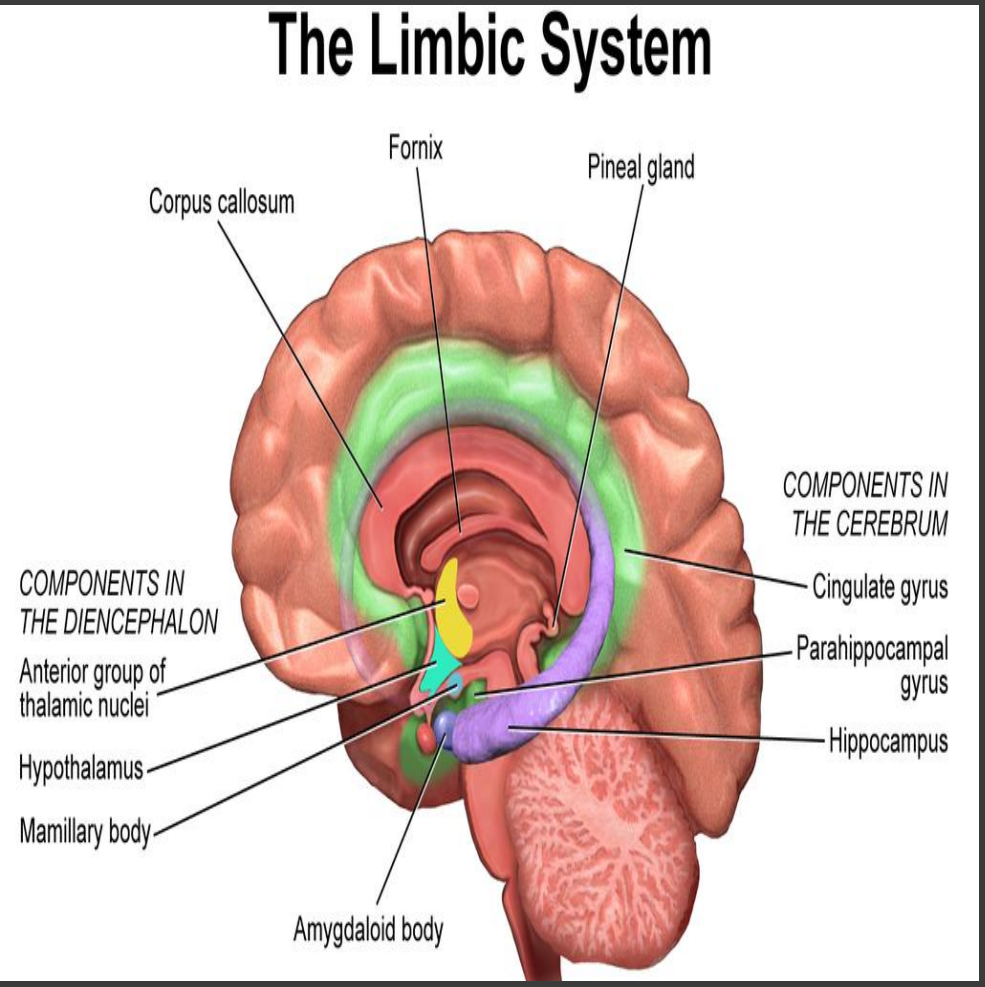
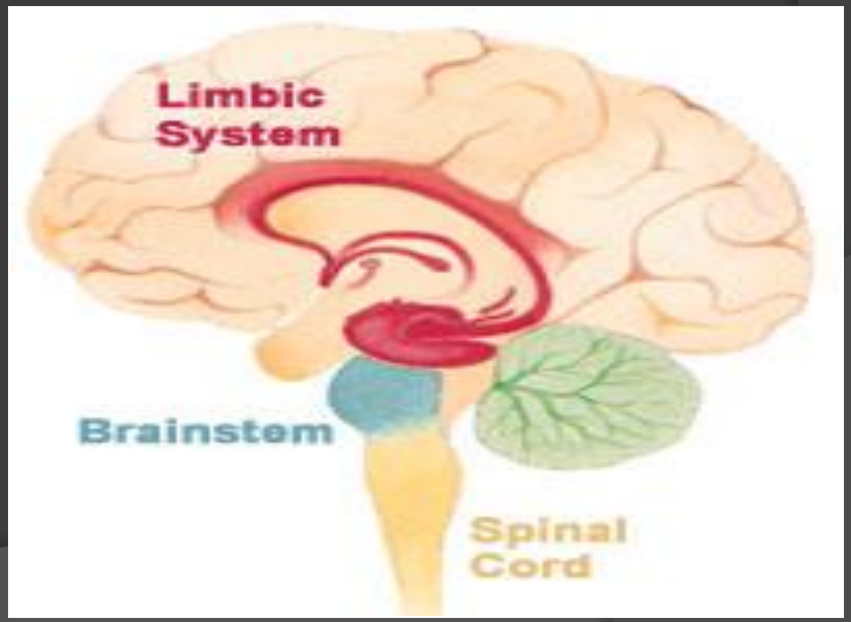


Thalamus & Limbic System



Prof. Saeed Abuel Makarem &
Dr.Sanaa Alshaarawy

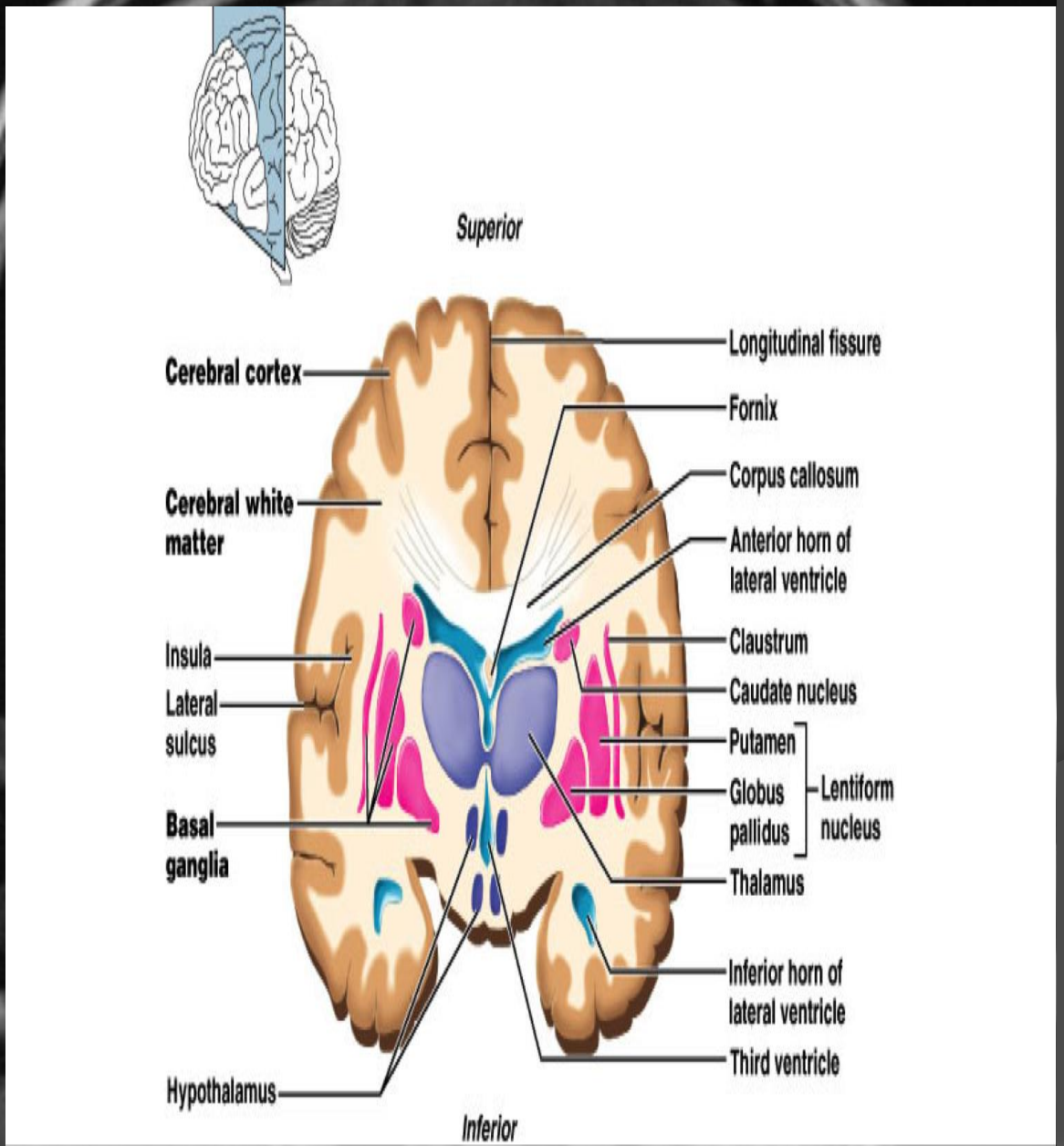
Objectives

By the end of the lecture, you should be able to:

- Describe the anatomy and main functions of the thalamus.
- Name and identify different nuclei of the thalamus.
- Describe the main connections and functions of thalamic nuclei.
- Name and identify different parts of the **limbic system.**
- Describe main functions of the **limbic system.**
- Describe the effects of lesions of the **limbic system.**

Thalamus

- It is the **largest nuclear mass** of the whole body.
- It is the **largest part** of the **diencephalon**
- It is formed of **two oval masses** of **grey matter**.
- It is the gateway to the cortex.
- Together with the hypothalamus they form the **lateral wall of the 3rd ventricle.**



Thalamus

•It sends the received information to the cerebral cortex from *diverse brain regions*.

• Axons from every sensory system **(except olfaction)** synapse in the thalamus as the **last relay site 'last pit stop'** before the information reaches the cerebral cortex.

