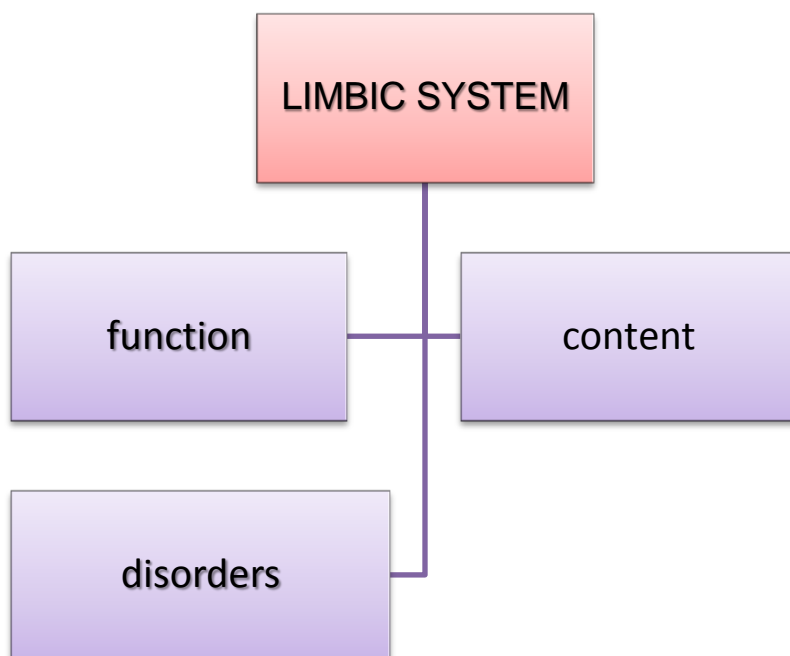
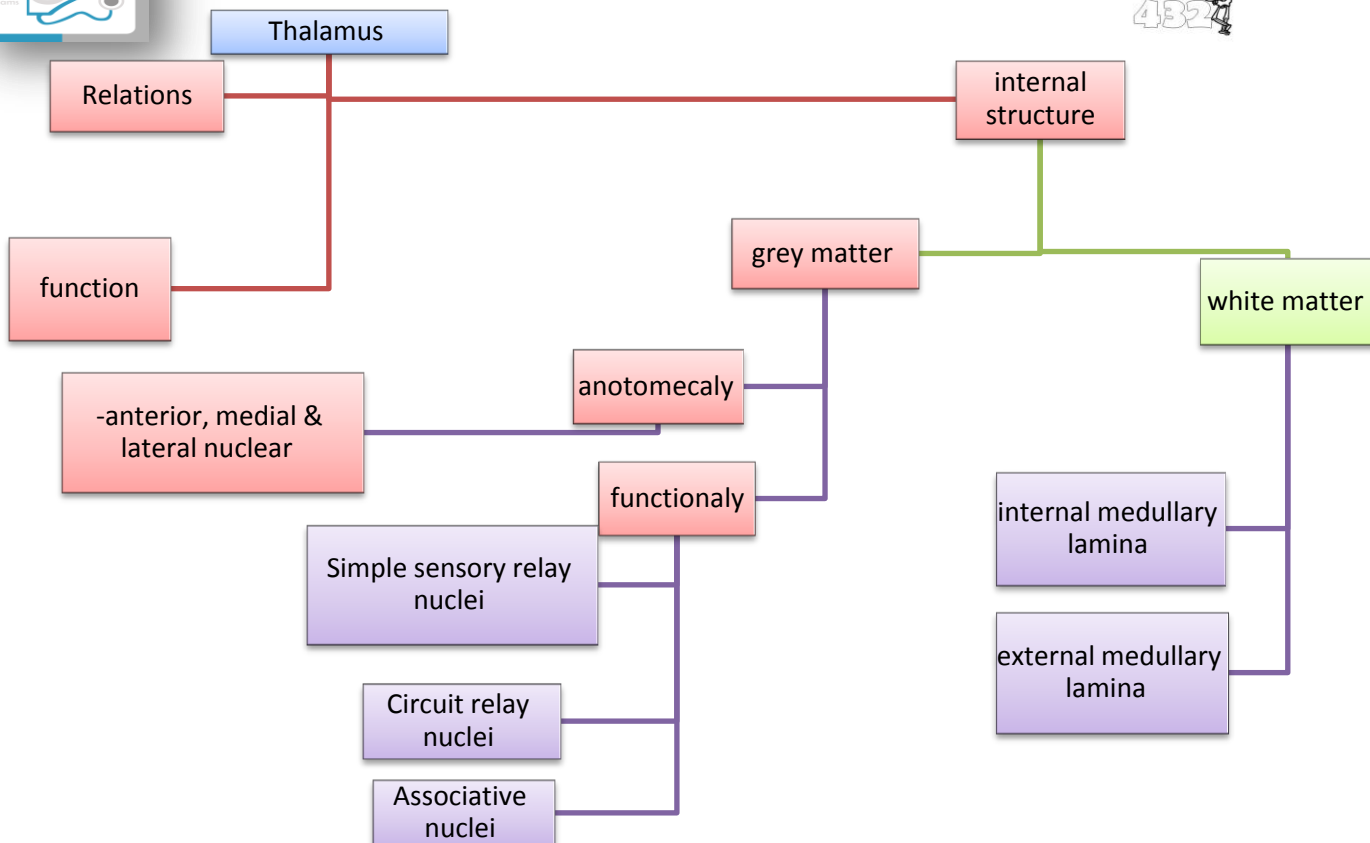




