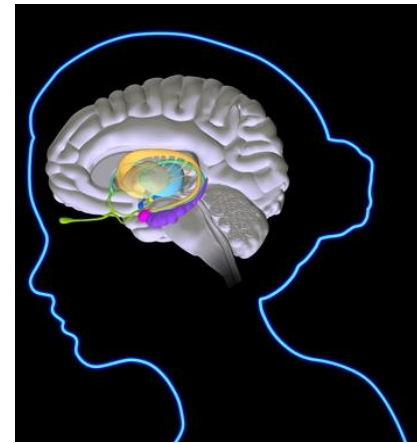




Lecture:

Khalleedd✓

Limbic System

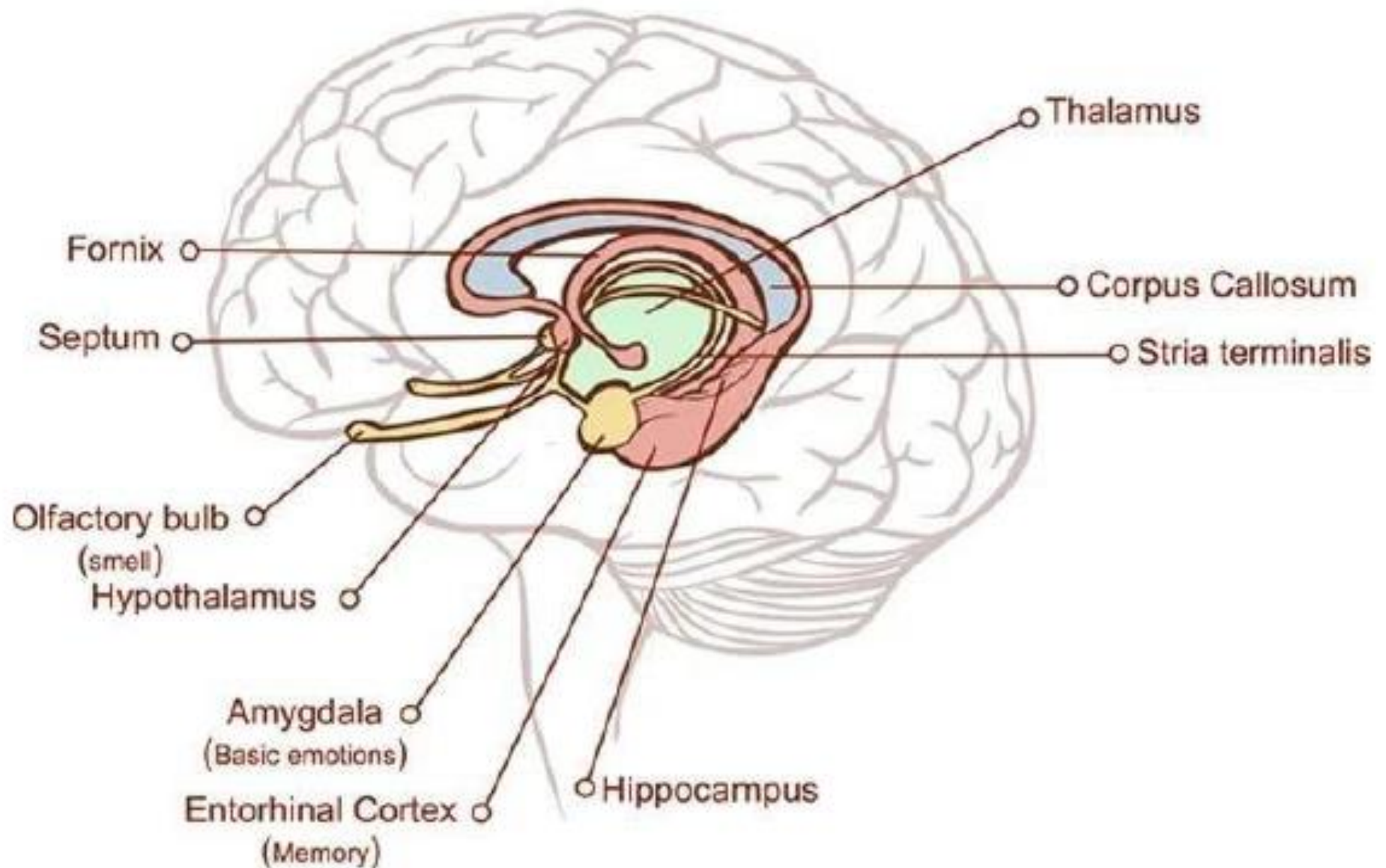
Dr. Eyad M. Hussein

MD, Ph.D of Neurology
Consultant in Neurology Department,
Nasser Hospital,

^{Border system} The Limbic System

- The word “limbic” means "border".
- Originally, the term “limbic” was used to **describe** the border structures around the basal regions of the cerebrum.
- It separates the medial surface of the cerebral cortex from the diencephalon.^{Thalamus and related structure}
- **The term limbic system:** describe both cortical areas
^{Cortex}
2 parts: (Limbic lobe) and (Subcortical structures), located mainly
in the medial and inferior regions of the cerebral
^{Temporal lobe}
hemispheres.
- **Now** structures beyond this border zone are also included
thalamus and hypothalamus.^{Functionally not anatomy}

The Limbic System



What Is The Function of the Limbic System?

It control a variety of functions including:

- Emotions.
 - Emotion associated with sexual behavior.
- Behavior & Mood (happy, cry, laugh, sad, afraid, aggression, depression).
- Motivation.
- Memory.
- Visceral & motor responses involved in (sex, pleasure, hunger, and reproduction).
- Olfaction. Smell function is cause it is close to uncus and smell center

The Structures of the Limbic System

The limbic system is composed of four main structures:

- Limbic lobe or cortex.

Gray matter mainly in medial surface of temporal lobe of cerebral hemisphere

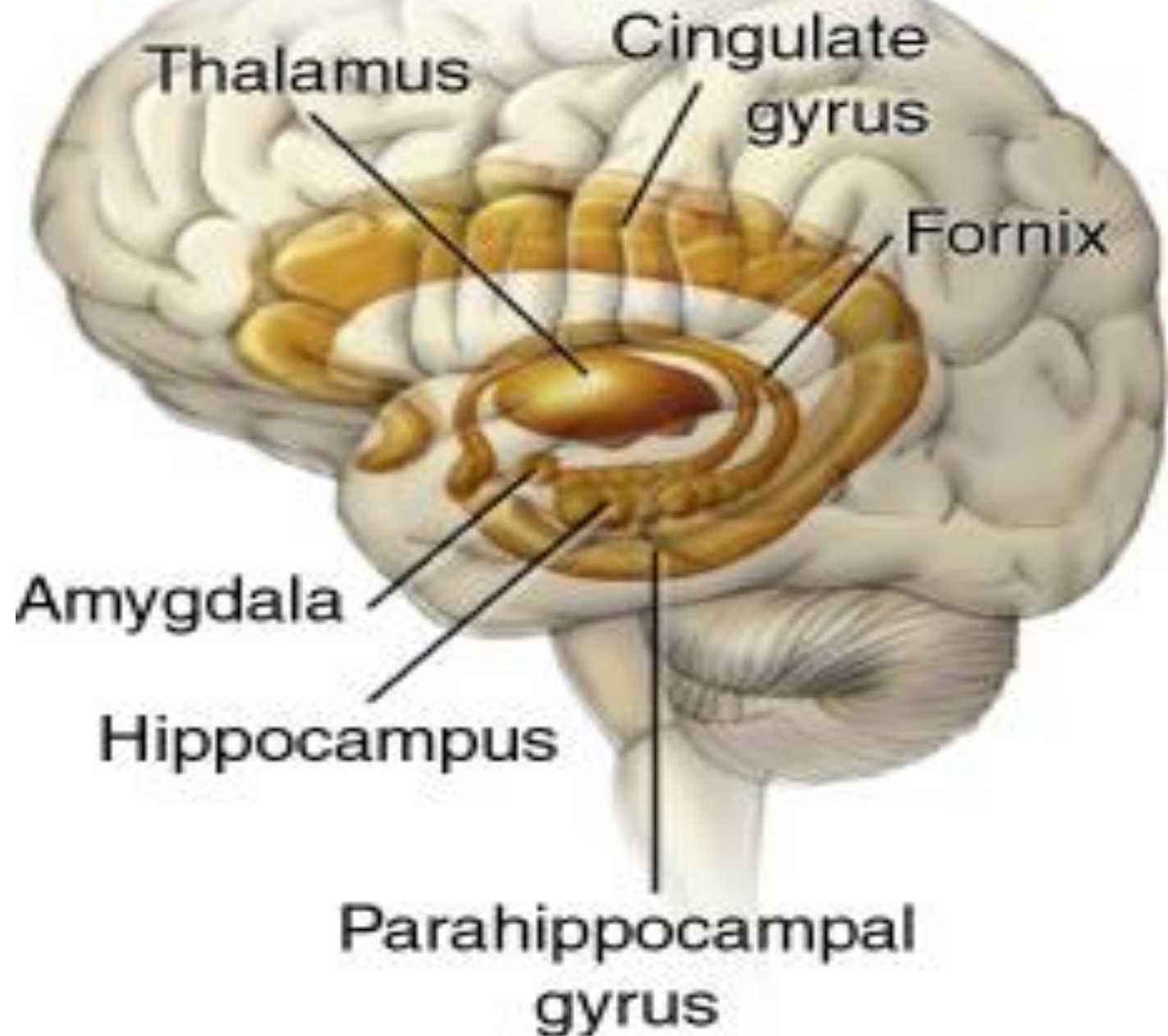
- Amygdala.
- Hippocampus.
- Fornix.
- Septal area.

