

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ



Anatomy of Cerebral Hemispheres

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Color Code

- Important
- Doctors Notes
- Notes/Extra explanation

Objectives

At the end of the lecture, the students should be able to:

- ✓ List the parts of the cerebral hemisphere (cortex, medulla, basal nuclei, lateral ventricle).
- ✓ Describe the subdivision of a cerebral hemisphere into lobes.
- ✓ List the important sulci and gyri of each lobe.
- ✓ Describe different types of fibers in cerebral medulla (association, projection and commissural) and give example of each type.

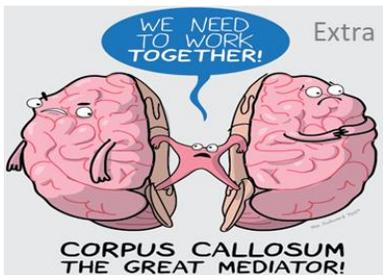
Cerebrum

- Largest part of the forebrain. (makes up 2/3rd weight off all brain)

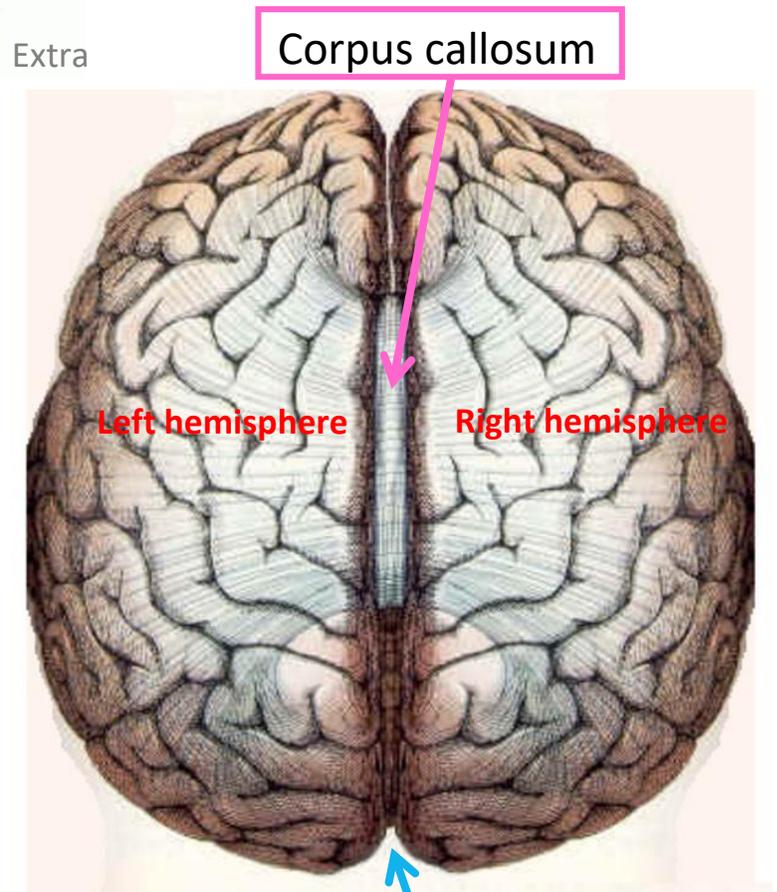
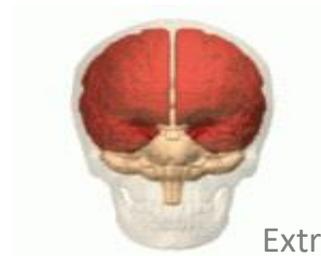
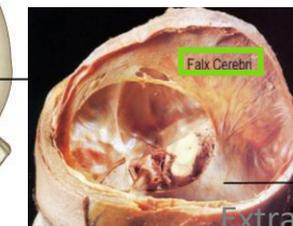
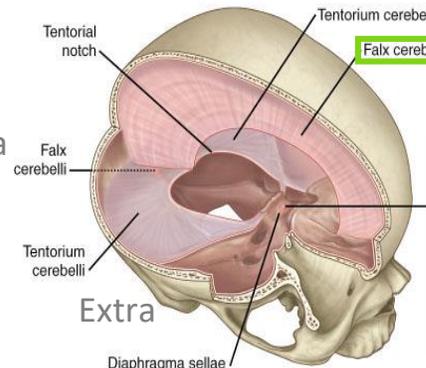
(recall: the forebrain gives the cerebral hemispheres and the diencephalon)

- Divided into two halves, the **cerebral hemispheres** (right and left), which are separated by a deep **median longitudinal fissure** which lodges the **falx cerebri***.

- In the depth of the fissure, the hemispheres are connected by a bundle of fibers called the **corpus callosum**.



*It is a large, crescent-shaped fold of meningeal layer of dura mater that descends vertically in the longitudinal fissure between the cerebral hemispheres



Median longitudinal fissure

Cerebrum

Cerebral Hemispheres

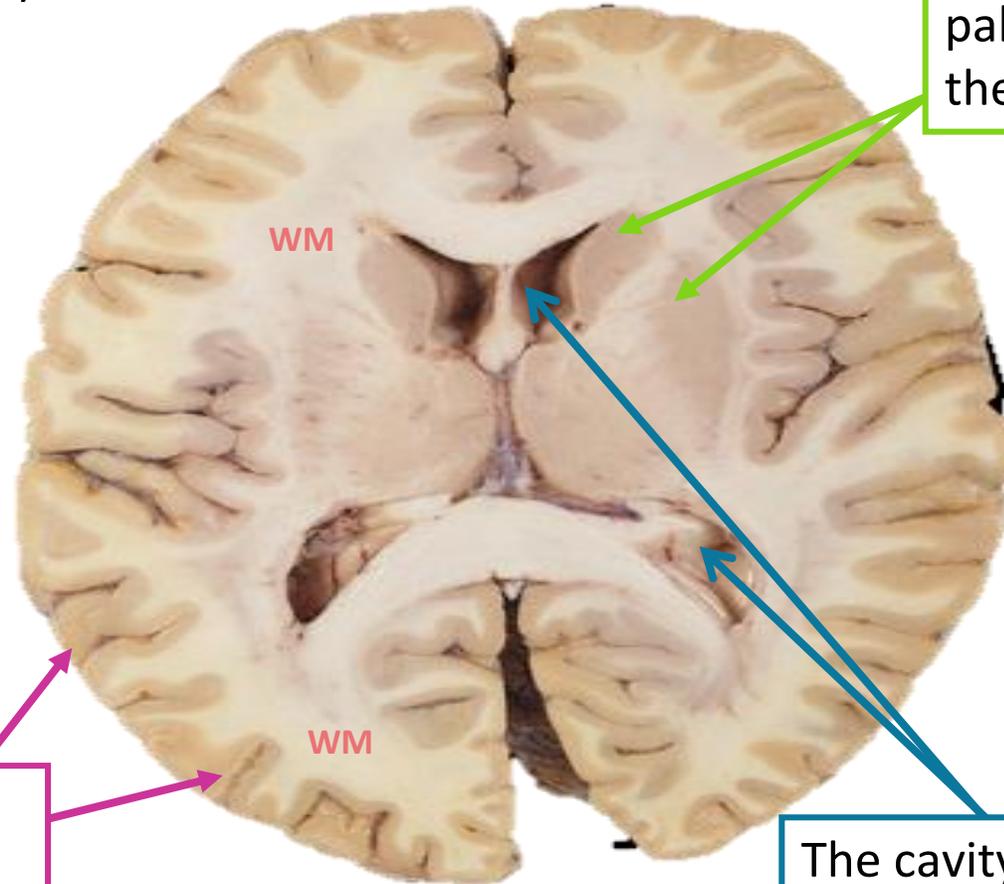
The structure of cerebral hemispheres includes:

Buried within the white matter lie a number of nuclear masses (caudate, putamen, globus pallidus) collectively known as the **basal ganglia**.

Deeper to the cortex, axons running to and from the cells of the cortex form an extensive mass of **white matter (WM)**.

Contains synapses (50 trillion)

Superficial layer of grey matter, the **cerebral cortex**.

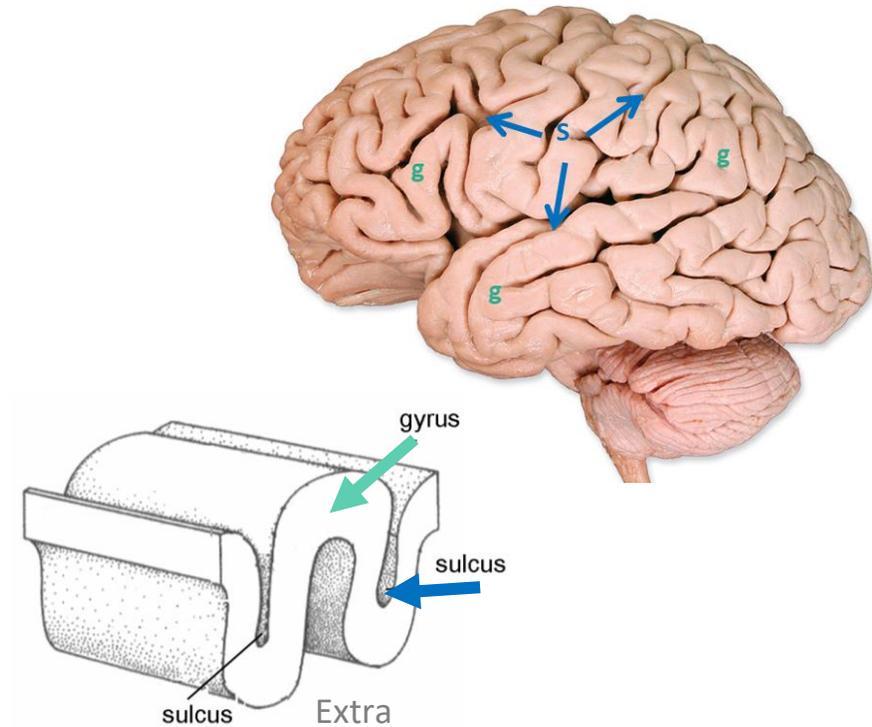
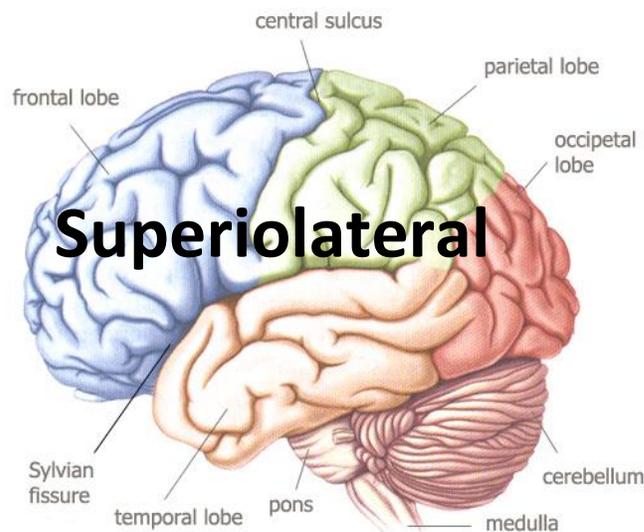
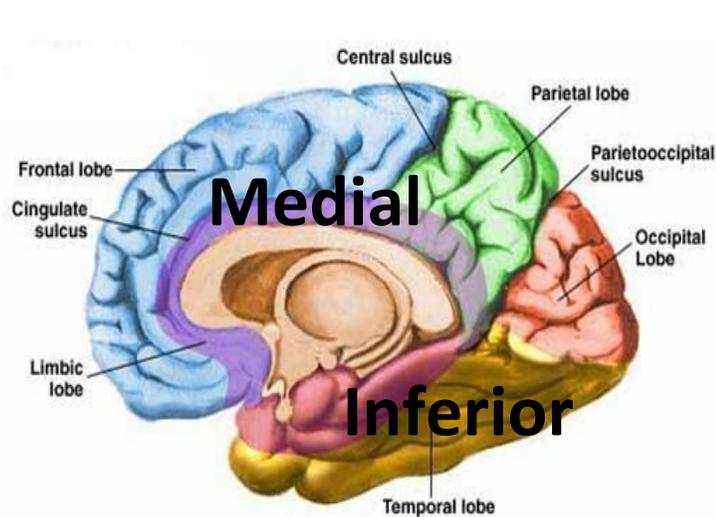


The cavity of hemisphere is called the **lateral ventricle**.

