



# Limbic system

**By**

**Dr. Amr Medhat Abbas**

**Professor of Medical Physiology**



# Learning outcomes:

- **At the end of the lecture, you will be able to:**

1. Describe the components of the limbic system.
2. Explain the functions of the limbic system.



# Limbic system

The limbic system consists of parts of the brain that are important in:

1. Initiation of emotions.
2. Regulation of emotional behavior

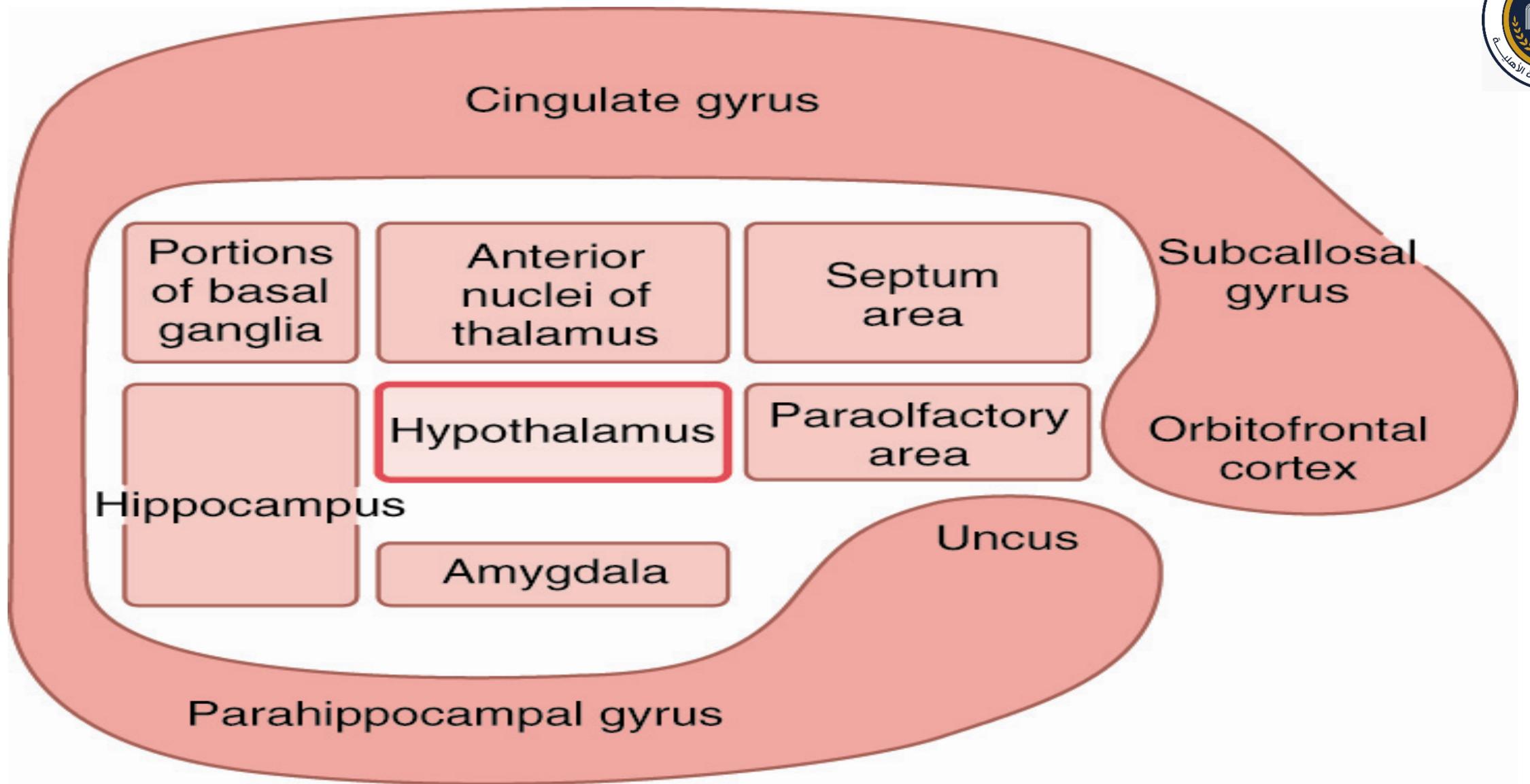
# Components of limbic system



## (I) Limbic cortex:

### - A ring of old cortex:

- Beginning in orbitofrontal area on the ventral surface of the frontal lobe.
- Extending upward in front and over the corpus callosum on the medial aspect of cerebral hemispheres to cingulate gyrus.
- Passing posteriorly to corpus callosum & downward on ventromedial surface of temporal lobe, to para-hippocampal gyrus, pyriform area & uncus.