Subcortical structures

- Mammillary bodies.
- Anterior thalamic nucleus

❖ These structures form connections between the limbic system and the hypothalamus, thalamus and cerebral cortex.

Limbic System



The Limbic Lobe

- C-shaped ring of **grey matter** on the medial surface of each Of temporal lobe cerebral hemisphere, surrounding the corpus callosum.

- It includes:

1. Subcallosal area.

2. Cingulate gyrus.

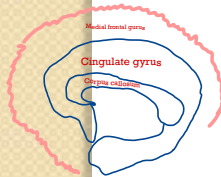
It follow medial part of frontal lobe
Callosal sulcus pass through it ACA (anterior cerebral artery)

3. Parahippocampal gyrus.

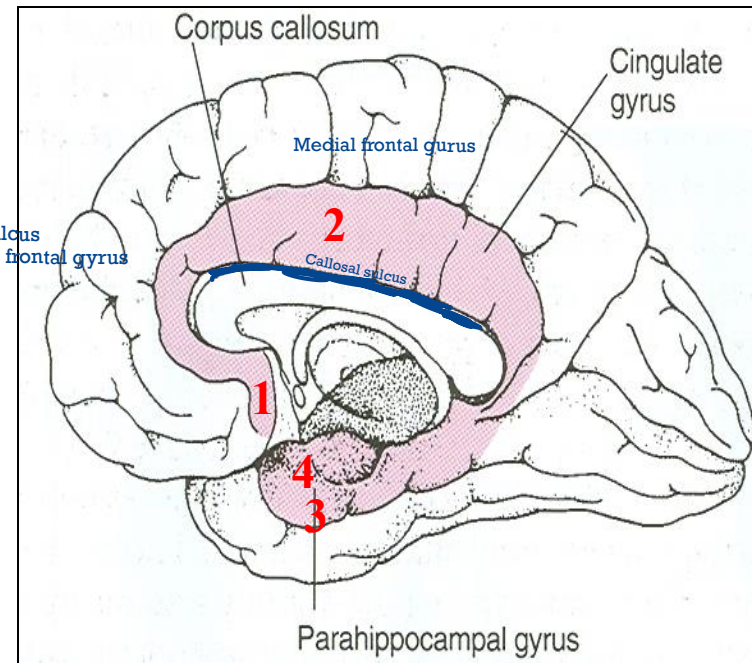
In medial and medioinferior surface of temporal lobe

4. Uncus.

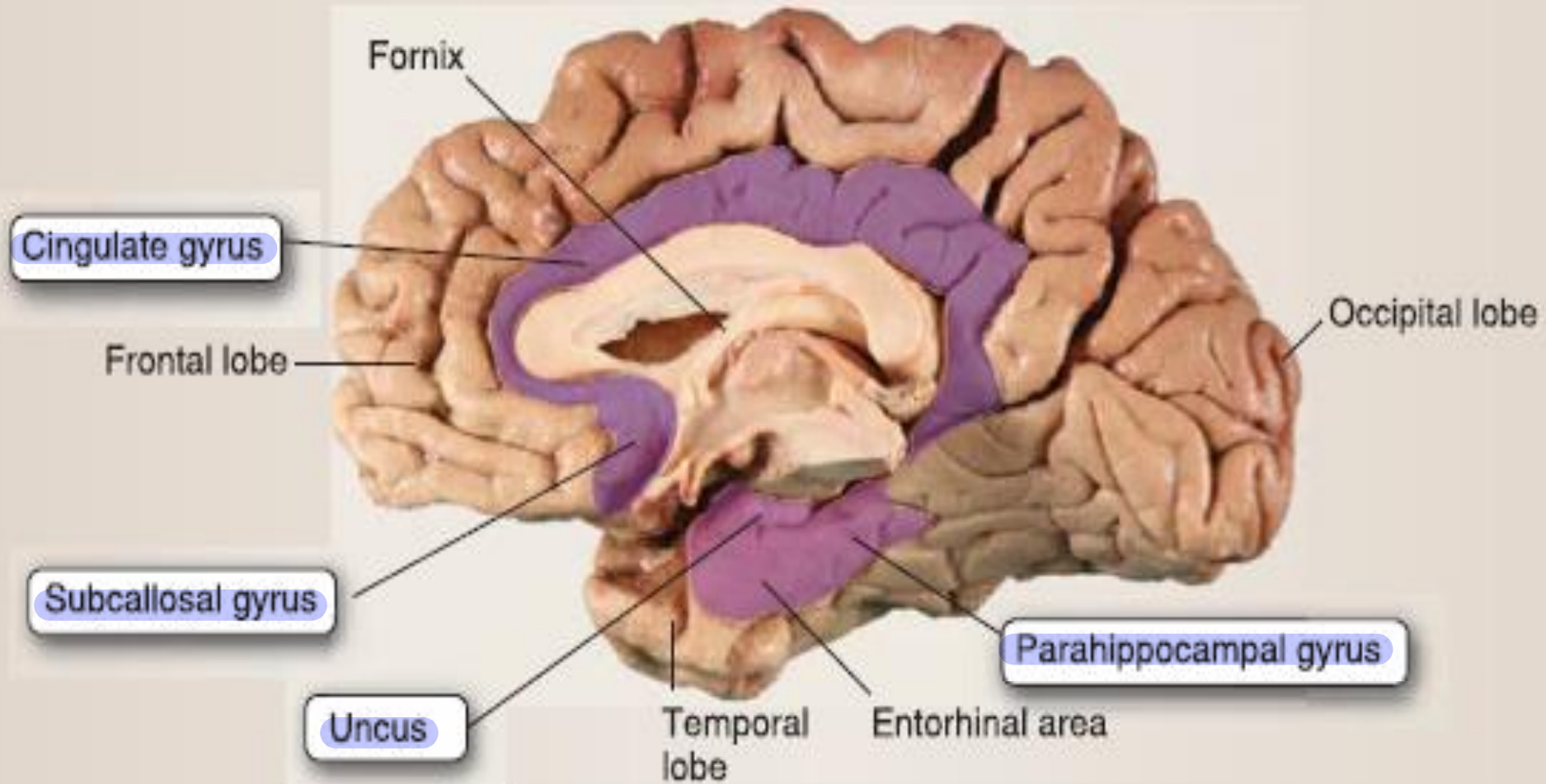
In olfactory and smell function
So it plays important role in smell function