Cerebrum Surfaces

- The superficial layer of grey matter is *highly convoluted* to form a complex pattern of ridges (**gyri**) and grooves (**sulci**). Gyri (plural) gyrus (singular)
Sulci (plural) sulcus (singular)
- This arrangement maximize the surface area of the cerebral cortex (about 70% is hidden within the depths of sulci).

Each hemisphere has **3 surfaces**: Superiolateral, Medial, and Inferior.
The inferior has two parts: tentorial and orbital



Cerebrum Lobes

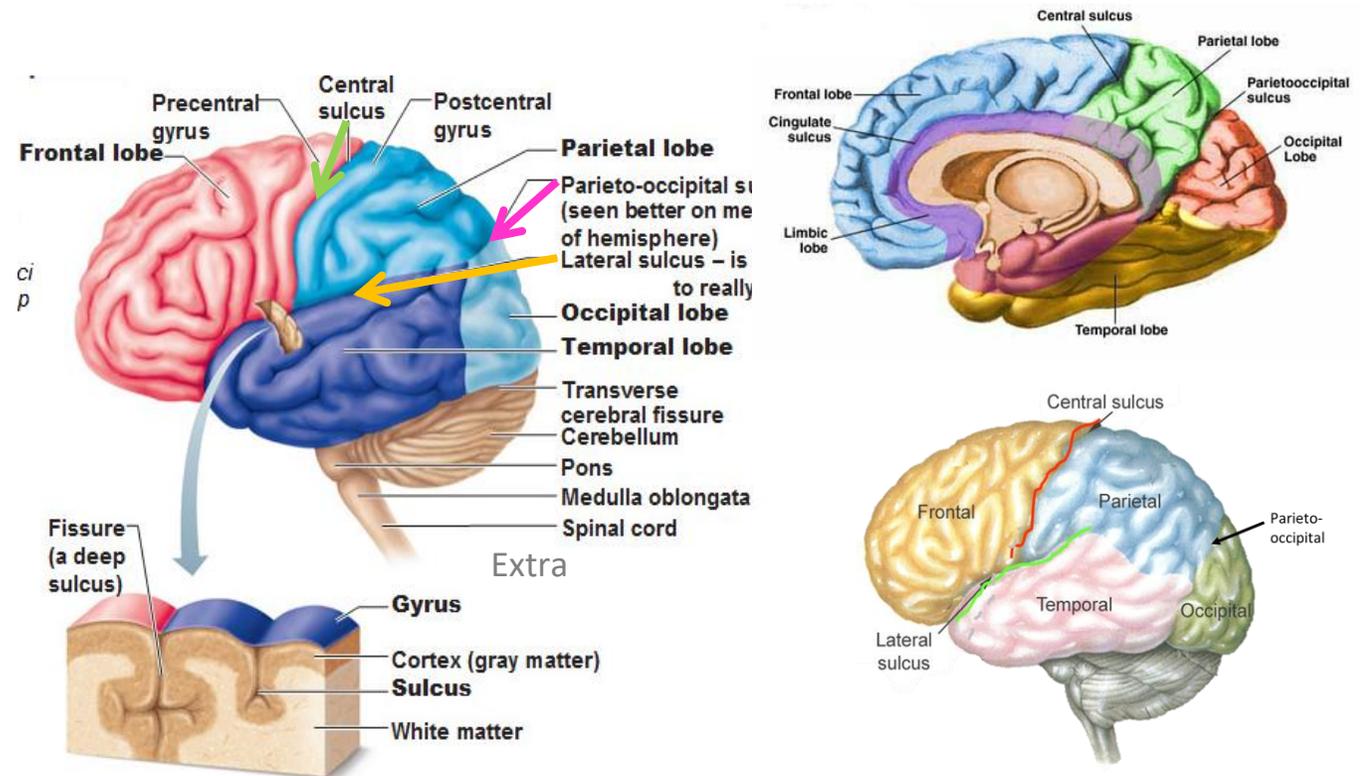
*not everyone has the same gyri and sulci in their brain. If we view different brains we might not find the same sulci/gyri present in both. But these 3 sulci (central, lateral, & parieto-occipital) are found in almost everyone

central	Seperates frontal+parietal
lateral	Seperates frontal+parietal+temporal
parieto-occipital	Seperates parietal+occipital

- Three sulci, consistent in their position* (**central**, **lateral** (sylvian) & **parieto-occipital**) are used to divide each hemisphere into the four lobes.
- Each hemisphere is divide into **FOUR** lobes (named after overlying bones): Frontal, Parietal, Temporal, and Occipital.

Lobes	Function
Frontal	motivation, motor function, smell, mood and aggression (personality and emotion)
Parietal	reception and evaluation of sensory information via thalamus
Temporal	smell, hearing, memory and abstract thought
Occipital**	visual processing

**Oculus means eye in latin so occipital = vision

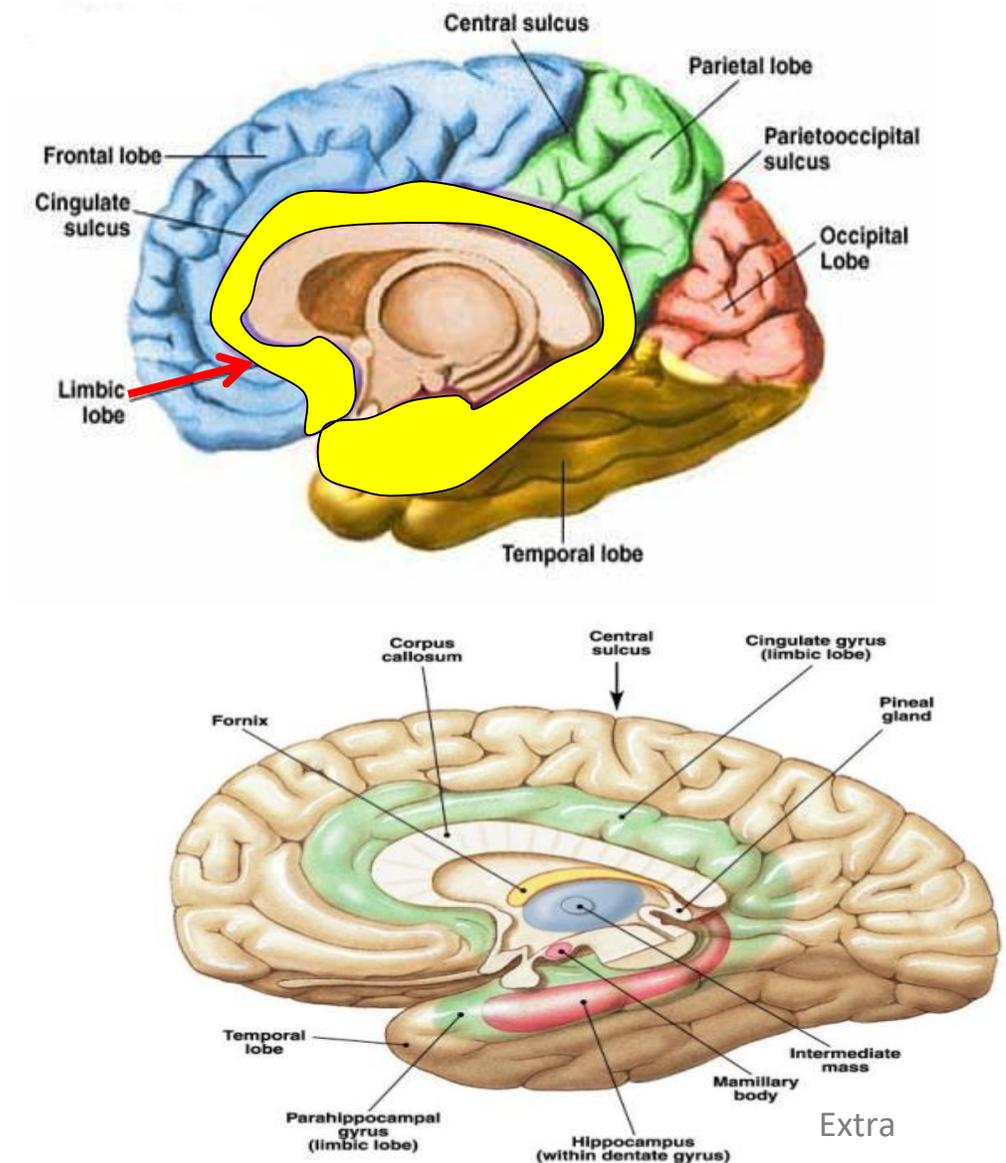


Cerebrum Lobes

Functionally each hemisphere contains a 'limbic lobe' on the medial surface.

It is responsible for:

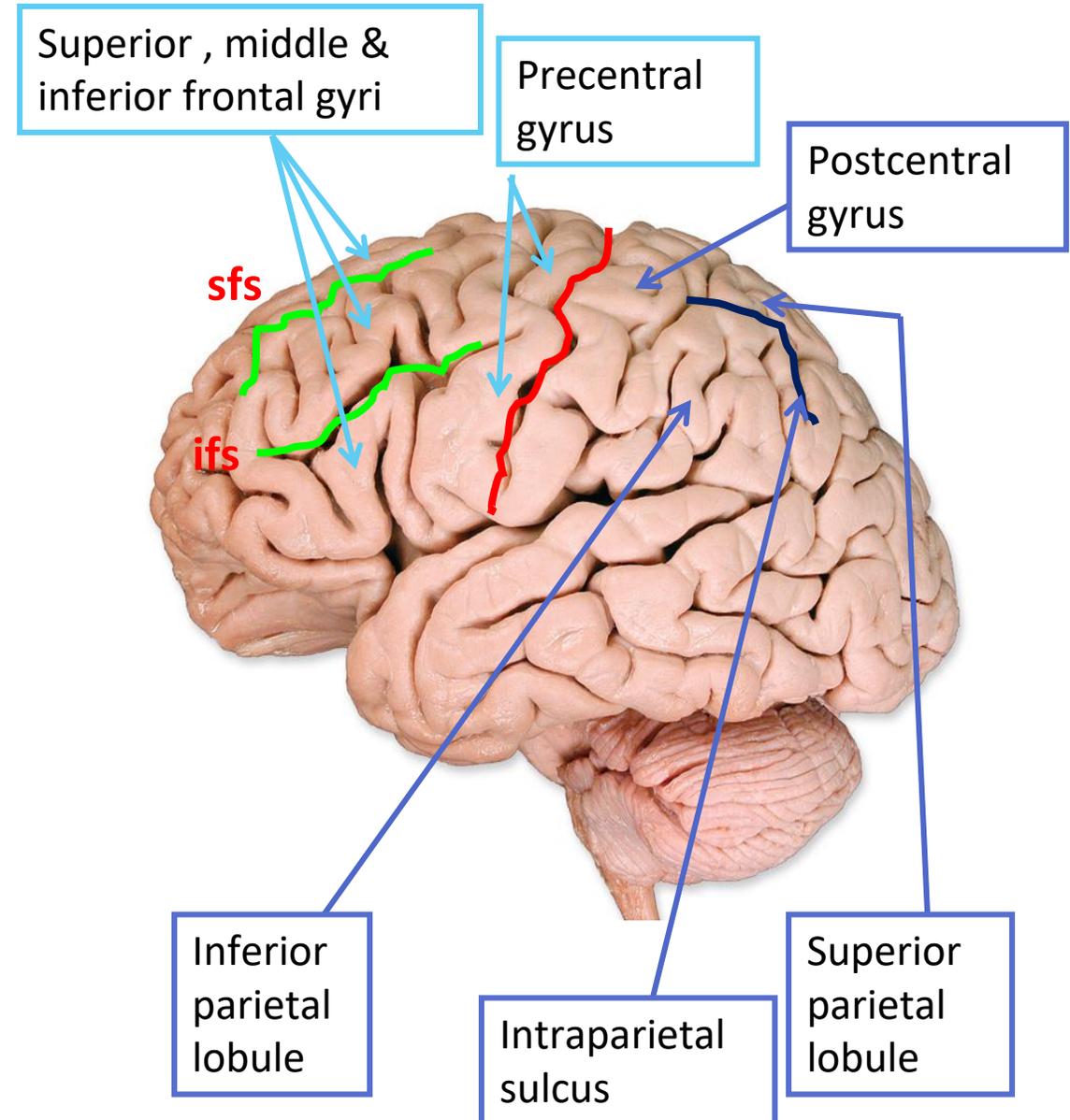
- Establishing emotional states
- Linking conscious intellectual functions with the unconscious autonomic functions
- Facilitating memory storage.



