

CNS

Anatomy

0 slides

0 sheets

▶ number

17

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Diencephalon

At first where we can find cavity of the Diencephalon (3rd ventricle)?

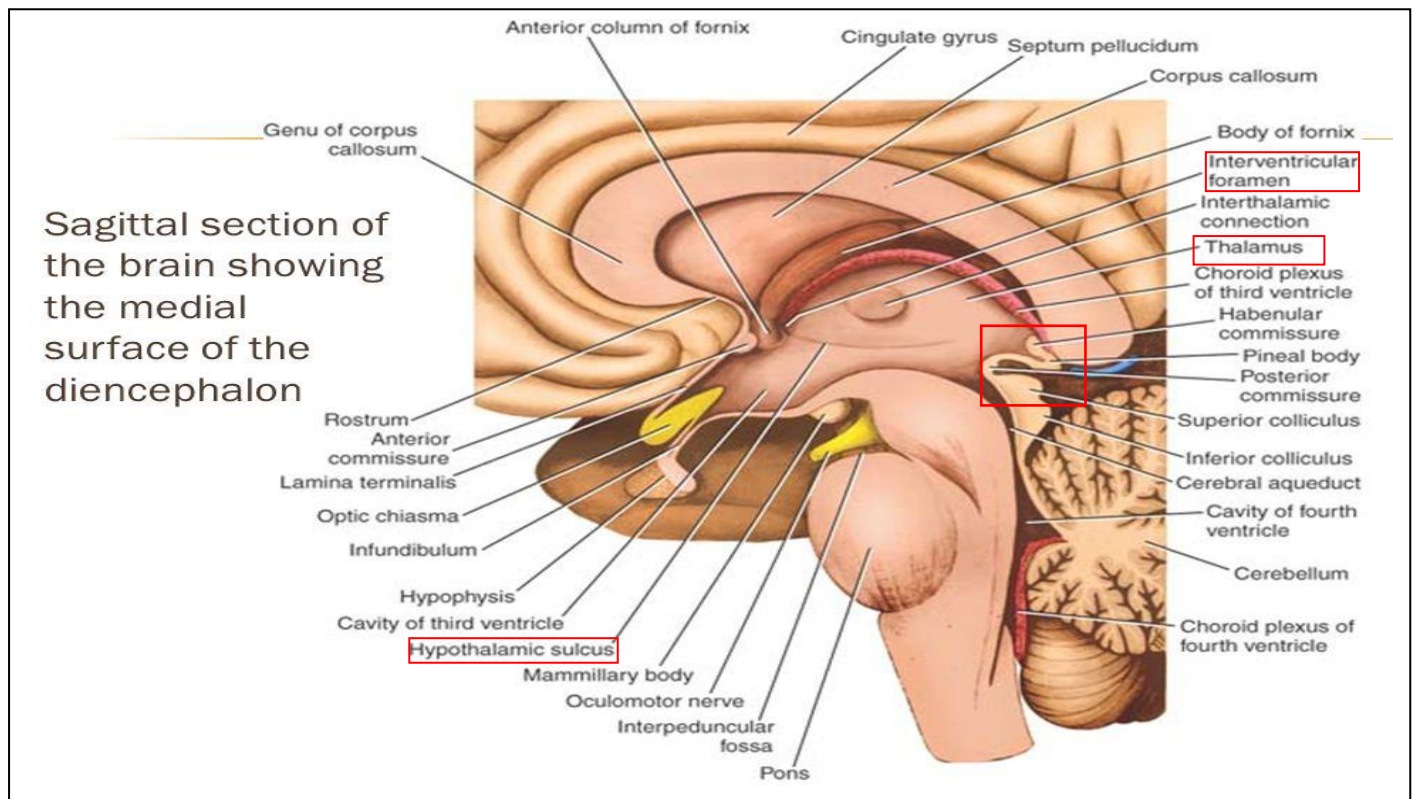
It's located between the two cerebral hemispheres, near the midline of the brain above the midbrain.

Remember we took little embryology in the first lecture, we said that the brain composed of three vesicles which are forebrain, midbrain and hindbrain. Then the forebrain will divide into two telencephalon and diencephalon which is the topic of our lecture.

Diencephalon is the family of thalamus which is Thalamus, Epithalamus, Metathalamus, Hypothalamus and Subthalamus.

****Now let's take section and describe the diencephalon surface:**

1- We take a sagittal section so the medial surface of the brain appears.

