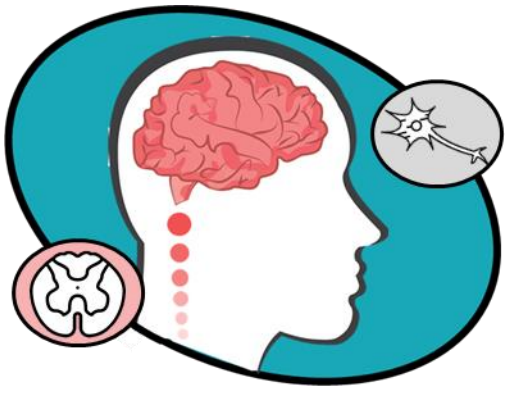


CNS

Anatomy

Sheet Slide

Number

8

Done by:

Lojayn Salah

Corrected by:

Doctor:

Maha Albeltagy

Salam all, this will be the last sheet included in the midterm exam, Good luck😊

This sheet includes the following:
1) Explanation for two questions related to the previous lectures.
2) Anatomy of the Diencephalon
3) The rest of the functional areas in the brain (slides 44-71 from the first folder)

At the beginning of this lecture the doctor started discussing two questions related to the previous lectures:

First Question:

The Following physical signs and known anatomical data strongly suggested the involvement of the left middle cerebral artery except:

a) Paralysis of the right side of the face of the face and the right arm was more severe than that of the right leg.

b) The presence of aphasia.

c) The central branches of the middle cerebral artery do not supply the lentiform nucleus, the caudate nucleus, and the internal capsule.

d) The left middle cerebral artery supplies the entire lateral surface of the cerebral hemisphere, except for the narrow strip supplied by the anterior cerebral artery.

e) The left posterior cerebral artery supplies the occipital pole and the inferolateral surface of the cerebral hemisphere.

The answer is: C

Explanation: First of all, to be able to answer such questions you should imagine this artery supplies which area in the brain, and you should imagine the position of the vessel (the artery mentioned in the question is found on the lateral side)

a) true; because the leg is supplied by the anterior cerebral artery on the medial side.

b) true; because Broca and Wernicke both are supplied by the middle cerebral artery.

c) wrong; because the middle cerebral artery participates in the blood supply.

d+e) true.

Second Question:

Select the correct answer:

a) The primary visual area is located in the walls of the parietooccipital sulcus.

b) The visual cortex receives afferent fibers from the medial geniculate body.

c) The right half of the visual field is represented in the visual cortex of the right cerebral hemisphere.

d) the superior half of the visual field passes to the inferior portion of the visual cortex.

e) The secondary visual area (Brodmann areas 18 and 19) is surrounded by the primary visual area on the medial and lateral surfaces of the hemisphere.

The answer is: D

Explanation:

a) wrong; because it's found on the calcarine sulcus not on the parietooccipital (Parietooccipital sulcus if found 1 cm on the lateral surface then it curves on the whole medial surface, so it has no relation with the primary visual area.

b+c+e) wrong

d) true.

Now Let's start with the main topic of this Sheet:

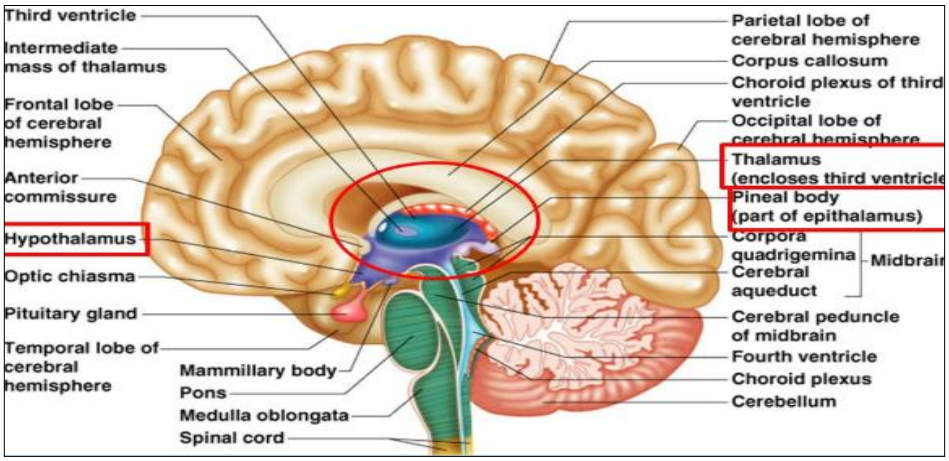
DIENCEPHALON

It is the area that lies between the two cerebellar hemispheres, it's developed embryologically from the forebrain vesicle, forebrain vesicle is divided into three vesicles:

two telencephalic which will give the cerebral hemisphere, basal nuclei and the internal capsule.

