

CNS

ANATOMY

13

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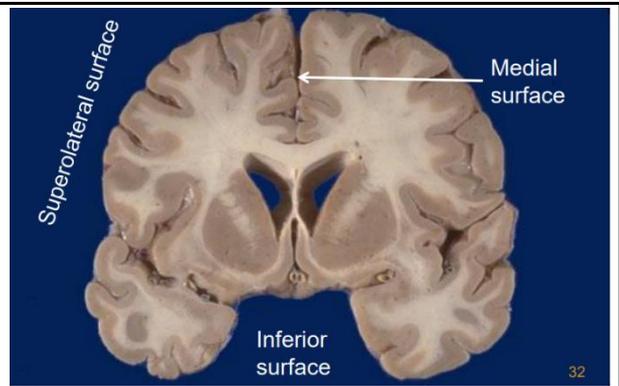
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The surfaces of the cerebral hemisphere:

Each hemisphere has 3 surfaces:

1. Superolateral surface
2. Medial surface
3. Inferior surface



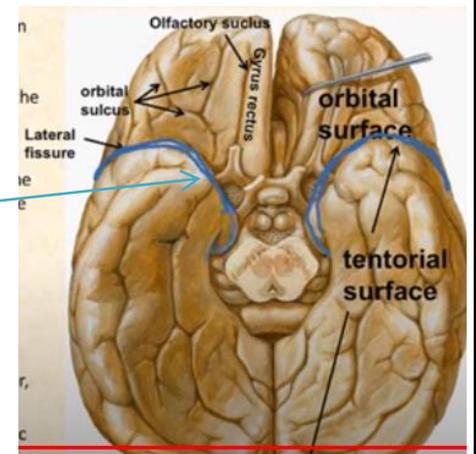
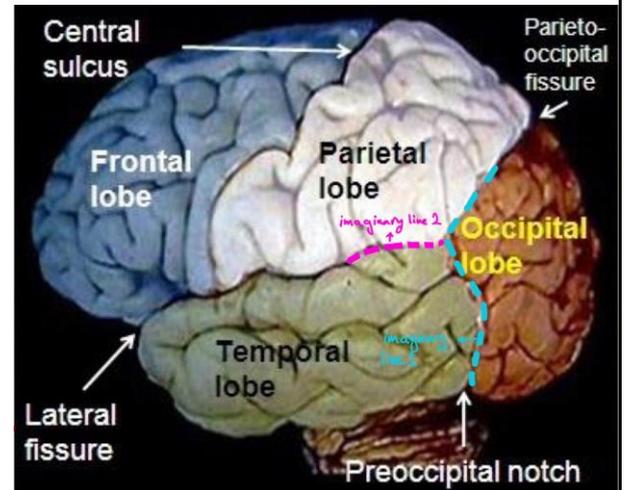
We have four lines which divide each hemisphere into 4 lobes: -keep your eyes on this pic throughout the upcoming four points-

1. Central sulcus (of Rolando):

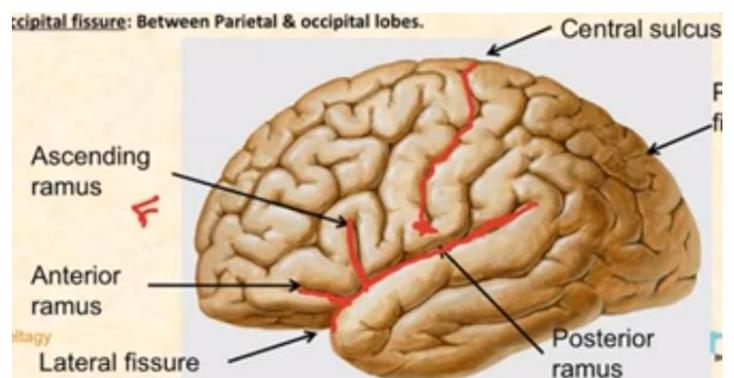
- It extends from the superomedial border (upper one inch of the medial surface) at a point a little behind the midpoint between the frontal & occipital poles and ends **slightly above** the middle of the posterior ramus of the lateral fissure. (Pay attention: It does **not** meet the posterior ramus of the lateral fissure). So it begins on the medial surface then it runs through the superolateral surface of the brain.
- The central sulcus separates the frontal lobe anteriorly and the parietal lobe posteriorly.

2. Posterior ramus of the lateral fissure:

- the lateral fissure (of sylvius) begins on the *inferior surface* of the brain lateral to the anterior perforated substance, this part of the lateral fissure is called the **stem** of the lateral fissure, then it extends horizontally and laterally to reach the superolateral surface of the brain where it divides into 3 branches :



- **Anterior ramus:** Runs forwards(anteriorly) in the inferior frontal gyrus
- **Ascending ramus:** Ascends in the inferior frontal gyrus.
- **Posterior ramus:** Runs backwards & ends by turning upwards in the parietal lobe.