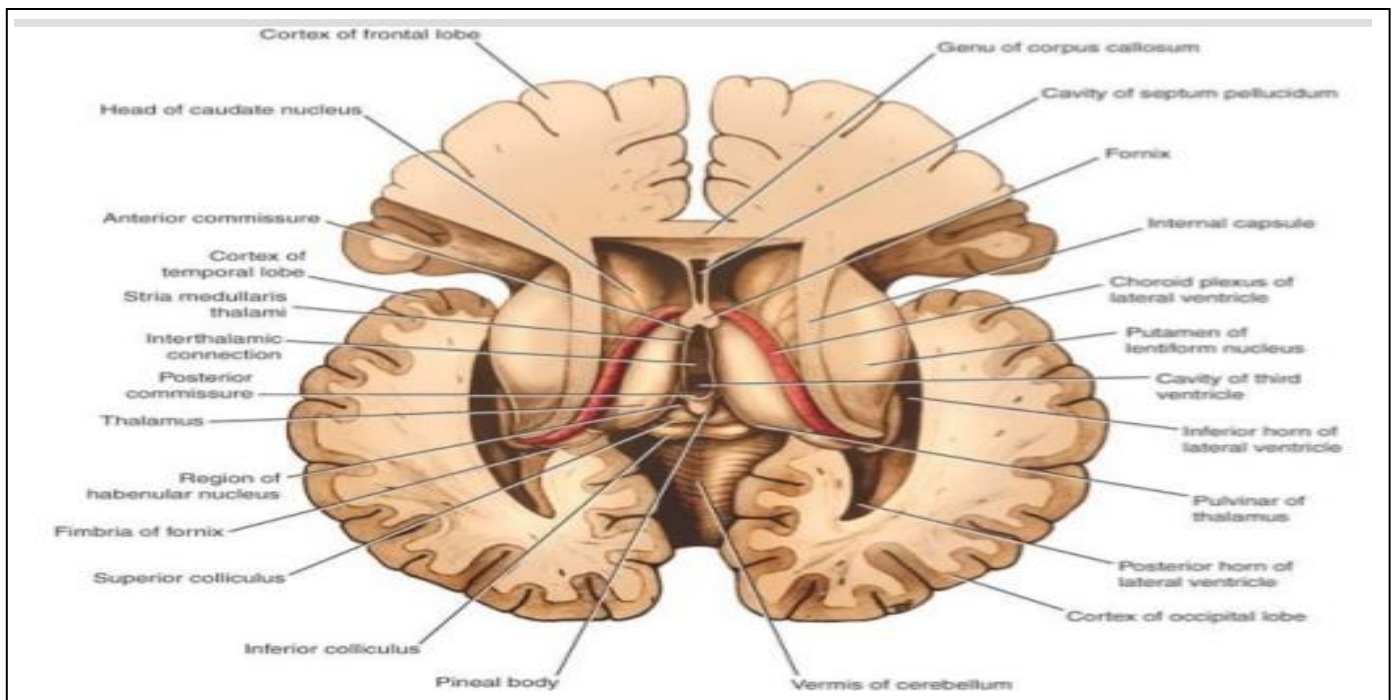


So what can you see on the medial surface?

- The largest part in the middle is the thalamus, and then anterior inferior to it is the hypothalamus.
- Notice the hypothalamic sulcus between the interventricular foramen and cerebral aqueduct, where thalamus found above it and hypothalamus below it.
- In the most posterior part there are two nuclei: lateral and medial geniculate body and they are the metathalamus.
- Epithalamus that composed of pineal gland, habenular Commissure and posterior Commissure.
- subthalamus between the lower surface of the thalamus and upper surface of midbrain (tegmentum).

Note: Try to review and search more pictures for better understanding.

2- Now let's view it from the lateral surface, be aware!! in this section we look in the lateral surface superiorly after we cut the roof of the 3rd ventricle which is corpus callosum so you can see the cavity of 3rd ventricle between two thalami.



- In this section you will see genu of corpus callosum, septum pellucidum, fornix then 3rd ventricle.

- If you go lateral to the thalamus you will see the caudate nucleus above and the lentiform nucleus below. Remember that between the head of caudate and lentiform anterior limb of internal capsule run, and between lentiform and thalamus the posterior limb of internal capsule run. All of that also related (thalamus and caudate) to the floor of body lateral ventricle.

You know the horns of the lateral ventricle and as the picture show you will notice the inferior horn since it lies in temporal lobe. Relations were described bef



** Diencephalon formed the lateral wall of 3rd ventricle, remember 3rd ventricle doesn't have medial wall, and let's recall the roof and the floor of it:

Roof: corpus callosum, fornix and septum pellucidum between them.

Floor: formed by hypothalamus that also forms the anterior wall.

**The cavity of the 3rd ventricle divides the diencephalon into 2 halves.

** Each half is divided by the hypothalamic sulcus (which extends from the interventricular foramen to the cerebral aqueduct) into ventral & dorsal parts:

1- Dorsal part includes: Thalamus, Epithalamus & Metathalamus.

