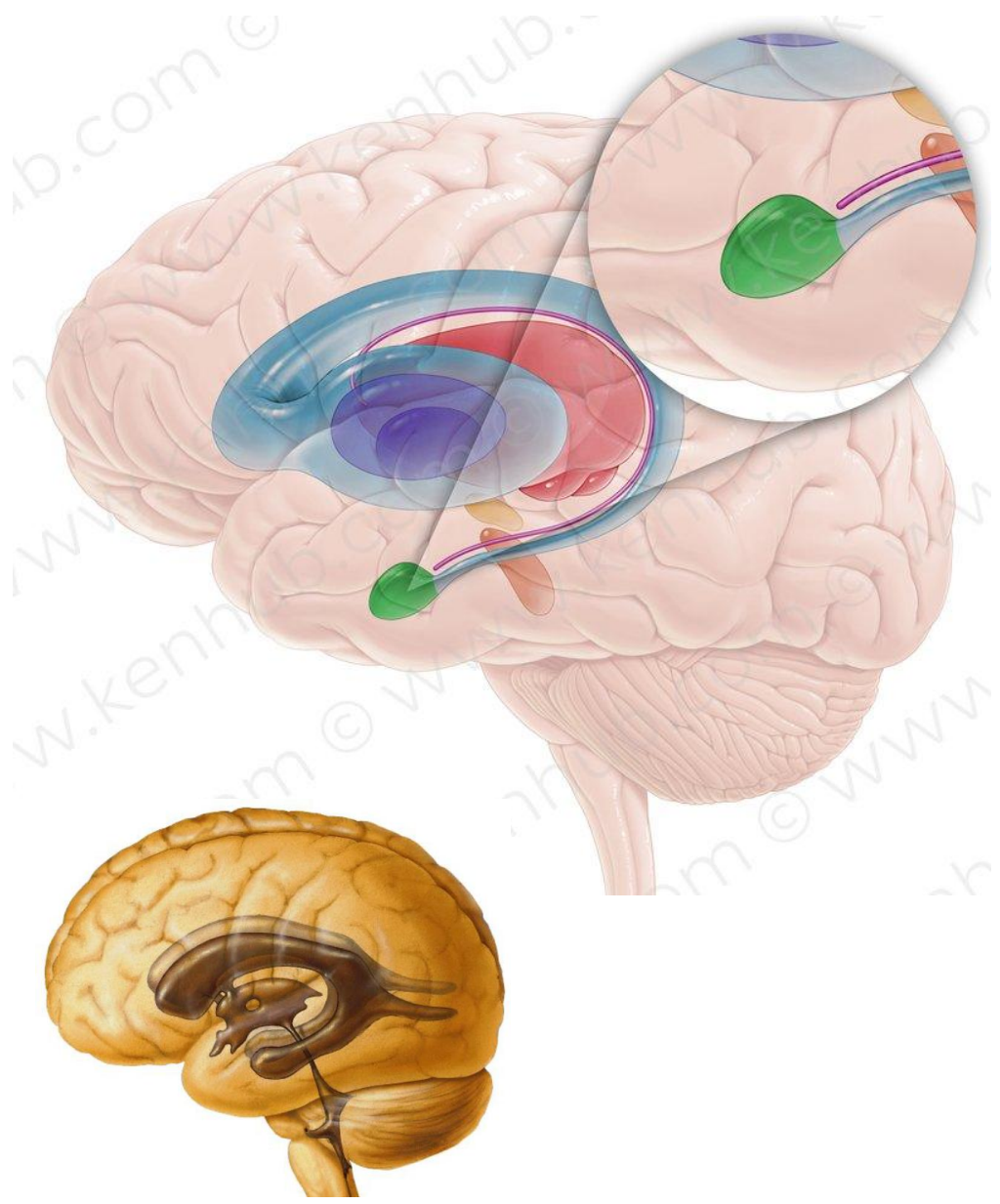


Body of fornix