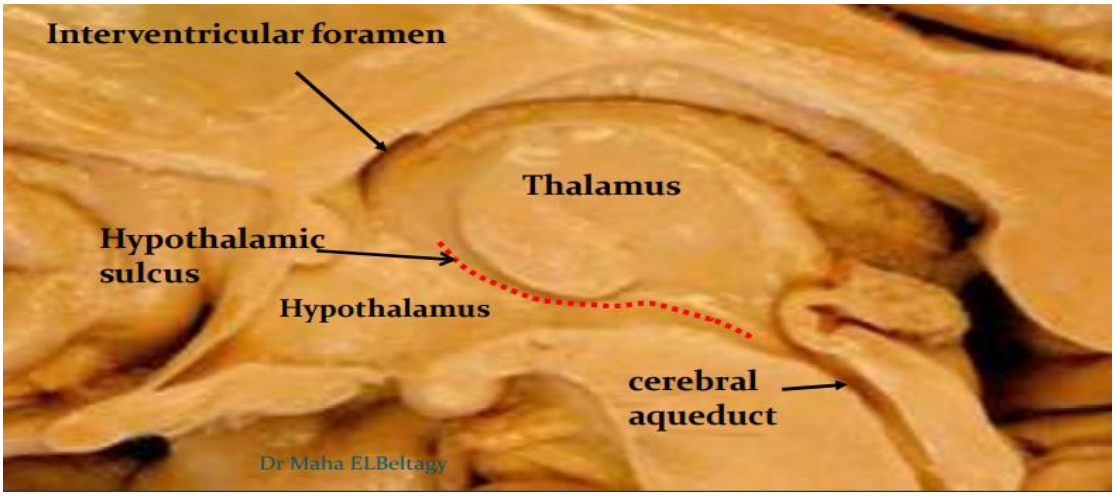
diencephalon (the middle vesicle) which is comprised of:

- Thalamus
- Hypothalamus
- Subthalamus
- Epithalamus
- Metathalamus



* Notice the position of the third ventricle in the picture above.

Look at the picture below then read the info below it:



Thalamus: This is the shape of the thalamus, it appears in the sagittal section as well as the medial side of the brain. It lies above the hypothalamus.

* There is a sulcus that separates between the thalamus and the hypothalamus which is called **Hypothalamic sulcus**, this sulcus extends from the interventricular foramen to the upper part of the cerebral aqueduct.

* Hypothalamic sulcus relations: The thalamus lies above it , epithalamus lies posterior to it, hypothalamus and the subthalamus lie inferior to the sulcus.

Other components of the diencephalon:

1- Epithalamus= Pineal gland + Habenular and posterior commissures:

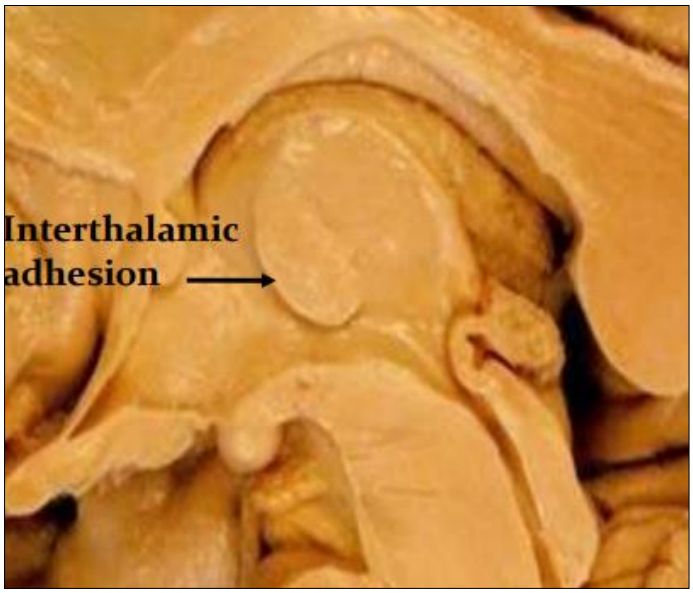
One of the structures that are related to the thalamus is the pineal gland, above it there is a commissure called Habenular commissure and below it there is another commissure called posterior commissure. And as written above the epithalamus is composed of all these three structures.