Objectives:

By the end of the lecture, the student 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





First: The thalamus system:

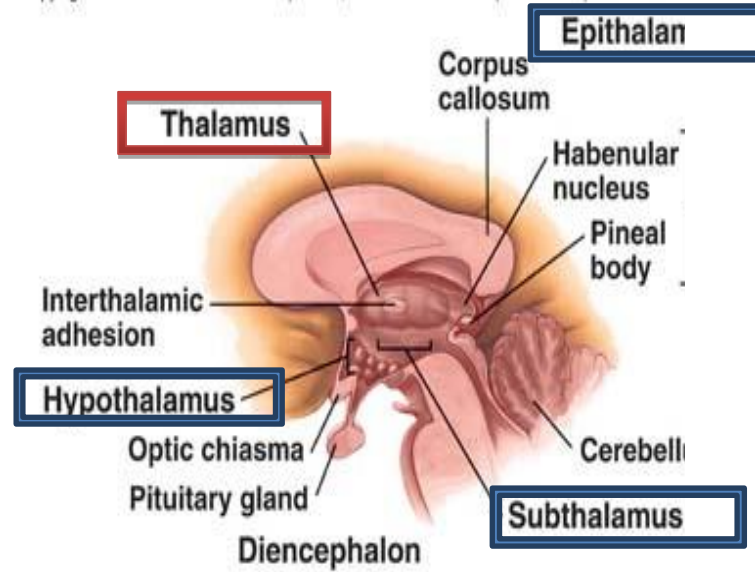
THALAMUS

Overview:

- It is the largest part of the **diencephalon**
- It is the **largest nuclear mass** of the whole body.
- It is formed of **two oval masses of grey matter**.
- It is the **gateway** to the sensory cortex.
- It resembles a small **hen** (hen means egg: because it has anterior tapering head (مستدق) and posterior broad head).
- Together with the hypothalamus they form the **lateral wall of the 3rd ventricle**
- It relays and sends received information to the cerebral cortex.
- Axons from every sensory system (**except olfaction**) synapse in the thalamus as the last relay site '**last stop**' before the information reaches the cerebral cortex.
- There are some thalamic nuclei that receive input from:
 1. Cerebellar nuclei,
 2. Basal ganglia
 3. Limbic brain regions.



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Relations

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

4 Surfaces	
Superior: Fornix ,Caudate nucleus and lateral ventricle. (s).	
Medial: The 3 rd ventricle. It is connected to the thalamus of the opposite side by the interthalamic connexus= interthalamic adhesion= Massa intermedia . (See the pic below)*	Lateral: Posterior limb of the internal capsule (L).
Inferior: (see the pic in page #3) Anteriorly: Hypothalamus Posteriorly: Subthalamus.	



2 Ends

Anterior end:

Forms a projection, called the anterior tubercle of thalamus

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

Posterior end:

Forms a **projection called Pulvinar** which lies **above the superior colliculus and the lateral & medial Geniculate bodies.** (Both medial and lateral geniculate body are called metathalamus)



Internal structure

White matters	
ž <u>External medullary lamina:</u>	ž <u>Internal medullary lamina:</u>
<ul style="list-style-type: none"> ▪ Covers the lateral surface of the thalamus. ▪ separating the reticular nucleus from the rest of nuclei. ▪ It consists of thalamocortical & corticothalamic fibers. 	<ul style="list-style-type: none"> ▪ 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.