Cerebrum Lobes

Main gyri in **superolateral** surface:

Frontal Lobe	
Gyri	Precentral gyrus
Sulci	Superior frontal sulci Inferior frontal sulci
	(divide lobe into) superior, middle & inferior frontal gyri
Parietal Lobe	
Gyri	Postcentral gyrus
Sulci	Intraparietal sulcus
	dividing the lobe into superior & inferior parietal lobules.

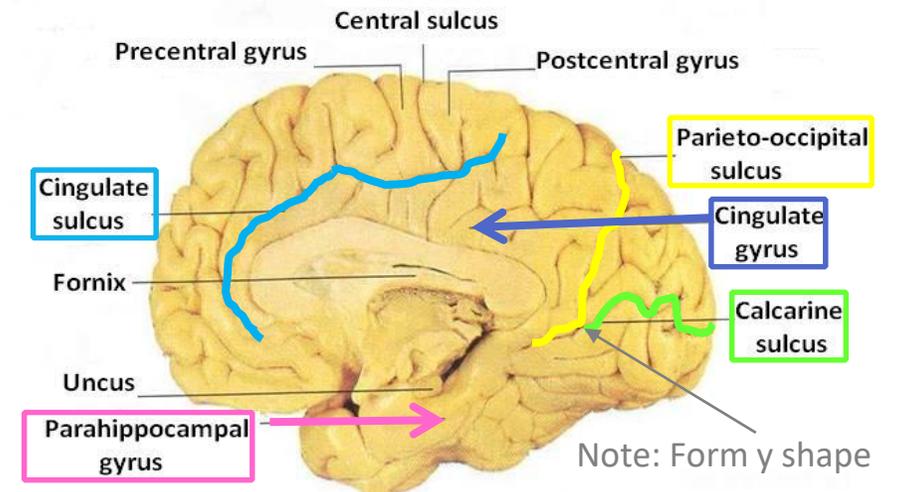
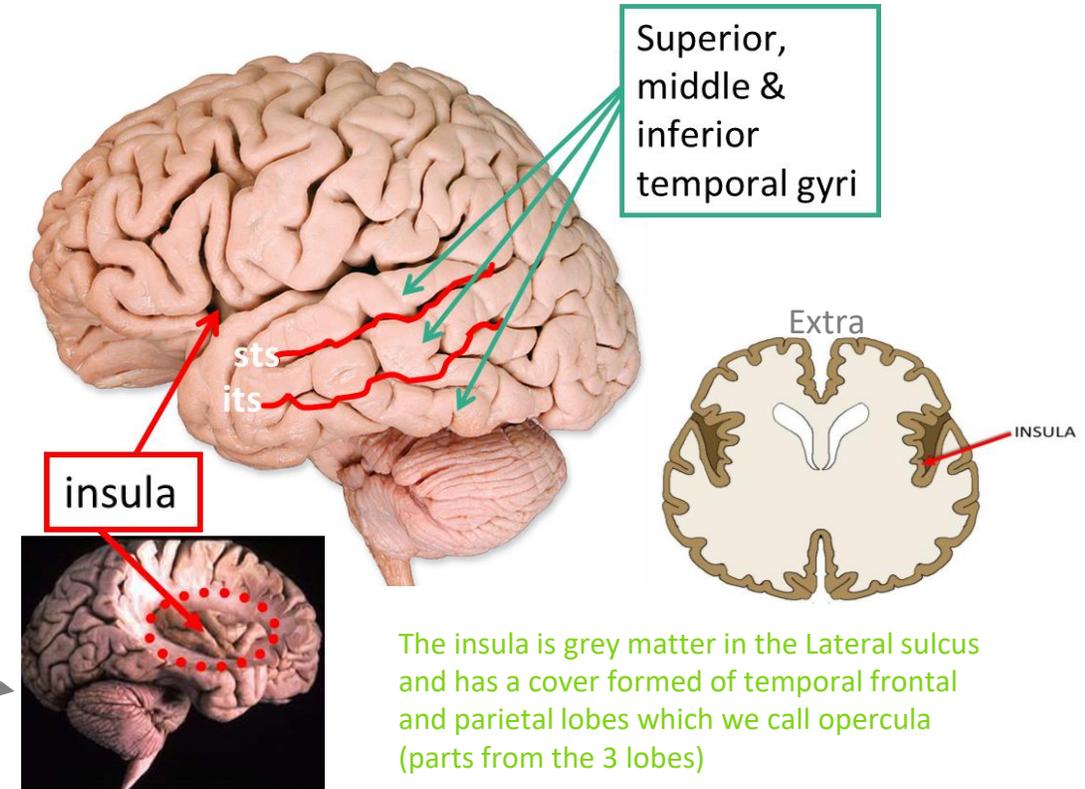


Cerebrum Lobes

Temporal lobe	
Gyri	Superior, middle & inferior temporal gyri
Sulci	Superior & inferior temporal sulci giving rise to superior, middle & inferior temporal gyri.
Insula (normal cerebral cortex but inside)	the gyri in the depth of lateral fissure/sulcus*, covered by parts of frontal, parietal & temporal lobes called the opercula (removed in lower pic so we can see the insula).

Medial Surface	
Gyri	1. <u>Cingulate</u> , 2. <u>Parahippocampal</u>
Sulci	1. <u>Parietooccipital</u> , 2. <u>Calcarine</u> , 3. <u>Cingulate</u>

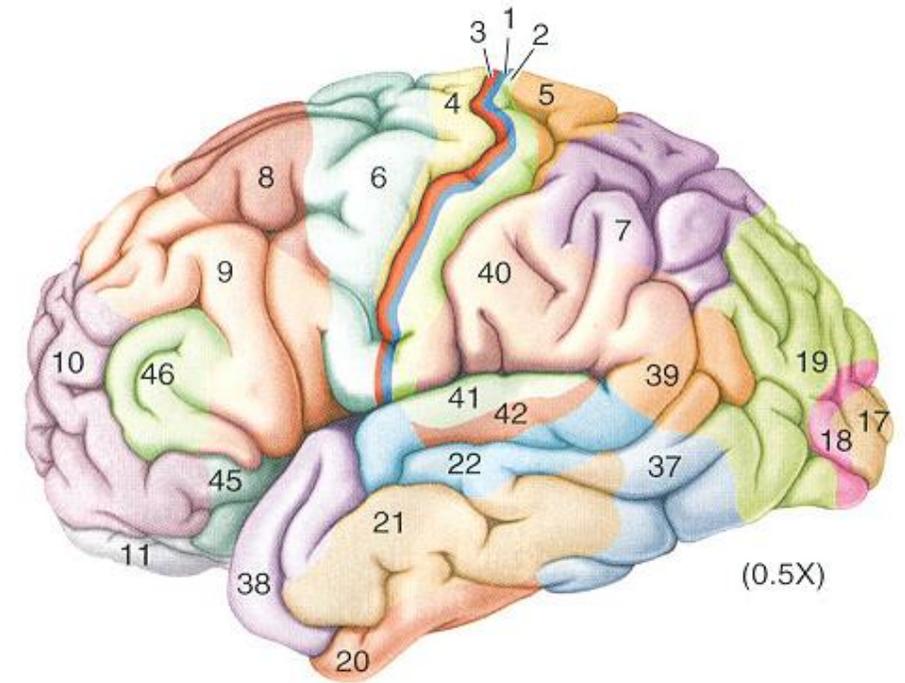
*Fissure and sulcus both mean groove. But fissure is deeper



Broadmann's Map



- **Brodmann** produced a *numbered*, cytological map of cerebral cortex based upon its regional histological characteristics.
- The basis of Brodmann's cortical localization is its subdivision into '**areas**' with similar cellular and laminar structure.
- Brodmann's numbering of these cortical locations has become one of the *standard ways in which clinicians identify brain areas*.

