Limbic System

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A 7-year-old boy is brought into the emergency room for severe headache, nausea, and fever. His parent states that the patient had been in good health until 2 days previously. Bright lights seem to bother him. On examination, he appears lethargic and ill. His temperature is 102°F. Movement of the neck seems to cause some pain. The heart and lung examinations are normal. The patient refuses to flex his head so that his chin will touch his chest because the effort is too painful.

- What is the most likely diagnosis?
- What is the most likely anatomical mechanism for this condition?

Introduction

Limbic system – part of cortical and subcortical structures performs primary maintenance of organism, food and sex

Concept

- *Rhinencephalon* (*smell brain*) – previous name of limbic system
- Associated with sense of smell and smaller in size in humans
- *Limbic cortex* is allocortex, hence consists of three neuronal layers
- Transition zone (3 to 6 neuronal layers) – called *juxta-allocortex* lies between allocortex and neocortex
- Neocortex consists of six neuronal layers

Functions of limbic system

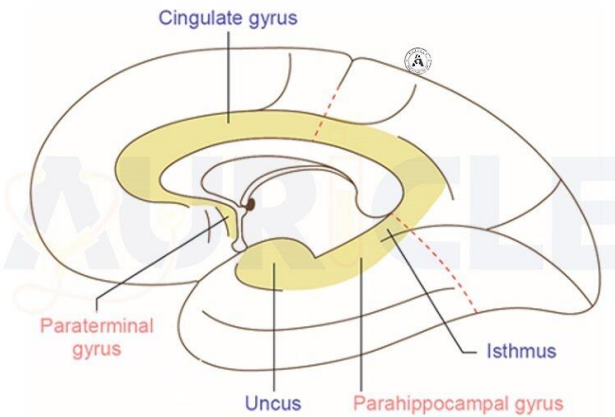
- Emotional reactions
- Integration of olfactory, visceral, and somatic impulses
- Learning and retention of recent memory
- Emotional reactions, that are essential for maintenance of self and species, include:
- Procuring, storing, and eating food
- Sex
- Rearing of young
- Other emotions: Fear, rage, defense reactions, production of salivation and nausea on perception of smell
- Visceral responses based on emotions
- Thus, limbic system is called *visceral brain*

Components of limbic system

- Consists of many cortical and subcortical areas
- Hypothalamus – major control headquarter

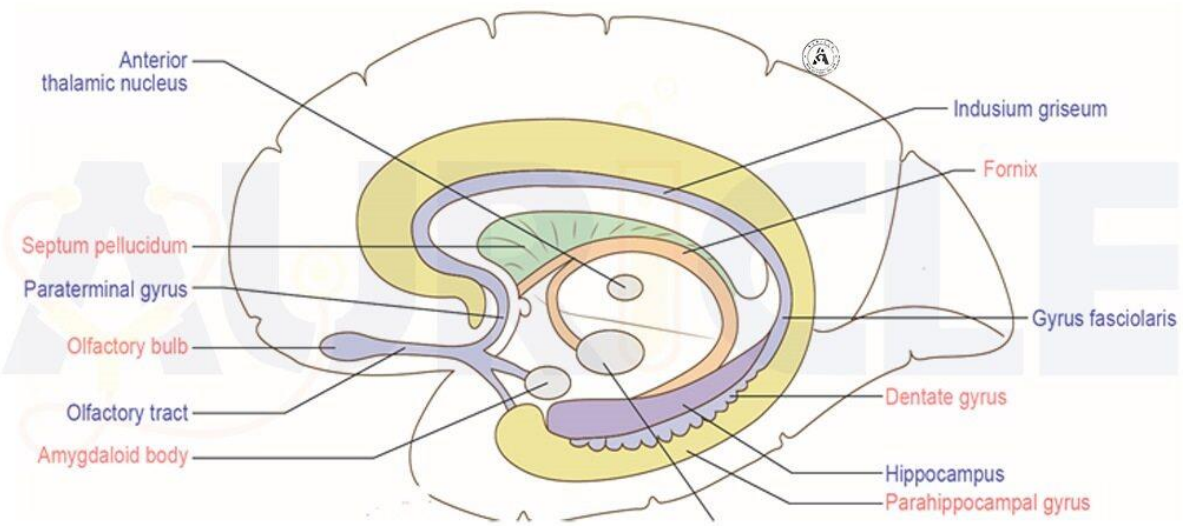
Cortical area

- *Limbic lobe*: Consists of paraterminal (subcallosal) gyrus, cingulate gyrus, Isthmus, parahippocampal gyrus, uncus, collateral and rhinal sulci



