Systemic Module
CNS

“Anatomy
Cerebral Hemispheres

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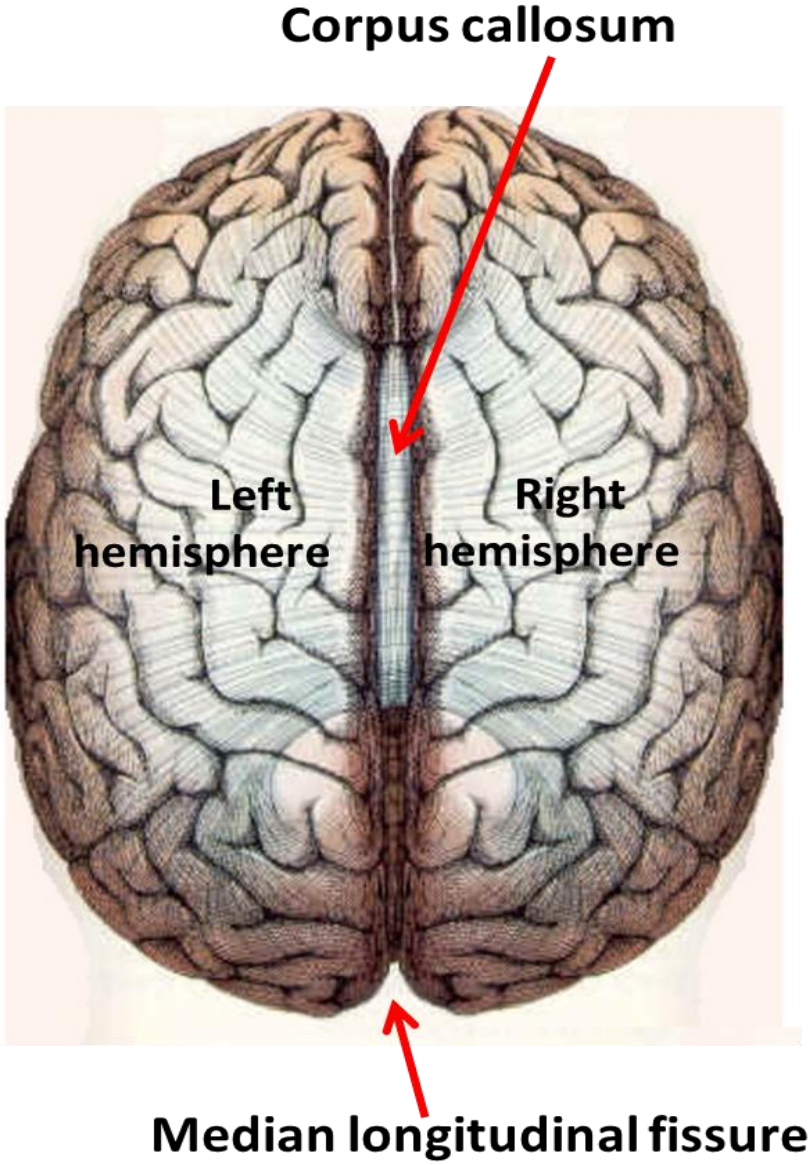
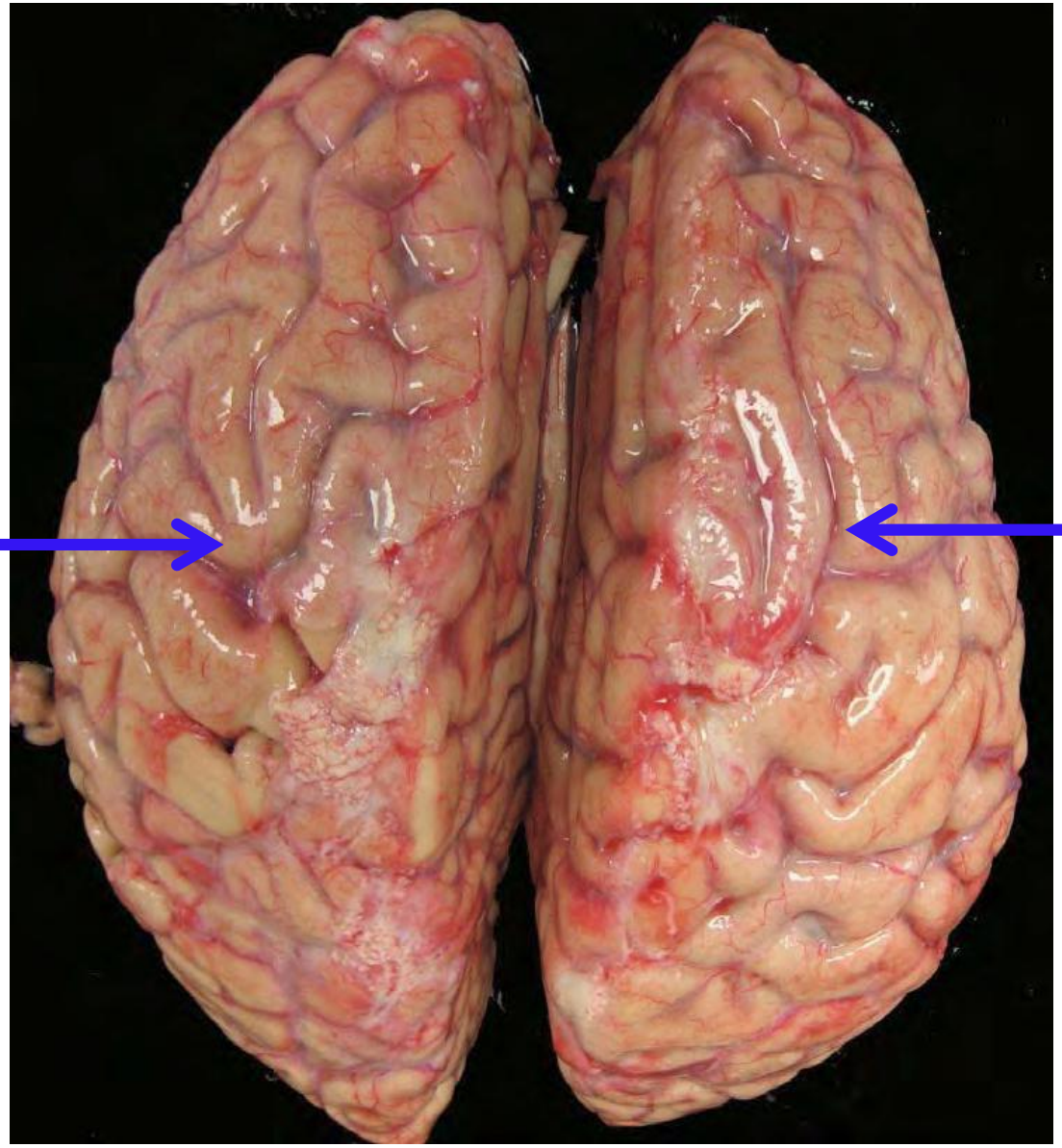
Cerebrum

- The cerebrum is the largest part of the brain.
- The cerebrum is divided into two halves, the **cerebral hemispheres.**
- The two cerebral hemispheres are separated by a deep **median longitudinal fissure.**
- The two cerebral hemispheres are connected by a bundle of fibers called the: **corpus callosum.**



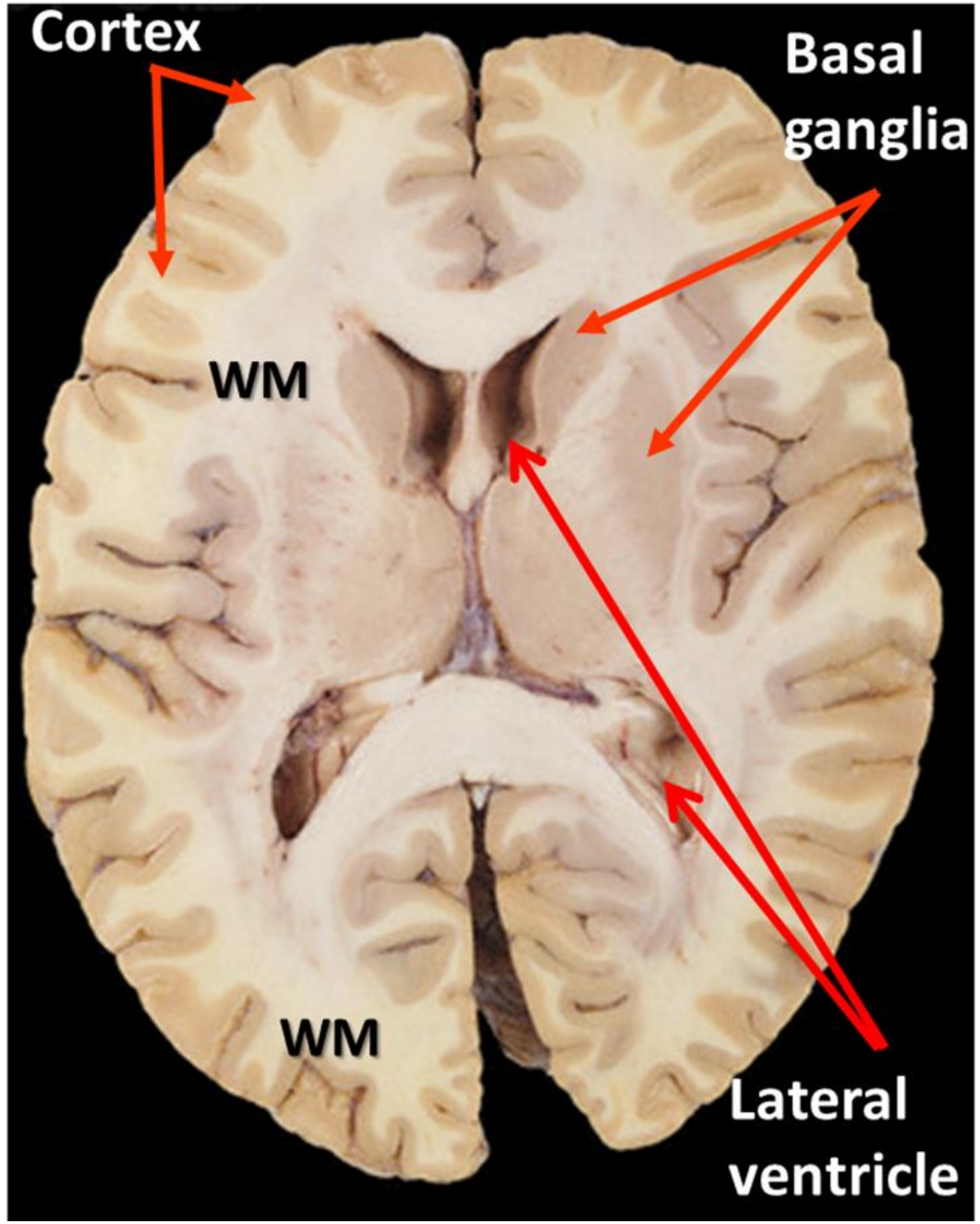
Left hemisphere



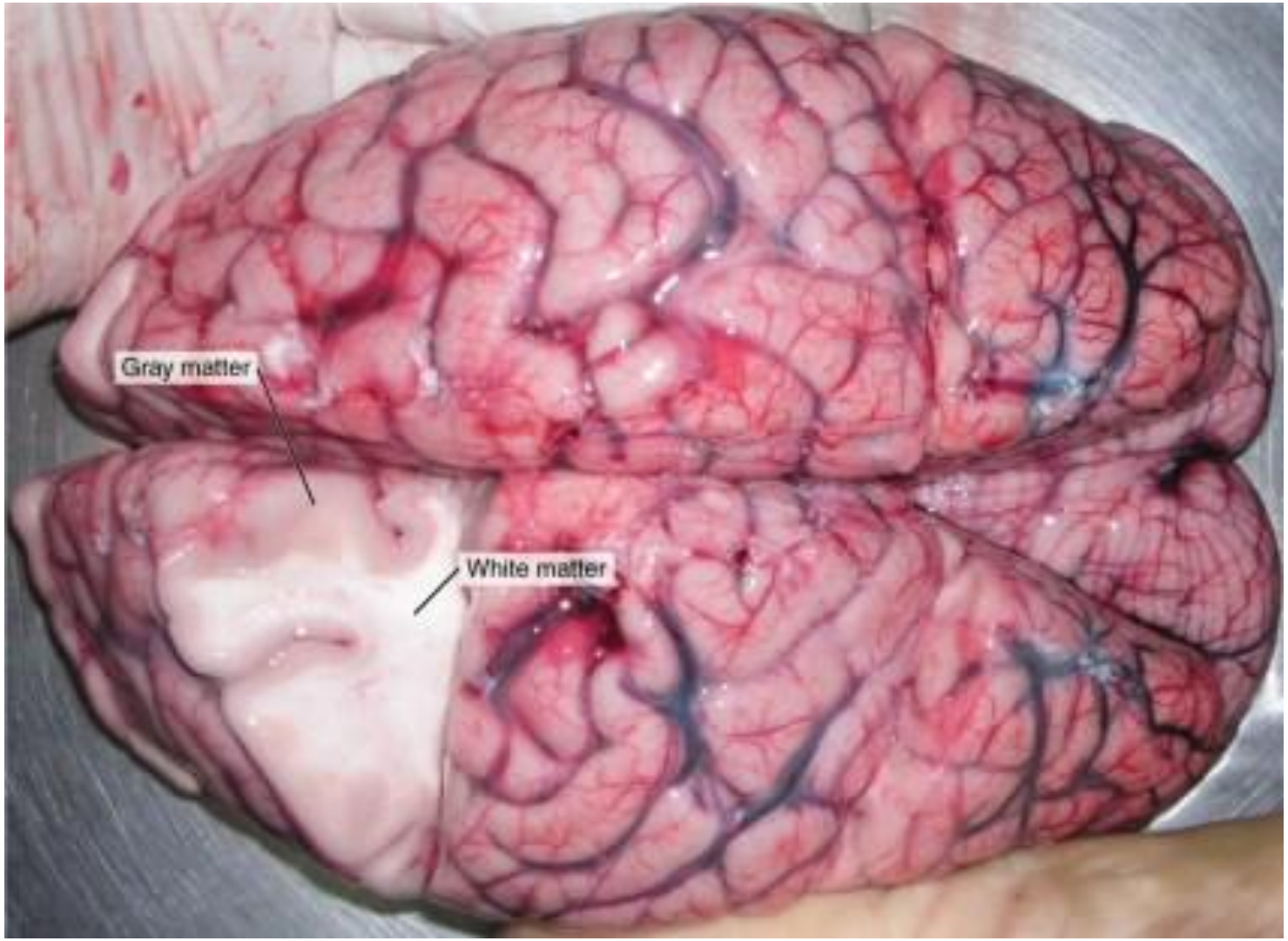
Right hemisphere

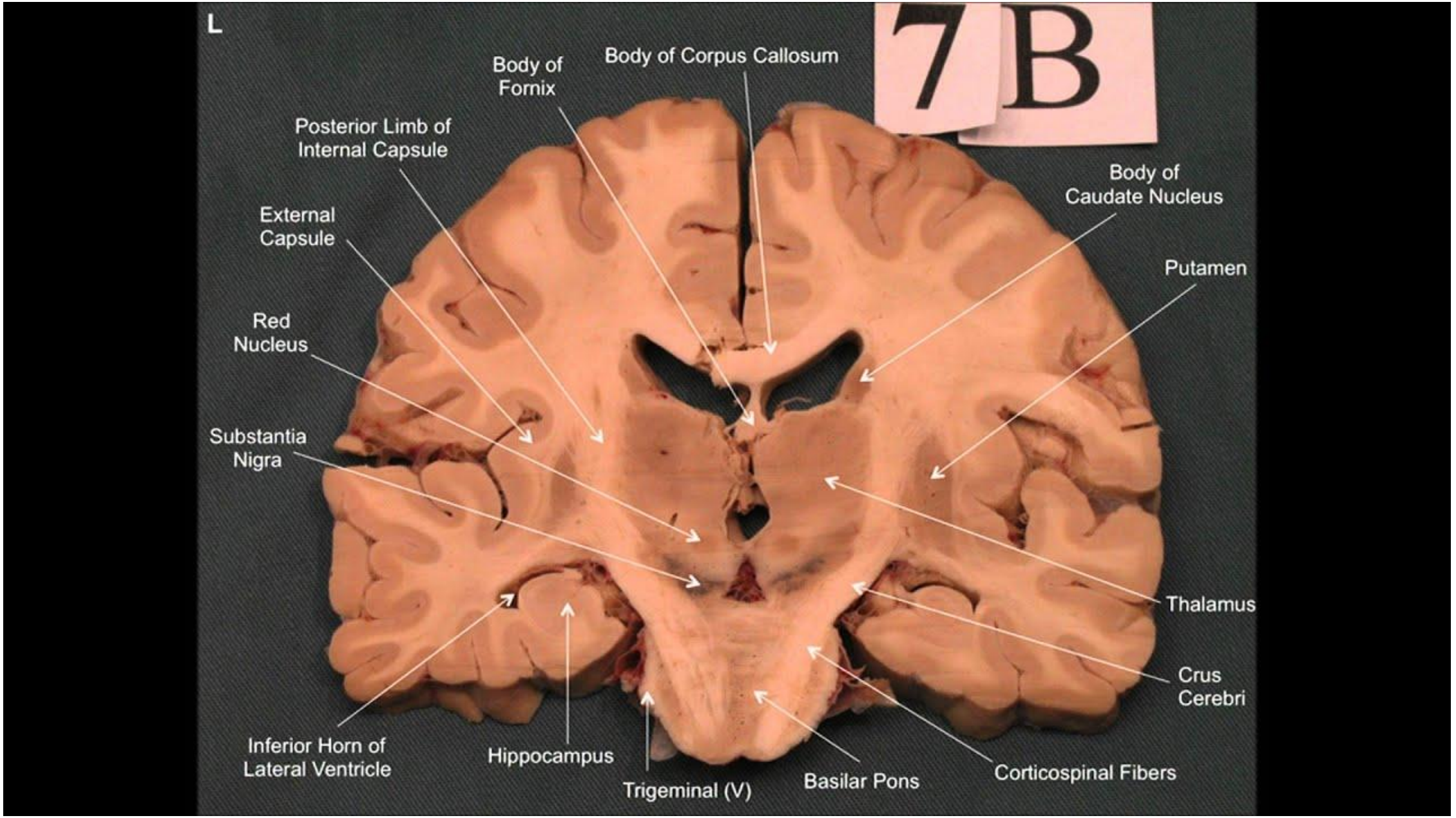
The Structure of Cerebral Hemispheres

- **The structure of cerebral hemispheres includes:**
  - Superficial layer of **grey matter** (2-4mm) forms the **cerebral cortex.**
  - Deeper to the cortex, axons running to and from the cells of the cortex form an extensive mass of **white matter (WM).**
  - Buried within the white matter lie a number of nuclear masses collectively known as the **basal ganglia.**
  - The cavity of hemisphere is called the **lateral ventricle.**

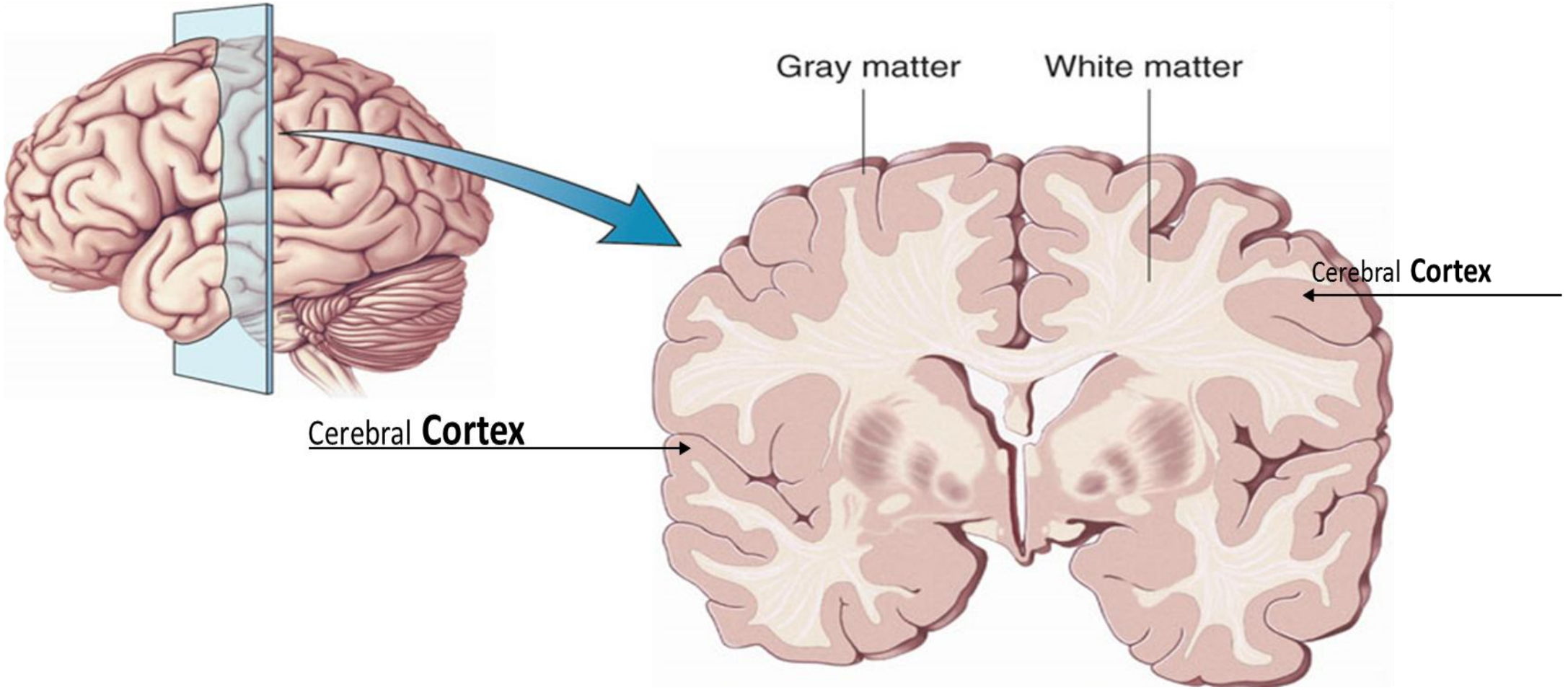

Cortex
Basal ganglia
WM
WM
Lateral ventricle

Grey matter and White matter

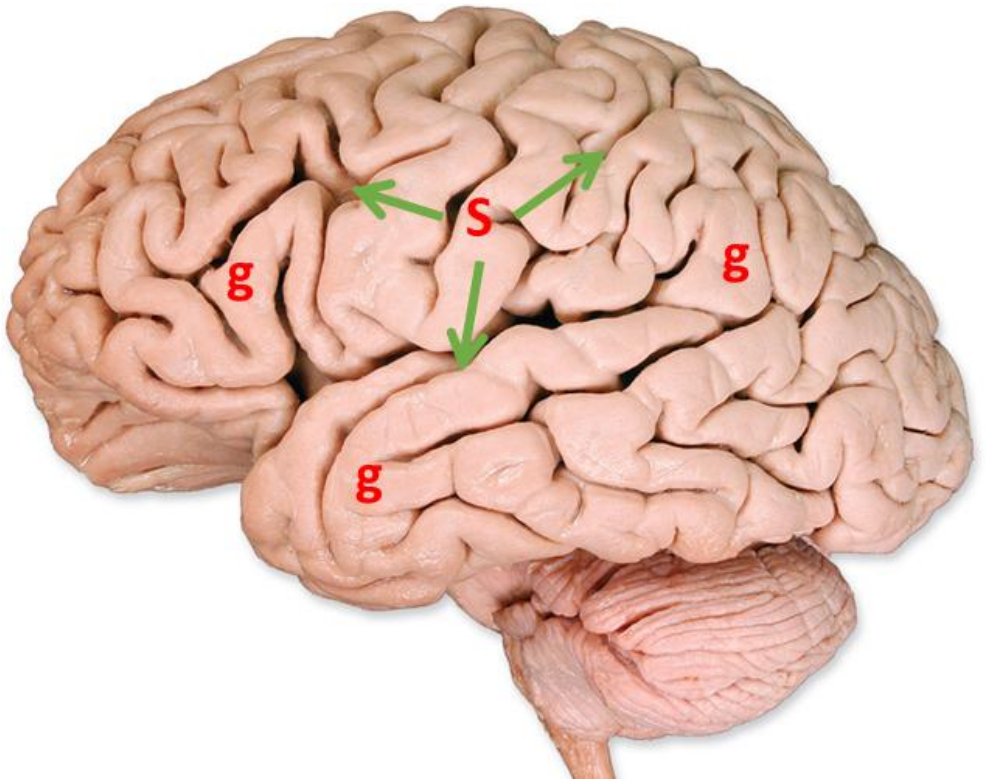


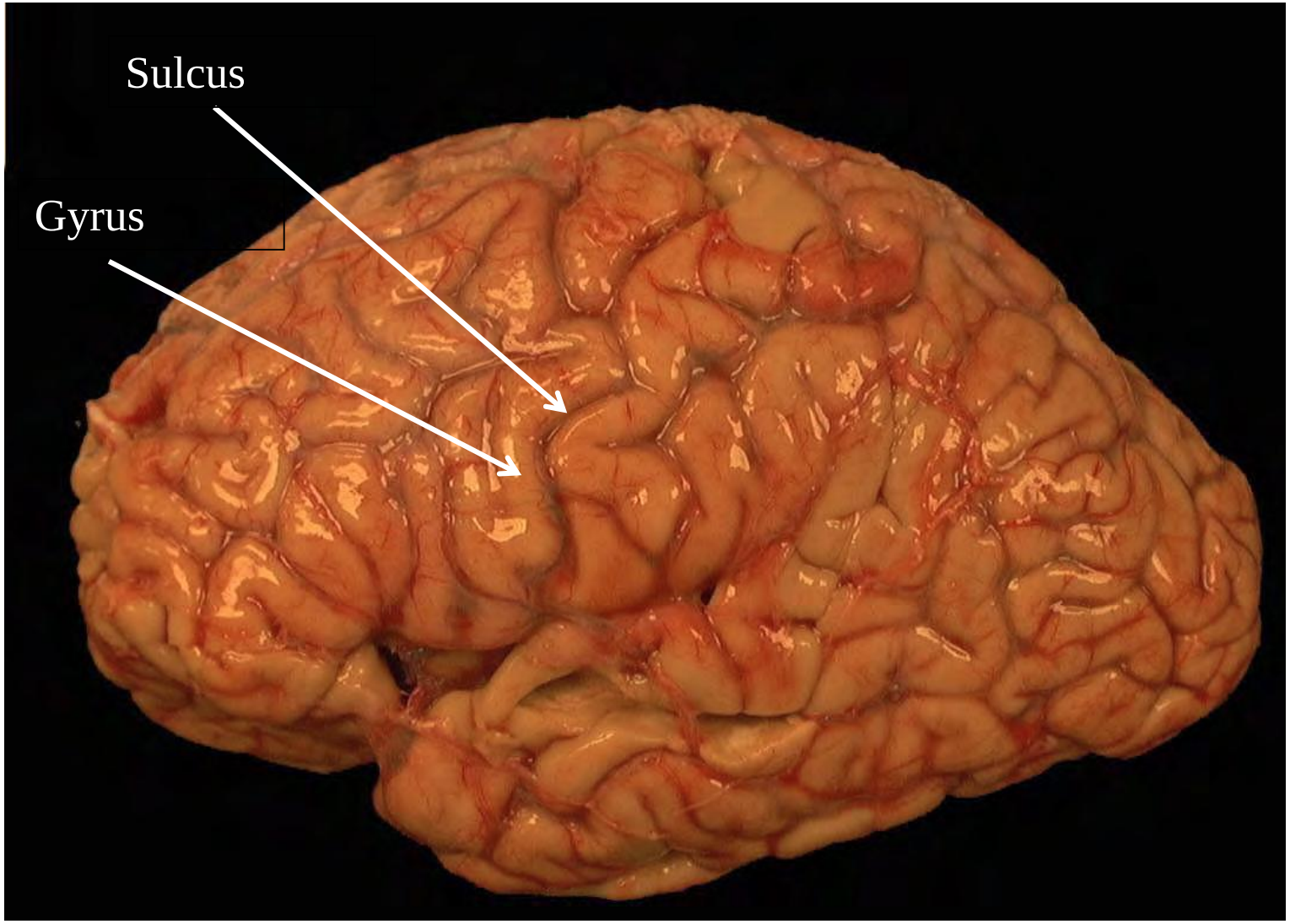

L
7B
Body of Fornix
Body of Corpus Callosum
Posterior Limb of Internal Capsule
Body of Caudate Nucleus
External Capsule
Putamen
Red Nucleus
Substantia Nigra
Thalamus
Crus Cerebri
Inferior Horn of Lateral Ventricle
Hippocampus
Trigeminal (V)
Basilar Pons
Corticospinal Fibers

Cerebral Cortex - The outermost layer of gray matter making up the superficial aspect of the cerebrum.



- The superficial layer of grey matter is irregular, and it has elevated folds called **gyri** *(singular:* ***Gyrus****)*
- The gyri are separated by grooves called **sulci** *(singular:* ***Sulcus****).*
- This arrangement maximize the surface area of the cerebral cortex (about 70% is hidden within the depths of sulci).




Sulcus
Gyrus

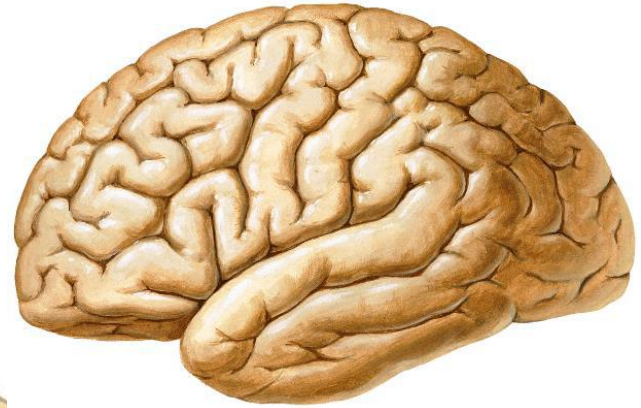
The Surfaces of Each Cerebral Hemisphere

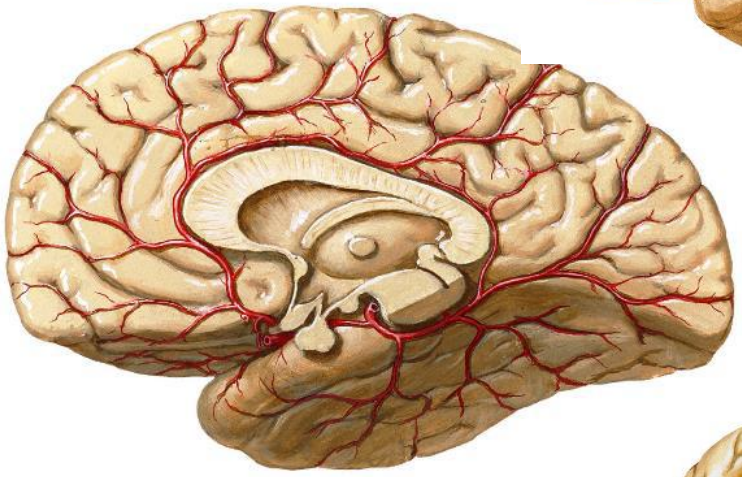
- Each cerebral hemisphere has 3 surfaces:

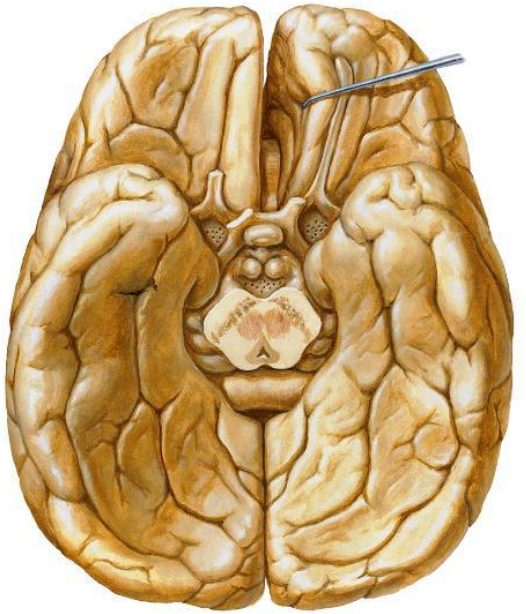
1. **Lateral (superolateral) surface:** convex to fit the skull cap.

2. **Medial surface:** Flat and vertical, related to the falx cerebri and median longitudinal fissure.

3. **Inferior surface:** Divided into orbital and tentorial parts by the of lateral sulcus.