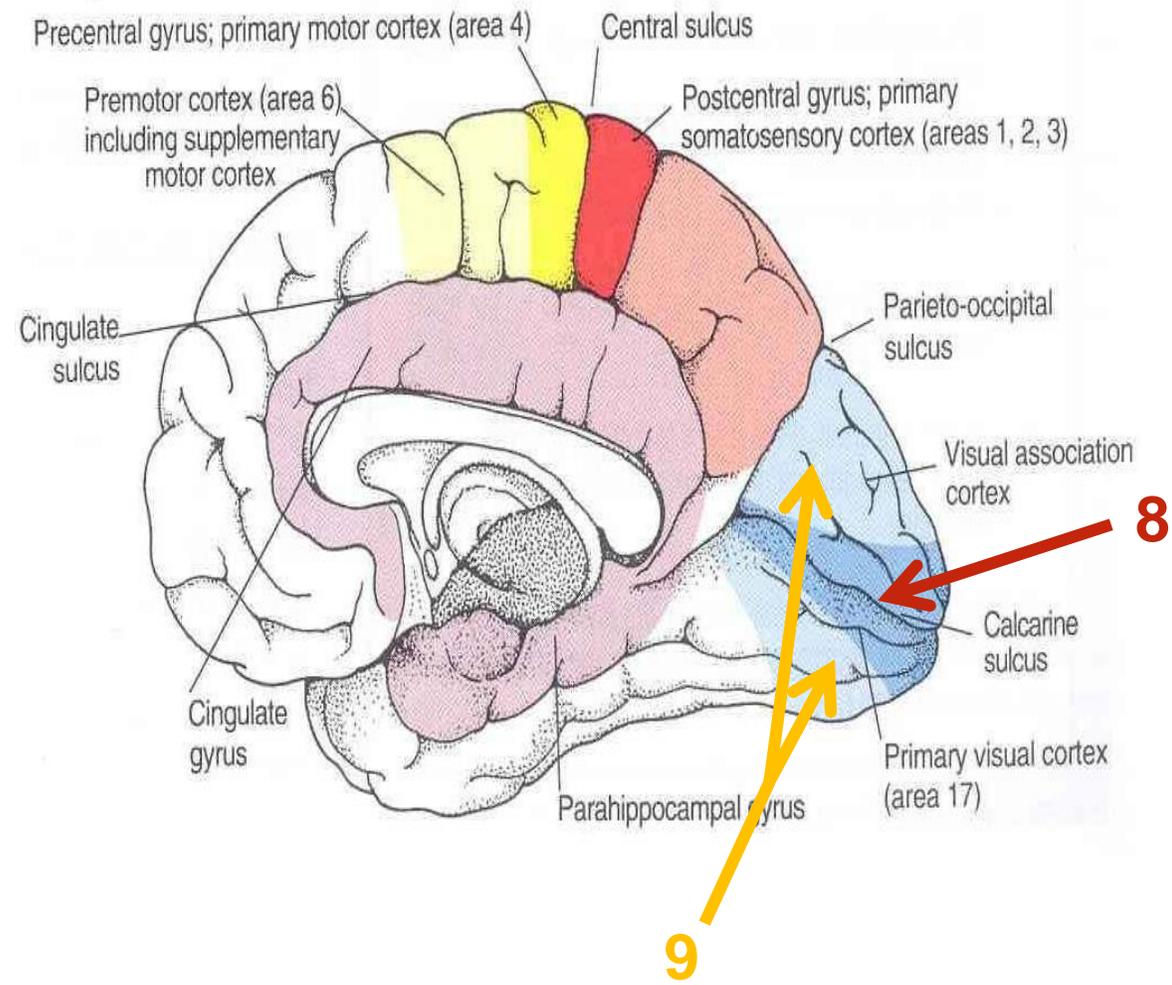
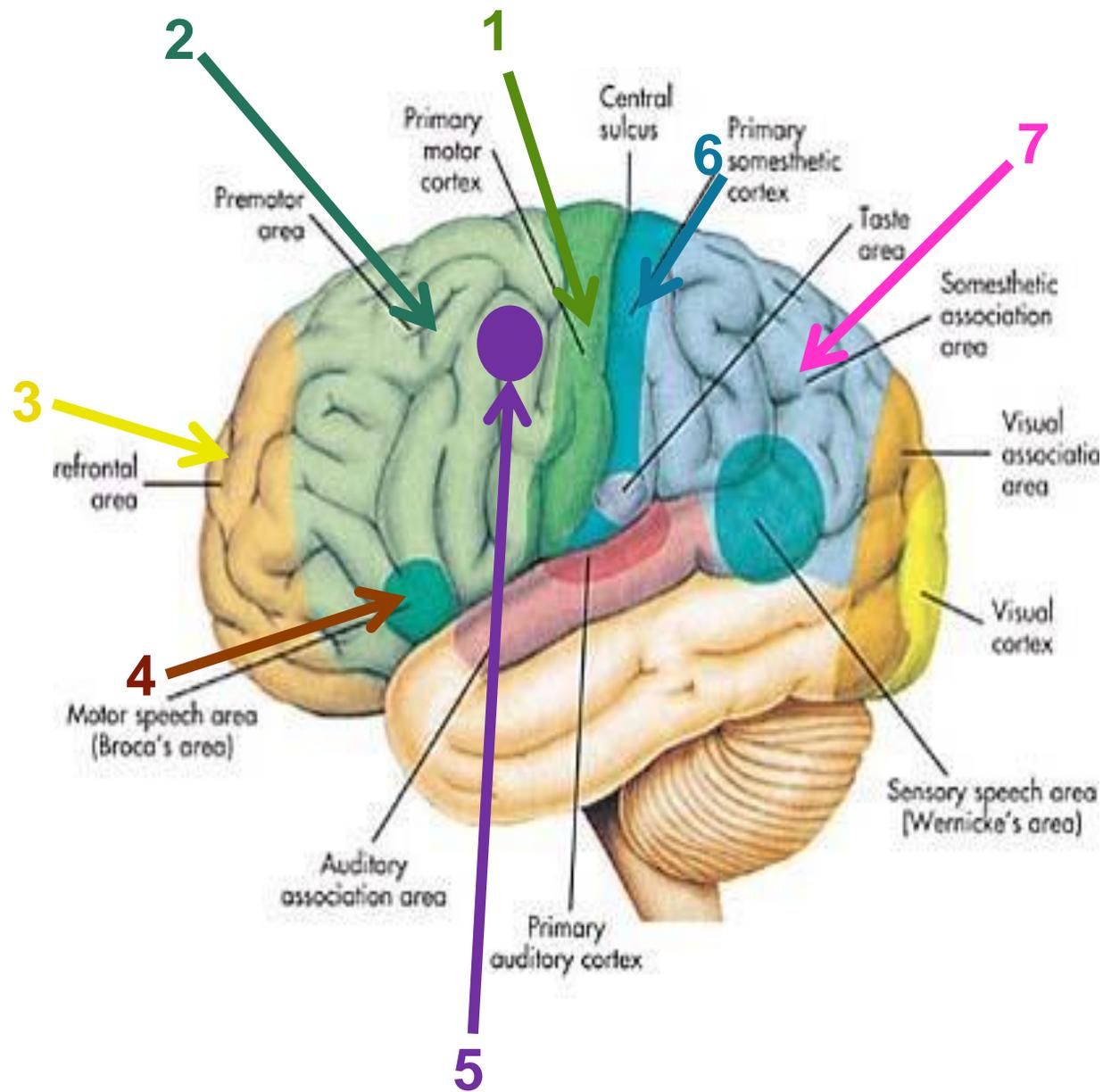


Brodmann's map

In the spinal cord the grey matter was divided into rexed laminae. Here broadmanns map is similar but in the cerebral hemispheres

Functional Areas of the Cerebral Cortex

Frontal Lobe			<i>The functions are only on the boys' slides</i>
1-Primary motor cortex	Located in <i>precentral gyrus</i>	Brodman's area 4	allows conscious control of skilled voluntary movement (i.e. controls skeletal muscles)
2-Premotor cortex:	Located in the region immediately <i>anterior to the precentral gyrus</i>	Brodmann's area 6	Controls learned, repetitious, or patterned motor skills, typing, playing a musical instrument. Coordinates simultaneous or sequential actions. Involved in the planning of movements.
3-Prefrontal cortex:	Extensive region of the frontal lobe <i>anterior to premotor area.</i>		Involved with intellect, cognition, recall, and personality. Necessary for judgement, reasoning, persistence, and conscience. Also related to mood. Closely linked to limbic system (emotional part of brain)
4-Broca's (motor speech) area: <i>(in the premotor area)</i>	Located in the <i>inferior frontal gyrus</i> of the dominant hemisphere, usually left	Brodmann's area 44 & 45	A motor speech area that directs muscles of the tongue. Is active as one prepares to speak.
5-Frontal eye field:	Located in the <i>middle frontal gyrus</i> immediately in front of premotor cortex	Brodmann's area 8	



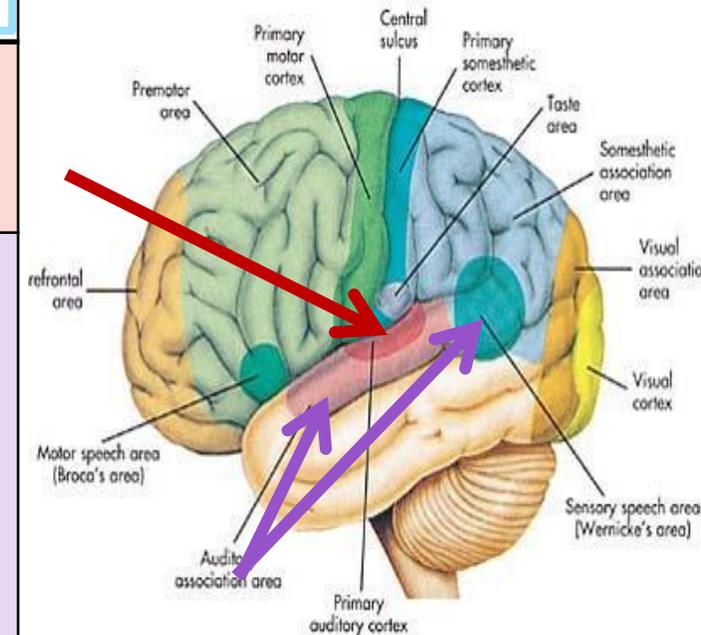
Functional Areas of the Cerebral Cortex

Parietal lobe			
<i>The functions are only on the boys' slides</i>			
6-Primary somatosensory cortex	located in <i>postcentral gyrus</i>	Brodmann's area 1, 2, 3	Involved with conscious awareness of general somatic senses Receives information from the skin and skeletal muscles Exhibits spatial discrimination Precisely locates a stimulus
7-Parietal association cortex	located <i>posterior to primary somatosensory cortex</i> .		Integrates sensory information زي المترجم Forms comprehensive understanding of the stimulus Determines size, texture, and relationship of parts.

Occipital lobe			
<i>The functions are only on the boys' slides</i>			
8-Primary visual cortex	located on the <i>medial surface of the hemisphere</i> , in the gyri surrounding the calcarine sulcus	Brodmann's area 17	Receives visual information from the retinas
9-Visual association cortex	located <i>around the primary visual cortex</i>	Brodmann's area 19	Interprets visual stimuli (e.g., color, form, and movement)

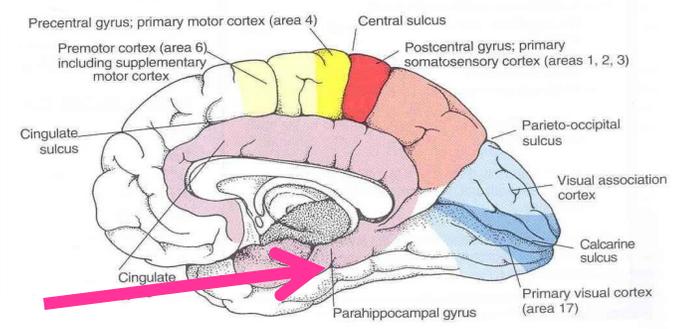
Functional Areas of the Cerebral Cortex

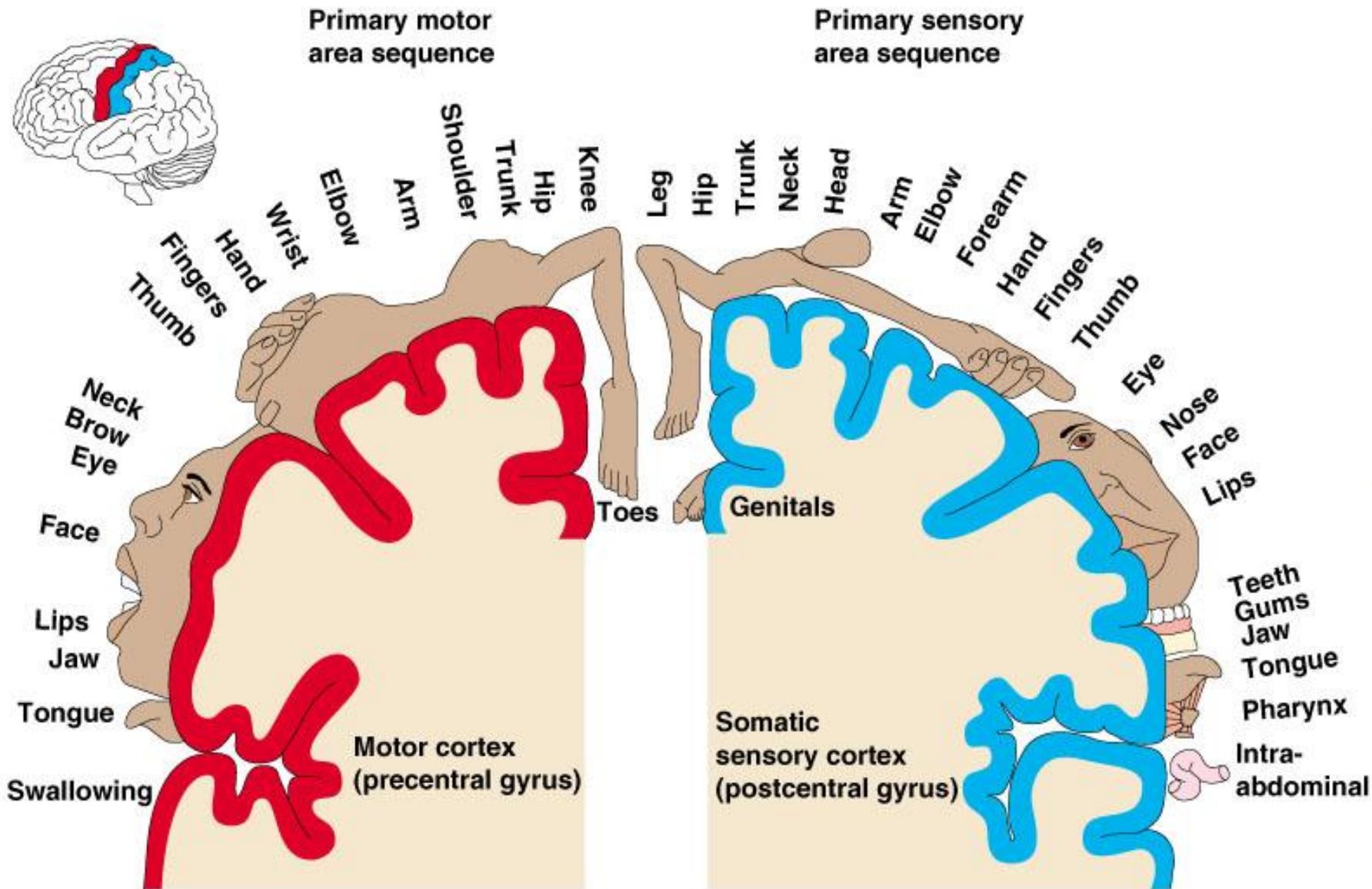
Temporal Lobe <i>The functions are only on the boys' slides</i>			
Primary auditory cortex	located in the superior surface of the <i>superior temporal gyrus</i>	Brodmann's area 41, 42	Receives information related to pitch, rhythm, and loudness
Auditory association cortex	located immediately around the primary auditory cortex (also includes Wernick's area) Located posterior to the primary auditory cortex		Stores memories of sounds and permits perception of sounds Involved in recognizing and understanding speech Lies in the center of Wernicke's area <i>Auditory is always associated with speech (I need to hear so I can speak)</i>