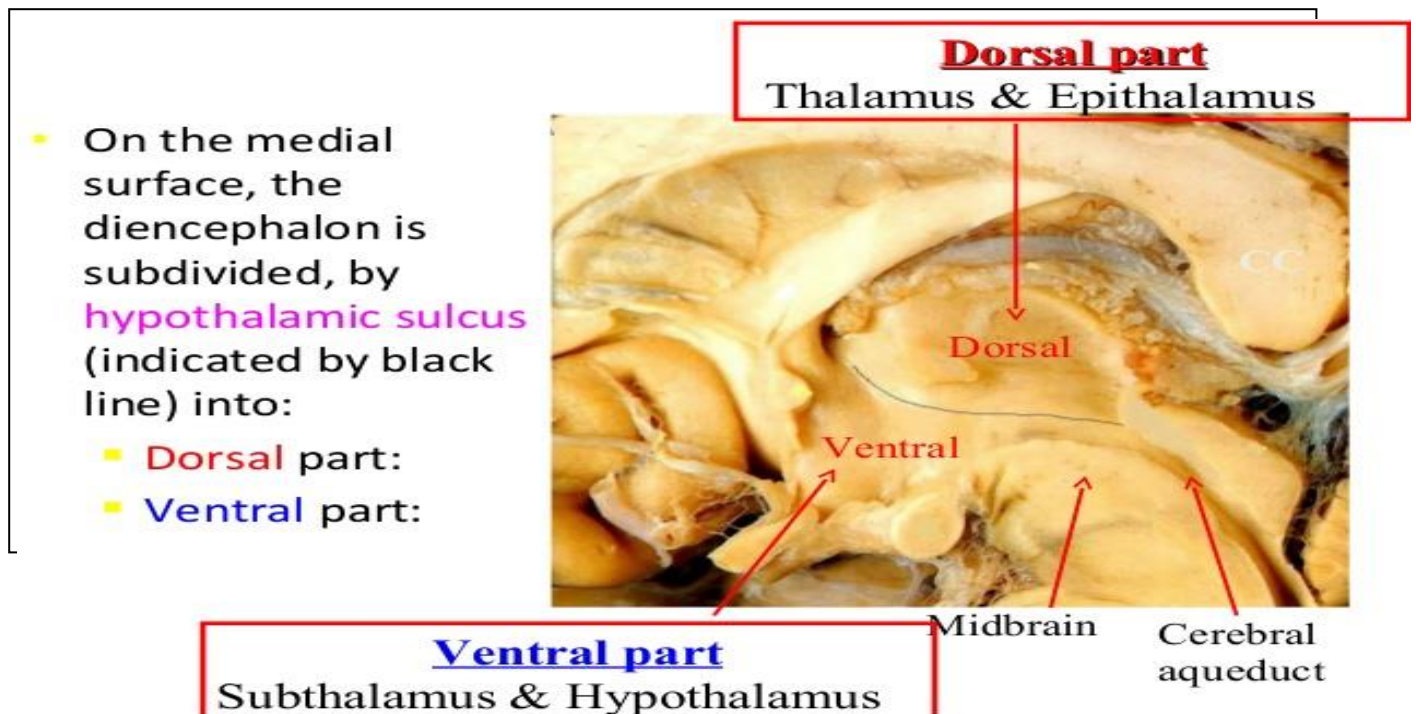
2- Ventral part includes: Hypothalamus & Subthalamus.

It's worth to know:

** Interventricular foramen situated anatomically between thalamus which the anterior of the thalamus make the posterior border of interventricular foramen, and the anterior column of the fornix that make its anterior border.

** Foramen of Monro connects the lateral ventricles with the third ventricle at the midline of the brain.

** In this picture try to identify and locate each part of the diencephalon, sulcus, structures that surround them and the borders we talked about (please refer to the slide):



THALAMUS

- It is a large egg shaped mass of grey matter which forms the main sensory relay station for the cerebral cortex.
- It forms part of the lateral wall of the 3rd ventricle & the part of the floor of the body of the lateral ventricle.
- The 2 thalami are connected by interthalamic adhesion, this adhesion is part from thalamic tissue not a white matter and that's why we don't call it commissure but adhesion.

-Shape and relations:

Oval shape has 2 ends and 4 surfaces:

- 1- Anterior end: narrow and forms the posterior boundary of the IVF (interventricular foramen).
- 2- Posterior end: Pulvinar overhanging the MGB and LGB, these two are the metathalamus.

And epithalamus which is the pineal gland habenular Commissure and posterior Commissure.

- 3- Upper surface: floor of body of lateral ventricle.
- 4- Medial surface: lateral wall of third ventricle.
- 5- Lateral surface: caudate above & lentiform below separated from it by internal capsule
- 6- Lower surface: hypothalamus anterior and subthalamus posterior.



Classification of Thalamic Nuclei

At first let's figure out how to know posterior and anterior surfaces of the thalamus:

- If you see medial and lateral geniculate bodies and a ball like structure which is pulvinar, then you are definitely in the posterior surface.
- If you see reticular nucleus (as its name implies it has a relation with the reticular formation), then you are in the anterior surface.
- The thalamus itself is divided into lateral and medial parts where lateral is more outward toward the lentiform and medial is more inward.
- Medial part contains the dorsomedial nucleus (or mediodorsal) that goes to prefrontal cortex.

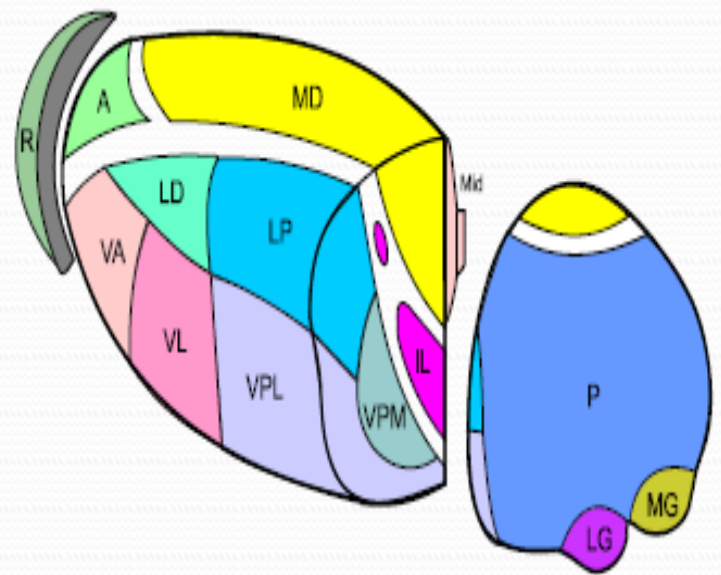
** What forms and separates these two parts is the **internal medullary lamina** which is a Y-shaped bundle from the white matter that divides the thalamus into:

- 1- Anterior surface between limbs of the Y-shaped bundle that contains anterior nuclei of the thalamus.
- 2- Lateral surface.
- 3- Medial surface.

