ANATOMY

SHEET NO. Dr.Maha – lecture 2

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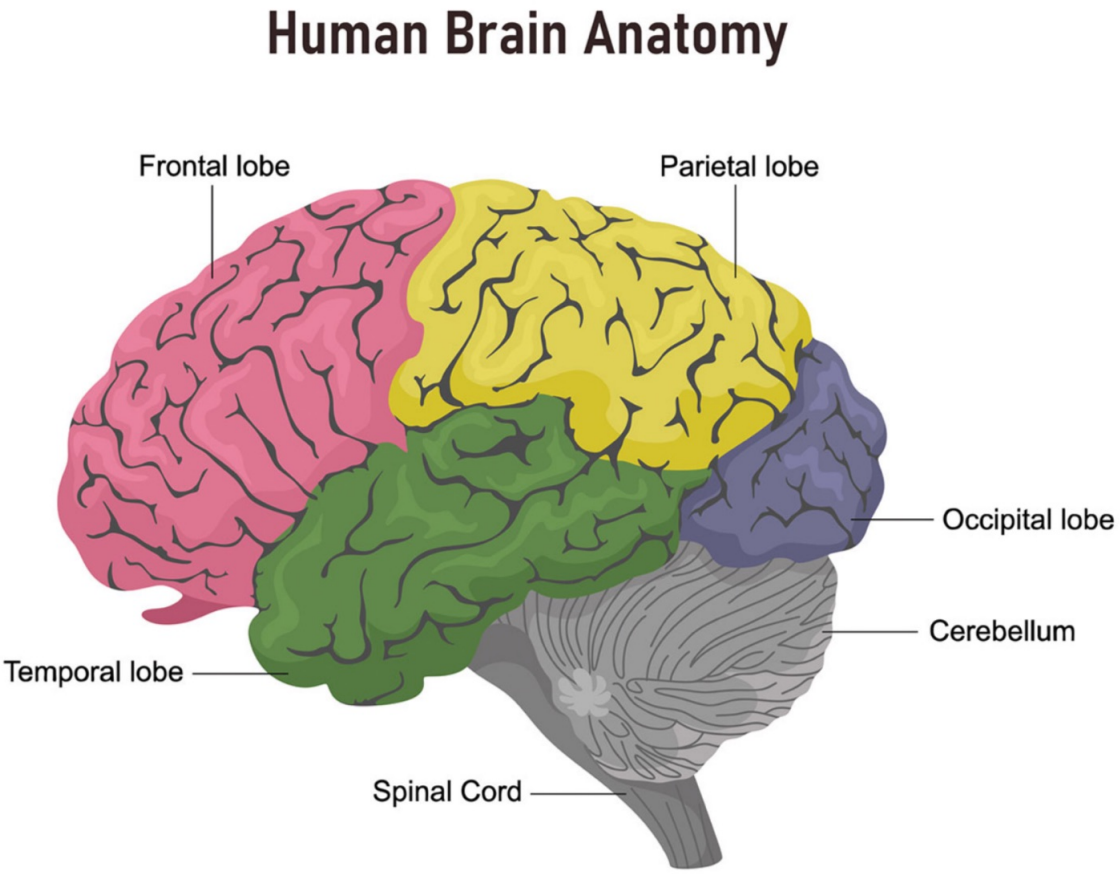
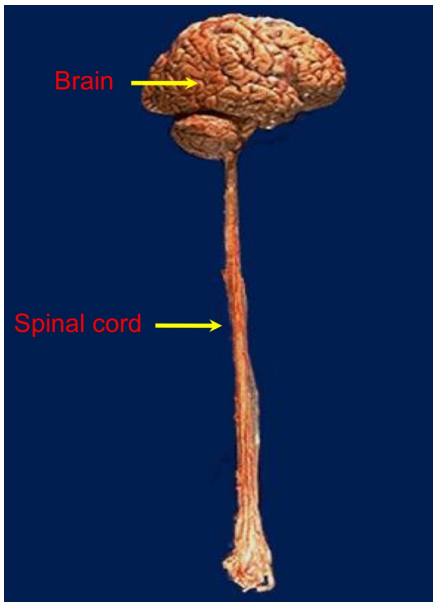
CNS: the brain





The **central nervous system** consists of:

1) The **brain**:Within the skull.
2) The **spinal cord**: Within the vertebral canal.