A



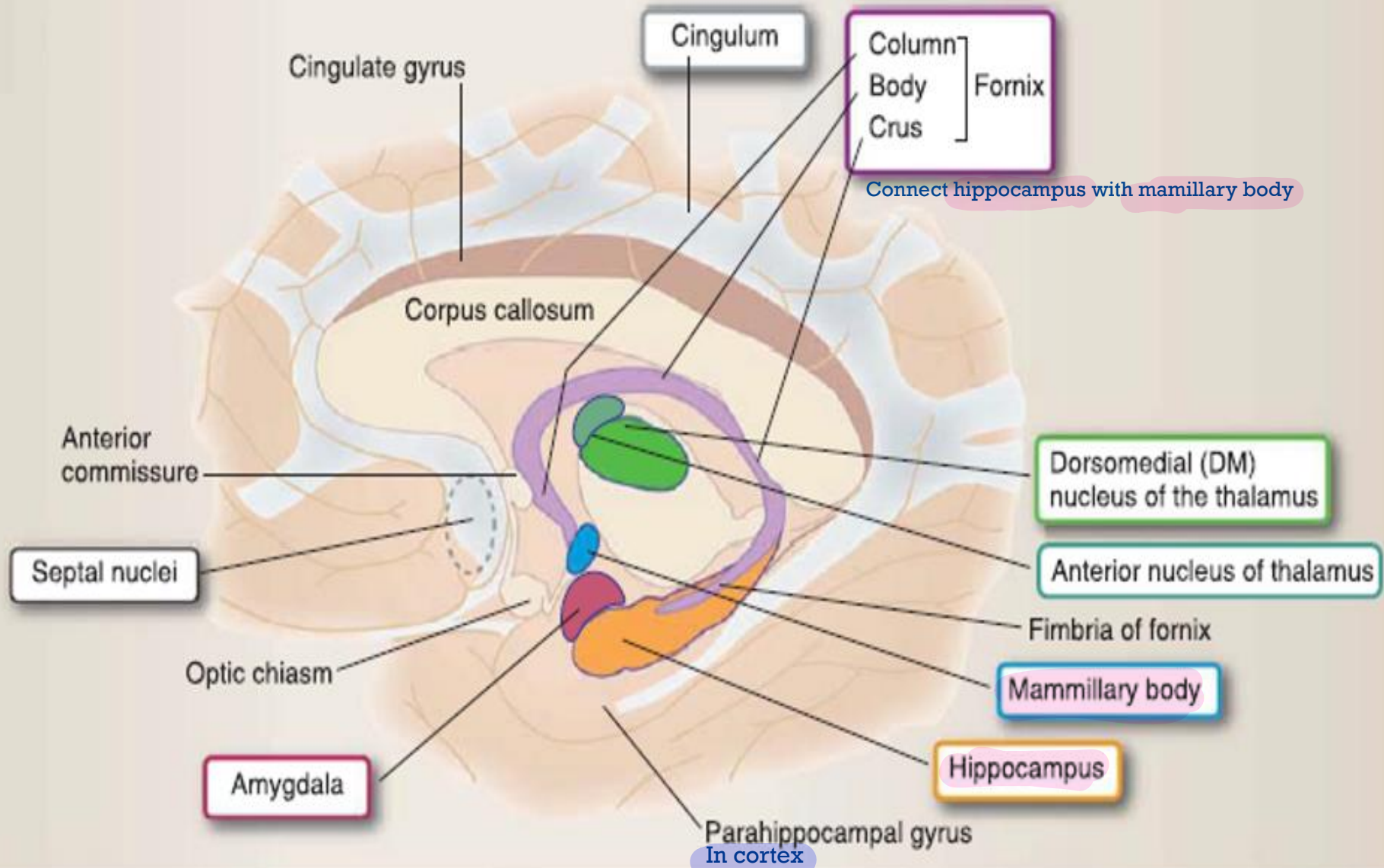
Cortical Areas of the Limbic System



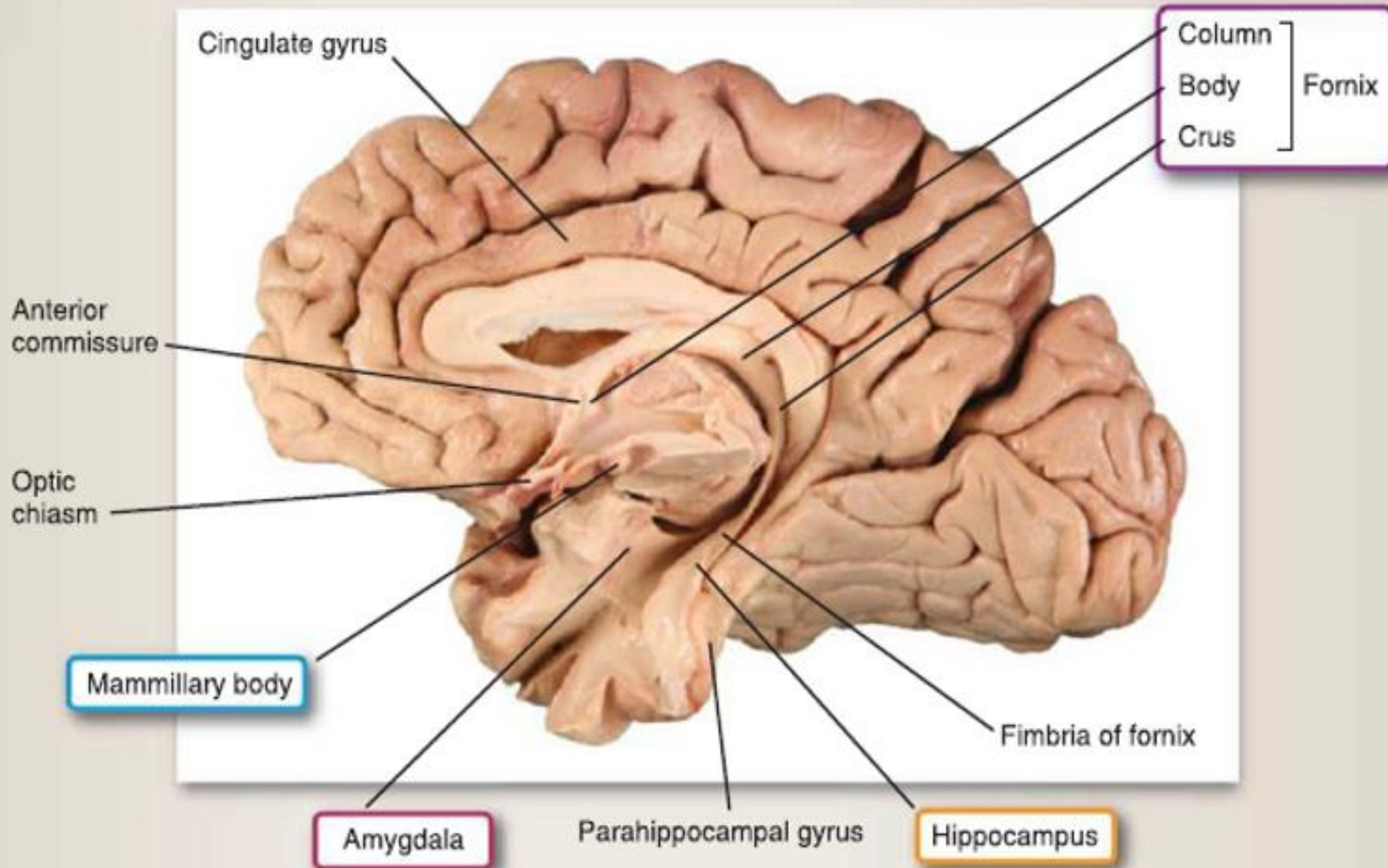
The Subcortical Structures of Limbic System

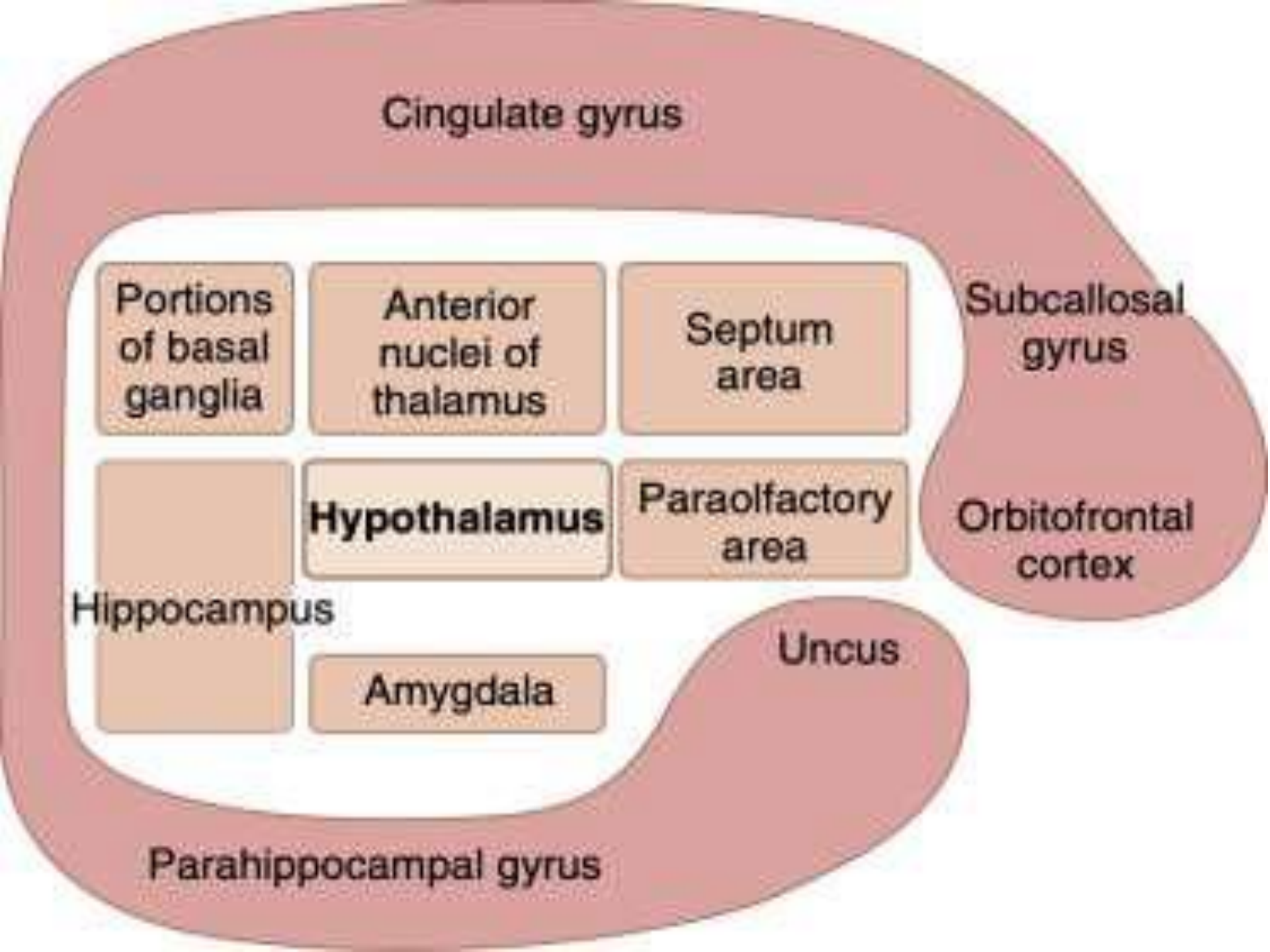
1. Hippocampal formation. While parahippocampal gyrus is related to the cortex
2. Amygdala. Follow basal nuclei and follow the temporal lobe → in the tail of caudate
Work in fear situations with sympathetic nervous system
3. Septal areas.
4. Prefrontal area.

The Subcortical Structures of the Limbic System



Midsagittal View of the Brain





The Hippocampus

Follow the subcortical limbic system

- It is a horseshoe paired structure, one in each cerebral hemisphere.
- It is a relatively large structure, about 5 cm in length.
- **Site:** It is a scrolled structure in the inferomedial part of the temporal lobe. Inferior to it lies the parahippocampal and uncus

The Structures of the Hippocampal Formation

- Consists of three major parts:

1. The hippocampus proper, also called **Ammon hon.**

2. The **dentate gyrus.**

Dentate nucleus in cerebellum → related to fine coordination
If dentate nucleus is impaired → cause incoordination in fine activity motor
Fastigial nucleus in cerebellum → responsible for trunk coordination
globus and emboliform nucleus → responsible for muscle tone

3. The **subiculum.**

Cerebellar damage patient face muscle hypotonia
Upper motor neuron damage patient face hypertonia

فالأمر يعدل ويصح

Multiple sclerosis patient → damage of more than one system → so never face spasticity

Follow the limbic lobe (cortex)

- **The parahippocampal gyrus:** the cortex overlying the hippocampal formation.

