



Central Nervous System

Lecture 7: Cerebral Hemisphere

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CEREBRAL HEMISPHERES

EXTERNAL FEATURES

** The surface of the cerebral hemisphere is composed of grey matter “**cerebral cortex**” that is thrown into grooves “**sulci**” separated by folds “**gyri**” to increase the surface area.

** Each cerebral hemisphere has 3 poles, 3 surfaces, 5 borders & 5 lobes.

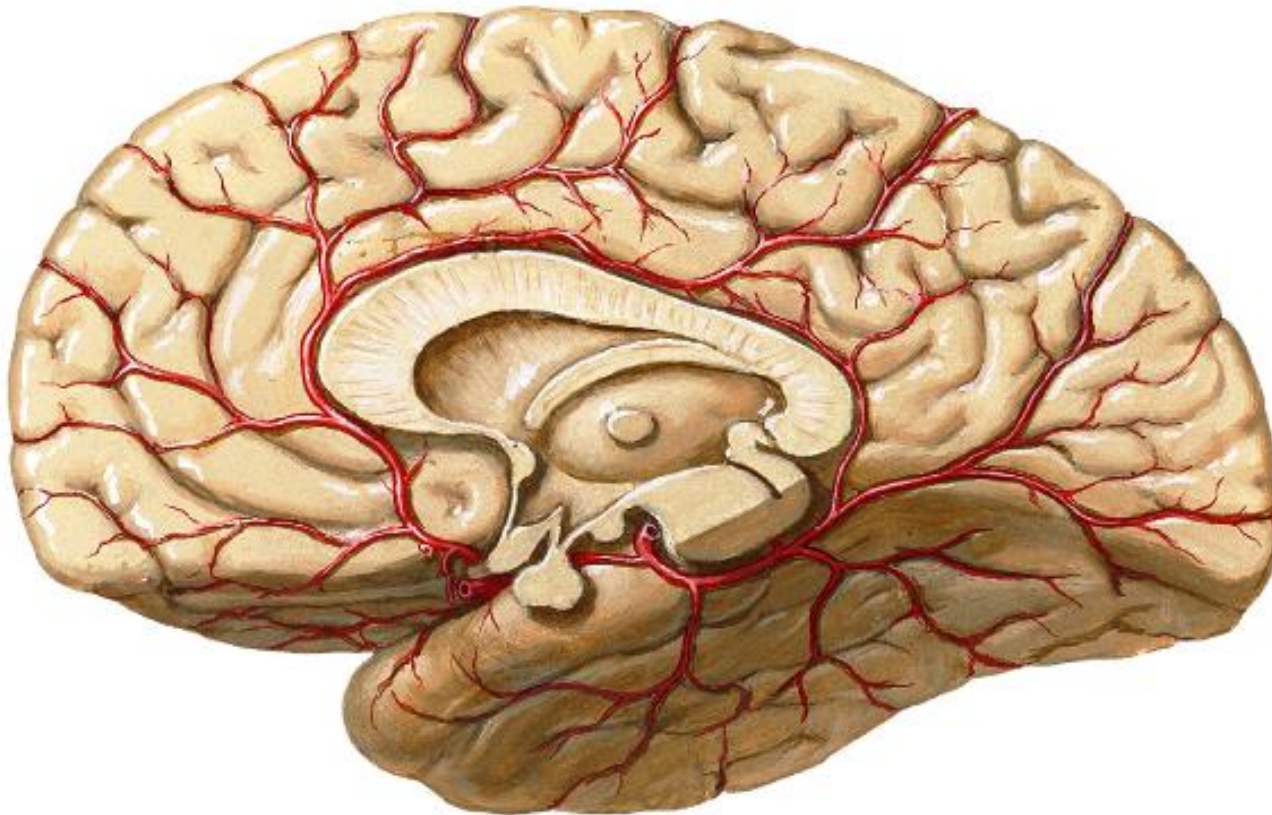
A. 3 poles: frontal, temporal & occipital.

B. 3 surfaces:

1. Superolateral: convex to fit the skull cap.



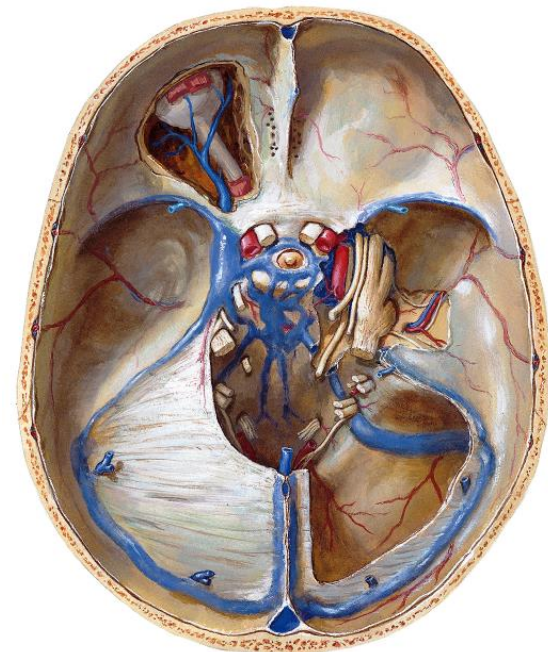
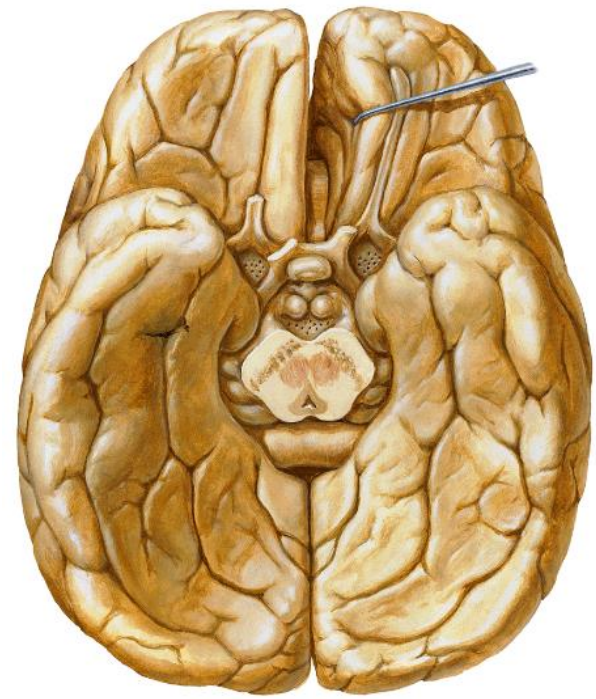
2. Medial: flat & separated from its fellow of the opposite side by the longitudinal cerebral fissure which contains a fold of dura “the falx cerebri” and the anterior cerebral vessels. At its bottom, the two hemispheres are connected by a bridge of white fibers “the corpus callosum”.