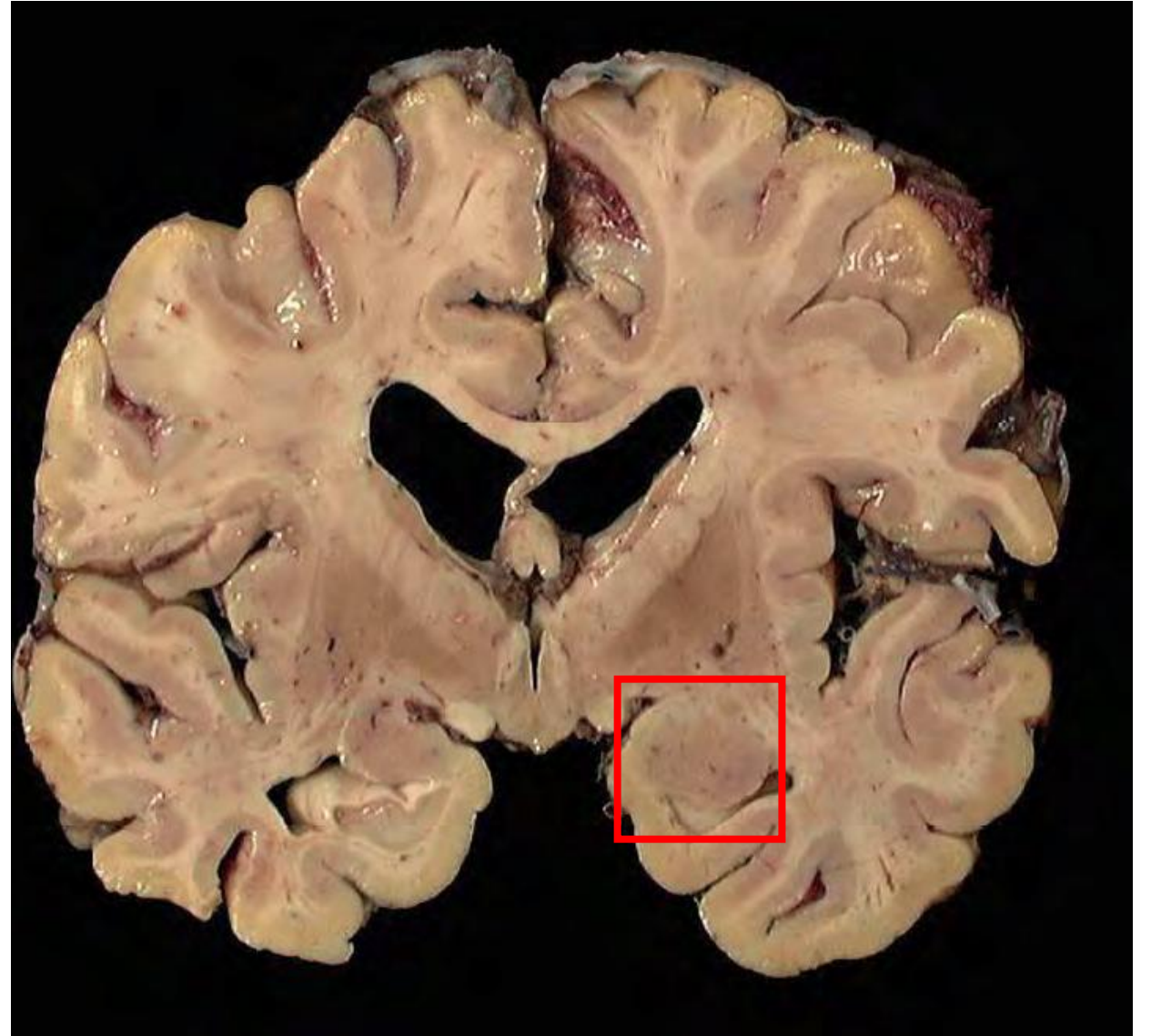
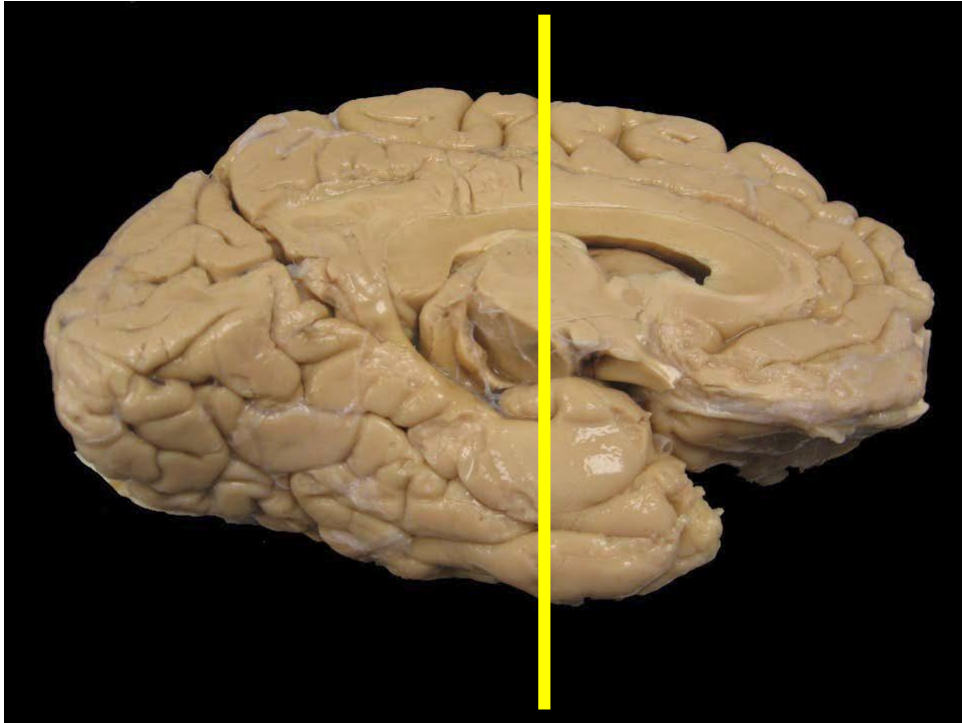
Amygdala