3. **An imaginary line between parieto-occipital fissure and preoccipital notch:** (imaginary line 1 in pic above):
 (parieto- occipital fissure -which is between parietal & occipital lobes- exists along the **medial** surface and extends to the upper one cm on the superolateral surface (the opposite of the central sulcus), (pre-occipital notch is located in the lower margin of the brain).
4. **An imaginary line connecting the posterior ramus of lateral fissure to meet the previous imaginary line** we will end up having → (imaginary line 2) see the picture above.

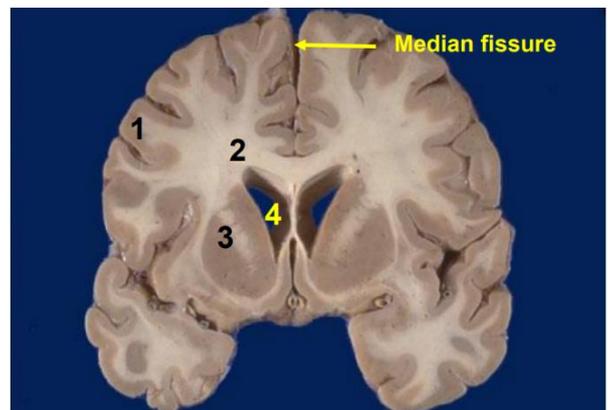
SO at the end we will have four lobes:

1. Frontal lobe: anterior to the central sulcus.
2. Parietal lobe: posterior to the central sulcus until we reach the parieto-occipital fissure and the imaginary line between parieto-occipital fissure and preoccipital notch (imaginary line 1)
3. Temporal lobe: below the posterior ramus of the lateral fissure and the imaginary line (imaginary line 2).
4. Occipital lobe: which lies behind the imaginary line between parieto-occipital fissure. and preoccipital notch (imaginary line 1).

Components of the cerebral hemisphere (coronal section)

It consists mainly of (please notice the numbers applied on this picture, you will refer back to them many times throughout this sheet)

- 1- Outer grey matter (cerebral cortex)
- 2- White matter.
- 3- Basal nuclei (inner grey matter)
- 4- Lateral ventricle.



- Remember: Grey matter is a collection of neuronal cell bodies / white matter is a collection of axons.

✚ The grey matter in the coronal section is of two main areas:

- Outer grey matter or **cerebral cortex**
- Basal nuclei (inner grey matter)

NOTE:

You can imagine the Coronal section as if you cut the brain at the coronal suture in the skull

1. Cerebral cortex(outer grey matter):

- ❖ 2-3 mm in thickness. However, its weight is 30-40% of brain's weight because it extends inside the gyri of different areas of the brain.
- ❖ Each cerebral hemisphere is concerned with the sensory and motor functions of the opposite side (**contralateral side**) of the body.

Why?

Functions

- It is very important for the process of the **consciousness**
- Allows for sensation, voluntary movement, self-awareness, communication, recognition, and more.
- Has an importance in **learning** process and synapses between neurons

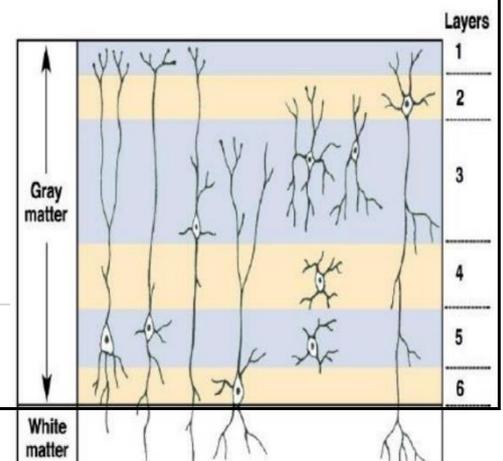
✚ What is the difference between consciousness and alertness??

- Consciousness occurs when the sensation from different parts of the body and internal organs reaches the cortex (if it does not reach the cortex, we will not be aware of these sensations). Also if the orders are not arising from the cerebral cortex the motor execution will not be formed. Consciousness is the function of cerebral cortex.
- Alertness is not a function of the cerebral cortex; it is the function of the **reticular formation**. (Reticular formation: is a collection of grey and white matter inside the brain stem that is responsible for alertness), so an example here is that when you sleep the reticular formation will sleep with you, thus it will not send excitatory impulses (stimulation) to the cerebral cortex, therefore we conclude that the reticular formation stimulates the cerebral cortex as long as you are awake. **So there is no consciousness if there is no alertness.**

The layers of the cerebral cortex: the details of the cerebral cortex are not that much important for you to memorize, just focus on LAYER 5; the most important layer and its component. (This what the doctor said)

✚ the cerebral cortex is divided histologically into six layers (the numbers begin from outside to inside):

- **1st layer (Molecular layer):**
Has axons and dendrites of many neurons whose cell bodies are found in other layers. **There are no cell bodies in this layer.**
- **2nd layer (external granular layer):**



Has densely packed **stellate cells** and **small pyramidal cells** (the pyramidal cells have different sizes)

- **3rd layer (external pyramidal layer):**

Has **medium pyramidal cells** and loosely packed **stellate cells**

- **4th layer (internal granular layer):**

Has *only* densely packed **stellate cells**.