•There are some thalamic nuclei that receive input from:

1. Cerebellar nuclei,
2. Basal ganglia- and
3. **L**imbic-related **brain regions**.

Relations

- ***It has 4 surfaces & 2 ends.***

Surfaces

Lateral:**(L)**

Posterior limb of the **internal capsule**

Medial:

The **3rd ventricle**

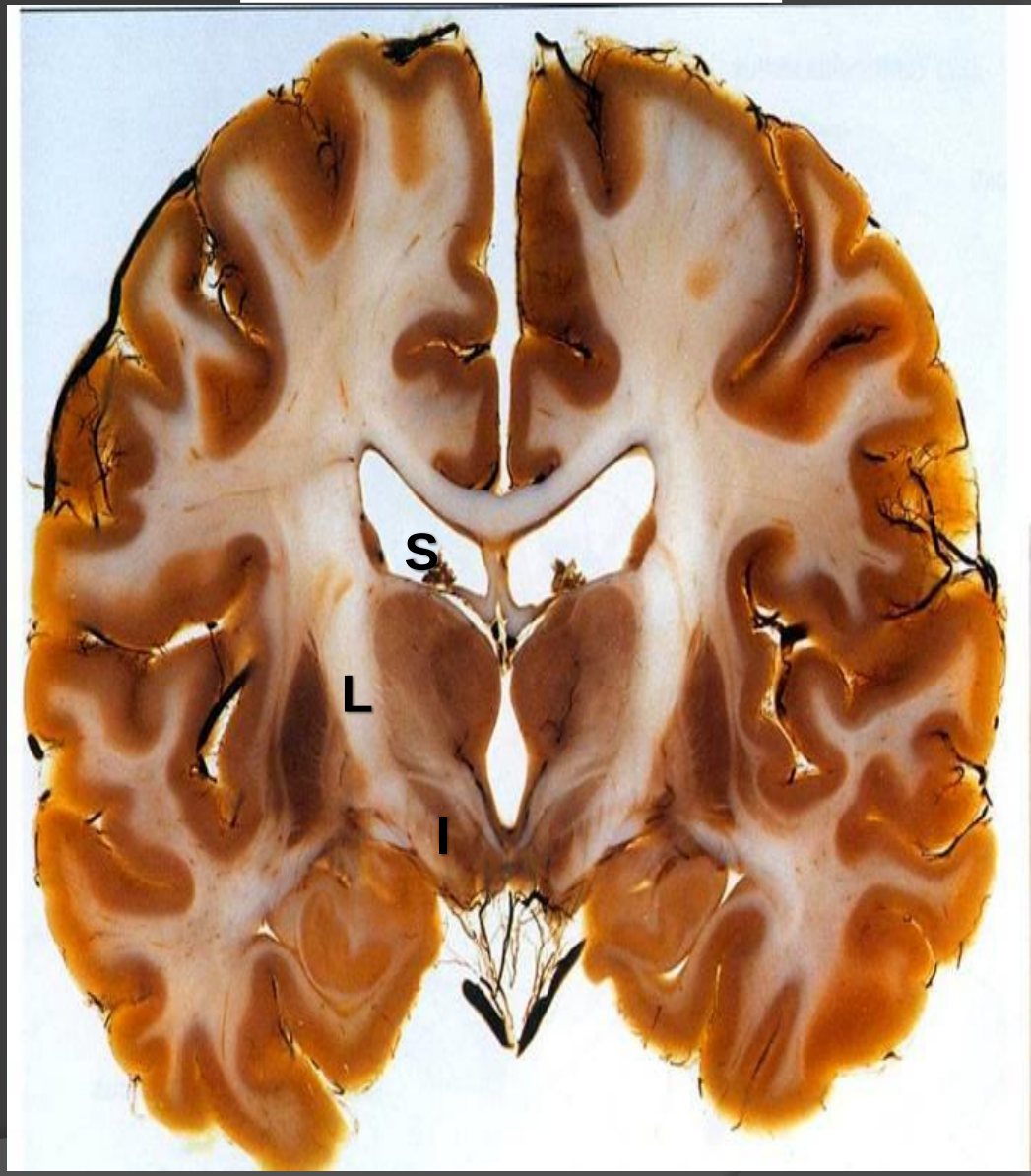
- It is connected to the thalamus of the opposite side by the **interthalamic** connexus, **(adhesion) or Massa intermedia.**

Superior: **(s)**

Lateral ventricle and **fornix**.

Inferior: **(I)**

Hypothalamus, anteriorly & **Subthalamus** posteriorly.



Coronal section

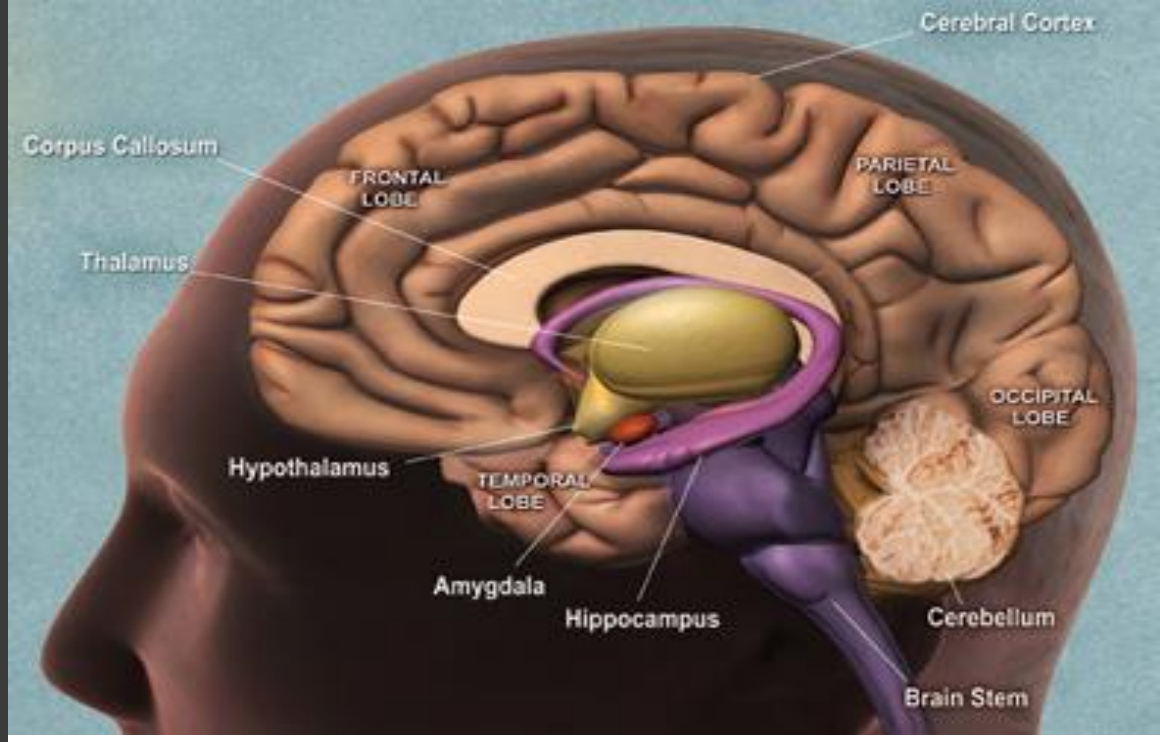
Anterior *end*:

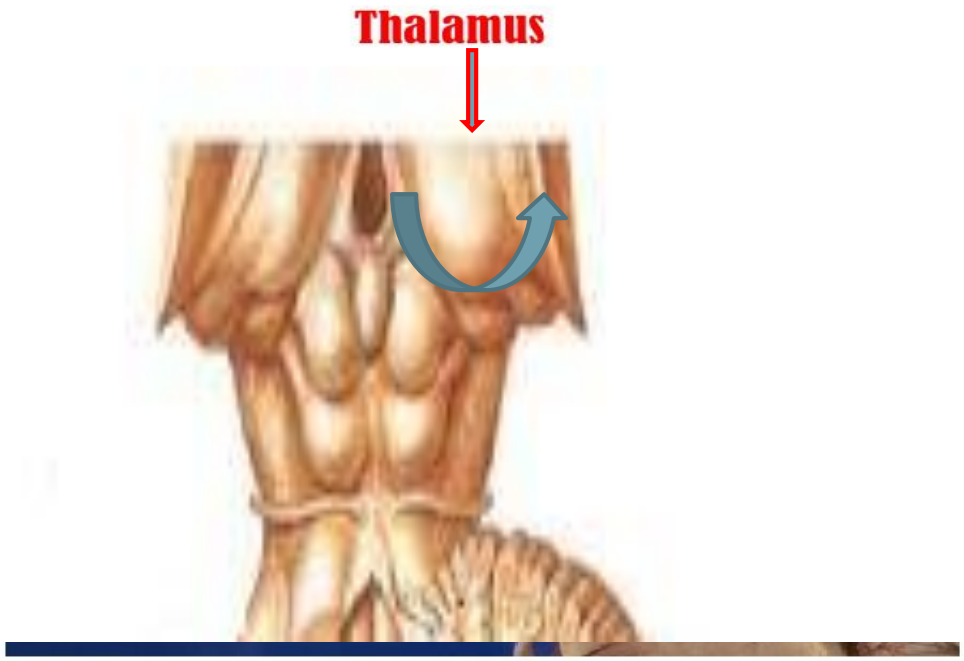
*Forms a projection, called the **anterior tubercle.***