Follow the subcortical structures of limbic system

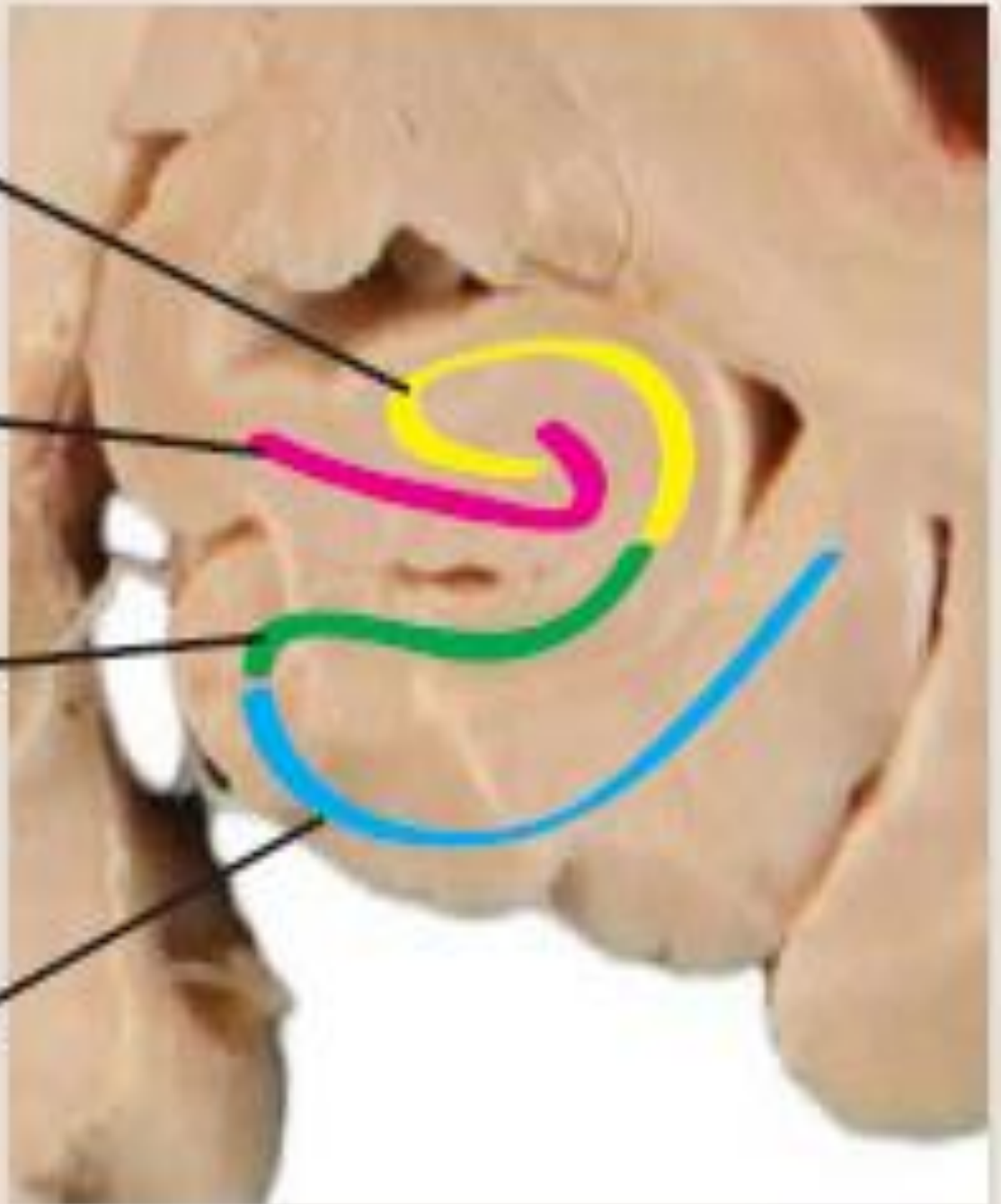
Ammon horn

Dentate gyrus

Subiculum

Parahippocampal
gyrus

Cortex



Function of Hippocampus

Important in Alzheimer → related to long term memory storage

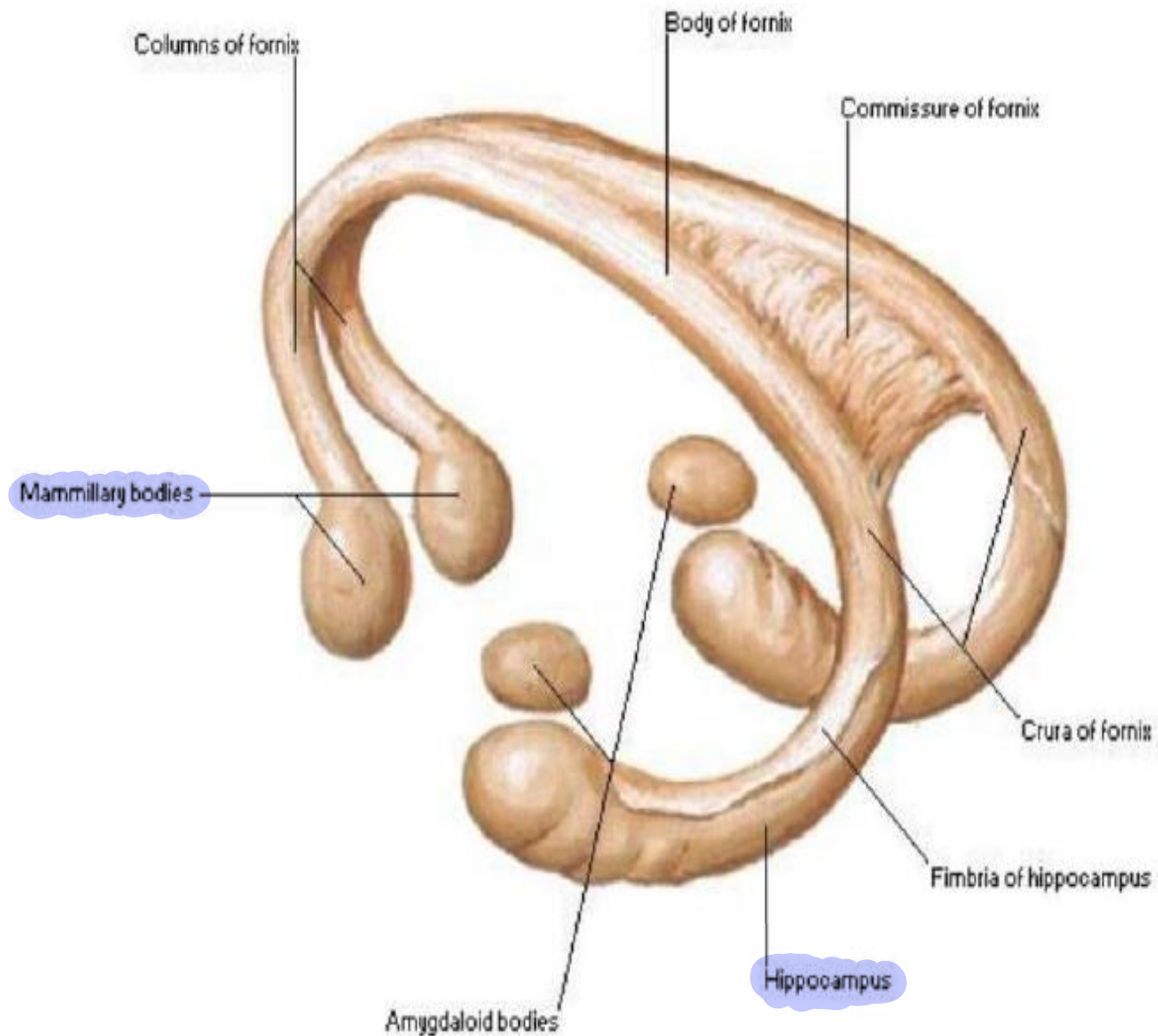
- It acts as **a memory indexer** by sending memories to the appropriate part of the cerebral hemisphere for **long-term storage**. Convert from short to long
- Formation, organization, and storage **of memories**.
- It is important in **forming new memories** and connecting emotions and senses, such as smell and sound, to memories.