3. **Inferior:** divided by the stem of lateral sulcus into:

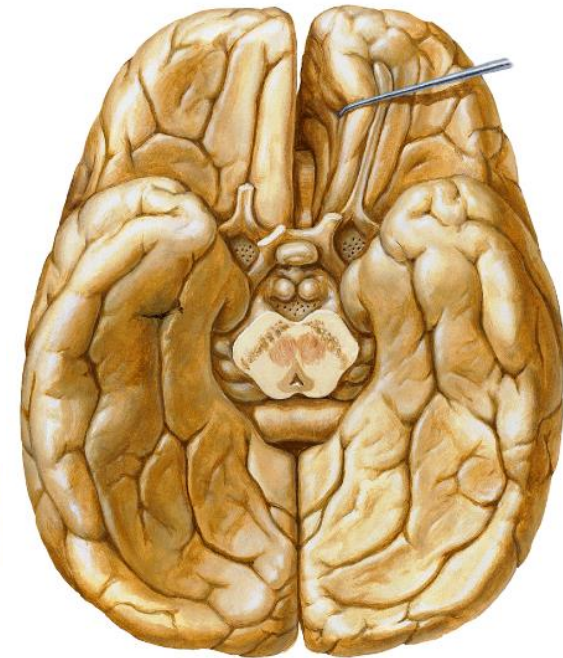
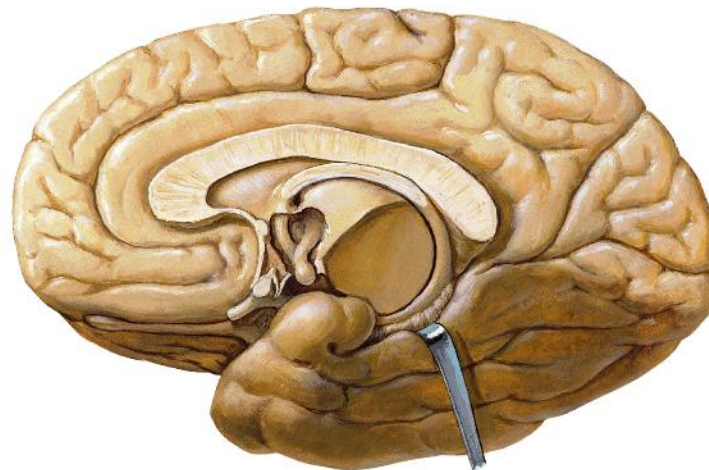
i. **Ant. orbital part:** Directed downwards and laterally & related to the ant. cranial fossa.

ii. **Post. tentorial part:** Directed downwards and medially & related to the middle cranial fossa & the tentorium cerebelli.



C. 5 borders:

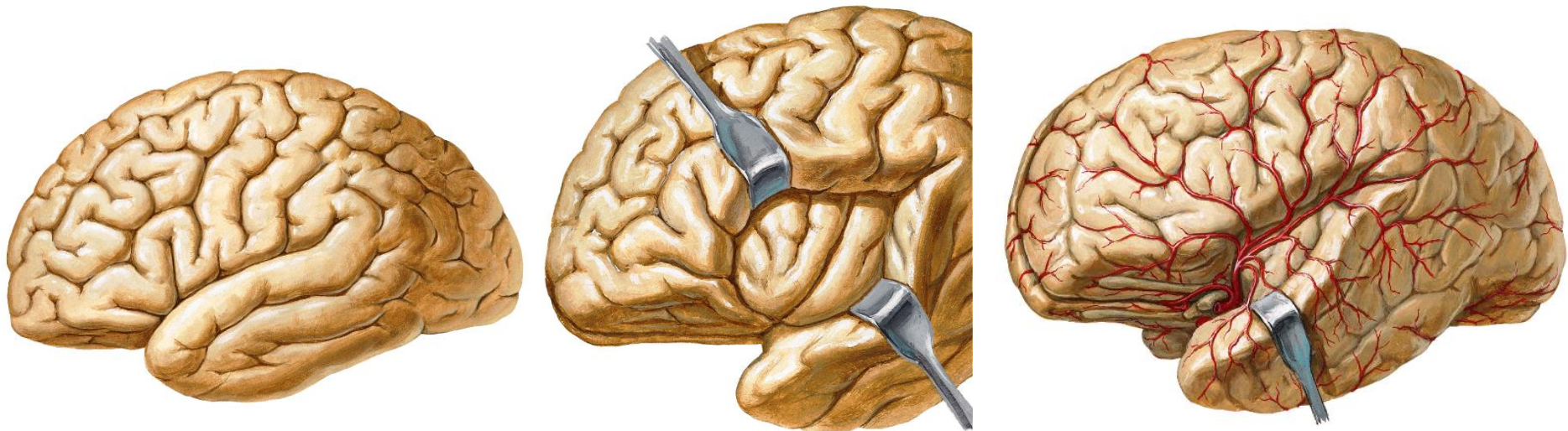
- 1. Superomedial: separates the superolateral & medial surfaces.**
- 2. Inferolateral: separates the superolateral & tentorial surfaces.**
- 3. Superciliary: separates the superolateral & orbital surfaces**
- 4. Medial orbital: separates the orbital & medial surfaces**
- 5. Medial occipital: separates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



