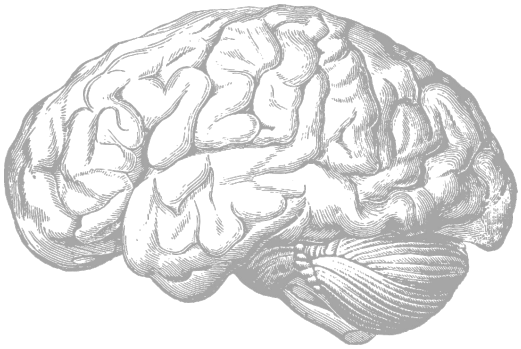
Anatomy of the Limbic System and Thalamus

CNS Block



Color Index

- Main Text
- Female Slides
- Male Slides
- Drs' Notes
- Important
- Extra info

The Editing File

Objectives

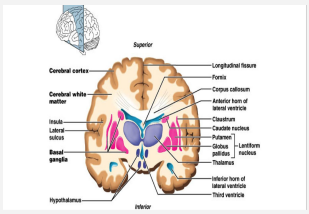
- Describe the **anatomy** and main **functions** of the **thalamus.**
- Name and identify different **nuclei of the thalamus.**
- Describe the **main connections and functions** of **thalamic nuclei.**

- 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.

You can find Atlas by Clicking HERE!

Thalamus

Introduction:



- It is the largest nuclear mass of the whole body.
- It is the largest part of the diencephalon.
- It is formed of 2 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.
- 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:

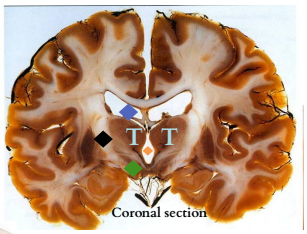
1. **Limbic related brain regions**
2. **Cerebellar Nuclei**
3. **Basal Ganglia**

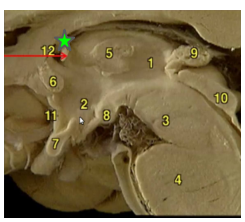
Relations of the Thalamus

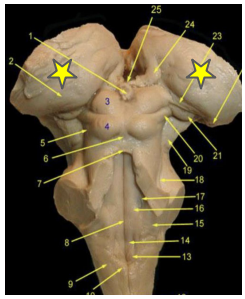
It has 4 Surfaces and 2 Ends:

surfaces			
lateral ◆	medial ◆	superior/dorsal ◆	inferior/ventral ◆
Posterior limb of the **internal capsule**	**The 3rd ventricle:** In some people it is connected to the thalamus of the opposite side by Interthalamic connexus (adhesion) or **Massa intermedia**	- **Lateral ventricle** - **Fornix**	-**hypothalamus** anteriorly -**Subthalamus** posteriorly

Ends	
Anterior	**Posterior**
Forms a projection, called the anterior ★ tubercle. It lies just **behind** the **interventricular foramen.**	Broad Forms a projection called ★**Pulvinar** which lies above the **superior colliculus** and the lateral & **medial Geniculate** bodies.



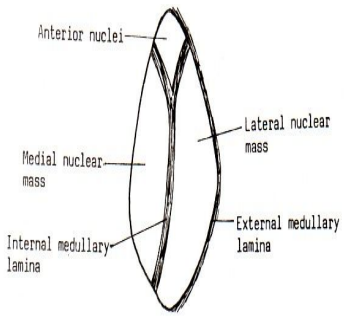




Internal Structures of The Thalamus

External Medullary Lamina:

- White matter that covers the lateral surface.
- It consists of thalamocortical & corticothalamic fibers.



Internal Medullary Lamina:

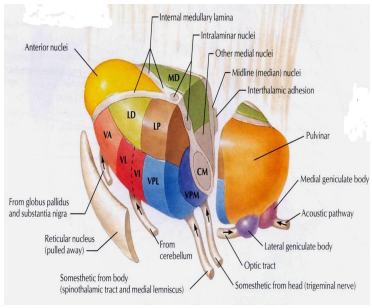
- White matter that's made of bundles of Y- shaped myelinated (afferent & efferent) fibers.
- It divides the thalamus into: anterior , medial, lateral nuclear groups.
- Each of these groups is subdivided into a number of named nuclei.