- **5th layer (internal pyramidal layer)**

Has the **largest pyramidal cells**.

It is the most important layer in the cerebral cortex. Why?? As it has the majority of **giant pyramidal cells of betz**, which bring out the pyramidal tracts (the major projection fibers that control the movement of other side of the body).

- **6th layer (multiform layer)** has multiple sized pyramidal cells and loosely packed stellate cells.

Layers	Components	Schematic	Afferents	Efferents
I – Molecular	Axons and Dendrites (Cell processes)		From other regions of Cortex and Brainstem	To other regions of cortex (Intra-cortical Association functions)
II - External granular	Densely packed Stellate cells + Small pyramidal cells			
III – External pyramidal	Loosely packed Stellate cells + Medium pyramidal cells			
IV – Internal granular	Densely packed Stellate cells only		+ From Thalamus	
V – Internal pyramidal	Large pyramidal cells only (few stellate cells) – Giant Pyramidal cells of Betz		+ From Brain stem	To Brain stem & Spinal cord (Projection fibers)
VI - Multiform	Multiple sized pyramidal cells + Loosely packed stellate cells			To Thalamus

After these layers we have the **white matter** which is the axons of the different types of cells which exist in the cortex.

2. Basal nuclei: another type of grey matter

Function

It is very important in controlling and sequencing **motor movement**. *It has no relation with the sensory function of the brain* (will be discussed later).

3. white matter: -many details of these will be mentioned in future lectures, just have an overview till now-

- Divided into three types of fibers: **commissural** fibers, **association** fibers and **projection** fibers
- **Corpus callosum** (go to sagittal section in page 8): is the biggest type of commissural fibers, which are around three hundred millions of neurons that **connect between the right and the left hemisphere**, < if you cut these connections between the right and left hemisphere you will have a phenomena called **brain disassociation** in which your right side of the body that's controlled by your (left hemisphere) is not aware of your left side of the body that's controlled by your (right hemisphere), and so motor and sensory information which is produced by the right

Extra:

- **Commissural fibers** connect corresponding regions of the left and right hemispheres of the brain.
- **Association fibers** connect brain regions within the same hemisphere.
- **Projection fibers** connect the cerebral cortex to the brainstem and spinal cord.

cerebral hemisphere is working independently of that's produced by the left one, which usually results in a motor disorder called **apraxia** >.

- The internal capsule: is a very important white matter located between the basal nuclei. It consists of *projection* type of fibers.

4. Lateral ventricles:

Remember, ventricle means cavity, so what's the importance of these cavities inside our cerebrum?? They are important in the **lightening** the brain weight -the same concept that we see in the Para nasal sinuses which lightens the weight of the skull bones-.

- ✓ Inside these cavities we have **CSF** that resembles the lymph in our body, The CSF works as a scavenger for the waste products that we may have in our CNS as a result of the brain activity by draining them into the venous circulation of the brain.

✓ The ventricles of the brain:

- Two lateral ventricles: **One inside each cerebral hemisphere** (number 4 in the picture). We can call the right one the first ventricle and the left one the second ventricle or vice versa it does not matter.
- The third ventricle: located between the right and the left hemispheres.
- The fourth ventricle: lies between the cerebellum posteriorly and the brain stem anteriorly.

NOW LETS SWITCH GEARS!! By mentioning the anatomical sulci and gyri of each lobe, while the function of them will be in a separate lecture

- ✚ The surfaces of the cerebral hemisphere show elevations called **GYRI** & grooves called **SULCI**. (The gyri is the part that performs the function because it has the cerebral cortex)
- ✚ Deep sulci are called fissures.
- ✚ The surface of the hemisphere is divided into different areas. Each area contains a group of cells that perform a specific function.
- ✚ The sulci and gyri are named according to their anatomical locations.

The most important sulci of the superolateral surface are:
central sulcus + lateral fissure +
parieto-occipital fissure

- **Frontal lobe:** have a look on the pic in the next page

❖ Sulci of the frontal lobe -

The first thing to do here is to locate the **central sulcus**.