D. 5 lobes: frontal, parietal, temporal, occipital & limbic; in addition to a hidden insula.

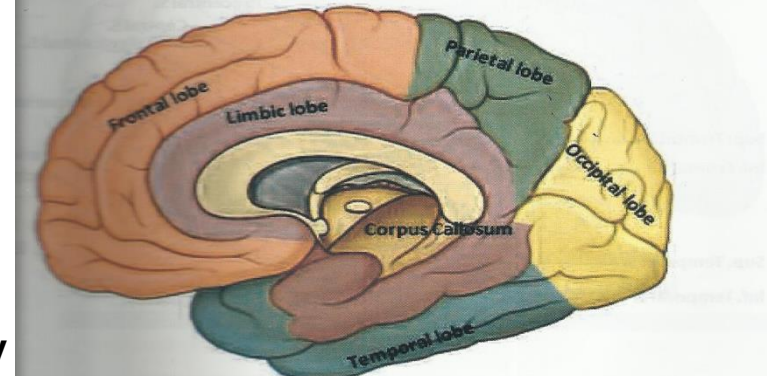
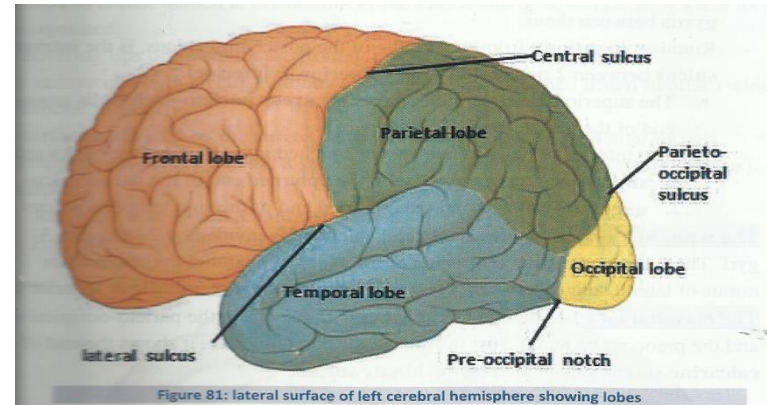
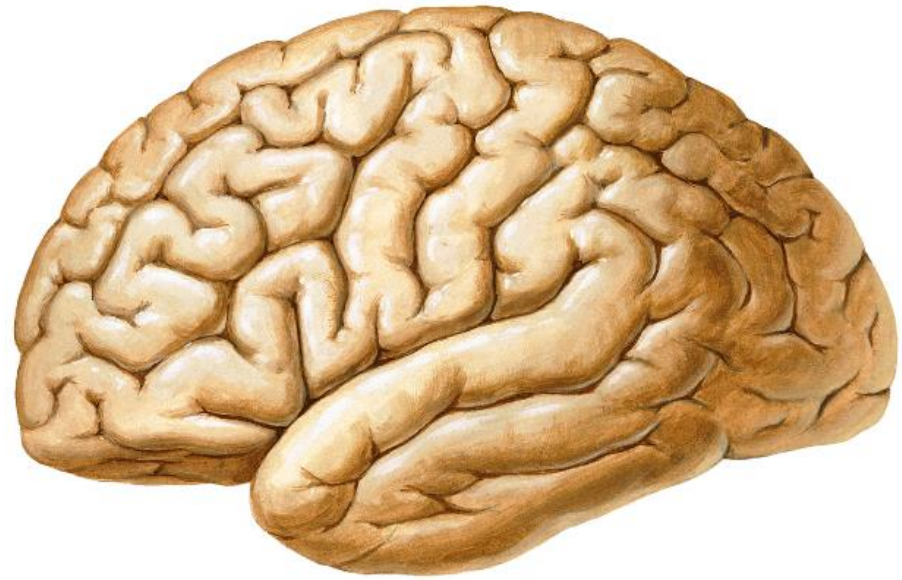
**** Major sulci that separate the lobes:**

1. Lateral sulcus (Fissure of Sylvius): has a stem and 3 rami. Its stem runs between the orbital & tentorial parts of the inferior surface; the 3 rami are: anterior horizontal, anterior ascending & posterior; the latter is long & is considered as the continuation of the stem. When its lips are separated, the insula & middle cerebral vessels are seen in its floor.



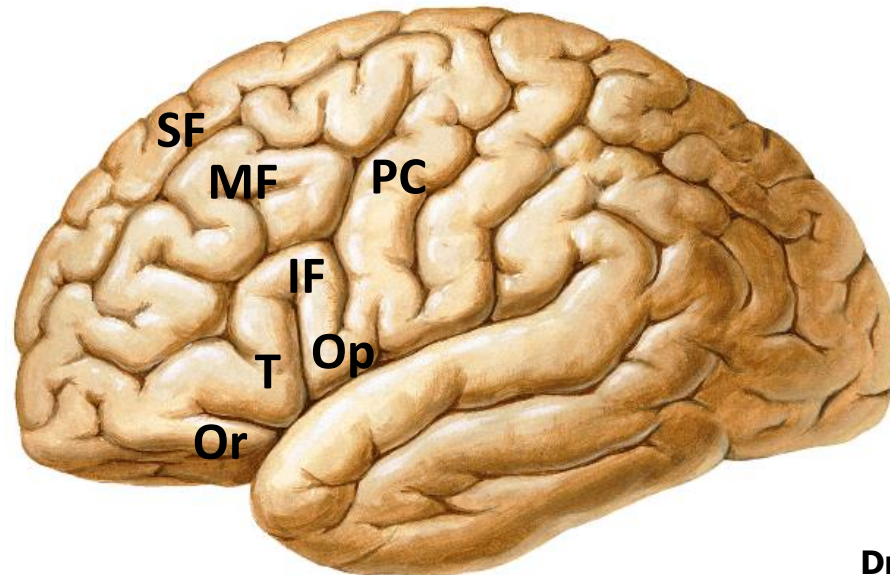
2. The central sulcus (Fissure of Rolando): Begins on the superomedial border just behind the midpoint between the frontal & occipital poles. Runs between the frontal and parietal lobes & between the motor and sensory areas. When its lips are separated, the opposed walls show interlocking gyri.

3. An imaginary line: connecting the end of the parietooccipital sulcus with the preoccipital notch on the inferolateral border (5 cm in front of the occipital pole); separates the parietal and occipital lobes.



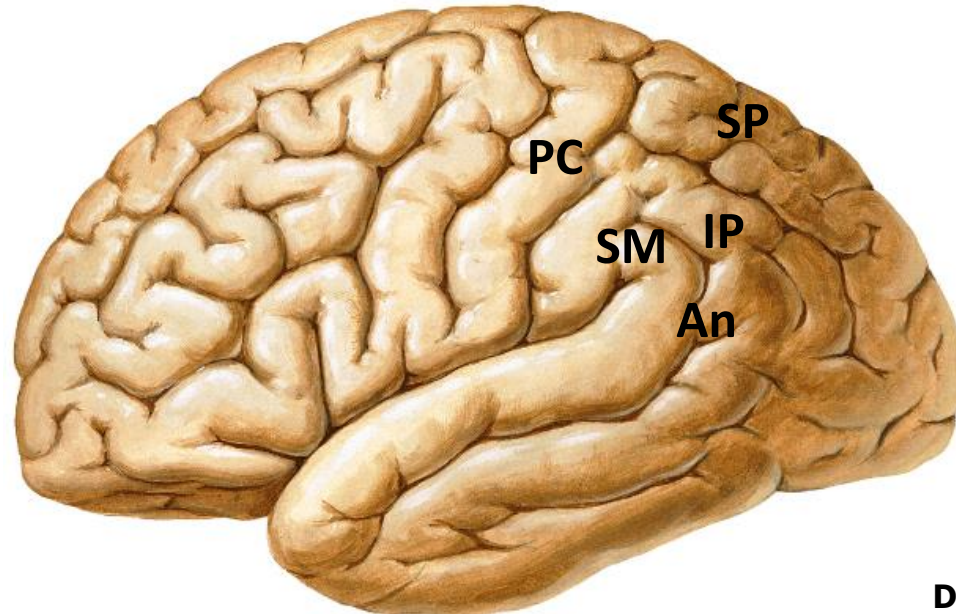
SULCI & GYRI ON SUPEROLATERAL SURFACE

- A. The frontal lobe:** lies anterior to the central sulcus above the lateral sulcus. It contains 3 sulci & 4 gyri.
- ** The precentral sulcus (PC)** runs parallel to the central sulcus with the precentral gyrus between them.
 - ** Extending anteriorly from the precentral sulcus are 2 frontal sulci (superior & inferior) between 3 frontal gyri; superior (SF), middle (MF) & inferior (IF). The inferior frontal gyrus is invaded by the anterior horizontal and ascending rami of the lateral sulcus dividing it into 3 parts from before backwards: pars orbitalis (Or), pars triangularis (T) & pars opercularis (Op).**