The Fornix

- **Fornix:** It is C-shaped group of fibers connecting the hippocampus with mammillary body.
- **It consists of:**
 - ✓ **Column.** Close to mammillary body
 - ✓ **Body.**
 - ✓ **Crus.**
 - ✓ **Fimbria.** Close to hippocampus
- The Fornix is an important component of Papez
If cut by neurodegenerative disorder → cause dementia
Circuit. Like circle of Willis

Hippocampus and Fornix

Schema of Fornix



Cingulate gyrus

Cingulum

Column
of
fornix

Body
of
fornix

Crus
of
fornix

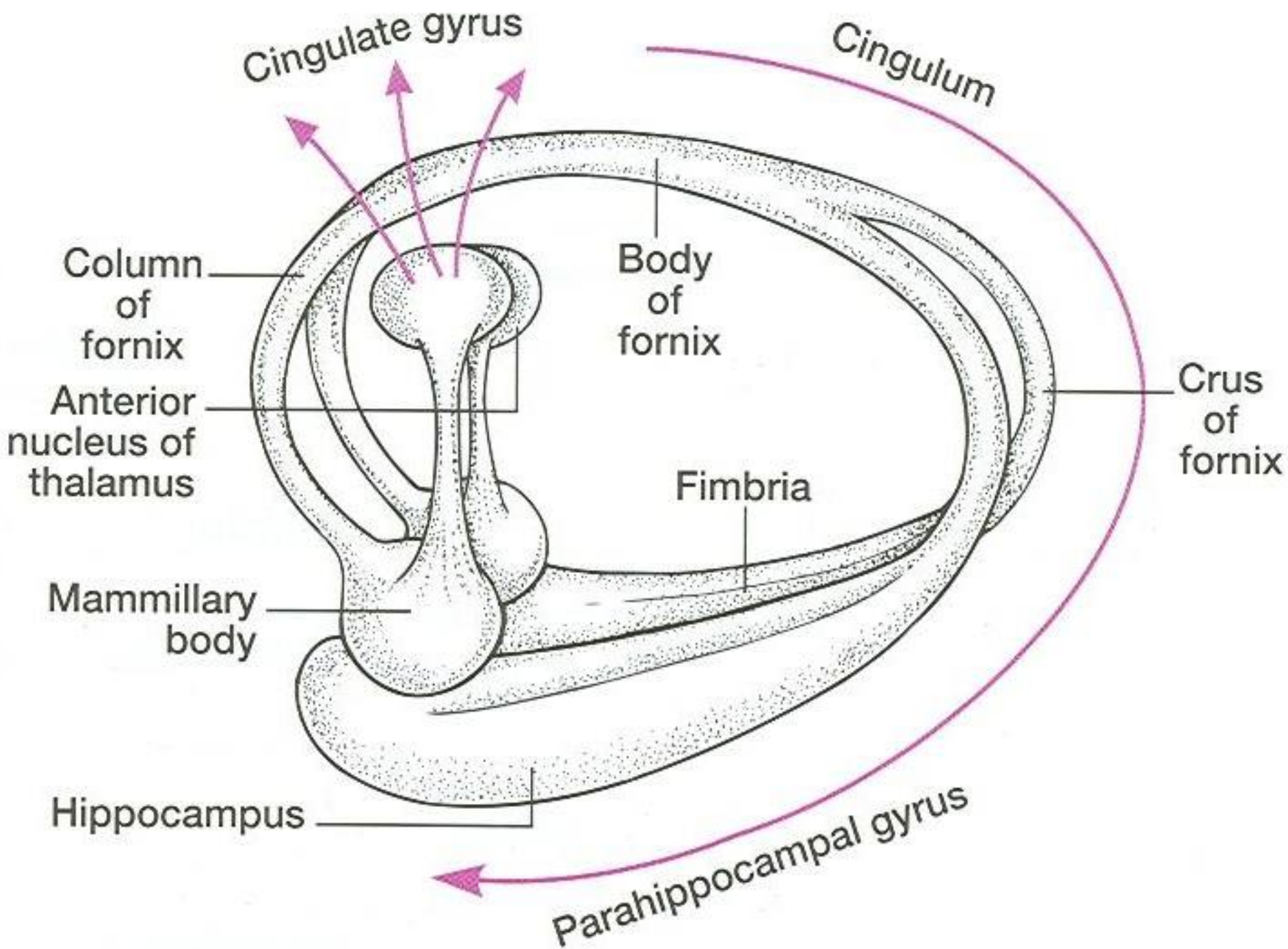
Anterior
nucleus of
thalamus

Fimbria

Mammillary
body

Hippocampus

Parahippocampal gyrus



Amygdala

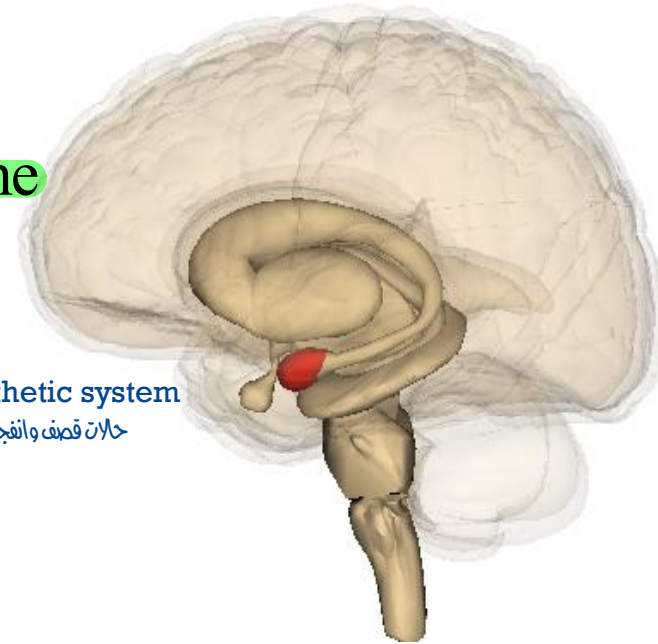
It is part of basal nuclei → in temporal lobe
Follow the subcostal structure of limbic system

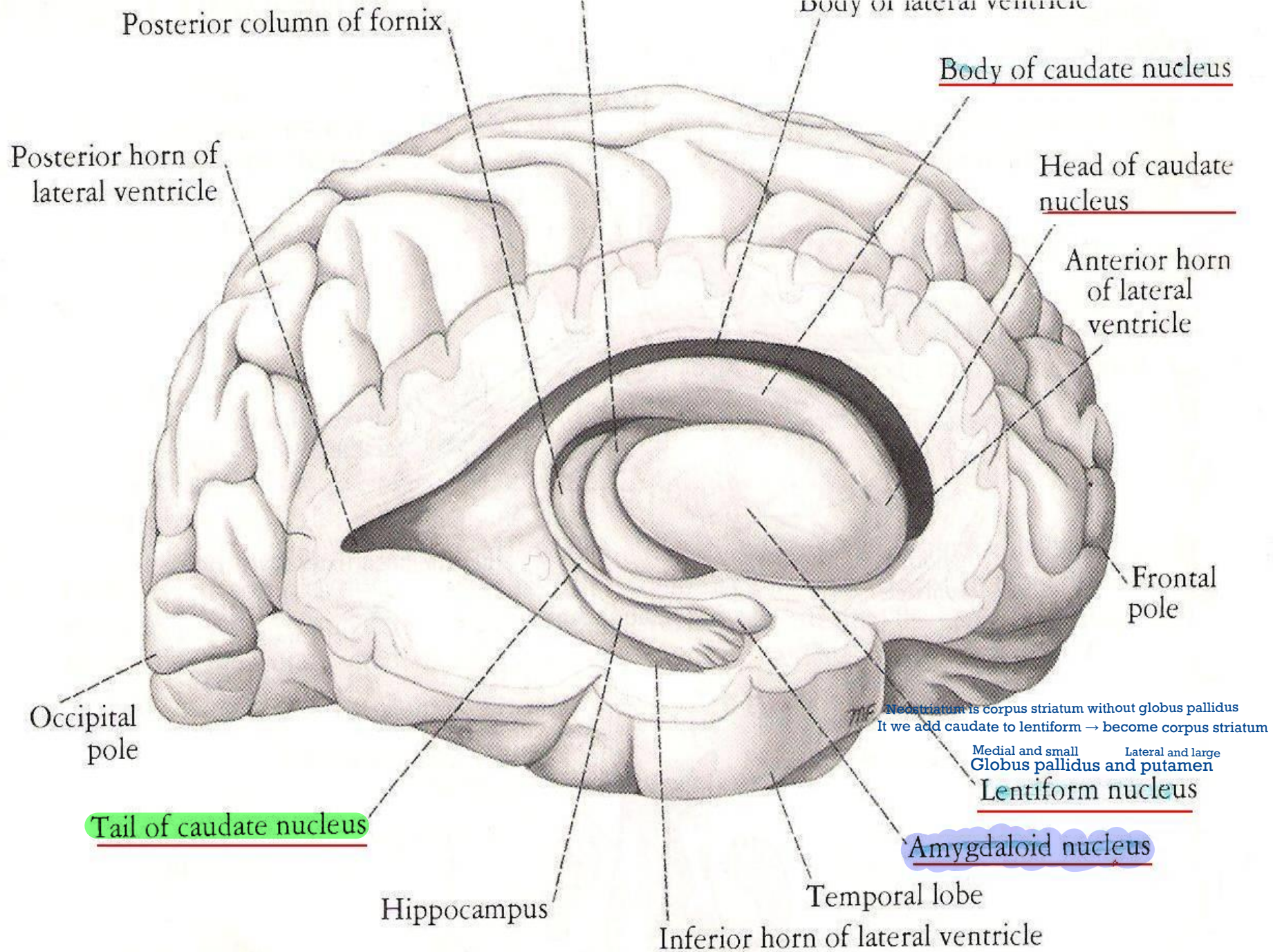
(Amygdaloid Nuclear Complex)

- **Site:** almond shaped mass of nuclei that lies deep to the uncus near the temporal pole, close to the tail of the caudate nucleus.
Composed of head body tail

- **Function:** It is involved in: With sympathetic system
حالات قصيف وانفجاريتها الشغلات

- ✓ Fear,
- ✓ Emotions,
- ✓ Anger,
- ✓ Smell.