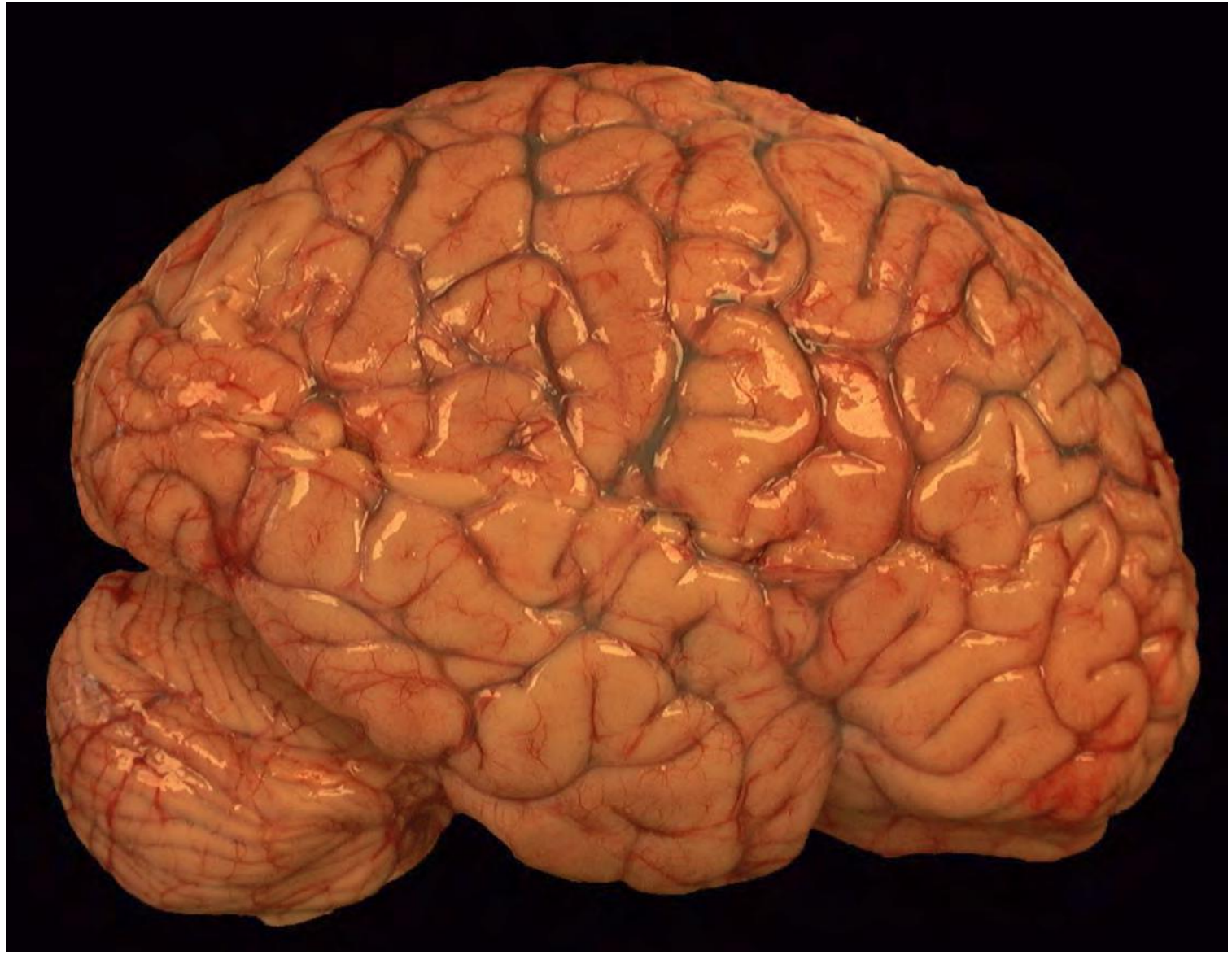




Lateral view of a right half brain

Dorsal

Posterior



Anterior

Ventral

Medial view of a left half brain

Dorsal

Posterior

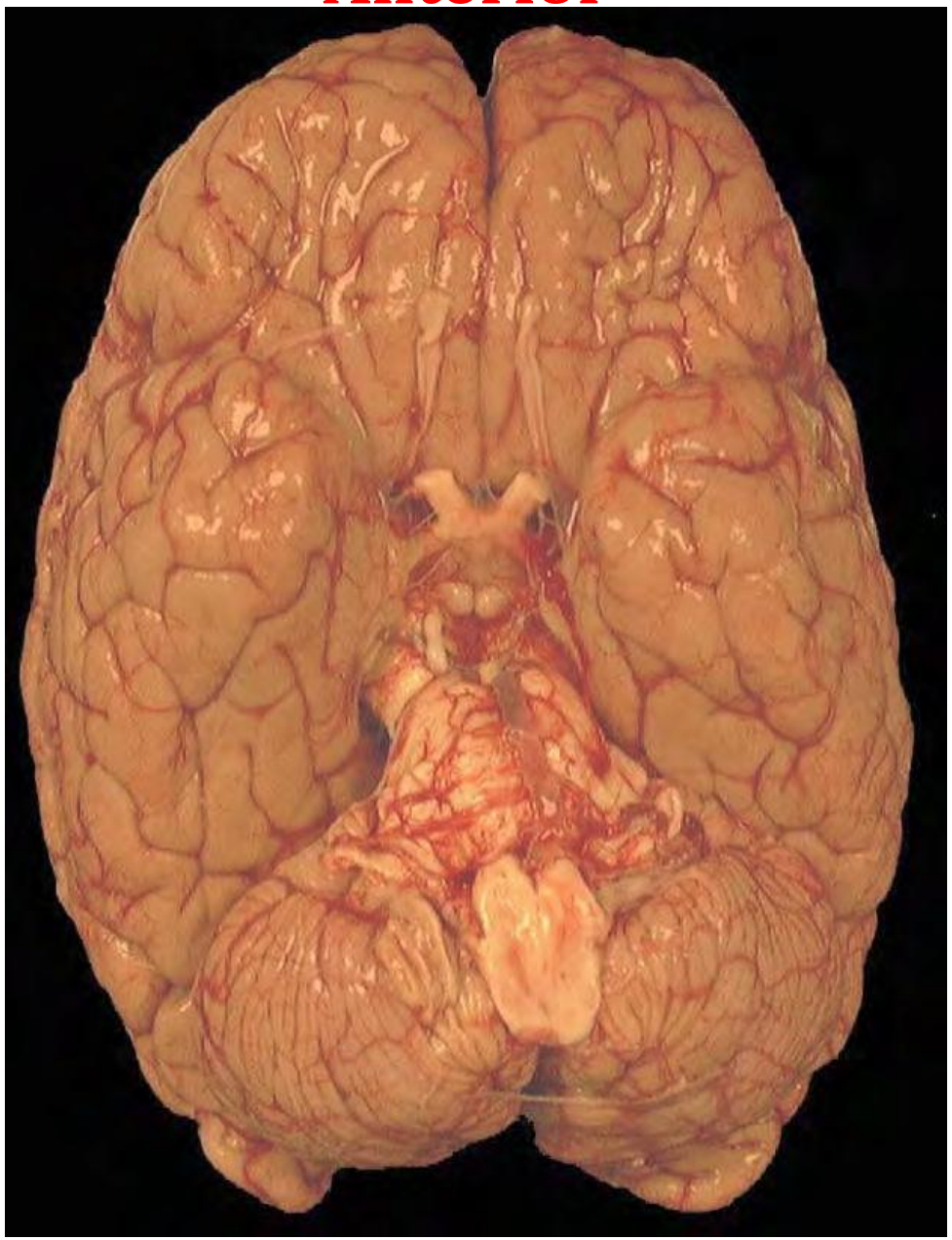
Anterior

Ventral

Ventral view of a human brain

Anterior

Lateral



Lateral

Posterior

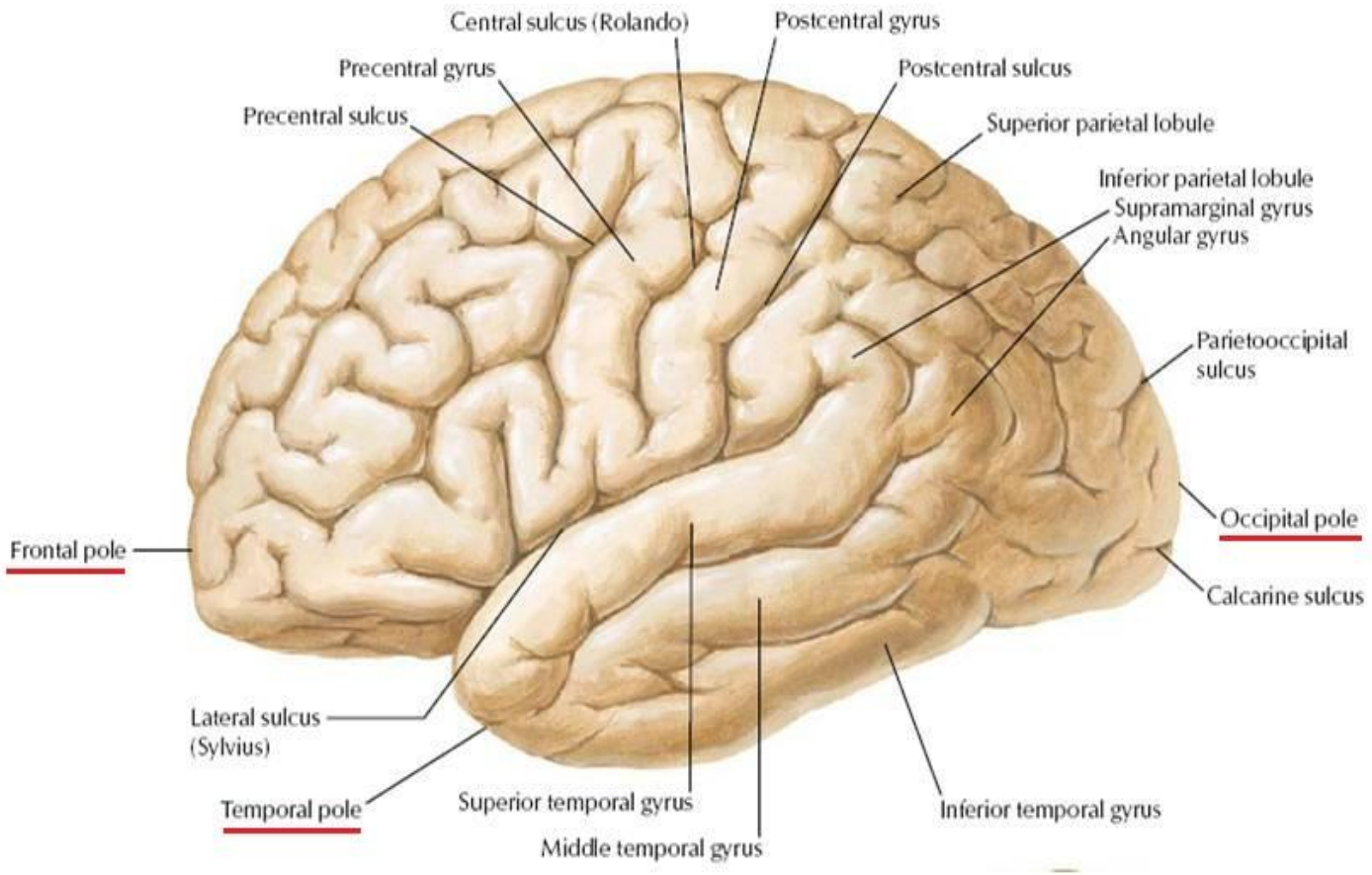
The Poles of Cerebral Hemisphere

- **Each cerebral hemisphere has 3 poles:**

1. **Frontal pole:** at the anterior end of the frontal lobe.

2. **Temporal pole:** at the anterior end of the temporal lobe.

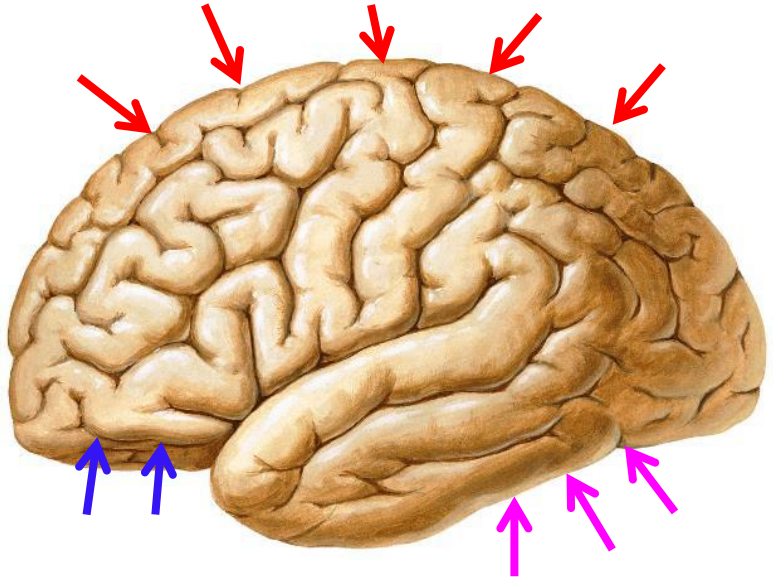
3. **Occipital pole:** at the posterior end of the occipital lobe.

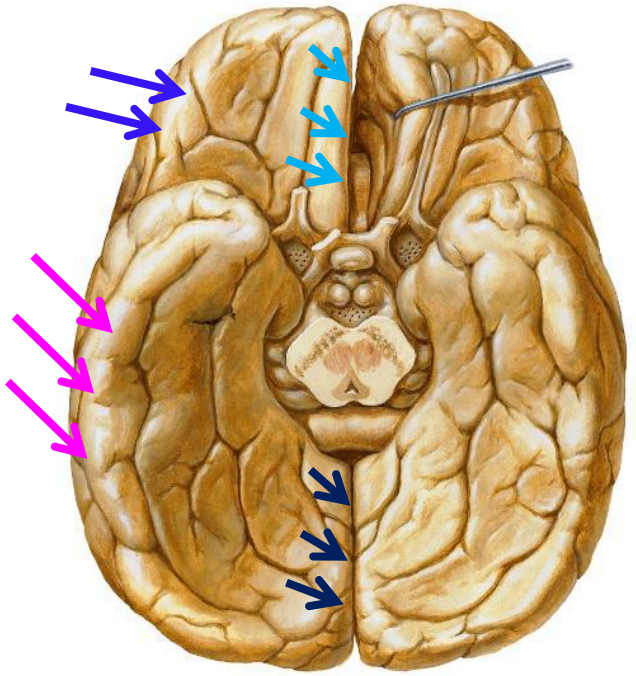


The Borders of Cerebral Hemisphere

- **Each hemisphere has five borders:**

1. **Superomedial:** separates the superolateral & medial surfaces.
2. **Inferolateral:** separates the superolateral & tentorial surfaces.
3. **Superciliary:** separates the superolateral & orbital surfaces.
4. **Medial orbital:** separates the orbital & medial surfaces.
5. **Medial occipital:** separates the tentorial & medial surfaces

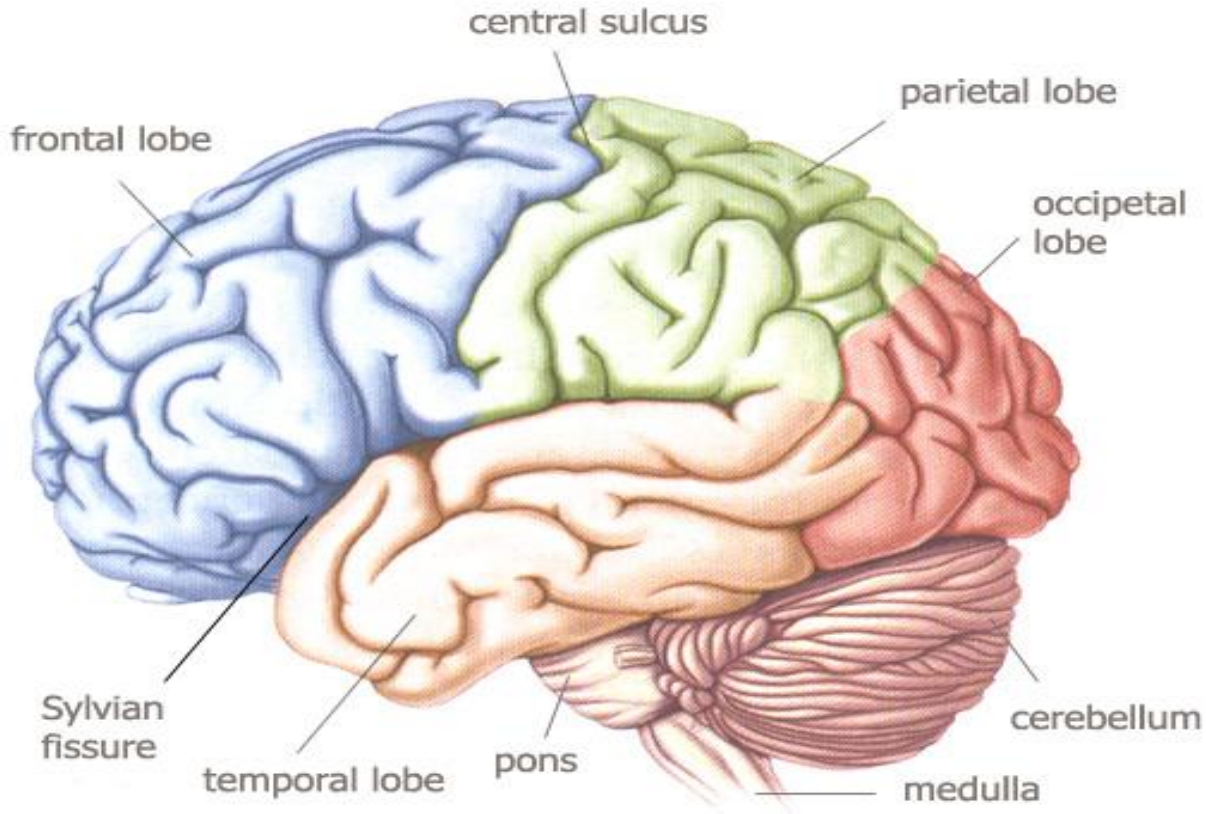




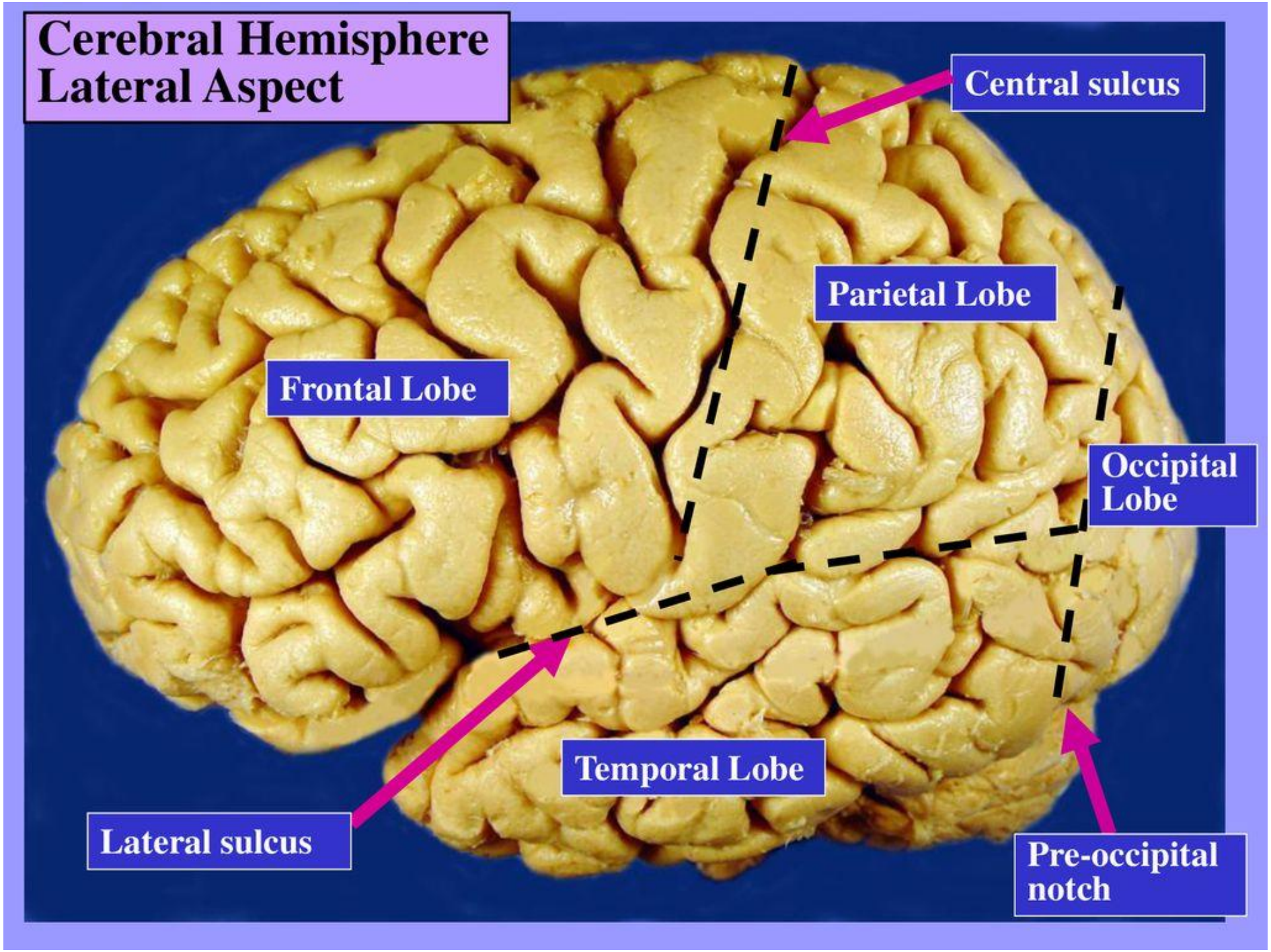
The Lobes of Cerebral Hemisphere

- **Each hemisphere is divided into FOUR lobes (named after overlying bones):**

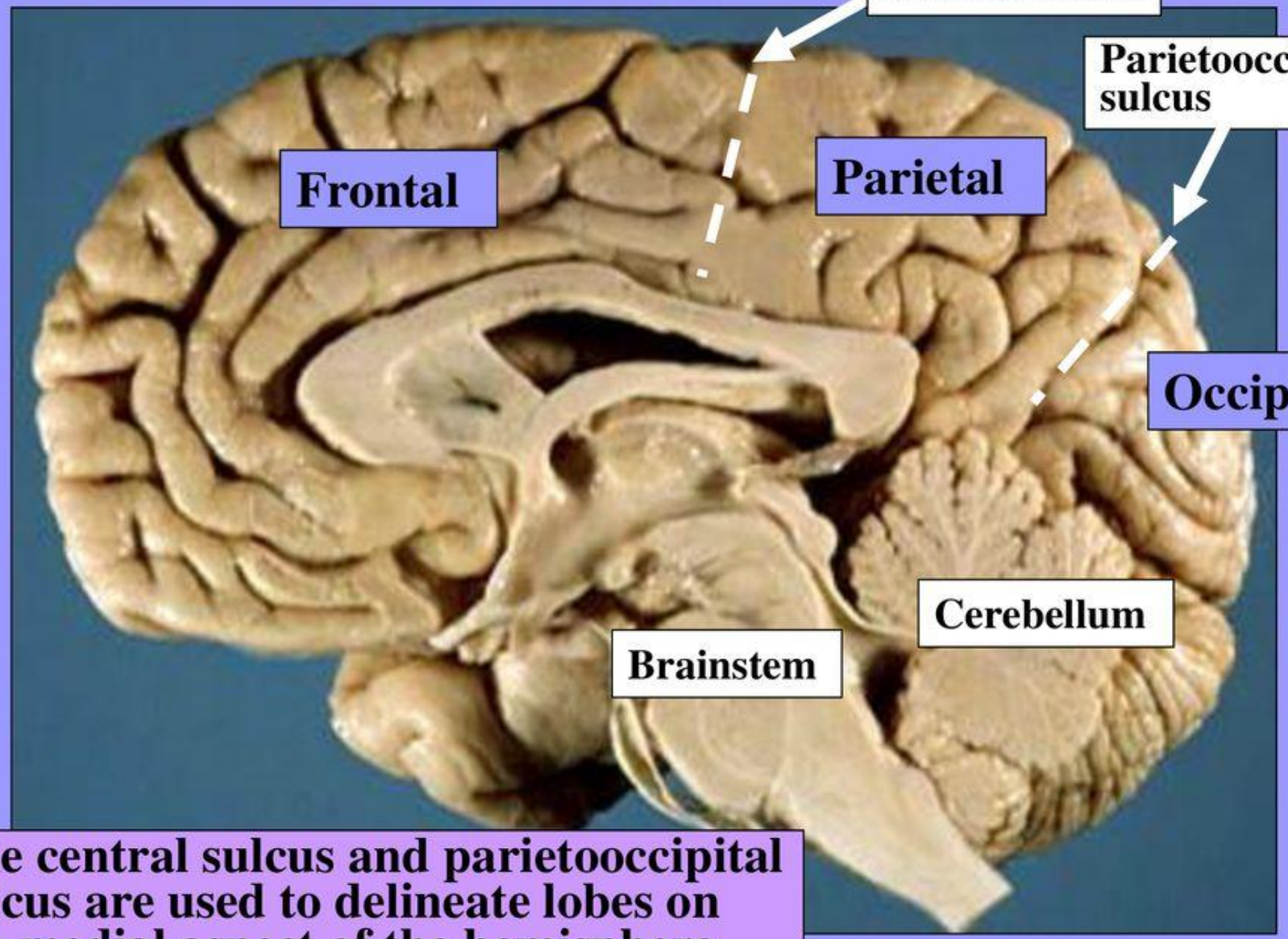
  1. **The frontal lobe.**
  2. **The parietal lobe.**
  3. **The temporal lobe.**
  4. **The occipital lobe.**



- **Insula:** the gyri lie deep in the lateral fissure, **sometime considered as a 5TH lobe.**

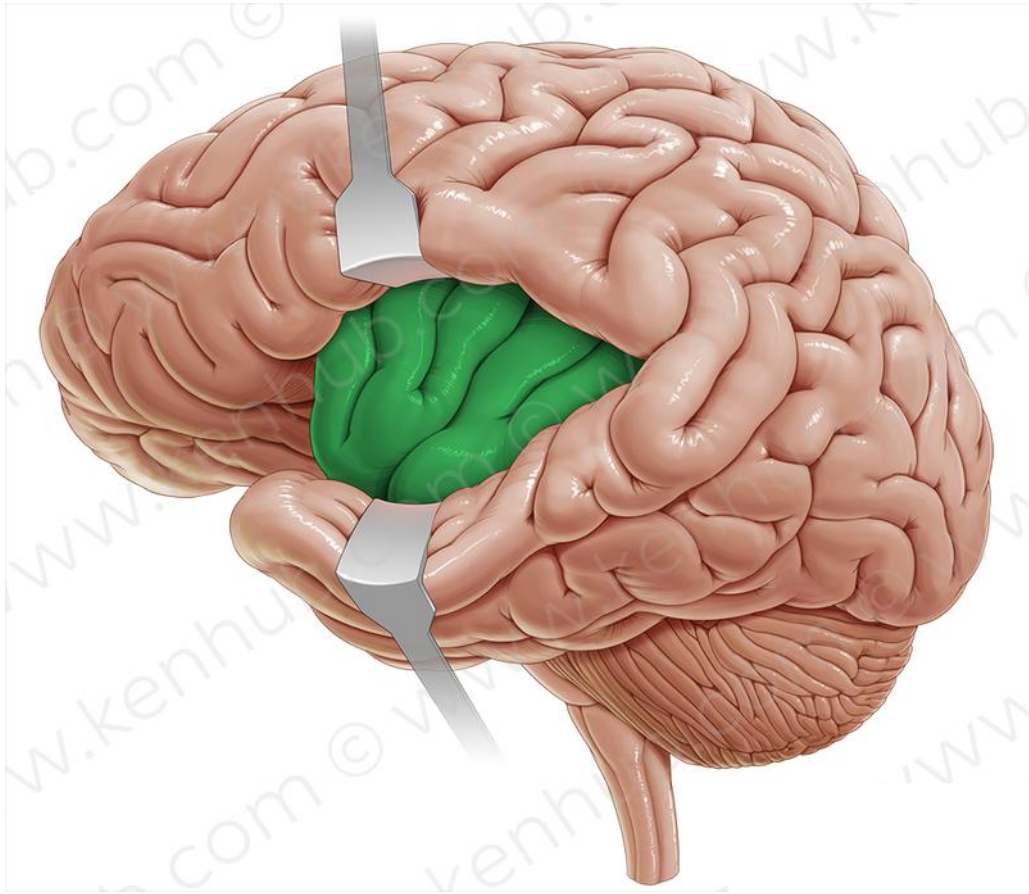

Cerebral Hemisphere
Lateral Aspect
Central sulcus
Parietal Lobe
Frontal Lobe
Occipital
Lobe
Temporal Lobe
Lateral sulcus
Pre-occipital
notch

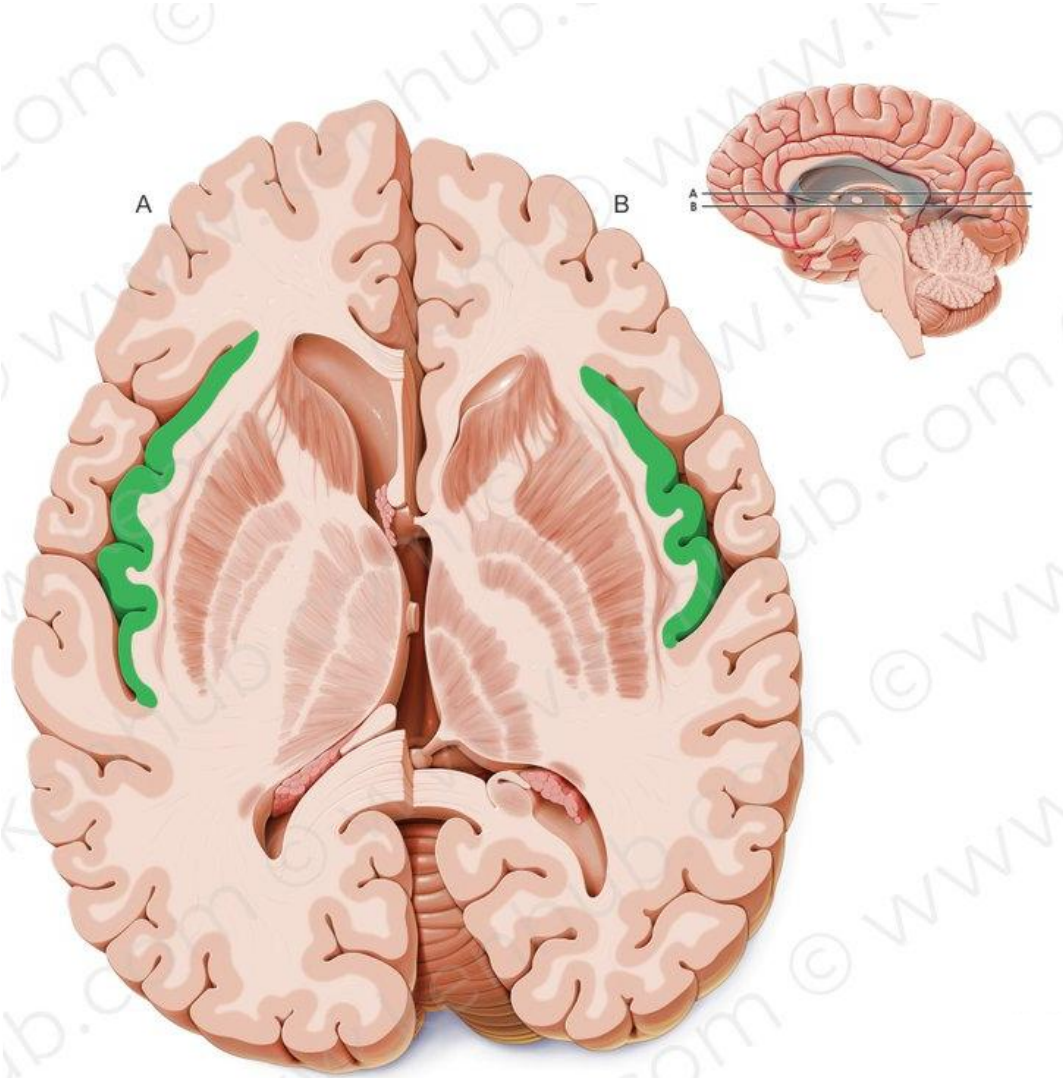
Medial Aspect/ Cerebral Hemisphere (Mid-Sagittal Section)



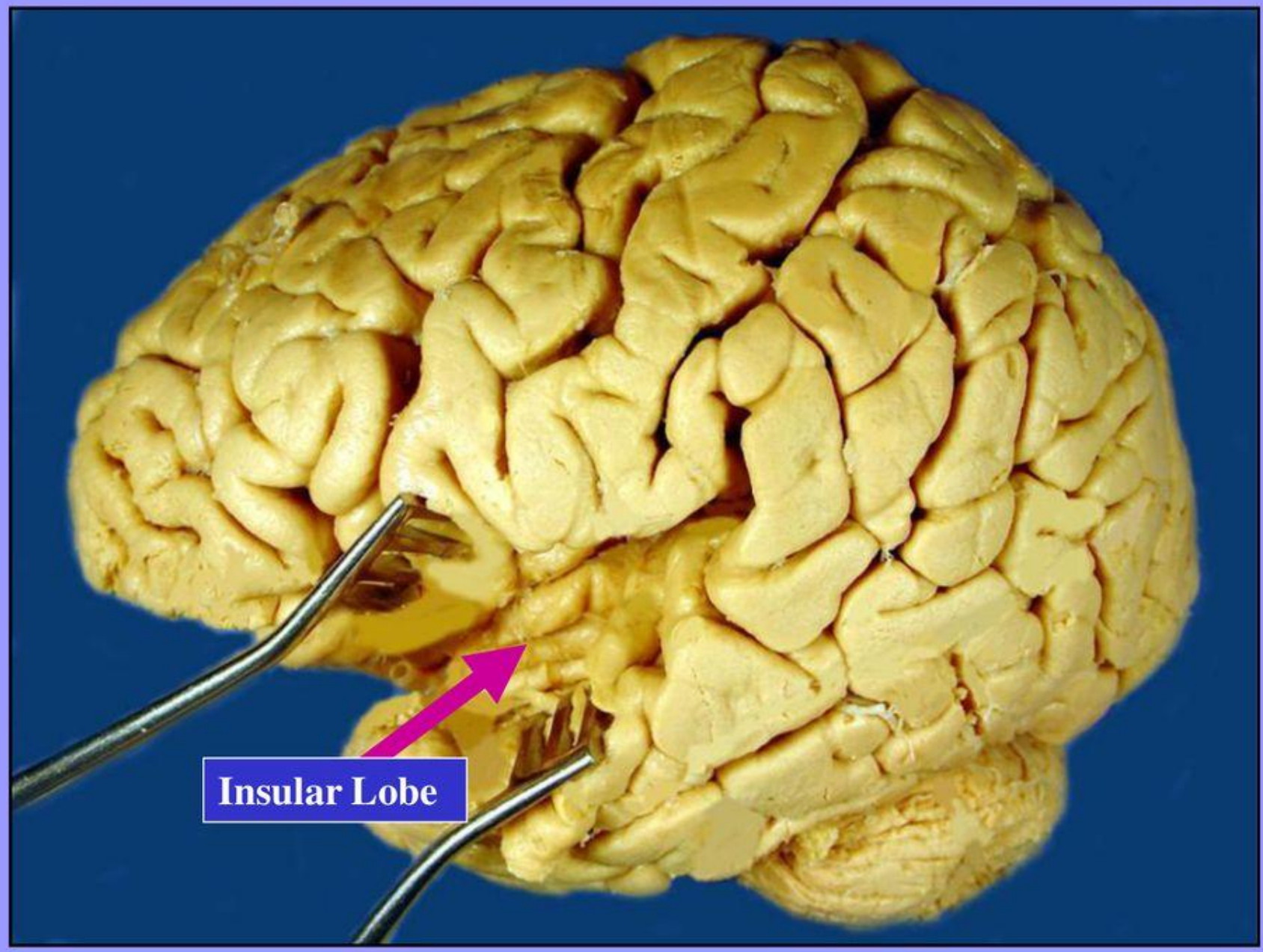
The central sulcus and parietooccipital sulcus are used to delineate lobes on the medial aspect of the hemisphere.