Embedded within the **internal medullary lamina** lie Intralaminar nuclei.
The **external medullary** lamina covers the lateral surface, in which lies thin reticular nucleus.

Lateral Nuclear Group

It is divided into: Dorsal & Ventral tiers.

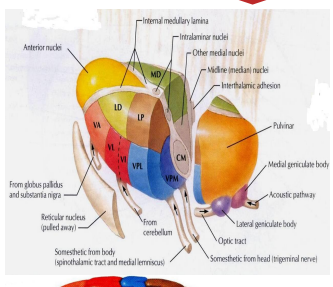
ventral tier	dorsal tier
1- Ventral Anterior (VA). 2- Ventral Lateral (VL). 3- Ventral Intermediate (VI). 4- Ventral Posterior (VP) (VPL,VPM / PLVNT , PMVNT). 5- Medial & Lateral geniculate nuclei.	1- Lateral Dorsal (LD). 2- Lateral Posterior (LP). 3- Pulvinar.

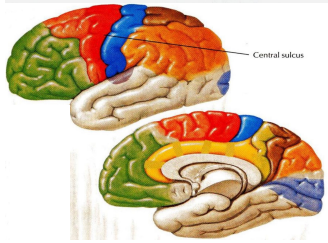


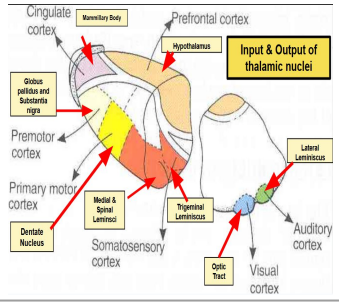
Projection of thalamic nuclei

MCQ

Nucleus	Afferent	Efferent
Anterior thalamic nucleus	Mammillary body	Cingulate gyrus (limbic system)
Medial thalamic nucleus	Hypothalamus	Prefrontal cortex and frontal
Ventral anterior nucleus	Globus pallidus and substantia nigra	Premotor cortex
Ventral lateral nucleus	Dentate nucleus (cerebellum)	Primary motor cortex
Ventral posterior lateral nucleus	Medial and spinal lemnisci	Sensory cortex
Ventral posterior medial nucleus	Trigeminal lemniscus	Sensory cortex
Lateral geniculate nucleus	Optic tract	Visual cortex
Medial geniculate nucleus	Lateral Lemniscus	Auditory cortex







Limbic System

1 Introduction:

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

2 The Limbic System controls a variety of functions :

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

The Alien from the Pathology took a trip to Anatomy just to ask you this :
Edward received a head injury while hiking. Afterward, friends note that he is easily angered and has difficulty in planning and completing complex tasks. What structure most likely was injured?

A. Prefrontal cortex
B. Cingulate gyrus
C. Postfrontal cortex
D. Amygdala

Answer: A (note that there is difficulty in completing complex tasks , in case there is not then the answer is D)

Limbic System

3 Structures of the Limbic System?

The limbic system is a set of composed of four main brain structures including

The limbic system is composed of four main structures :

1- Limbic cortex (Lobe).