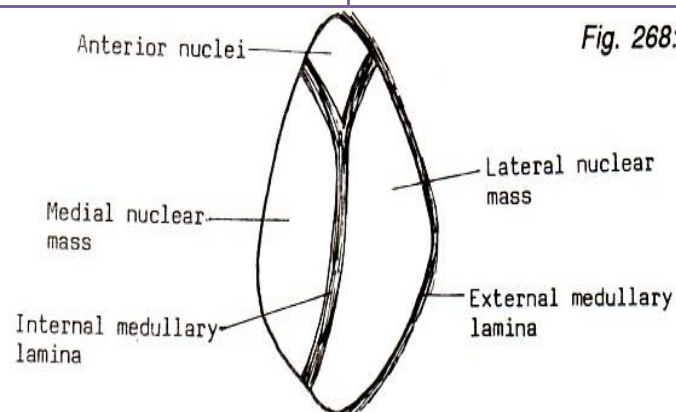
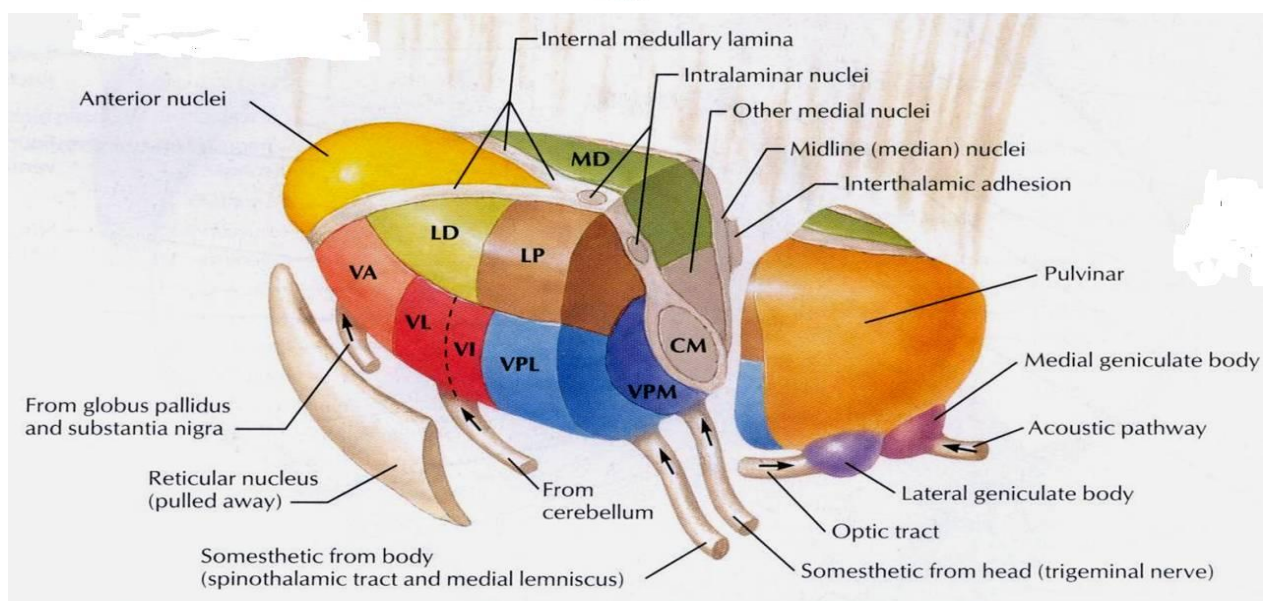


Fig. 268:



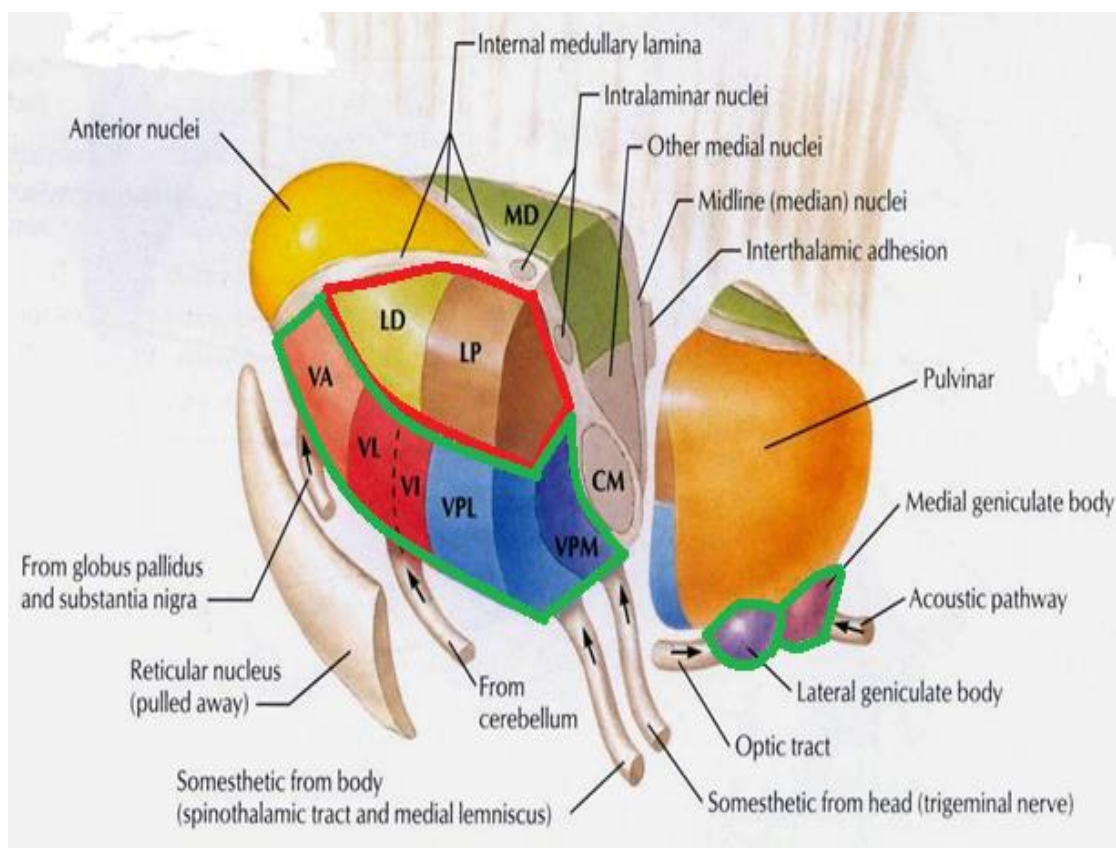


Lateral Nuclear Group: It is divided into: **Dorsal & Ventral tiers**

<i>Dorsal tiers</i>	<i>Ventral tiers</i>
<u>which contains:</u> <ol style="list-style-type: none">1. Lateral Dorsal (LD)2. Lateral Posterior (LP)3. Pulvinar.	<u>which contains:</u> <ol style="list-style-type: none">1. Ventral Anterior (VA)2. Ventral Lateral (VL) (also called ventral intermediate)3. Ventral Posterior (VP) (:which divide into ventral posterior lateral and ventral posterior medial) (PLVNT, PMVNT)4. Medial geniculate N.5. Lateral geniculate N.