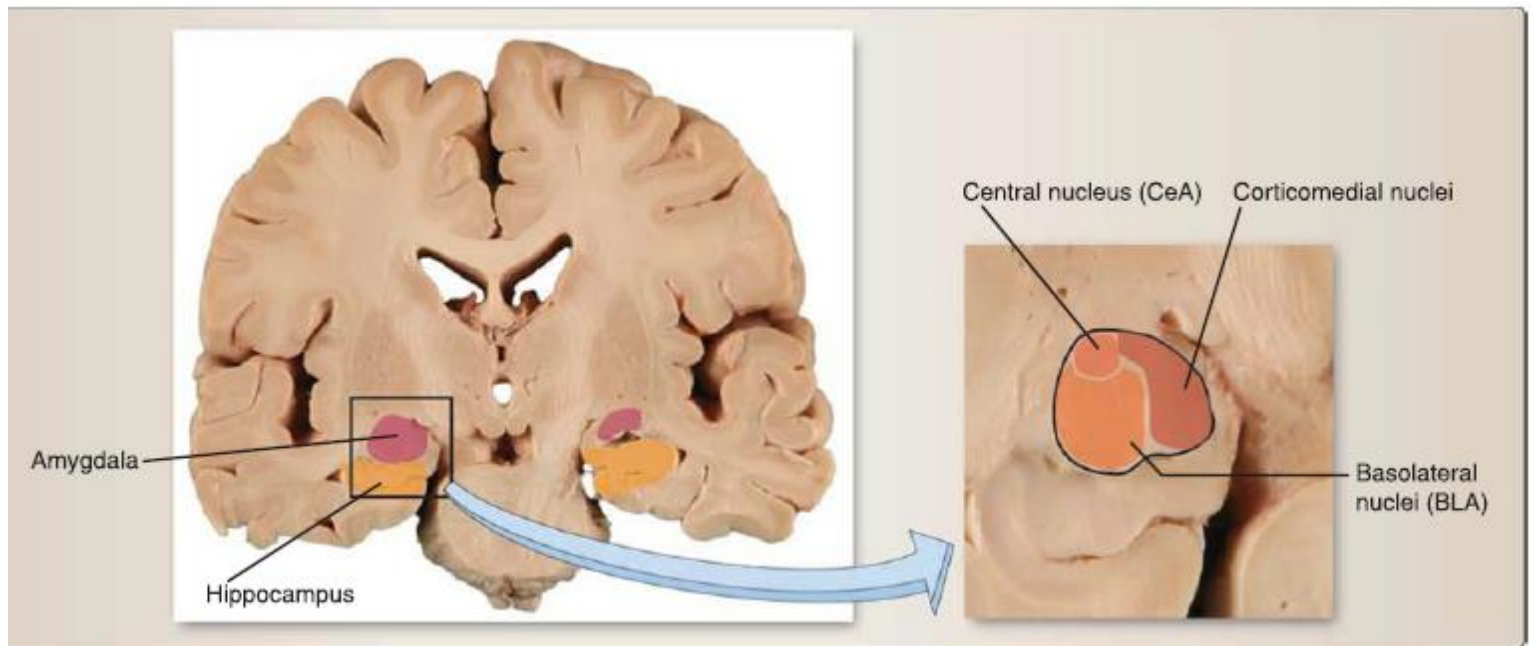




Structures of Amygdala

Divided into three major groups: Each nucleus has inputs and outputs

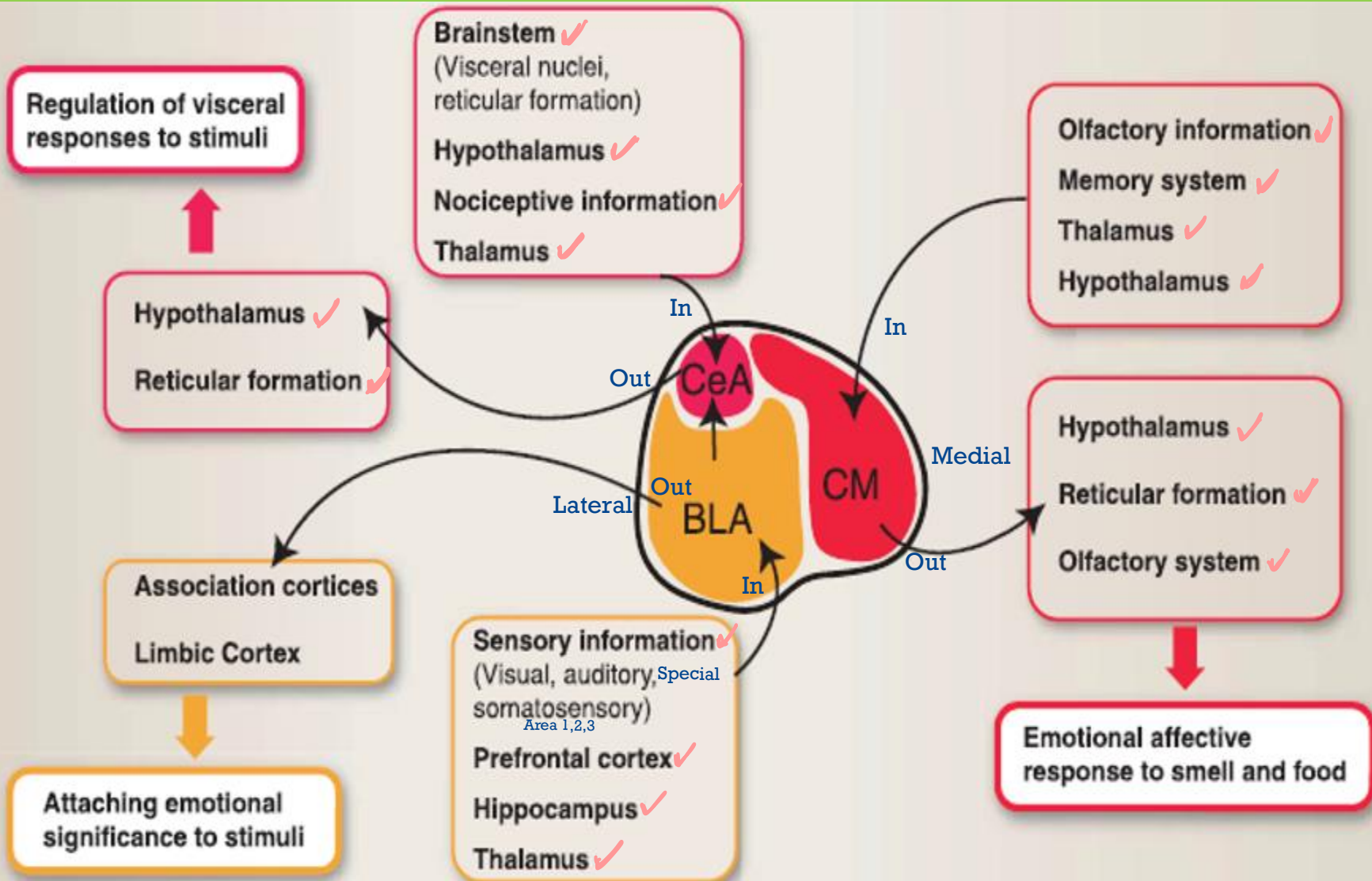
1. Basolateral nucleus, Lateral part
2. Central nucleus, In between 1 and 3
3. Corticomedial nucleus. Medial part