2- Hippocampus

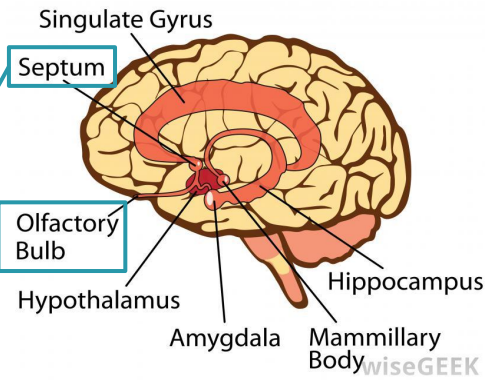
3- Amygdala

4- Septal area

5- Prefrontal area

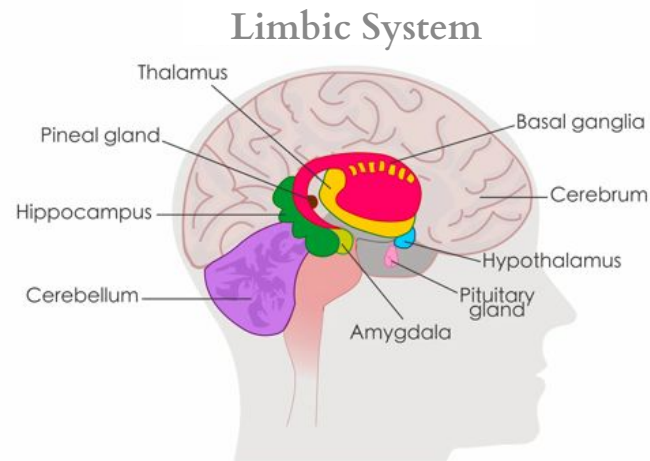
These structures form connections between the limbic system and the hypothalamus, thalamus and cerebral cortex. The **hippocampus** is important in **memory and learning**, while the **limbic system** itself is important in the control of the **emotional responses.**

LIMBIC SYSTEM STRUCTURES



Cortical Structures

- Limbic lobe
- Hippocampal formation & Amygdala
- Septal areas.
- Prefrontal area (Olfactory cortex)



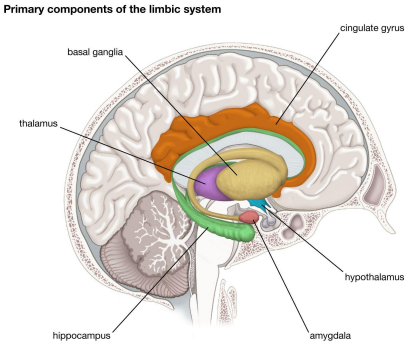
Structures of Limbic system

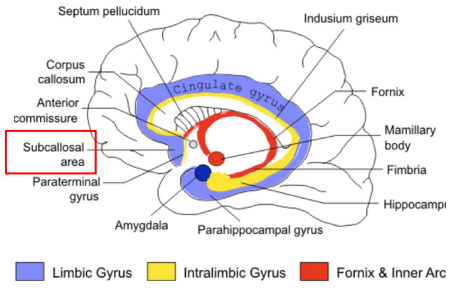
Structures Of Limbic System

Limbic Cortex (Lobe) :

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

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





Hippocampus :

- Involved in: Formation, Organization, and Storing memories. It is important in forming new memories and It connects emotions and senses, such as smell and sound, to memories.
- It is a horseshoes 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:

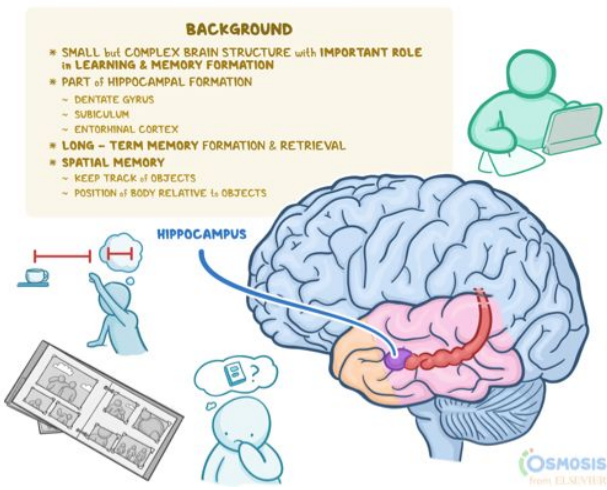
1. **Long-term storage.**
2. **Retrieving them when necessary.**

