CNS

Doctor 2021

Anatomy

Sheet (9)

Writer: Raghad Abdullah & Selina Sorour

Corrector: Roa'a Abdullah

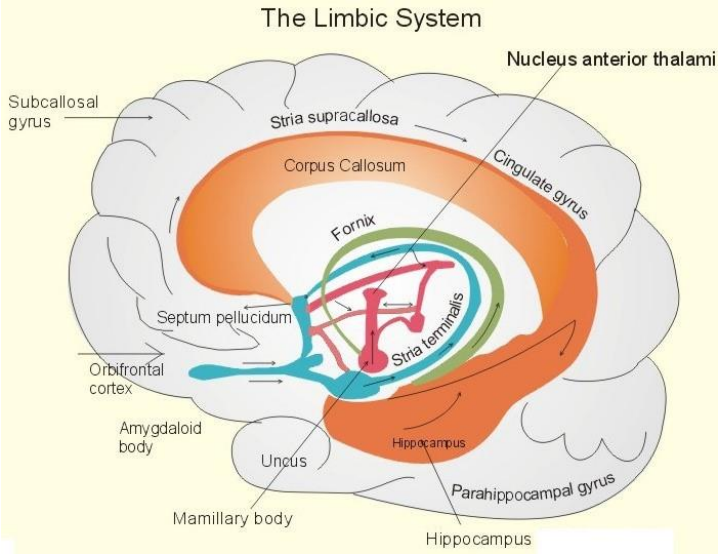
Doctor: Mohammad Alsalem

Limbic system

- The limbic system can be called the emotional mind since it is related to emotions and the mechanisms of recent memory.

COMPONENTS OF THE LIMBIC SYSTEM:

1. **Cortical structures** (all are within the gray matter):
   - Limbic lobe
   - Hippocampal formation
   - Prefrontal cortex
     - the most anterior part of the frontal lobe, related to emotions and personality in general.
   - Septal areas
     -near septum pellucidum, which is found between the 2 lateral ventricles.



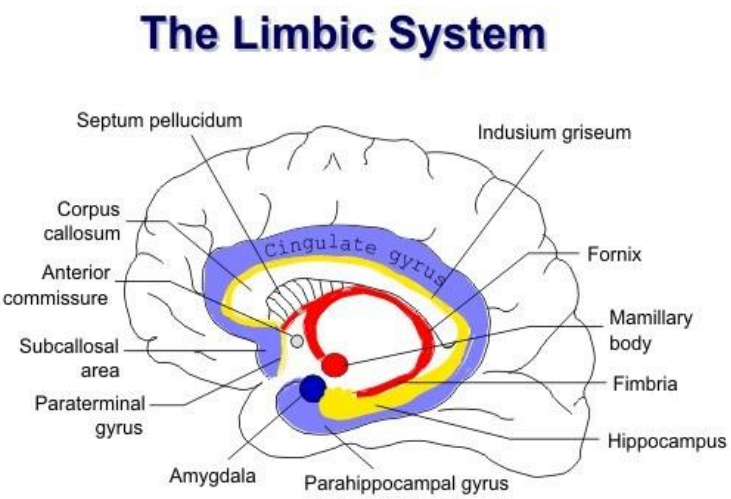
2. **Subcortical structures**
   - Hypothalamus
     -in the gray matter of diencephalon.
   - Anterior nucleus of thalamus
     - it's also a part of the diencephalon.
     - the thalamus contains y-shaped white matter that divides it into anterior (which contains the anterior nucleus), medial and lateral.
   - Amygdaloid nucleus
     - found near the tail of the caudate nucleus.
     -anatomically it's considered a basal nucleus, but functionally it's related to the limbic system and its function is related to emotions.
3. **Connecting pathways** (white matter that connects the cortical & subcortical structures forming a circuit):
   - Fornix
     - the bridge between the hippocampus and the mammillary bodies of the hypothalamus
   - Cingulum
   - Stria terminalis
   - Medial forebrain bundle

Limbic lobe:

c-shape group of structures seen on the medial surface of the brain (hemisphere) between the cerebral cortex and diencephalon.

components:

- Subcallosal area
  -below the corpus callosum – which is part of the commissural fibers-.
- Isthmus
- Cingulate gyrus
- Parahippocampal gyrus
- Uncus
  -anterior to the parahippocampal gyrus.