*It lies just **behind** the interventricular foramen.*

Posterior *end*: *Broad*

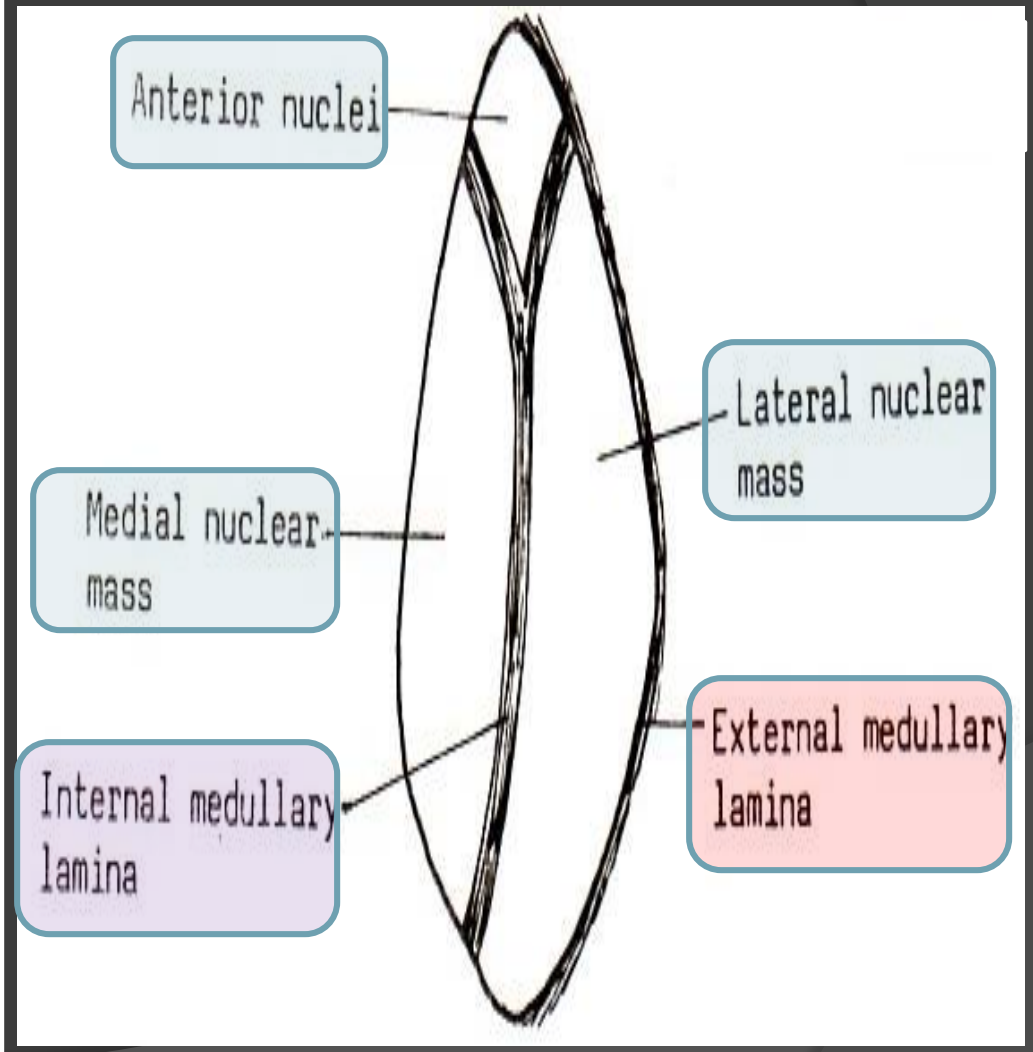
*Forms a projection called **Pulvinar** which lies **above** the superior colliculus and the lateral & medial Geniculate bodies.*





Internal Structure

- **White matter:**
  - ***External medullary lamina:***
  - Covers the lateral surface.
  - It consists of thalamocortical & corticothalamic fibers.
  - ***Internal medullary lamina:***
  - Bundle of Y- shaped myelinated (afferent & efferent) fibers.
  - It divides the thalamus into: **anterior , medial, lateral nuclear groups.**
  - Each of these groups is subdivided into a number of named nuclei.



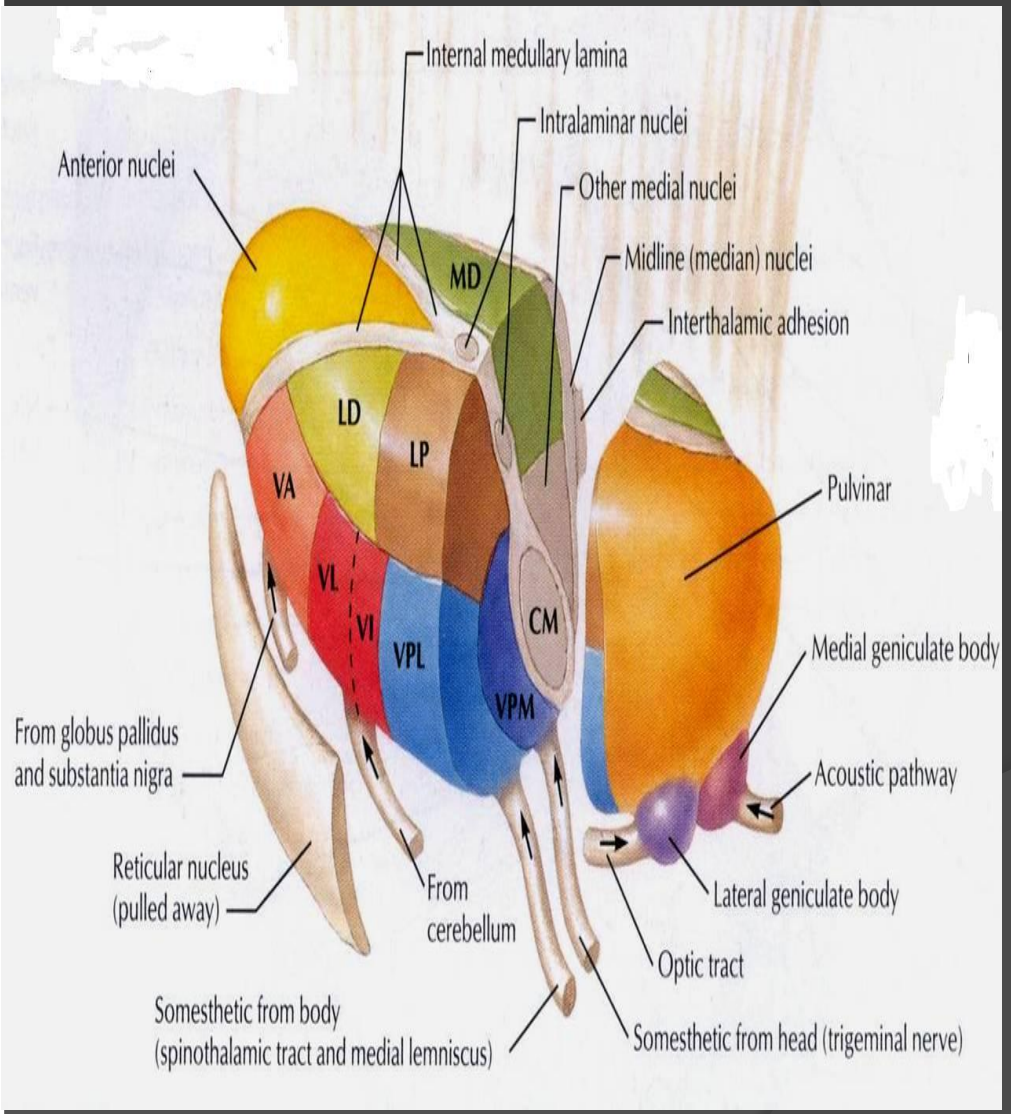
Lateral Nuclear Group

- It is divided into: Dorsal & Ventral tiers
- **Dorsal tier:**
- which contains:

1. Lateral Dorsal (LD)&
2. Lateral Posterior (LP)
3. Pulvinar.

- **Ventral tier,**
- which contains :

1. Ventral Anterior (VA)
2. Ventral Lateral (VL)
3. Ventral Intermediate (VI)
4. Ventral Posterior (VP) (PLVNT, PMVNT)
5. Lateral & Medial Geniculate nuclei.



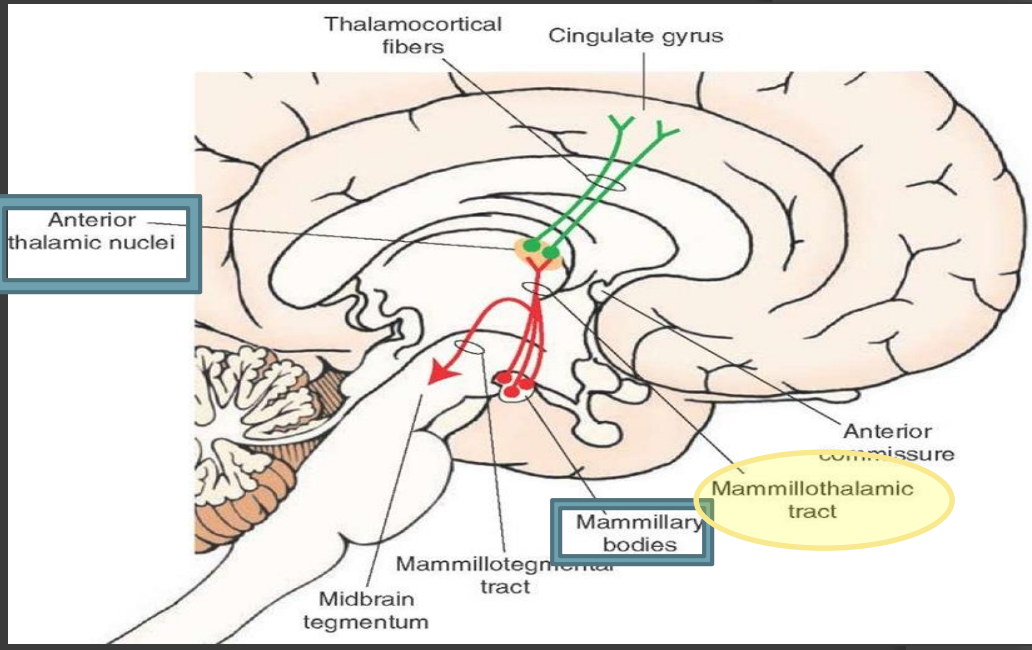
Projection of thalamic nuclei

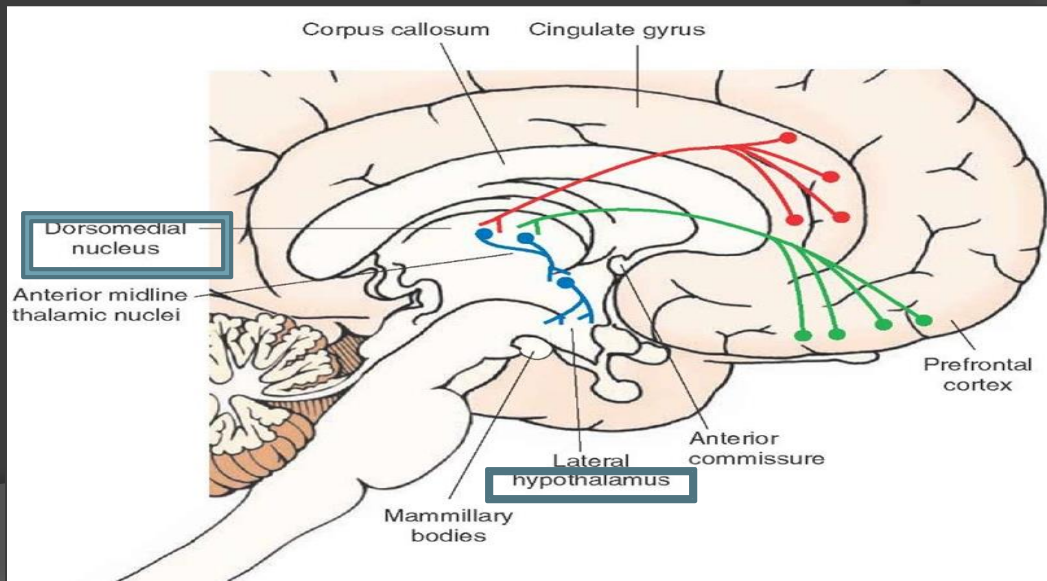
Anterior Thalamic Nuclei

- **Afferent:** Mammillary body.
- **Efferent:** Cingulate gyrus, (limbic system)
- ----------

Medial Nuclei

- **Afferent:** Hypothalamus.
- **Efferent:** Prefrontal cortex & Frontal.