Now let's get into more details:

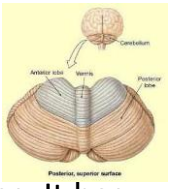
The brain consists of:

- Cerebrum:
  - 2 cerebral hemispheres: separated from each other by median fissure; the median fissure is a longitudinal sulcus that contains the falx cerebri inside it, which is one of the important Dural folds that have superior & inferior sagittal sinuses passing through them. These sinuses are important for the blood supply & CSF drainage.

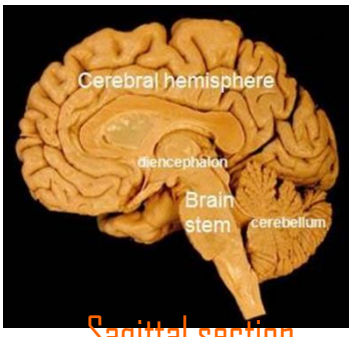
- Diencephalon: brain tissue between the Rt. & Lt. cerebral hemispheres. It's formed of the thalamus & her family: hypothalamus, subthalamus, epithalamus & metathalamus. It also includes the space between the Rt. & Lt. thalamus & hypothalamus which we call the 3rd ventricle. We can only see this ventricle in a **sagittal section** [an extremely important section in a CT scan or MRI as it indicates many details]. Right below the diencephalon we have the brain stem.

- Brain Stem: [forms the base of the brain]
  - Midbrain: divided into two parts due to the cerebral aqueduct of Sylvius; a canal that connects the 3rd ventricle to the 4th one.
  - Pons.
  - Medulla.

Note|| the 4th ventricle is formed by (the pons & upper medulla oblongata) anteriorly and the cerebellum posteriorly.



- Cerebellum:
  - 2 cerebellar hemispheres.
  - The Vermis: a structure that connects the two cerebellar hemispheres. It has many important tracts passing through it & it is the reason the cerebellum controls balance and coordination of different movements.



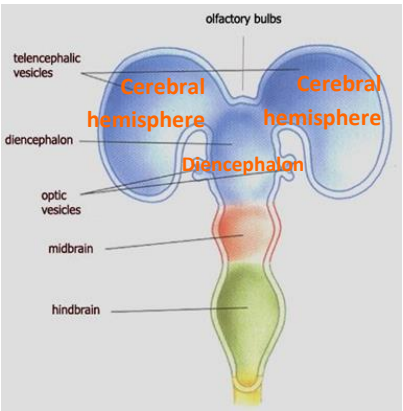
Sagittal section.

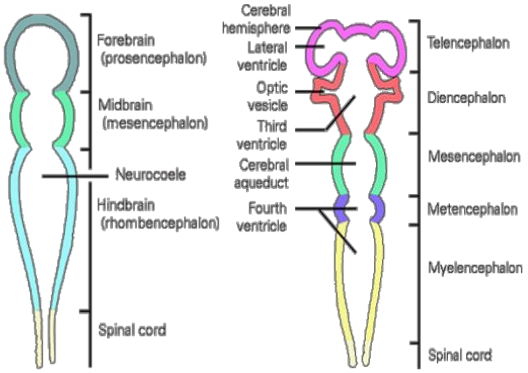
On embryological basis the brain is basically a neuronal tube formed by three vesicles:

- Forebrain [prosencephalon]: the proximal brain vesicle.
  - 2 Cerebral hemispheres.
  - Diencephalon: Later, the 3rd ventricle will form here.

- Midbrain [mesencephalon]: the middle brain vesicle.

- Hindbrain [rhombencephalon]: the distal brain vesicle.
  - Pons.
  - Medulla Oblongata.
  - Cerebellum.