2- Subthalamus:
It is the small area that lies below the hypothalamic sulcus and above tegmentum of the midbrain.

3- Metathalamus:
It consists of two nuclei called: Medial and Lateral Geniculate bodies.

4- Hypothalamus:
Group of nuclei, most of it lies in the interpeduncular fossa.

Now, let's dig deeper in the **Thalamus:**



- It is a large relay station in the brain, that receives all sensation signals.

- Between both parts of the thalamus there is interthalamic adhesion, that connects both parts of the thalamus at their medial surfaces.

- Thalamus lies in the floor of the body of the lateral ventricle (remember that the floor of the lateral ventricle is composed of: thalamus and body of caudate nucleus)

- Thalamus lies in the lateral wall of the third ventricle.

**** it's important to memorize the relation between the thalamus and the ventricles.**

Thalamus is **Oval** in shape and has **2 ends** and **4 surfaces**:

Anterior end: narrow and forms the posterior boundary of the interventricular foramen (IVF).
* Note: Interventricular foramen is bounded anteriorly by the anterior column of the fornix, and posteriorly by the anterior end of the thalamus.

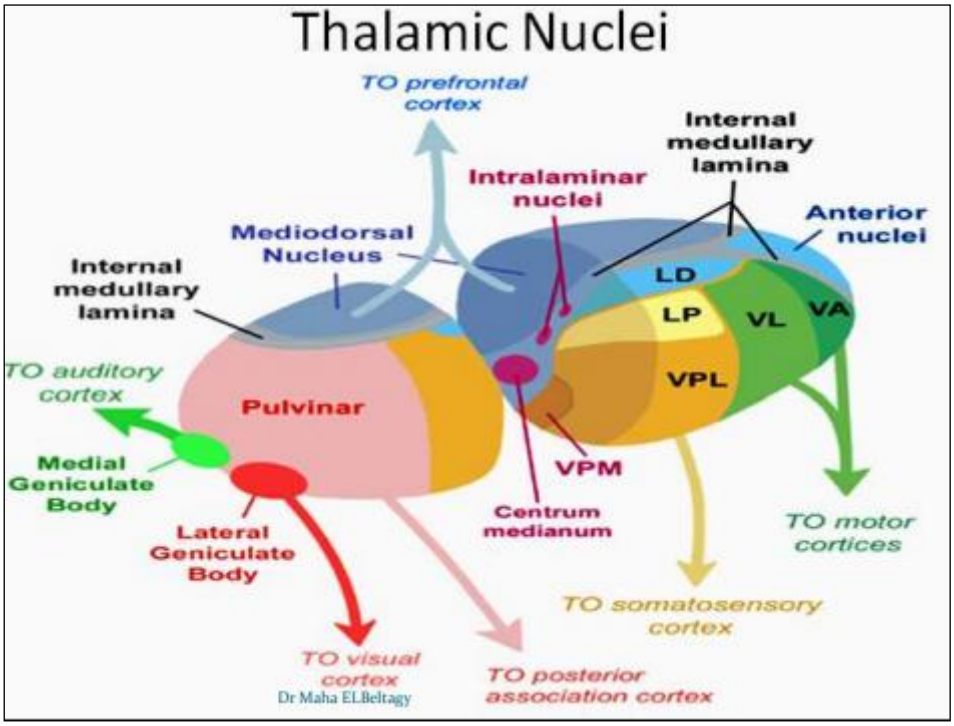
Posterior end: It's connected to the epithalamus, the posterior end has another name (**Pulvinar**) which overhangs the 2 nuclei: medial and lateral geniculate bodies (MGB and LGB respectively).

Upper surface: is related to the floor of body of lateral ventricle. The upper surface is separated from the fornix by the Choroid fissure (remember that the choroid plexus of the lateral ventricle and the choroid plexus of the third ventricle pass through this fissure).

Medial surface: forms the lateral wall of third ventricle

Lateral surface: related to caudate above and to lentiform below separated from it by posterior limb of internal capsule.

Lower surface: hypothalamus anterior and subthalamus posterior



Thalamus has a lot of nuclei; each nucleus receives a particular type of signal either sensory or motor (the thalamic nuclei aren't just for sensory signals).