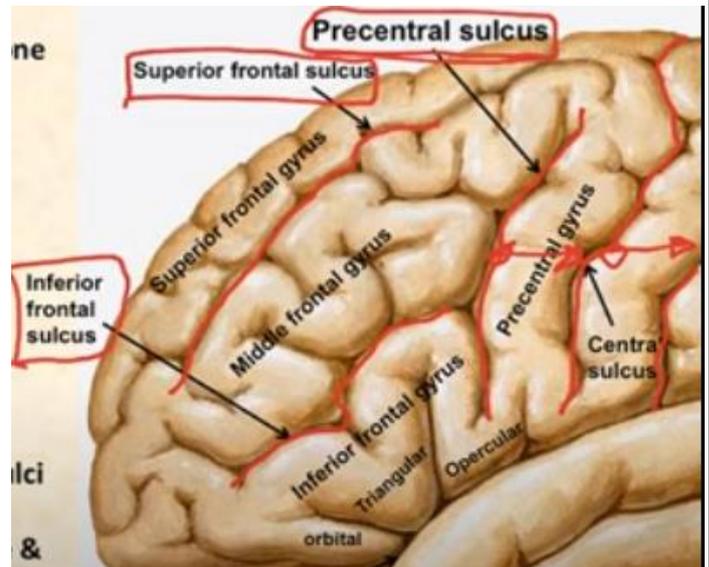
Note: parallel to central sulcus one fingerbreadth, we have two other sulci anteriorly and posteriorly. The anterior one is called **precentral** sulcus located in the *frontal* lobe and the posterior one is the **postcentral** sulcus located in the *parietal* lobe.

- **Precentral sulcus:** Parallel to & one finger in front of the central sulcus.
- **Superior frontal sulcus.**
- **Inferior frontal sulcus.**

❖ **Gyri of the frontal lobe:**

Each gyrus from these gyri has a function. Gyri in the frontal lobe are very important because the frontal lobe is the motor lobe of the brain. It is divided by the sulci of the frontal lobe into:

- **Precentral gyrus:** located between central & precentral sulci (the motor area of the opposite side of the body (motor area 4 in Brodmann classification)).
- Superior & inferior frontal sulci divide the remaining part equally into **superior frontal gyrus** (located superior to superior frontal sulcus), **middle frontal gyrus** (between superior and inferior frontal sulci) and **inferior frontal gyrus** (below the inferior frontal sulcus).



The inferior frontal gyrus is subdivided into three subgyri by anterior and ascending rami of the lateral fissure. REMEMBER: we have two limbs from the posterior lateral fissure in the frontal lobe (ascending ramus and anterior ramus).

1. **Orbital gyrus** (below the anterior ramus)
2. **Opercular gyrus** (below the ascending ramus)
3. **Triangular gyrus** (between the anterior and ascending rami)

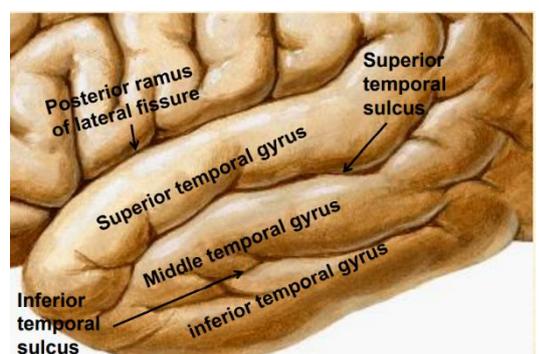
○ **Temporal lobe:**

❖ **Sulci & Gyri of the Temporal lobe:**

- It contains 2 sulci: **Superior & inferior temporal sulci.**
- The 2 sulci divide the temporal lobe into 3 gyri: **superior, middle & inferior temporal gyri.**

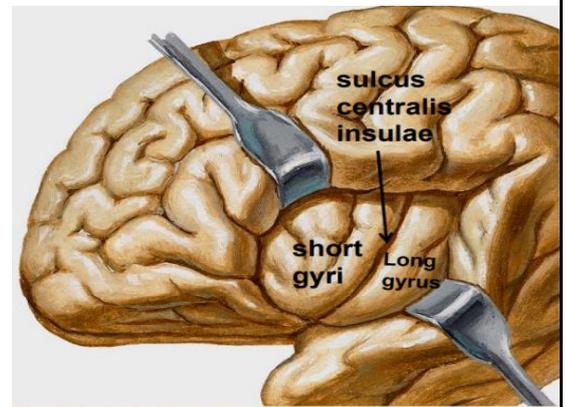
○ **The insula (Island of Reil)**

(It is called the 5th lobe because it has sulci, gyri and a separate function)



Side note: broca's area (an area located in the inferior frontal gyrus), is the motor area of coordination of different muscles **related to speech production**

- It lies at the bottom of the lateral fissure, so you have to separate the two lips of the lateral fissure to see it.
- It is conical in shape having a base (surrounded by circular sulcus) & an apex directed inferiorly towards the anterior perforated substance.
- It is divided by **sulcus centralis insulae** into:
 - **Anterior part divided into 3-4 short gyri.**
 - **Posterior part with one long gyrus** which is usually divided near its upper part.