## (II) Subcortical limbic structures:

- Thalamus
- Hypothalamus.
- Hippocampus.
- Amygdala
- Para-olfactory areas.
- Septal nucleus
- Parts of basal ganglia.

# Functions of limbic system



## \*Role of limbic system in motivation and emotional behavior:

The limbic system regulates patterns of behavior related to the following physiological functions:



# 1- Control of the feeding behaviour:

- This is one of the functions of amygdaloid nuclei.
- The amygdaloid nuclei differentiate food into edible and inedible on the basis of past experience.
- The stimulation of these nuclei causes chewing and licking movements, while its damage leads to hyperphagia associated with ingestion of all kinds of food and objects.

## 2- Fear and rage reactions:

- The limbic system receives information from different association areas of the cortex about various environmental stimuli.
- During exposure to threat, many limbic centers especially the amygdale, evoke protective emotional reactions (e.g. fear or rage reactions).

## Fear reaction

- If an animal is **threatened**, it usually tries to **escape**.

## Rage reaction

- If a threatened animal is **cornered**, it **attacks & fights**.

## Manifestations

Autonomic responses: as pupillary dilatation, sweating

Autonomic responses: as pupillary dilatation, hair erection

Somatic responses: as turning the head seeking escape.

Somatic responses: as biting.

### 3- Control of sexual behavior and reproduction:

#### ➤ Hypothalamus controls:

- a) Onset of puberty,
- b) Sexual function and activity.

➤ The behaviour components that accompany the sexual act are regulated by limbic cortex and hypothalamus as evidenced by:

- a) Bilateral damage of amygdale → hypersexuality.
- b) Removal of limbic cortex → loss of interest in other sex.

## 4- Punishment and reward response:

### A) Reward effect:

- Stimulation of certain areas in limbic system & hypothalamus, e.g. lateral, ventromedial nuclei of hypothalamus, amygdale and septal nuclei → pleasure and satisfaction (reward effect).

➤ The transmitter that is responsible for this sense is dopamine.



➤ The cocaine seems to produce its euphoric effect by increasing dopaminergic activity in the reward system.

## B) Punishment effect:

- Stimulation of certain areas in limbic system & hypothalamus, e.g. peri-aquiductal & periventricular areas → displeasure, rage, fear, escape (punishment effect) → avoidance of these punishing stimuli.

❖ So, there are 2 mechanisms in hypothalamus & limbic systems:



- The one promoting pleasure, comfort and placidity called reward or approach system whereas
- the other one promoting anxiety, fear and rage called punishment or avoidance system.
- So, emotional state is determined by the balance between the two systems.

# 5- Role of reward & punishment in learning & memory:



## ➤ Role in learning:

- Everything we do is related to reward and punishment. If we do something rewarding, we continue doing it and if we do something punishing, we stop doing it.

## ➤ Role in memory:

- If the stimulus causes neither reward nor punishment experience → can't be remembered easily i.e. no transformation into long-term memory and become hardly to be remembered.
- If the stimulus causes either reward or punishment → transformation of short-term memory into long-term memory and become hardly to be forgotten (remembered).

- The limbic system differentiates the sensory signals into significant ones which are stored in memory and insignificant ones which are ignored.
- Damage of hippocampus → anterograde amnesia.

## 6- Olfaction:

- Limbic system is concerned with perception and discrimination of different odours.
- It stores the olfactory memories and controls the emotional responses to olfactory stimuli.



# References

1. Costanzo, Linda S. "BRS Physiology (Board Review Series)." (2018).
2. Ganong, William F. "Review of medical physiology." (2020).
3. Hall, John E and Hall, Micheal E. "Guyton and Hall Textbook of medical physiology." (2021).