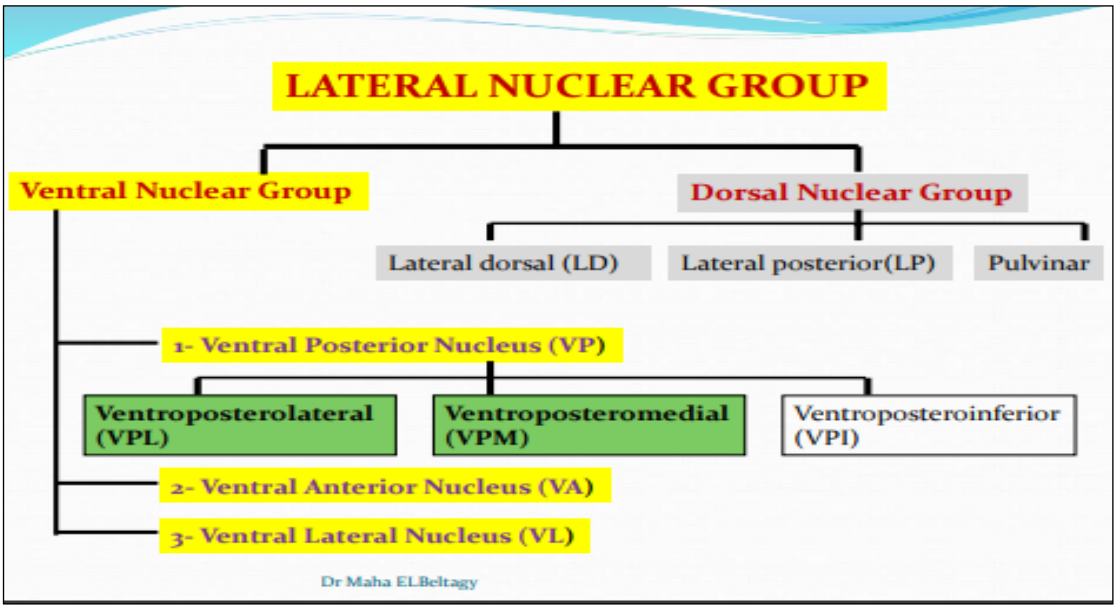
- Sensory signals are transmitted through certain tracts called spinal lemnisci, lateral and ventral spinothalamic, the name implies that the signal will go to the somatosensory region (nuclei) of the thalamus where they will relay. Once the sensory information has been transmitted to the thalamus, it is sent to the postcentral gyrus in the parietal lobe in the cerebral cortex (to be specific the signals will go to area 3,1,2).

Which one of these nuclei are most important? And what should we know about those nuclei?

First of all, all what you need to know about the thalamic nuclei will be written in this sheet, anything else won't be included ^^

- Now, look at the image above and notice the Y shaped lamina, it's called the internal medullary lamina, this lamina divides the thalamus into medial and lateral parts.
- Between the bifurcation of the stem of the Y shaped lamina (the two limbs of the Y) lies Anterior nucleus of the thalamus

Remember: As we said previously, the posterior end of the thalamus (pulvinar) has 2 nuclei (MGB and LGB) which form the metathalamus.



Lateral nuclear group is the most important structure in the thalamus, all the ascending and descending tracts do their function in the lateral nuclear group.

- Lateral nuclear group is divided into ventral and dorsal Lateral nuclear groups (don't pay much attention to the dorsal one because our main focus will be on the ventral group).

Ventral Nuclear group is further subdivided into: **VP, VL and VA** nuclei.

* All what I need to Know about **VA and VL** nuclei is they are specific to motor activity signals, and at the end there will be connection between VA and VL with the motor cortex and there will be certain circuits with the basal nuclei and cerebellum (we aren't supposed to know what are these circuits, but we should know that VA&VL are motor nuclei).

VP is divided into:

a) VPL. We'll hear a lot about VPLNT (ventral posterolateral nucleus of the thalamus) when we study the spinal cord.
b) VPM
c) VPI. (not very important).

Why do VPL and VPM are important?

Because they are responsible about receiving sensation signals from all the body.

VPL will receive signals from spinal lemniscus (tract) such as ventral and lateral spinothalamic (we mentioned them in this sheet previously) which transmit pain, temperature and touch sensations.

Those ventral and lateral spinothalamic will go through spinal lemnisci to relay in the VPL nucleus in the thalamus, from this nucleus sensory radiation will be sent to area 3,1,2 in the parietal lobe in the cortex.

VPM is special for the trigeminal tract, that means it transmits sensations of the face, this trigeminal lemniscus/tract ends in VPM nucleus and from there it will go to the lower part of the 3,1,2 area in the cortex (remember that the lower area is special for receiving sensory signals from the face).