Insula





Opening the lateral sulcus reveals the insular lobe.



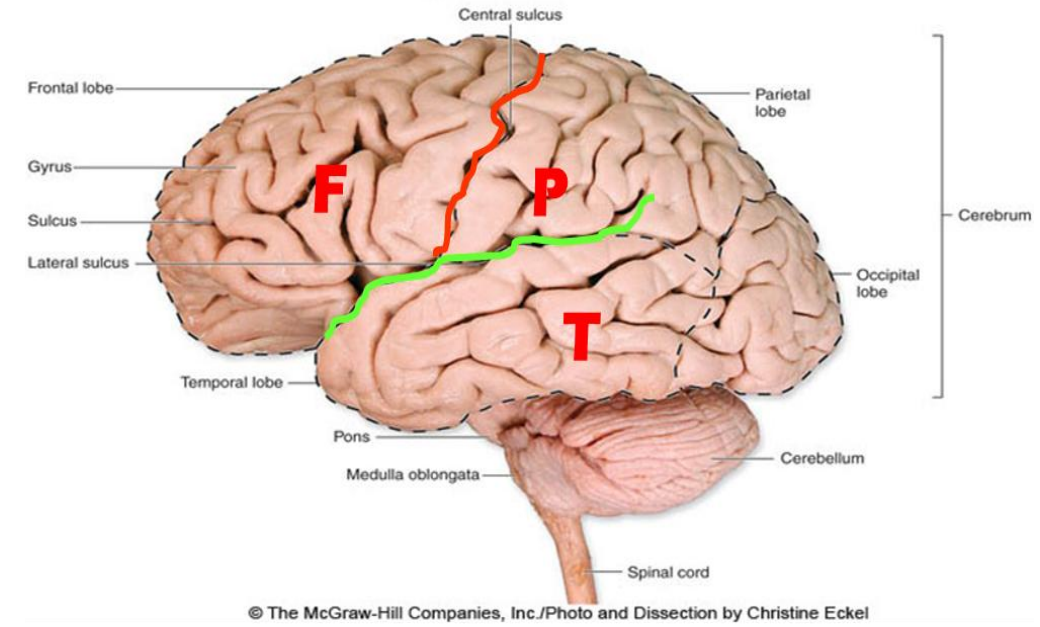
Major Sulci that Separate the Lobes

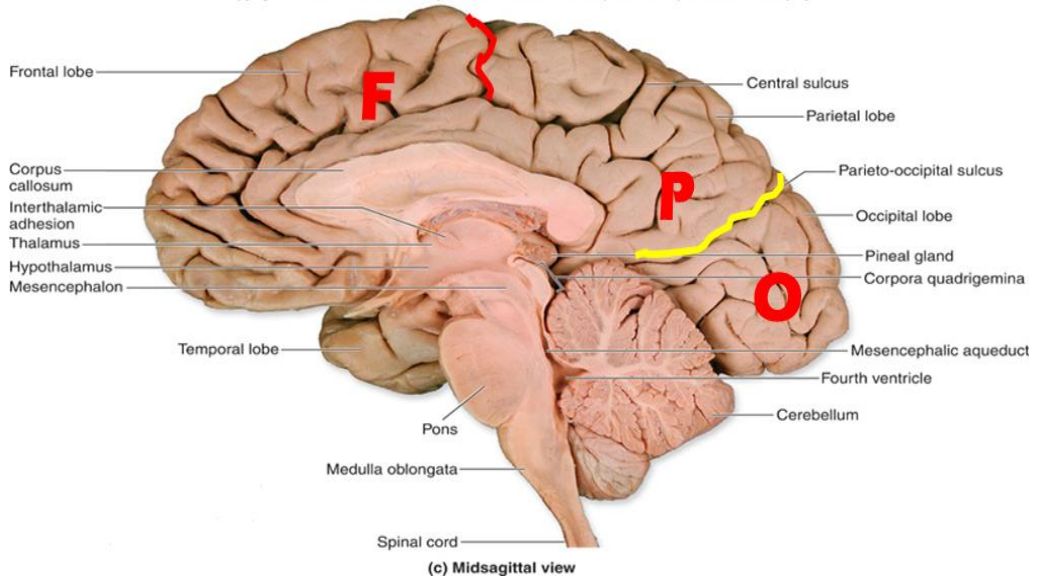
- **Three sulci, are used to divide each hemisphere into lobes:**

1. **Central sulcus:** Separates the frontal lobe (in front) from parietal lobe (behind).

2. **Lateral sulcus:** Separates between frontal and parietal lobes (above) and temporal lobe (below).

3. **Parieto-occipital sulcus:** It found on the medial surface of the hemisphere between parietal and occipital lobes.



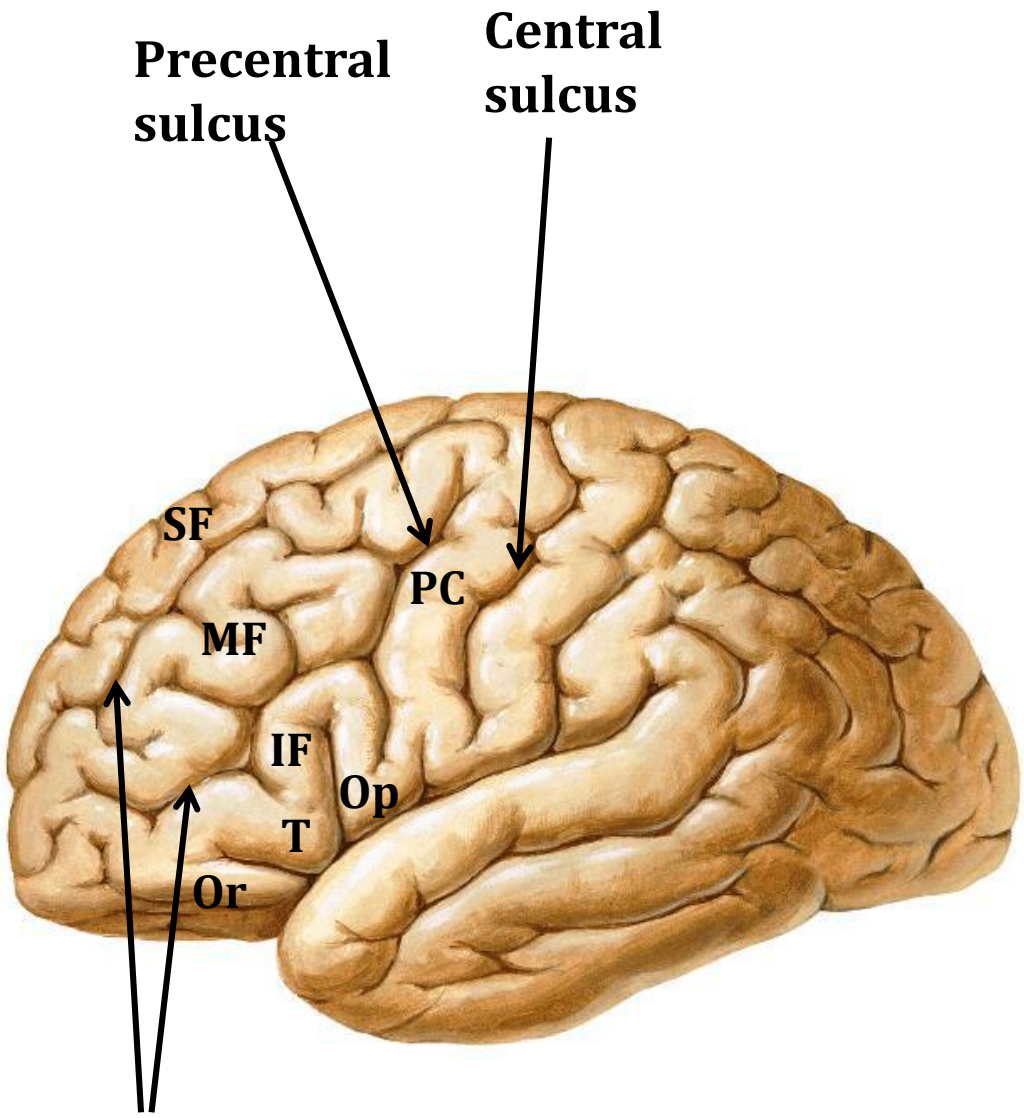


(c) Midsagittal view

Sulci and Gyri of the Superolateral Surface

Frontal Lobe

- **The precentral sulcus:** runs parallel to the central sulcus
- **Precentral gyrus (PC):** lies between the precentral sulcus and central sulcus
- **Superior & inferior frontal sulci** divide the remainder of the frontal lobe into **superior (SF), middle (MF) & inferior frontal (IF) gyri**
- The inferior frontal gyrus is invaded by the *anterior horizontal and ascending rami of the lateral sulcus* dividing it into 3 parts: **opercular part (Op), a triangular part (T), and an orbital part (Or).**



Superior & inferior frontal sulci

Frontal Lobe

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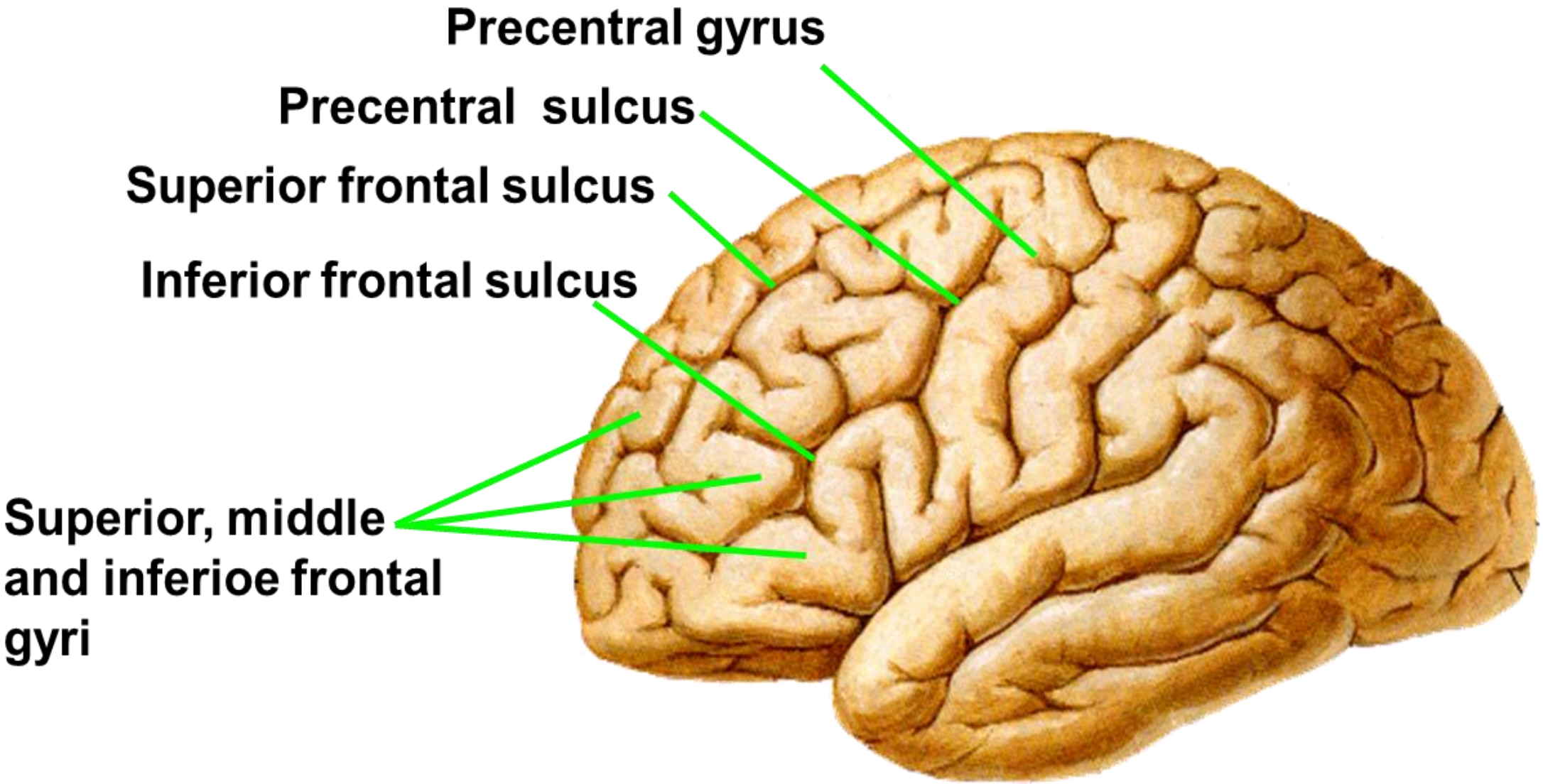
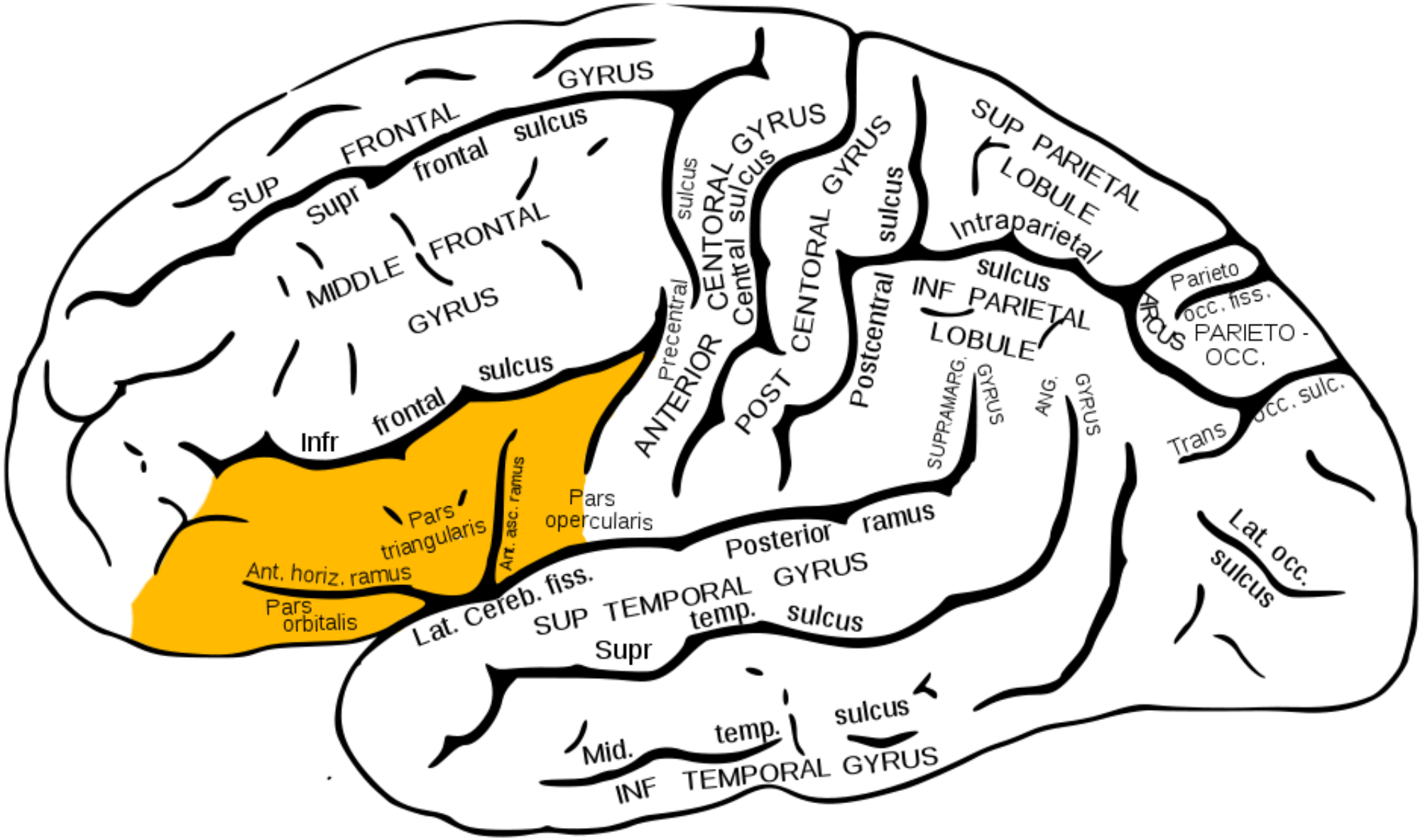


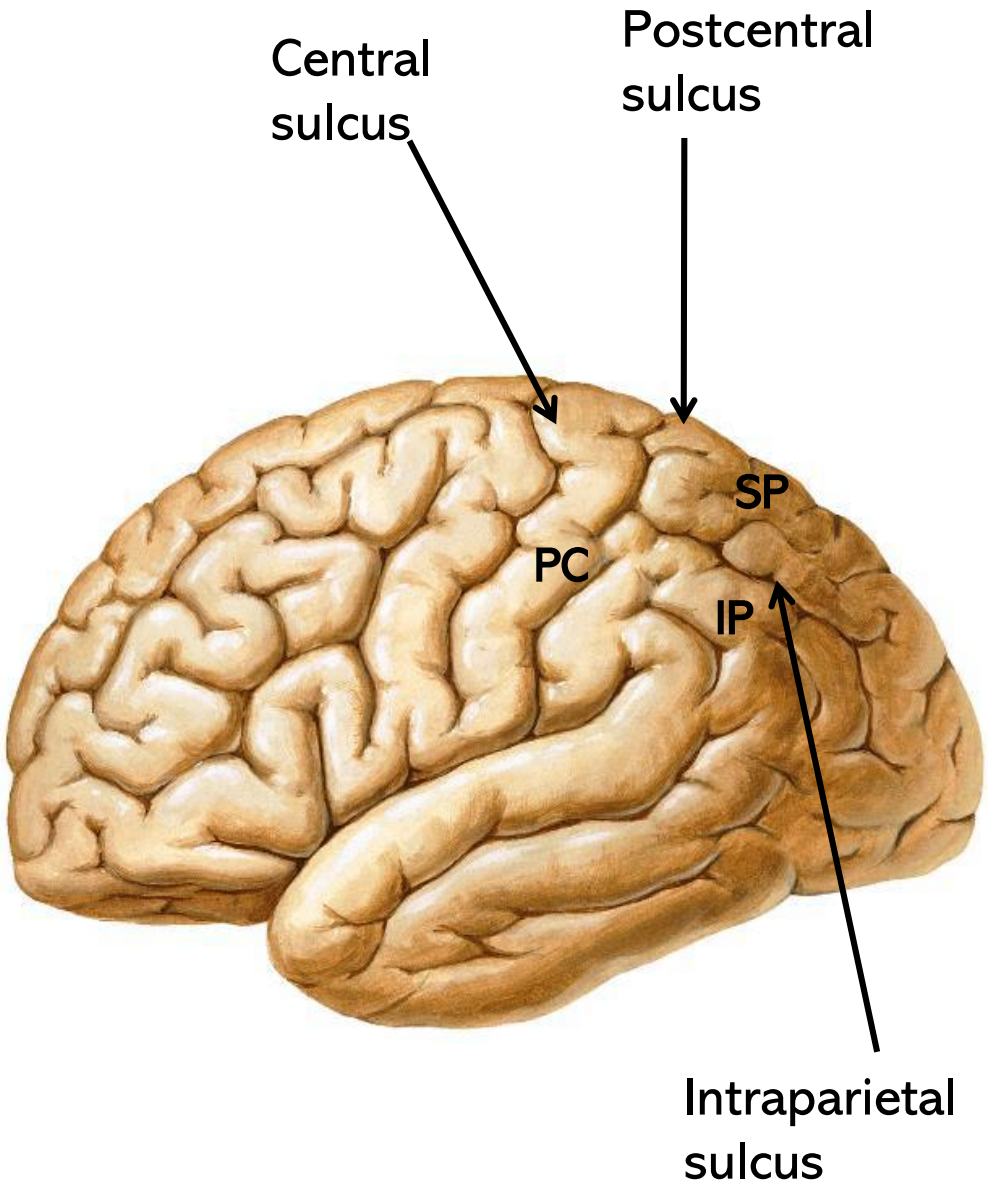
Sulci and gyri of frontal lobe

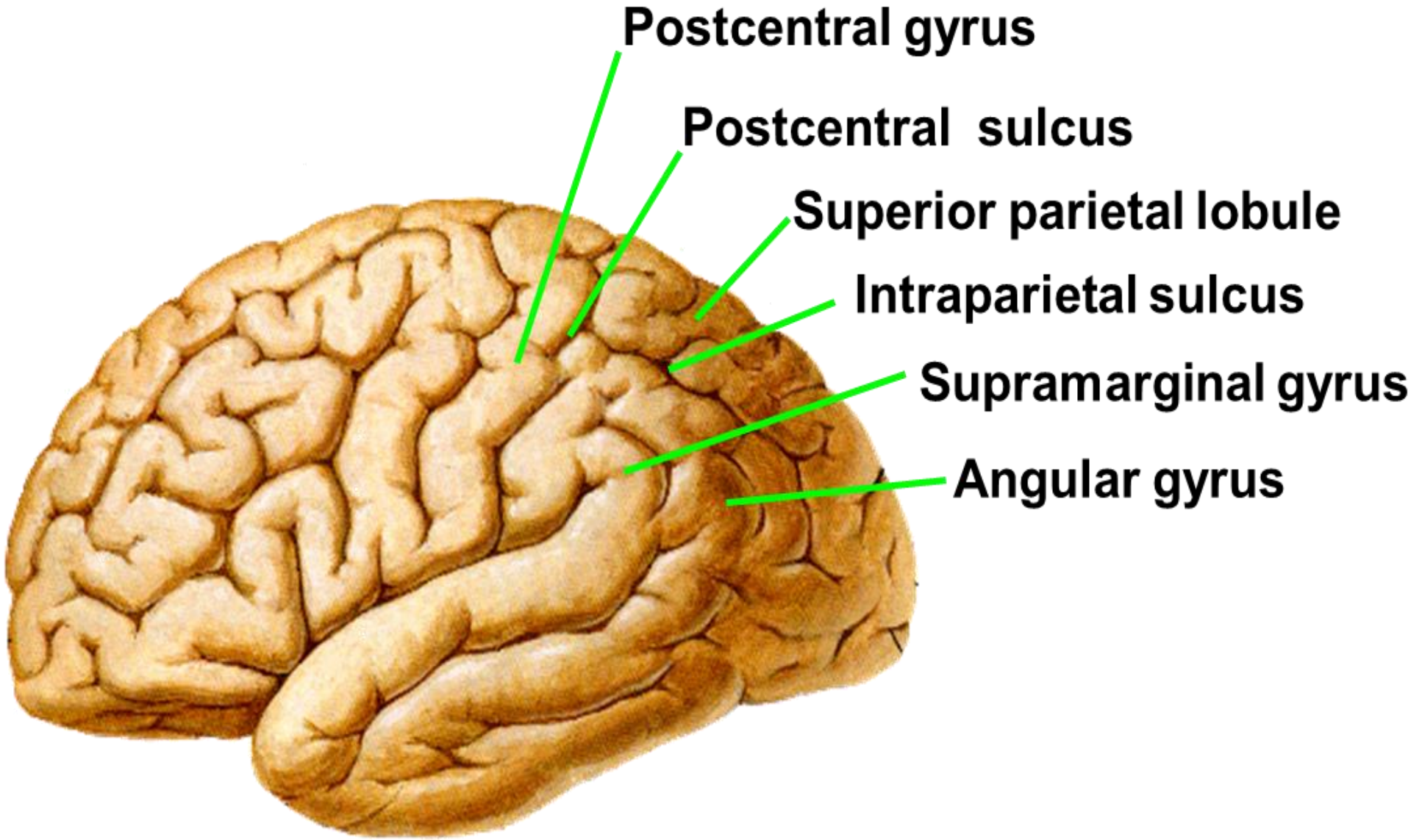
Opercular part , Triangular part, Orbital part in the Inferior frontal gyrus



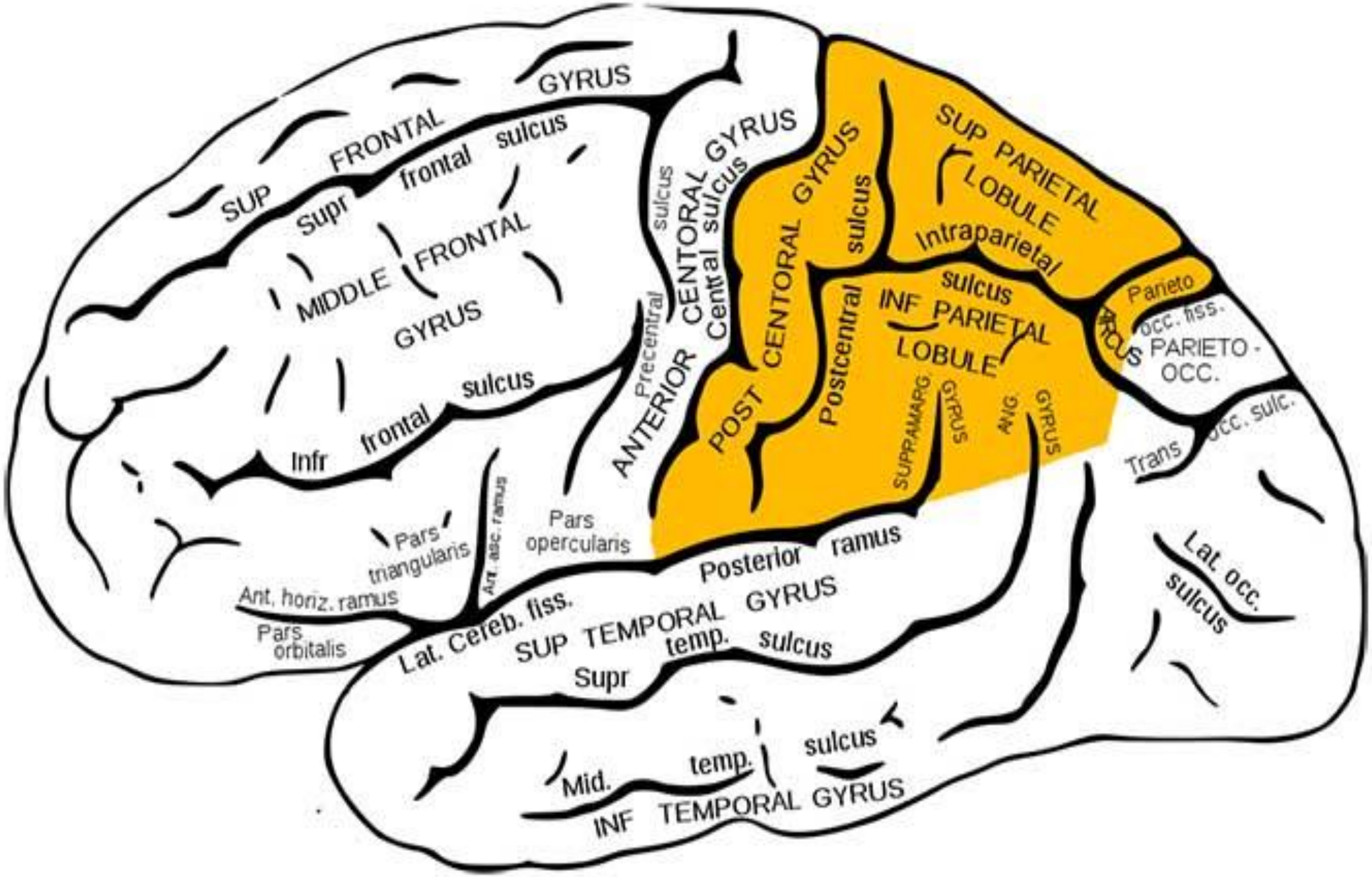
Parietal Lobe

- **The postcentral sulcus**
- **Postcentral gyrus**
- **Intraparietal sulcus** dividing the lobe into **superior (SP) & inferior (IP) parietal lobules**
- The inf. parietal lobule (IP) shows 2 arched gyri:
  - **Supramarginal gyrus** small gyrus surrounding the upper end of lateral sulcus.
  - **Angular gyrus:** small gyrus surrounding the upper end of the superior temporal sulcus





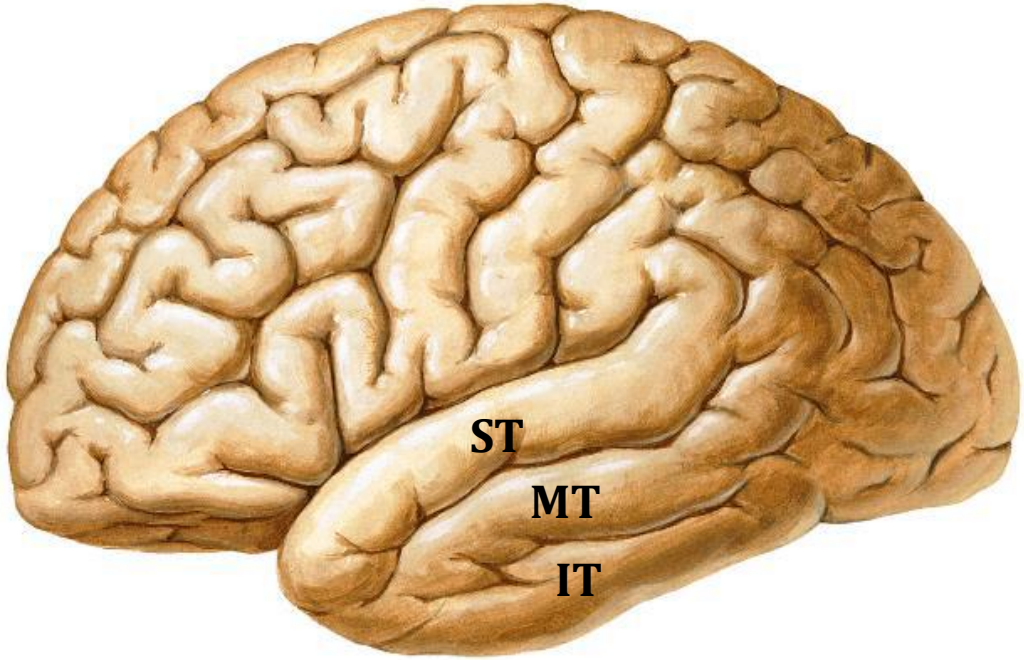
Sulci and Gyri of Parietal Lobe


SUP FRONTAL GYRUS
Supr frontal sulcus
MIDDLE FRONTAL GYRUS
Infr frontal sulcus
Precentral sulcus
ANTERIOR CENTORAL GYRUS
Central sulcus
POST CENTORAL GYRUS
Postcentral sulcus
SUP PARIETAL LOBULE
Intraparietal sulcus
INF PARIETAL LOBULE
SUPRAMARG. GYRUS
ANG. GYRUS
Parieto occ. fiss.
PARIETO - OCC.
Trans occ. sulc.
Lat. occ. sulcus
Pars triangularis
Pars opercularis
Ant. ascend. ramus
Ant. horiz. ramus
Pars orbitalis
Lat. Cereb. fiss.
Posterior ramus
SUP TEMPORAL GYRUS
Supr temp. sulcus
Mid. temp. sulcus
INF TEMPORAL GYRUS

Temporal Lobe

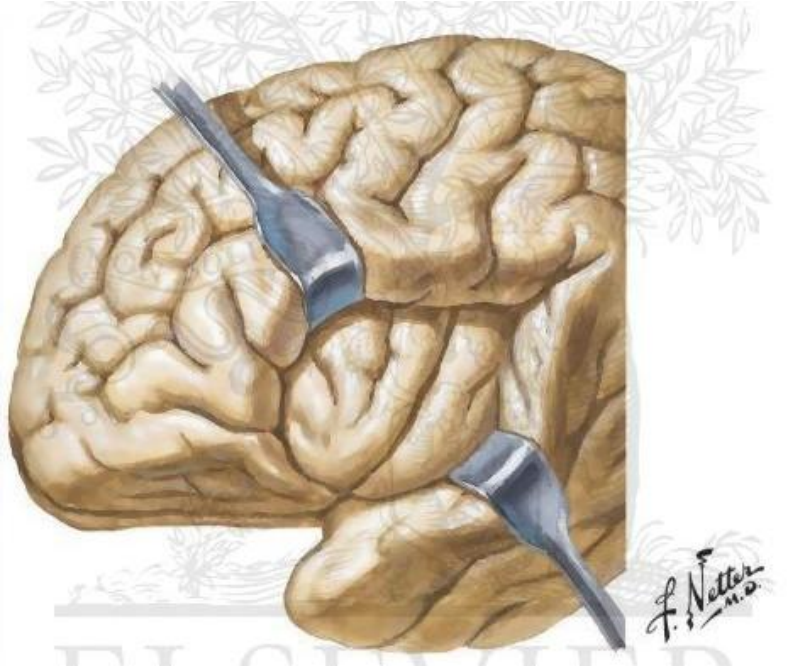
- **Superior & inferior temporal sulci** giving rise to **superior, middle & inferior temporal gyri.**

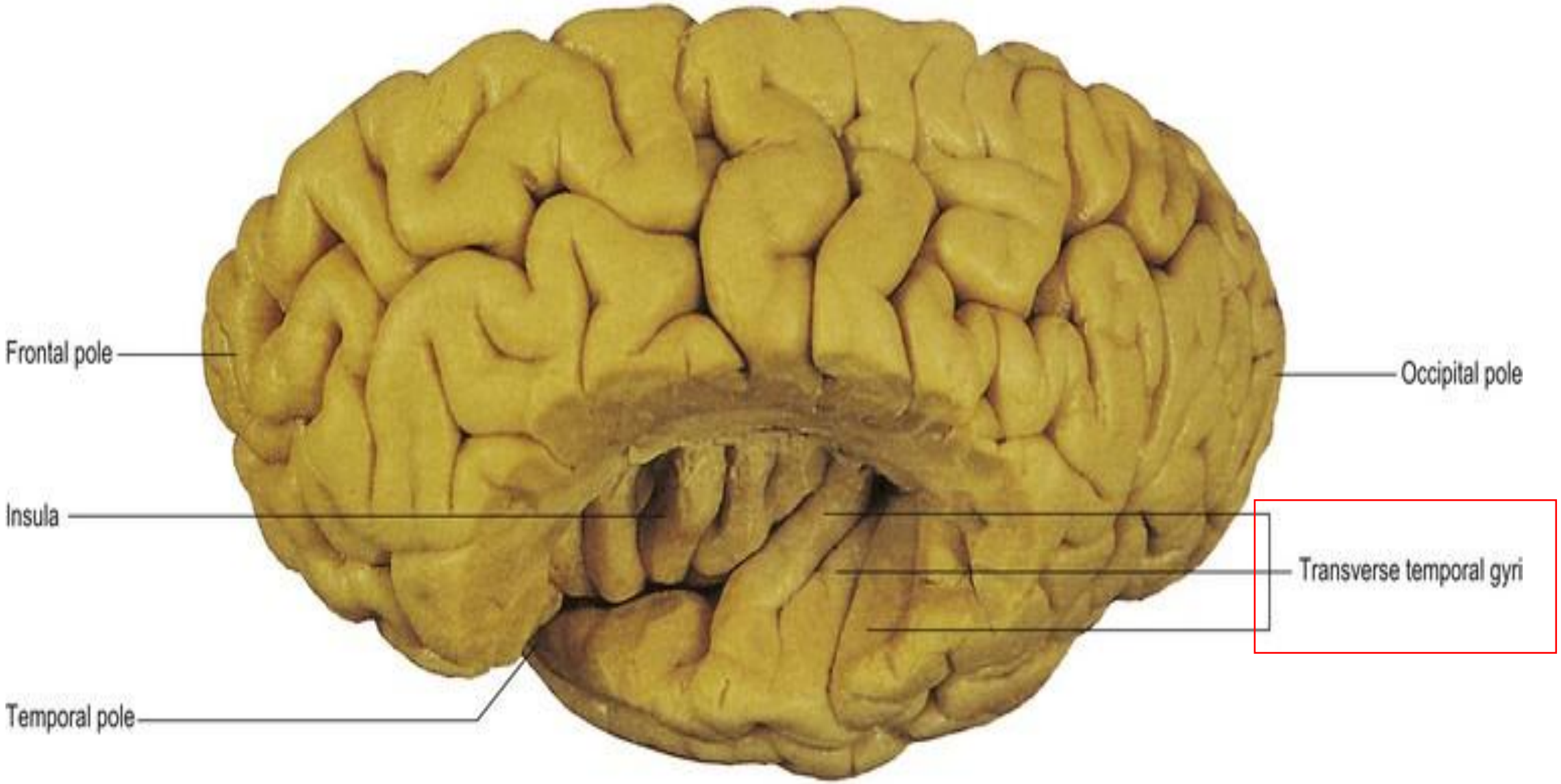
- **Transverse temporal gyri** (Heschl's convolutions) on the superior aspect of temporal lobe.