سبب تسمية السيستم

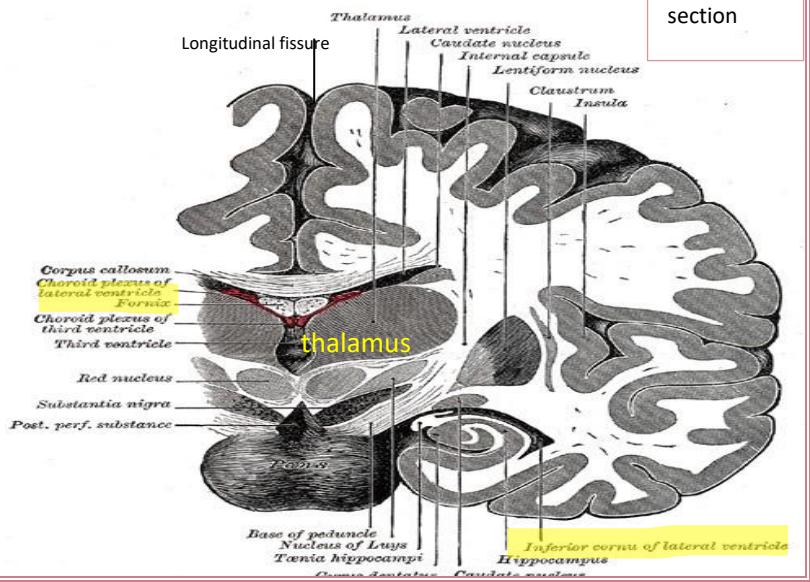
Limbic : الحدي

It was thought that the system was found between the telencephalon (the cortex) & diencephalon hence it was called limbic but then it was discovered that there are structures in this system beyond this “border” like the prefrontal cortex.

The hippocampal formation consists of:

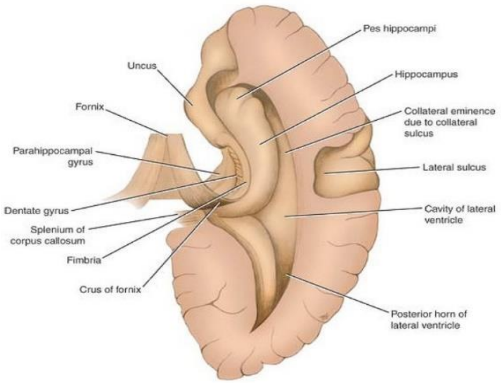
- Hippocampus
  -is the floor of the inferior horn of the lateral ventricle.
- Dentate gyrus
- Parahippocampal gyrus

Coronal section

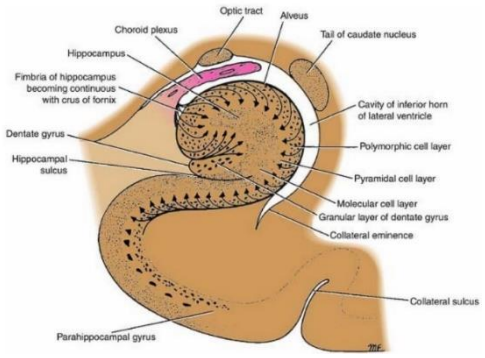


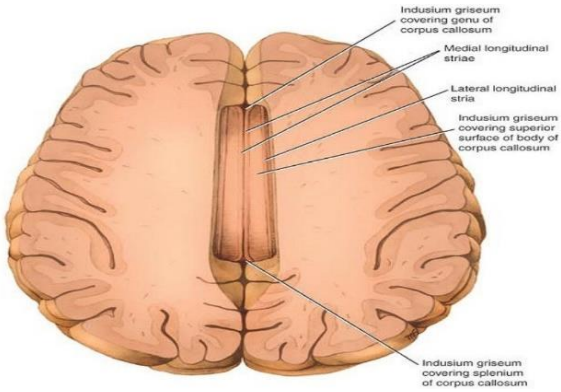
Hippocampus:

Superior view



- Curved elevation of gray matter that extends throughout the entire length of the floor of the inferior horn of the lateral ventricle
- **Anterior end:** pes hippocampus
- **Posterior end:** beneath the splenium of the corpus callosum
- **Alveus**: thin layer of white matter covering the ventricular surface of the hippocampus
- **Fimbria**
  -Fibers of the alveus collect to form it
- **Crus** of the fornix
- **Dentate gyrus**:
  narrow, notched band of gray matter that lies between fimbria and parahippocampal gyrus.
  Anteriorly: continued into the uncus
  Posteriorly: becomes continuous with the indusium griseum.



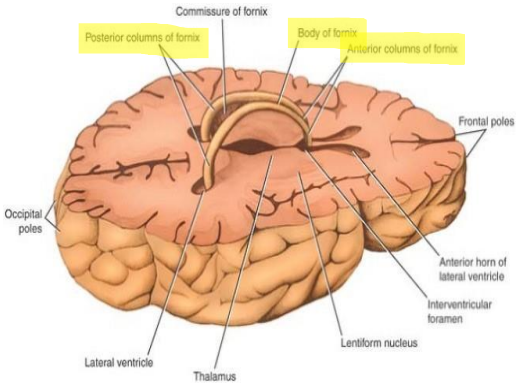


Indusium griseum is a thin layer of gray matter that covers the superior surface of the corpus callosum.

The fornix (connecting pathway):

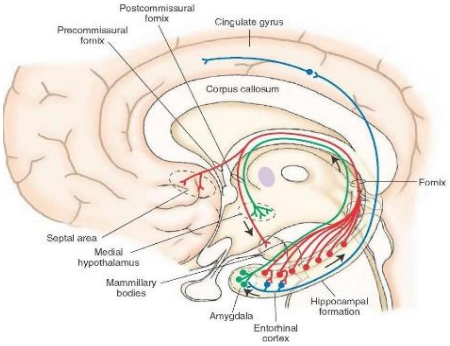
- from the hippocampus (a lateral structure) to the hypothalamus (a medial structure) so the direction of the fibers is anteromedial.
- The nerve fibers first form the alveus, (thin layer of white matter covering the ventricular surface of the hippocampus), then converge to form the fimbriae.

- The fimbriae of the two sides arch forward above the thalamus and below the corpus callosum to form the posterior columns of the fornix.
- The two columns then come together in the midline to form the body of the fornix.
- The commissure of the fornix consists of transverse fibers that cross the midline from one column to another just before the formation of the body of the fornix.



Septal areas

- Grey matter in the septum pellucidum in front of lamina terminalis, which is the anterior wall of the third ventricle.
- Connections from the olfactory bulb, hippocampus, hypothalamus, amygdala (Papez circuit)
- Centre of pleasure
  -when stimulated gives euphoria.



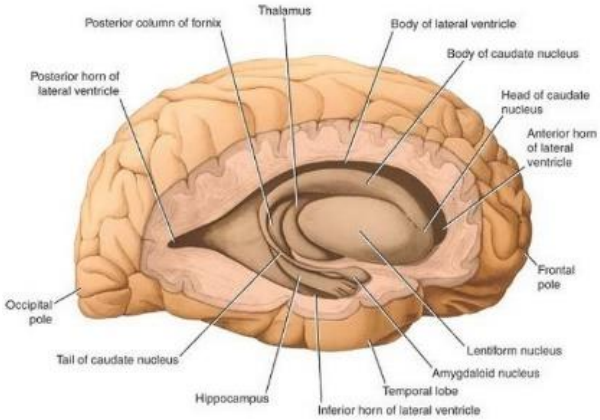
Amygdaloid nucleus

It's the large nucleus located at the end of the tail of the caudate (anterior to it) and forms the roof of the inferior horn of the lateral ventricle.