Parahippocampal gyrus: Hippocampus = seahorse/حسان البحر

- located in the *inferomedial part of temporal lobe*.
- Deep to this gyrus lies the **hippocampus** and the **amygdala**, which are parts of **limbic system**





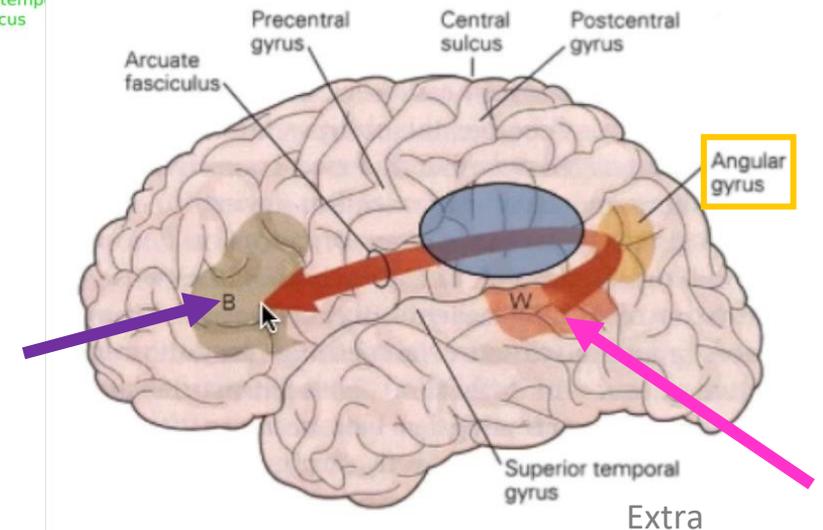
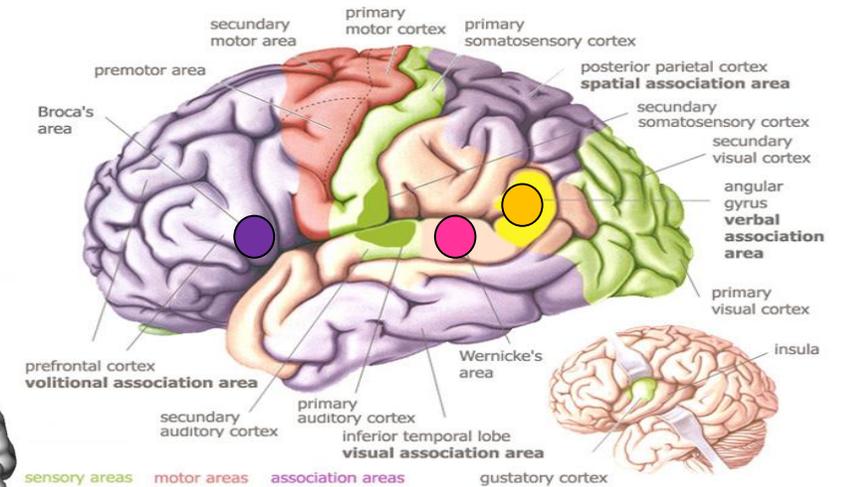
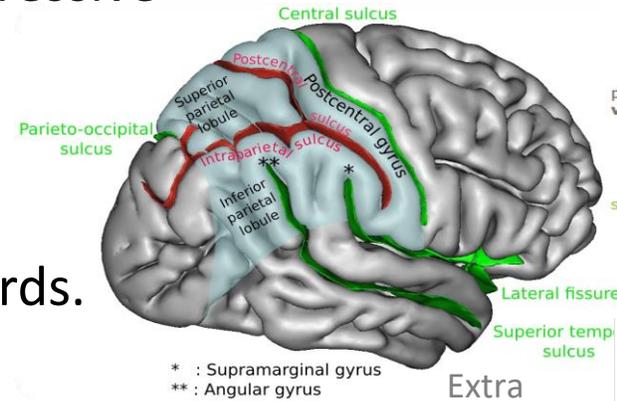
- The body is represented upside down
- Upper part is toes and leg and as we go down the brain we reach the body and hands and face and finally the larynx.
- Representation of the body is according to precise function not size so a lot of space (largest area) is for fingers tongue and larynx, while the trunk has a small area.

Language Area

- Organized around the lateral fissure.
- **Broca's area**: concerned with expressive aspects of language.
Motor: so if there is a lesion he cannot speak
- **Wernick's area**: responsible for comprehension of the spoken words.
Wernick = supramarginal
- Nearby regions of temporal lobe and parietal lobe (**angular gyrus & supramarginal gyrus** of the inferior parietal lobule) are important in naming, reading, writing, and calculation.

Doctor's Note:

Injury to (angular gyrus & supramarginal gyrus) doesn't cause the loss of ability to talk, it only affect reading, writing, naming and calculation.



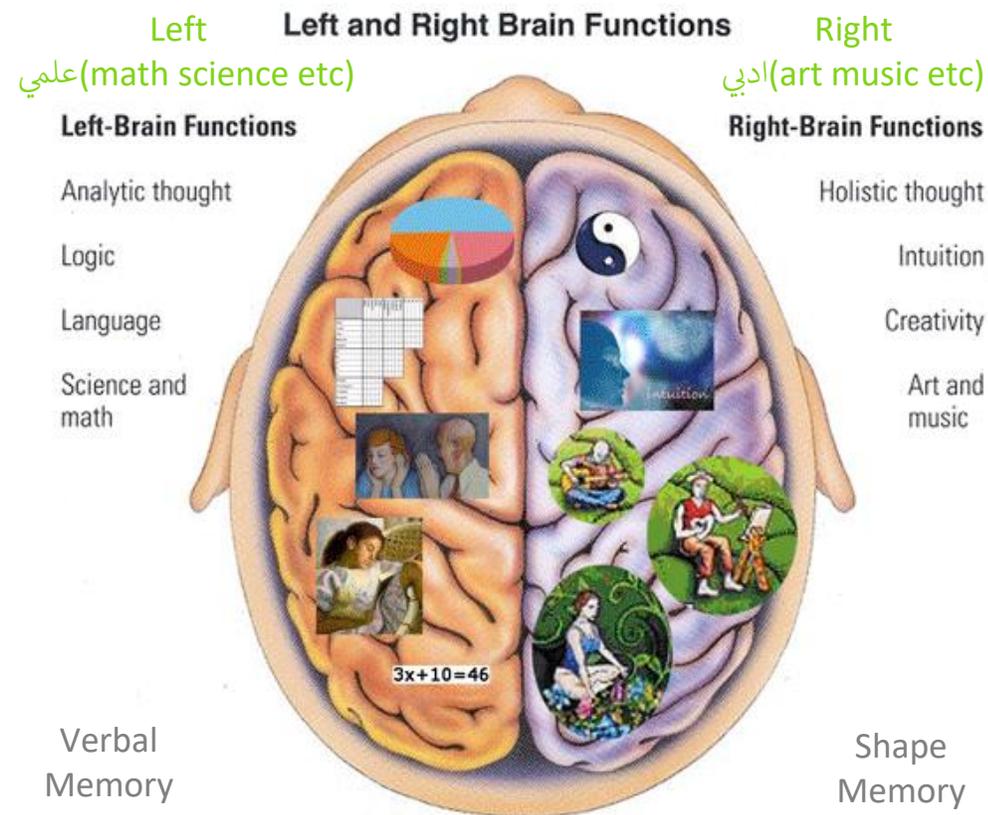
Hemispheric Dominance

- The localization of **speech centers & mathematical ability** (Calculation and language) is the criterion for defining the dominant cerebral hemisphere.*
- In 96% of normal **right-handed** individuals and 70% of normal **left-handed** individuals, the left hemisphere contains the language centers. These are **left hemisphere dominant**.
- Cerebral dominance becomes established during the **first few years after birth**.
When child starts talking and language centers are formed then the dominance will occur

*note: these centres are present in both sides but more active in one side.

Example: in left dominance the broca's area that is active is in left (we have it in the right but inactive)

The right will become active if there is injury to left but will take time. So after the injury the person cannot talk but after time the right side becomes active and he can talk again.



Hemispheres communicate via the corpus callosum

White Matter

- Underlies the cortex
- Contains: 1. Nerve fibers 2. Neuroglia cells 3. Blood vessels.
- The nerve fibers originate, terminate or sometimes both, within the cortex.
- Depending on their origin & termination, these nerve fibers are classified into three types:

1. Association fibers:*

Unite different parts of the same hemisphere

2. Commissural fibers:**

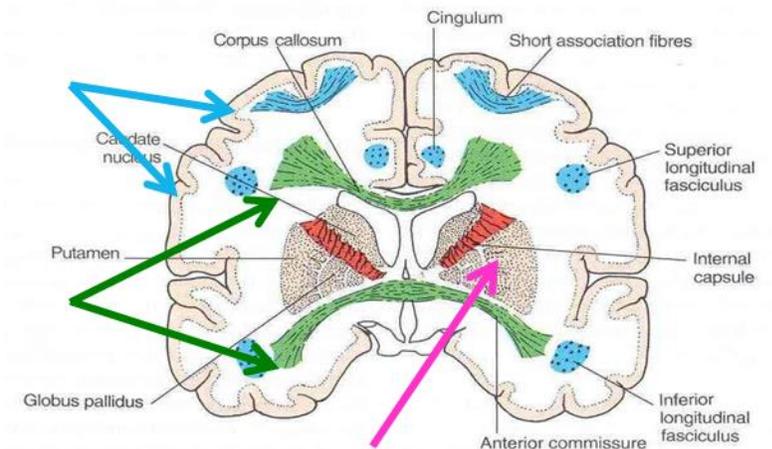
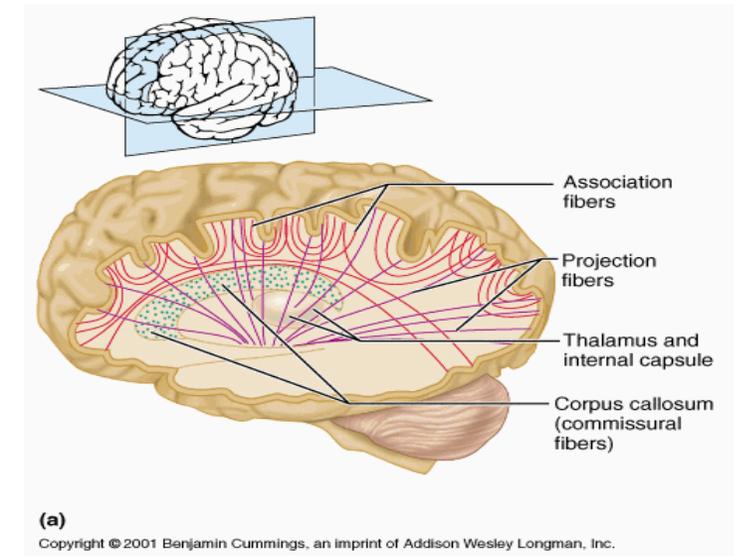
Connect the corresponding regions of the two hemispheres

3. Projection fibers: Consisting of :

- a. Afferent fibers conveying impulses to the cerebral cortex.
- b. Efferent fibers conveying impulses away from the cortex.