Thalamic Connectivity and function:-

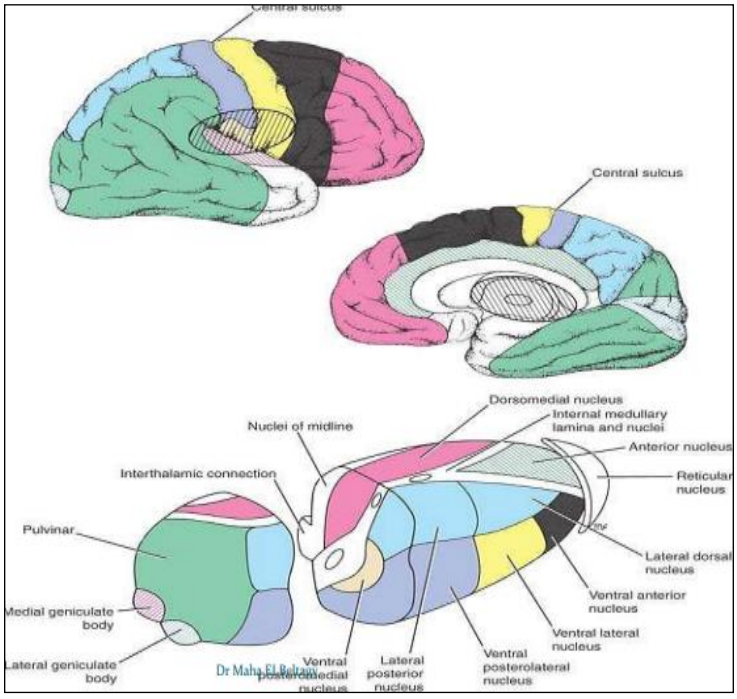
I. Sensory Input: All types of sensation (general sensation, special sensation, taste, equilibrium, hearing, vision) will go to VPM & VPL nuclei in the thalamus.

II. Motor Input: it will be connected to the parts that control movement (cerebellum, basal ganglia), VA and VL will receive the motor input in the thalamus.
III. Reticular Formation.

IV. Limbic System: there is a certain nucleus in the hippocampus that is connected with the thalamus (mammillary nucleus and hippocampus).

Student question: How to know each nucleus in the thalamus is connected to which part in the cerebral cortex?

Answer: this picture on the right gives the same colour for each part in the cerebral cortex that is connected to its related nuclei in the thalamus.



For example;
a) the lined green part of the cerebral cortex (the cingulate gyrus -that contains the limbic system-) is represented in the anterior nucleus in the thalamus.

b) VPL and VPM nuclei in the thalamus that are coloured with light blue are connected to the postcentral gyrus (remember that they are sensory).

c) Precentral gyrus is connected to the VL nucleus.

The information in the previous picture is arranged in the table below (not all the information in the table are required just the highlighted ones which I will explain):

Nucleus	Afferent	Efferent	Function
Anterior	Mammillothalmic tract,cingulate gyrus, hypothalamus	Cingulate gyrus,hypothalamus	Emotion and memory
Dorsomedial	Prefontal cortex, hypothalamus	Prefontal cortex, hypothalamus	Intergration 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	Trigiminal lemniscus	Area 3,1,2	general sensation
VPL	Medial & spinal lemnesci	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

The important information from the table above:

- VA & VL nuclei function is related to motor activity.
- VPM receives from trigeminal lemniscus and sends to area 3,1,2. And its function is related to general sensation of the face.
- VPL afferent fibers are medial and spinal lemnisci, it transmits general sensation of the opposite half of the body.
- LGB afferent fiber is the optic tract that is connected to visual cortex, so this nucleus has a function related to vision.
- MGB afferent fiber is from lateral lemniscus which goes to the superior temporal gyrus for hearing.

SUMMARY for the table:

- ❖ VA, VL → Motor activity.
- ❖ VPM,VPL → General sensation → area 3,1,2
- ❖ MGB → Hearing.
- ❖ LGB → Vision.

**** NOTE:** all the previously mentioned nuclei are *Lateral nuclei* in the thalamus except *MGB&LGB* which are found *posteriorly*.

Thalamic Radiations:

The doctor said that she talked about this topic in the basal ganglia online lecture (she said this topic is VERY important!)