- Almond shaped collection of nuclei.
- Lies anterior to the tip inferior horn of lateral ventricle, embedded in uncus.
- The **Stria Terminalis** is a bundle of fibers that connect the amygdala with structures such as hypothalamus, the septal area, and the habenula.
- These communication between the amygdala and regions of the hypothalamus to regulate the **fear and anxiety responses.**





Exploring the Amygdala



Papez Circuit

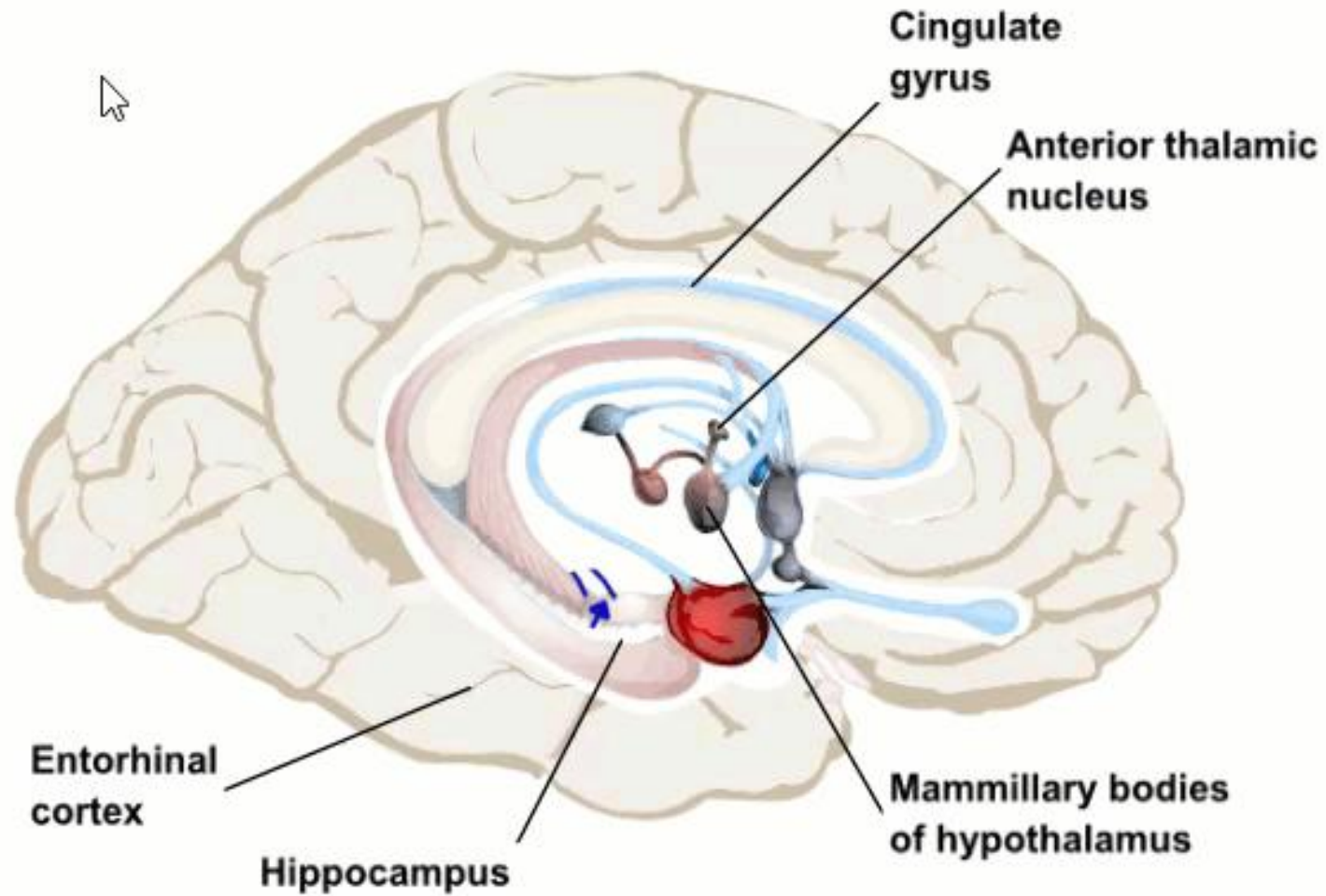
- **Papez circuit:** James Papez (1937) described a closed circuit involved in the expression of emotions.
- Recent studies show that it has a more significant role in memory (the consolidation of recent memory) than in emotions.
- It begins and ends with the hippocampus