- There are also nuclei in the internal medullary lamina itself they are named **intralaminar nuclear group** which also have a connection with the reticular formation.

** look at the figure in the next page and try to identify the position of each nuclear group:

- I. Lateral Nuclear Group
- II. Medial Nuclear Group
- III. Anterior Nuclear Group
- IV. Posterior Nuclear Group
- V. Metathalamic Nuclear Group
- VI. Intralaminar Nuclear Group
- VII. Thalamic Reticular Nucleus



letter and they are:

- 1- Ventral Posterior Nucleus (VP) that composed of:
Ventroposterolateral (VPL), Ventroposteromedial (VPM) and Ventroposteroinferior (VPI).
- 2- Ventral Anterior Nucleus (VA).
- 3- Ventral Lateral Nucleus (VL).

b) The posterior one named **Dorsal Nuclear Group**, you will notice that they use the terms dorsal and posterior in naming these nuclei, its fine don't be confused. Which are:
Lateral dorsal (LD), Lateral posterior (LP) and Pulvinar.

Now let's talk about the function and relation of each nucleus especially the lateral nuclear group:

1- Ventral Posterior Nucleus (VP):

- VPL** is collect the sensory from all the body through posterior column, lateral and anterior spinothalamic tracts, then it give it and connect it with post central gyrus.
- **VPM** it's for trigeminal that collect sensation from face, and also give it to post central gyrus.

- **VPI** is not important, non specific nuclei and also has a relation in sensation.

2- Ventral Anterior Nucleus (VA):

Its connect with basal ganglia which act as its Adviser for motor activity from motor cortex (area4 &6)

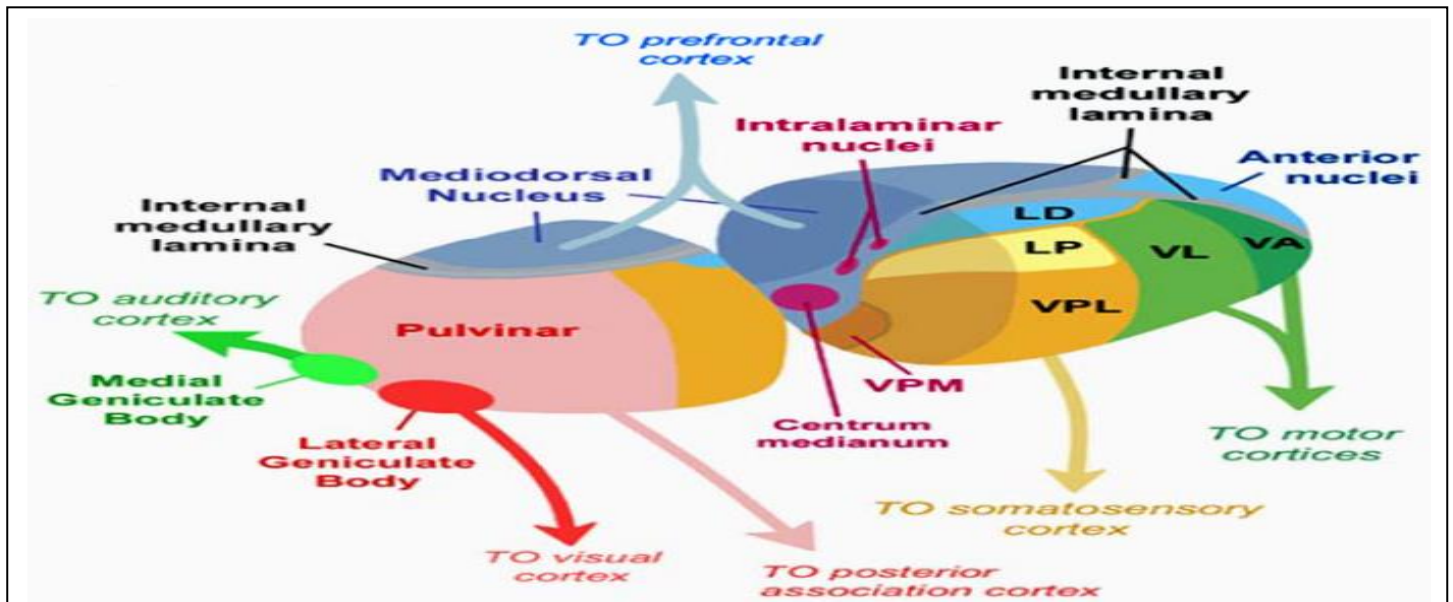
3- Ventral Lateral Nucleus (VL):

It's the same function as VA but it connects with cerebellum mainly.

4- Dorsal Nuclear Group:

They are non specific nuclei.