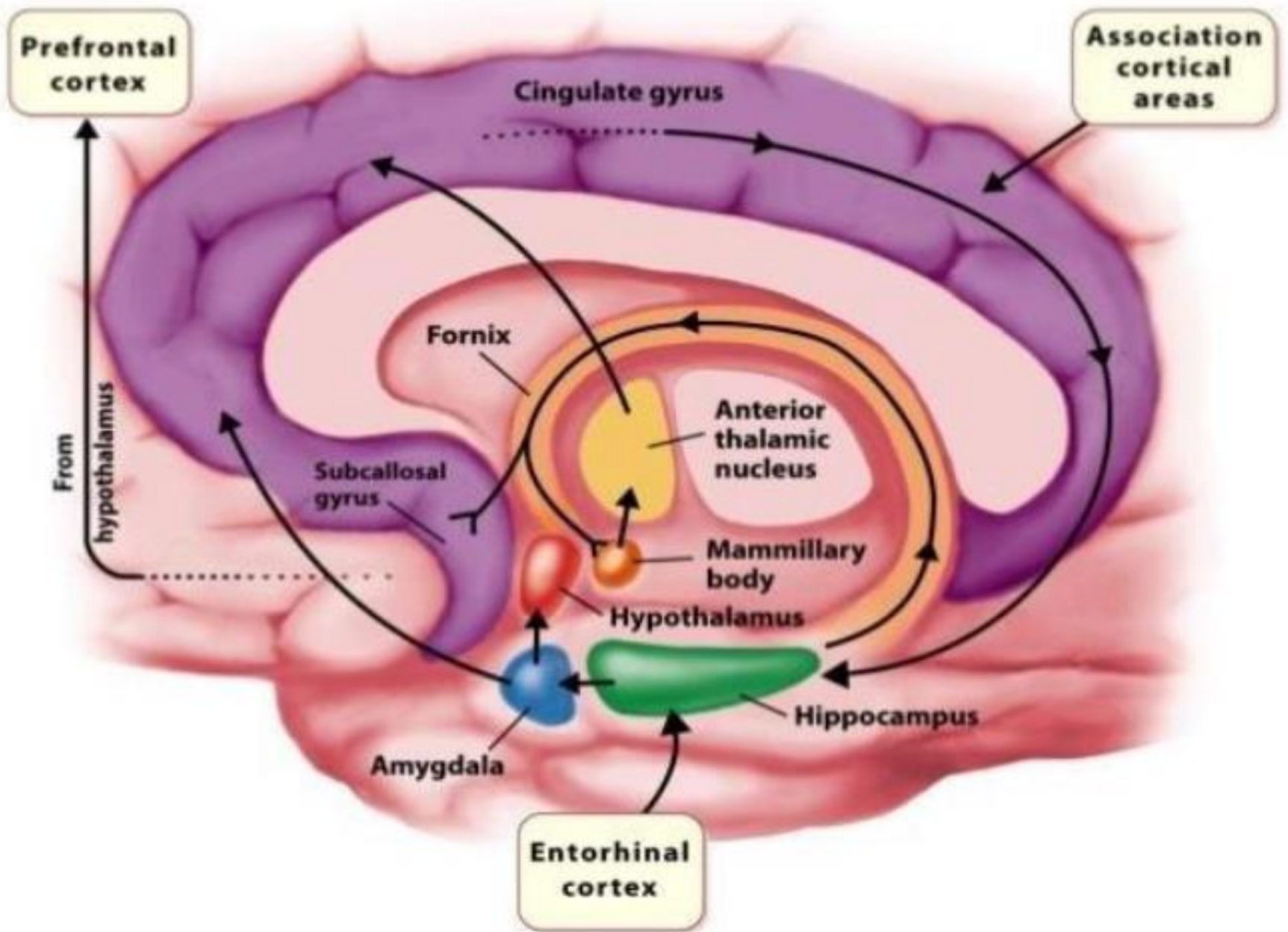
Connections of Amygdala

- **Inputs:** association areas of visual, auditory & somatosensory cortices.
Area 1,2,3 postcentral gyrus
- **Outputs:** hypothalamus & autonomic nuclei in the brain stem.
Autonomic CN → 10973
3 → edinger westphal nucleus (EWN)
7 → superior salivary nucleus
9 → inferior salivary nuclear
10 → dorsal motor nuclei of vagus nerve
- **Lesion:** lack of emotional responses & docility. الانقياد

The Amygdala and its Projections



- **BLA** - basolateral nuclei of amygdala.
- **CeA** - central nucleus of amygdala.
- **CM** - corticomedial nuclei of amygdala.



The Septal Nuclei

Follow the subcostal structures of limbic system

- **Site:** are a small group of nuclei in the medial wall of the **frontal lobe**, rostral to the **anterior commissure** and bordering on the anterior horn of the lateral ventricle.
- **Main connections:**
 - ✓ To Hypothalamus.
 - ✓ To Habenular nuclei.
Follow the commissures
- **Function:**
 - ✓ It is the **pleasure** zone.
 - ✓ Sexual feelings and feelings of orgasm.

Related to the fornix

The Papez Circuit or Network

- In 1937, **Dr. James Papez**, an American neuroanatomist, proposed the idea that the experience of emotion involved reciprocal interactions between the diencephalon and the cerebral cortex.

Limbic system

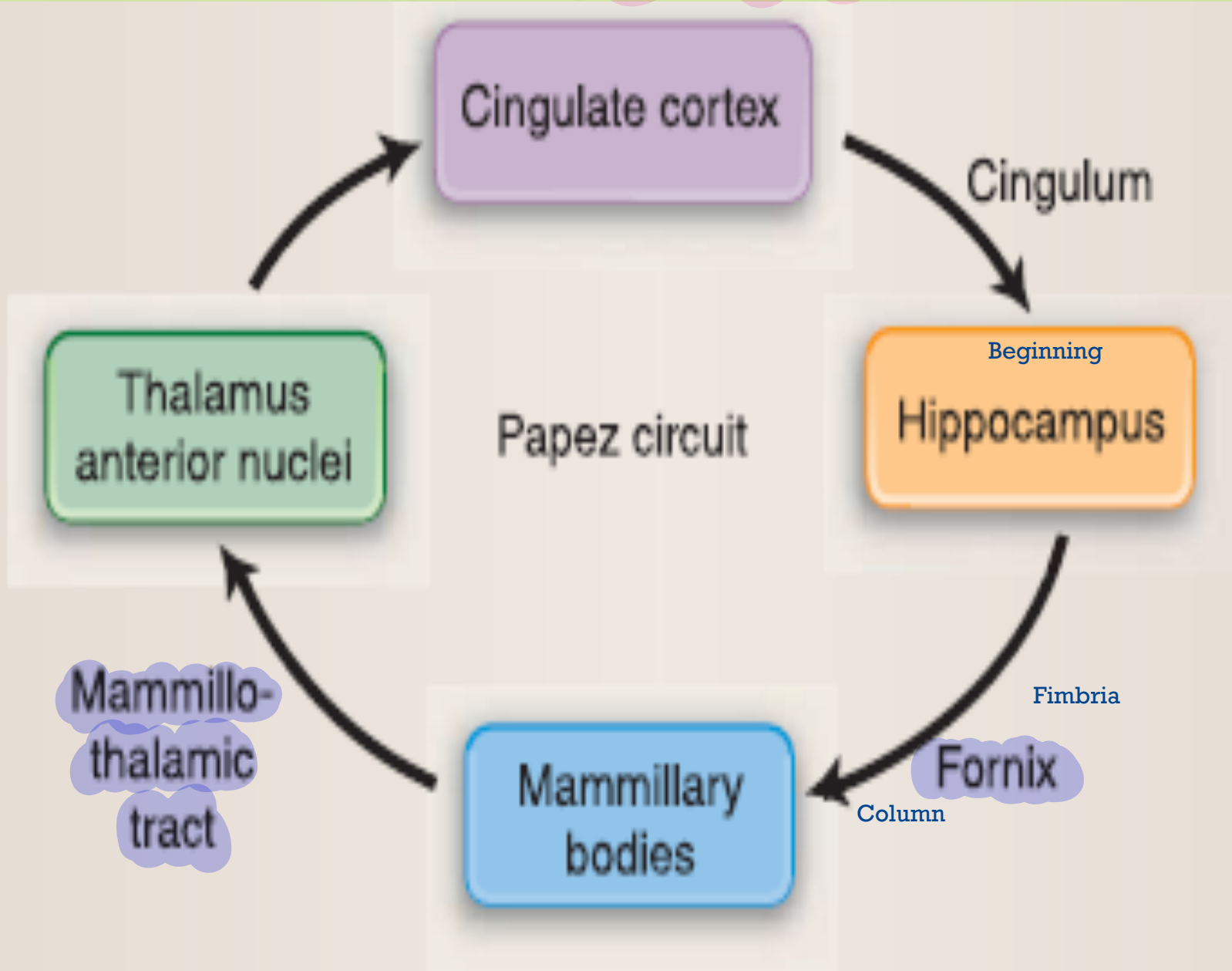
If the connection damaged we gonna face dementia, problems in memory and emotions

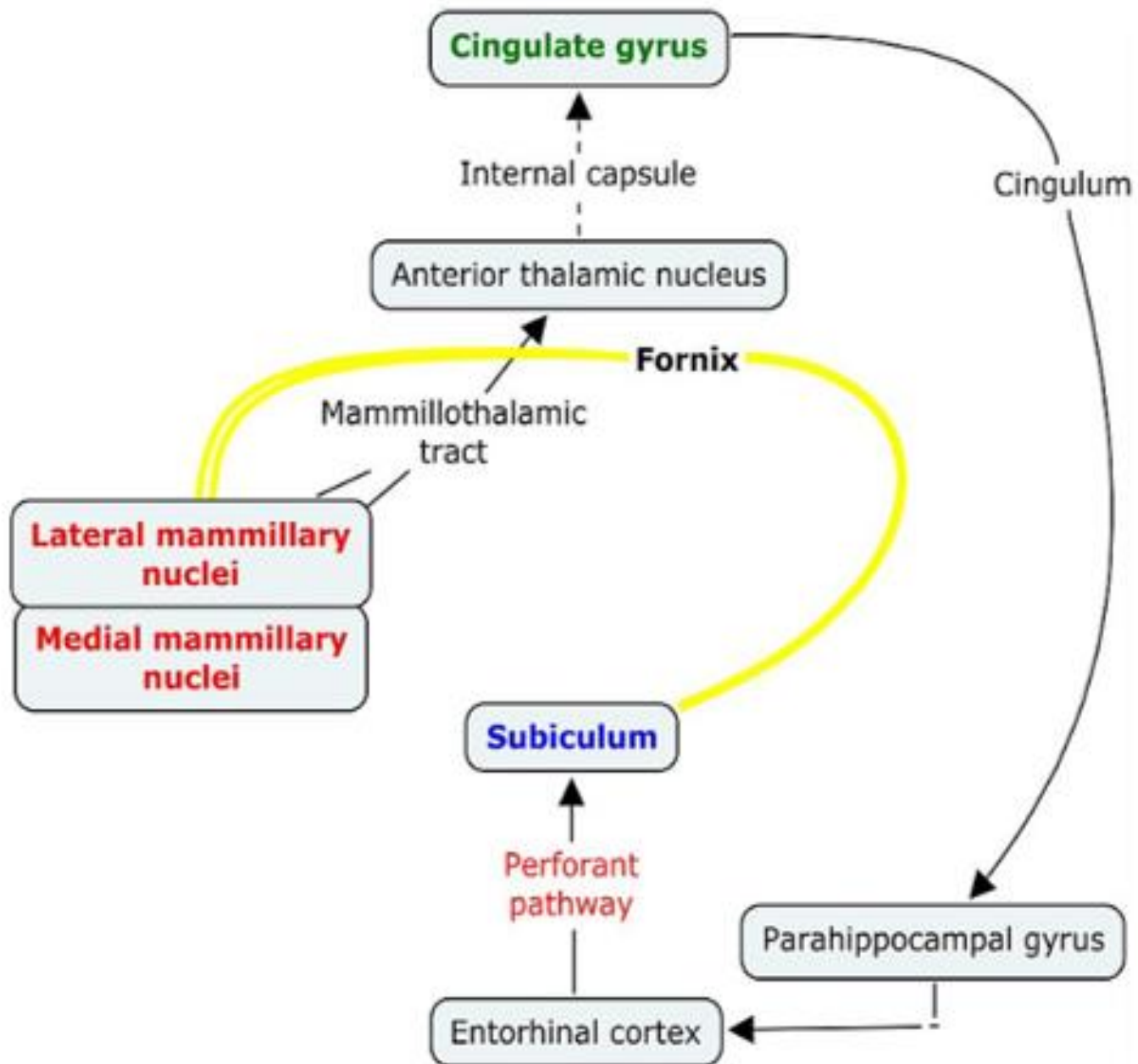
❖ The Papez Circuit included:

- The output from the **hippocampus** through the **fornix**.
- Termination of the **fornix** in the **mammillary bodies**.
- Outflow from the **mammillary bodies** through the **mammillothalamic tract** to the **anterior nucleus of the thalamus**.
- Projections from the **anterior nucleus** to the **cingulate gyrus**.
- Output from the **cingulate gyrus** back to the **hippocampus**.