The developmental divisions of the brain

Primary vesicle	Secondary vesicle	Derivatives
Prosencephalon	telencephalon	Cerebral cortex Cerebral white matter Basal ganglia
	diencephalon	Thalamus Hypothalamus Subthalamus Epithalamus
Mesencephalon	mesencephalon	Midbrain
Rhombencephalon	metencephalon	Cerebellum Pons
	myelencephalon	Medulla oblongata

Dr Maha ELBeltagy 27

All of this will be covered in detail as we uptrace forward in the course so don't worry about it, just get familiar with it.

Let's continue our journey, moving on to the Cerebral hemispheres' anatomical division.

It is held from a group of sulci [depression/أخاديد] & gyri [elevation/تَلافيف]; a higher proportion of the gyri indicates a higher intelligence [higher IQ] as the brain's functional areas & wiring [synapses] between the neurons increases. Each gyrus have a specific function differ from the one aside to it, and some of them may have a helper function. The IQ-gyri relationship was noted after examining the brain of Albert Einstein by MRI; he has the highest IQ tell now.

Let's see how the sulci & gyri divide the cerebrum…

We have 4 lines that divide each hemisphere into 4 lobes:

- Two sulci:
  - The central sulcus: starts 1 inch on the medial surface of the brain & continues to the lateral surface. We call it the superolateral surface as part of it starts superiorly then it resumes laterally [the central sulus doesn't meet with the lateral fissure as it ends about ½ inch/1 cm above the lateral fissure].
    It separates between the frontal [motor] lobe & parietal lobe,
    The parietal lobe extends until it reaches the parieto-occipital fissure and the 1st imaginary line posteriorly.
  - Posterior ramus of lateral fissure.
- Two imaginary lines:

- Imaginary line between Parieto-occipital fissure [that extends on the medial sagittal surface of the brain and to 1 inch on its lateral surface] & Preoccipital notch.
- Imaginary line connecting the posterior ramus of lateral fissure to the previous line. The posterior ramus of lateral fissure is called so because it starts from the inferior surface of the brain separating it into 2 anatomical parts:
  - ✓ Anterior orbital part: as it is resting on the bony orbit.
  - ✓ Posterior tentorial part: because below it we have the tentorial sheath of the dura; this sheath separates between the tentorial surface of the brain & the cerebellum [the cerebellum→ located at the base of the brain].

  On the inferior surface of the brain the lateral fissure starts from what we call the stem of the lateral fissure; so, the structure seen superiorly is the posterior ramus of the extended fissure.

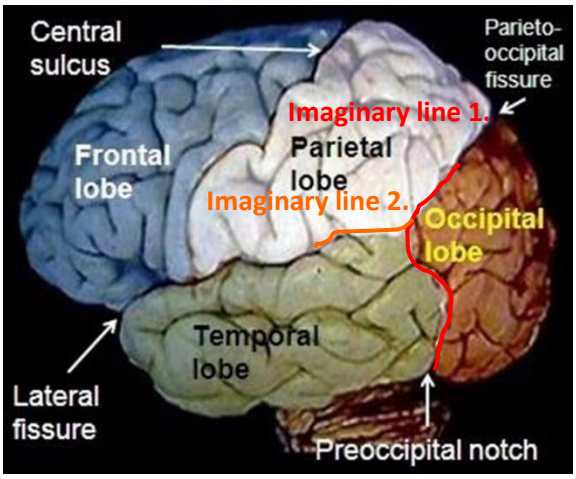
Thus, each hemisphere is divided into 4 lobes & 3 poles:

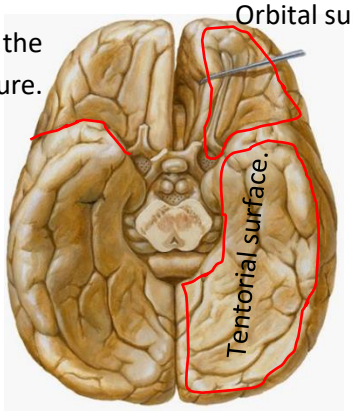
- Frontal lobe.
- Parietal lobe.
- Temporal lobe.
- Occipital lobe

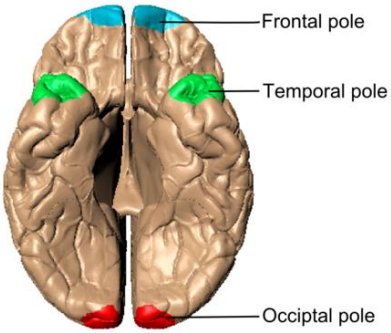
A pole of the brain is the most pointed end of a lobe; we have 3 poles which help u orient the brain when looking at it…

2 anterior poles [the frontal & temporal] & 1 posterior pole [the occipital].