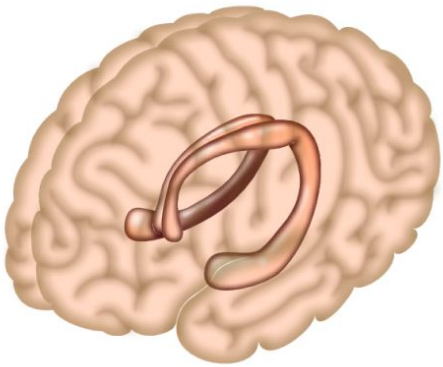
- **Site:** It is a scrolled (infolding) inferomedial part of temporal lobe.
- **Function:**

1. Memory (file new memories as they occur).
2. The hippocampus & its connections are necessary for **consolidation of new short-term memories.**
3. Its principal efferent pathway is called the fornix.

- **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 limbic system with hypothalamus to control emotions)





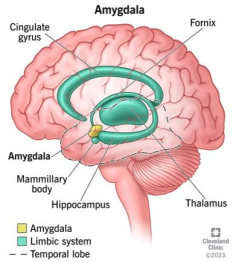
Structures of Limbic system

Structures Of Limbic System

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 : mnemonic FEAR

1. Fear
2. Emotions
3. Anger ; aggression
4. Hormonal secretions.



- **Connections of Amygdala :**

Inputs	Outputs
Association areas of visual, auditory & somatosensory cortices.	Hypothalamus & Autonomic nuclei in the brainstem.

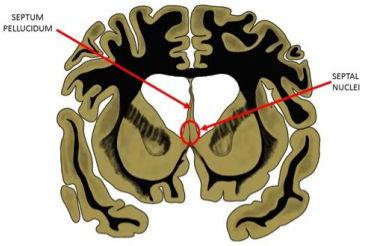
- **Lesion:**

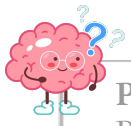
- Lack of emotional responses.
- Docility (reduced or impaired emotional expression)

Septal Nuclei :

- **Site:** Located anterior to the interventricular septum and anterior to hypothalamus.
- **Function:** It is the **pleasure** zone, sexual & emotional behaviour zone.
- **Main connections:** It sends projections to:

- Hypothalamus
- Habenular nuclei (lie in epithalamus of diencephalon).





Pathology Note :

Patient with Alzheimer typically present in the beginning with memory loss, particularly day-to-day memory and new learning. Over time, there is increasing disability in managing daily activities such as finances and shopping.

- Loss of motor skills then causes difficulty in dressing, cooking, and cleaning.
- Later in the disease, there is agitation, restlessness, wandering, and disinhibition. This may cause considerable upset to family and carers.
- Terminal stages cause reduced speech, immobility, and incontinence.

Lesions Associated with Limbic Lobe Disorders

Korsakoff's Psychosis

Korsakoff syndrome is a chronic memory disorder caused by severe deficiency of:
1- Thiamine (vitamin B-1)
2- Alcoholic intoxication.
Inability to remember recent events and long-term memory gaps.
Anterograde amnesia= Inability to gain new memories.
Psychosis retrograde=loss of new memories at the time of lesion and loss of retained old memories occurred before the injury.

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 memories.