Components of limbic system

- *Hippocampal formation*: Consists of hippocampus, dentate gyrus, gyrus fasciolaris, and indusium griseum



Components of limbic system

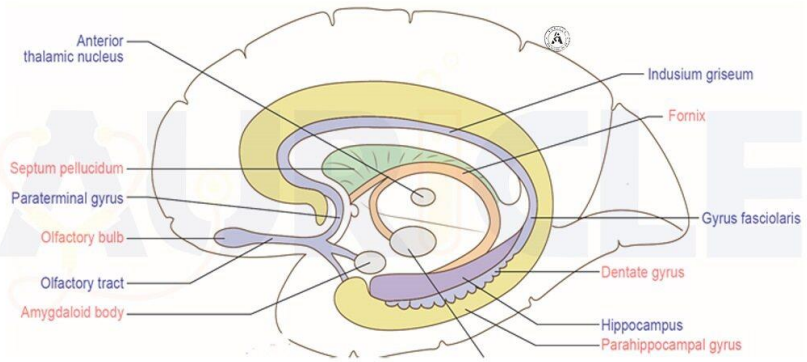
Subcortical structures

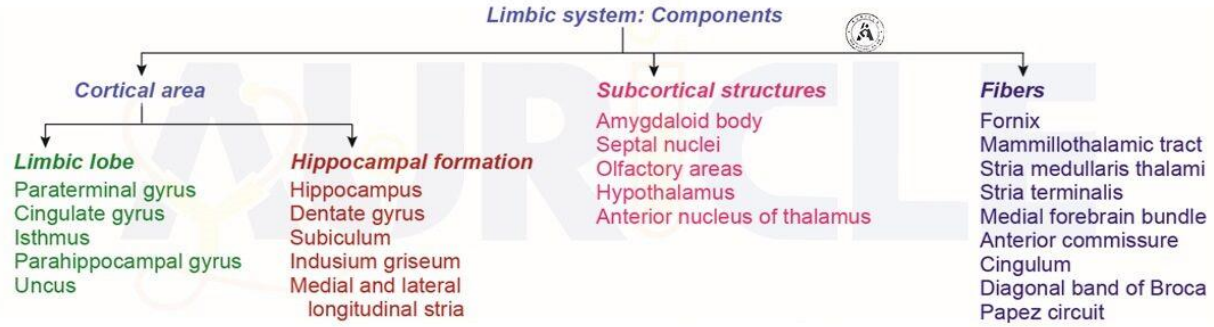
- Amygdaloid body
- Septal nuclei
- Olfactory bulb
- Hypothalamus – main headquarter of limbic system
- Anterior and dorsomedial nucleus of thalamus