Insula

- The gyri in the depth of lateral fissure



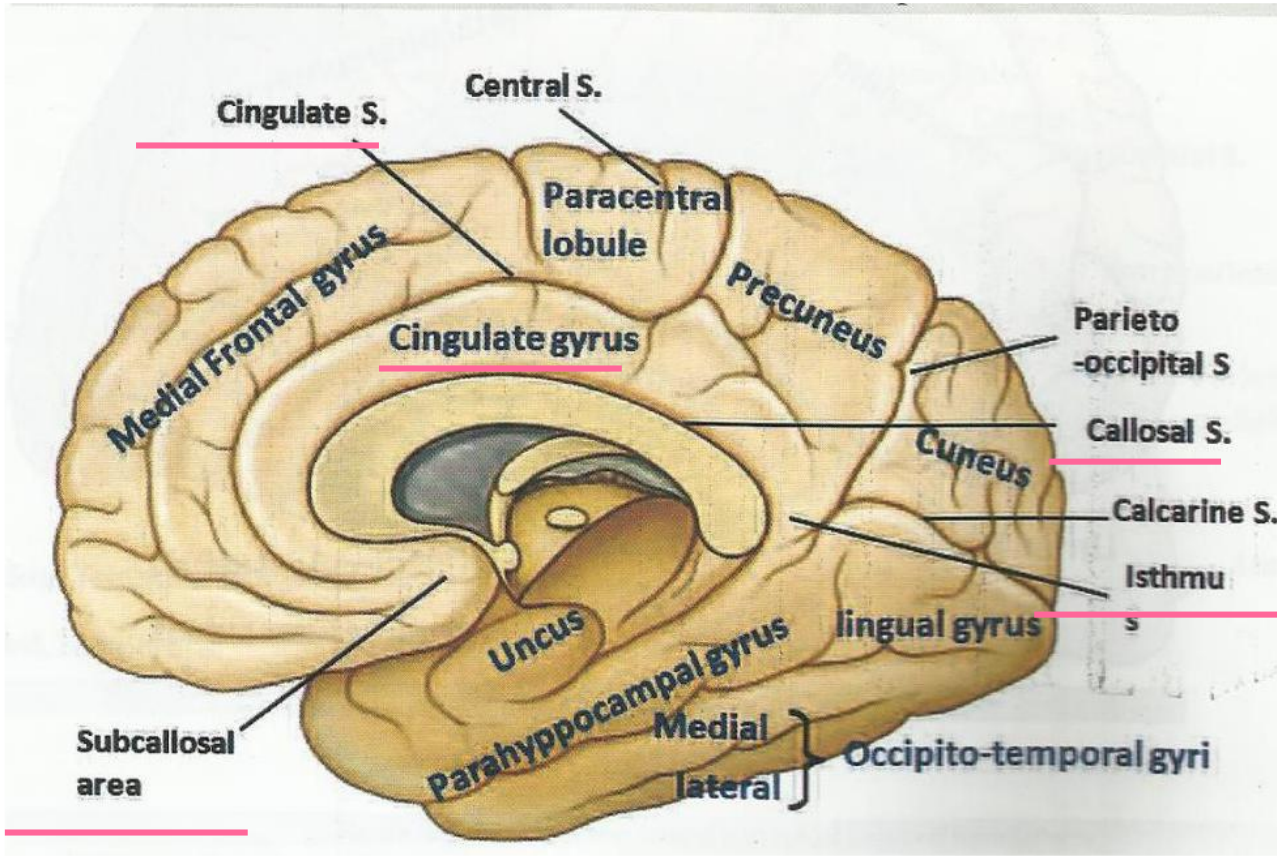

Frontal pole
Occipital pole
Insula
Transverse temporal gyri
Temporal pole

Sulci and Gyri of the Medial Surface

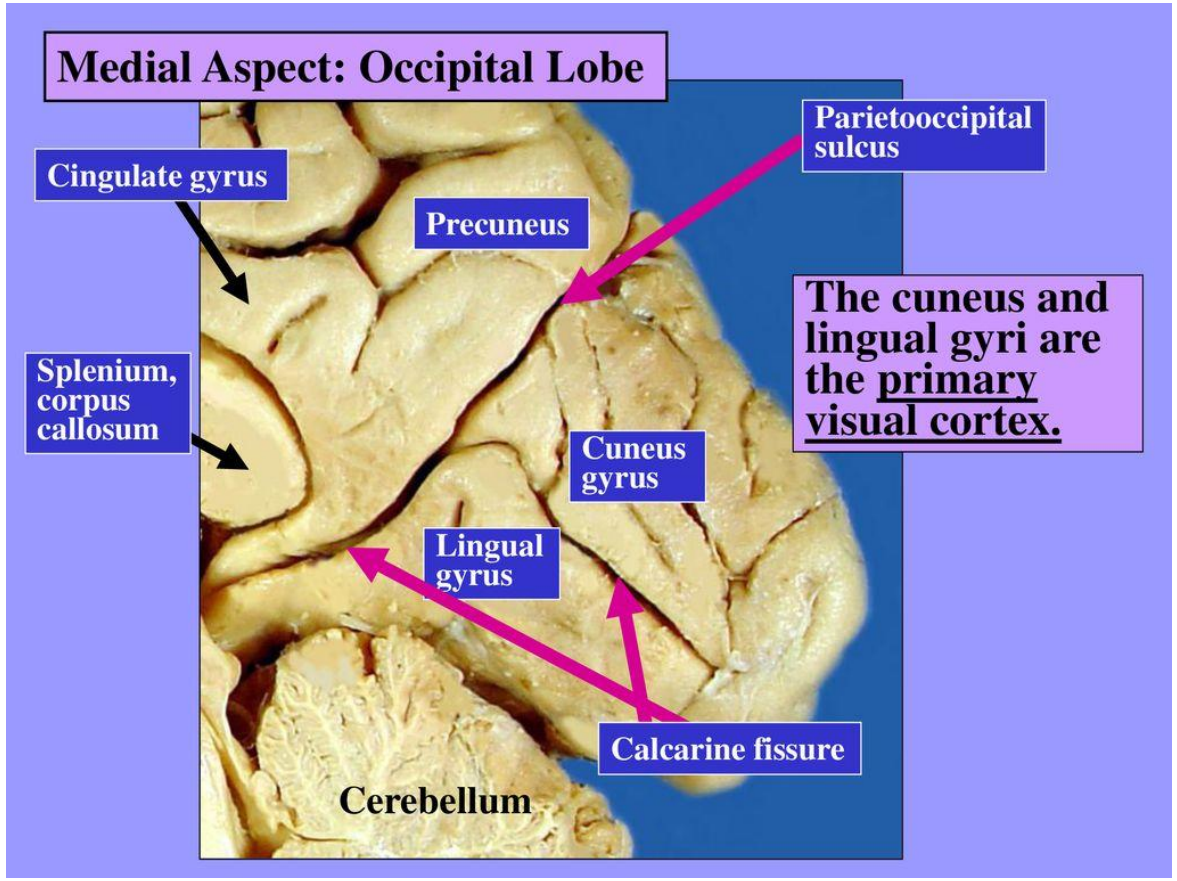
- **The corpus callosum** is the largest commissure of the brain

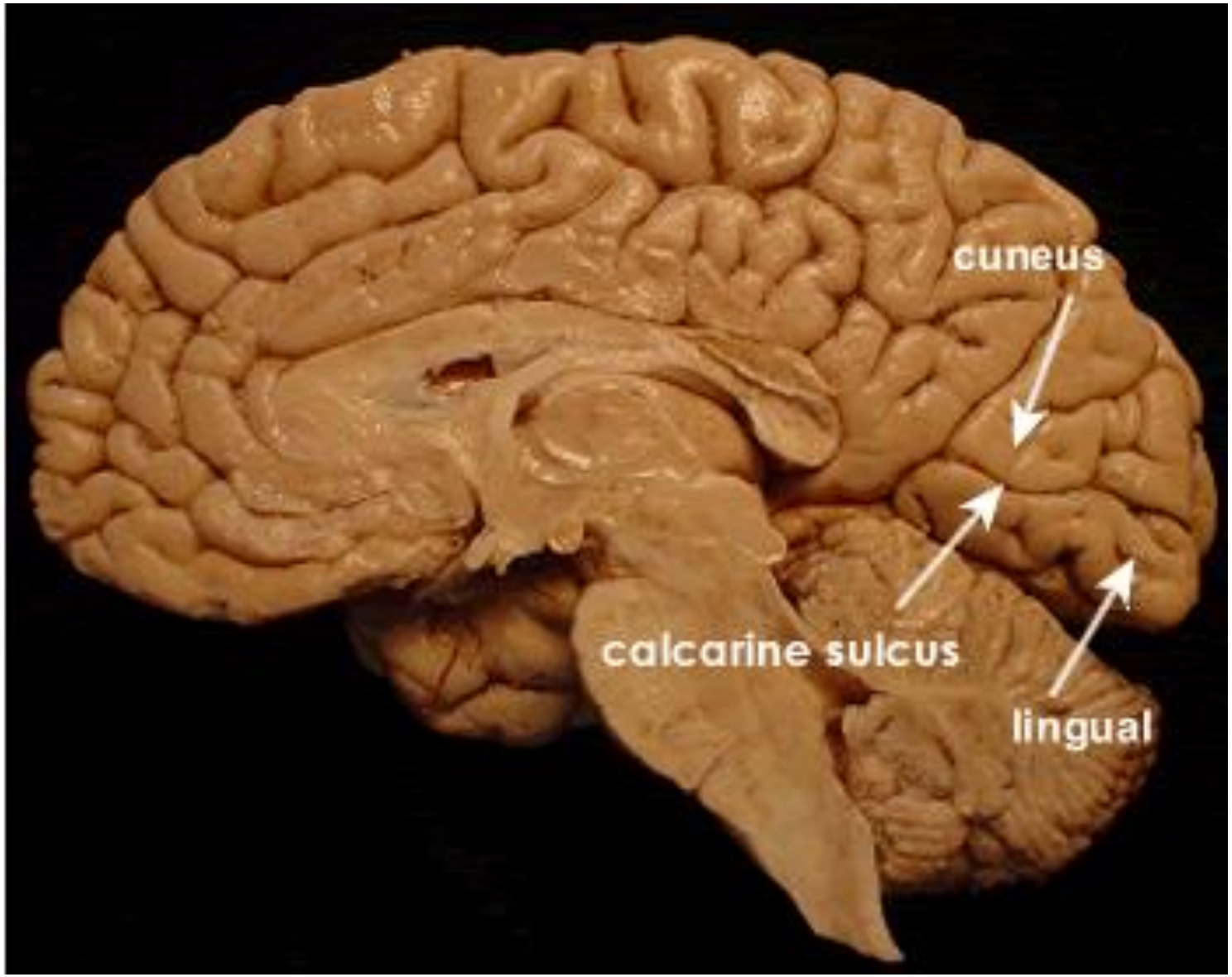
- **The cingulate gyrus** forms an arch above the corpus callosum, separated from it by the **callosal sulcus** and limited above by a Y-shaped **cingulate sulcus**.

- The anterior end of the cingulate gyrus is continuous with the **subcallosal area** below the rostrum of corpus callosum & its posterior end is continuous with **Parahippocampal gyrus** at the isthmus.



- **The Medial frontal gyrus** lies in front of the paracentral lobule.
- **The Paracentral lobule** is a continuation of pre- and post-central gyri onto the medial aspect of hemisphere on the edges of the central sulcus.
- **Parieto-occipital sulcus**
- **Calcarine sulcus**
- **Precuneus gyrus** in front of the parieto-occipital sulcus
- **Cuneus gyrus** above the calcarine sulcus
- **Lingual gyrus** below the calcarine sulcus.

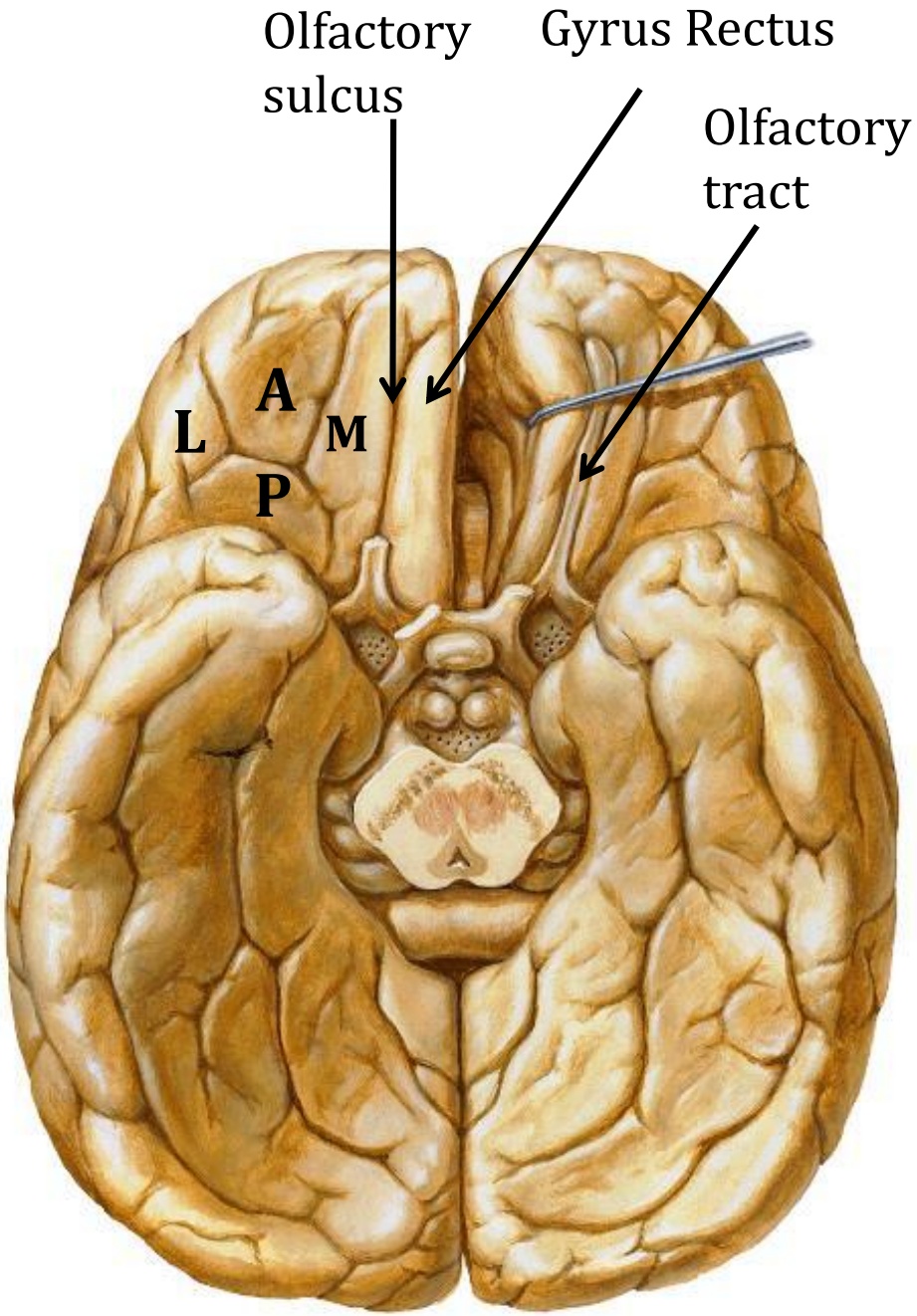


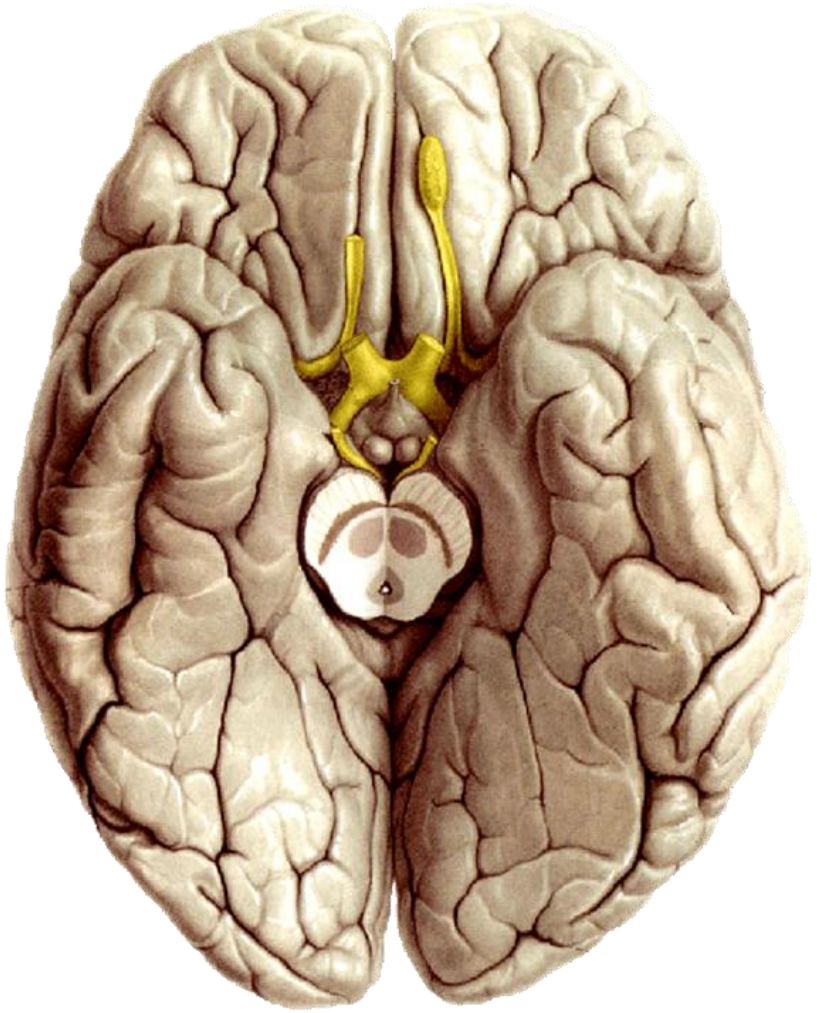

cuneus
calcarine sulcus
lingual

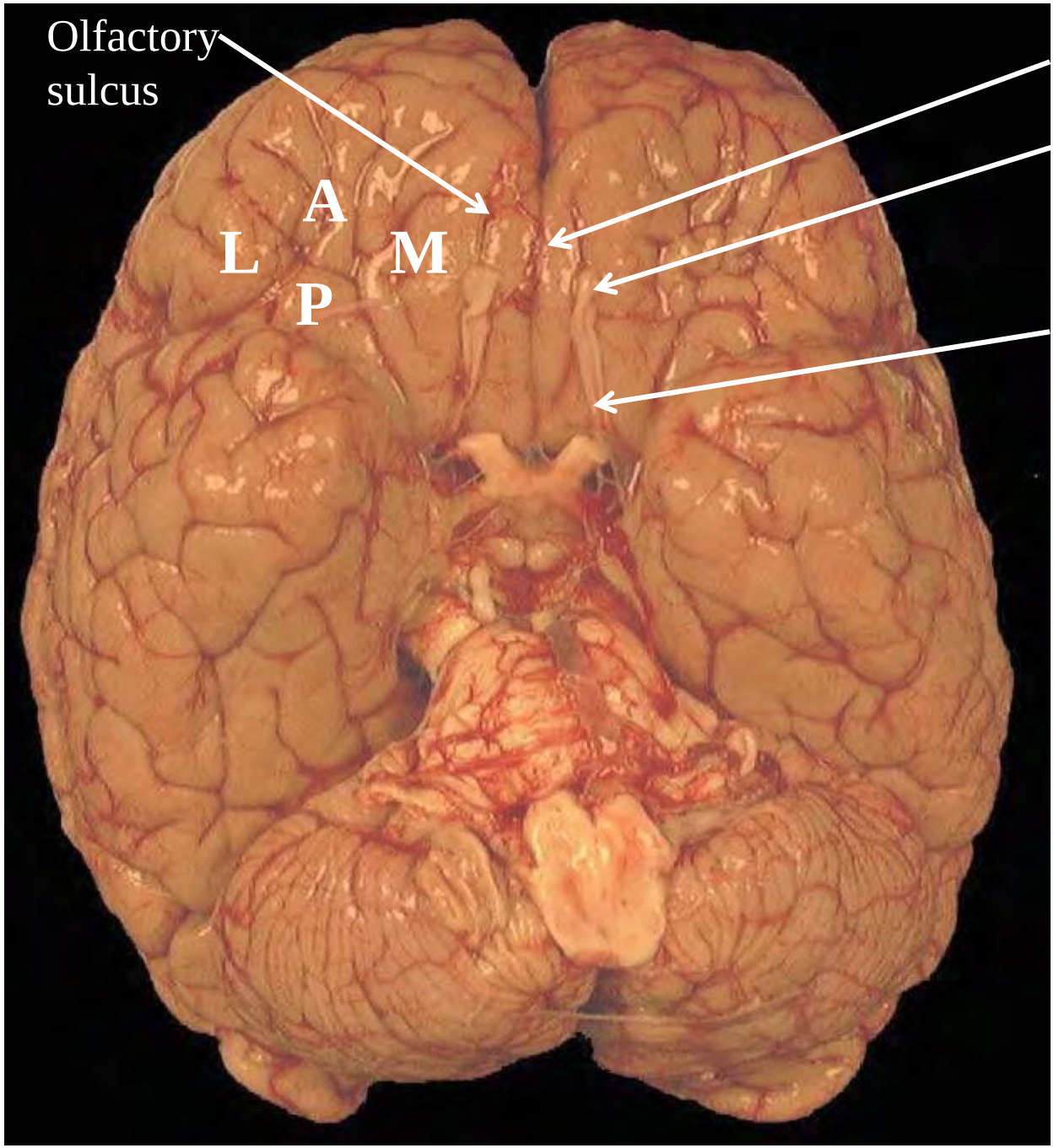
Sulci and Gyri of the Inferior Surface

Orbital part presents:

- **The olfactory sulcus** partly occupied by the olfactory bulb and tract**.**
- Medial to the olfactory sulcus: **gyrus rectus**
- Lateral to the olfactory sulcus: H-shaped **orbital sulci** are seen between four **orbital gyri** (anterior (A), posterior (P), medial (M) & lateral(L) orbital gyri).



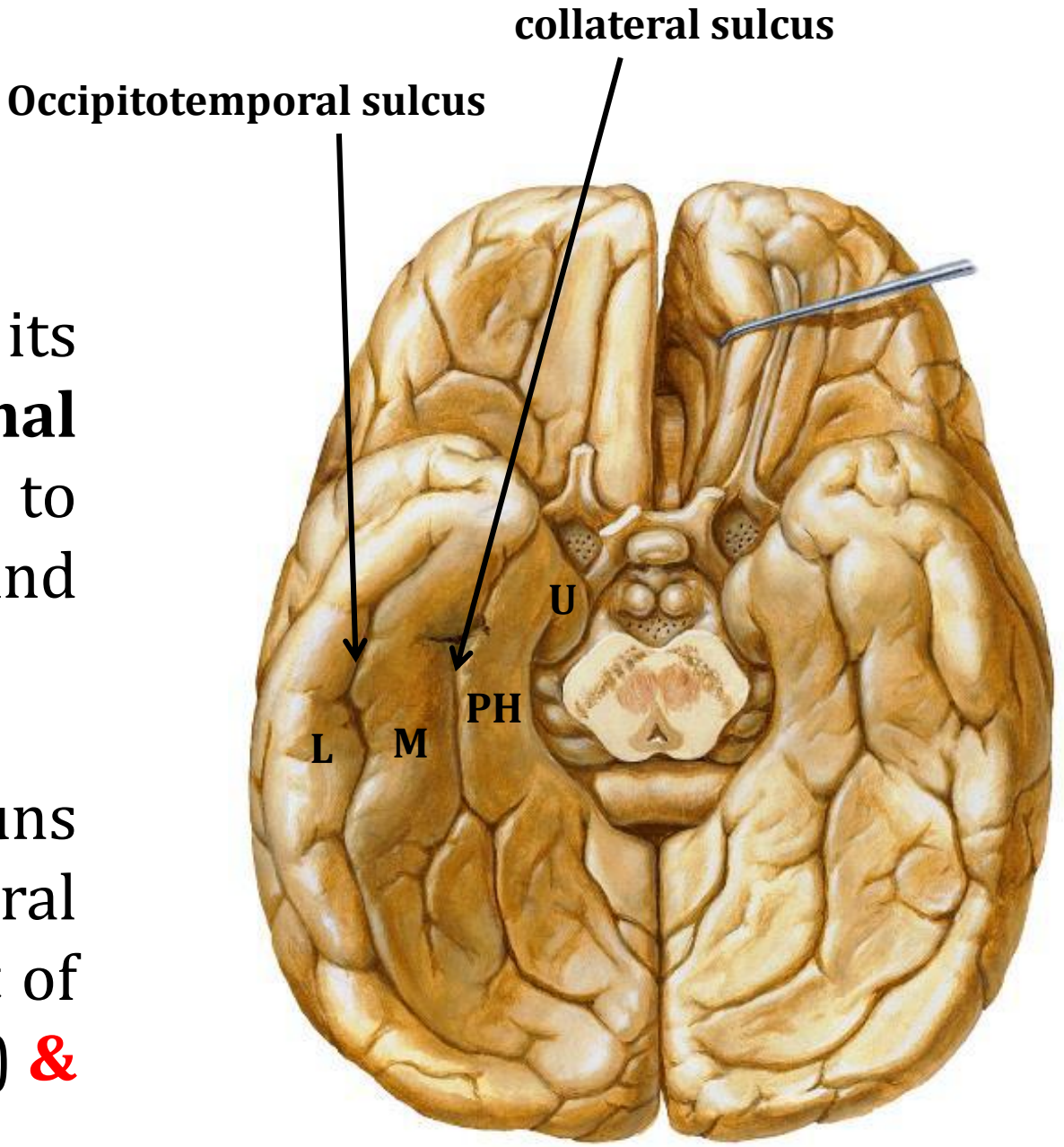



Olfactory sulcus
A
L
M
P
Rectus Gyrus
Olfactory bulb
Olfactory tract

Tentorial part presents:

- The **collateral sulcus** (with its anterior continuation: the **rhinal sulcus**) runs longitudinally lateral to the **parahippocampal gyrus** (PH) and its anterior hook-like **uncus** (U).

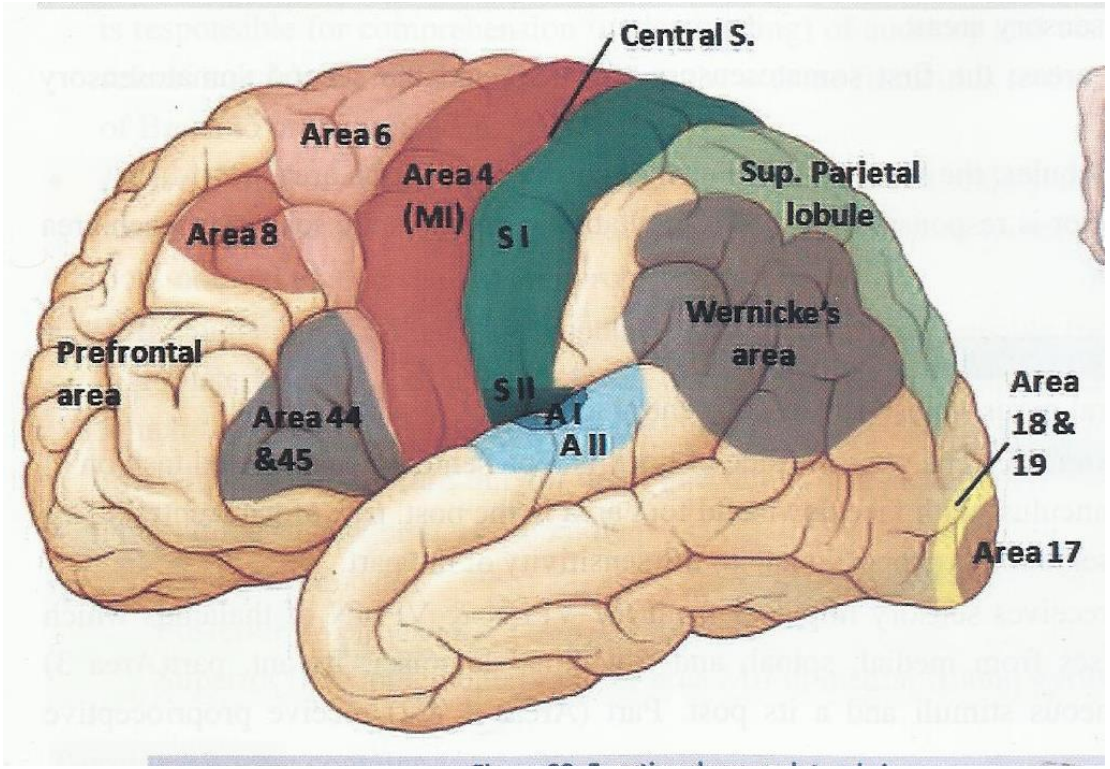
- The **occipito-temporal sulcus** runs from the occipital pole to the temporal pole and divides the remaining part of the tentorial surface into **medial** (M) **& lateral** (L) **occipito-temporal gyri**.