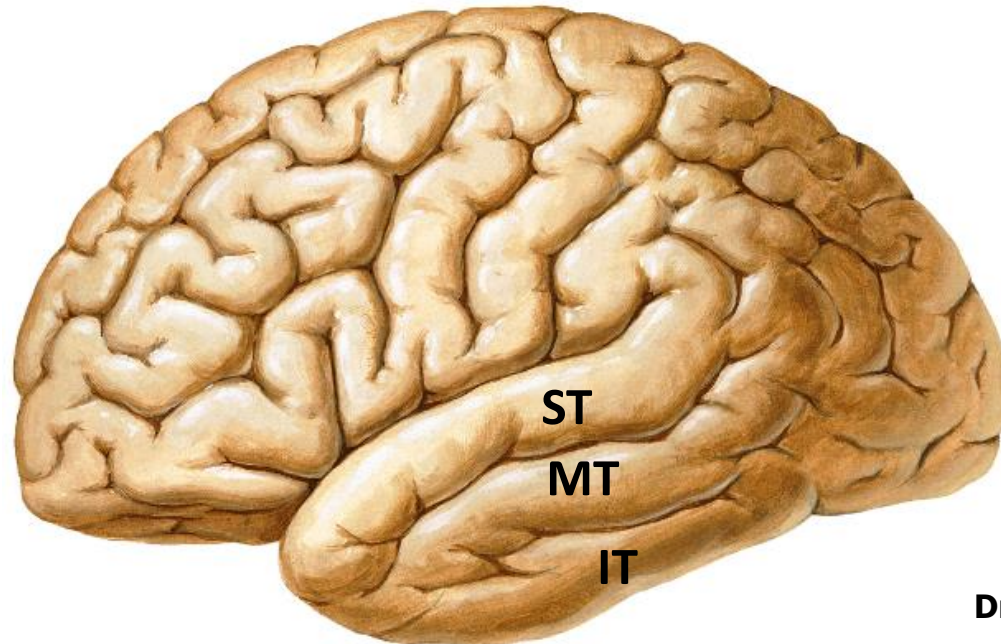


B. The parietal lobe: extends from the central sulcus to the parieto-occipital sulcus, above the lateral sulcus. It contains 2 sulci & 3 gyri.

- ** The postcentral sulcus (PC) runs parallel to the central sulcus with the postcentral gyrus between them.
- ** Running posteriorly from the middle of the postcentral sulcus, is the intraparietal sulcus between 2 parietal lobules (superior & inferior).
- ** The superior parietal lobule (SP) makes the arcus parieto-occipitalis around the end of the parieto-occipital sulcus.
- ** The inf. parietal lobule (IP) shows 2 arched gyri (from before backwards):
 1. supramarginal gyrus (SM) around the upturned end of the lateral sulcus.
 2. angular gyrus (An) around the upturned end of the sup. temporal sulcus

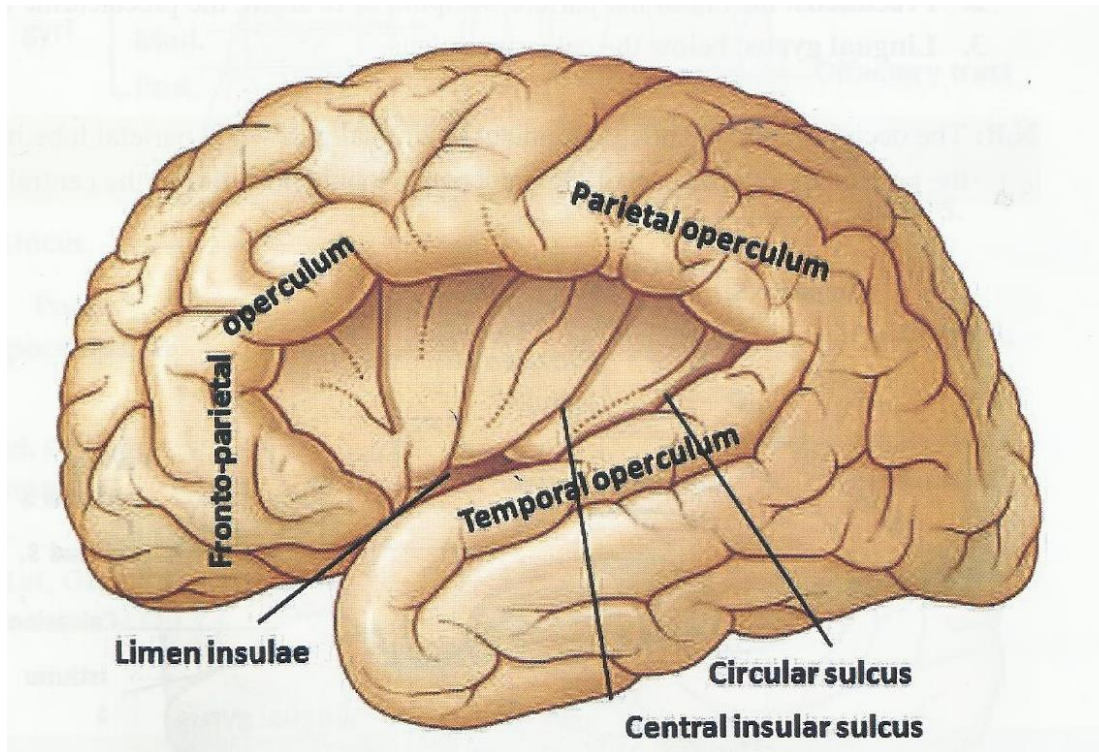


- C. The temporal lobe:** lies below the lateral sulcus. It is divided by 2 sulci into 3 gyri. The 2 temporal sulci (superior & inferior) run parallel to the posterior ramus of lateral sulcus between 3 temporal gyri; superior (ST), middle (MT) & inferior (IT).
- D. The occipital lobe:** lies behind the imaginary line between the parieto-occipital sulcus and the preoccipital notch. Just in front of the occipital pole, it shows the end of the calcarine sulcus surrounded by the lunate sulcus.