- Anatomically part of the basal nuclei
- Functionally considered part of limbic system

-Involved in:

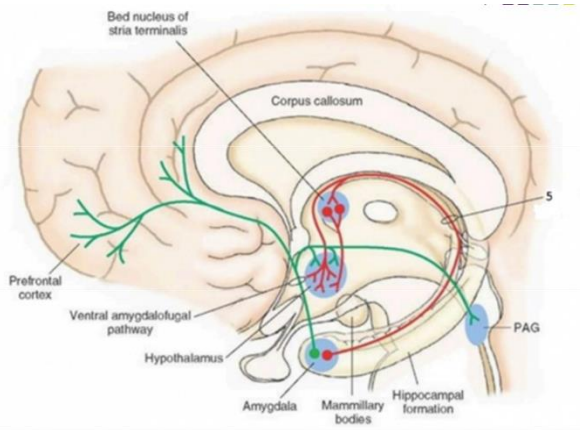
1. Memory
2. Decision making
3. Emotions



Connecting pathways

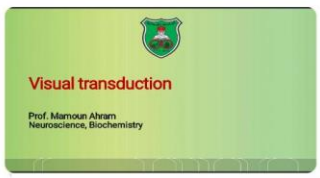
Stria terminalis

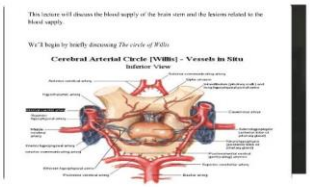
- Bundle of nerve fibers runs posteriorly in the roof of the inferior horn of the lateral ventricle on the medial side of the tail of the caudate nucleus.
  -All its fibers are curved.
  -Connects the amygdaloid nucleus with the hypothalamus.
  -Considered the output of the amygdaloid nucleus.

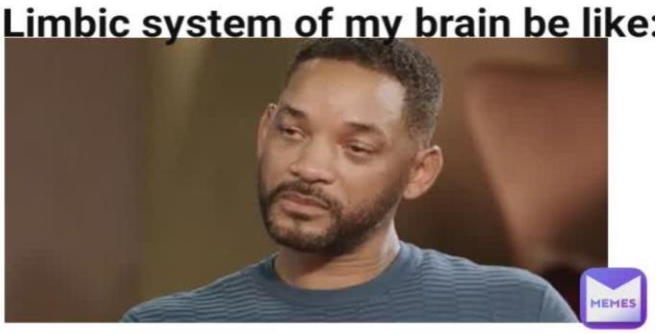


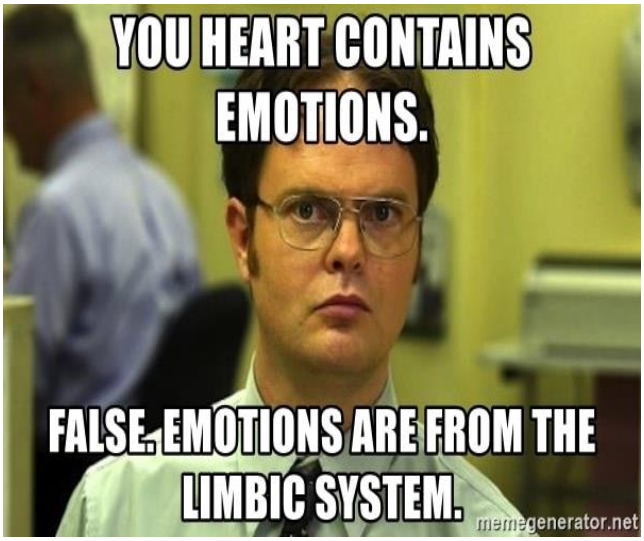
فاصل و نواصل ههه

After studying these lectures:









Papez circuit

- This circuit connects sensory information with emotions and is also related to the process of memory consolidation.
- An example of this connection is the anterolateral spinothalamic sensory tracts. The cingulate gyrus is one of the terminal pathways of the ALS, where slow pain fibers give input to the cingulate gyrus which is responsible for the emotional aspect of pain.

Now we'll start explaining the Papez circuit:

1. The hippocampus receives input from the cingulate gyrus through the cingulum which is a collection of white matter.

2. The mammillary bodies (MB) of the hypothalamus are connected to the hippocampus through the curved fibers of the fornix.