Functional Areas of the Cerebral Cortex

Frontal Lobe

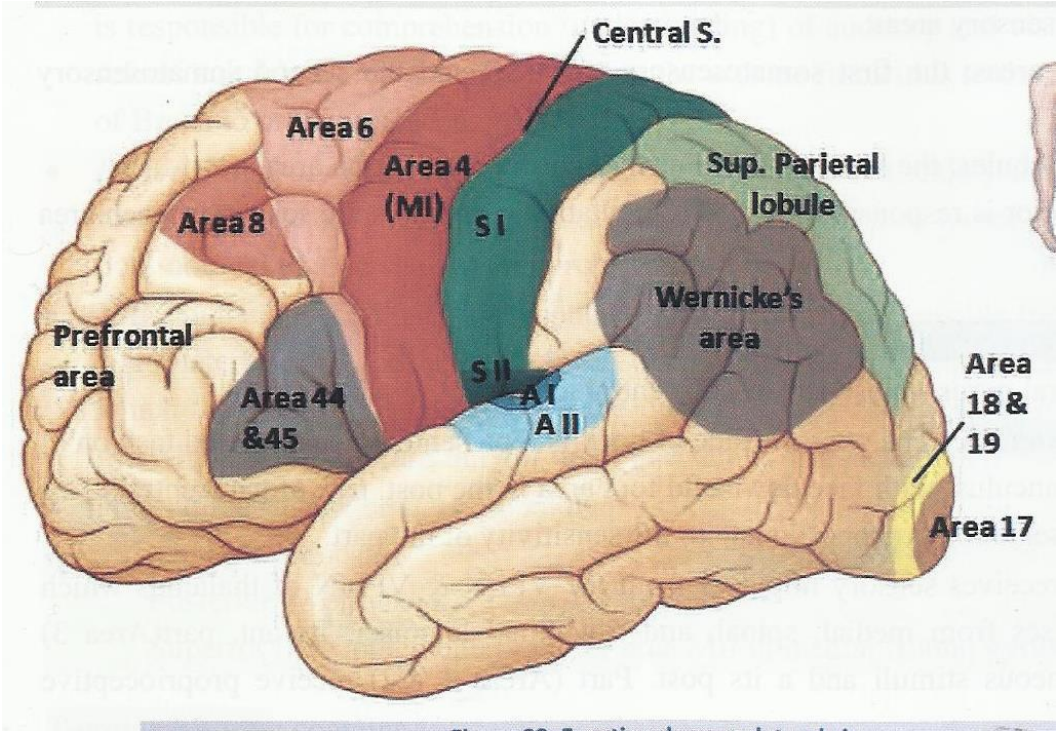
- Its posterior part; **Precentral area**; is **motor in function**
- Its anterior part; **prefrontal area**; is **responsible for the higher mental functions.**



Frontal Lobe

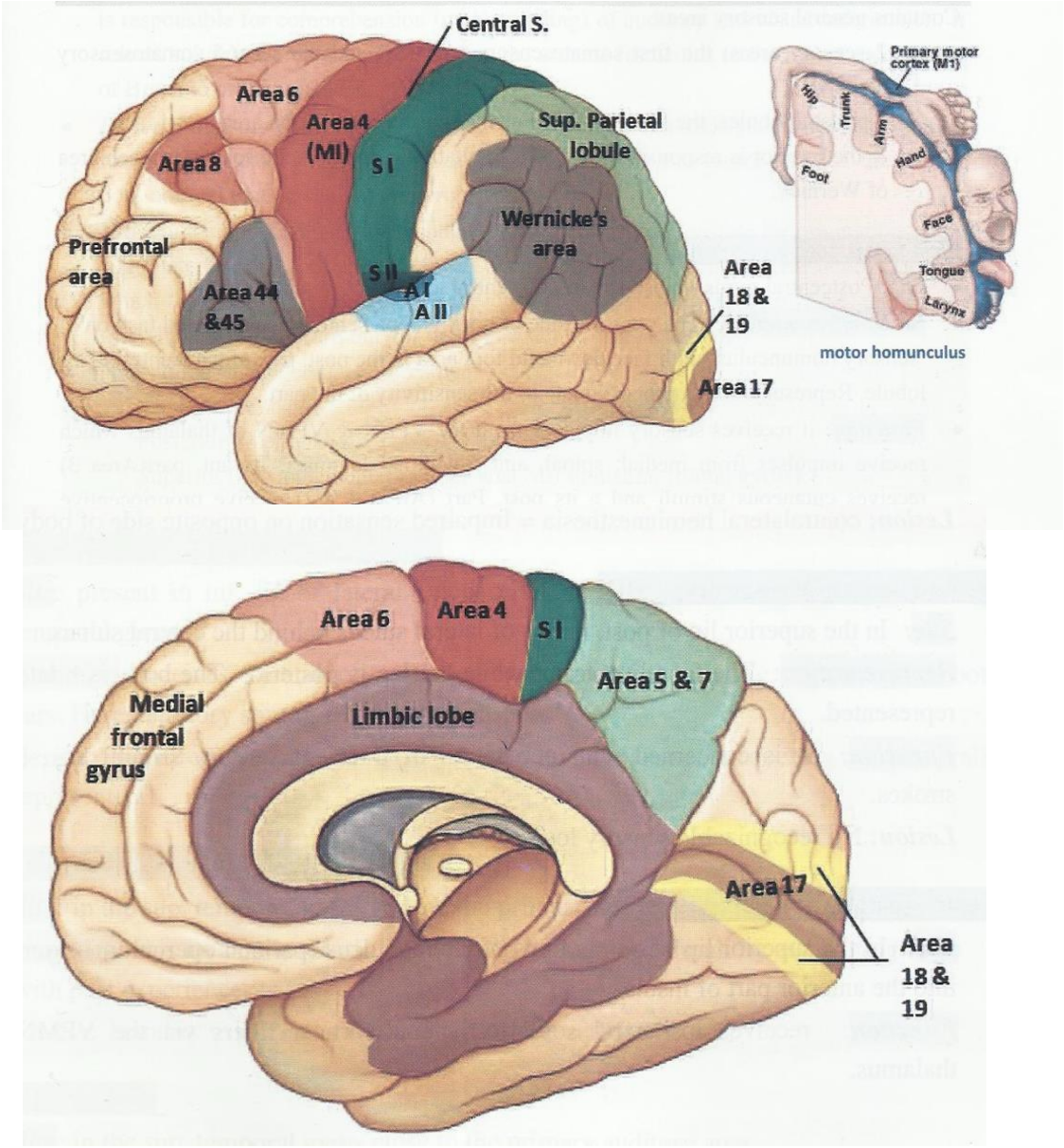
- Precentral area includes:

1. **Primary motor area (Area 4)**
2. **Premotor area (Area 6)**
3. **Frontal eye field (Area 8)**
4. **Broca's area (Areas 44 & 45)**



Primary Motor Area (Area 4)

- **Site:** Precentral gyrus and anterior portion of paracentral lobule
- **Function:** It generates motor orders to the voluntary muscles (execution of a movement) of the opposite of half of the body.
- **Body representation:** contains a map of the contralateral ½ of the body, this representation is **motor homunculus.**
- **Lesion:** Contralateral **spastic hemiplegia (Paralysis)** especially skilled, fine movements.

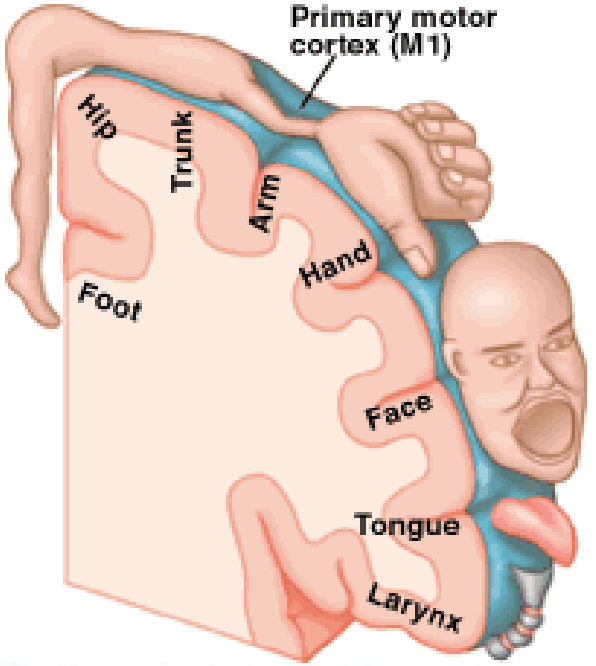


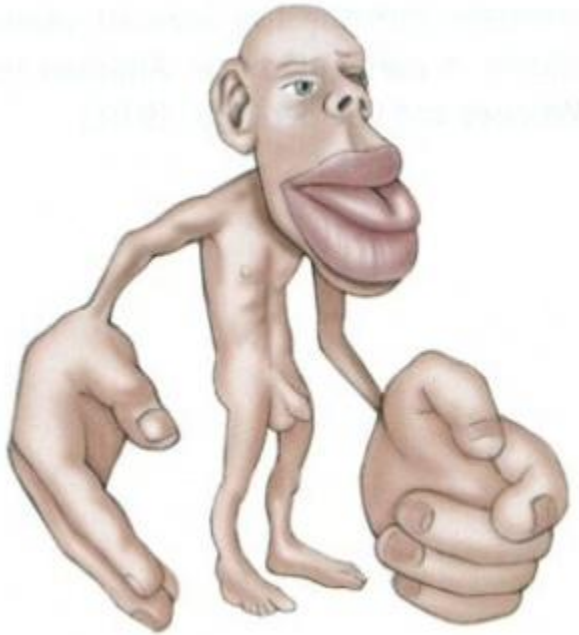
Characteristics of the motor Homunculus

1. **Contralateral:** the muscle of each side of the body is represented in the opposite motor cortex.

2. **Proportional to the skill**: parts with fine skilled movements (e.g. hands) occupy larger areas.

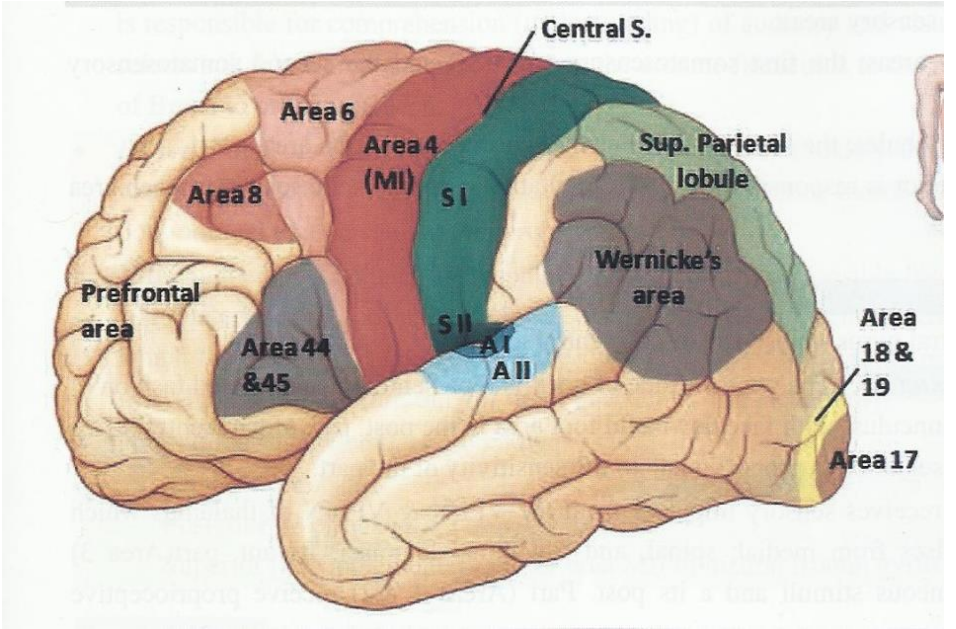
3. **Inverted** (i.e., head represented in the inferior part of the precentral gyrus just above the lateral fissure & the leg and foot in the paracentral lobule).

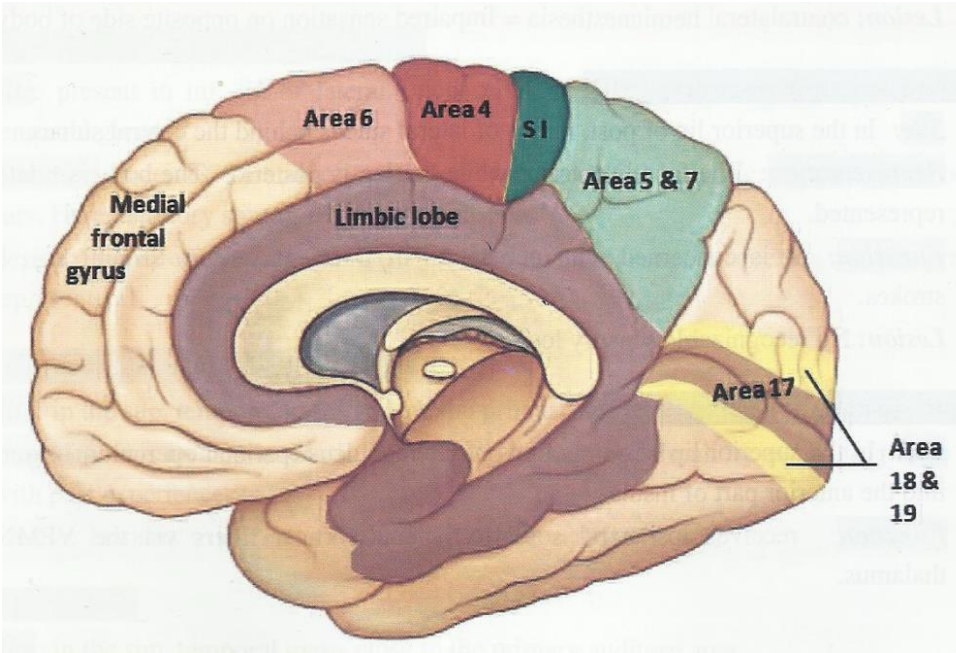




Premotor area (Area 6)

- **Site:** In the posterior parts of superior, middle and inferior frontal gyri. Also extends on medial surface of cerebral hemisphere including the region of supplementary motor cortex.





- **Function:**

  1. Planning of movements
  2. Stores the programs of related to motor experiences. (based on past experience).
  3. Also Adjusts the posture to start the movement and inhibits muscle tone and deep reflexes on the opposite side of the body.

- **Lesion:**
  - Difficulty in the performance of skilled movements in the absence of paralysis **"Apraxia".**

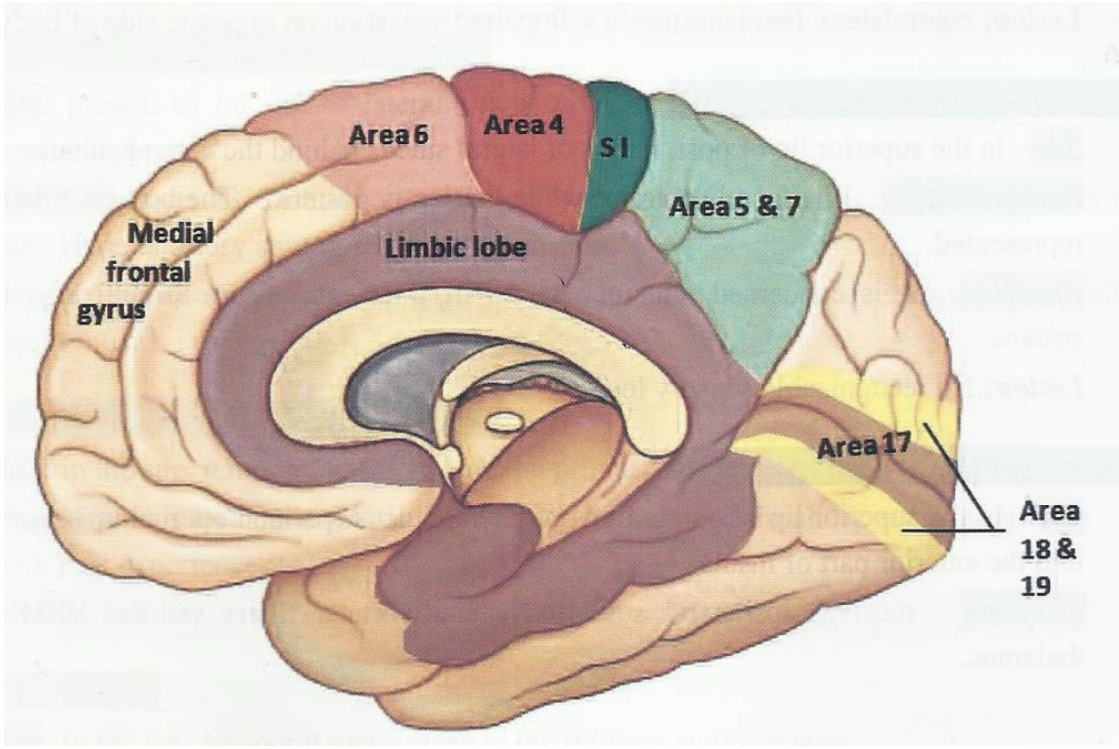
Supplementary motor area (area 6)

- **Site:** the continuation of area 6 into the medial frontal gyrus anterior to the paracentral lobule.

- **Function:** Involved in motor planning especially for movements requiring two muscle groups.

  - E.g. Using two hands to pick up a box.

- **Lesion:** Lesion of the supplementary motor area causes hypotonia with no paralysis.

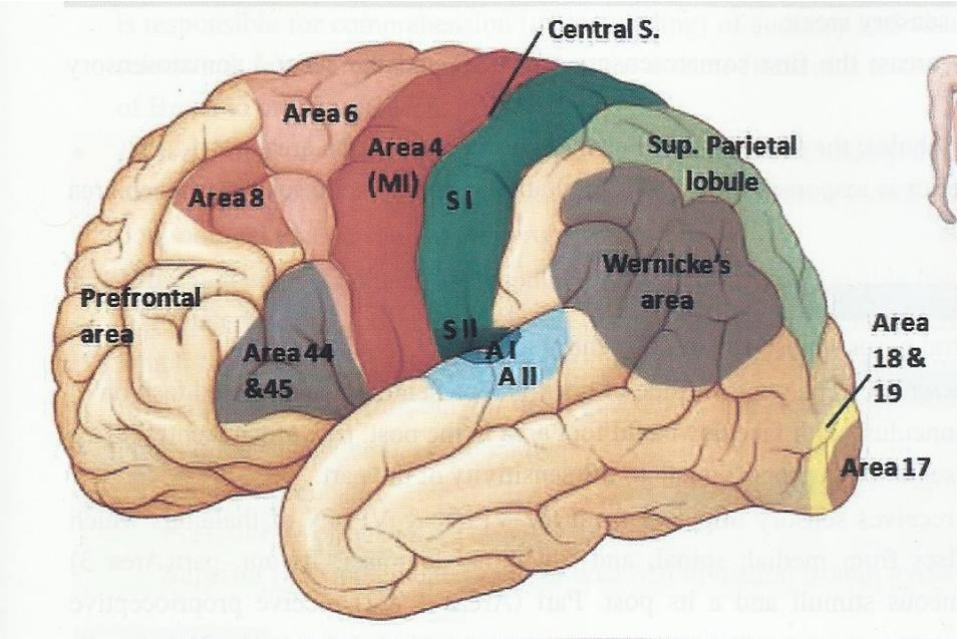


Frontal Eye Field (Area 8)

- **Site:** Posterior part of middle frontal gyrus in front of area 6.

- **Function:** Controls voluntary conjugate eyes movement. Its stimulation leads to conjugate deviation of both eyes to the opposite side (scanning movement of eyeball).

- **Lesion:** impairment of deviation of both eyeball to the opposite side. So, unopposed action of frontal eye field of normal side will cause deviation of both eyes to the side of lesion.



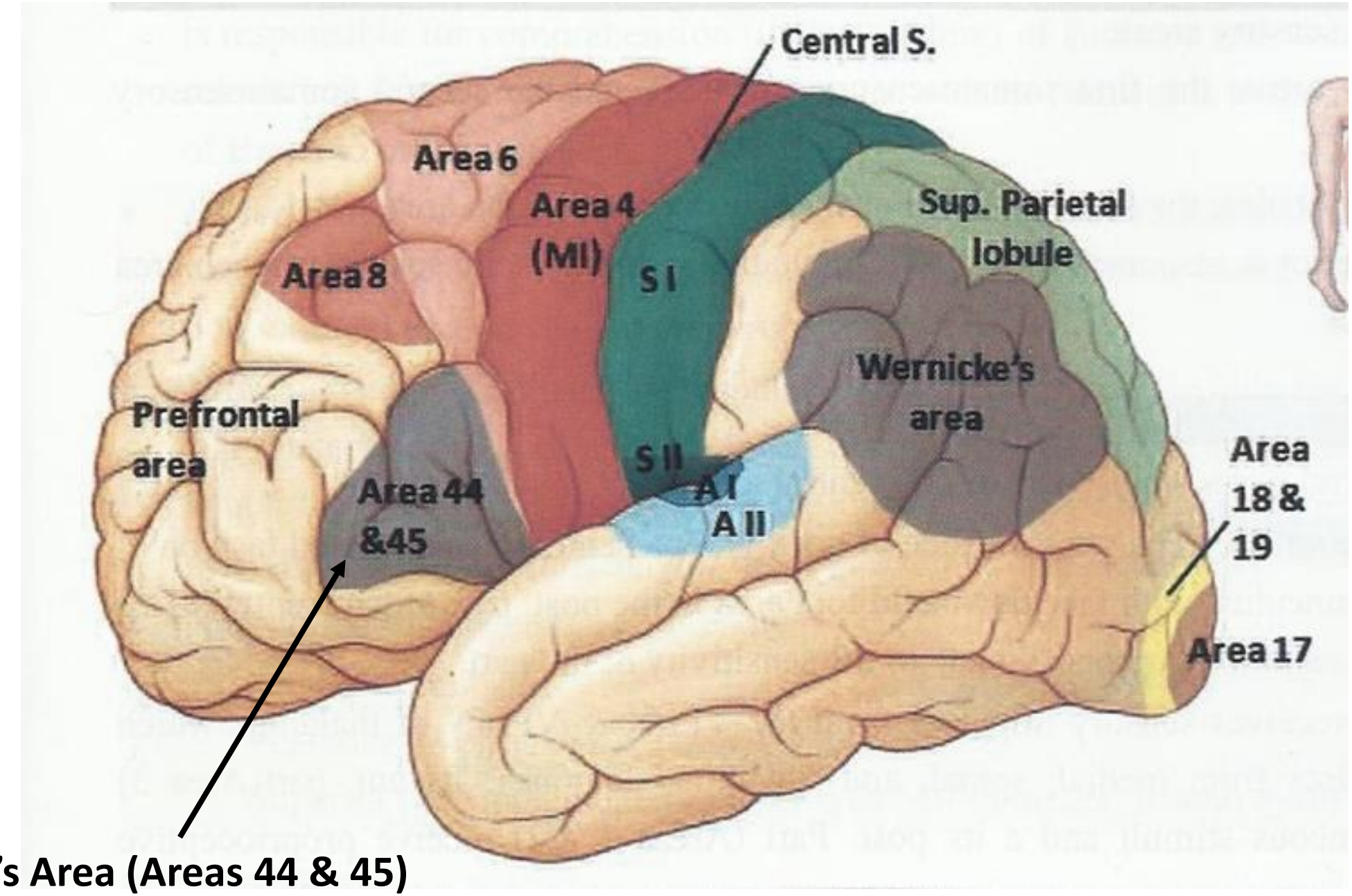
Broca's Area (Areas 44 & 45) - Motor Speech Area

- **Site:** in the opercular part and triangular part of the inferior frontal gyrus of **dominant hemisphere** (usually left) and not presented in both hemispheres.

- **Function:** Store speech program that are used by the motor area to produce normal speech.

  - Receive input from the sensory speech area (*Wernicke's area*) in the temporal lobe and send output to the lower part of motor area which control speech muscles.

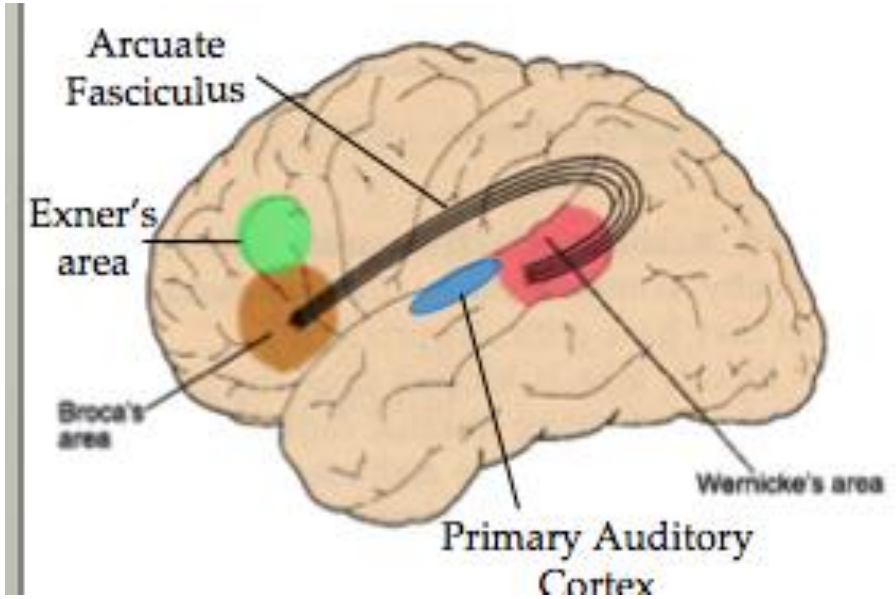
- **Lesion:** **Motor (expressive) aphasia**; the patient know what he wants to say but cannot express his thought (but can express himself in written form).



Broca's Area (Areas 44 & 45)

Exner's area (area 45)

- **Site:** Adjacent to Broca's expressive speech area in the middle frontal gyrus of the dominant hemisphere.
- **Function:** Motor center for writing.
- **Lesion:** **Agraphia**; the patient cannot express ideas in written words.

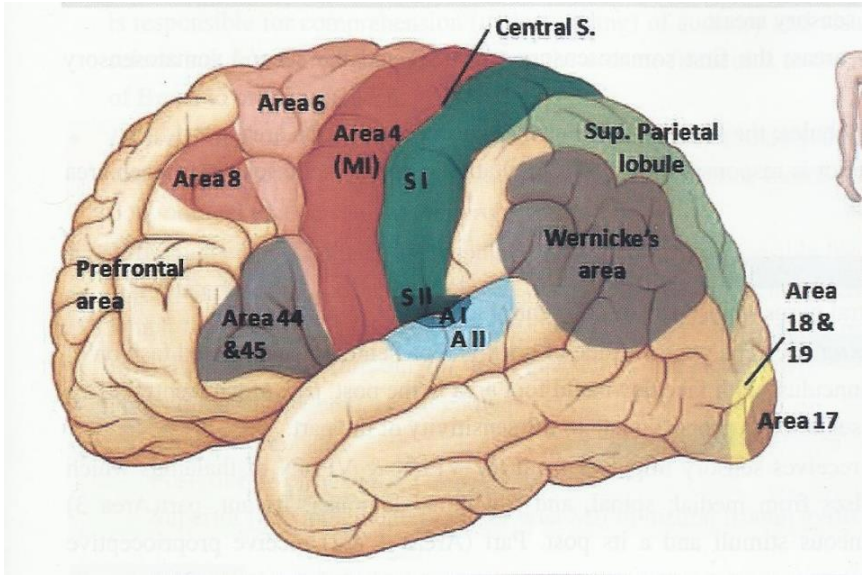


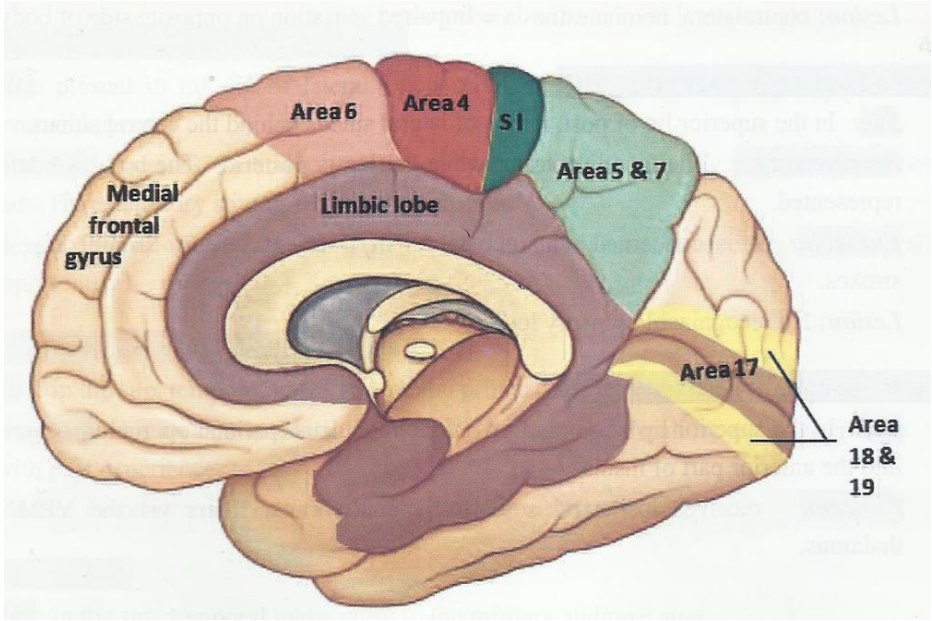
Prefrontal Area

- **Site:** Extensive region of the frontal lobe anterior to premotor areas (Anterior part of frontal lobe & its adjacent inferior and medial surfaces).

- **Function:** Involved in highest brain functions such as : thinking, decision making, judgment, motivation, feeling of responsibility, Personality, Social behavior, emotions.

- **Lesion:**
  - Changes in social behavior, personality, mood.
  - Disturb his judgment and ability to take decision or solve problems.

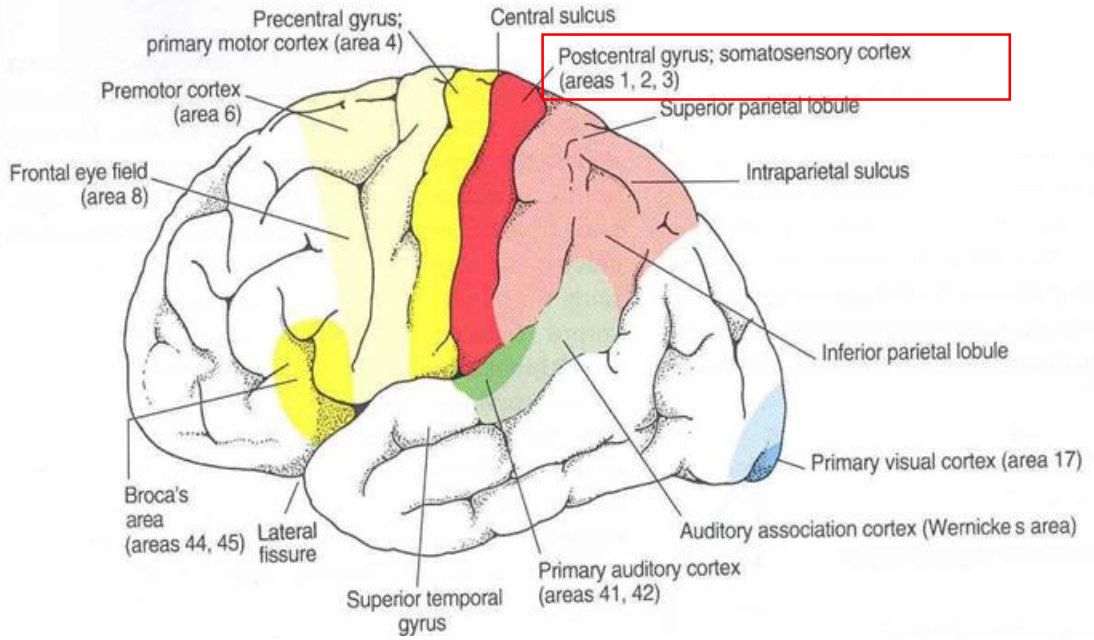


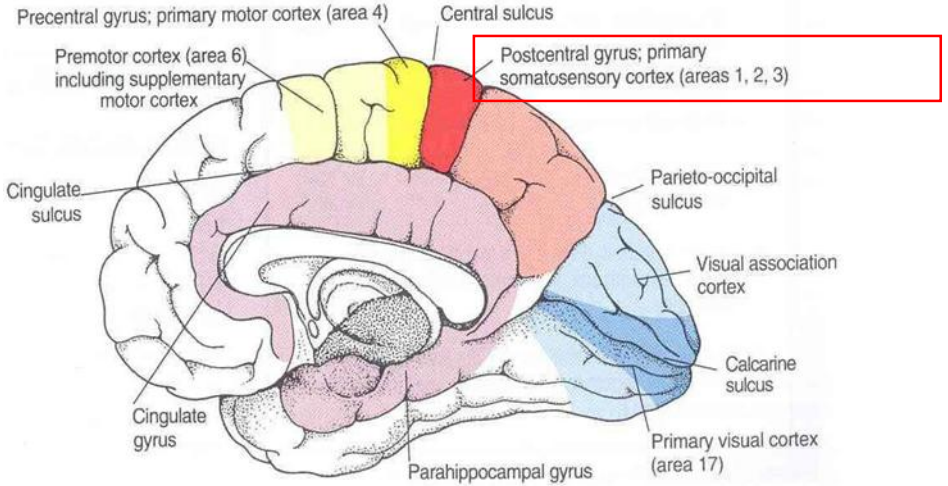


Parietal Lobe

Primary somatosensory cortex (Areas 1,2and 3)

- **Site:** Postcentral gyrus and posterior part of paracentral lobule.
- **Body representation**: is called **sensory homunculus** which is *contralateral*, *inverted*, and *proportional to the sensitivity of the part*.
- **Function:** Receive general sensations (pain, touch, temperature, proprioception).
- **Lesion: Contralateral hemianesthesia,** loss or impairment of general sensations on the opposite side of body.

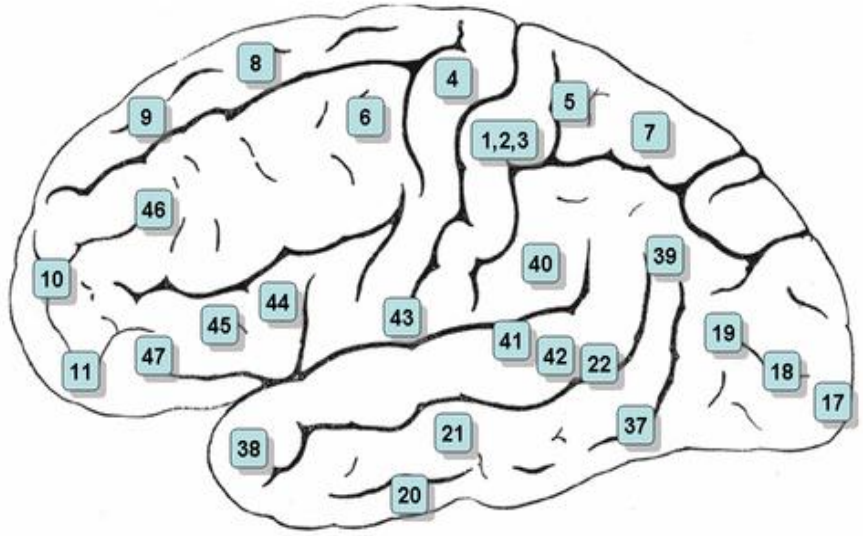


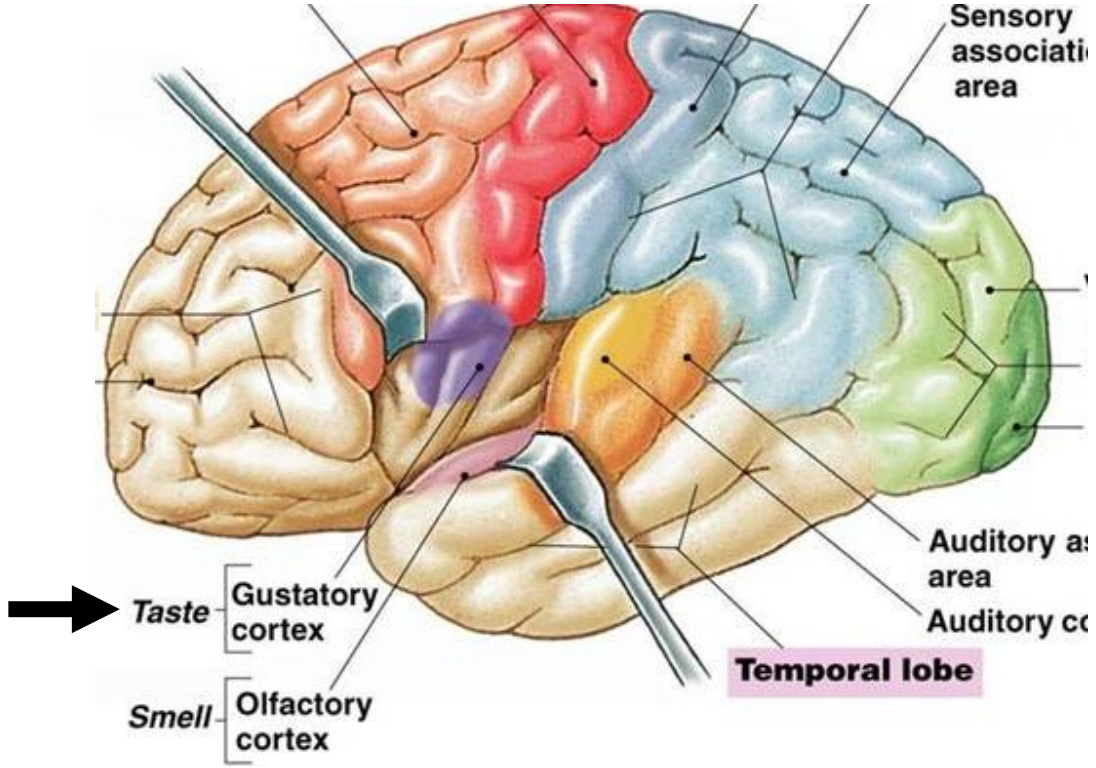


Taste area (Area 43)

- **Site:** In the superior lip of posterior ramus of lateral sulcus (parietal operculum) extending into the anterior part of insula.