PLVNT: posterior lateral ventral nuclei tire

PMVNT: posterior medial ventral nuclei tire





Functional Organization of Thalamic Nuclei

- All thalamic nuclei project to the **ipsilateral** (same side) cerebral cortex **EXCEPT reticular nucleus**. (which doesn't project to the cortex but it goes to other thalamic nuclei or reticular formation, and it's found in the **anterior group**)
- **Precise Point to Point projections** sometimes found between individual thalamic nuclei and restricted cortical zones.
(Precise Point to Point projections also called: **(reciprocal innervation)** (which the thalamic nuclei project to an area in the cortex in this area also send fibers to the same thalamic nuclei)
- This type of nuclei are called '**Specific nuclei**'
- All specific nuclei lie within the **ventral tier of the lateral nuclear group**.



Classification of thalamic nuclei according to their projection:

They could be classified into **3 groups** each contains **4 nuclei, (12 nuclei)**.

A) Simple Sensory Relay Nuclei

Very important!!!

They receive **sensory impulses**, and relay them to the sensory cortex. (Post central gyrus)

nucleus	Afferent fiber (AFF)	(Efferent fiber) EFF	Functions
posterolateral ventral nucleus (PLVN)	Medial & Spinal lemnisci *	sensory cortex	Receive sensory information for pain, temperature and touch from the whole body
Posteromedial ventral nucleus (PMVN)	Trigeminal lemniscus	Sensory cortex	Receive sensory information for pain, temperature and touch from the face and anterior part of scalp
lateral geniculate body (LGB)	Optic tract	Optic radiation and visual cortex	Visual sensation
medial geniculate body (MGB)	Lateral lemniscus	Auditory radiation and auditory cortex	Auditory sensation

* Medial lemniscus : formed by gracile and cuneatus

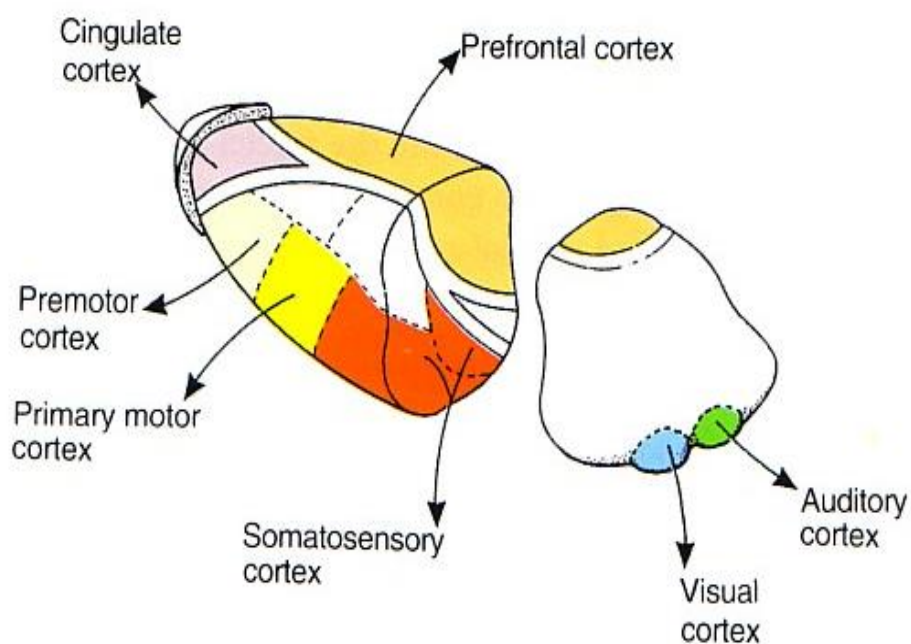
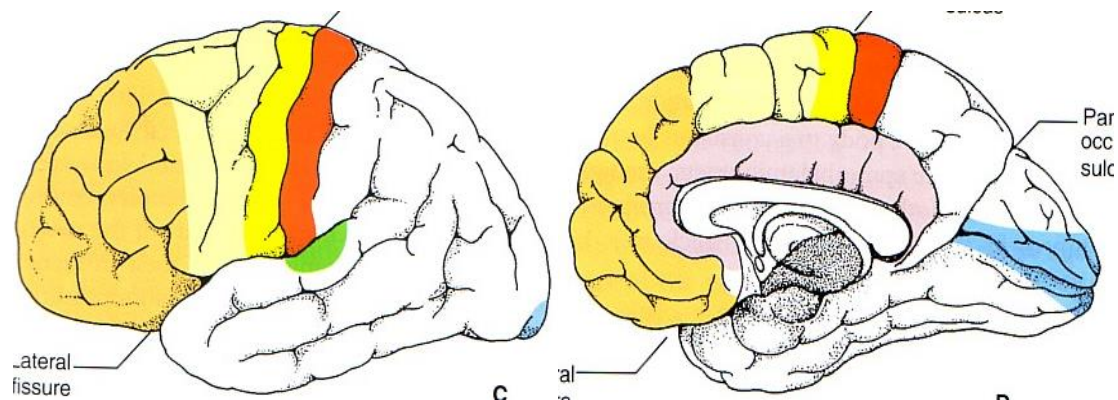
Spinal lemniscus: formed by ventral and lateral spinothalamic tracks



B) Circuit relay nuclei:

They receive impulses from different areas of CNS and relay them to specific areas in cerebral cortex, they include:

- 1. Lateral ventral nucleus (primary motor cortex).**
- 2. Anterior ventral nucleus (premotor cortex).**
- 3. Anterior nucleus (cingulate gyrus) Limbic System.**
- 4. Part of dorsomedial nucleus.**





C) Associative nuclei:
They receive impulses from other thalamic nuclei then send processed information to the association areas of the cerebral cortex,
They include:

1-Part of dorsomedial nucleus.