Projection of thalamic nuclei

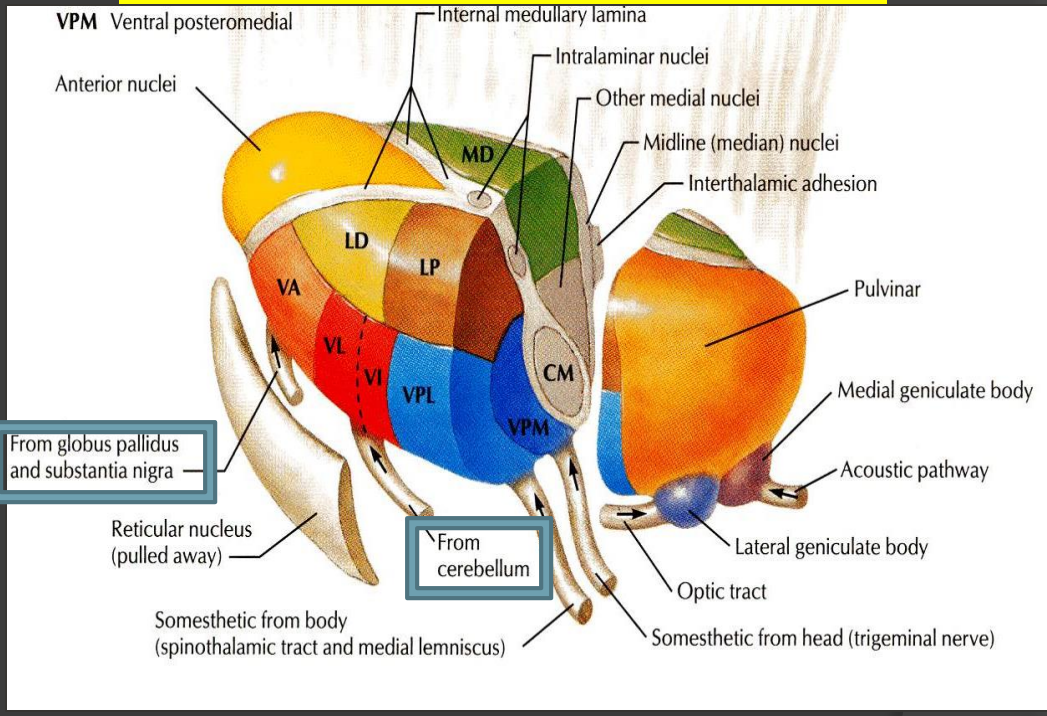
Ventral Anterior Nucleus

- **Afferent:** Globus pallidus body.
- **Efferent:** Premotor cortex.
- ----------

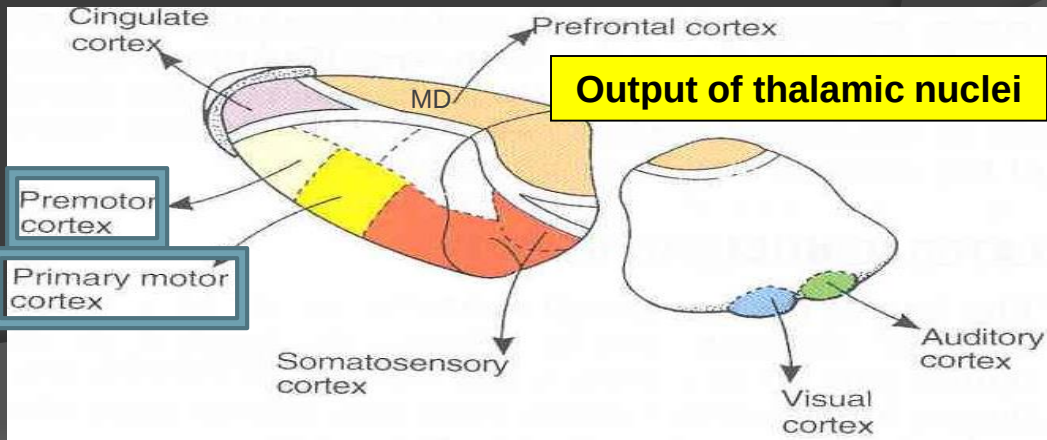
Ventral Lateral Nucleus

- **Afferent:** Dentate Nucleus
- **Efferent:** primary motor cortex.

Input of Ventral Thalamic Nuclei



Output of thalamic nuclei



Projection of thalamic nuclei

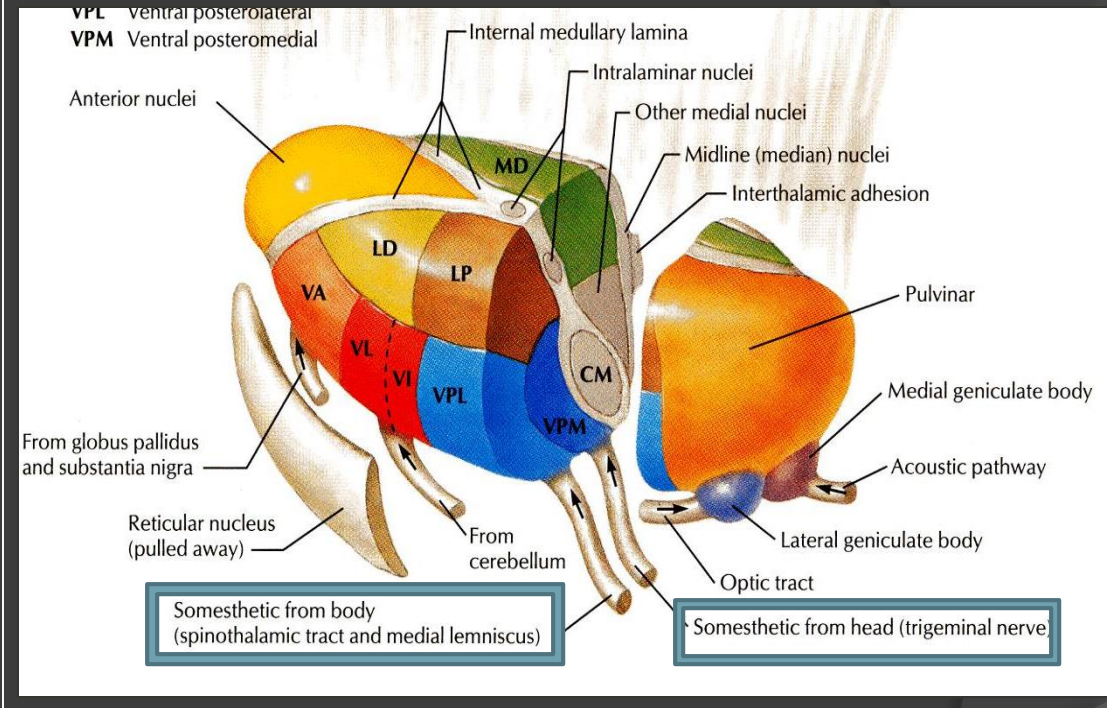
Ventral Posterior Lateral Nucleus

- **Afferent:** Medial and spinal leminsci.
- **Efferent:** Sensory cortex.
- ----------

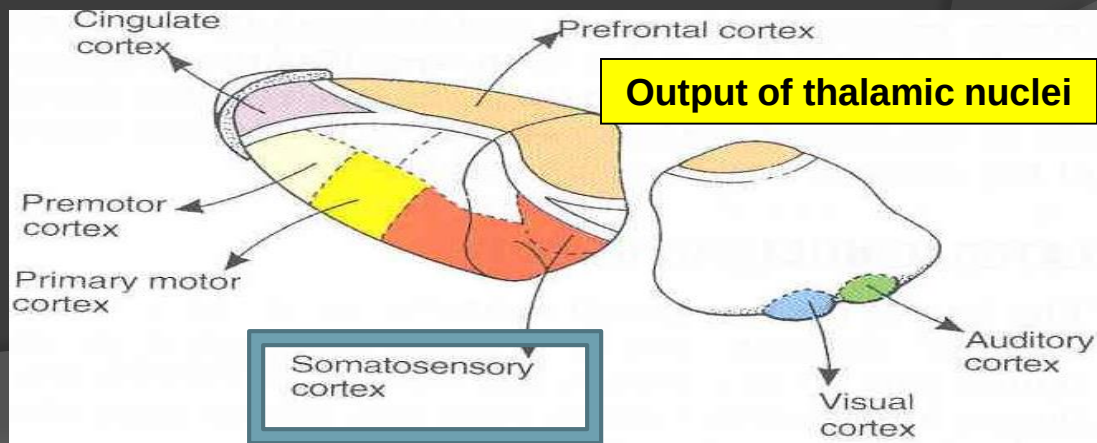
Ventral Posterior Medial Nucleus

- **Afferent:** Trigeminal Leminiscus
- **Efferent:** Sensory cortex.