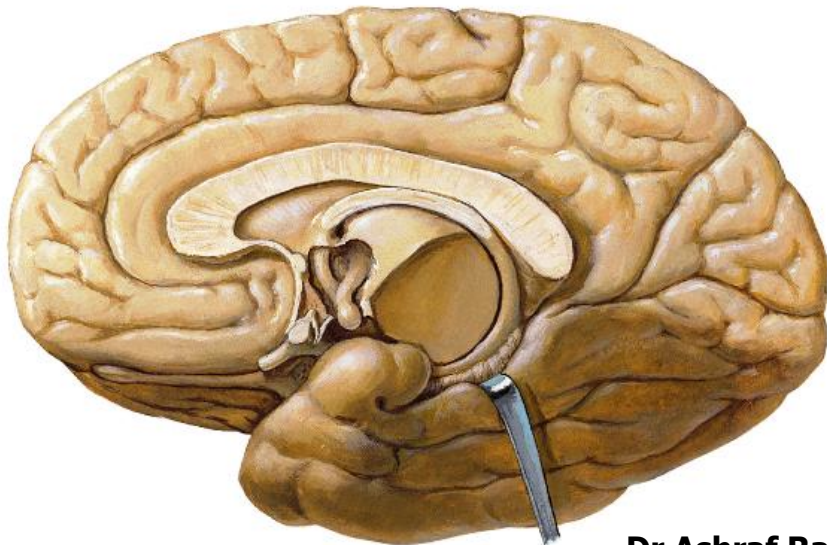
**** The insula (Island of Reil):**

- * An area of cortex hidden at the bottom of the lateral sulcus & can be seen when its lips are separated.
- * **Functions:** 1. Ant. part: taste, smell & autonomic areas.
2. Post part: 2nd somatosensory area (SII).

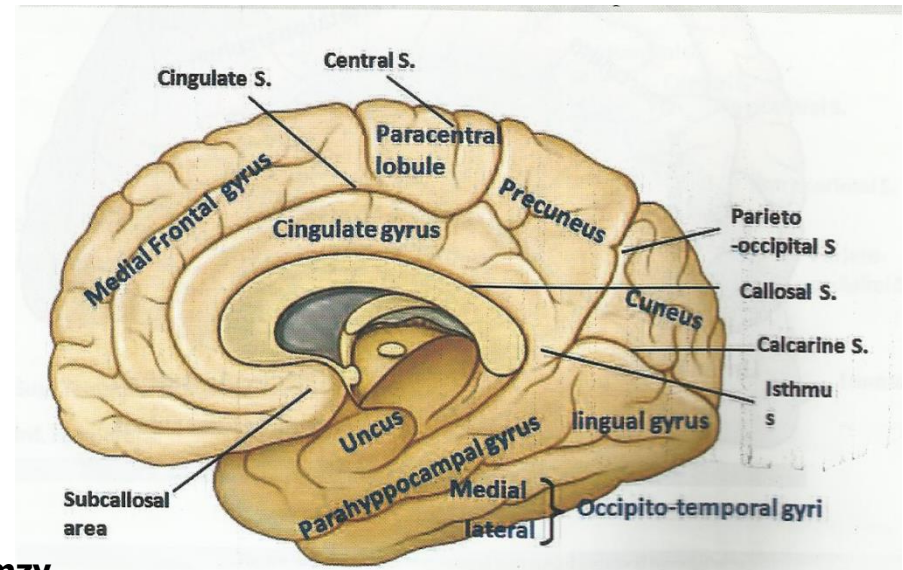


SULCI & GYRI ON MEDIAL SURFACE

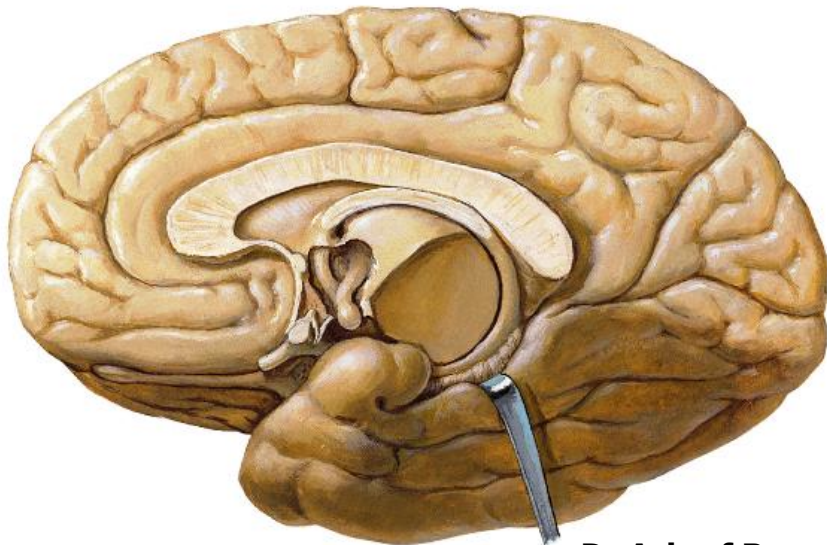
- ** **The corpus callosum** (the largest commissure of the brain) appears as an arch formed of 4 parts: rostrum, genu, body & splenium from before backwards.
- ** Above the corpus callosum: there are 2 sulci & 3 gyri:
- ** **The cingulate gyrus** forms an arch above the corpus callosum, separated from 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.



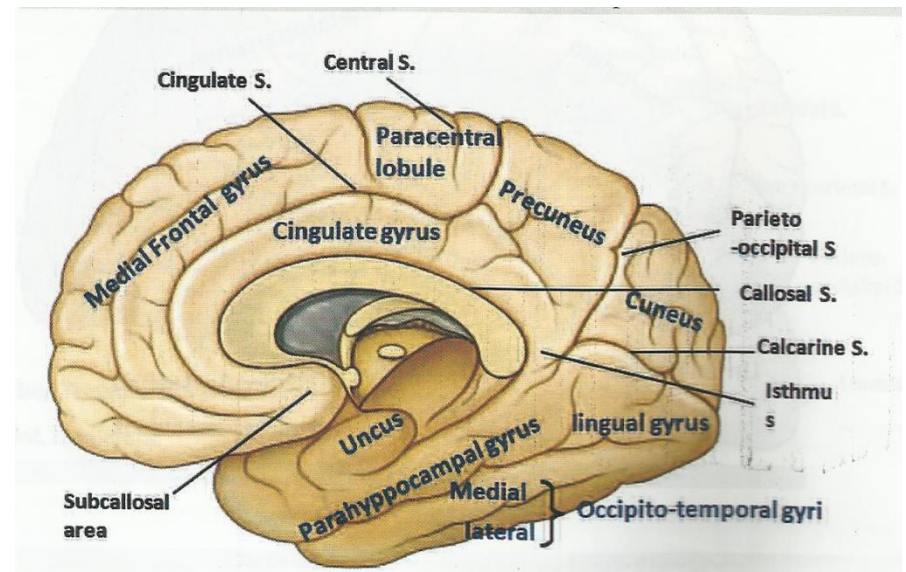
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- ** The Medial frontal gyrus** lies above the stem of the cingulate sulcus
- ** The Paracentral lobule** lies between the branches of the cingulate sulcus. It contains the beginning of central sulcus between extensions of the precentral- & postcentral gyri.
- ** Behind the corpus callosum:** there are 2 sulci & 3 gyri:
- * Sulci:**
 - 1. Parieto-occipital sulcus:** runs upwards & cuts the superomedial border 2 inches in front of the occipital pole to reach the superolateral surface.
 - 2. Calcarine sulcus:** inverted V divided opposite its junction with the parieto-occipital sulcus into precalcarine & postcalcarine parts. The latter cuts the occipital pole to appear on the superolateral surface.