2- Pulvinar

3- Lateral dorsal nucleus.

4- Lateral posterior nucleus.

Note: prof. Saeed said: The **blue** one in the schedule below is **very very important**

Functional Organization of the Thalamic nuclei

Nucleus	Function	Inputs (AFF)	Outputs (EFF)
Anterior	Association	Mamillary body & Hippocampus	Cingulate cortex
Medial nuclear group	Association	Amygdala, Olfactory cortex & hippocampus	Prefrontal cortex, hippocampus
Lateral dorsal	Association	Amygdala, Olfactory cortex & hippocampus	Cingulate cortex and other limbic regions
Lateral posterior	Association	Superior colliculus, pretectum	Occipital parietal, temporal association
Medial geniculate	Specific nucleus	Inferior colliculus	1ry auditory cortex
Lateral geniculate	Specific nucleus	Left & right eyes (optic Tract)	1ry visual cortex
Posteromedial ventral	Specific nucleus	Trigeminothalamic tract	1ry somatosensory
Posterolateral ventral	Specific nucleus	Medial & spinal Lemnisci	1ry somatosensory
Posterior nucleus	Specific nucleus	Superior & Inferior Colliculi	1ry somatosensory
Ventral lateral	Specific nucleus	Globus pallidus	1ry motor cortex
Ventral anterior	Specific nucleus	Globus pallidus	1ry motor cortex
Intralaminar	Diffuse nucleus	Spinal cord, spinothalamic, reticular formation, cerebellar nuclei, globus pallidus, sup. Colliculus.	Cerebral cortex & stratum
Reticular	Diffuse nucleus	Reticular formation, corticothalamic, thalamocortical	Dorsal thalamic nuclei



Second : the limbic system:

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:**
 - 1- **Cortical structures**
 - 2- **Subcortical structures**
 - 3- **Olfactory system**
- **Looped connections** that all project to the **hypothalamus**.

WHAT IS THE MAIN FUNCTION OF THE LIMBIC SYSTEM?

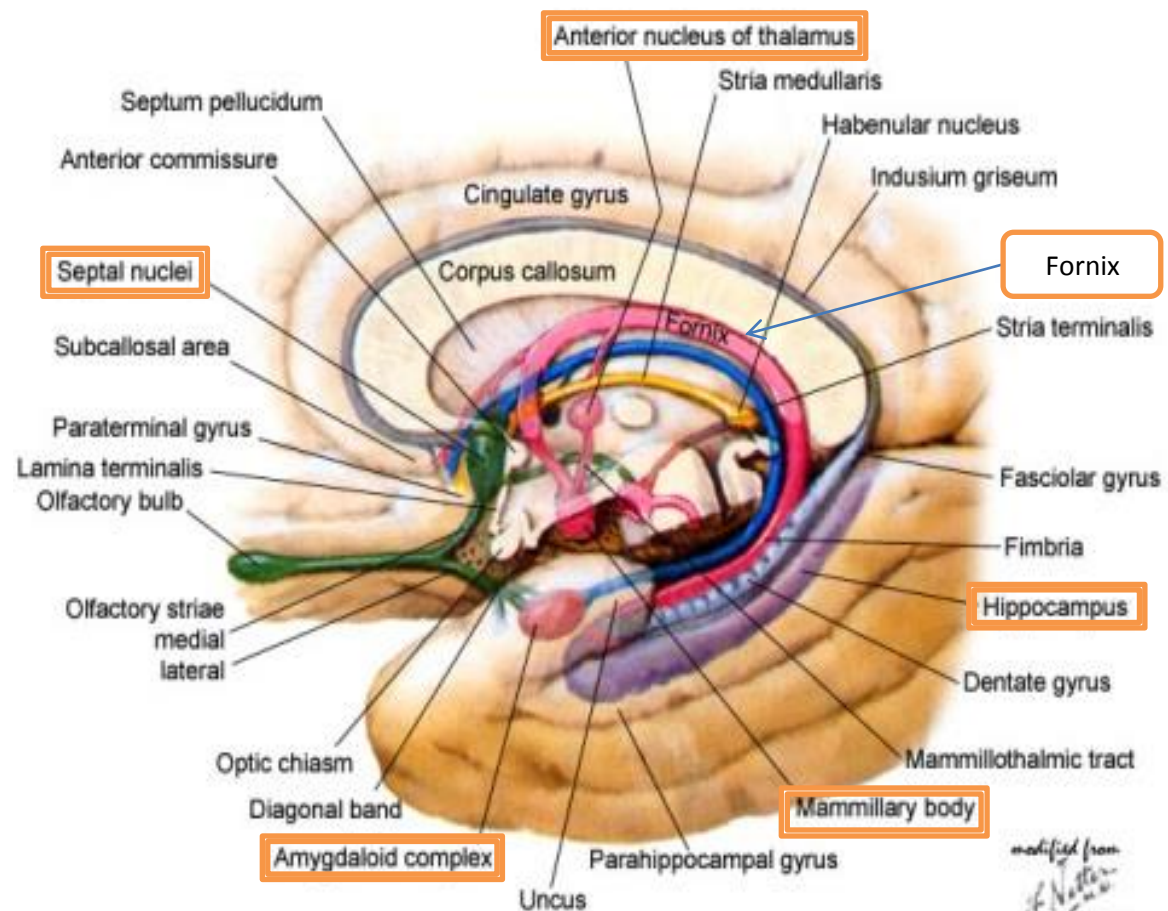
It control a variety of functions including:

- ❖ **Pleasure sensation**
- ❖ **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.**



The limbic system is a set of brain structures including:

1. Limbic cortex or limbic lobe.
2. Hippocampus & Hippocampal formation.
3. Amygdala.
4. *Anterior thalamic nuclei*
5. Hypothalamus (mammillary body).
6. Septum nuclei
7. Fornix
8. Olfactory system.
9. Habenular nuclei. (found in both side of pineal gland)





So, again **what are the Parts of the limbic system?**

CORTICAL STRUCTURES + SUBCORTICAL STRUCTURES + OLFACTORY SYSTEM

ALL THESE STRUCTURES HAVE SEVERAL LOOPING CONNECTING PATHWAYS. (Connect with the hypothalamus)

CORTICAL STRUCTURES			
1. Limbic lobe.	2. Hippocampal formation.	3. Septal areas.	4. Prefrontal area.

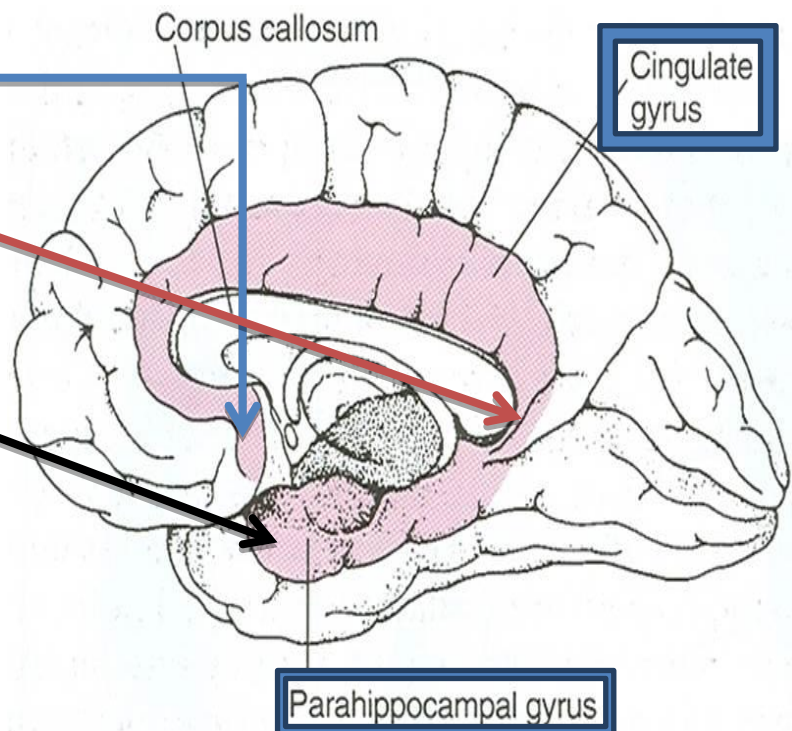


LIMBIC LOBE:

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

It includes:

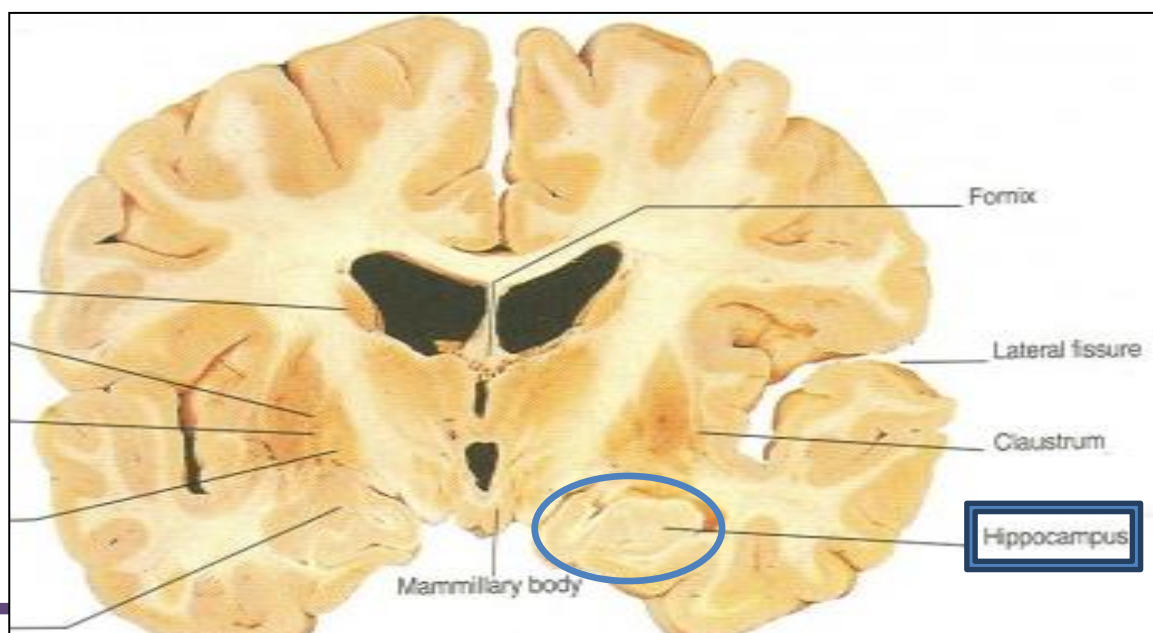
- 1- Subcallosal area
- 2- Cingulate gyrus
- 3- Isthmus
- 4- Parahippocampal gyrus
- 5- Uncus. (area 28)