Its Function

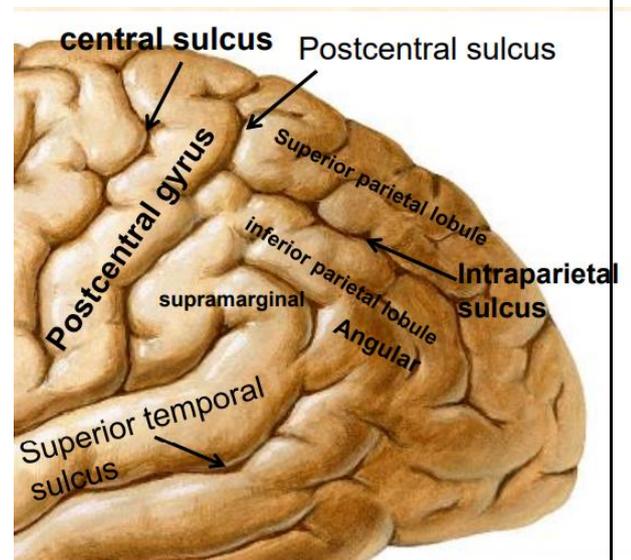
- ✓ : The insula is related to **taste** (gustatory area).
So when the taste is transmitted from different nerves (CN7,9,10), it will eventually reach the cerebral cortex (mainly the insula that's why it is called (higher gustatory center) after passing through the thalamus.
- ✓ Is also related to the **autonomic functions** of the slow pain like: sweating, tachycardia. **Remember:** We have fast and slow pain. The slow pain has an emotional aspect which is transmitted by a separate tract that is different from those of fast pain. Deep pain comes mainly from deep organs because it is predominantly long lasting. **THE Limbic system** (seen mainly in the sagittal section (medial side of the brain)) is responsible for the emotional aspect of the slow pain

○ Parietal lobe:

❖ Sulci & Gyri of the Parietal lobe:

The major sulci in the parietal lobe are: **postcentral sulcus and the intraparietal sulcus**

- **Postcentral sulcus:** parallel to & one finger behind the central sulcus.
- ❖ **Postcentral gyrus:** (Between the central & postcentral sulci): the sensory area of the opposite side of the body (this means that it receives the sensation that comes from the opposite side of the body).
- **Intraparietal sulcus:** Begins at the middle of the postcentral sulcus & divides the remaining part of the parietal lobe into: -
 - ❖ **Superior parietal lobule:** (lobule is a larger gyrus) above the intraparietal sulcus.



- ❖ **Inferior parietal lobule:** below the intraparietal sulcus.

Inferior parietal lobule is further divided into:

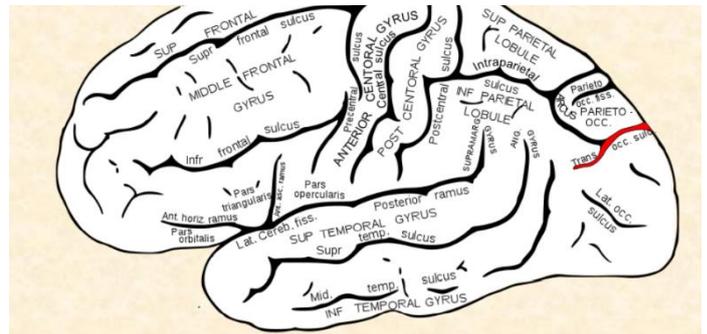
- ❖ **Supramarginal gyrus:** Above the upturned end of the post ramus of lateral fissure in other words, *around the posterior end of the posterior ramus of the lateral fissure.*
- ❖ **Angular gyrus:** Above the upturned end of superior temporal sulcus area 39 (*around the posterior end of the superior temporal sulcus*)
- ❖ **Posterior part:** Above the upturned end of the inferior temporal sulcus.

○ Occipital lobe:

- **Transverse occipital sulcus (lunate)**

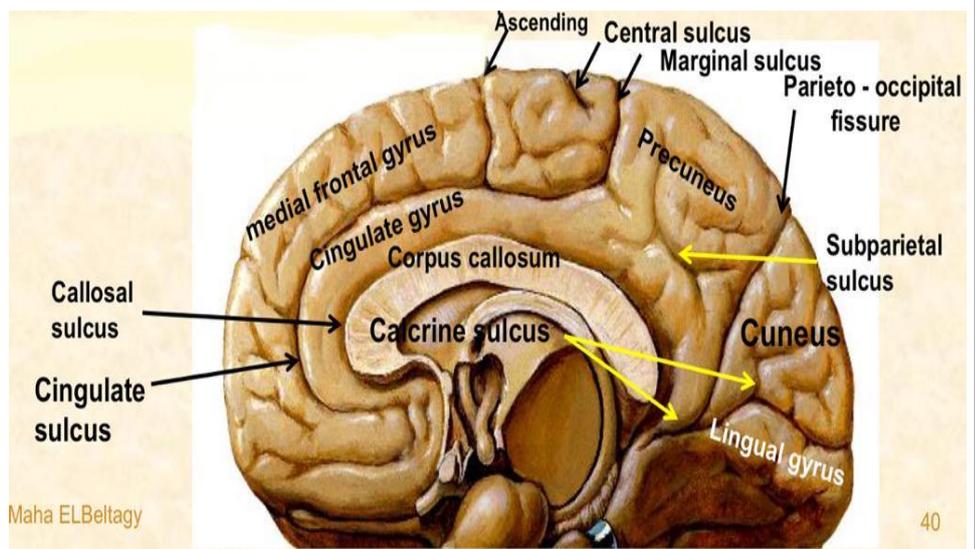
- **Lateral occipital sulcus (horizontal):** divides the lateral surface of the occipital lobe into a **superior and an inferior gyrus.**