- **Function:** Receive taste.

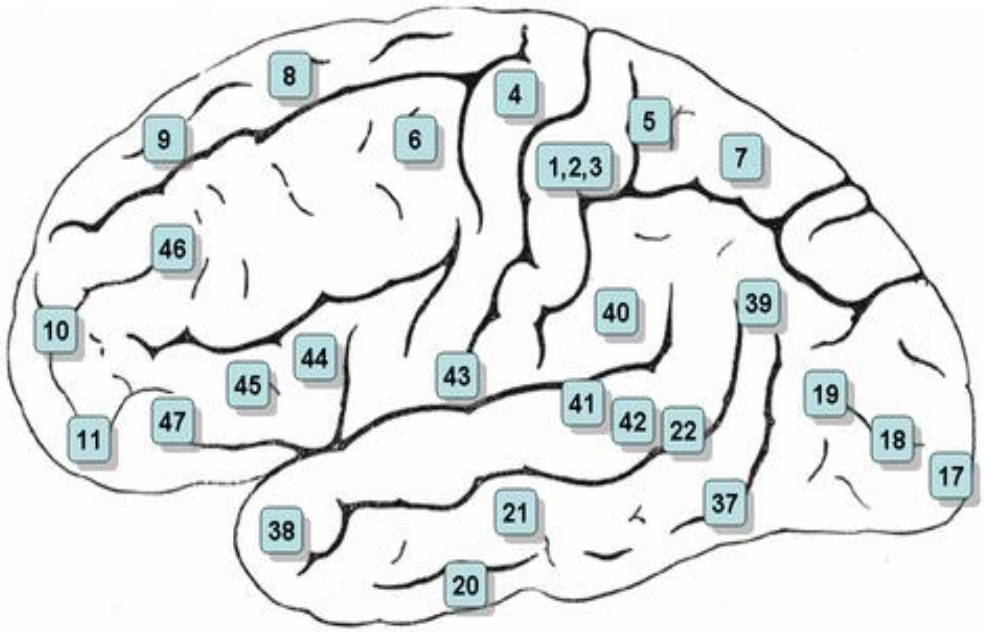




Association sensory Cortex (Areas 5 and 7)

- **Site:** In the superior parietal lobule

- **Function:** Interpretation of general sensation based on previous experiences, and helps an individual to recognize or identify shape, size, surface character, texture of an object by handling but without looking at it, i.e. without help of vision. This power is known as **stereognosis.**



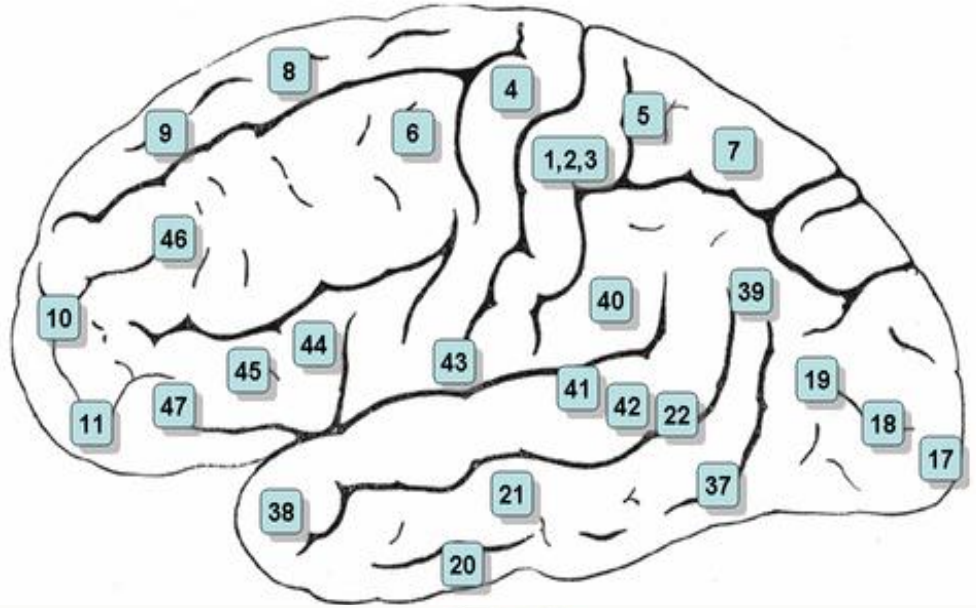
- **Lesion:** **Tactile agnosia** (astereognosis) inability to recognize familiar objects by touch.

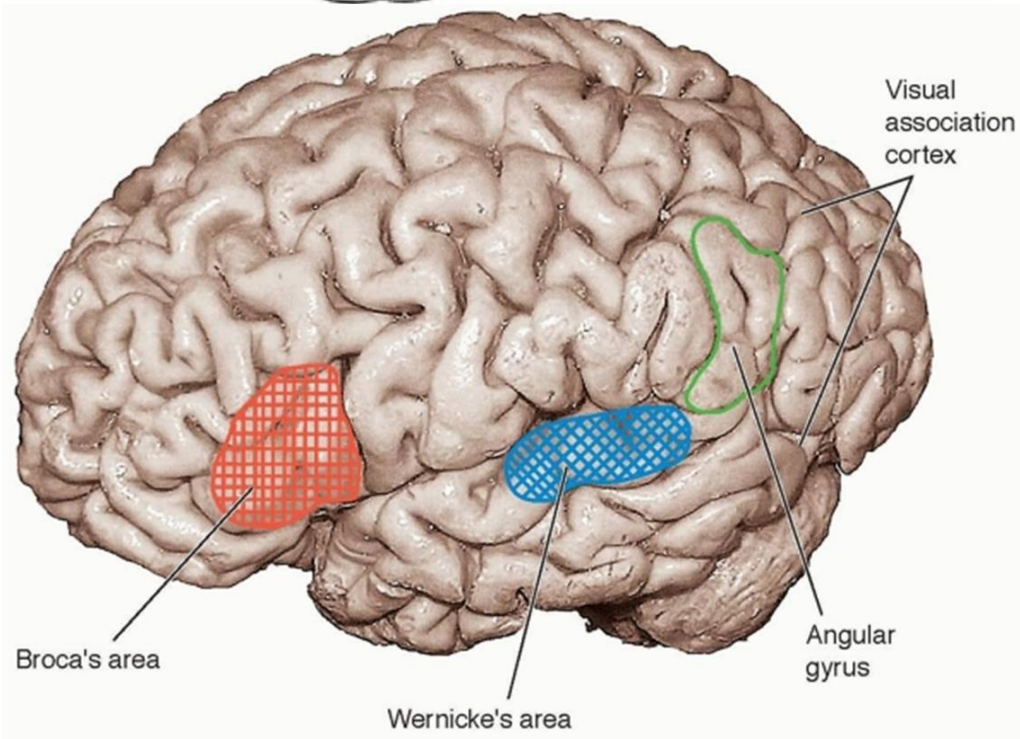
Angular Gyrus (area 39)

- **Site:** part of the inferior parietal lobule in dominant hemisphere.

- **Function:** *consider as part of Wernicke's area in the dominant hemisphere,* important for understanding the written language.

- **Lesion:** **"Alexia"**-word blindness- patient loss his ability to understand the meaning of what he reads (although he can see the words).

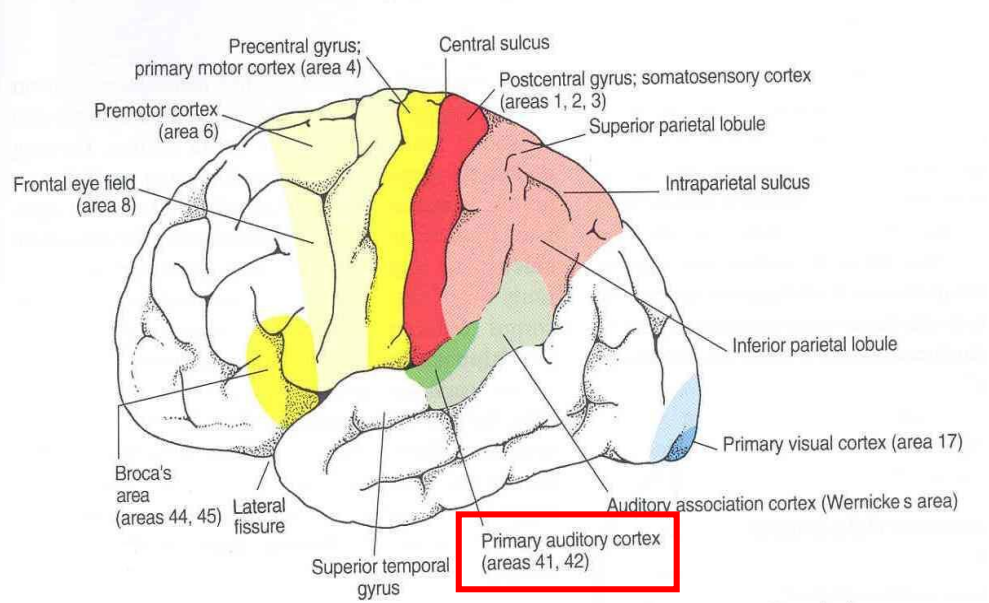


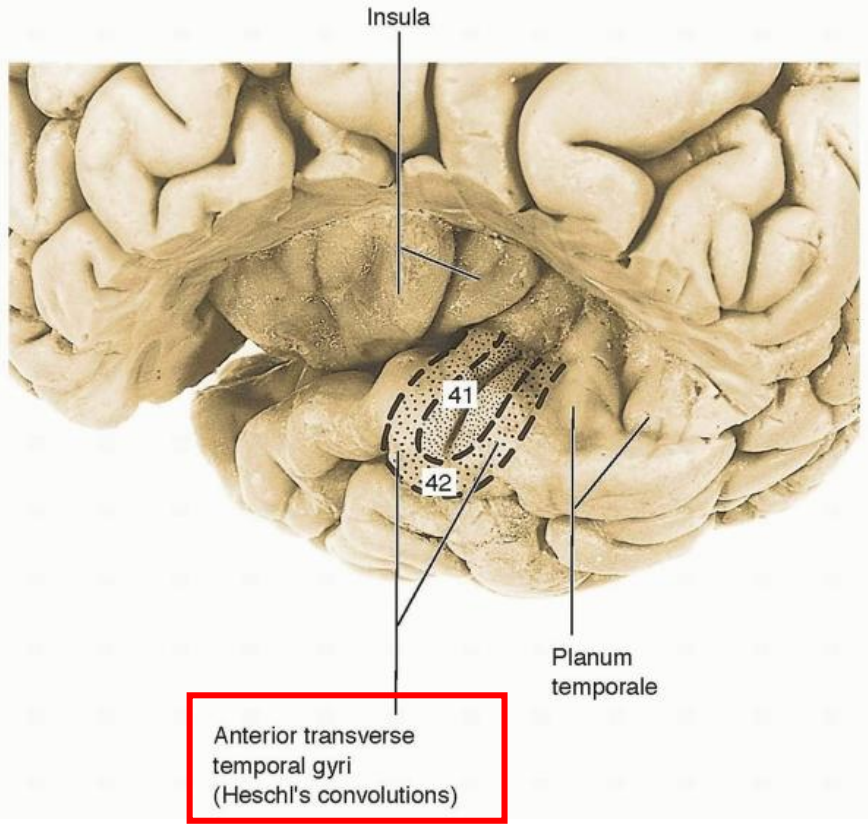


Temporal Lobe

Primary auditory area (area 41,42)

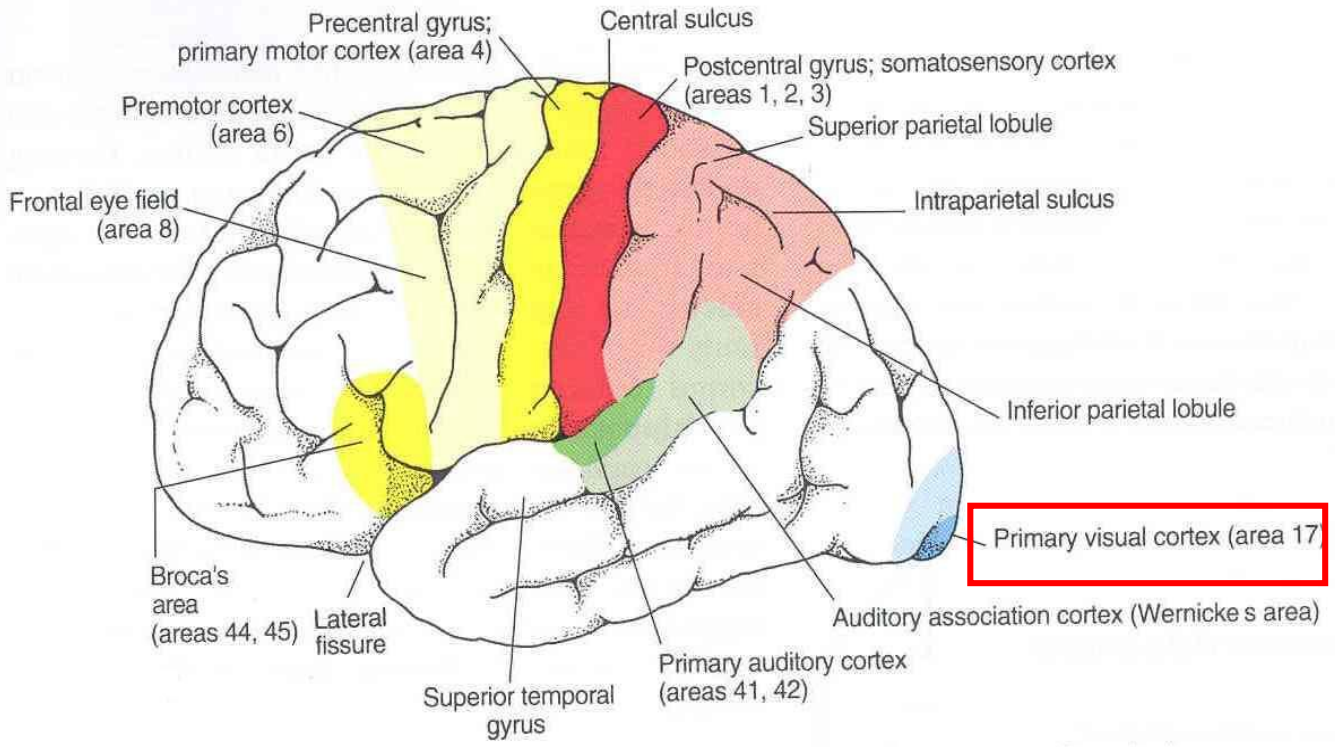
- **Site:** In the inferior lip of lateral sulcus (Heschl's convolutions) + the adjacent part of superior temporal gyrus.
- **Function:** Receive auditory information from both ears
- **Lesion:** Hearing impairment, never deafness as hearing is bilaterally represented.





Auditory association area (area 21, 22)

- **Site:** Surrounding and immediately posterior to primary auditory area at the posterior aspect of the superior temporal gyrus posterior.
- **Function:** understanding and recognition of the hearing sensations.
- **Lesion:** loos of ability to recognize the familiar sounds **"auditory agnosia".**



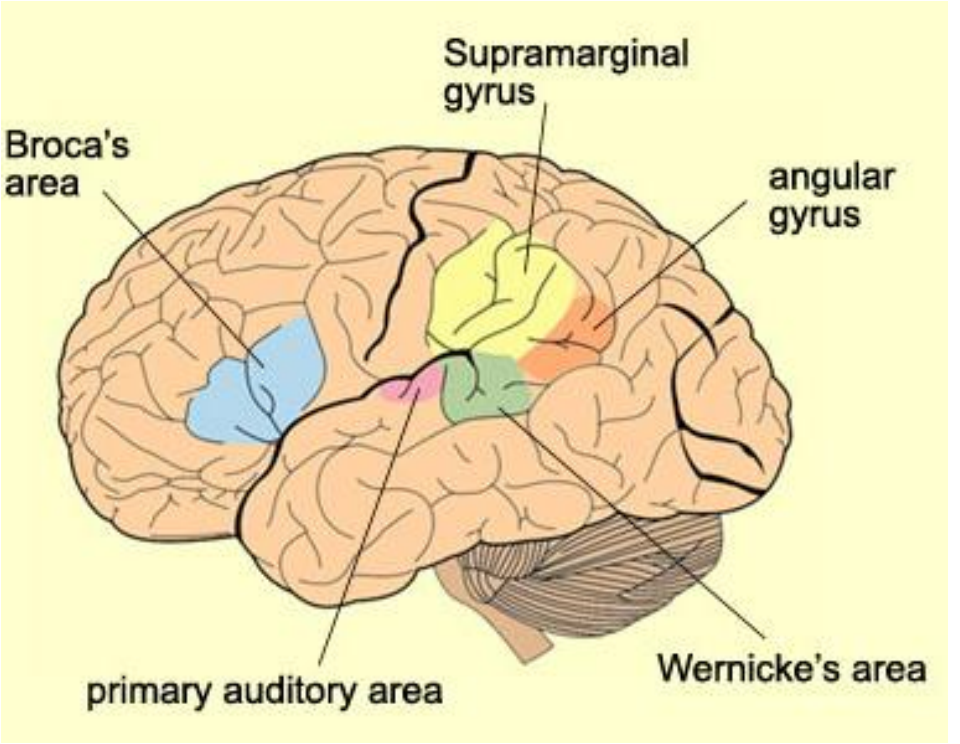
Sensory speech area (area 22,39,40)

- The posterior part of auditory association area in the dominant hemisphere is called **sensory speech area** or **wernicke's area.**

  - The supramarginal gyrus (area 40) and the angular gyrus (area 39) are considered as part of Wernicke's area

- **Function:** Comprehension of the spoken language.

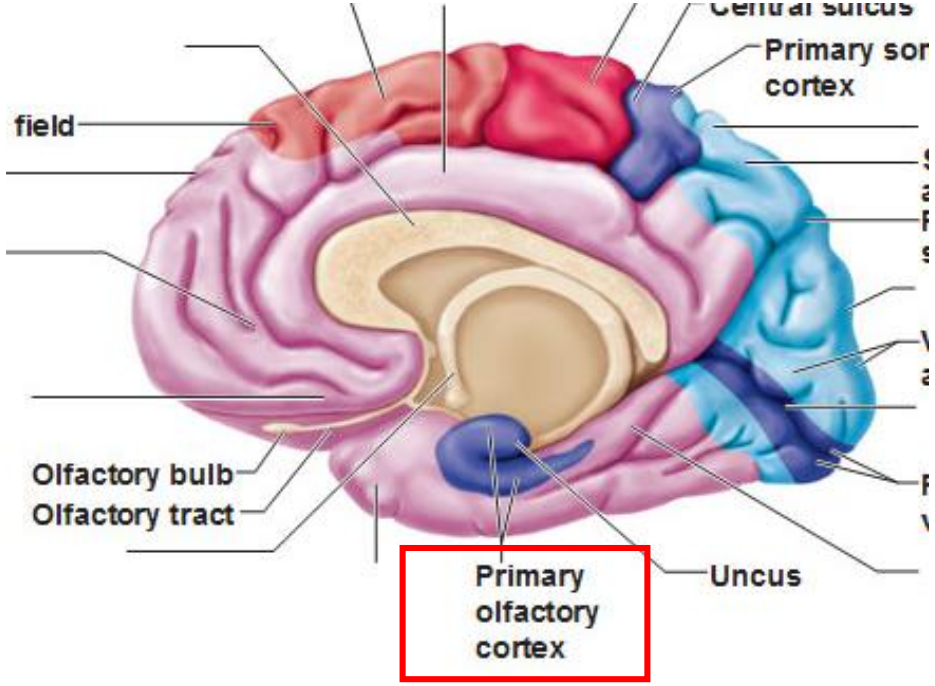
- **Lesion:** **"Sensory aphasia"** the patient hears but does not understand (recognize) what he hears.



Olfactory areas

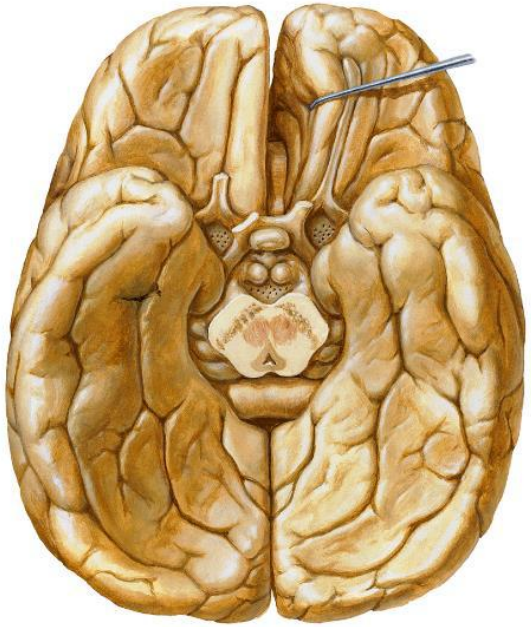
- 1ry olfactory area: in 3 regions = uncus + part of amygdala + apex of insula.

- 2ry olfactory area: in Parahippocampal gyrus which also contains center for memory and learning.



Facial Recognition Area

- **Site:** on inferior surface of temporal and occipital lobes.
- **Lesion:** **Prosopagnosia** (face blindness) the ability to recognize people by faces is impaired.



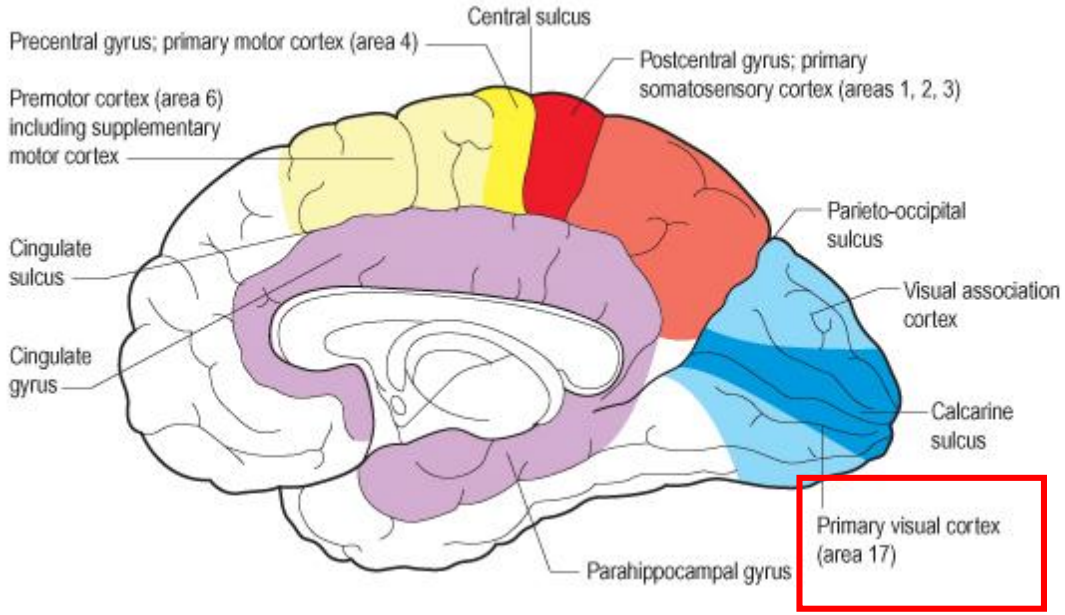
Occipital Lobe

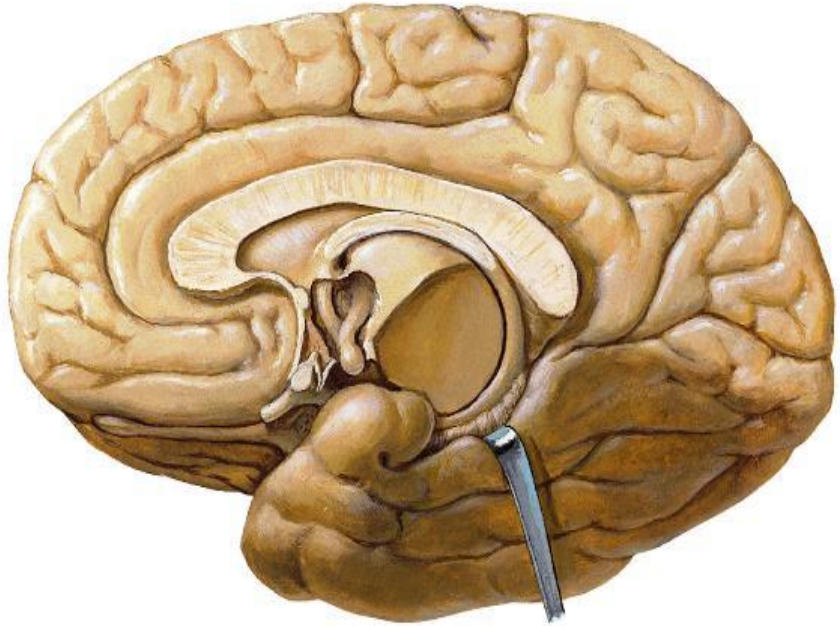
Primary Visual area (area 17)

- **Site:** Lies on the medial in the gyri immediately above and below the calcarine sulcus.

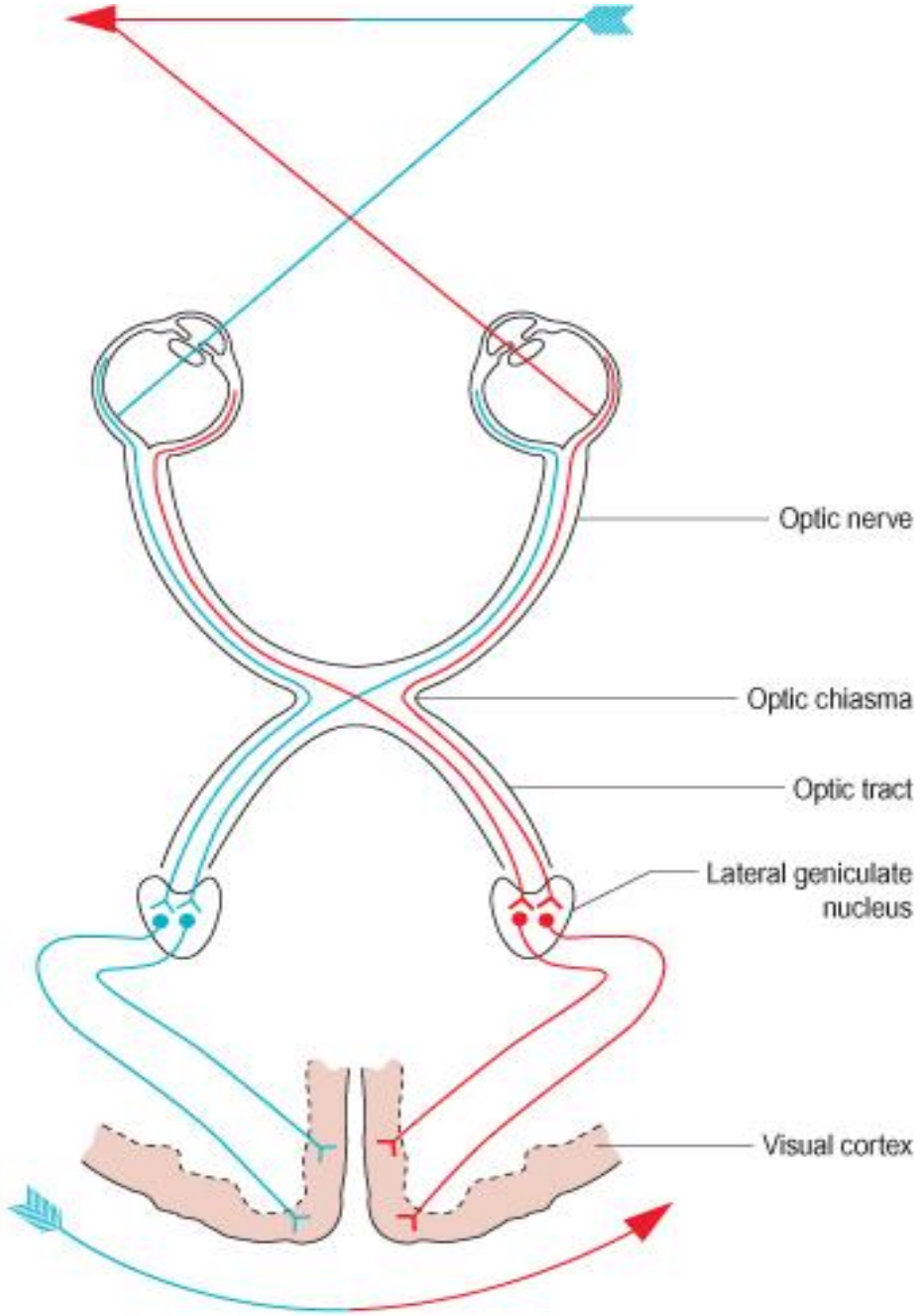
- **Function:** Receive input from the ipsilateral half of each of the two retinas >>> therefore responsible for vision in the contralateral half of each of the two visual fields.

- **Lesion:** **Contralateral homonymous hemianopia** (loss of opposite field of vision).





The primary visual cortex receive input from the ipsilateral half of each of the two retinas, therefore responsible for vision in the contralateral half of each of the two visual fields.

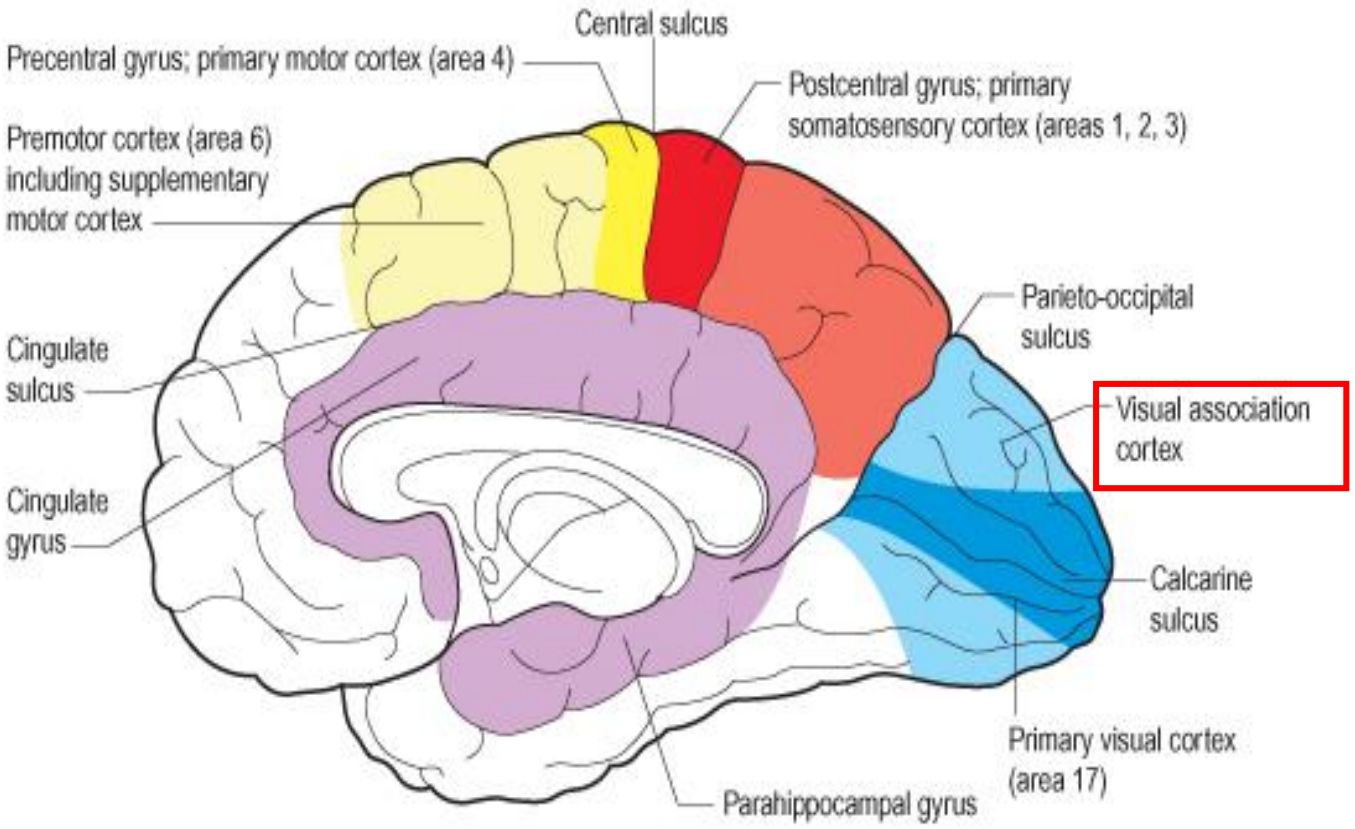


Visual Association Area (area 18,19)

- **Site:** Lie around area 17.