What do we mean by thalamic radiations is that they are large bundles of nerve fibers connecting the thalamus with the cerebral cortex by way of the internal capsule, and they are four in number:

First Radiation: Anterior thalamic Radiation (Thalamocortical):
Fibers of the anterior nucleus are connected to the frontal lobes of the cingulate gyrus (limbic system), then it ascends in the anterior limb of the internal capsule.

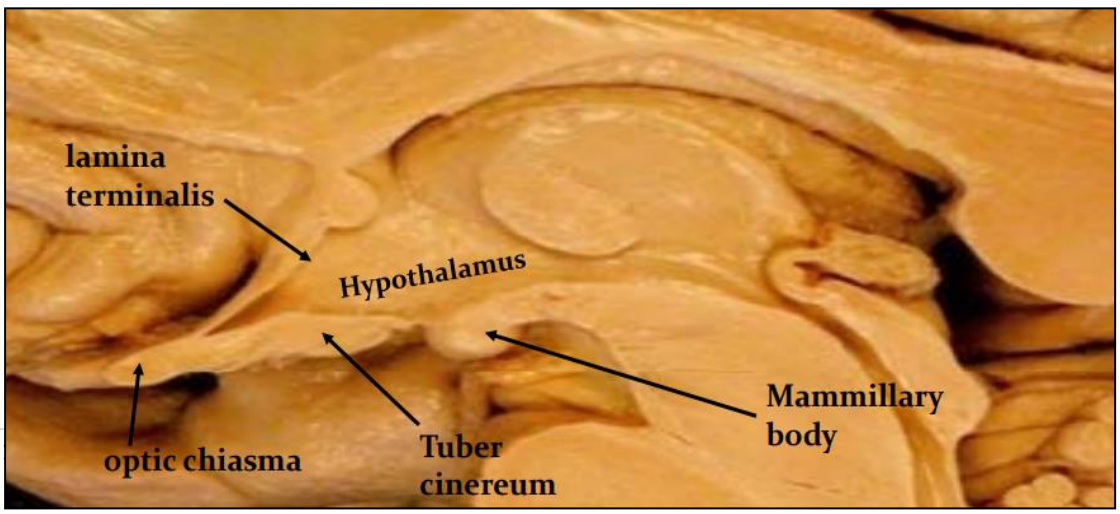
Second Radiation: Superior thalamic Radiation (sensory radiation):
This is the most important radiation, it transmits the sensation from VPL and VPM to area 3,1,2 then it ascends through **posterior half** of posterior limb of the internal capsule.

Third Radiation: Posterior thalamic Radiation (optic radiation):
From LGB to visual cortex, Retrolentiform part of the internal capsule
** it's called posterior thalamic radiation because it's directed toward the occipital lobe.

Fourth Radiation: Inferior thalamic Radiation (auditory radiation):
Between MGB and the auditory area in the sublentiform.

** it's called Inferior thalamic radiation because it's directed toward the inferior temporal lobe.

Now, we're going to talk about the **hypothalamus** (the doctor didn't mention a lot of details):
The hypothalamus is found inferior to the hypothalamic sulcus (remember, it connects between interventricular foramen and the cerebral aqueduct).



In the previous lectures, when we talked about the walls of the third ventricle we said that there is a structure called anterior commissure with Lamina terminalis which are directed downward to end in the optic chiasma. From the optic chiasma if we go posteriorly we'll notice the Tuber cinereum which hangs the Infundibulum, the infundibulum holds the pituitary gland, and the last structure in the hypothalamus is called Mamillary body.

* We can understand that the hypothalamus begins from the beginning of Lamina terminalis → optic chiasma → tuber cinereum→ Mammillary bodies.

* Also, we can notice that the hypothalamus is divided into two parts:
a) Horizontal Part: tuber cinereum and Mammillary bodies.
b) Vertical Part: Lamina terminalis and optic chiasma.

Function of the Hypothalamus: The doctor read the slide quickly:

1) Homeostasis (food intake, water and electrolyte balance, temperature regulation and circadian rhythm.
2) Endocrine control via pituitary gland (Growth hormone, reproductive hormones, stress hormones).
3)Autonomic control (sympathetic and parasympathetic responses).
4) Limbic function (memory and emotions.

Epithalamus:

As we said previously, it consists of pineal gland, Habenular commissure and anterior commissure.