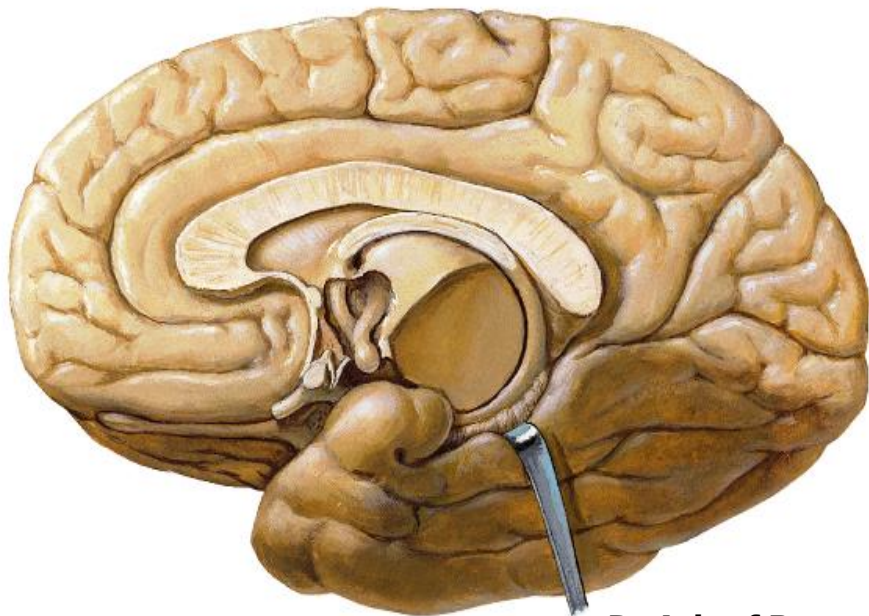
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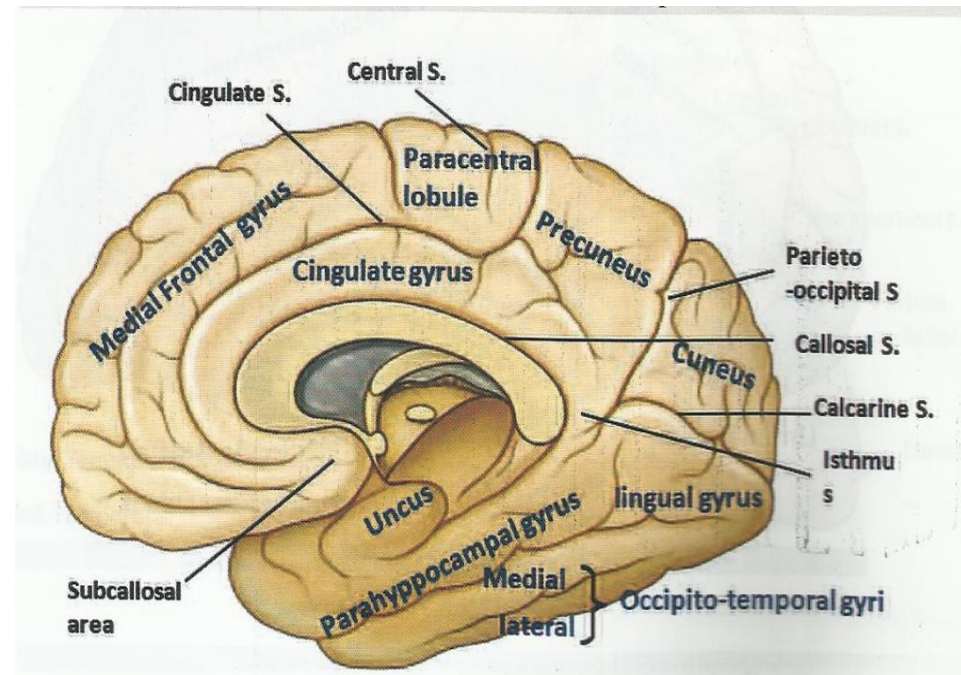
**** Gyri:**

1. Cuneus: wedged between the parieto-occipital & postcalcarine sulci.
2. Precuneus: in front of the parieto-occipital S. & above the precalcarine S.
3. Lingual gyrus: below the calcarine sulcus.

**** N.B.:** The occipital lobe includes the cuneus & lingual gyri while parietal lobe includes the precuneus and the part of the paracentral lobule posterior to the central sulcus.