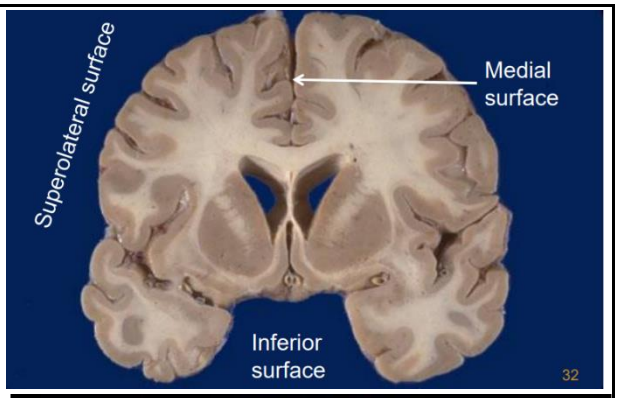
The Preoccipital notch is a posteriorly pointed structure, in front of the occipital pole.





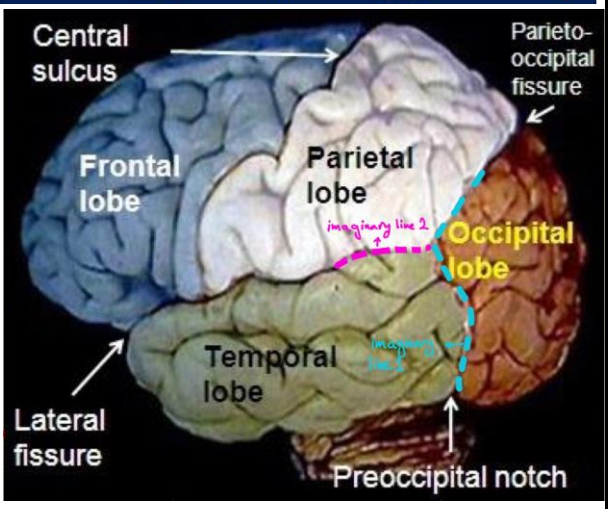


The surfaces of the cerebral hemisphere:



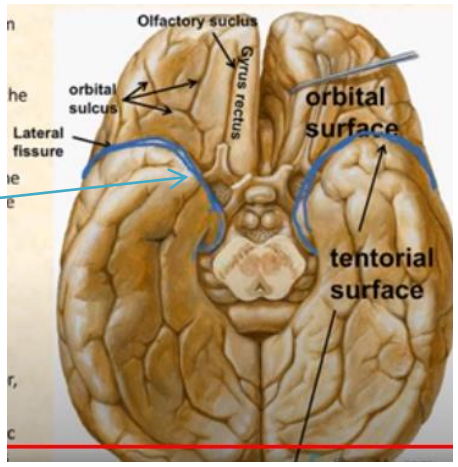
Each hemisphere has 3 surfaces:

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

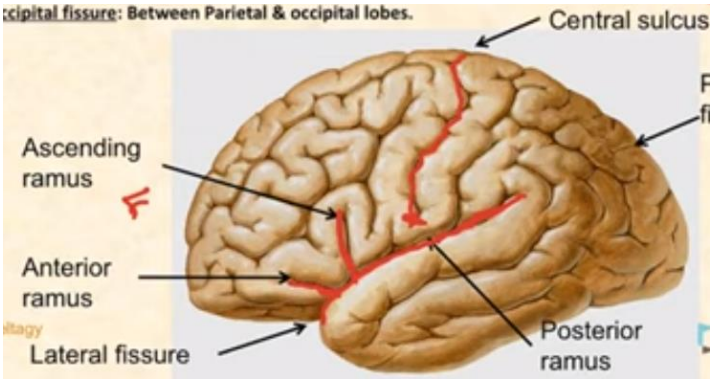


We have four lines which divide each hemisphere into 4 lobes: -keep your eyes on this pic throughout the upcoming four points-