*Similar areas in the same lobe (short)
But from different lobes (long)

**Same area but in two hemispheres.
Example corpus callosum which will help the two hemispheres act in harmony



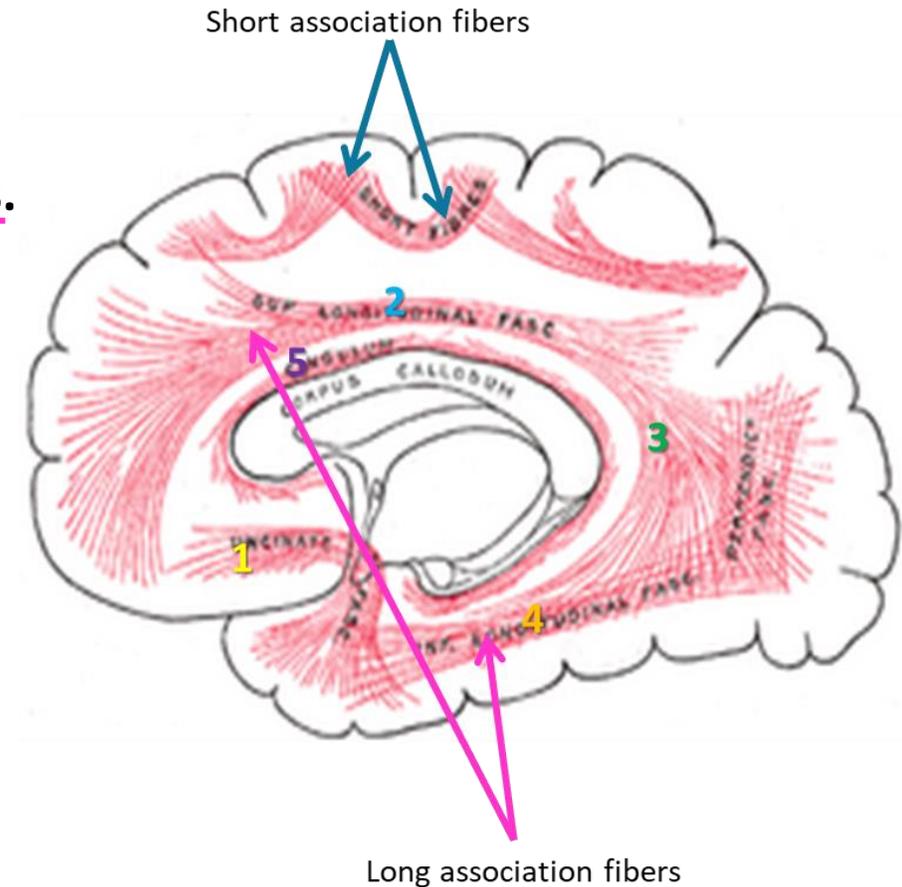
White Matter

1. Association Fibers

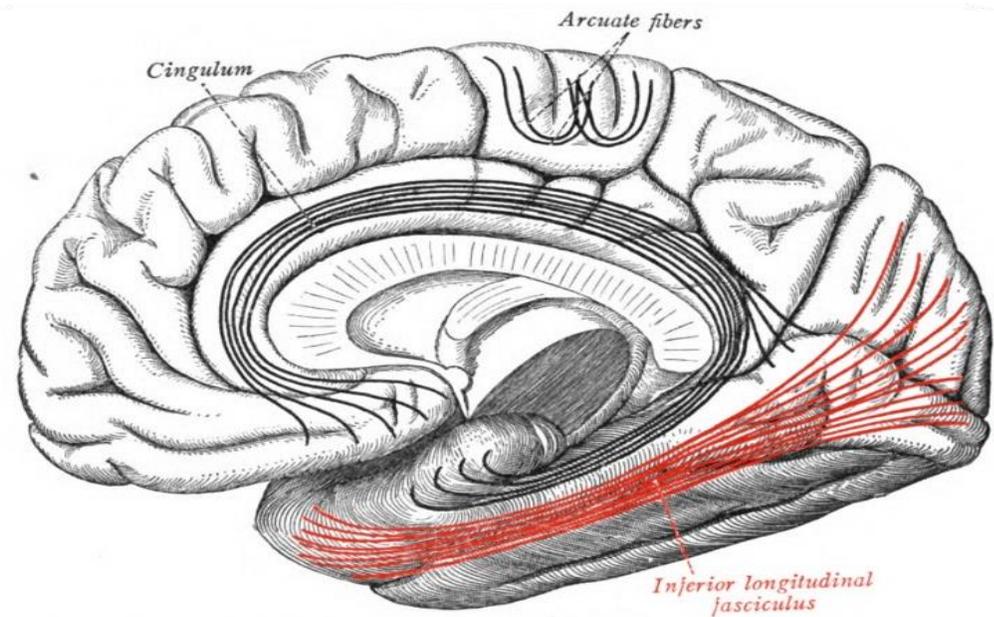
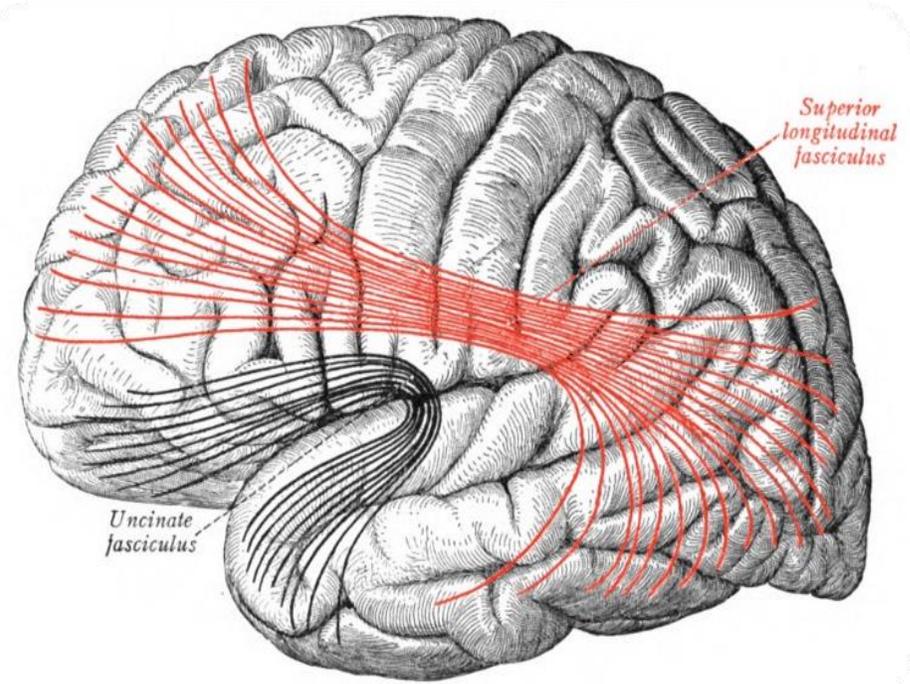
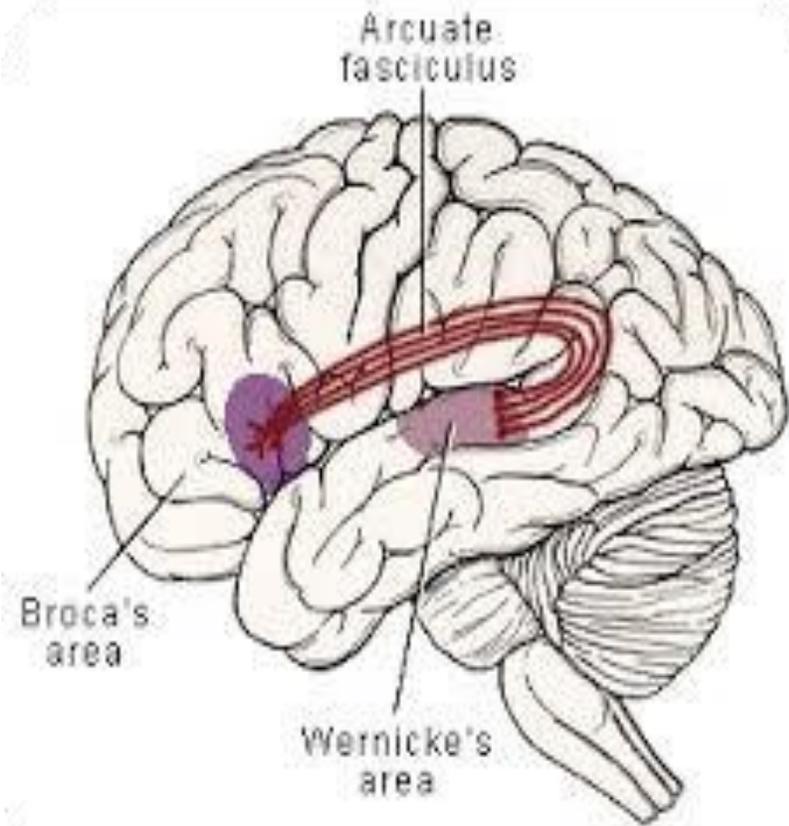
Only on the boys' slides

- Unite different parts of the same hemisphere.
- Are of two kinds:
 - Those connecting adjacent gyri, **short association fibers**
 - Those connecting more distant parts, **long association fibers**.

Long Association Fibers	
1. Uncinate fasciculus	connects frontal to temporal lobe.
2. Superior longitudinal fasciculus	connects the frontal, occipital, parietal, and temporal lobes
3. Arcuate fasciculus	connect gyri in frontal to temporal lobes
4. Inferior longitudinal fasciculus	connects occipital to temporal pole
5. Cingulum	connects frontal & parietal lobes to the para-hippocampal gyrus and adjacent temporal gyri



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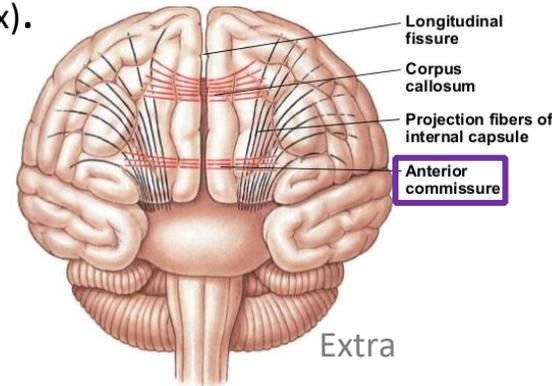
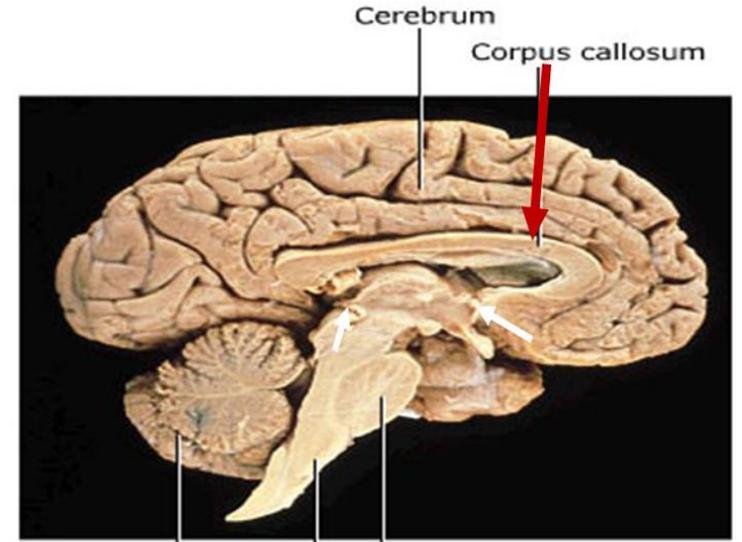