- ✚ The function of the occipital lobe is mainly presented in the medial surface because the center of vision exists in the medial surface.



○ The medial surface (sagittal section):

- **Corpus callosum:** In the sagittal section we run in the longitudinal fissure, so we cut the connection between the right and left hemisphere which is **corpus callosum** (the biggest commissural fibers).
- **Fornix:** commissural fibers below the corpus callosum in the sagittal section.
- **The thalamus:** egg shaped structure below the fornix in the sagittal section (the largest sensory and relay station in the brain, the secretary of the brain, it receives all



sensations that come from the spinal cord and then distributes it to different parts of the brain. For example, if the sensation is vision, it will send this sensation to the occipital lobe. If it is pain, touch or temperature, it will send it to the parietal lobe or if it is related to the auditory system, it would send it to the temporal lobe.

- **Hypothalamus:** anterior to the thalamus.
- **Septum lucidum:** between the corpus callosum and fornix (this septum closes the cavity inside the cerebral cortex (the lateral ventricle)
If you cut the sagittal section correctly, you will see the septum lucidum.

So up to now we have from the superior to the inferior: corpus callosum then septum lucidum then fornix then thalamus and anterior to the thalamus we have the hypothalamus.

Sulci of the sagittal section:

- **Callosal sulcus** (surrounds corpus callosum), it is very important sulcus as it has the anterior cerebral artery (ACA) passing in it. (ACA originates from the internal carotid artery).
- **Cingulate sulcus:** runs above and parallel to callosal sulcus.
 - It begins with the anterior end of the callosal sulcus then curves around corpus callosum -does not surround the corpus callosum completely- it **terminates** by turning upwards to meet the superomedial border of the brain to form **the marginal sulcus** (the end of cingulate sulcus).
 - It also gives the **ascending ramus** of cingulate sulcus (like the ascending ramus from the posterior ramus of the lateral fissure)
- **Subparietal (suprasplenic) sulcus:** appears as a continuation of cingulate sulcus in the medial side of the parietal lobe.

Nomination

Why suprasplenic?? Because it is above the splenium (part of corpus callosum). The parietal lobe has the intraparietal fissure in the superolateral surface & **Subparietal (suprasplenic)** sulcus in the medial surface.

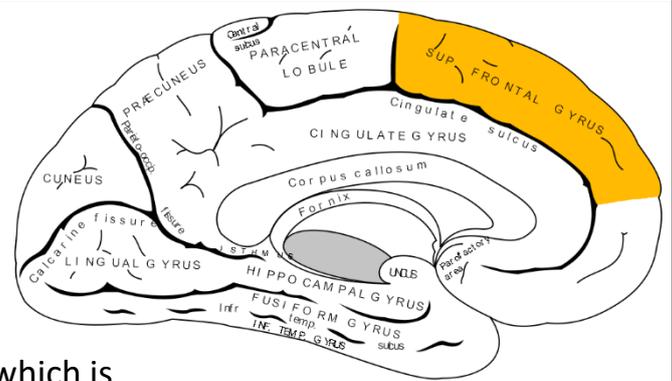
- **Parieto-occipital fissure:** between the parietal & occipital lobes, this extends totally in the **medial surface** as we mentioned before; do you remember that? Here it is in the sagittal section check it out!
 -
 - **Calcarine sulcus** or calcarine fissure (fissure is a deep sulcus): begins near the occipital pole. Its importance comes from its location around the visual area.

Gyri of the sagittal section:

- ❖ **Cingulate gyrus:** lies between Corpus callosum (or callosal sulcus) & cingulate sulcus.

It is important as it represents the main part (the main gyrus) of **the limbic system**

and this is why we called it **the limbic lobe** which is considered the 6th lobe of the brain. Little about the limbic system in the next page. So we have 4 anatomical lobes in the lateral surface, and the insula (5th lobe) and finally the limbic lobe (6th lobe).



- ❖ **Paracentral lobule:** lies between ascending ramus and the marginal sulcus.

Importance → It has the motor and sensory area of the lower limb. Also, it controls the movement of the sphincters in the body.

- ❖ **Medial frontal gyrus:** (sup frontal gyrus in the picture)

Anterior to the paracentral lobule.

Function → it plays a role in human's personality.