Papez Circuit

It is formed as follows:

1. The hippocampus is connected to the mammillary bodies of hypothalamus via the **fornix**.
2. The mammillary body is connected to the anterior nucleus of thalamus via the **mammillo-thalamic tract**.
3. The anterior nucleus of thalamus is connected to the anterior part of the cingulate gyrus via the **anterior thalamic radiation**.
4. The cingulate gyrus connects to the parahippocampal gyrus & uncus via the **cingulum**.
5. The parahippocampal gyrus (Entorhinal cortex – Area 28) connects to the hippocampus thus closing the circuit.

5.5 Input Pathways of the Hippocampus



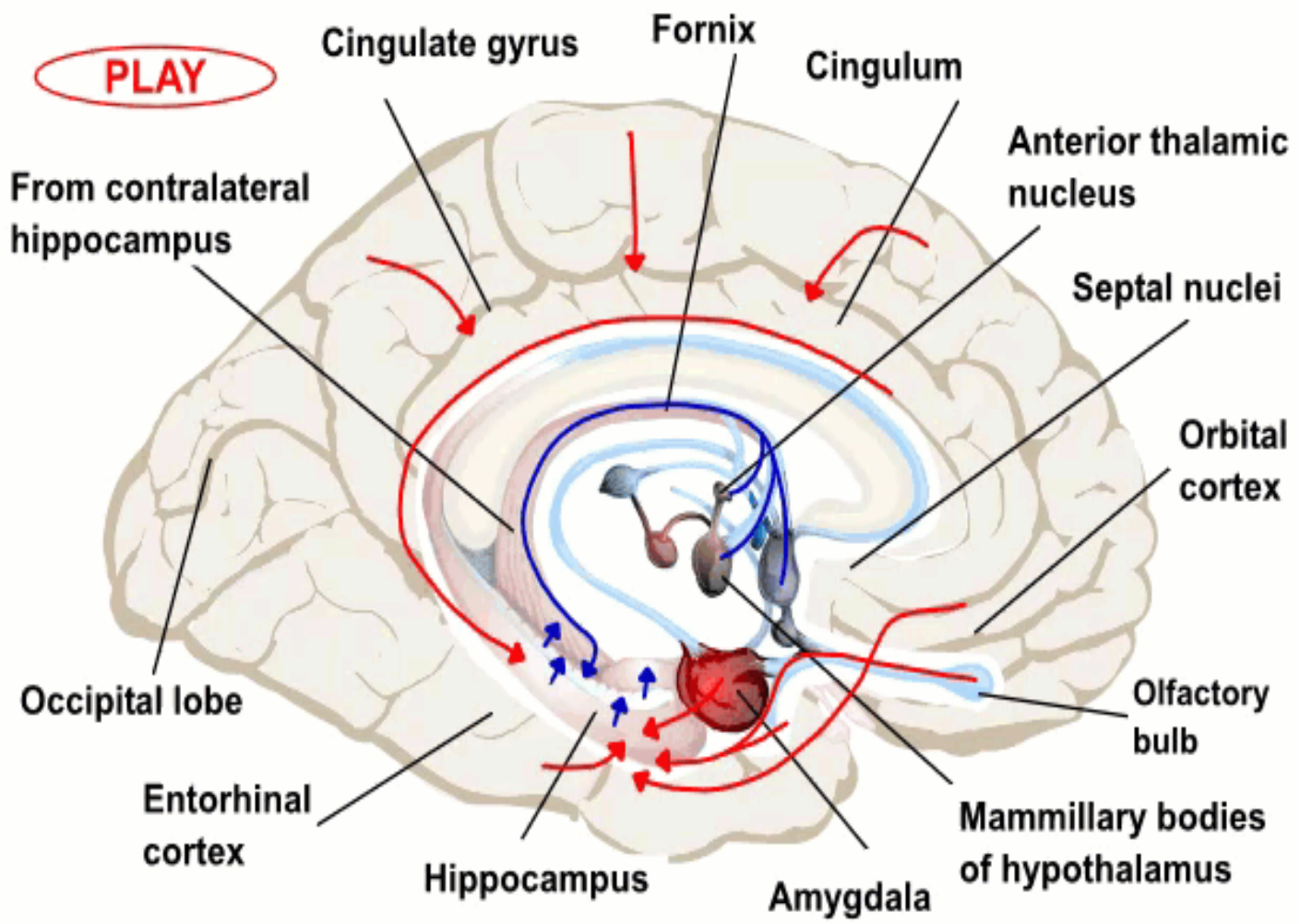
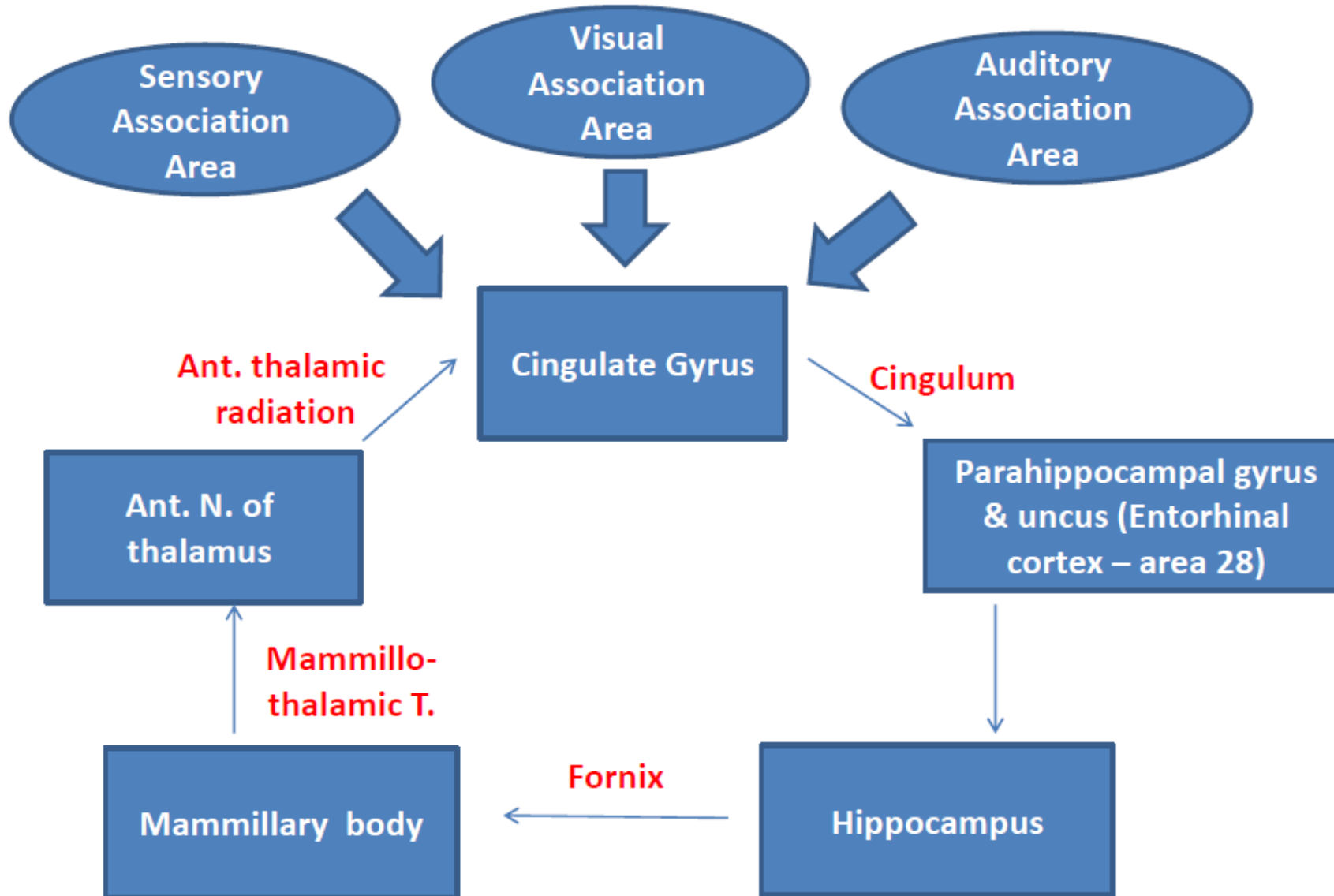


Figure 5.8
 Inputs or afferents to the hippocampus. Major inputs come from the entorhinal cortex, which in turn communicate inputs from the cingulate, temporal, orbital, and olfactory cortices and amygdala to the hippocampus.