** Look at the figure below it summarizes the nuclei and their relation:



** We finish talking about the most important nuclei and there function so let's talk about

Reticular nuclei

We said it found on the anterior surface, it has connection with cerebral cortex, Subcortical Structure which is reticular formation that found in midbrain, pons and medulla.

- So it makes connection between reticular nucleus, cerebral cortex, thalamus and the brainstem. By this connection regulation of thalamus occurs.

Summary of Thalamic Connectivity and function

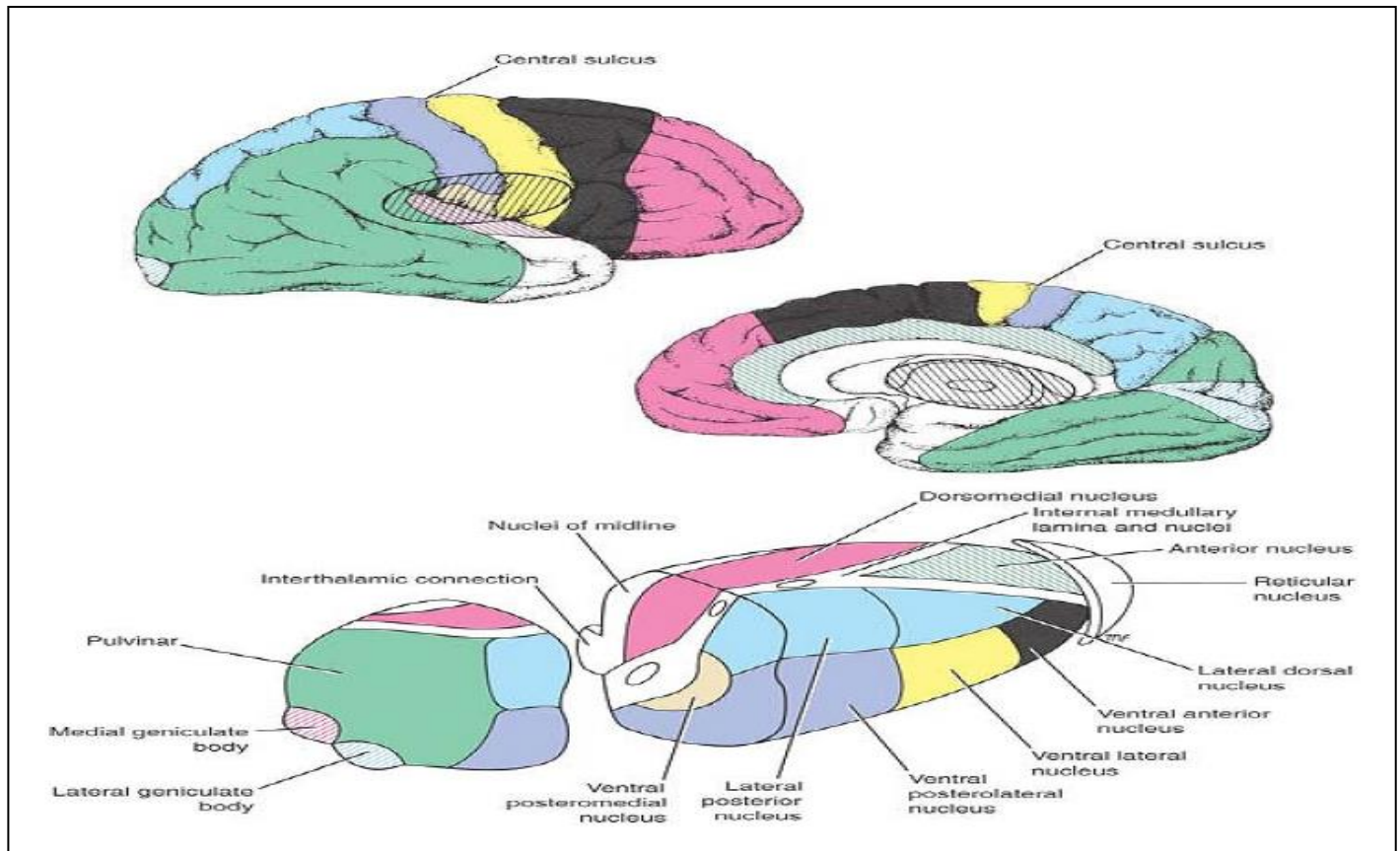
You know that the thalamus considered as the secretary, so it's classified the input received to, and then it will take it to its part and area in the cortex:

- 1- Sensory Input:
 - General sensation through VPL and VPM nuclei to area 3,1,2.
 - special sensation, Taste, equilibrium, hearing through medial geniculate to auditory cortex in temporal, vision through lateral geniculate to visual cortex in occipital.
- 2- Motor Input: Cerebellum through VL to area 4 &6, basal ganglia through VL to area 4&6.
- 3- Reticular Formation.
- 4- Limbic System: mammillary nucleus, hippocampal formation.