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 sylvuis) 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 line1 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)

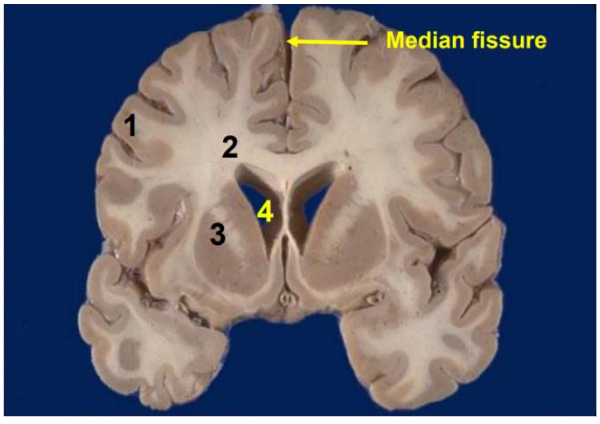
It consists mainly of (please notice the numbers applied on this picture, you will refer back to them many times throughout this sheet)

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.

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

- The grey matter in the coronal section is of two main areas:
  - Outer grey matter or **cerebral cortex**
  - Basal nuclei (inner grey matter)

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.

Why?

- Each cerebral hemisphere is concerned with the sensory and motor functions of the opposite side (**contralateral side**) of the body.

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

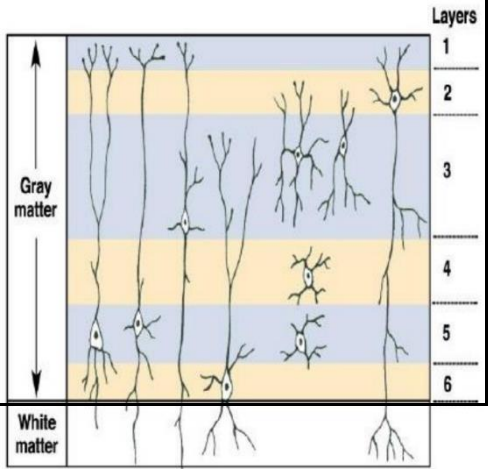
What is the difference between consciousness and alertness??

- 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)

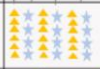
- the cerebral cortex is divided histologically into six layers (the numbers begin from outside to inside):

- **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	Epomedicine.com	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 most important sulci of the superolateral surface are: central sulcus + lateral fissure + parieto-occipital fissure

- 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.

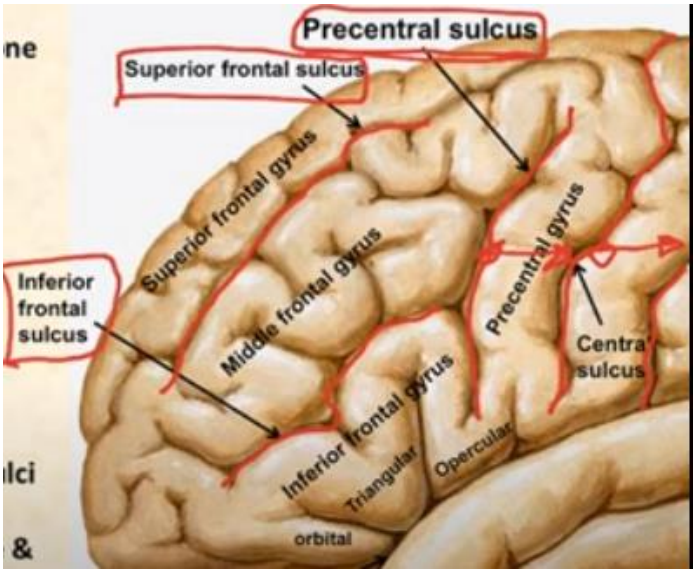
○ Frontal lobe: have a look on the pic in the next page