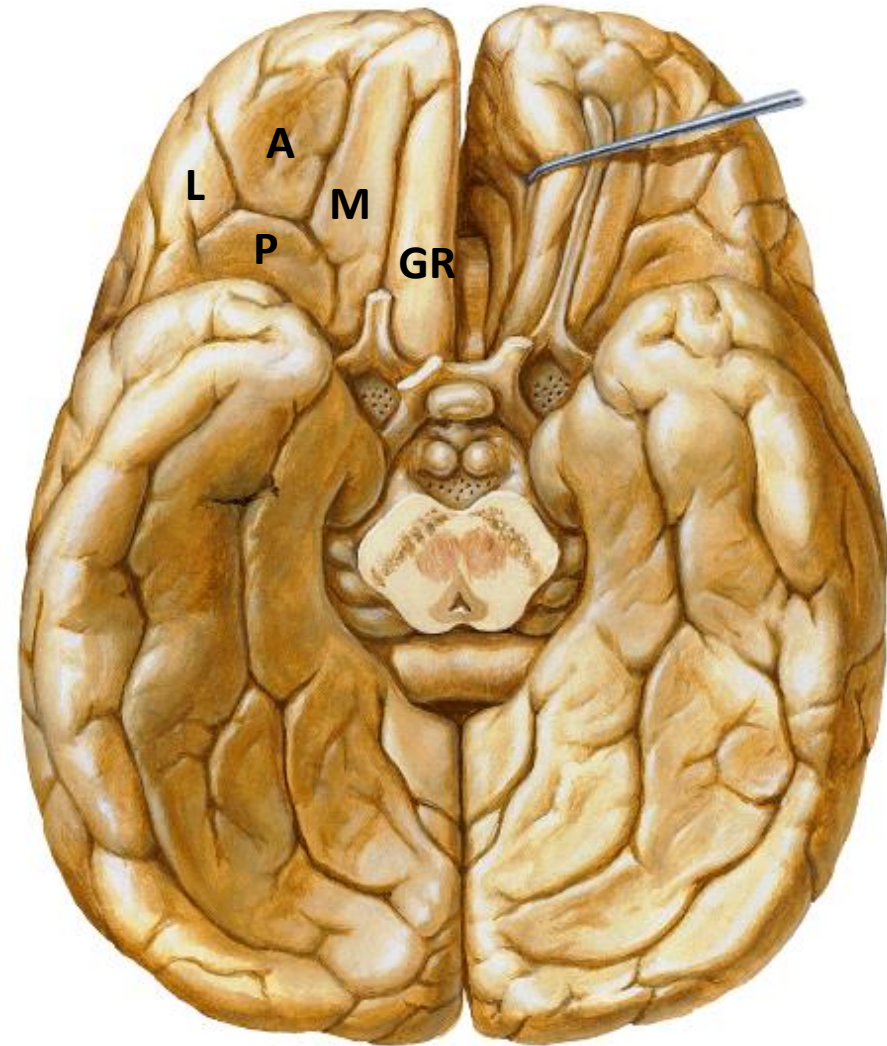


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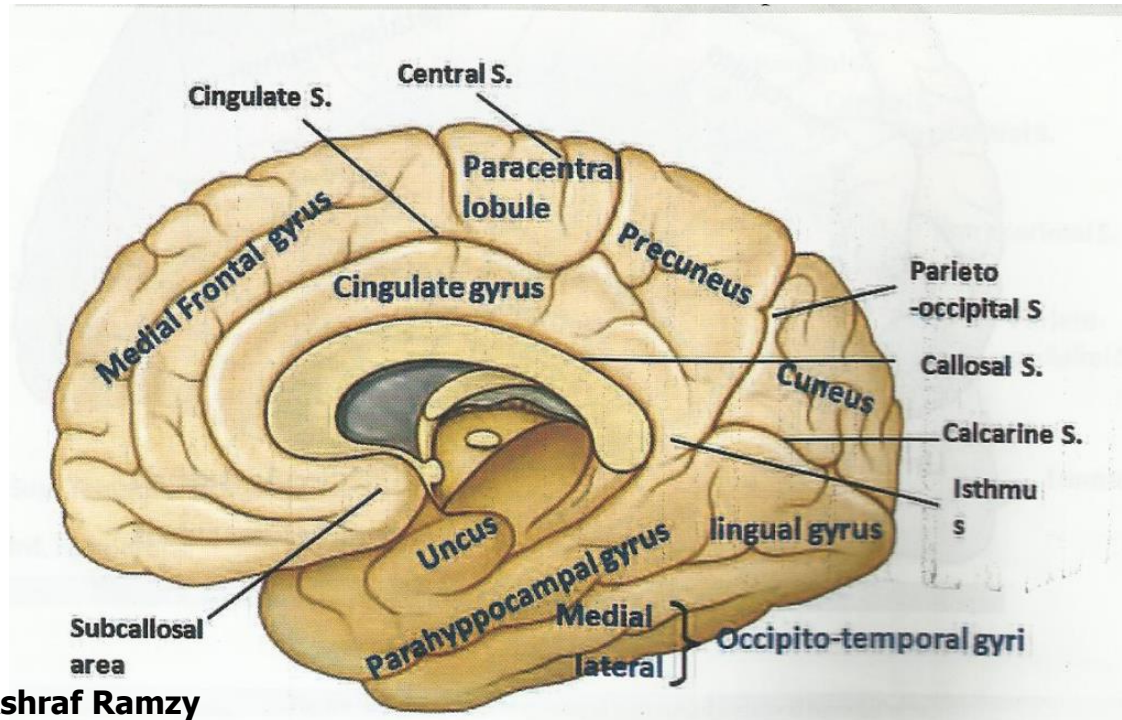
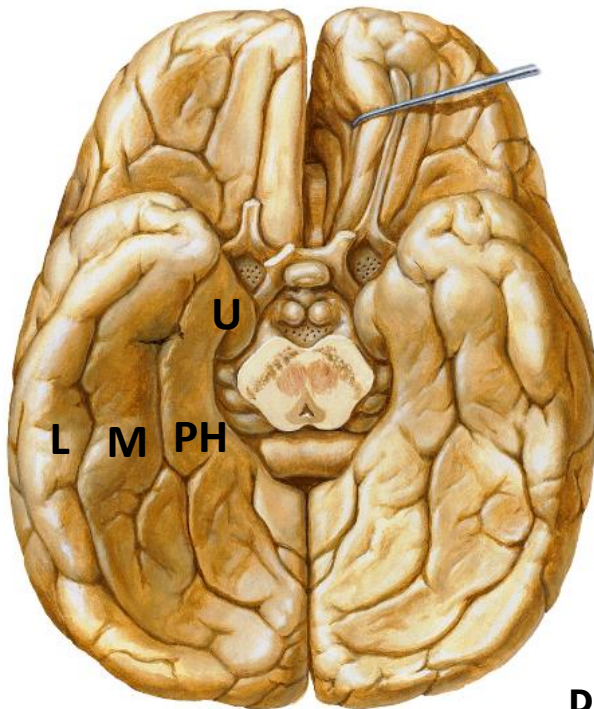
SULCI & GYRI ON INFERIOR SURFACE

- ** Orbital part: shows:**
- * The olfactory sulcus lodges the olfactory bulb and tract.**
- * Medial to it is the gyrus rectus.**
- * Lateral to it: H-shaped orbital sulci are seen between four orbital gyri; anterior (A), posterior (P), medial (M) & lateral(L) orbital gyri.**



**** Tentorial part: shows:**

- * 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 med. (M) & lat. (L) occipito-temporal gyri.
- ** N.B.: The limbic lobe: includes the parahippocampal gyrus, the isthmus, the cingulate gyrus & the paraolfactory area.**