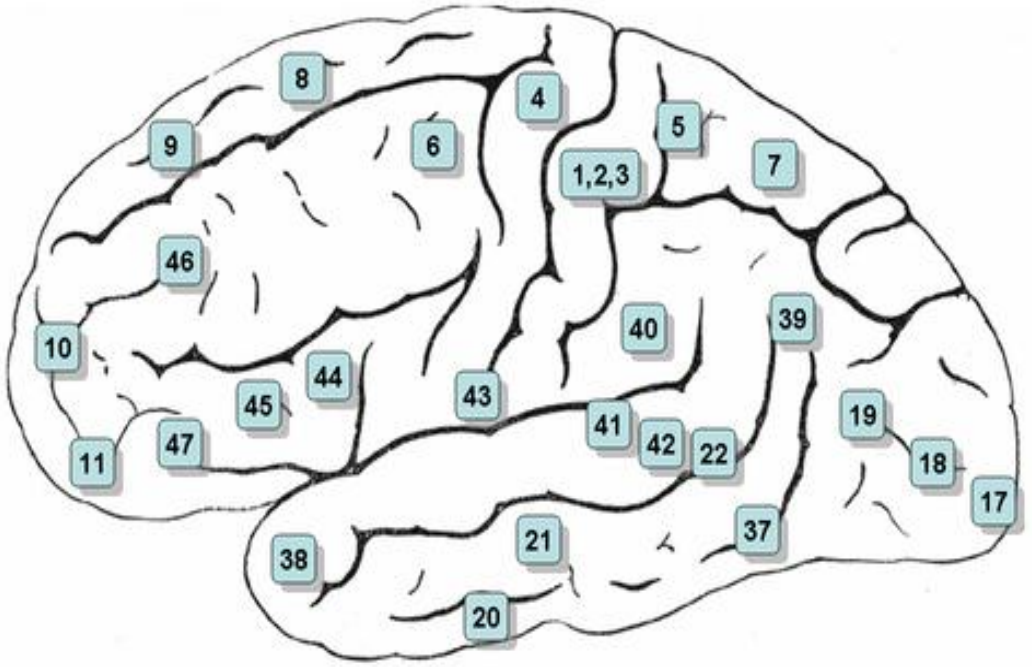
- **Function:** Receive visual information and relate them to pervious visual experience to recognize and appreciate what we see.

- **Lesion:** "**visual agnosia**" – loss of the ability to recognize objects in the opposite visual filed (the patient cannot understand the meaning of what is seen)



- Other visual association areas include areas in the middle and inferior temporal gyri (area 20, 21 and 37)

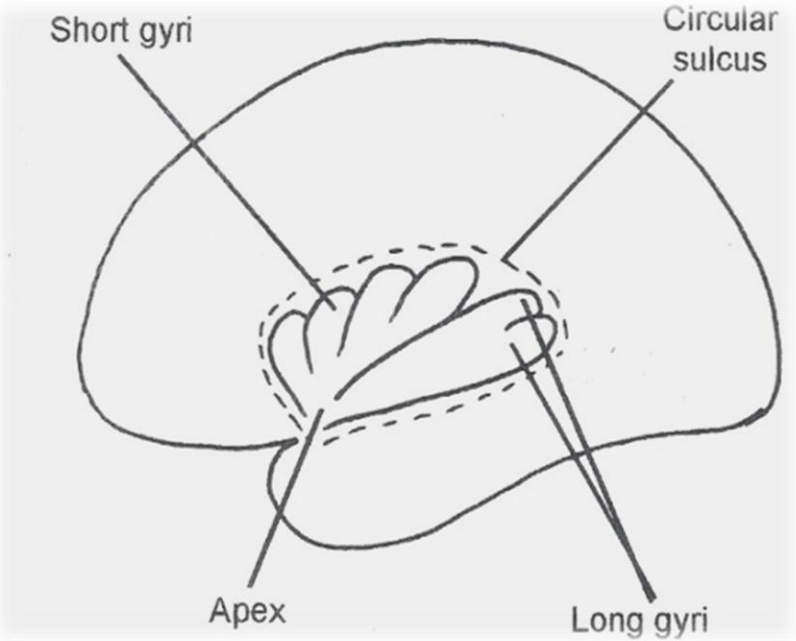
- Also area 39 (angular gyrus) is also considered as visual association area



The Insula

- The insula is subdivided two long gyri (behind) and 3-4 short gyri (in front).

- **Function of the insula:** cortical taste center and some visceral activities (e.g. salivation, visceral pain).

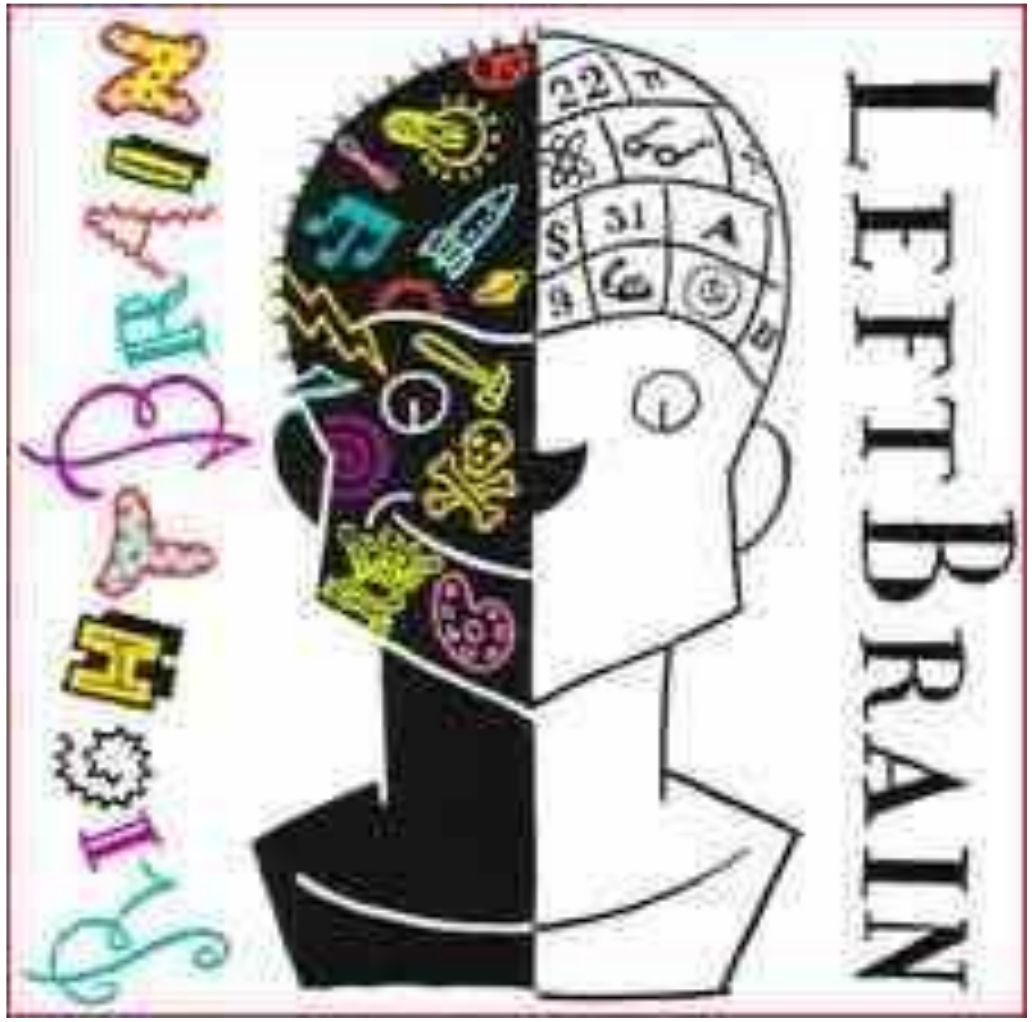


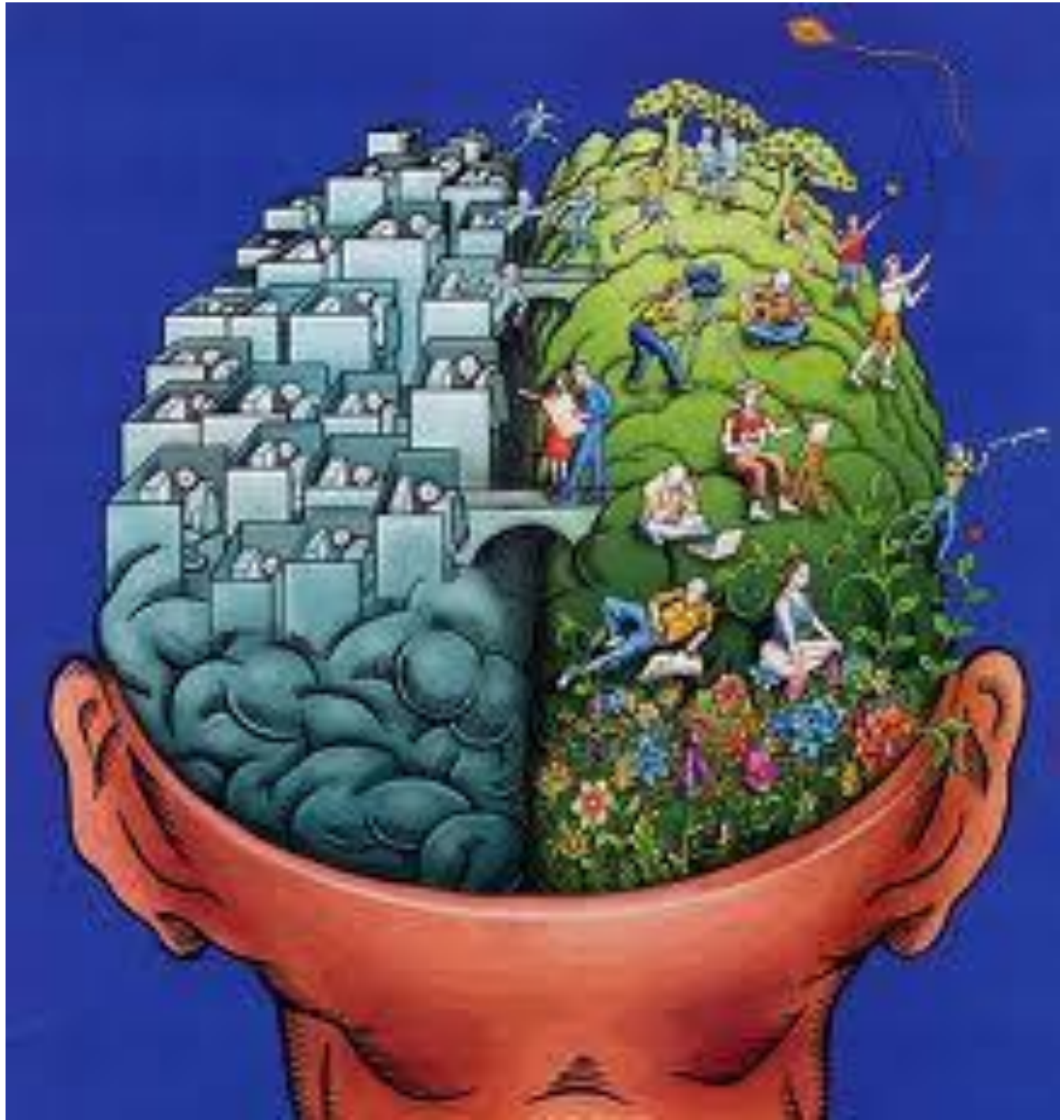
Dominant and Nondominant Hemisphere

- Certain higher cognitive functions are dealt with primarily, or even exclusively, by one of the cerebral hemispheres, which is then referred to as **dominant** for that function.

- **Left brain** is for Spoken/written language, Mathematical ability, Scientific skills, Logic

- **Right Brain** is for music/art awareness, 3D forms, insight, imagination (the artist)





Look at the chart and say the COLOUR not the word

YELLOW BLUE ORANGE
BLACK RED GREEN
PURPLE YELLOW RED
ORANGE GREEN BLACK
BLUE RED PURPLE
GREEN BLUE ORANGE

Left – Right Conflict

Your right brain tries to say the colour but your left brain insists on reading the word.

Language Areas

- The cortical areas important for language are:

1. **Broca's area**
2. **Wernicke's area**
3. **Angular gyrus**
4. **Exner's area**

- In 97% of human, the dominant hemisphere for language is the **left.**

- Therefore, speech is a function of Left hemisphere (**contain the centers of language comprehension and production**)

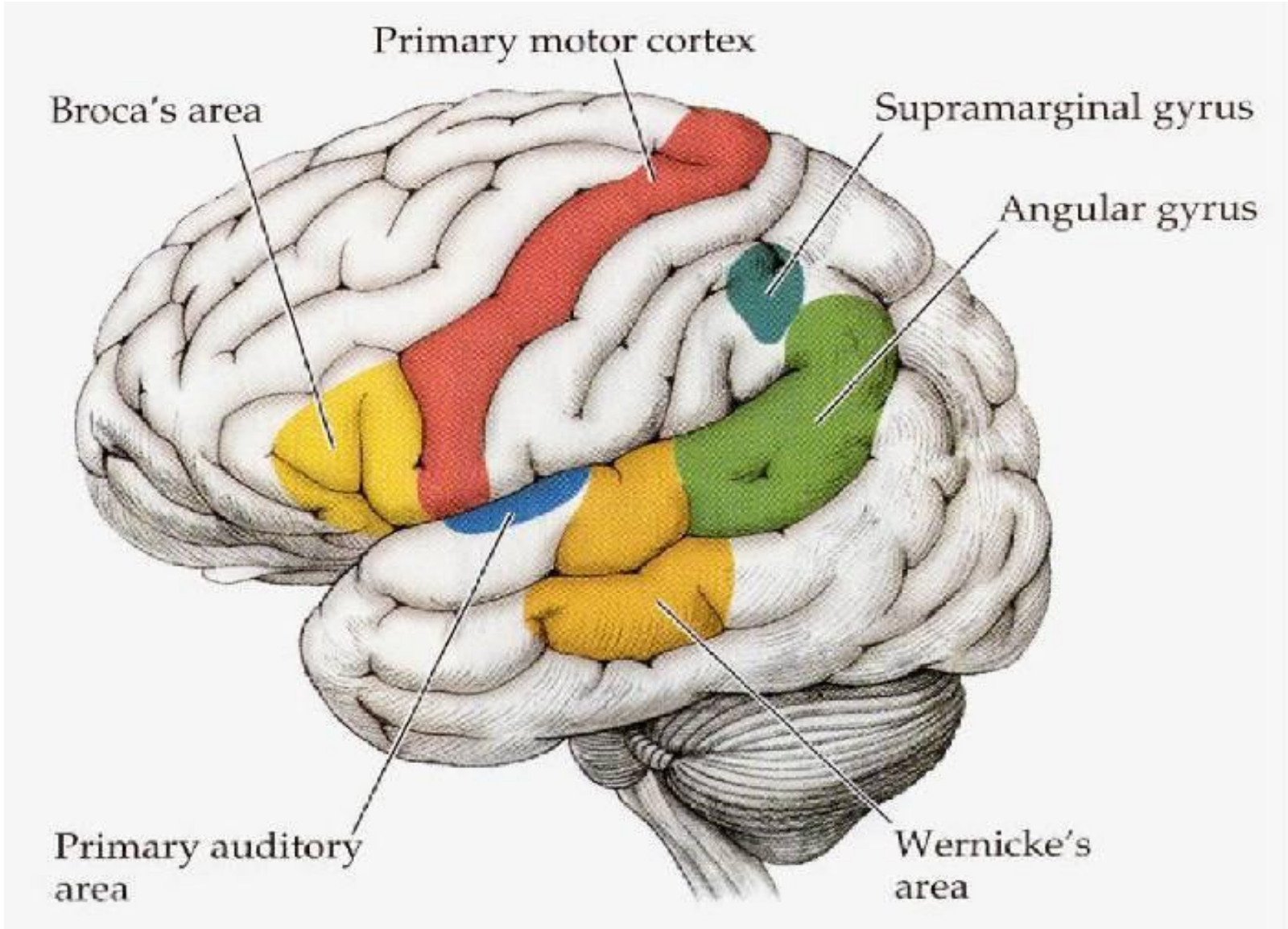
Language Areas

- Two areas for Receptive Language

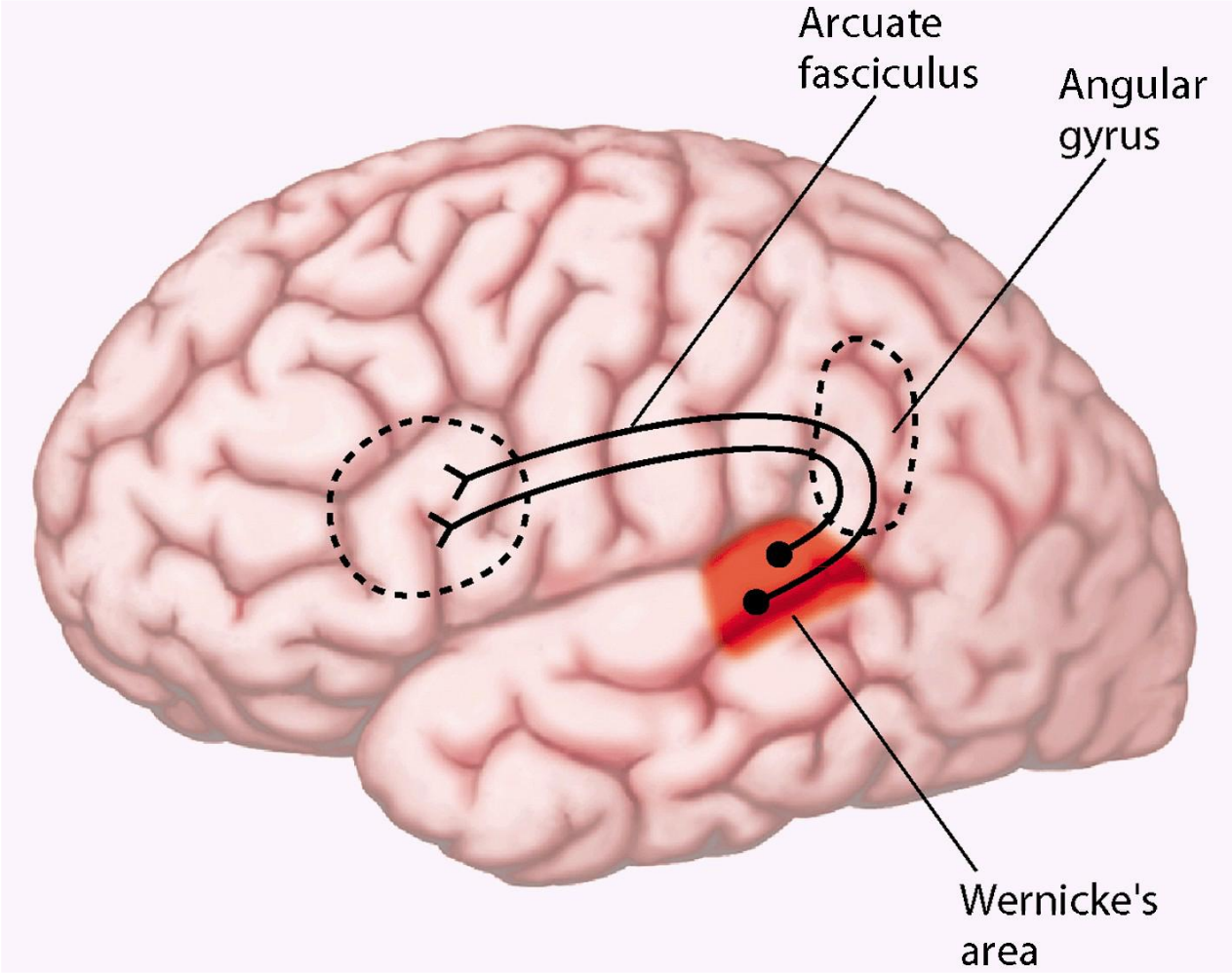
  1. **Wernicke's area**
  2. **Angular gyrus**

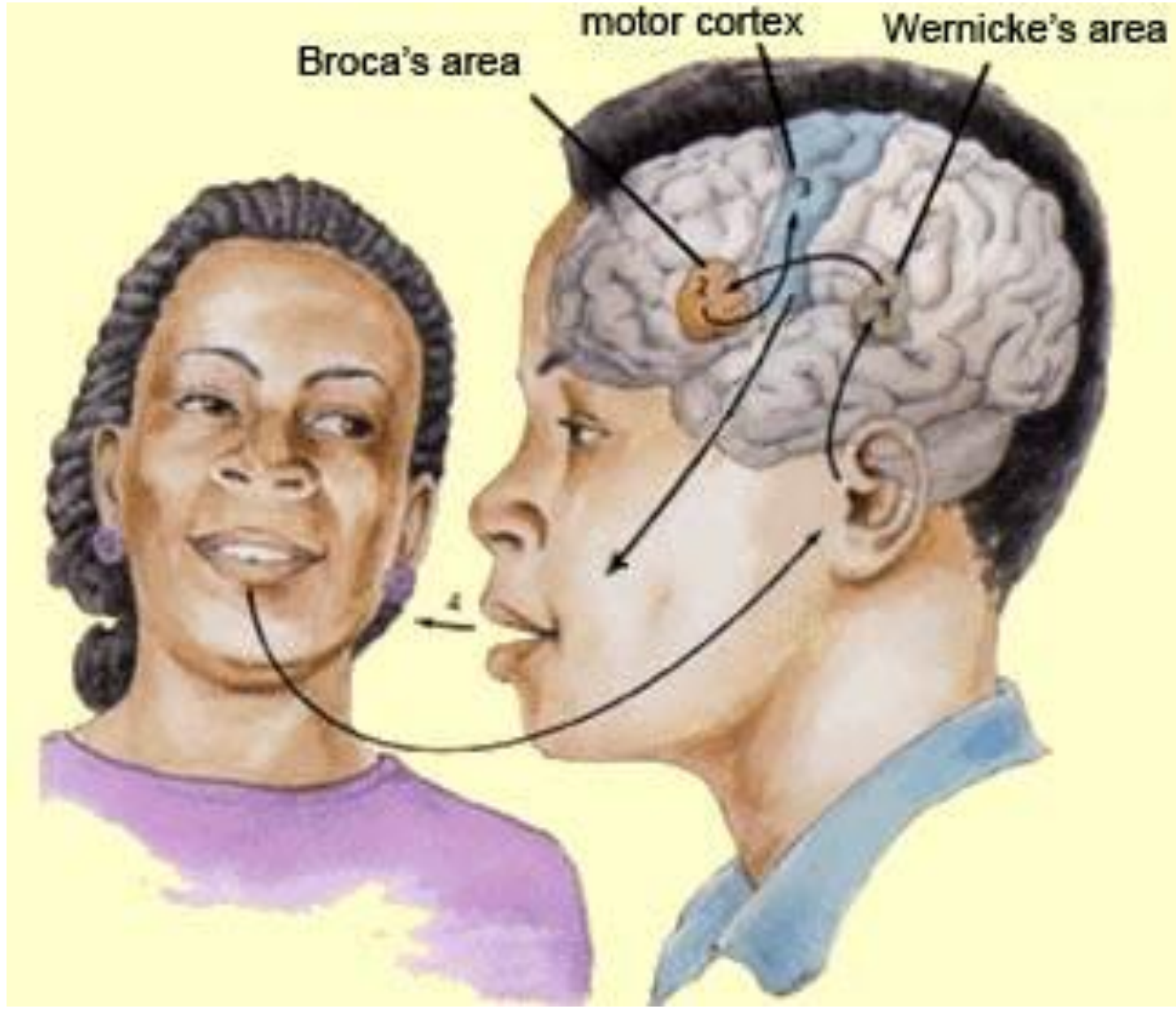
- Two areas for Expressive Language

  1. **Broca's area**
  2. **Exner's area**


Primary motor cortex
Broca's area
Supramarginal gyrus
Angular gyrus
Primary auditory area
Wernicke's area

- A deep, white matter tract, connecting the **Wernicke's area** to the **Broca's area**, also called **arcuate fasciculus.**




motor cortex
Wernicke's area
Broca's area

Language Area

- Disturbance in language is **aphasia**

1. **Motor aphasia**

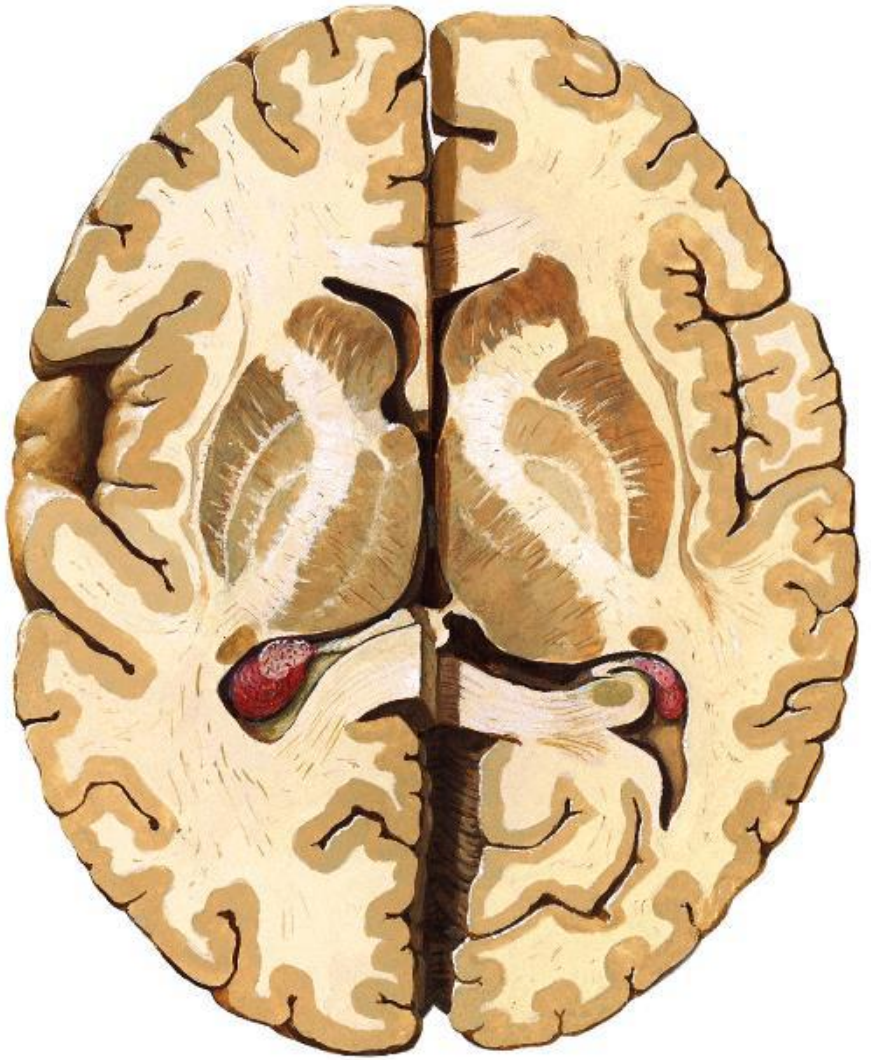
2. **Sensory aphasia**
   A. Auditory aphasia
   B. Visual aphasia or Alexia

3. **Global aphasia**
   - Obstruction of middle cerebral artery which supplies Wernicke's, Angular , and Broca's areas >>> Damage to these areas leads to global aphasia >> patient can not talk, write or read .

The White Matter of the Cerebrum

- Consists of **myelinated nerve fibers** .
- The nerve fibers originate, terminate or sometimes both, within the cortex.
- Three types of fibers in the white mater:

1. **Association fibers**
2. **Commissural fibers**
3. **Projection fibers**

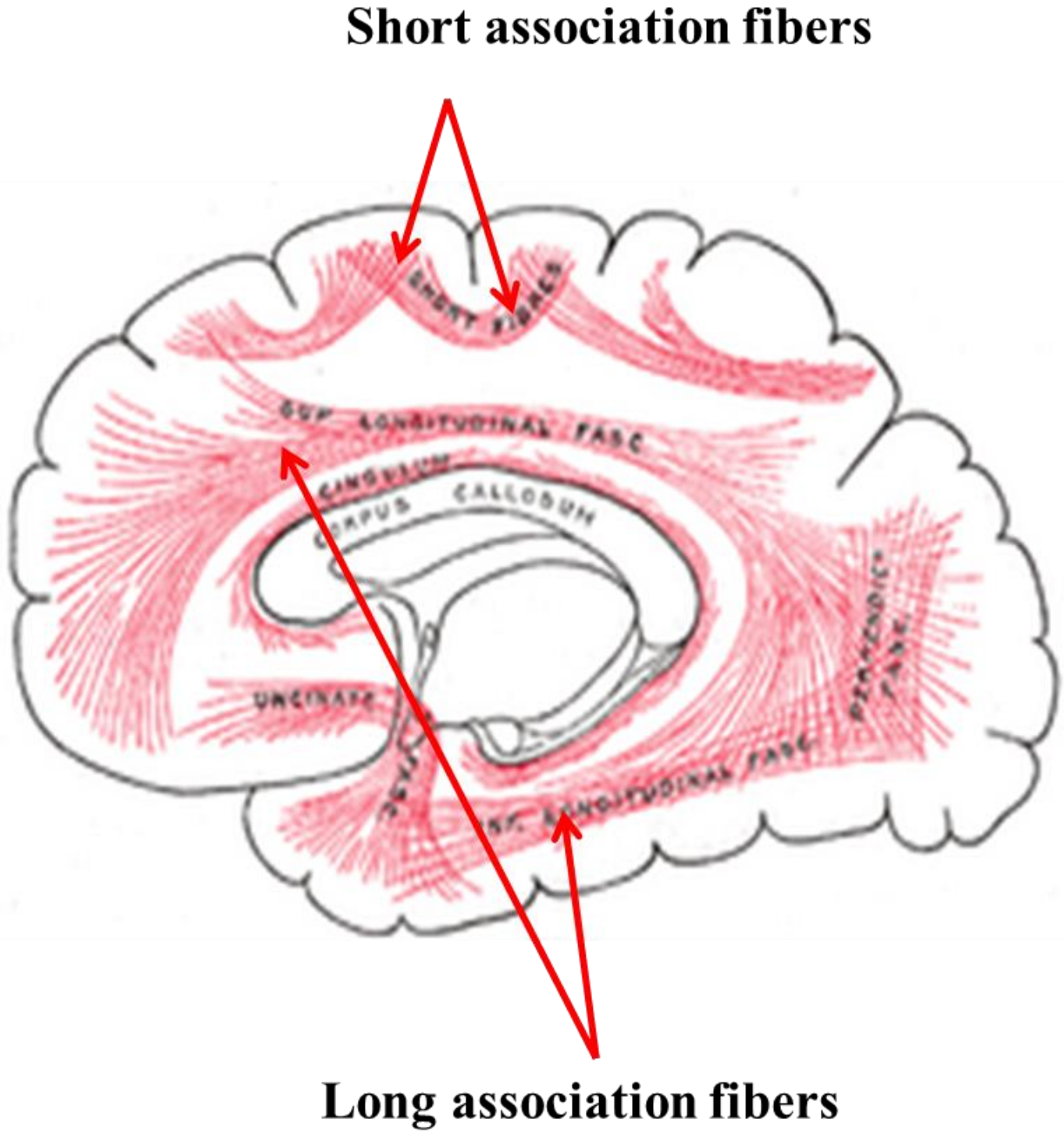


Association fibers

- Connect different regions in the same hemisphere.
- They are of two kinds:

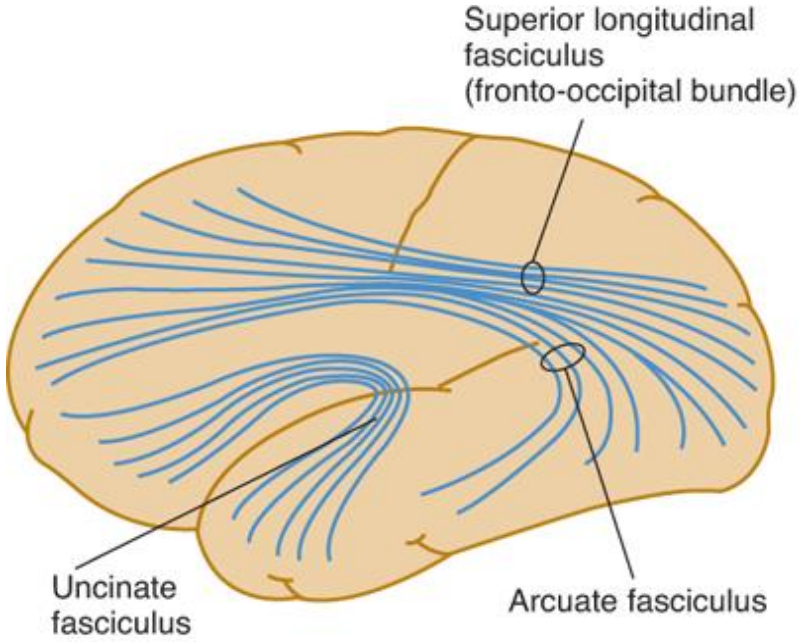
A. Those connecting adjacent gyri, **short association fibers**.

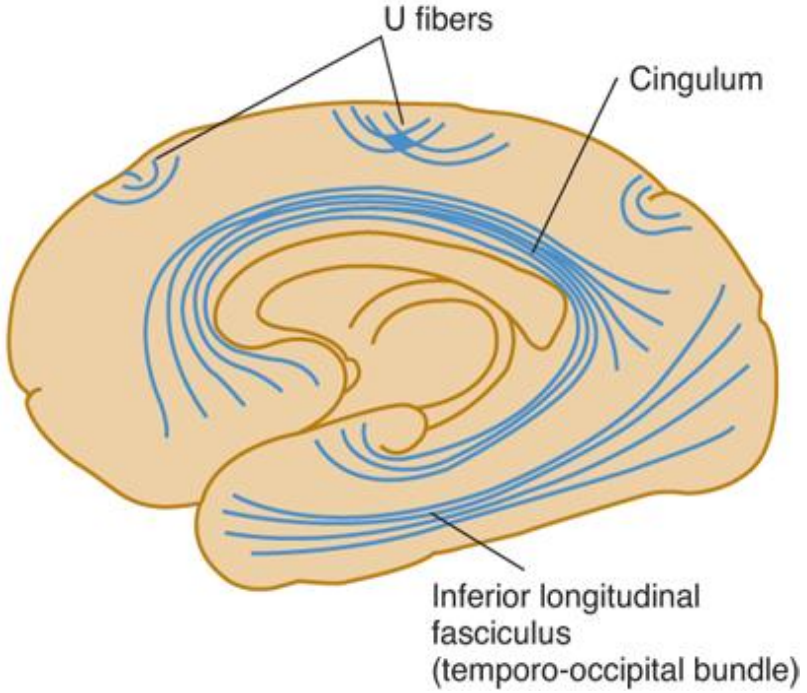
B. Those connecting more distant parts, **long association fibers**.