Components of limbic system

Fibers of limbic system

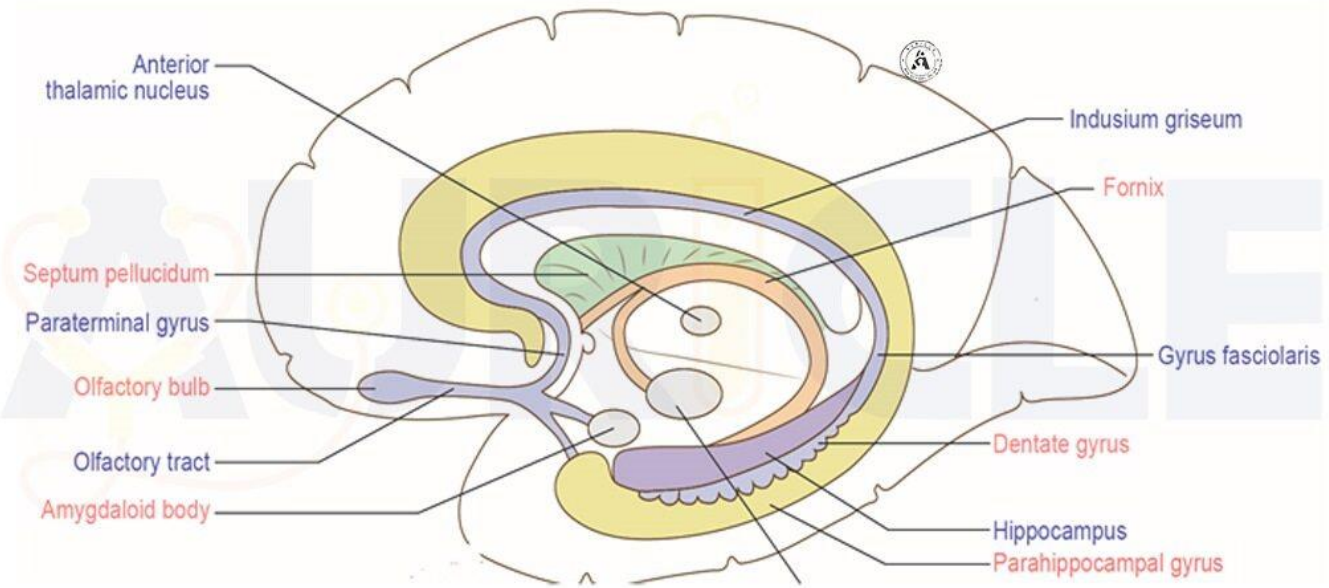
- Include
  - Fornix
  - Mammillothalamic tract
  - Stria medullaris thalami
  - Stria terminalis
  - Medial forebrain bundle
  - Anterior commissure
  - Cingulum
  - Diagonal band of Broca
  - Papez circuit





Amygdaloid body

- *Synonym*: Amygdaloid nuclear complex
- *Definition*: Almond-shaped mass of gray matter lies in anterior part of parahippocampal gyrus



Amygdaloid body

Location

- Lies above tip of inferior horn of lateral ventricle, beneath lentiform nucleus
- Posteriorly, continuous with tail of caudate nucleus and stria terminalis

Connections

- *Afferent*: From primary olfactory area
- *Efferent*
  - *Stria terminalis* –efferent fibers of amygdaloid body form stria terminalis
  - Takes C-shaped course along with caudate nucleus

Amygdaloid body

Termination

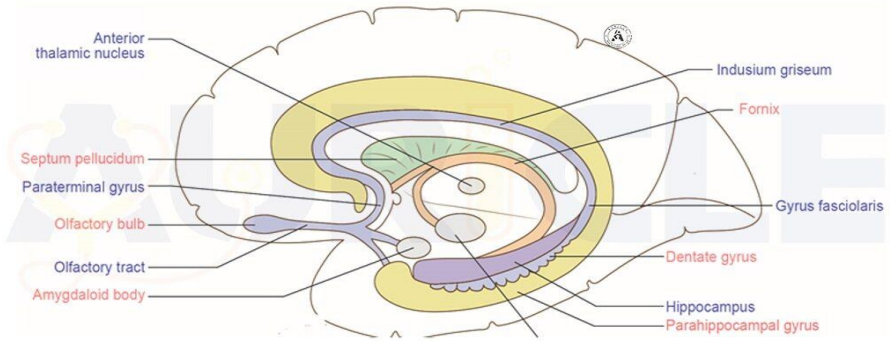
- Stria terminalis ends in septal area and anterior region of thalamus
- *Stria medullaris thalami* –some fibers of stria terminalis run backward and end in habenular nucleus

Functions

- Controls somatic responses of internal needs
- Controls smell-mediated sexual behavior

Lesion

- Bilateral damage to amygdaloid body reduction in fear and increase in sexual activity



Amygdaloid body

Definition

Almond-shaped
Gray matter in the anterior part of parahippocampal gyrus, above the tip of inferior horn of lateral ventricle

Connections

Afferent: Primary olfactory area
Efferent: Stria terminalis
- Septal area
- Anterior region of thalamus
- Stria medullaris thalami to habenular nucleus

Functions

Controls somatic responses of internal needs
Controls smell-mediated sexual behavior

Lesion of amygdaloid body → ↓Fear, ↑Sexual activity

Septal area and septal nuclei

- Consists of
  - *Paraterminal gyrus*: Narrow strip of cortex lies along the anterior surface of lamina terminalis