The table below summarizes all the nuclei you need to know just what we talked about:

Nucleus	Afferent	Efferent	Function
Anterior	Mammillothalamic tract, cingulate gyrus, hypothalamus	Cingulate gyrus, hypothalamus	Emotion and memory
Dorsomedial	Prefrontal cortex, hypothalamus	Prefrontal cortex, hypothalamus	Integration of somatic, visceral, olfaction
LD & LP	Cerebral cortex	Cerebral cortex	unknown
VA	Premotor cortex, BG	Premotor cortex, BG	Motor activity
VL	Premotor cortex, cerebellum	Premotor cortex, cerebellum	Motor activity
VPM	Trigeminal lemniscus	Area 3,1,2	general sensation
VPL	Medial & spinal lemnisci	Area 3,1,2	general sensation
Intralaminar	Reticular formation	Cerebral cortex	Alertness
Reticular	Cerebral cortex	Other thalamic nuclei	Regulate thalamus
MGB	Lateral lemniscus	Superior temporal gyrus	hearing
LGB	Optic tract	Visual cortex	Vision

**** Look at the figure below, the color in the cortex follow the color of the thalamic nuclei represents the function and relation:**



In this figure:

- In the anterior surface white color represents reticular & intralaminar nuclei with reticular formation in the cortex and brainstem.
- In the posterior light green represent the LGB with occipital cortex connect through optic radiation, the red lines represent MGB with Superior temporal gyrus connect through Lateral lemniscus for hearing.
- In the medial part pink color represent dorsomedial nuclei with lateral and medial prefrontal cortex for behavior, autonomic, planning, smell and limbic system functions.
- Anterior of the thalamus between two limbs of the Y shaped bundle the green lines present the anterior nucleus with cingulate gyrus for limbic system.
- In the lateral surface: black color present VA with basal ganglia in the premotor area (area 6), yellow color present VL with cerebellum specifically lateral part of it cerebrocerebellum or neocerebellum with motor cortex area 4, the blue color present VPL with postcentral gyrus connect through medial and spinal lemniscus, the last one is VPM with area 3, 2, 1 also that represent trigeminal

**** try to look at this figure while memorizing the previous table.**

**** Thalamic radiation**, we heard about it when we talked about internal capsule and its five limbs (try to recall them). Thalamic radiation is the fibers that will come out after the relay of function in the thalamus to the cerebral cortex. They come out as corona radiata from the internal capsule. There are:

- Anterior thalamic radiation that connect between anterior of the thalamus and cingulate gyrus.
- Superior thalamic radiation which is sensory radiation that found in the posterior half of posterior limb of internal capsule, remember the anterior half of posterior limb for corticospinal motor fibers and the middle cerebral artery run also in the posterior limb which gives of cerebral hemorrhage artery (charcot's artery).

**** charcot's artery**, when the patient go through hypertension then sleep, he will wake up suffering from contralateral hemiplegia, because of hemorrhage in this artery will lead to its rupture since has thin wall that so easy to rupture so contralateral motor and sensory dysfunction occur.

- Posterior thalamic radiation runs in the retro- lentiform part of internal capsule.
- Inferior thalamic radiation related to auditory, runs between medial geniculate body and auditory cortex, it runs in the sub- lentiform part of internal capsule.

Clinical Syndromes of the Thalamus

Related to the part or nuclei that has the lesion:

1- Posterolateral thalamic syndromes:

Sensory disorders related to damage in VP nucleus producing pain (hypersensetivity to pain) thalamic pain, the most important disorder is:

Thalamic (Dejerine-Roussy) syndrome numbness and burning on the opposite side.

2- Thalamic hand:

Lesion in the motor affection the muscles tone.

Patient will have weakness in pronation and flexion of wrist, flexion of metacarpophalangeal and extention of interphalangeal (altered muscle tone).



3- Anterolateral thalamic syndromes

Motor disorders, patient will suffer from paresis, ataxia (patient will walk like he drunk to support himself), motor incoordination, dysphagia.

But how to differentiate between sensory (PCML) and motor (cerebellar) ataxia?

You simply ask the patient to close his eyes if he sways then this will be sensory ataxia remember to put your hand around him for protection when falling this is called **positive Romberg's test**, for the cerebellar ataxia there is no difference between closing or opening the eyes he still can't move correctly.



HYPOTHALAMUS

- connected to pituitary gland, part of the Diencephalon and its inferior to hypothalamic sulcus.
- Extends from optic chiasma to the mammillary bodies.
- Forms the floor of the third ventricle, its horizontal part form the lateral wall of 3rd ventricle.
- Preoptic area is extending from optic chiasma to lamina terminalis and anterior commissure.
- Bounded laterally by the internal capsule.
- The hypothalamus extends from the anterior commissure, lamina terminalis, and optic chiasm. Caudally, tuber cinereum and mammillary bodies. the hypothalamus extends to the tegmentum of the midbrain.

Major constituents:

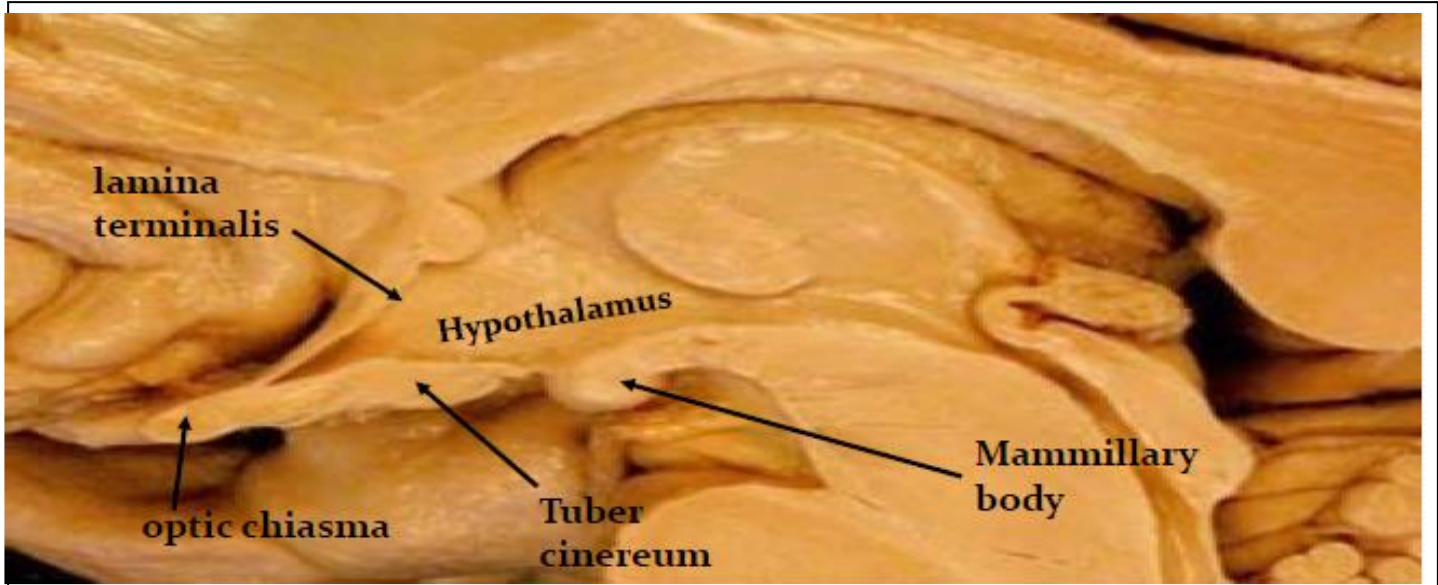
- Mammillary bodies.
 - Tuber cinereum, infundibulum and pituitary.
 - Nervous tissue adjacent to optic chiasma.
 - Preoptic region adjacent to lamina terminalis.
- Horizontal part (contents of interpeduncular fossa)
- Vertical part near the anterior commissure

** Lamina terminalis named like that since it found in the most terminal part in anterior wall of 3rd ventricle.

** Tuber cinereum its elevation from the hypothalamus situated in the basal surface of the brain, the most elevated part of it is medial eminence where infundibulum attaches then it terminating inferiorly on the pituitary gland.

** mamillary body it's the last nucleus situated in the horizontal part of hypothalamus.

** Try to identify the previous structures in this figure:



COMPONENTS OF HYPOTHALAMUS

You will find differences in the naming of these nuclei between the anatomists, but there is agreement on the functions.

** At first fornix come from hippocampus posteriorly, fimbria of the hippocampus make posterior column or crura of the fornix then it runs above the thalamus making the body then it forms anterior column that inter the brain to attach with mamillary body on the basal surface of the brain. So what divide the nuclei to lateral (to lateral ventricle) and medial (to the 3rd ventricle) zones are the connection between the anterior column of the fornix and mamillary body.

** It's not important to memorize the names of these nuclei
Don't memorize them!!



Function of hypothalamus

1- Homeostasis (food intake, water and electrolyte balance, temperature regulation and circadian rhythm, since it have hunger, thirst, satisfy centers.....etc).

2- Endocrine control via posterior loop pituitary gland, the anterior loop is connected through blood (portal circulation) difference in embryological origin.
(Growth hormones, reproductive hormones, stress hormones).

3- Autonomic control (sympathetic and parasympathetic responses).

4- Limbic function (memory and emotions), How?

This connection is introduced through the fornix that connects the mamillary body of hypothalamus and hippocampus the major part of limbic system.

Also through stria terminalis that make the roof of lateral ventricles it comes from the amygdala (found in the uncus), the fibers of stria terminalis goes to the base of the brain reaching the hypothalamus.

** So it related to memory and smell function.

** Detailed functions of hypothalamus in slide 24 Doctor said that we don't need to memorize it's just for your information.

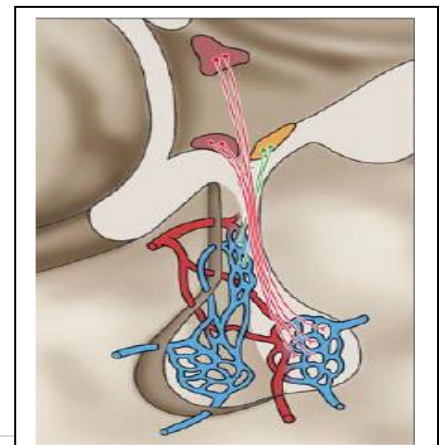
Hypothalamic Connections

Anterior pituitary

- From Pre-optic nucleus through Hypothalamo-hypophyseal portal circulation.
- Tubero-infundibular tract to Median eminence, then via Portal veins.
- For Gonadotropic releasing hormone and it release inhibitory hormones that affect the anterior pituitary.

Posterior pituitary

- From Supraoptic-hypophyseal tract, (neurohypophysis) through infundibulum.
- It release two hormones:
ADH / Vasopressin (supraoptic nuclei), for water reservation.
Oxytocin (paraventricular nuclei) for uterus contraction & Milk production.