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 lobe to temporal lobe.
5. Cingulum: connects the cingulate gyrus to the parahippocampal gyrus.

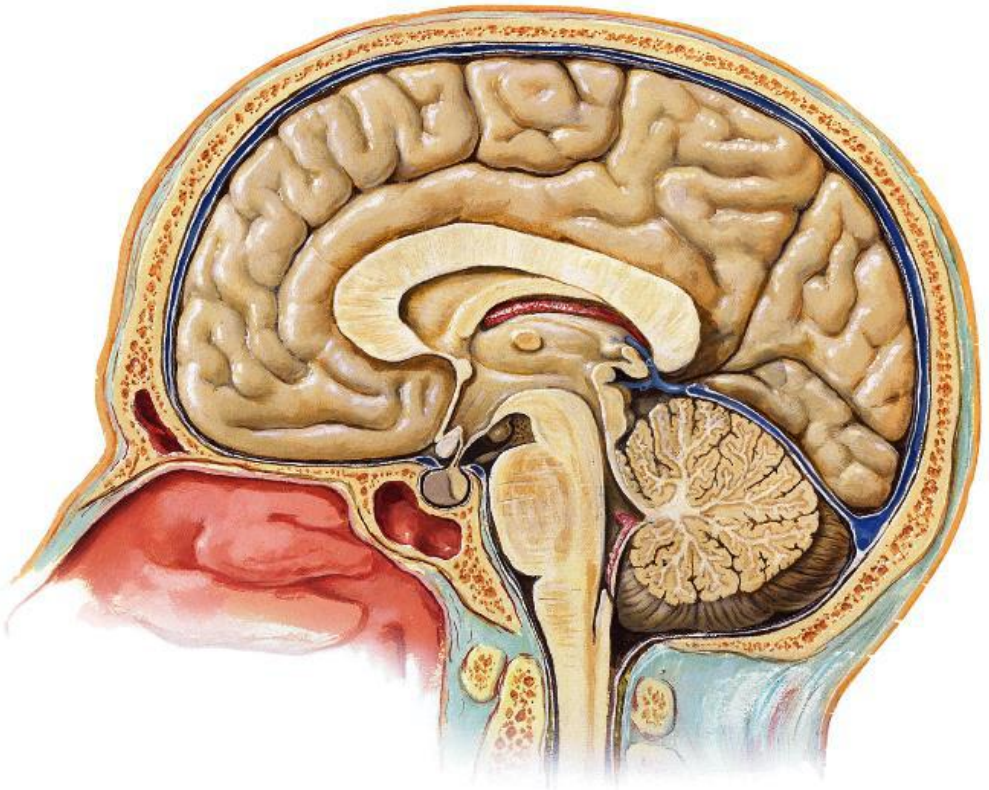


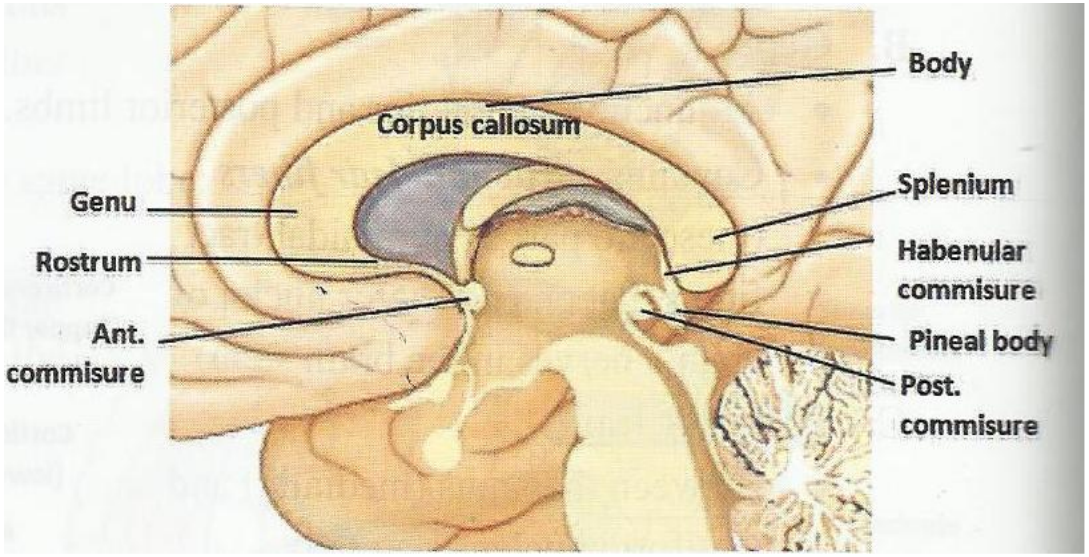


Commissural Fibers

- Connect the corresponding regions of the two hemispheres.

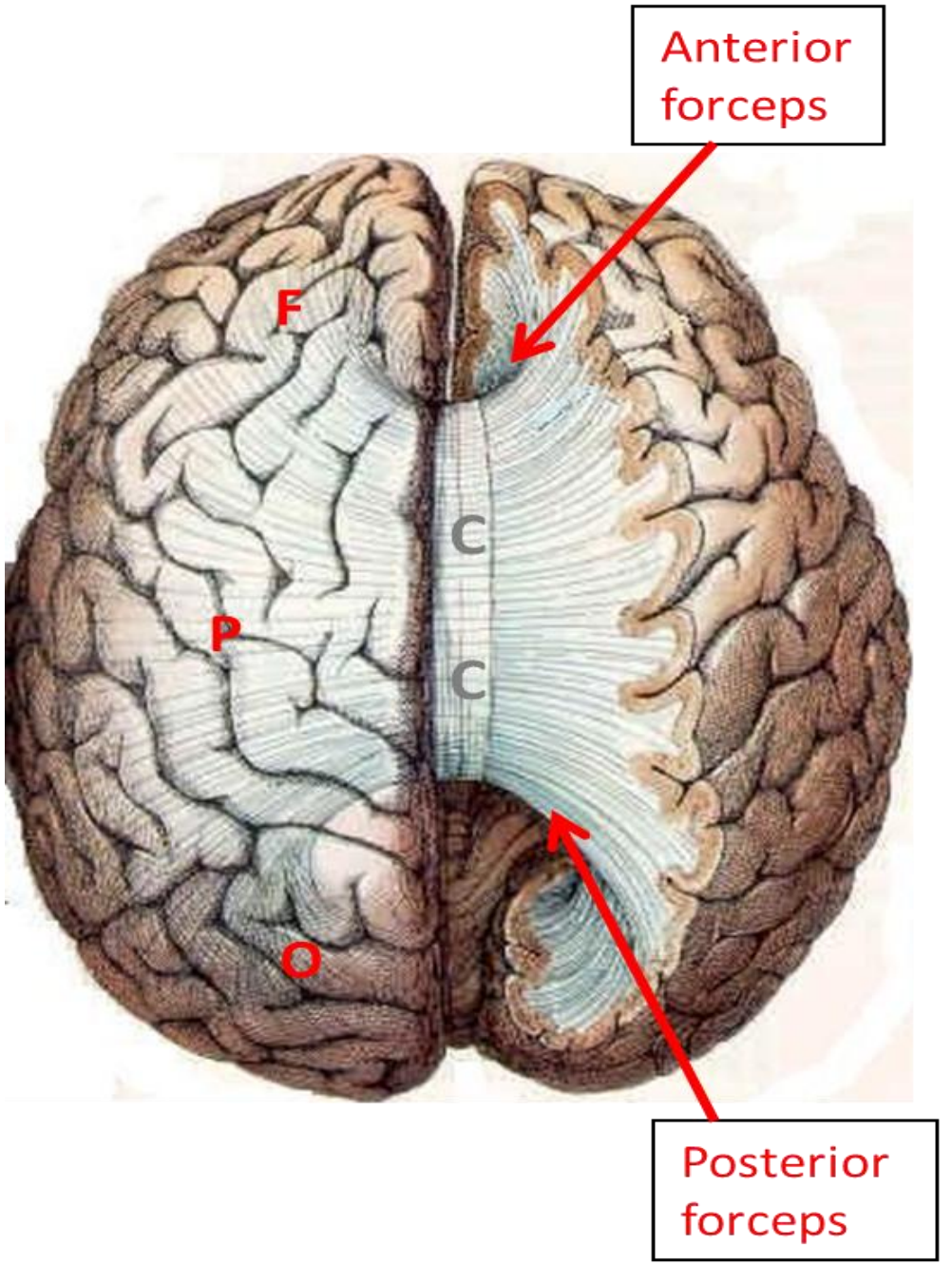
- Include:
  A. Corpus callosum.
  B. Anterior commissure.
  C. Posterior commissure.
  D. Hippocampal commissure (commissure of fornix).





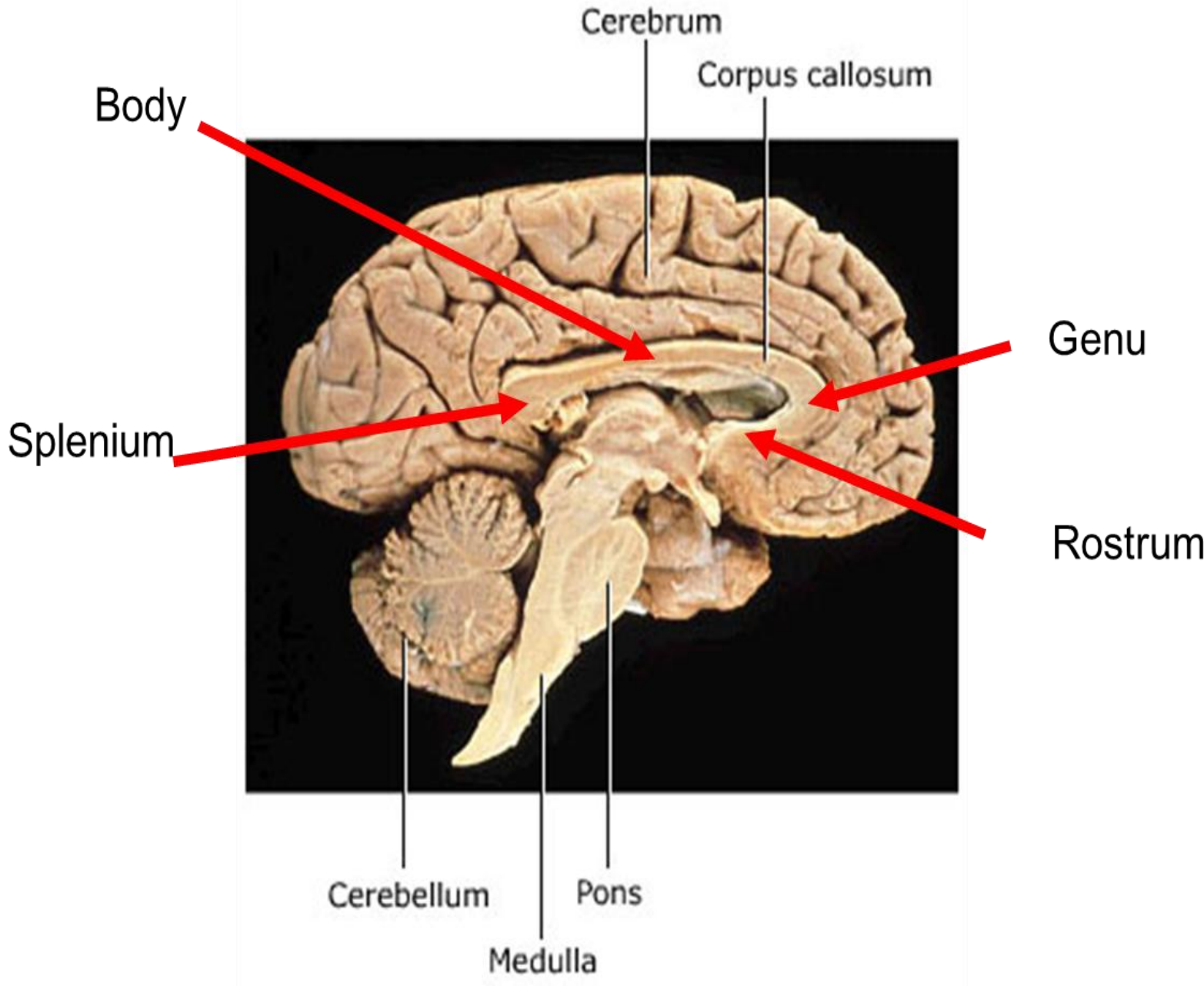
Corpus Callosum

- The largest commissure.
- 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**.
    - The callosal fibers linking the occipital poles, curve backward forming **posterior forceps**.



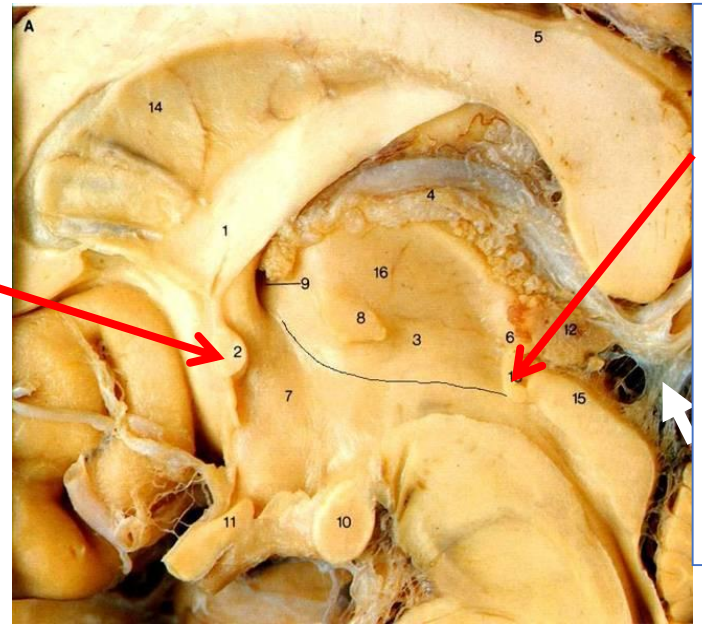
Parts of Corpus Callosum:

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



Anterior commissure:

- connects the inferior and middle temporal gyri & the olfactory regions of the two hemispheres

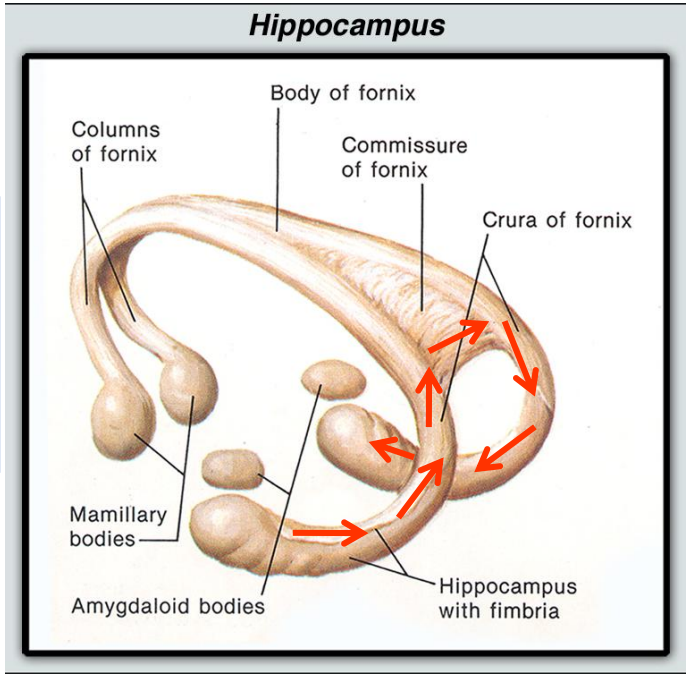


Posterior Commissure:

- connects the left and right midbrain
- Important in the bilateral pupillary reflex

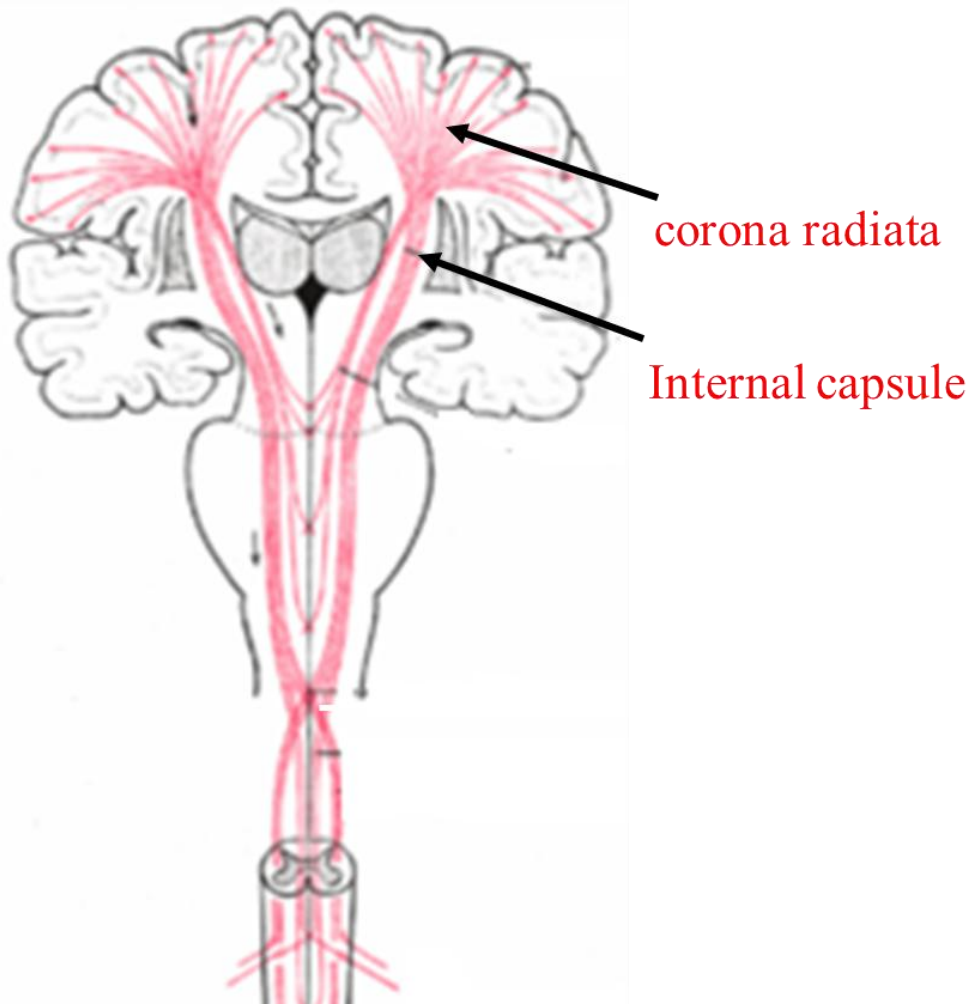
Hippocampal Commissure:

- connect the two hippocampi with each other



Projection Fibers

- Connect the cerebral cortex with the lower parts of the brain (ex: brain stem) and spinal cord
- Their fibers are either ascending or descending.
- Deeper to the cortex, these fibers are arranged radially as the **corona radiata**.
- Then the fibers converge downward, pass between **thalamus** and **basal ganglia** forming the **internal capsule.**

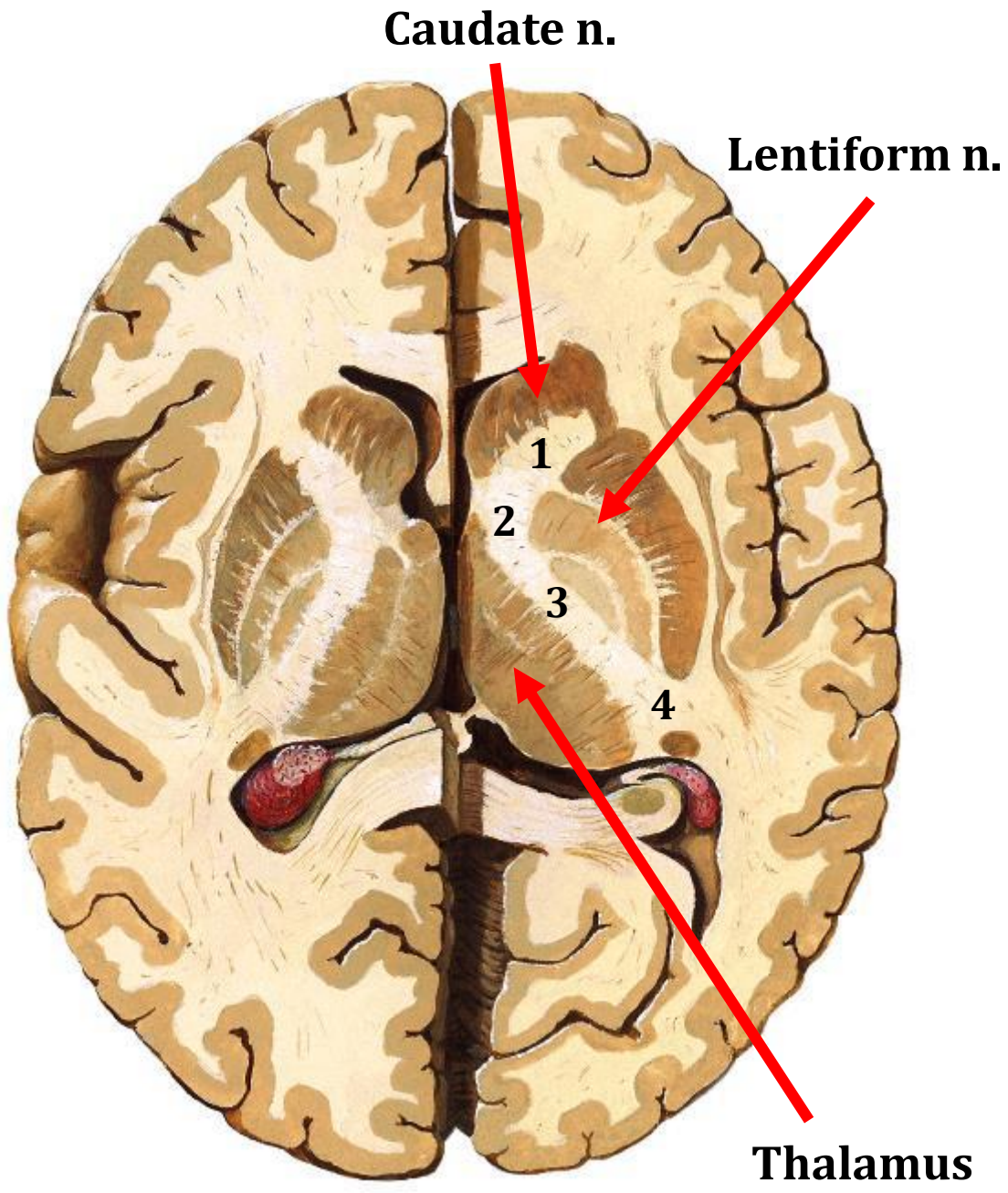


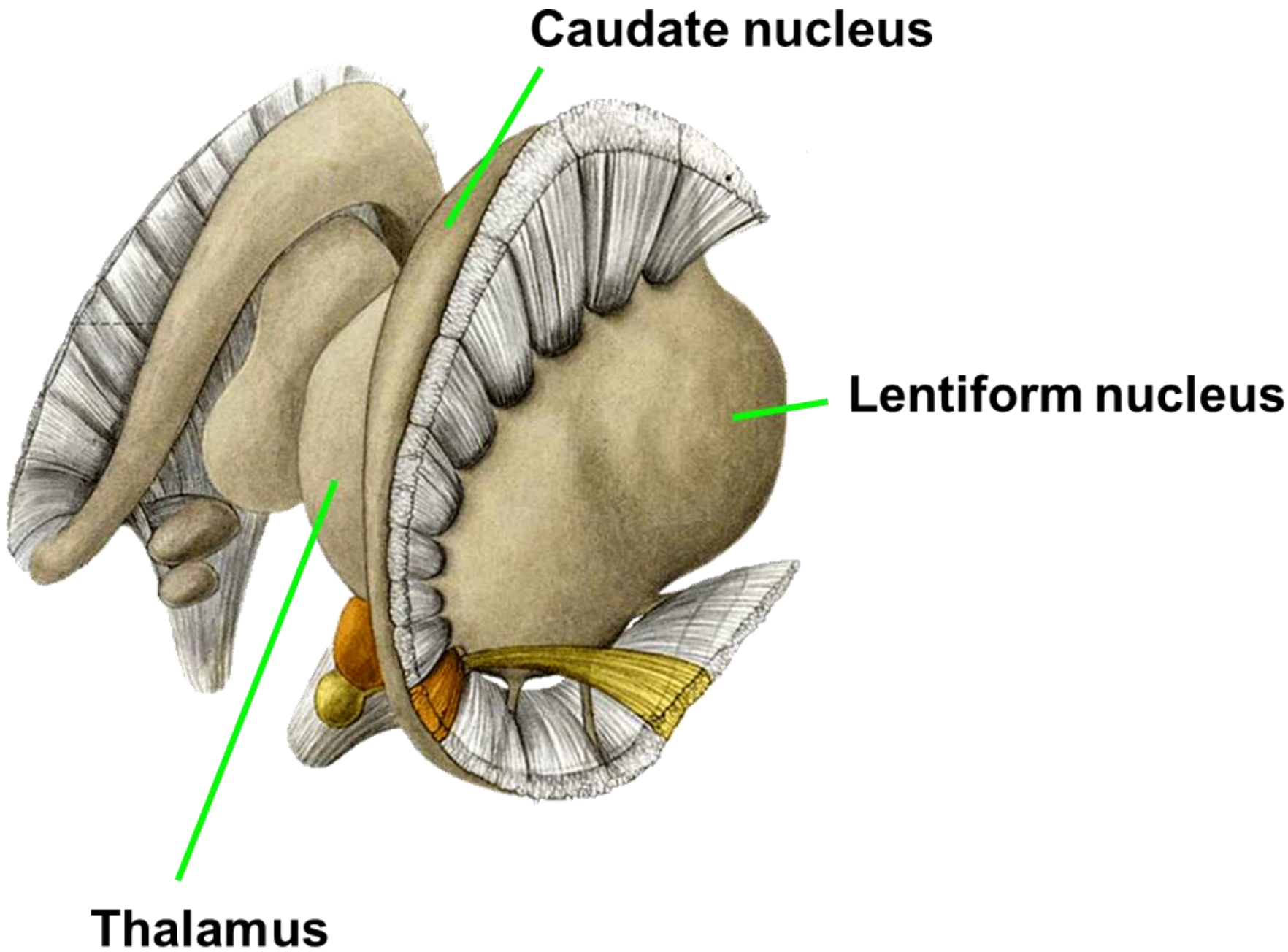
Internal Capsule

- Bundle of projection fibers running between three masses of grey matter: **thalamus**, **caudate nucleus** (medially) and **lentiform nucleus** (laterally).

- It is V-shaped, having:

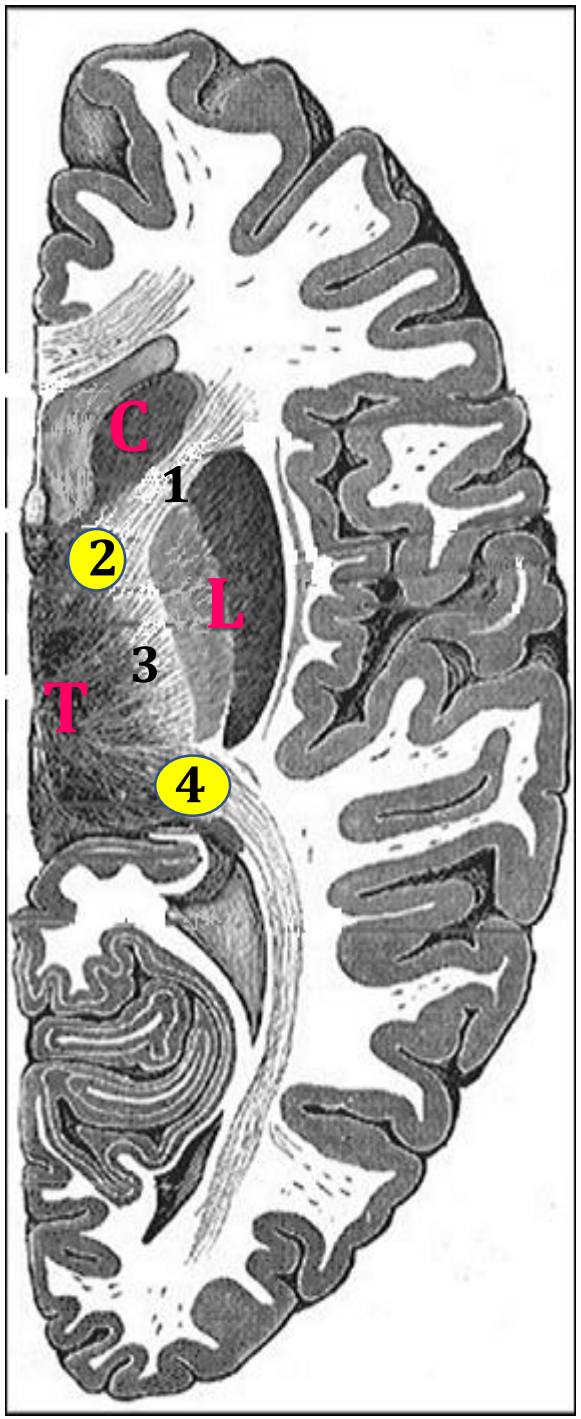
    1. **Anterior limb**
    2. **Genu**
    3. **Posterior limb**
    4. **Retrolentiform part**
    5. **Sublentiform part**



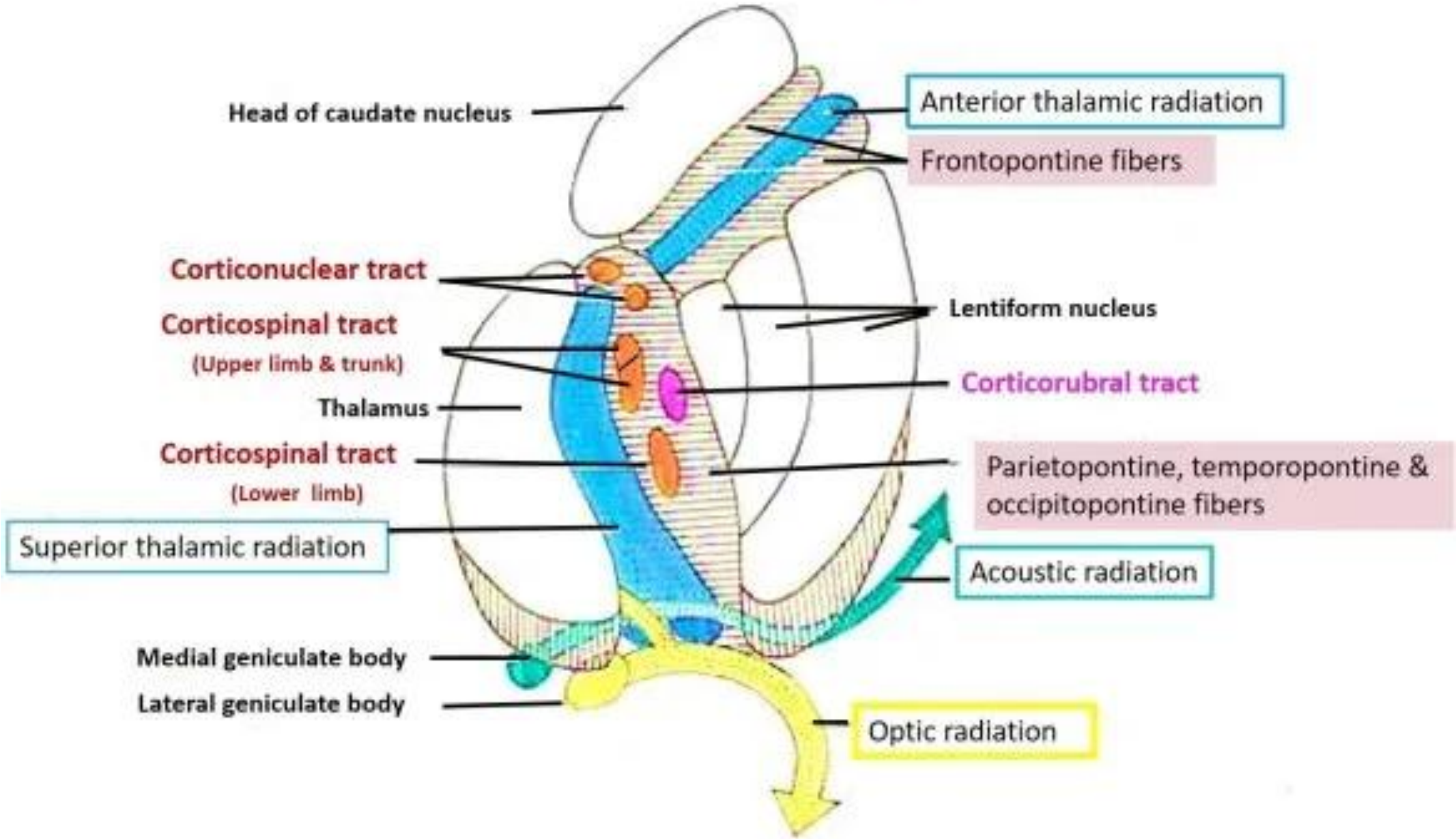

Caudate nucleus
Lentiform nucleus
Thalamus

- **Constituent fibers of internal capsule:**

1. **Anterior limb:** Anterior thalamic radiation and Frontopontine fibers
2. **Genu:** Corticonuclear fibers
3. **Posterior limb:** Corticospinal, Corticorubral and Superior thalamic radiation.
4. **Retrolenticular part**: Optic radiation
5. **Sublenticular part:** Auditory radiation



Constituent Fibers of Internal Capsule



Thank you

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