  Paraolfactory (*subcallosal*) *gyrus*
  - Narrow lamina on medial surface cerebral hemisphere in front of lamina terminalis

Septal area and septal nuclei

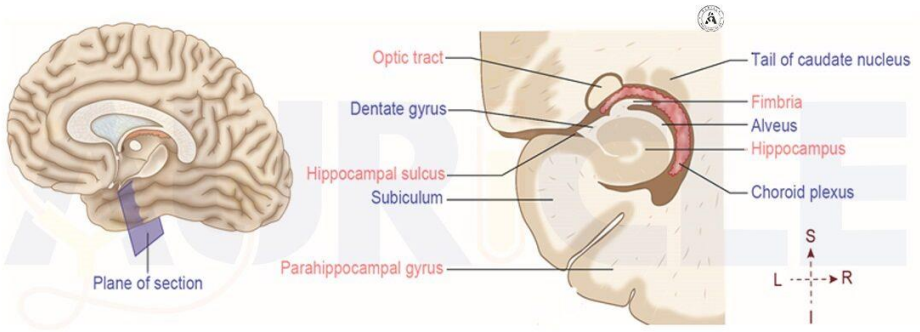
Function: Septal area – considered as pleasure zone

- *Paraolfactory* (*subcallosal*) *gyrus*
  1. Continuous around genu of corpus callosum with indusium griseum (*supracallosal gyrus*)
- *Paraolfactory area* (*subcallosal area*)
  1. Small triangular area on medial surface of cerebral hemisphere
  2. Lies anterior to subcallosal gyrus
  3. Inferiorly, continuous with *olfactory trigone*

Hippocampal formation

Part of limbic system

- Consists of
  - Hippocampus
  - Dentate gyrus
  - Subiculum
  - Indusium griseum
  - Medial and lateral longitudinal stria



Hippocampal formation

Functions

- Physiologically, part of limbic system
- Controls endocrine and visceral functions and emotional status
- Recent memory

Hippocampus

- C-shaped gray matter
- Hence, called *Ammon's horn*
- Located in floor of inferior horn of lateral ventricle

Pes hippocampus

- Anterior end of hippocampus with 2–3 digit-like ridges (similar to animals' paw, *pes* = foot)

Alveus

- Thin layer of white matter covers ventricular surface of hippocampus
- Are efferent fibers of hippocampus

Hippocampal formation

Fimbria of hippocampus

- Efferent fibers of hippocampus from alveus posteriorly these fibers converge to form fimbria of hippocampus
- Flattened band of white matter
- Lies superior to dentate gyrus
- *Crus of fornix*: Fibers of fimbria of hippocampus continue posteriorly as crus of fornix

Subiculum

- Lies between hippocampus proper and entorhinal area at inferomedial part of cerebral hemisphere

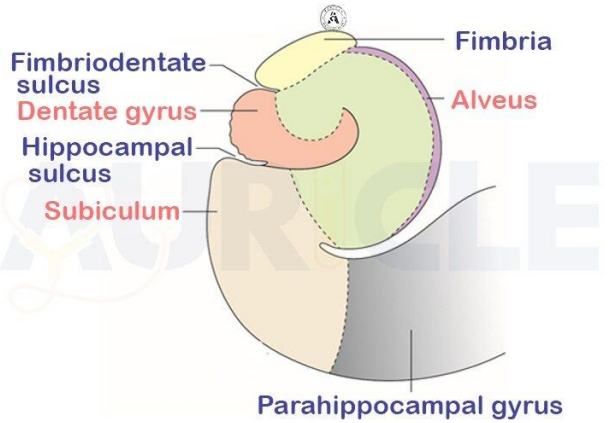
Hippocampal formation

Subiculum

- Transition zone (3 to 6 neuronal layers) and hence called juxta-allocortex

Dentate gyrus

- Narrow crenated, toothed strip of gray matter
- Lies on upper surface of parahippocampal gyrus
- Posteriorly, continuous with gyrus fasciolaris through indusium griseum



Tail of dentate gyrus

- Runs medially across inferior surface of uncus
- Here, forms tail of dentate gyrus

Hippocampal formation

Medial and lateral longitudinal stria

- Are two thin longitudinal strands of white fibers on each side
- Are embedded in indusium griseum