White Matter

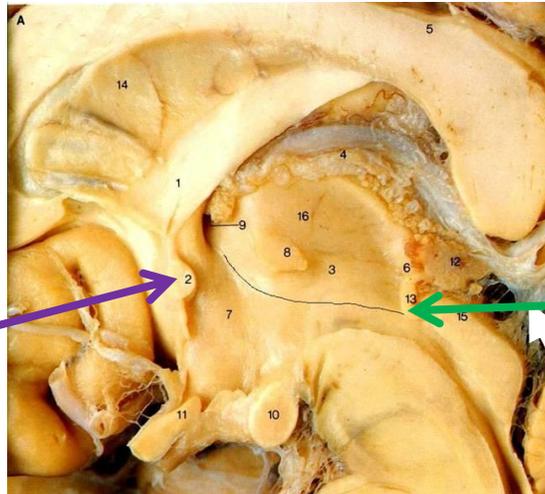
2. Commissural Fibers

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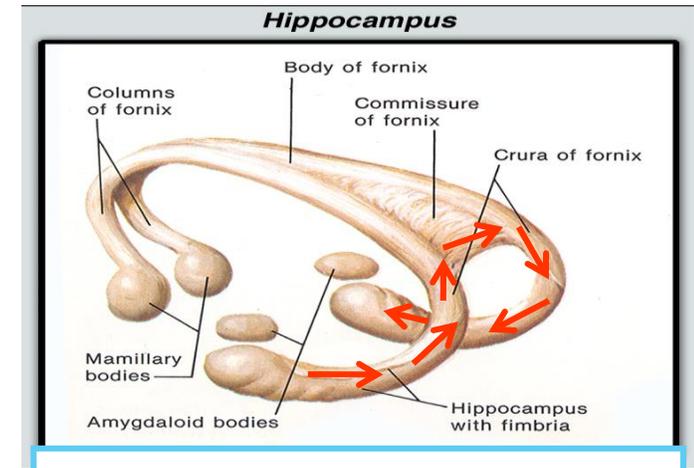
- Connect the corresponding regions of the two hemispheres.
- Include:
 - Corpus callosum.
 - Anterior commissure.
 - Hippocampal commissure (commissure of fornix).
 - Posterior commissure.



Anterior commissure: connects the inferior and middle temporal gyri & the olfactory regions of the two hemispheres



Posterior Commissure: connects the left and right midbrain Important in the bilateral pupillary reflex



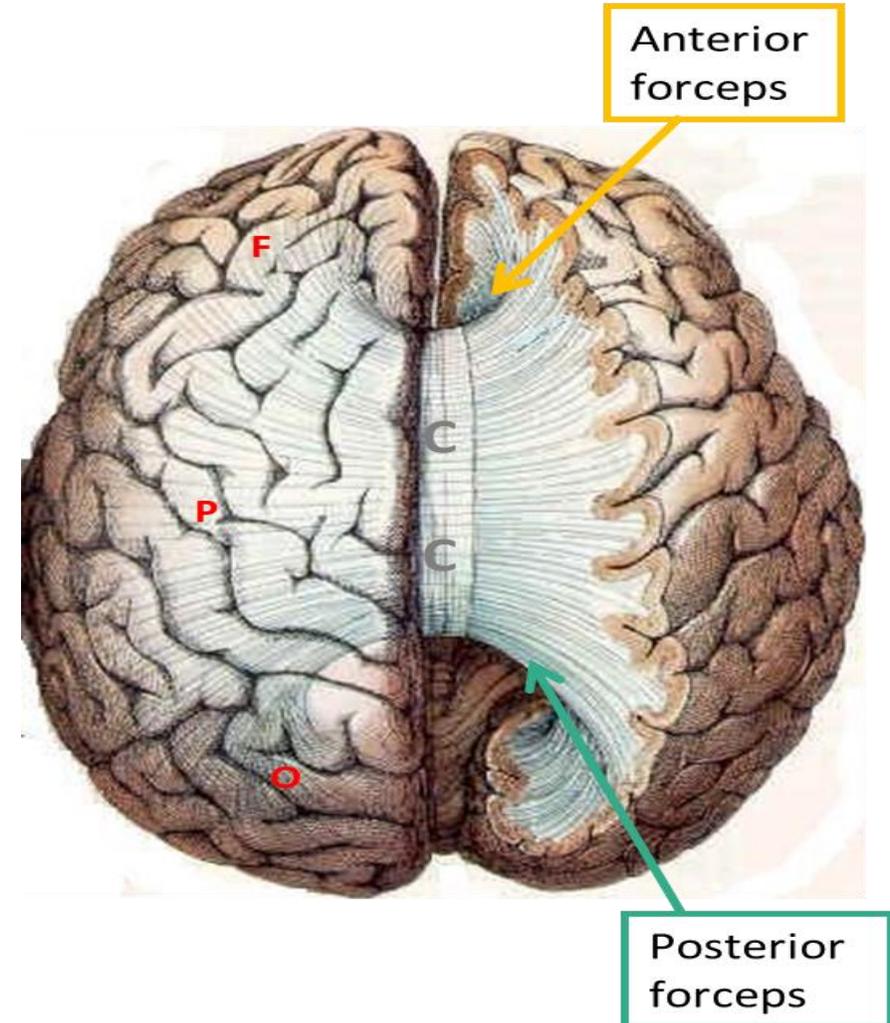
Hippocampal Commissure: connect the two hippocampi with each other

White Matter

2. Commissural Fibers

Corpus Callosum

- Connects the corresponding regions of the two hemispheres except the temporal lobes, that are connected by anterior commissure.
- It is shorter craniocaudally than is the hemisphere.
- The callosal fibers linking the frontal poles, curve forward forming anterior forceps (**forceps minor**).
- The callosal fibers linking the occipital poles, curve backward forming posterior forceps (**forceps major**).



Only on the boys' slides

White Matter

2. Commissural Fibers

Parts of Corpus Callosum:

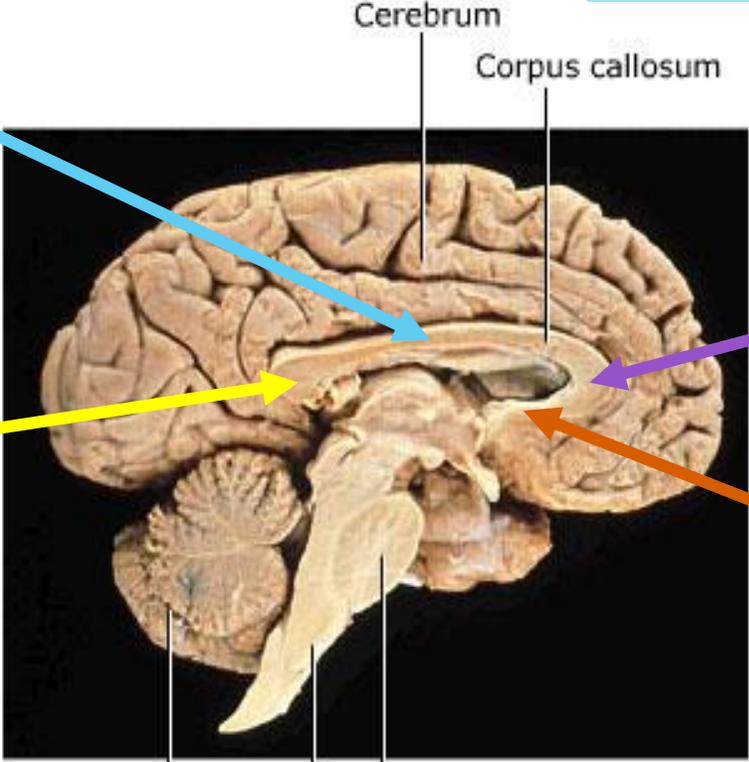
- 1. Body
- 2. Splenium
- 3. Genu
- 4. Rostrum

Body

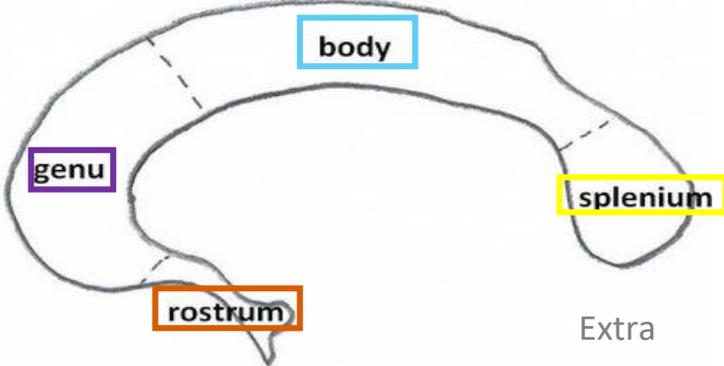
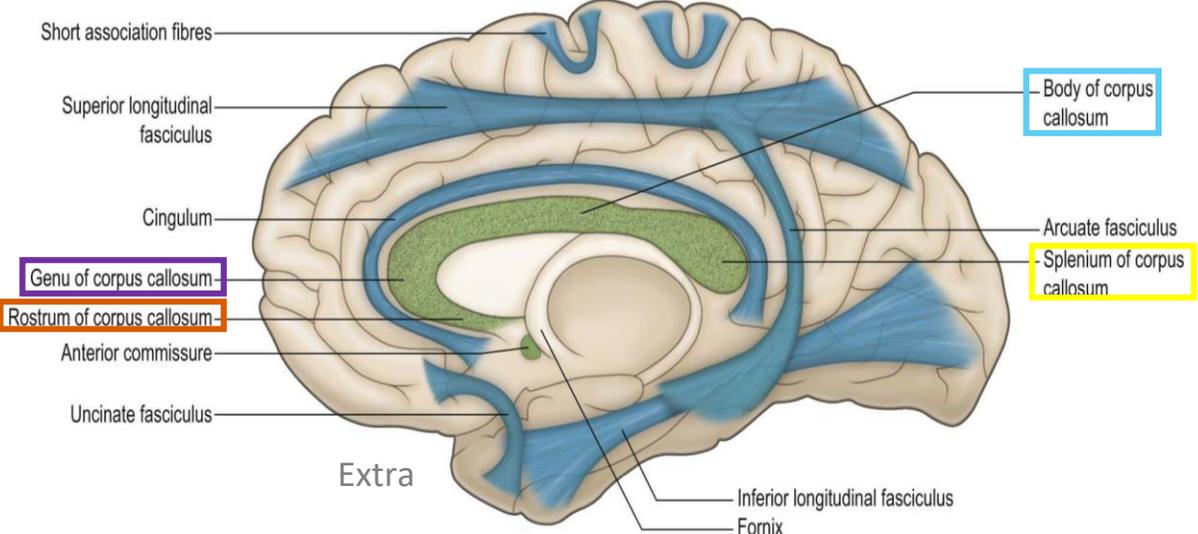
Splenium