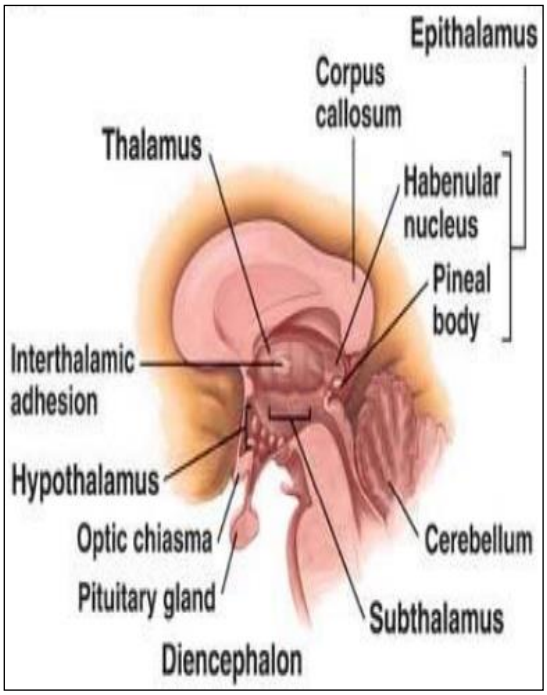
* Habenular nucleus is the nucleus founded inside the habenular commissure, there is something called medial and lateral Habenular nuclei.

* Pineal gland is found inferior to the splenium of corpus callosum.

What is the function of the epithalamus?

1) Connects the limbic system and other parts of the brain.

2) Pineal gland secretes melatonin which regulates the dark-light cycle



Metathalamus:

You already know that it is composed of LGB & MGB (we talked about their connections previously in this sheet"

Subthalamus:

The doctor said that if you watched the basal nuclei online lecture you'll know that there is direct and indirect pathways, subthalamus is involved in the indirect pathway because it has motor activity of the brain, also that's why it's considered as the motor zone of the hypothalamus.

The location of the subthalamus is below the thalamus and above the tegmentum of the midbrain.

In the last part of this lecture the doctor continued the part of the first lecture that wasn't explained.

Sensory areas

Postcentral gyrus represents the primary sensory area (**area 3,1,2**), what is this area?

localize, discriminates different sensations (it receives the sensation through VPM and VPL).

A lesion in the primary sensory area causes **Contralateral hemianathesia**: half of the patient's body won't feel the stimulus; if the lesion was in the right postcentral gyrus the patient will suffer from left contralateral hemianathesia and vice versa.

- Inferior to the postcentral gyrus around the posterior ramus there is a newly discovered area called secondary sensory area, this area is still under trials, the scientists said that its function is restricted to sensation coming from objects with tooth (toothbrush for example).

- Another area is called Somatosensory association area; the function of this area is understanding and interpretation of the signals, it links all the stimuli and can differentiate the 3D shape of each stimulus. If there was a lesion in this area this case will be called **Astereognosis**; which is the inability to identify the object with closed eyes, for example: you won't be able to know that you're hold a pen while closing your eyes.

The somatosensory association area is found in the superior parietal lobule and part of the inferior parietal lobule; because in the rest of the inferior parietal lobule there is another important area which is called Wernicke's

which is found around the posterior part of the posterior ramus of the lateral fissure, when this fissure goes a little bit superiorly, there would be another area called Angular area (area 39), the angular area should be attached to other visual areas because its function is in audio-visual linking.

** A lesion in Wernicke's causes **Fluent aphasia**, remember that the non-fluent aphasia is caused by a lesion in **Broca's area.**

How can we get the sensory-motor function?

The tract that controls the fine movements descends from the cortex (area 4), its fibers will go to the internal capsule, then they will go through midbrain, pons and medulla until they reach the spinal cord (keep this pathway in your mind I will refer to it in just a moment)

As we know that there is another area called premotor area which controls the coarse movement, it modifies the posture and coordinate the function of different large muscles.

There is a tract called the **pyramidal tract**, which transmits impulses from the cerebral cortex to the spinal cord, this tract's fibers come from: 40% comes from premotor area, other fibers come from the primary motor area, also, there are fibers that descend from precentral gyrus (sensory area) in the pyramidal tract.

There are other structures called: extrapyramidal tracts and extrapyramidal centers what are these?

Extrapyramidal tracts are part of the motor system network. The system is called extrapyramidal because its fibers don't reach the pyramid of the medulla oblongata, they might reach the pons, midbrain or in the medulla but outside the pyramid, the function of extrapyramidal tract is coordinate and process motor commands.
Example of extrapyramidal tracts:
Vestibulospinal tracts, Tectospinal tracts, Rubrospinal tracts, Reticulospinal tracts.