Indusium griseum (*supracallosal gyrus*)

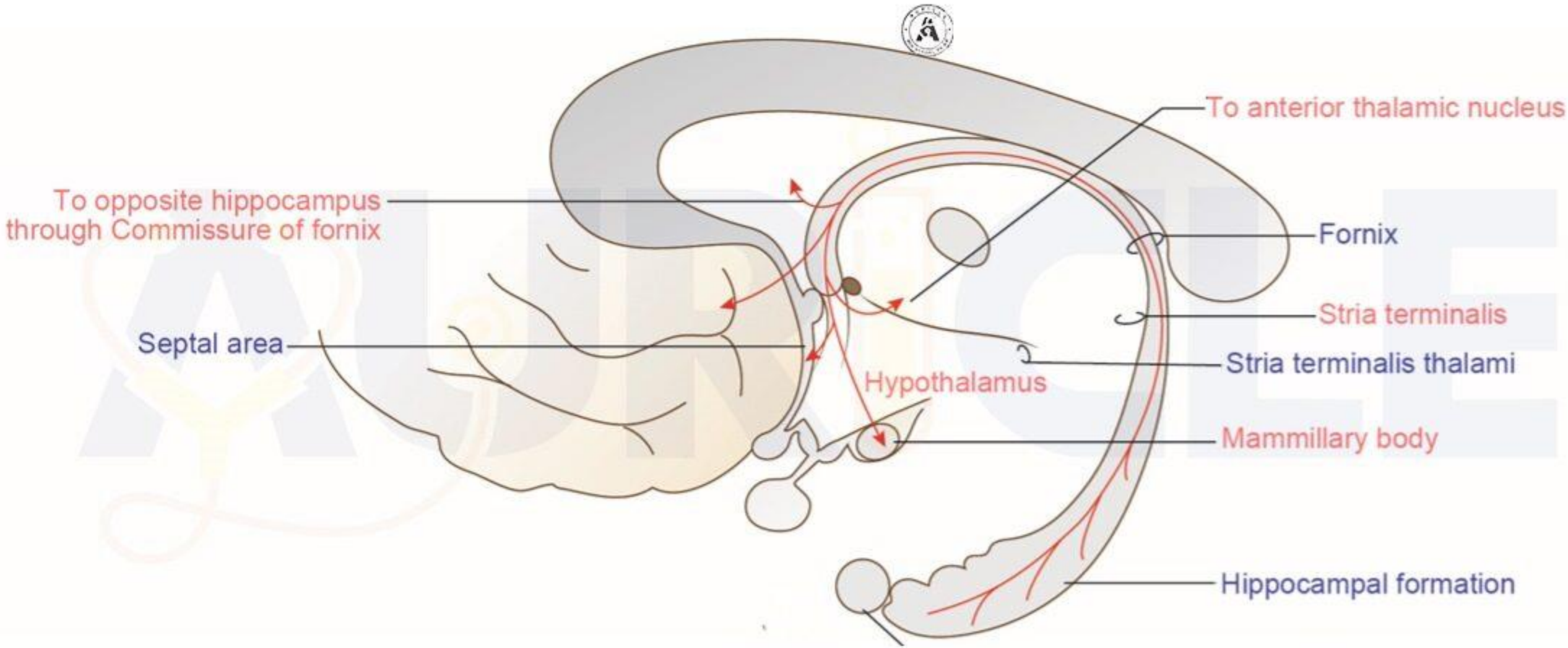
- Thin layer of gray matter covers superior surface of corpus callosum
- Anteriorly, continuous with paraterminal gyrus and posteriorly with gyrus fasciolaris

Connection of hippocampus

- *Afferent*: From entorhinal area
- *Efferent*: Through fornix to opposite hippocampus, septal area, anterior hypothalamic regions, mammillary body

Clinical integration

- Lesion of hippocampus results in loss of recent memory and psychomotor epilepsy