Input of Ventral Thalamic Nuclei



Output of thalamic nuclei

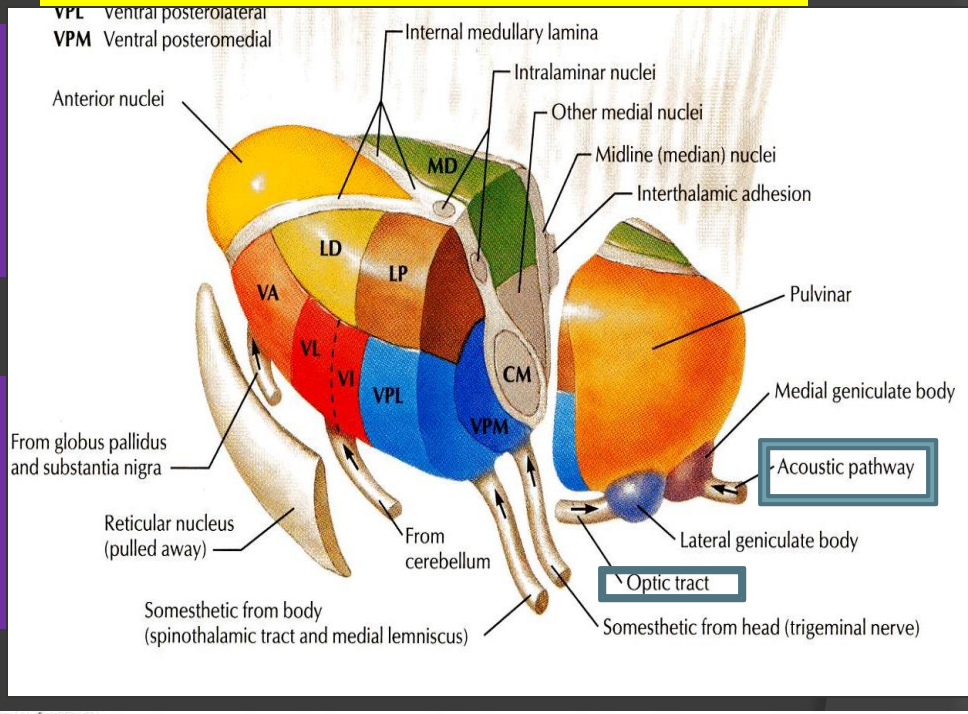


Projection of thalamic nuclei

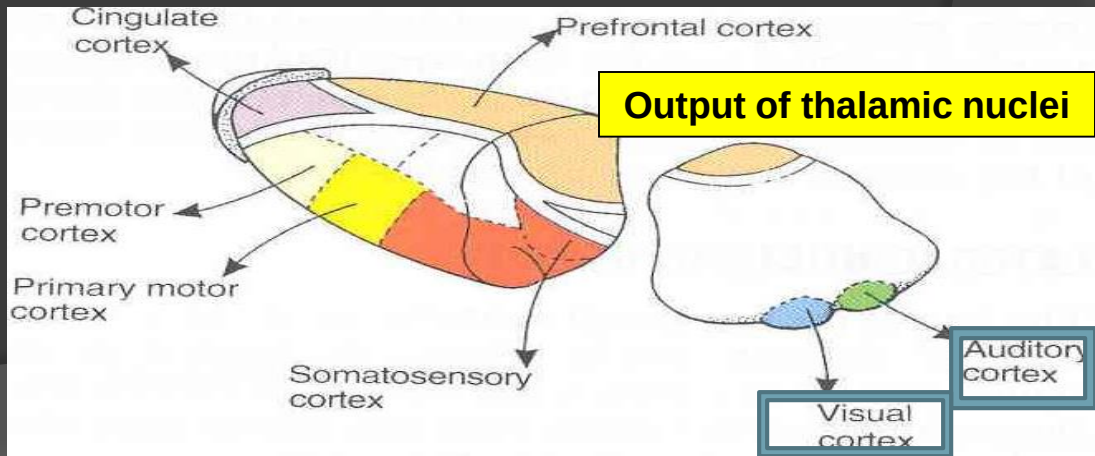
- **Lateral geniculate body :**
- **Afferent :** optic tract.
- **Efferent :** visual cortex

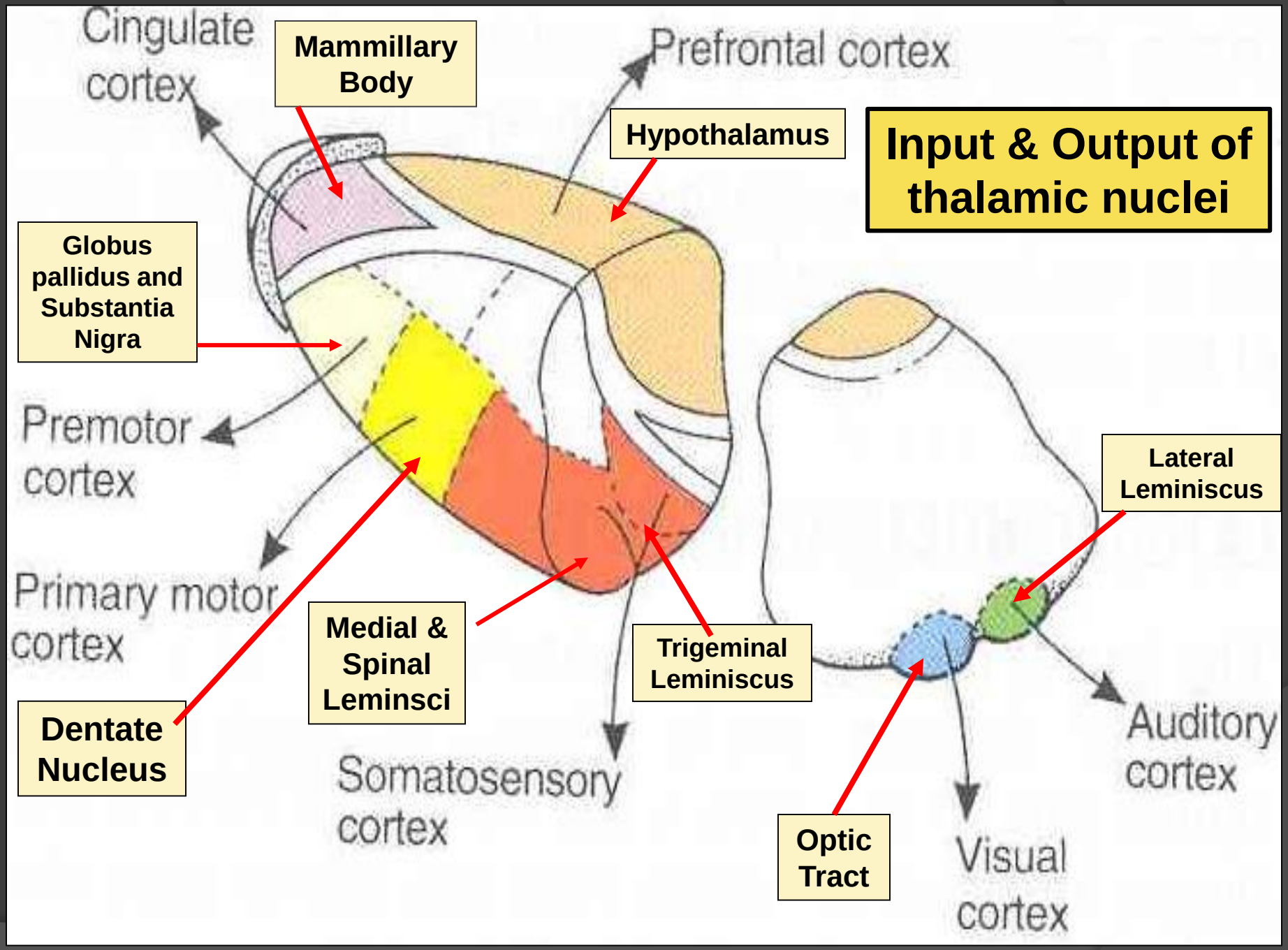
- **Medial geniculate body :**
- **Afferent :** lateral lemniscus.
- **Efferent :** auditory cortex.

Input of Ventral Thalamic Nuclei



Output of thalamic nuclei




Cingulate cortex
Mammillary Body
Prefrontal cortex
Hypothalamus
Input & Output of thalamic nuclei
Globus pallidus and Substantia Nigra
Premotor cortex
Primary motor cortex
Lateral Leminiscus
Medial & Spinal Leminsci
Trigeminal Leminiscus
Dentate Nucleus
Somatosensory cortex
Optic Tract
Visual cortex
Auditory cortex

LIMBIC SYSTEM

- The term "limbic" is from the Latin word ***Limbus***, for "border" or "**edge**".
- It separates the medial surface of the **cerebral cortex** from the **diencephalon**
- **It consists of** a number of **cortical** & **subcortical structures** with **looped connections** that all project to the **hypothalamus (particularly mammilary bodies)**.

WHAT IS THE FUNCTION OF THE LIMBIC SYSTEM?

It control a variety of functions including:

- **Emotions:**
- Emotional responses
- Behaviour & Mood (happy, cry, laugh, sad, afraid, aggression, depression)
- Motivation.
- **Memory.**
- **Visceral & Motor responses** involved in (sex, **pleasure**, hunger, and reproduction).
- **Olfaction.**

MEMORY

Pleasure sensation

The limbic system is composed of four main structures:

1. Limbic cortex (Lobe).

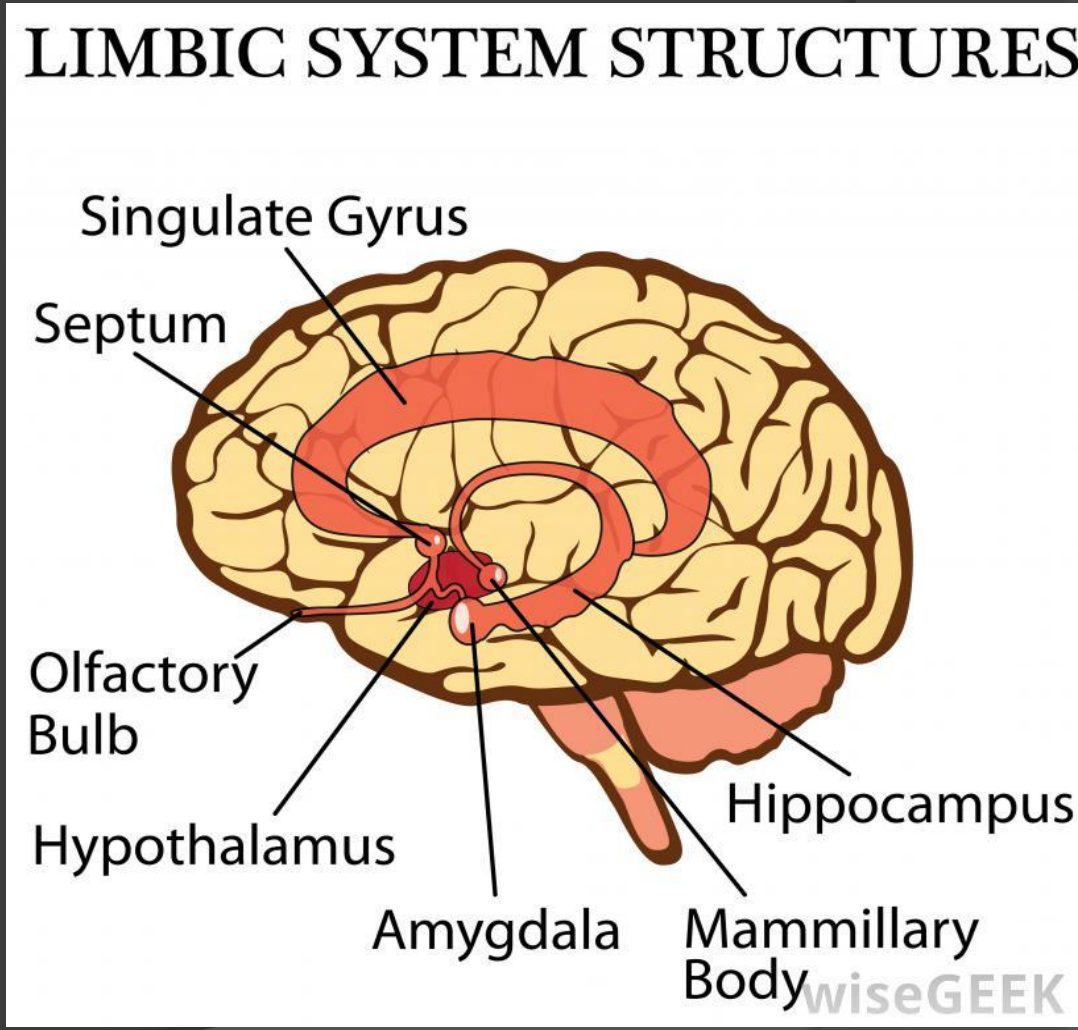
2. Hippocampus

3. Amygdala,&

4. Septal area.

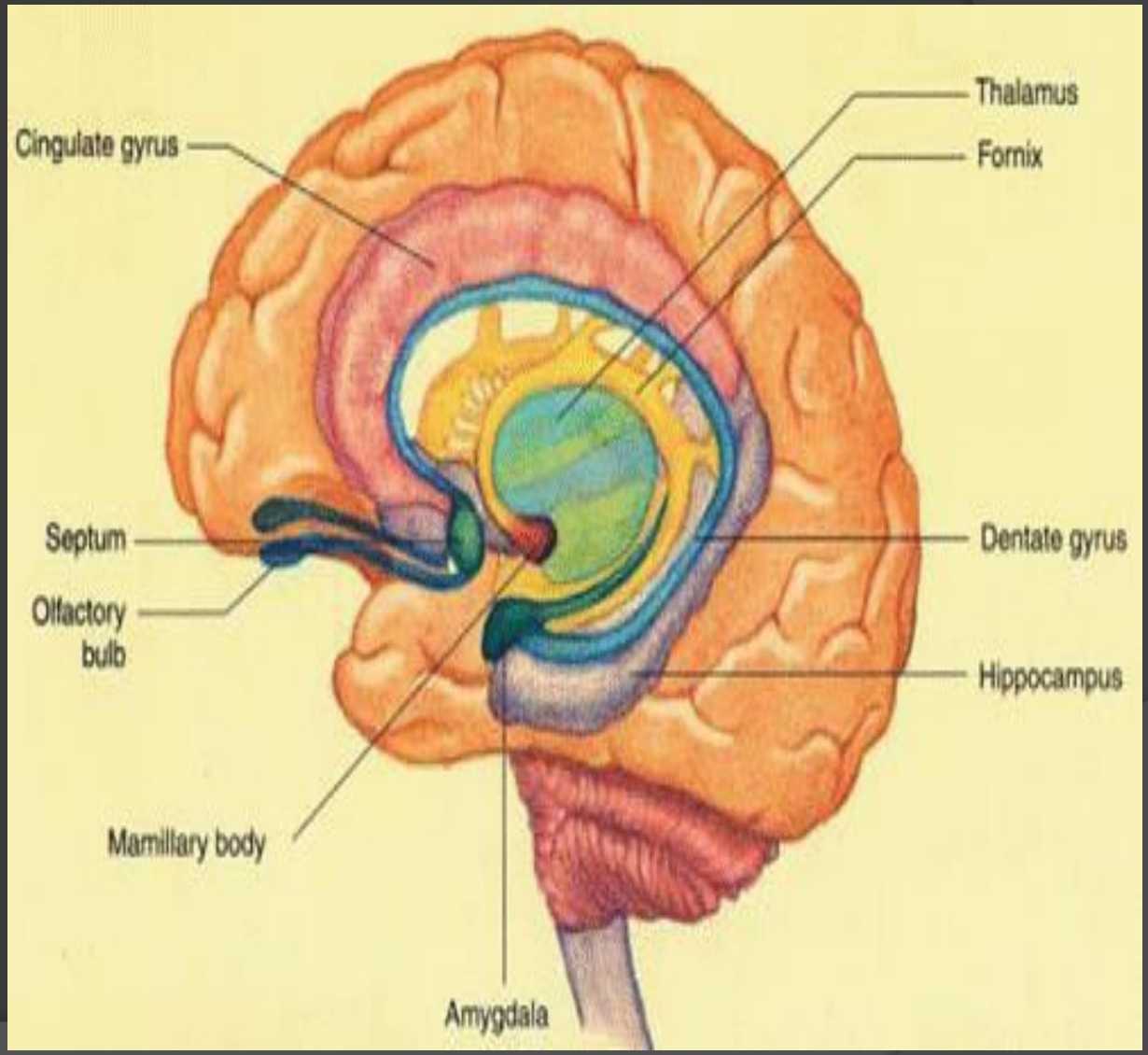
- These structures **form connections** between the hypothalamus, thalamus **and** cerebral cortex.
- The **hippocampus** is **important** in **memory** and **learning**, while the **limbic system itself** is important in the **control** of the **emotional responses**.

The limbic system is a set of brain structures including



CORTICAL STRUCTURES

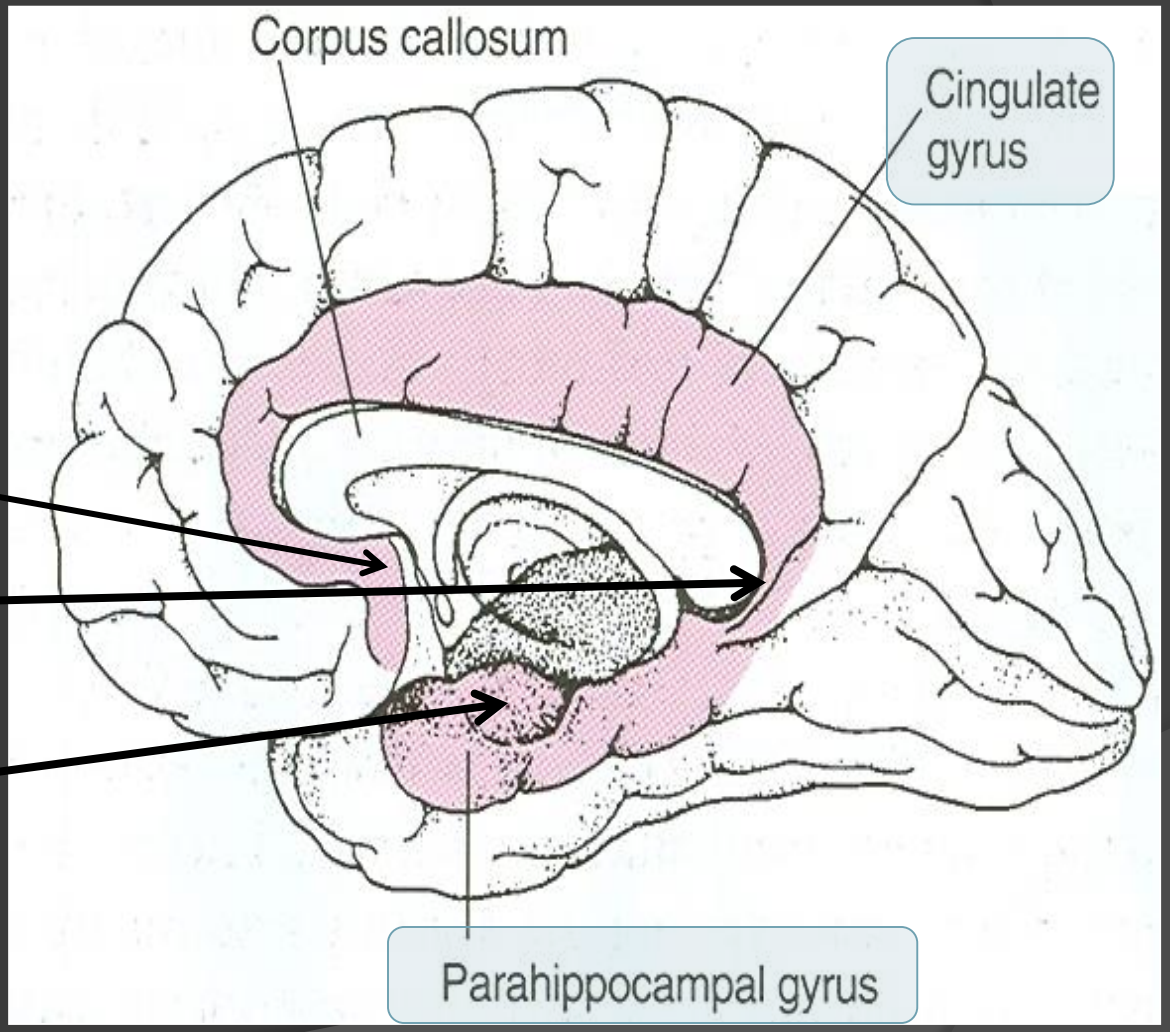
1. **Limbic lobe.**
2. **Hippocampal formation.**
3. **Septal areas.**
4. **Prefrontal area** (Olfactory cortex).