NOTE: Any tract that doesn't reach the pyramid of the medulla will be called Extrapyramidal tract.

* Extrapyramidal tracts don't work alone, they are under the control of **Extrapyramidal centers** that are found in the cerebrum and cerebellum (they are found in the basal ganglia, premotor area, SMA).

** If you don't understand the idea above, don't worry! We'll learn more about in the spinal cord lectures inshallah. But please remember that the postcentral has primary sensory area, and superior parietal lobule has somatoassociation area.

Visual Cortex:

Primary visual area (area 17) is found around the calcarine fissure, part of this area is on the cuneus and the other one is on the lingual gyrus.

Around area 17 there is another area called Visual association area (area 18). Generally speaking, a lesion in any association area will cause **AGNOSIA** which means the disability to identify or understand the signals (hearing agnosia, visual agnosia,..).
Visual association area is found in the medial and lateral sides of the rest of occipital lobe (the part that is not from primary visual area).

Occipital eye field: we took previously about frontal eye field where its function was conjugate eye movement to the opposite side, and we said that it's voluntary. Occipital eye field is found in the occipital lobe, it controls the reflexed action of the eye, for example: if someone scream behind you while you are studying this sheet, the movement of your eyes will be called reflexed movement and it's controlled by the occipital eye field.

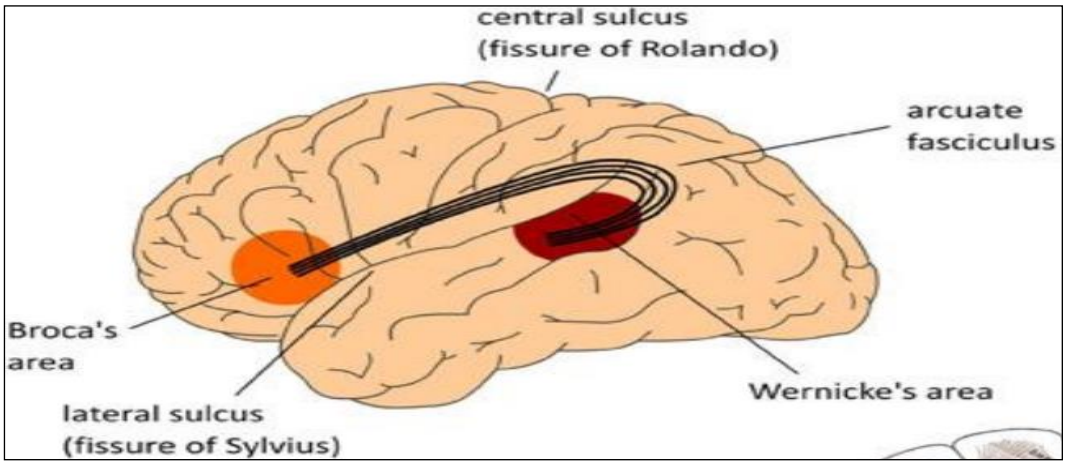
Auditory\Hearing area:

Primary Auditory area (area 41+42) is found in the middle of superior temporal gyrus, auditory association area is found in the rest of the superior temporal gyrus (area 22).

The doctor didn't mention any extra information about this area and she said we should read the rest of the information from the slides (slide 52-55).

Language area:

Language area has motor and sensory parts:



1) Motor Language area (Broca's area): it's found in the inferior frontal gyrus. A lesion in this area will cause **non-fluent aphasia**: poor speech with good comprehension; the patient is able to understand the words but he cannot do coordination to different muscles of speech.

2) Sensory Language area (Wernicke's area): it's composed of three areas not just one (Angular, Supramarginal, Posterior part of the auditory association area) more information is found in the online videos. If a patient has a lesion in this area he won't be able to understand both written and spoken words (**Fluent aphasia).**

-LOOK at thw picture above and try to identify the areas mentioned above.

Question: can the Wernicke's area function without the Broca's area?

Absolutely NO, how can I speak if I wasn't able to read and understand! There must be a connection between these two areas, this connection is called arcuate fasciculus which is a bundle of association fibers that connects the Wernicke's area with the Broca's area.

Motor Apraxia: We talked about it in the previous lectures, the patient won't be able to do the movement not because of paralysis of the muscles but because there is a certain defect in the corpus callosum, in the postcentral gyrus, or in premotor area 6.

Don't hesitate to ask me anything about this sheet

Your colleague:

Lojayn Salah