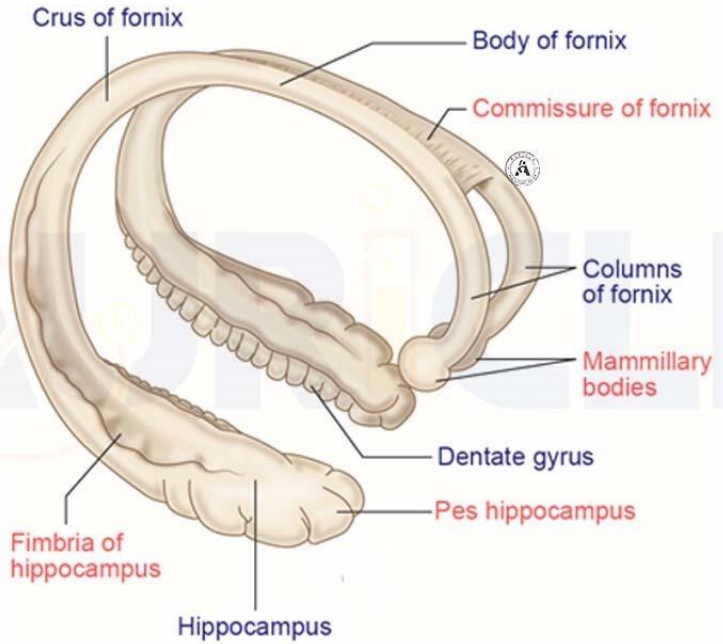

To anterior thalamic nucleus
To opposite hippocampus through Commissure of fornix
Fornix
Stria terminalis
Septal area
Stria terminalis thalami
Hypothalamus
Mammillary body
Hippocampal formation

Fornix

- *Definition*: Arched bundle of projection fibers from hippocampus to mammillary body

Parts

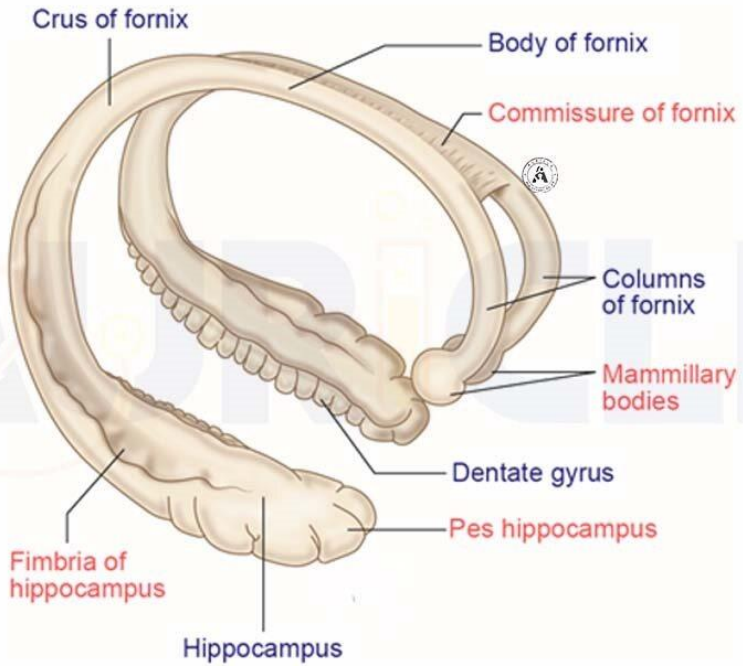
- Consists of
  - Posterior column (crus of fornix)
  - Body
  - Anterior column



Fornix

Formation

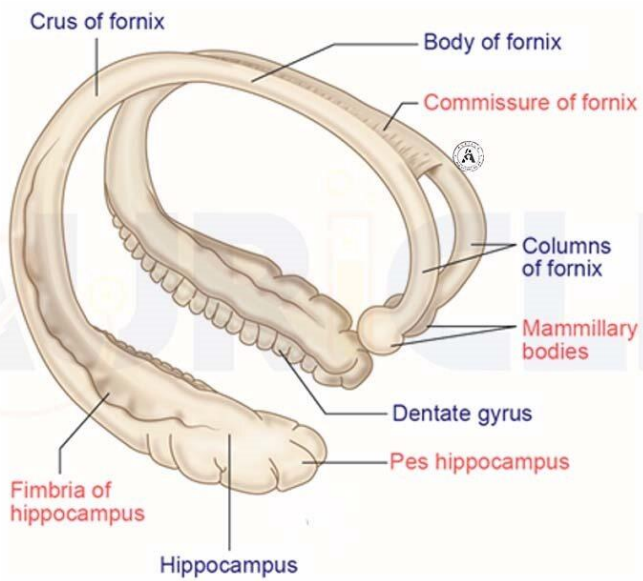
- Made-up of efferent fibers of hippocampus
- Axon of pyramidal cells of hippocampus → alveus (thin sheet of white matter covering ventricular surface of hippocampus) → fimbria (flat band) → crus of fornix
- *Crus of fornix*: Curves upward behind thalamus