Schizophrenia

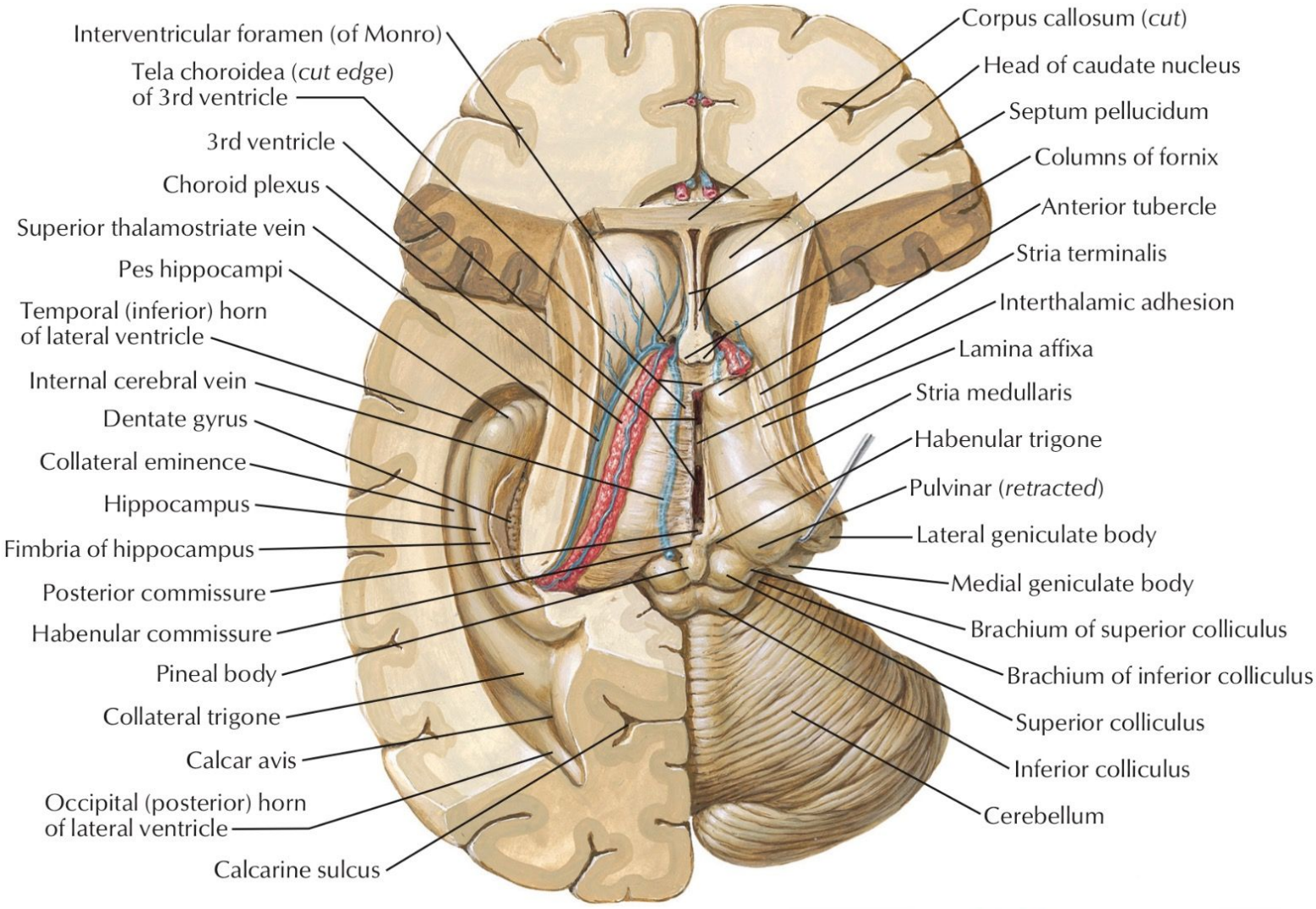
Mental disorder with abnormal behavior + inappropriate actions and feelings.

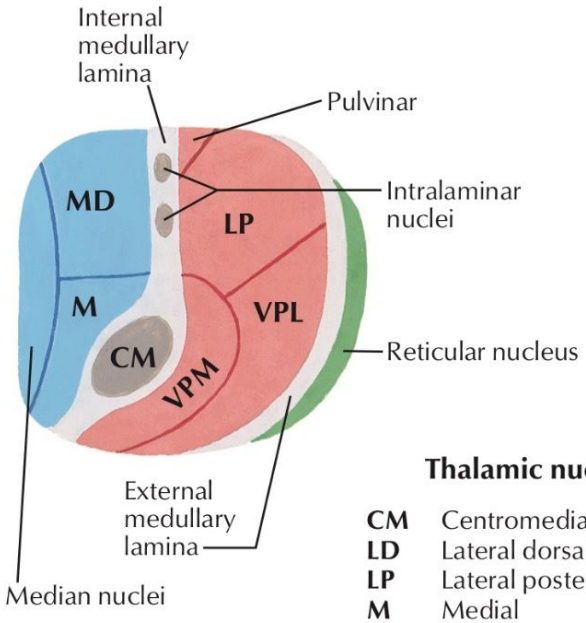
Martin noticed that his grandfather is having difficulty remembering his name over the past few months. Which of the following might be affected?