LIMBIC LOBE

- **C-shaped ring of grey matter** on the medial side of each cerebral hemisphere, surrounding the corpus callosum.
- **It includes:**

1. **Subcallosal area**
2. **Cingulate gyrus**
3. **Isthmus**
4. **Parahippocampal gyrus and the**
5. **Uncus.**



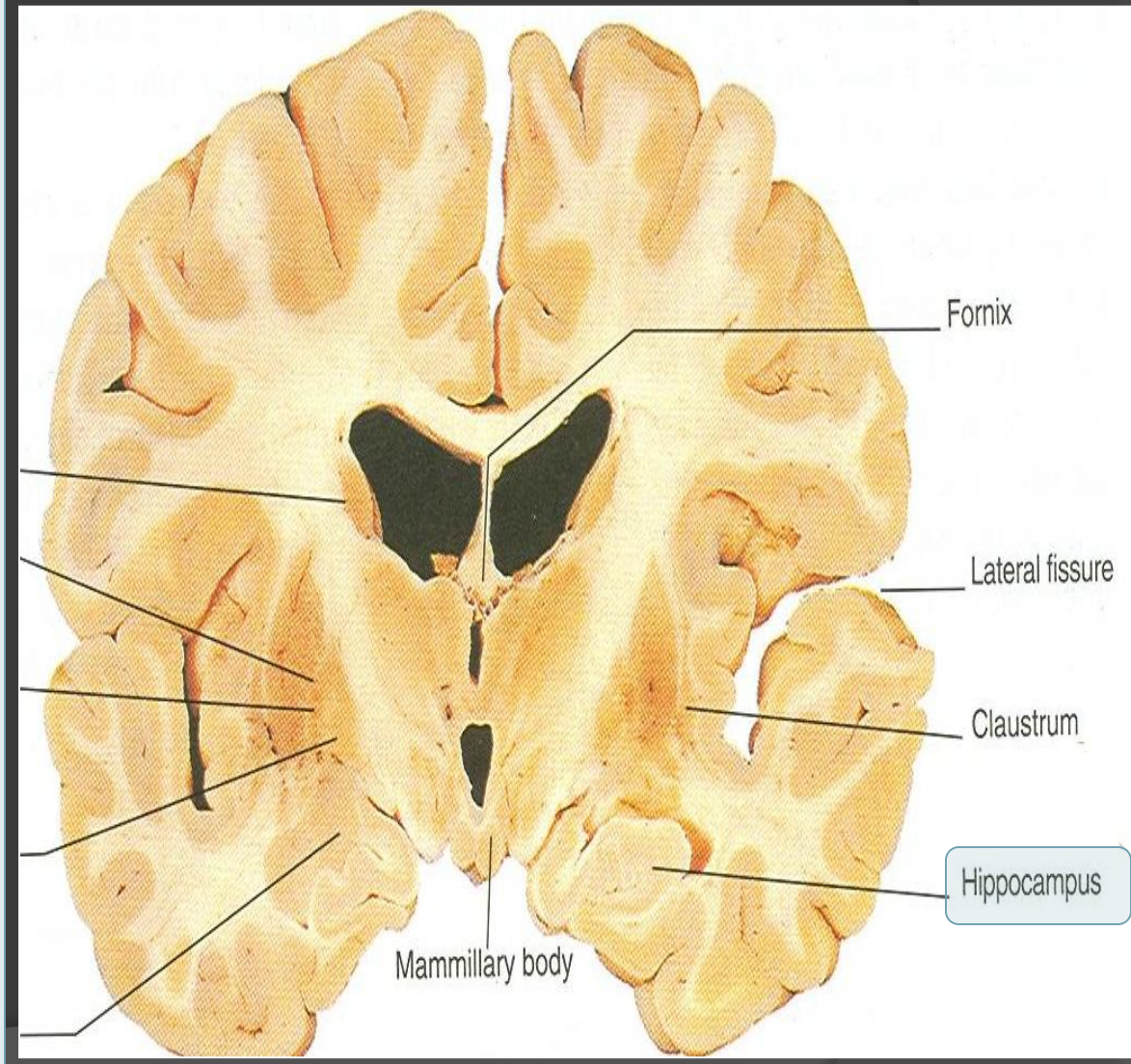
HIPPOCAMPUS

It is a **limbic system** structure that is involved in:
Formation,
Organization, and
Storing of **memories.**
It is important in **forming new memories** and connecting emotions and senses, such as smell and sound, to memories.

It is a horseshoe paired structure, one in each cerebral hemisphere.
It acts as a **memory indexer** by sending memories to the appropriate part of the **cerebral hemisphere** for **long-term storage** and **retrieving** them when necessary.

HIPPOCAMPUS

- **Site:**
- It is a scrolled **(infolding) inferomedial part of temporal lobe.**
- **Function:**
- **Memory (file new memories as they occur).**
- The hippocampus & its connections are necessary for ***consolidation*** of ***new short-term memories.***



HIPPOCAMPUS

- **Its** principal **efferent pathway** is called the:

FORNIX:

It is ***C-shaped group*** **of fibers** connecting the **hippocampus** with **mammillary body** and then to the **anterior nuclei of thalamus.**

It consists of:

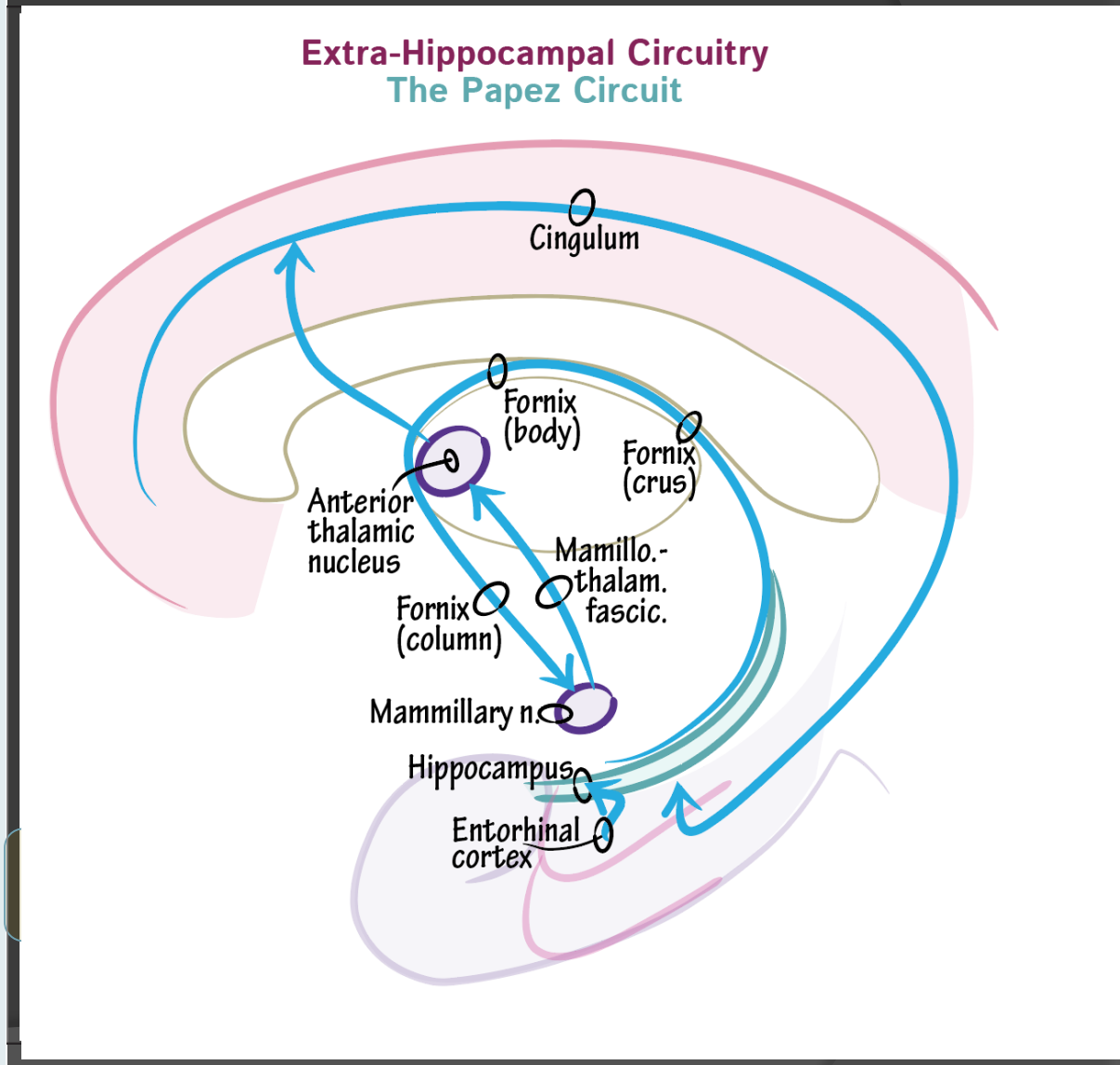
2 ***Fimbria,***

2 ***Crus,***

1 ***Body &***

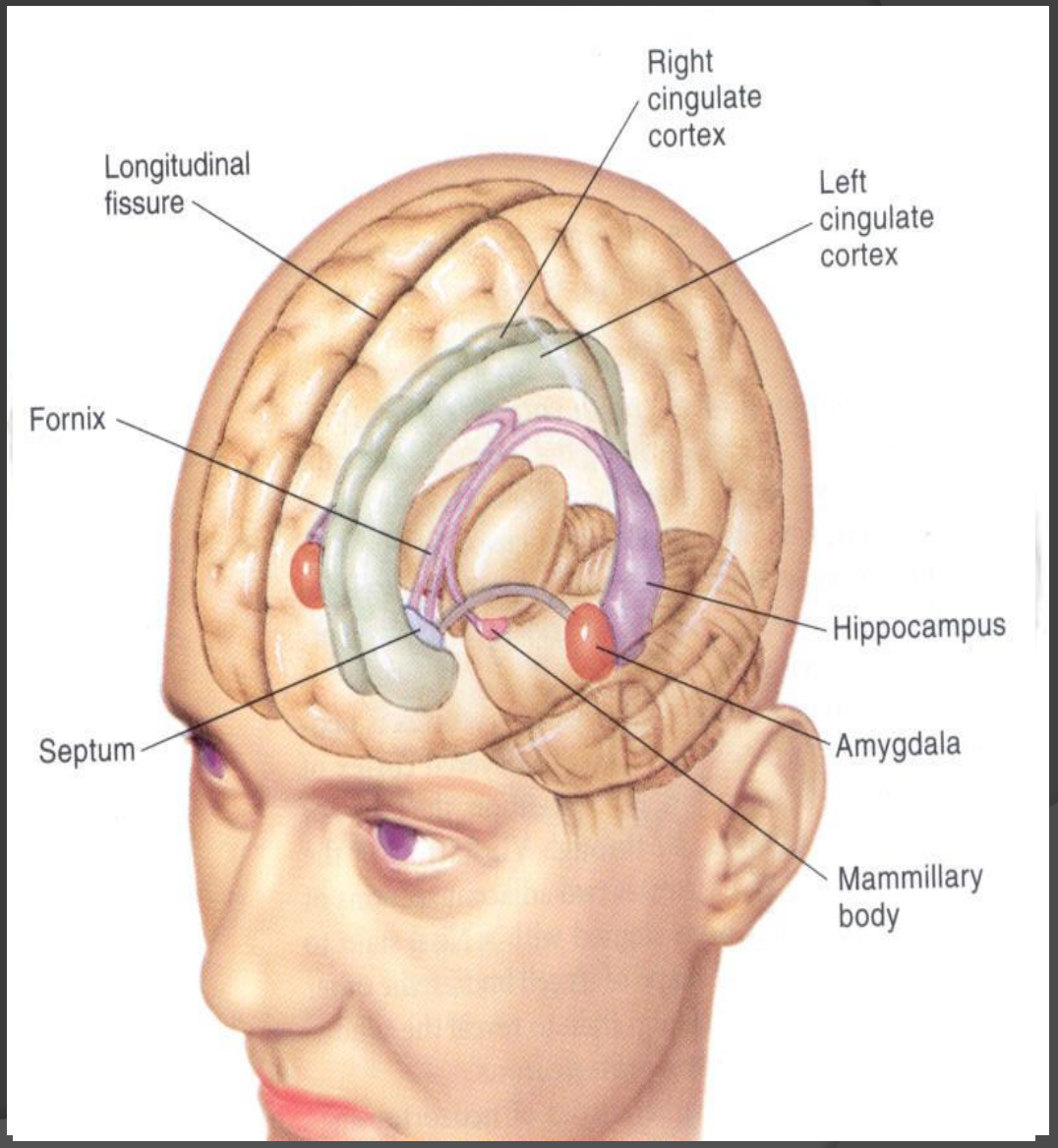
2 ***Column.***

- The **Fornix** is an **important component** of **PAPEZ CIRCUIT** (based on connecting the hypothalamus with limbic lobe to control emotions)



AMYGDALA

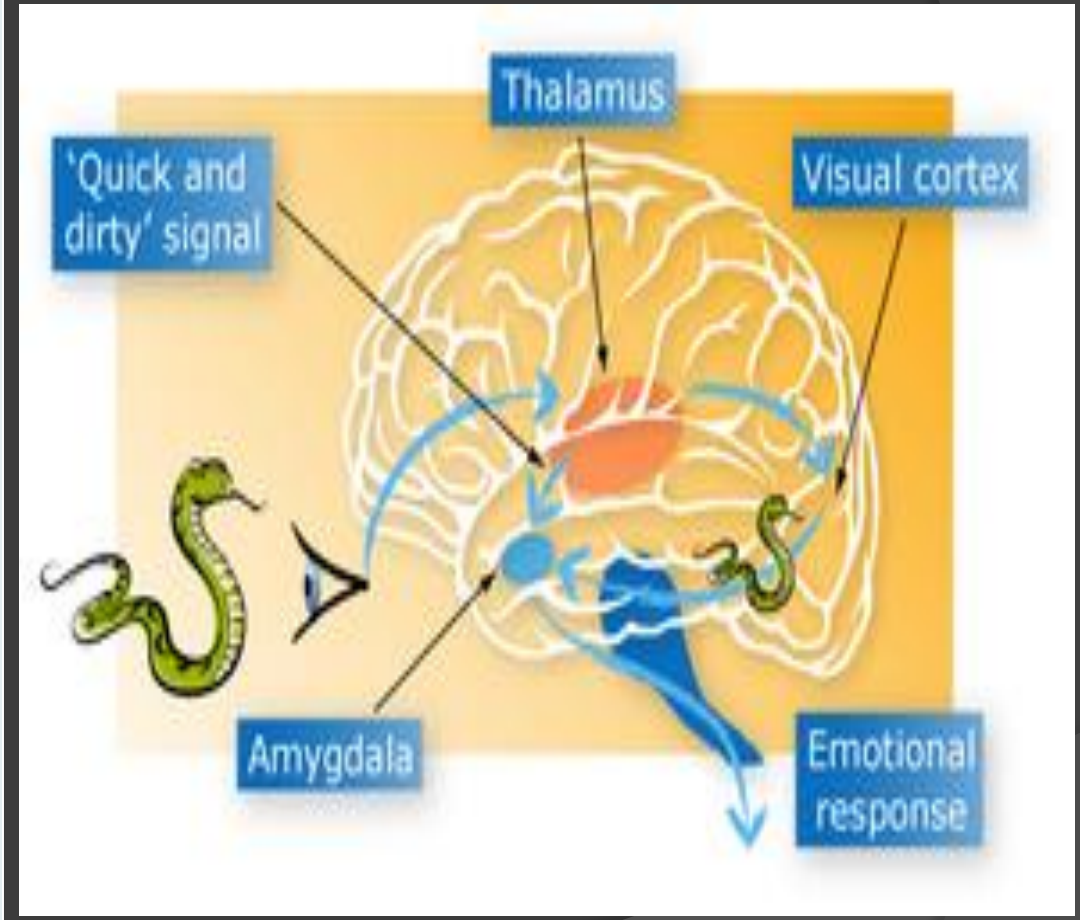
- **Site**:
- almond shaped **mass of nuclei** that lies **near the temporal pole**, deep within the temporal lobes ,close to the **tail of the caudate nucleus.**
- **Function:**
- **It is involved in**
- **Emotions :**
- **FEAR,**
- **Anger ; aggression &**
- **Hormonal secretions.**



CONNECTIONS OF **AMYGDALA**

- **Inputs:**
- **Association** areas of **visual**, **auditory** & **somatosensory cortices.**
- **Outputs**:
- **Hypothalamus** &
- **Autonomic nuclei** in the **brain stem**,
- **Lesion:**

  Lack of emotional responses & docility.



Septal nuclei

Site:

Located **anterior to** the interventricular septum (septum pellucidum).

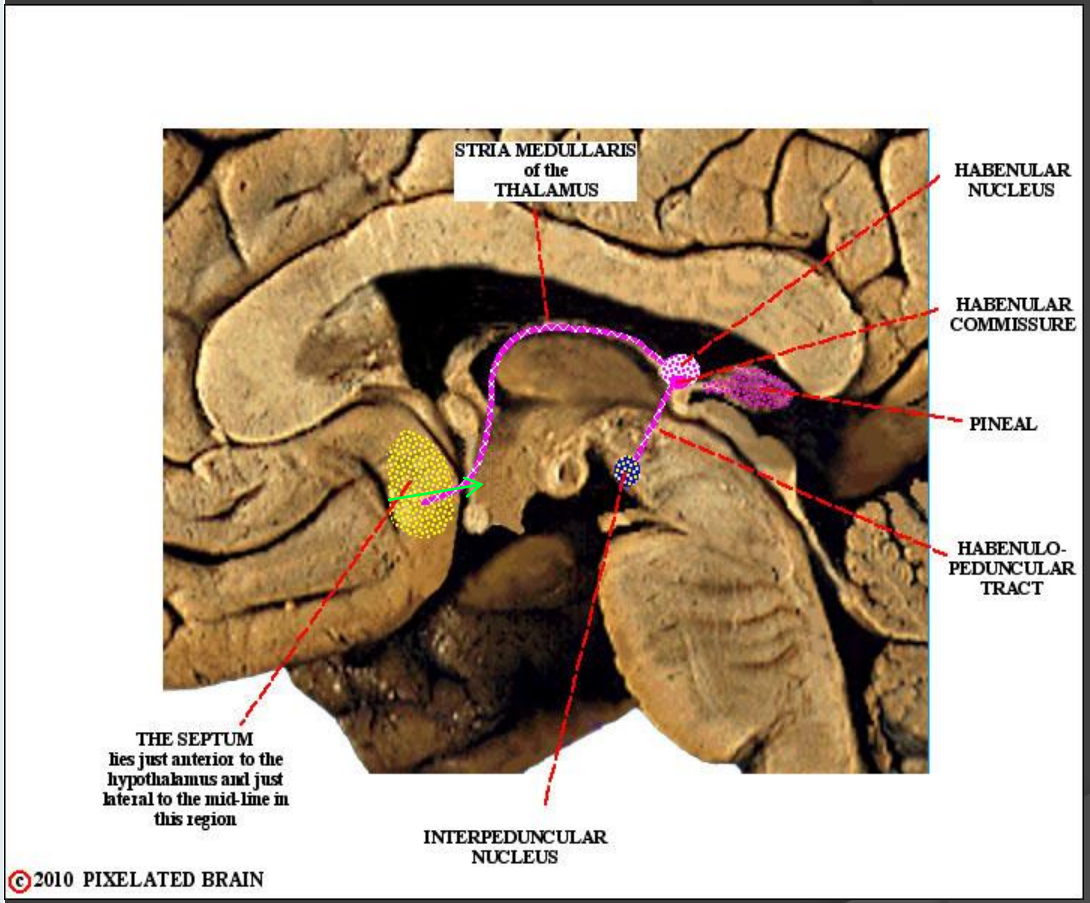
Main connections:

It sends projections:

1. To Hypothalamus
2. To Habenular nuclei

Function:

It is the **pleasure** zone.



Lesions associated with limbic lobe disorders

- **Korsakoff's psychosis :**
  Korsakoff syndrome is a chronic memory disorder caused by severe deficiency of thiamine (vitamin B-1) & alcoholic intoxication.
- **Inability to remember recent events and long-term memory gaps**
- **(Retrograde** = loss of retained old memories occurred before the injury **&** **(anterograde amnesia**= inability to gain new memories).
- **Temporal lobe epilepsy**
- The **hippocampus** is a common focus site in **epilepsy**, and can be damaged through **chronic seizures.**
- It is **sometimes damaged** in diseases such as **herpes encephalitis,**
- **Alzheimer's disease**: **hippocampus** is one of the first brain areas to show **damage** in Alzheimer's disease.**Anterograde amnesia** —the inability to form and retain new memmories.
- **Schizophrenia. (mental disorder with inappropriate actions and feelings).**


THANK YOU