Genu

Rostrum



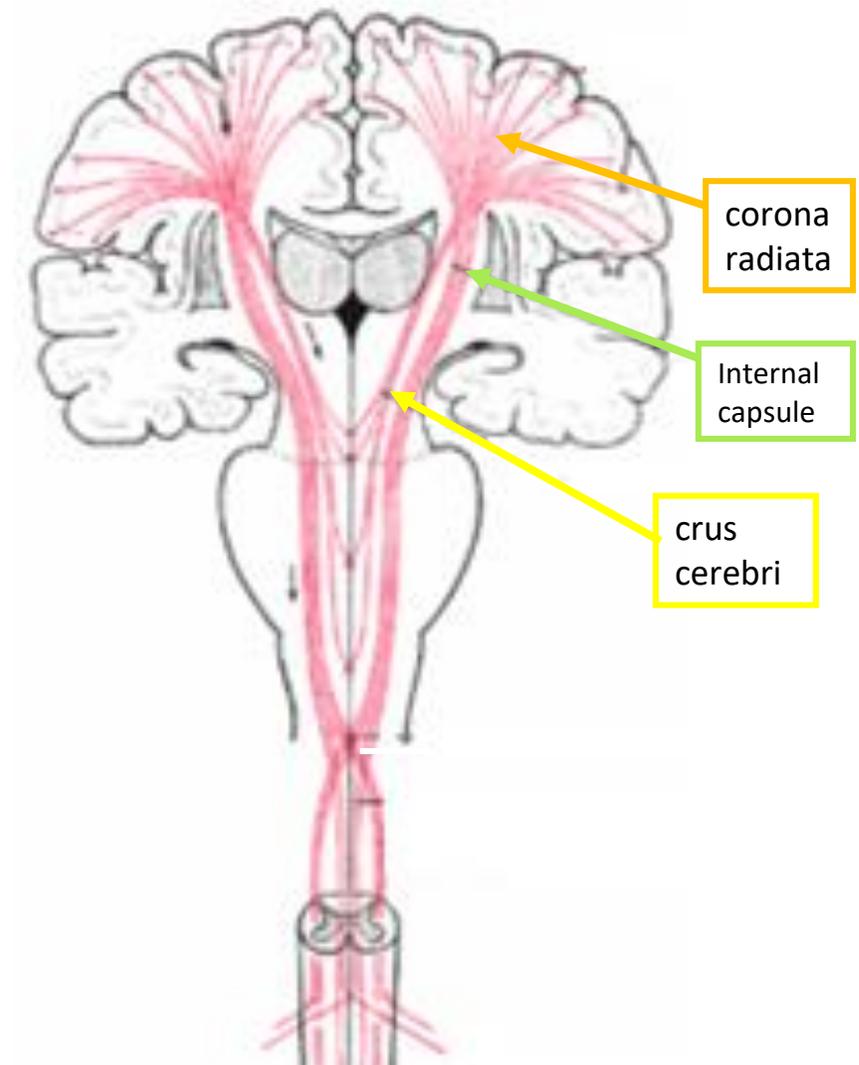
Corpus callosum



White Matter

3. Projection Fibers

- Consist of:
 - **Afferent fibers** conveying impulses to the cerebral cortex.
 - **Efferent fibers** conveying impulses away from the cortex.
- Deeper to the cortex, these fibers are arranged radially as the **corona radiata**.
- Then the fibers converge downward, form **internal capsule**, between thalamus and basal ganglia.
- Continue in the **crus cerebri** of the midbrain, **basilar** part of pons, & **pyramid** of medulla oblongata.



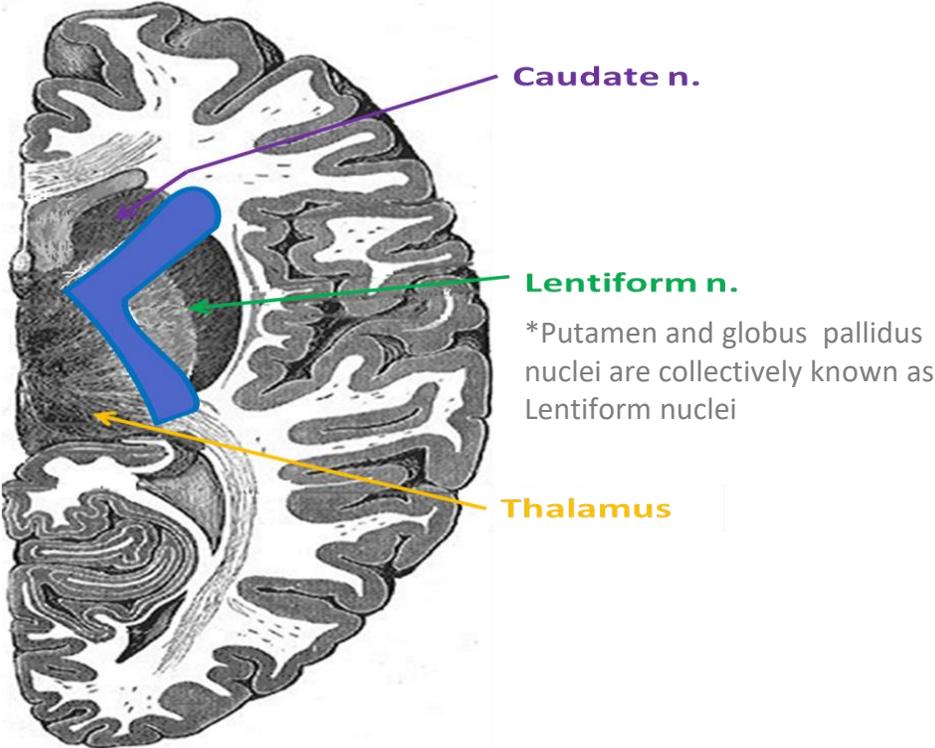
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White Matter

3. Projection Fibers

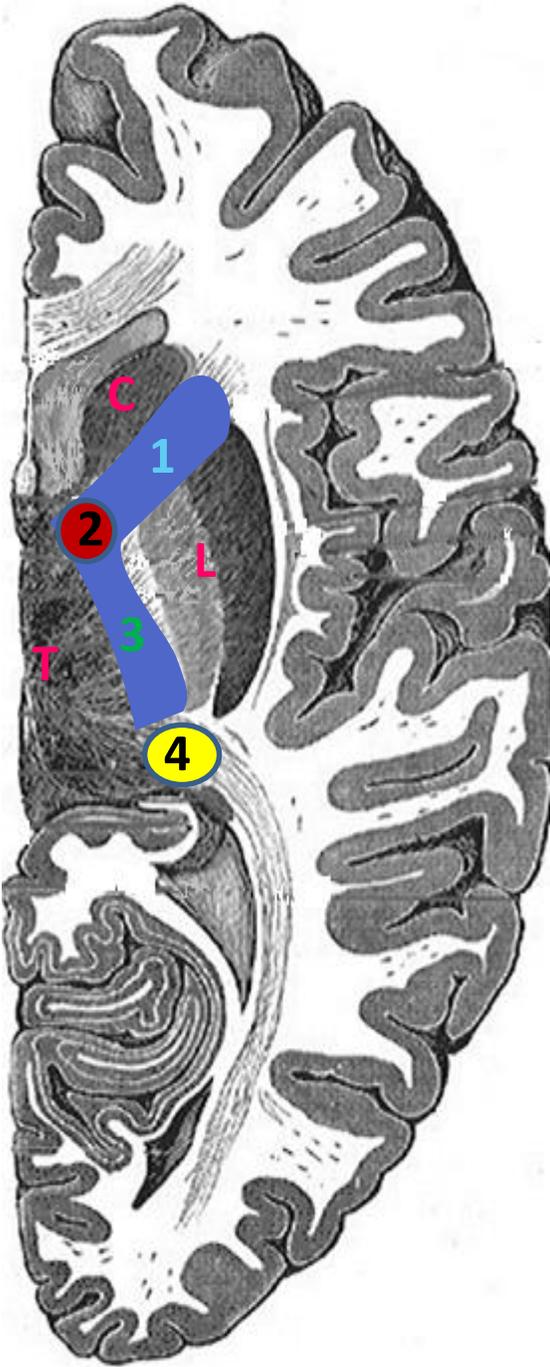
Internal Capsule

Bundle of projection fibers, passes through the interval between the thalamus and the basal ganglia (caudate & lentiform* nuclei)



Has 5 parts:

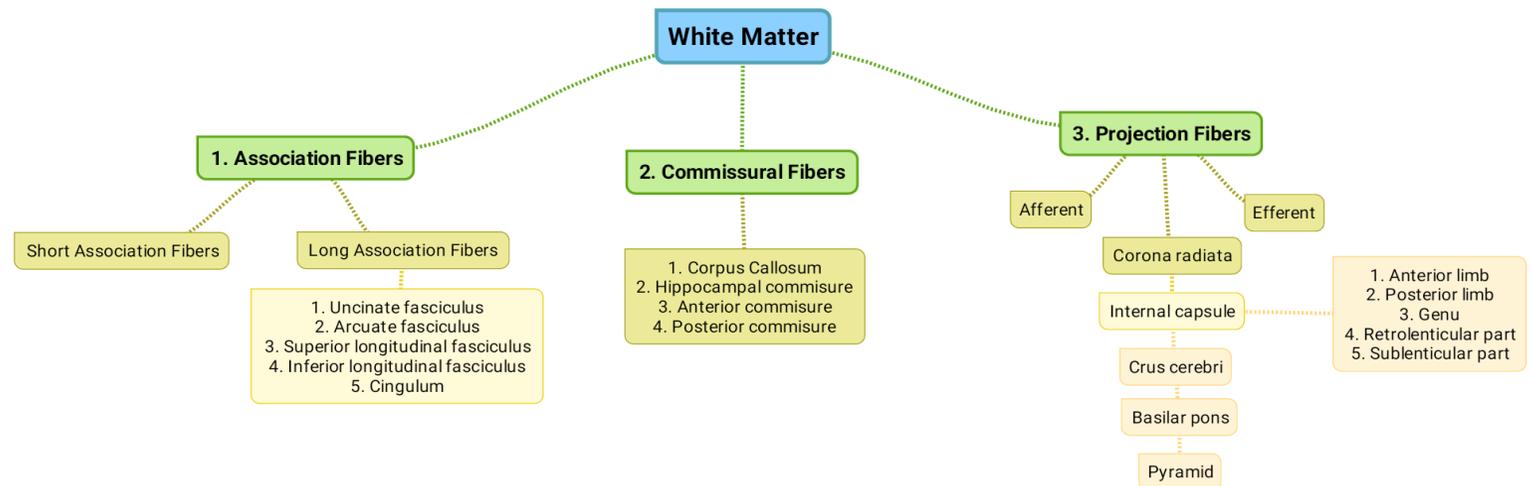
- 1. Anterior limb:** Thalamocortical & Frontopontine fibers
- 2. Genu:** Corticobulbar fibers
- 3. Posterior limb:** Corticospinal, Corticobulbar & Thalamocortical fibers.
- 4. Retrolenticular part:** Geniculocalcarine fibers
- 5. Sublenticular part:** Geniculo-temporal fibers.



Summary

Brodmann's Areas	
1	Primary somatosensory cortex
2	
3	
4	Primary motor cortex
6	Premotor cortex
8	Frontal eye field
17	Primary visual cortex
19	Visual association cortex
41	Primary auditory cortex
42	
44	Broca's area
45	

Lobe	Gyri	Sulci
Frontal	<ol style="list-style-type: none"> 1. Precentral gyrus 2. Superior frontal gyrus 3. Middle frontal gyrus 4. Inferior frontal gyrus 	<ol style="list-style-type: none"> 1. Superior frontal sulci 2. Inferior frontal sulci
Parietal	<ol style="list-style-type: none"> 1. Postcentral gyrus 	<ol style="list-style-type: none"> 1. Intraparietal sulcus
Temporal	<ol style="list-style-type: none"> 1. Insula 2. Superior temporal gyrus 3. Middle temporal gyrus 4. Inferior temporal gyrus 	<ol style="list-style-type: none"> 1. Superior temporal sulci 2. Inferior temporal sulci
Medial Surface	<ol style="list-style-type: none"> 1. Cingulate 2. Parahippocampal 	<ol style="list-style-type: none"> 1. Parietooccipital 2. Calcarine 3. Cingulate



MCQS

1-which of the following is not one of the surfaces of the cerebrum

- a)superiolatral
- b)medial
- c)posterior
- d)inferior

2-Which lobe is responsible for smell, hearing and memory?

- a)Frontal
- b)temporal
- c)Occipital
- d)parietal

3-Where is broca's area?

- a)frontal
- b)temporal
- c)occipital
- d)parietal

4-When is cerebral dominance becomes established ?

- a) before birth
- b) first few years after birth
- c) at puberty
- d) mid 40s

5-Which nerve fiber type connect corresponding regions of different hemisphere?

- a)Association
- b)commissural
- c)projection

SAQ

1.What is the function of afferent projection fibers?

Afferent fibers convey impulses to the cerebral cortex

2. Name the 4 Commissural Fibers:

- Corpus callosum.
- Anterior commissure.
- Hippocampal commissure (commissure of fornix).
- Posterior commissure.

- 1.C
- 2.B
- 3.A
- 4.B
- 5.B



Leaders:

Nawaf AlKhudairy
Jawaher Abanumy

Members:

Abdulmohsen alghannam
Abdulmalek alhadlaq
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Abdulmohsen alkhalaf
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Feedback



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References:

- 1- Girls' & Boys' Slides
- 2- Greys Anatomy for Students
- 3- TeachMeAnatomy.com