- ❖ **Cuneus:** is the wedge area between the parieto-occipital fissure & the calcarine sulcus.

Function → it has the *visual association center* which helps the visual area in understanding the visual stimulus.

- ❖ **Precuneus:** lies in front the parieto-occipital fissure and posterior to the end of cingulate sulcus (marginal sulcus) which is the medial aspect of the parietal lobe.

Function → Plays a role in memory.

- ❖ **Lingual gyrus:** below calcarine sulcus.

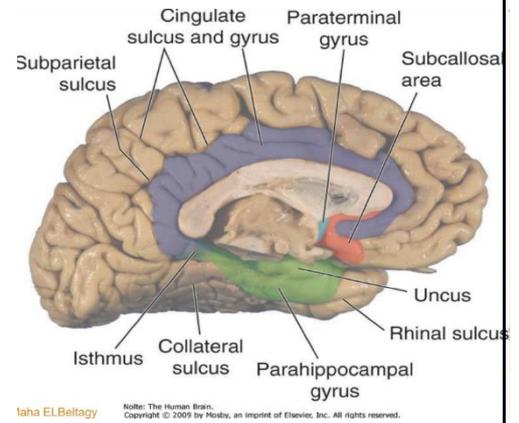
Function → has an importance in visual association area.

Namonation

It resembles the shape of the tongue and thus called lingual gyrus.

▪ The Limbic system:

It consists of nuclei and tracts that exist in the cerebrum (between the cerebrum and the hypothalamus, also between the cerebrum and the thalamus). The major gyrus that represents this system is the cingulate gyrus.



Its Function

Related to the control of the **emotions, behavior, sexual** function and has a

role in **olfaction**.

✓ **The Limbic loop** begins at the subcallosal area (anteriorly), then continues as cingulate gyrus, then goes inferiorly as para-hippocampal gyrus in the temporal lobe. (The limbic circuit and the limbic loop will be discussed in a separate lecture).

Summary:

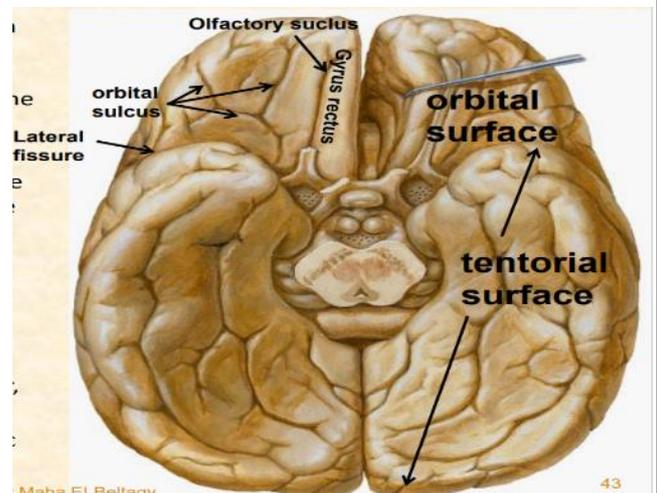
- ✚ The Sulci of the medial surface from posterior to anterior:
 1. Calcrine sulcus (fissure). 2. Parieto-occipital fissure. 3. Marginal sulcus. 4. Central sulcus. 5. Ascending sulcus (the marginal +ascending sulci are part of cingulate sulcus).
 - The Callosal sulcus is above the corpus callosum.
 - The Cingulate sulcus is above the callosal sulcus.
 - Subparietal sulcus is located in the medial aspect of the parietal lobe.
- ✚ The gyri of the medial surface (posterior TO anterior)
 1. Lingual gyrus. 2. Cuneus gyrus. 3. Precuneus gyrus. 4. Paracentral gyrus. 5. Medial frontal gyrus +cingulate gyrus

Sulci & Gyri of the inferior surface of the brain:

- ✚ The inferior surface is divided by the **stem** of the lateral fissure into a smaller anterior part known as the orbital surface which exists above the orbital bone & (a posterior part known as the tentorial surface).

✓ The orbital surface contains the following:

- **Olfactory sulcus:** located medially in the orbital surface near & parallel to the median fissure.



Namonation

The olfactory sulcus is named so because it contains the olfactory bulb. (Olfactory epithelium → olfactory stria → olfactory tract → the olfactory bulb)

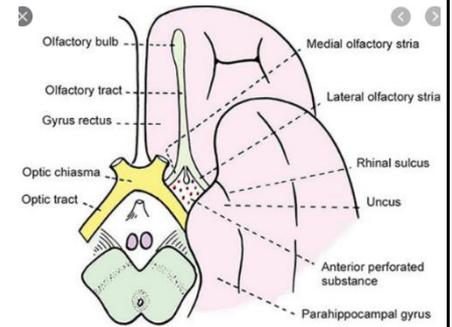
- Side Note: branches of the anterior cerebral artery pass through **anterior perforated substance**. Also, branches of posterior cerebral artery pass through the **posterior perforated substance**

➤ Gyrus rectus :

Lies medial to the olfactory sulcus. Continuous with superior frontal gyrus.