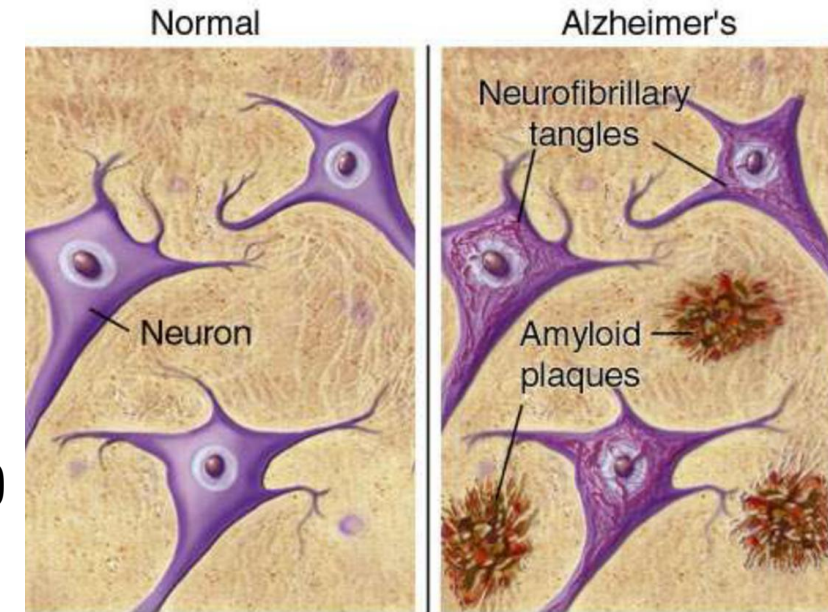
Papez Circuit



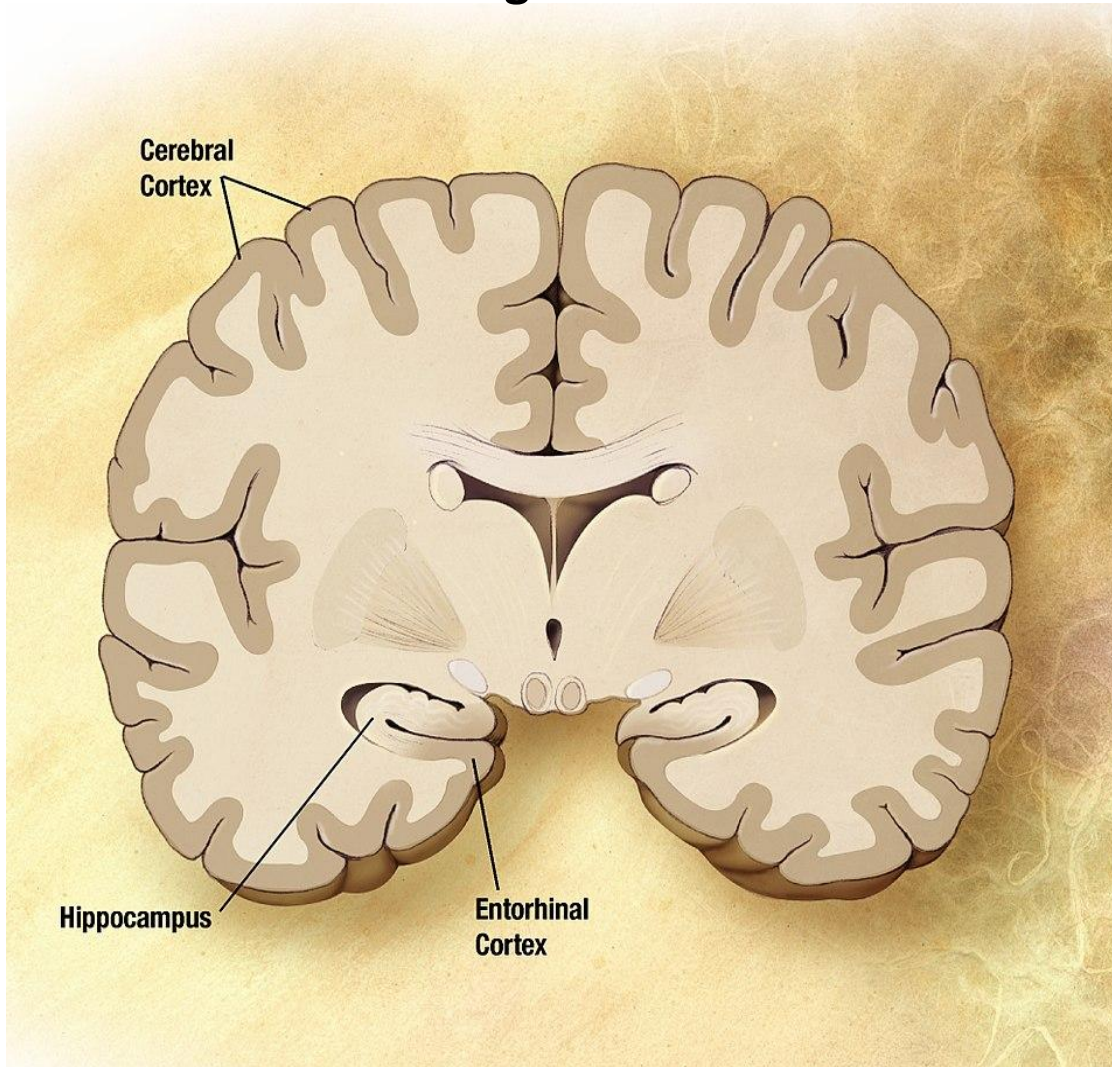
Lesions in the Limbic system

Alzheimer's Disease

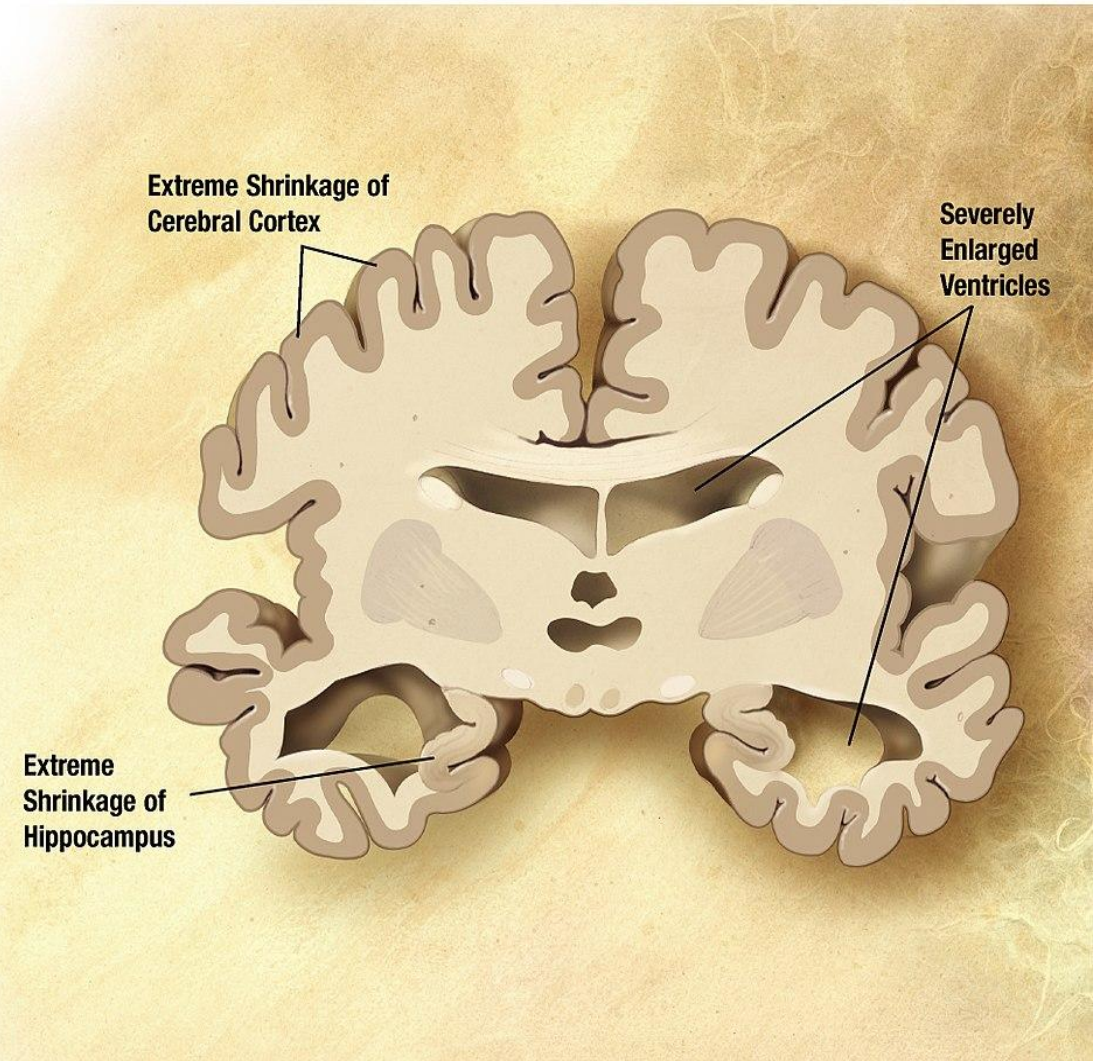
- Chronic neurodegenerative disease
- Bilateral loss of neurons in several structures.
 - Amyloid proteins build up and form amyloid plaques (outside cells)
 - Neurofibrillary tangles (inside cells), leads to neuronal death
- Hippocampus is one of first areas to degenerate, leads to **anterograde amnesia** (a loss of the ability to create new memories).
- Cortex also degenerates early, leads to **retrograde amnesia** and **dementia**.