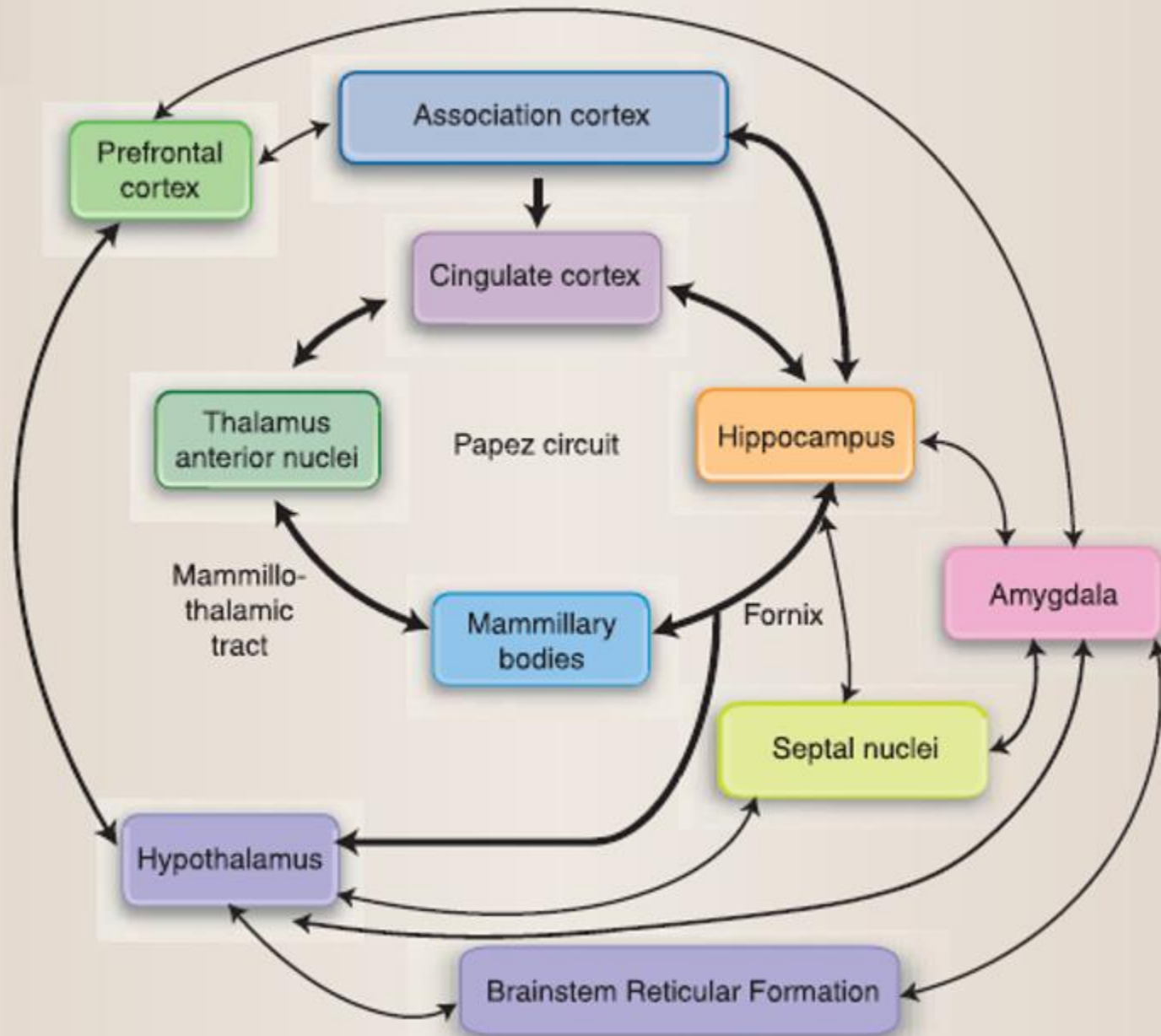
❖ **The clinical aspects of the Papez Circuit:** affected at an early stage of Alzheimer's disease.

The Papez Circuit





The Extended Papez Circuit



Lesions Associated With Limbic Lobe Disorders

- **Korsakoff's Psychosis Wernicke's-Korsakoff syndrome:**
Related to alcohol addiction

“Triad of ophthalmoplegia, ataxia, and confusion”

- **Eye signs:** nystagmus, ophthalmoplegia.
- **Ataxia:** cerebellar and sensory ataxia.
- **Cognitive changes:** amnesia and confusion.

- **Temporal lobe epilepsy:** Follow partial complex seizures **the hippocampus** In temporal lobe is a common focus site in epilepsy, and can be damaged through chronic seizures **“Hippocampal Sclerosis”**.

- **Viral Encephalitis:** as herpetic encephalitis. HSV-1

- **Limbic Encephalitis:** paraneoplastic encephalitis. Need IV Ig

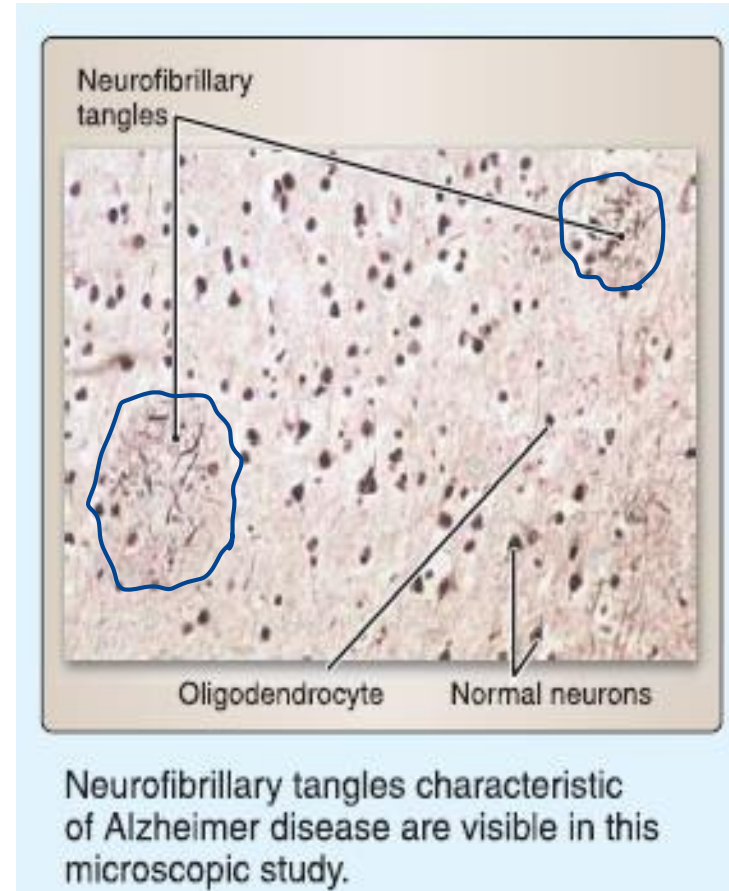
- **Alzheimer's Disease:** Degeneration The hippocampus is one of the first brain areas to show damage in Alzheimer's disease

- **Schizophrenia.** فصام

Alzheimer's Disease

- Is the most common dementia in the world and is characterized by neuronal loss and the presence of neurofibrillary tangles (abnormal tau protein) and amyloid plaques.
- It involves a gradual and progressive loss of both ^{Short} memory and cognitive function.
- The hippocampus and entorhinal cortex are among the first structures which involved in AD.

Microscopically



Alzheimer's Disease

- This is a serious neuro-psychiatric disease characterized by progressive loss of **short-term memory** followed by general loss of other brain functions.
- It is associated with progressive **degeneration** of **cholinergic nerve fibers** in the brain including the diffuse loss of the cholinergic projection between basal nuclei to the cerebral cortex, amygdala and hippocampus.
Loss of Ach → need cholinergis drugs to improve the symptoms not to stop the progression
- Anticholinesterase (cholinergic) drugs produce some improvement but it does **not** stop the progress of the disease.

Klüver-Bucy Syndrome

Bilateral damage of medial temporal lobe

- **Klüver–Bucy syndrome:** is a syndrome resulting from bilateral lesions of the medial temporal lobe (including amygdaloid nucleus).
- Memory loss and behavioral changes.
- They have an increased appetite, increased sexual activity, and visual agnosia.
- **Docility**, with unusually low aggression.
- **Klüver–Bucy syndrome** is more commonly found in monkeys, where the condition was first documented, than in humans.