❖ **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:

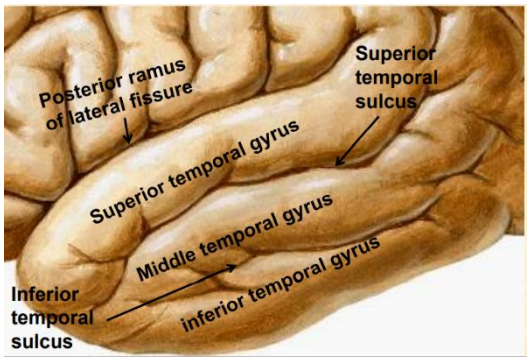
- **Precentral gyrus**: located between central & precentral sulci (the motor area of the opposite side of the body (motor area 4 in Brodmann classification).
- Superior & inferior frontal sulci divide the remaining part equally into **superior frontal gyrus** (located superior to superior frontal sulcus),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

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**

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:



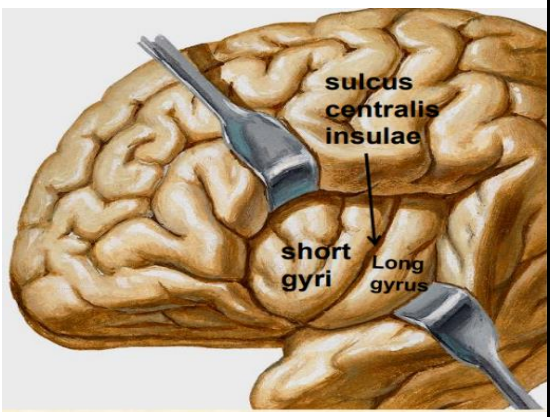
❖ **Sulci & Gyri of the Temporal lobe:**

- 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)

- 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.



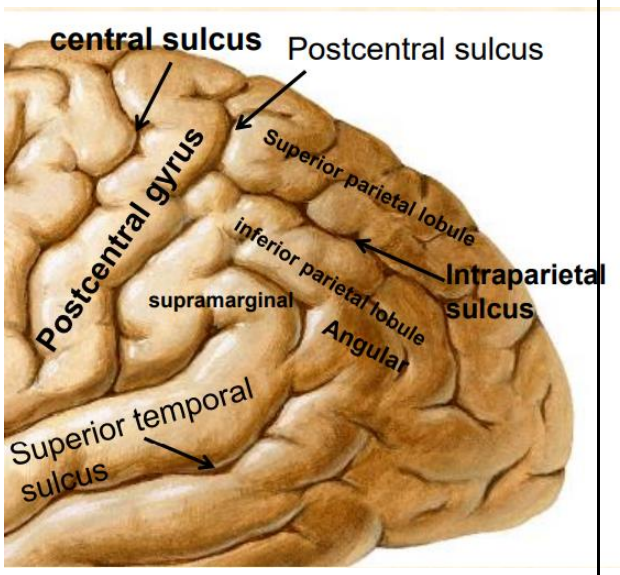
Its Function

✓ : 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.

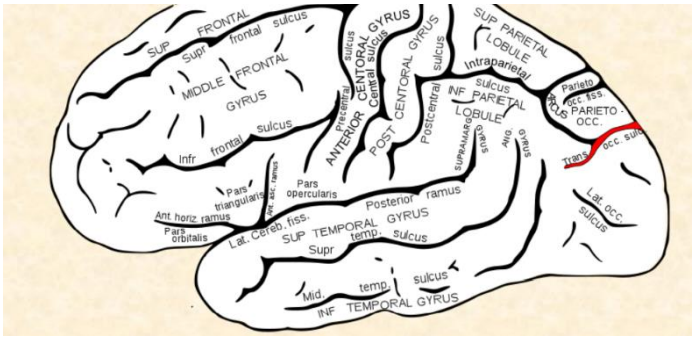
- **Inferior parietal lobule:** below the intraparietal sulcus.

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.

اللهم ما سألناكَ فاعطِنا، وما لم نَسألكَ فابتدِئنا، وما قَصُرت عنه آمالنا فلا تحرمنا