HIPPOCAMPUS (Cornu Ammonis):

- It is a **horseshoe paired structure**, one in each cerebral hemisphere.
- **Site:** It is a **scrolled structure** in the **inferomedial part of the temporal lobe**.
- 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 acts as a **memory indexer** by sending memories to the appropriate part of the cerebral cortex for long-term **storage and retrieving** them when needed.
- **Function:**
 - Memory (file new memories as they occur).
 - The hippocampus & its connections are necessary for **consolidation of new short-term memories**.
 - Its principal **effluent pathway is called the: FORNIX**





FORNIX:

- **It is C-shaped group of fibers connecting the hippocampus with mammillary body.**

- **It consists of:**

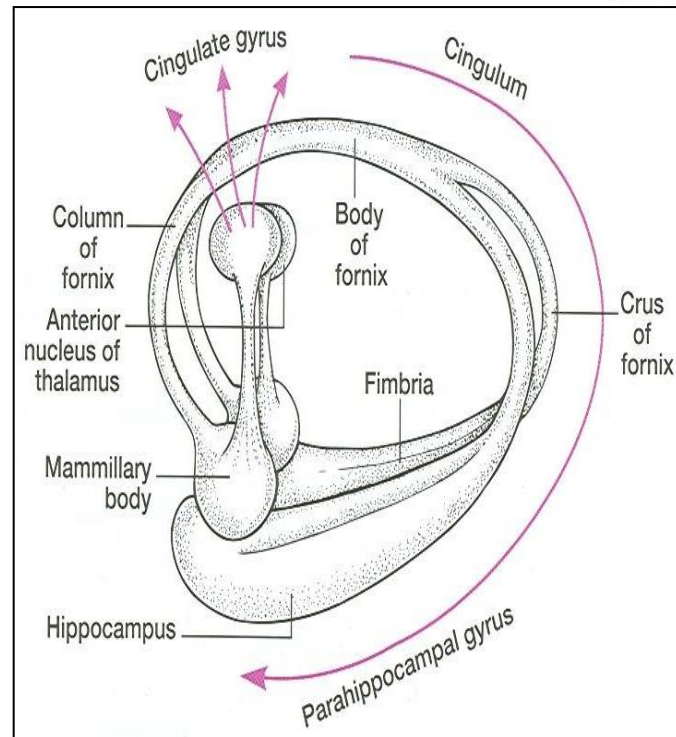
2 Fimbria,

2 Crus,

1 Body &

2 Columns.

- **The Fornix is an important component of PAPEZ CIRCUIT**



Papez's circuit connects the parahippocampal gyrus, hippocampus, fornix, mamillary body, anterior thalamic nucleus and cingulate gyrus.

CORTICAL STRUCTURES

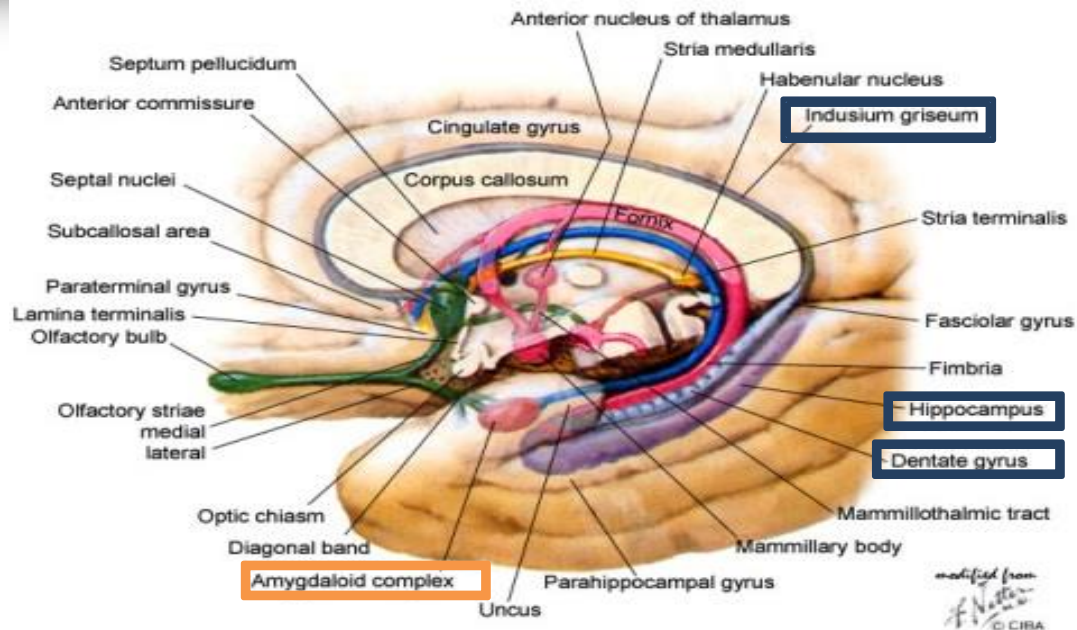
1. Limbic lobe.	2. Hippocampal formation.	3. Septal areas.	4. Prefrontal area.
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HIPPOCAMPAL FORMATION:

It consists of:

1. **Hippocampus**
2. **Dentate gyrus:** This lies between hippocampus & Parahippocampal gyrus. (medial to hippocampus)
3. **Subiculum,** (at the base (floor) of the hippocampus)
4. **Entorhinal area (area 28)**
5. **Induseum griseum**
(grey matter on the upper surface (Roof) of the corpus callosum).



- **Amygdala:** (part of limbic system)

AMYGDALA			
<p>shape: almond shaped mass of nuclei. Site: lies near the temporal pole, close to the tail of the caudate nucleus.</p>	<p>Function: It is involved in -FEAR , -Emotions. -Anger -Hormonal secretions.</p>	<p>Inputs: Association areas of visual, auditory & somatosensory cortices.</p>	<p>Outputs: Hypothalamus & Autonomic nuclei in the brain stem</p>
<p>Lesion: Lack of emotional responses & docility</p>			



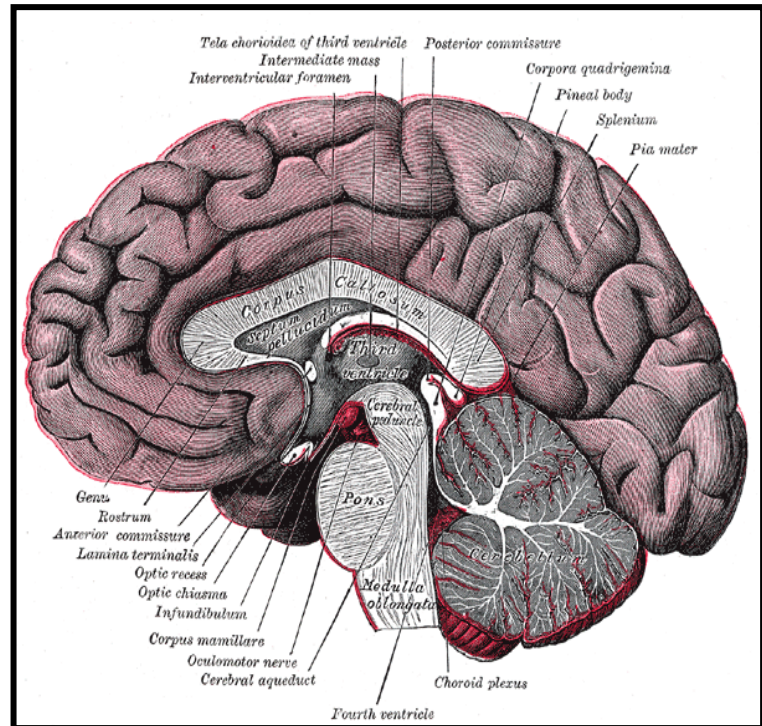
- Septal nuclei:

Site:

Located anterior to the interventricular septum

Main connections:

1. To Hypothalamus through medial forebrain bundle.
2. To Habenular nuclei through stria medullaris thalami.



Function:

It is the **pleasure zone** and it provides critical interconnections.

Lesions associated with limbic lobe disorders:

1. **Korsakoff's psychosis** :

(**Retrograde** = loss of new memories at the time of lesion with retained old memories)

&(**anterograde amnesia**= inability to gain new memories) **MOST COMMON IN ALCOHOLISM & B1 DEFICIENCY. (B1=thiamine)**



2. 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** (viral)*

3. Alzheimer's disease: *The hippocampus is one of the first brain areas to show damage in Alzheimer's disease*

4. Schizophrenia.



Questions:

1) posterior end of thalamus form :

- a) superior colliculus.
- b) anterior tubercle.
- c) Pulvinar.

2) which one of the following inferior to the thalamus :

- a) Hypothalamus.
- b) 3rd ventricle.
- c) internal capsule.

3) all of followings are Simple sensory relay nuclei except :

- a) Ventral posterolateral nucleus (VPL).
- b) Anterior ventral nucleus.
- c) Ventral posteromedial nucleus (VPM).

4) The Fornix is an important component of :

- a) Papes Circuit.
- b) Hippocampal formation.
- c) parahippocampal gyrus.

5) Septal nuclei connect to hypothalamus through :

- a) stria medullaris thalami.
- b) Fornix.
- c) Medial forebrain bundle.

6) Lesion of Amygdala results in :

- a) Motivation.
- b) Emotional responses & docility.
- c) Memory.



Q	ANS
1	C
2	A
3	B
4	A
5	C
6	B

GOOD LUCK

Anatomy Team Leaders:

Fahad AlShayhan & Eman AL-Bedica.