Fornix

Body of fornix

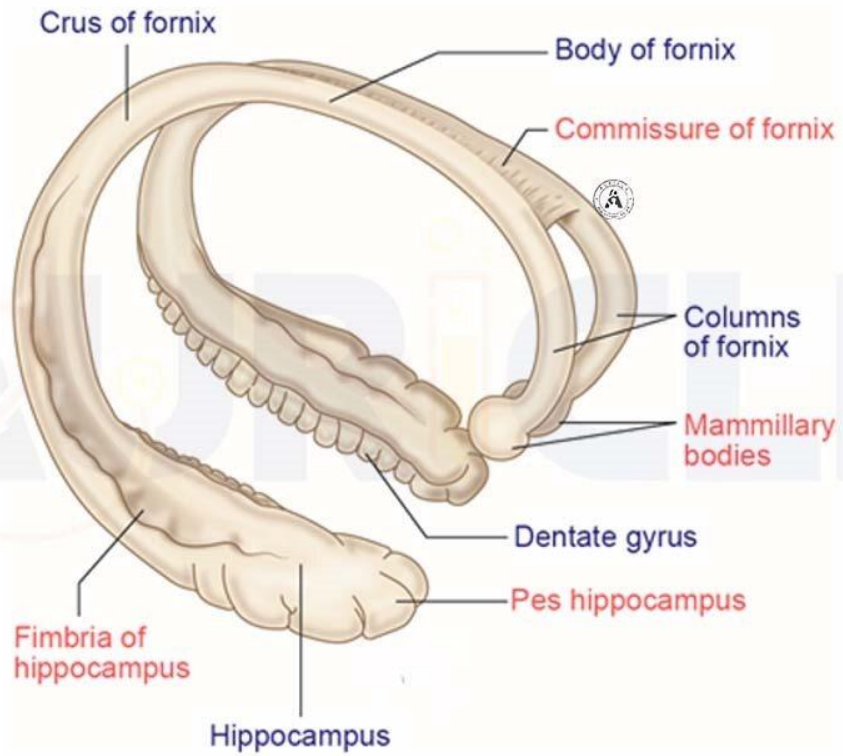
- Both crura (right and left) converge in midline to form body of fornix
- Lies above roof of third ventricle and below splenium and body of corpus callosum
- *Commissure of fornix*: Few fibers of crura decussate just posterior to the body of fornix as commissure of fornix (hippocampal commissure)



Fornix

Anterior column of fornix

- Anteriorly, body of fornix divides downward to anterior columns
- Each anterior column curves downward to anterior commissure
- Extends through hypothalamus and ends in mammillary body
- Few fibers terminate into septal areas
- *Functions*: Efferent tract of hippocampus



Clinical integration

- Bilateral damage to fornix causes inability in consolidation of short-term memory into long-term memory.

- Called *acute amnestic syndrome*

In the Papez circuit of the limbic system, between which combination is the hypothalamus placed on the basis of function?

A). Cingulate cortex - hippocampus

B). Hippocampus - Thalamus

C).Thalamus - Hippocampus

D). Parahippocampal gyrus - Thalamus

Archicortex of cerebrum is seen in-

A) frontal lobe

B) hippocampal formation

C) olfactory lobe

D) limbic lobe

Nuclei of the limbic system include all of the following EXCEPT:

A) Hippocampus.

B) Amygdaloid nucleus.

C) Caudate nucleus.

D) Anterior thalamic nucleus

The epithalamus:

A) Is part of the diencephalon.

B) Contains a gland that secretes melatonin.

C) Contains a nucleus that is part of the limbic system.

D) All of the above are correct

Hippocampal formation includes all EXCEPT:

A). Dentate gyrus

B). Subicular complex

C). Amygdaloid nucleus

D). Entorhinal cortex

Thank you…