A. Hippocampus
B. Frontal lobe
C. Implicit memory
D. Amygdala

Answer: A
I Guess my work here is done . See you later

EXTRA

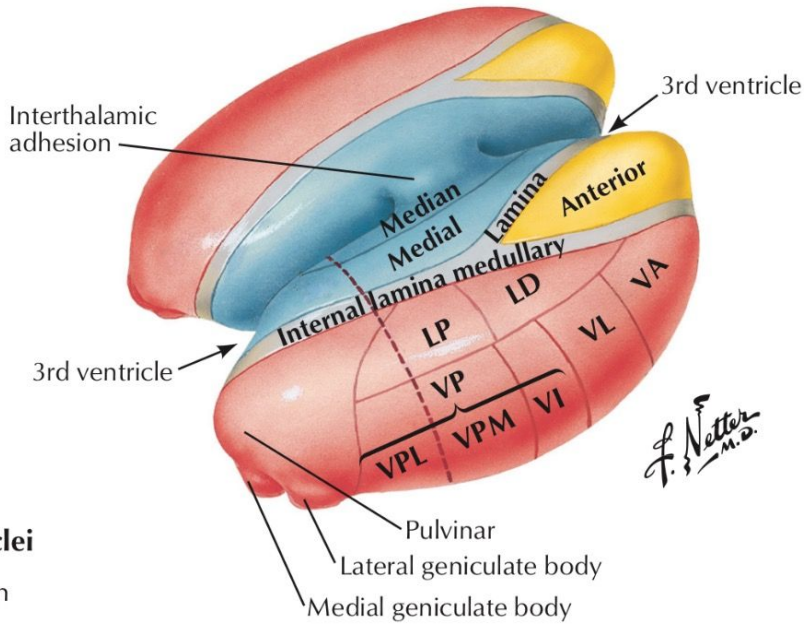




Schematic section through thalamus
(at level of broken line shown in figure at right)

Thalamic nuclei

CM	Centromedian
LD	Lateral dorsal
LP	Lateral posterior
M	Medial
MD	Medial dorsal
VA	Ventral anterior
VI	Ventral intermedial
VL	Ventral lateral
VP	Ventral posterior
VPL	Ventral posterolateral
VPM	Ventral posteromedial



Schematic representation of thalamus
(external medullary lamina and reticular nuclei removed)

Lateral nuclei
Medial nuclei
Anterior nuclei

MCQs

Q1.If a patient is recently diagnosed as Alzheimer's disease ; Where is the most likely site of lesion: Female Slides			
A. Hippocampus	**B.** Fornix	**C.** Amygdala	**D.** Septum
Q2. A patient with severe deficiency of thiamine complains of chronic memory disorder.Which one of the following disorders is most likely to have a lesion?: Female Slides			
A. Alzheimer's disease	**B.** Korsakoff's psychosis	**C.** Schizophrenia	**D.** Temporal lobe epilepsy
Q3. What is the principal efferent pathway of the hippocampus?			
A. Uncus	**B.** Isthmus	**C.** Cingulate gyrus	**D.** Fornix
Q4. The anterior thalamic nucleus projects to which one of the following?			
A. Cingulate gyrus	**B.** Premotor area	**C.** Amygdala	**D.** Sensory cortex
Q5. Which part of the limbic system is concerned with consolidation of new short-term memory?			
A. Amygdala	**B.** Fornix	**C.** Hippocampus	**D.** Septum
Q6. The function of amygdala is:			
A. Memory	**B.** Learning	**C.** Pleasure & production	**D.** Emotions as fear & anger

A1. A A2. B A3. D A4. A A5. C A6. D

FOR ANKI FLASHCARDS

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Almuthana Alageel

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