Epithalamus

- Related to limbic system.

- **Major constituents:**

1- Habenular Nucleus:

Medial Habenular Nucleus

Lateral Habenular Nucleus

2- Habenular Commissure

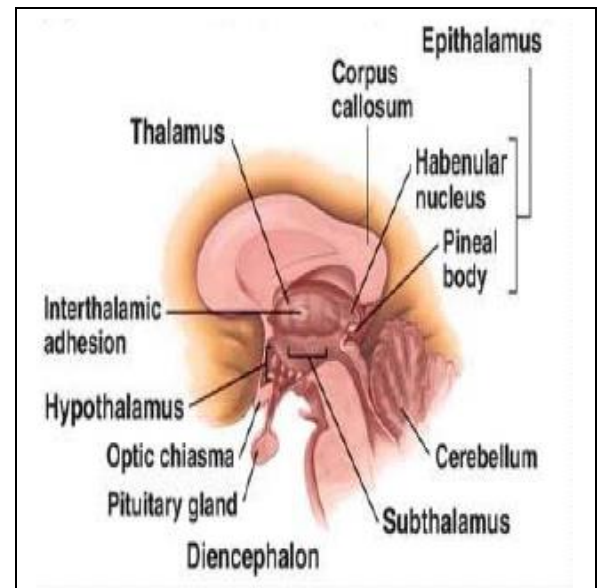
3- Pineal Gland (habenular commissure above and posterior commissure below).

Function:

- Connects the limbic system and other parts of the brain.
- Secretion of melatonin by the pineal gland to regulate sleep cycle.
- Regulation of pituitary gland through hypothalamus (pineal gland)

** Posterior commissure for light reflex since it's a connection between superior colliculi in the midbrain.

** Habenular commissure for smell function.



Metathalamus (Geniculate bodies)

Placed under pulvinar of the the thalamus

1- Medial Geniculate Body (MGB):

Receives afferents from medial lemniscus and inferior colliculus through inferior brachium.

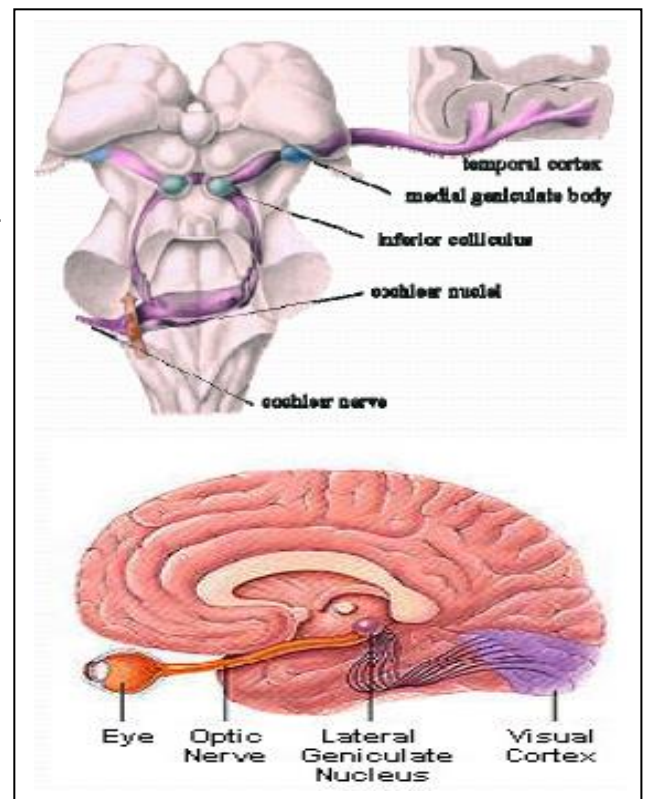
Gives efferents (auditory radiation) in sublentiform part of the internal capsule to auditory area in superior temporal gyrus.

2- Lateral Geniculate Body (LGB):

Receives afferents from optic tract

Gives efferents (optic radiation) in retrolentiform part of internal capsule to visual center in the occipital lobe

3rd order neuron in visual pathway.



Subthalamus (Basal Ganglia)

- Lies between thalamus & tegmentum of midbrain.
- Considered motor zone of the diencephalon because it connected with basal nuclei
- ** If you remember we said there is a connection between globus pallidus internal and thalamus through inhibitory fibers (GABA fibers), these fibers give the three bundles that we will mention them in a while.

Major constituents (3 nuclei and 3 bundles)

Nuclei

- Subthalamic nucleus
- Substantia nigra and red nucleus extend from midbrain to subthalamus.
- zona incerta (grey matter inside the subthalamus) its connections project extensively over the brain from the cerebral cortex down into the spinal cord (plays role in controlling pain).

3 bundles called Field of Forel (white matter)

- H ansa lenticularis, between the thalamus and subthalamic.
- H1 thalamic fasciculus
- H2 lenticular fasciculus
- ** These bundles (between the subthalamus and thalamus and Globus pallidus).

Sorry for any mistakes



"So stay true to your own nature. If you like to do p in a slow and steady way, don't let others make you feel as if you have to race. If you enjoy depth, don't force yourself to seek breadth. If you prefer single-tasking to multi-tasking, stick to your guns. Being relatively unmoved by rewards gives you the incalculable power to go your own way."