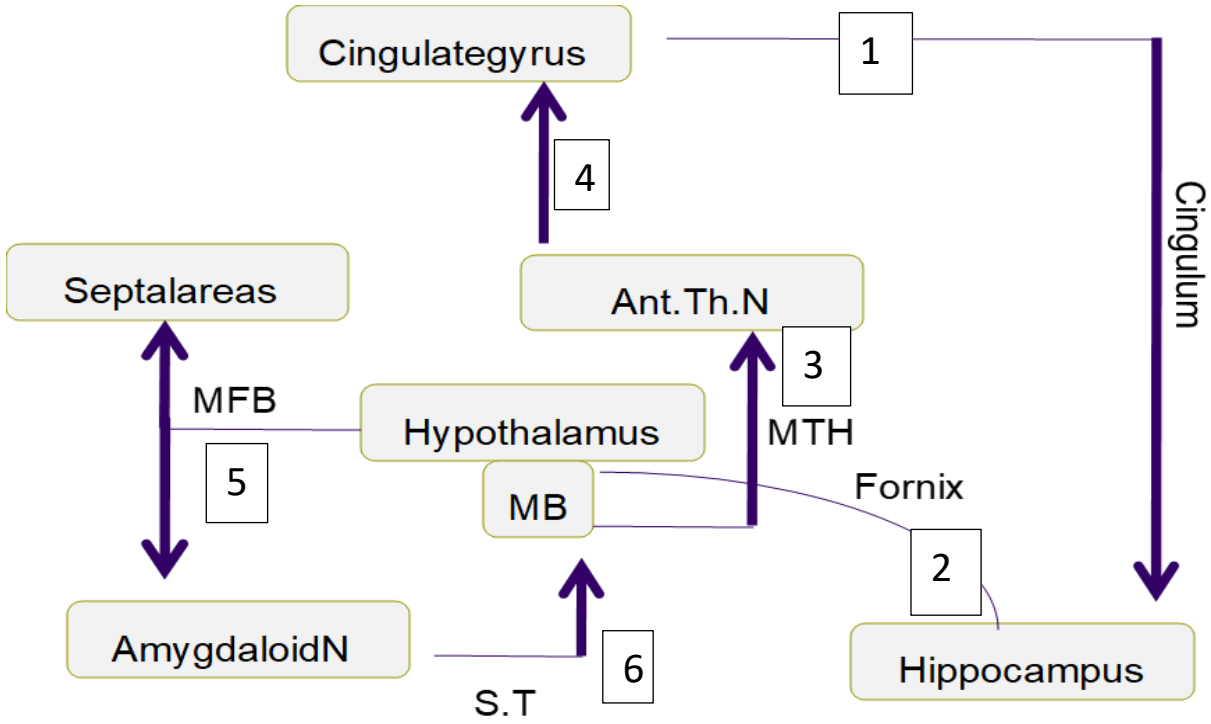
3. The mammillo-thalamic tract (MTH) is the white matter fiber that connects the MB of the hypothalamus with the anterior thalamic nucleus (Ant. Th. N).