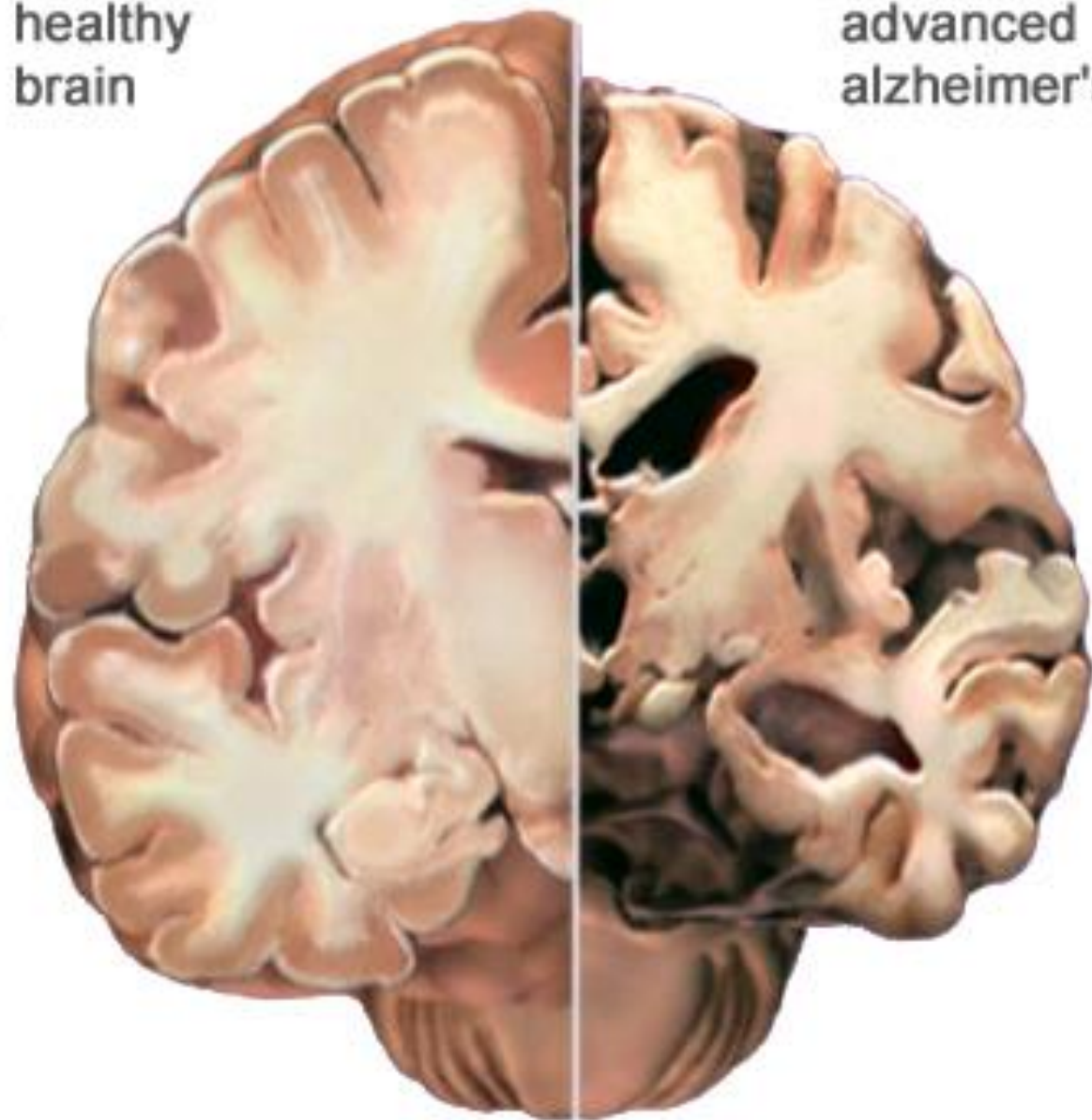
Normal aged brain



The brain of a person with Alzheimer's



healthy
brain



advanced
alzheimer's

Lesions in the Limbic system

Kluver-Bucy syndrome

- Neurobehavioral syndrome associated with bilateral lesion in temporal lobe including the amygdala.
 - The animals are fearless and placid, showing an absence of emotional reactions.
 - Hypersexuality
 - Visual agnosia (due to the loss of the visual association cortex)
 - Animals try to examine all object by mouth (oral tendency)
 - Hyperphagia (extreme weight gain without a strictly monitored diet)

Thank you

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