Its Function

Has a role in sexual function in human.



- **H-shaped orbital sulcus:** divides the remaining part into **anterior, posterior, lateral & medial orbital gyri**.

- Orbital gyri are connected with limbic system especially nucleus accumbens (reward reinforcement. (not mentioned by the doctor)

✓ The tentorial surface contains the following:

Namonation

According to the tentorium cerebelli that lies between the brain above and cerebellum below.

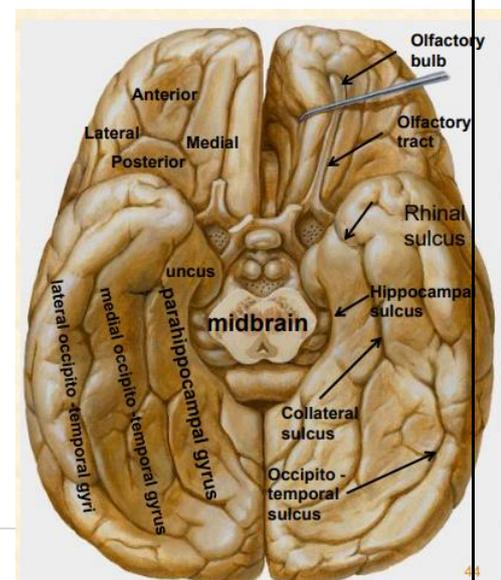
- **Hippocampal sulcus** or parahippocampal sulcus:

Separates the parahippocampal gyrus (the tentorial surface) from the midbrain (midbrain). And its given its name according to the hippocampus which is located in the parahippocampal gyrus.

- **Collateral sulcus:** below & parallel to the calcarine sulcus.

- **Rhinal sulcus:** (the anterior part of collateral sulcus) separates the temporal pole from the uncus.

- **Occipito-temporal sulcus:** extends from the occipital pole (posteriorly) into the temporal pole (anteriorly), lies between the medial occipitotemporal



or fusiform gyrus & lateral occipito - temporal or inferior temporal gyrus.

The Gyri of the tentorial surface:

➤ Para hippocampal gyri:

Between hippocampal sulcus and collateral sulcus. The structure inside it is the hippocampus. (It is located in the temporal lobe)

Its Function

- Very important for recent and short term memory

➤ Uncus: is the anterior end of parahippocampal gyrus

Has a nucleus called amygdala

Its Function

Has a role in the olfaction and the fear sense - amygdala-

- So the amygdala anatomically is related to the basal nuclei, but functionally it's related to the limbic system

➤ Medial occipito-temporal gyrus (lateral to the hippocampal gyrus).

Lies between the collateral sulcus and occipito-temporal sulcus.

Its Function

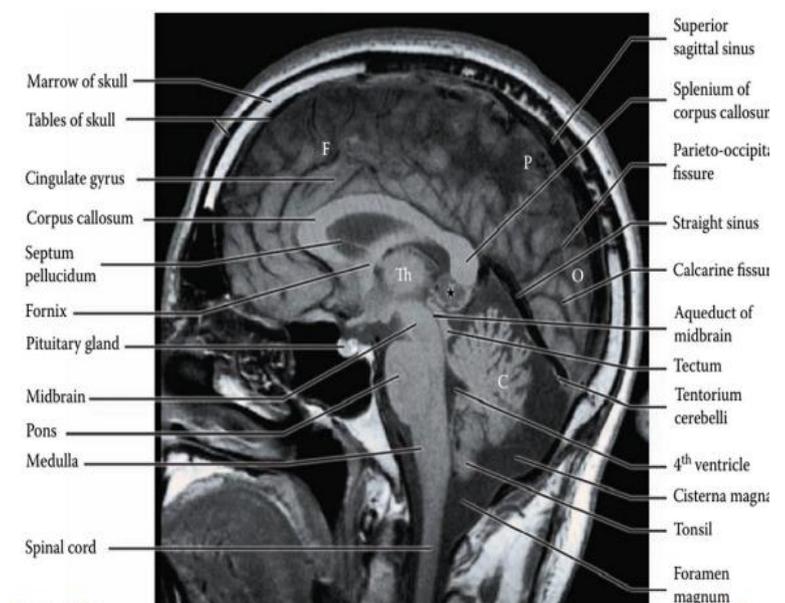
Involved in face recognition.

➤ lateral occipito-temporal gyrus (lateral to the Medial occipito-temporal gyrus).

Its Function

Involved in location recognition memory.

After this long sheet, have a break by trying to practice this brain MRI 😊



"يَا أَيُّهَا الَّذِينَ ءَامَنُوا أَصْبِرُوا وَصَابِرُوا وَرَابِطُوا وَاتَّقُوا اللَّهَ لَعَلَّكُمْ تُفْلِحُونَ"