4. Information from the (Ant. Th. N) go back to the cingulate gyrus (the cortex).

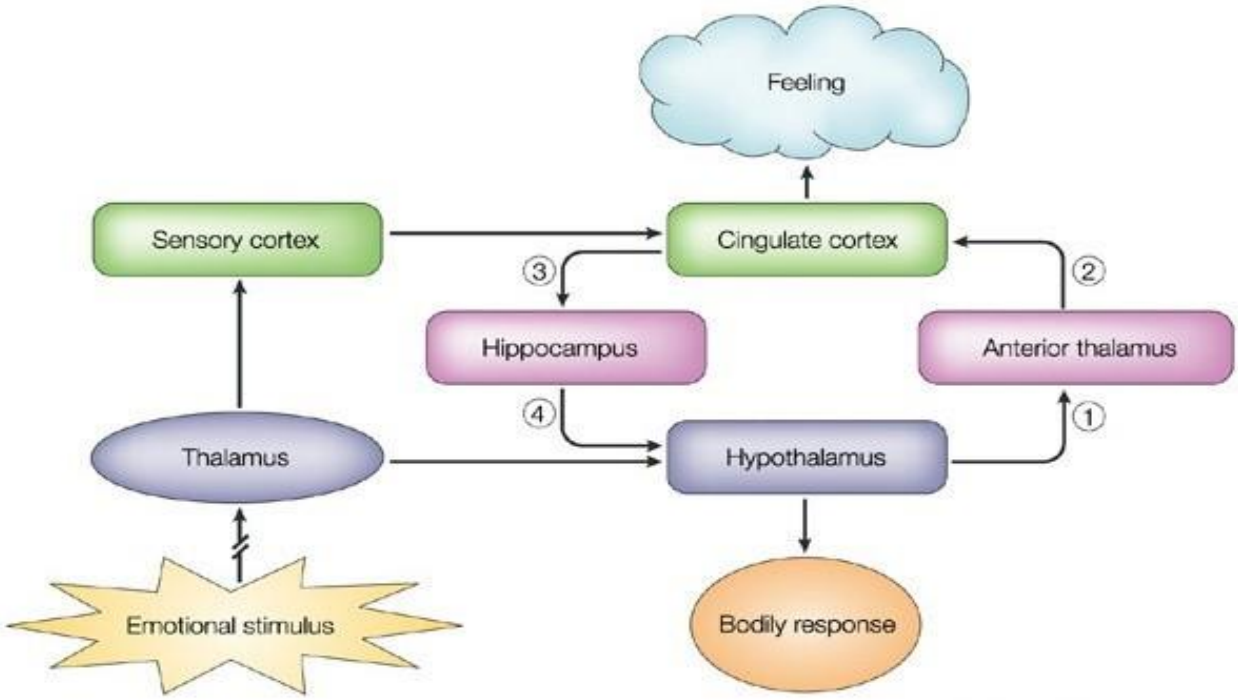
*This follows the rule that all information from sensory and motor systems must pass through the thalamus before reaching the cortex.

5. The hypothalamus also gives input to the septal areas and the amygdaloid nucleus through the medial forebrain bundles (MFB).

6. The output of the amygdaloid nucleus goes to the MB through the stria terminalis.



The picture below demonstrates how all sensory information reaching the sensory cortex will stimulate the cingulate cortex which will initiate the Papez circuit, this eventually will convert the feelings and emotions generated from the cingulate gyrus to bodily responses through the major output pathway of the limbic system, the hypothalamus, like sweating, tearing, and increasing heart rate etc.



1: MTH 3: cingulum 4: fornix

- **Hypothalamus is the major output pathway of the limbic system.**
  Functions of hypothalamus:
  -Emotions
  -Recent memory

Functions of the limbic system:

- **Instinct (Hypothalamus)**
- **Memory (Hippocampus)**
- **Emotions (Hippocampus, Amygdala, Prefrontal cortex, septal areas)**

Clinical points

- **Lesion of the hippocampus results in (anterograde amnesia)**
  -The individual is unable to store long-term memory
  -Memory of remote past events before the lesion developed is unaffected
  -hippocampus is the first area to show damage in Alzheimer disease
  - hippocampus is also related to navigation (the ability to memorize roads).
- **Kluver-Bucy syndrome: bilateral removal of amygdala**
  -Docility (compliance -opposite of aggression)
  -Show no evidence of fear or anger
  -increased sexual activity
  -Hyperphagia

E-LEARNING QUESTIONS:

1. **Which of the following structures represents the floor of the inferior horn of the lateral ventricle?**
   a. **Septal areas**
   b. **Hippocampus**
   c. **Tail of caudate nucleus**
   d. **Cingulate gyrus**
   e. **Hypothalamus**
2. **Which of the following connects hypothalamus to septal areas?**
   a. **Corpus callosum**
   b. **Anterior commissure**
   c. **Medial forebrain bundle**
   d. **Fornix**
   e. **Cingulum**

Ans: b, c

GOOD LUCK ☺

اللهم نستودعك أهالي غزة وفلسطين فانصرهم واحفظهم بعينك التي لا تنام واربط على قلوبهم وأمدهم بجندك وأنزل عليهم سكينتك وسخر لهم الأرض ومن عليها