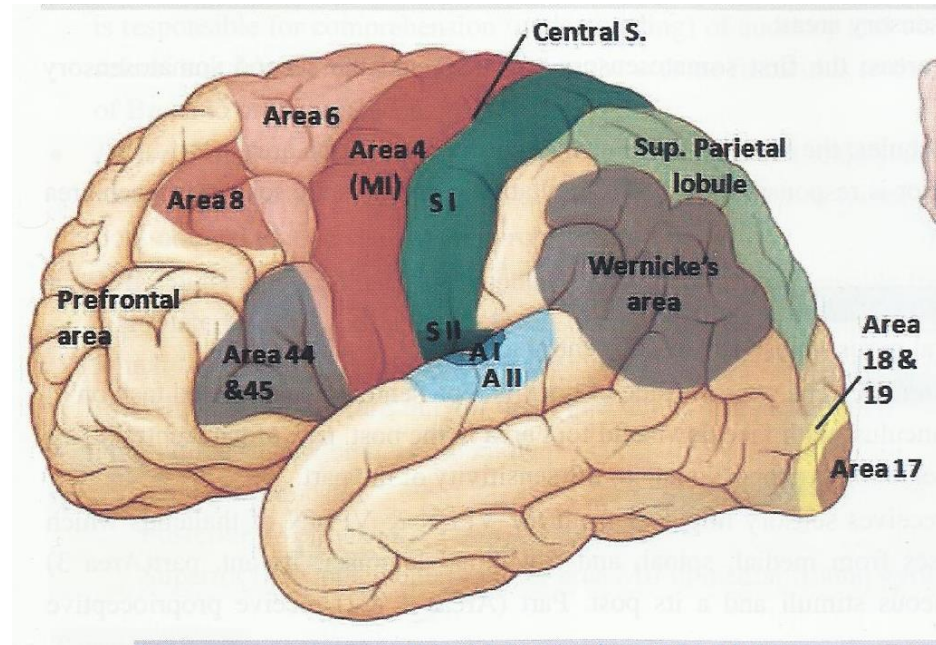
FUNCTIONAL CORTICAL AREAS

A. Frontal Lobe

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

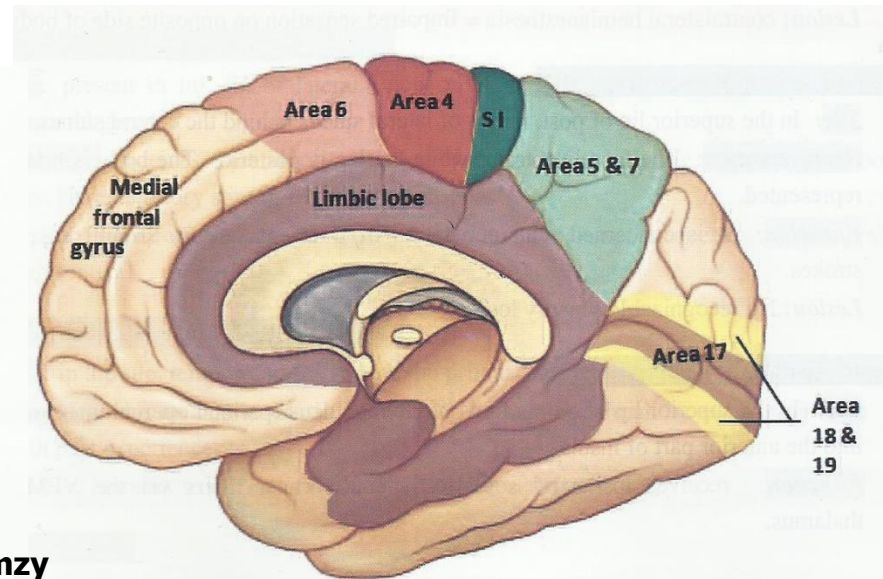
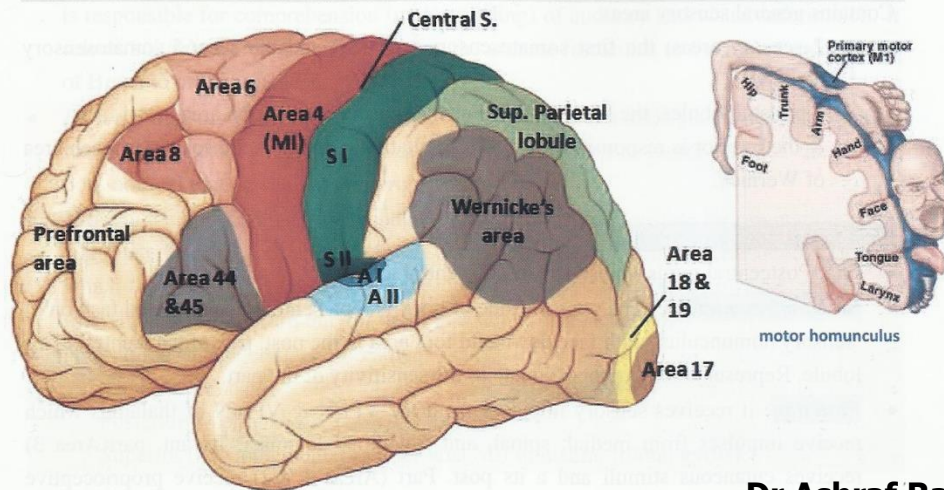
I. Precentral area: includes:

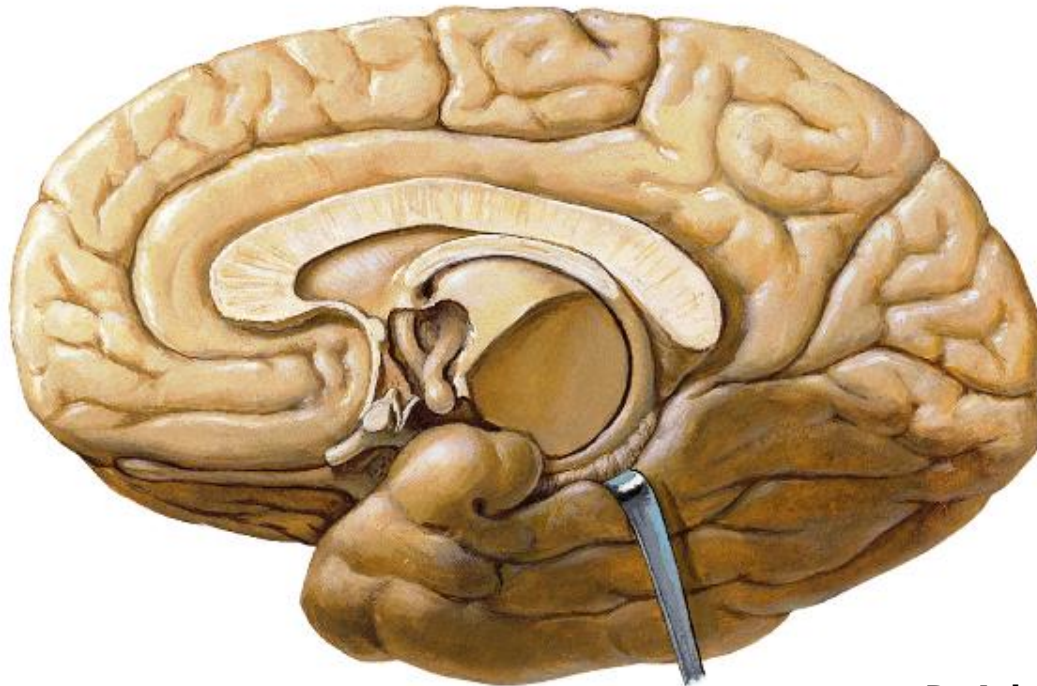
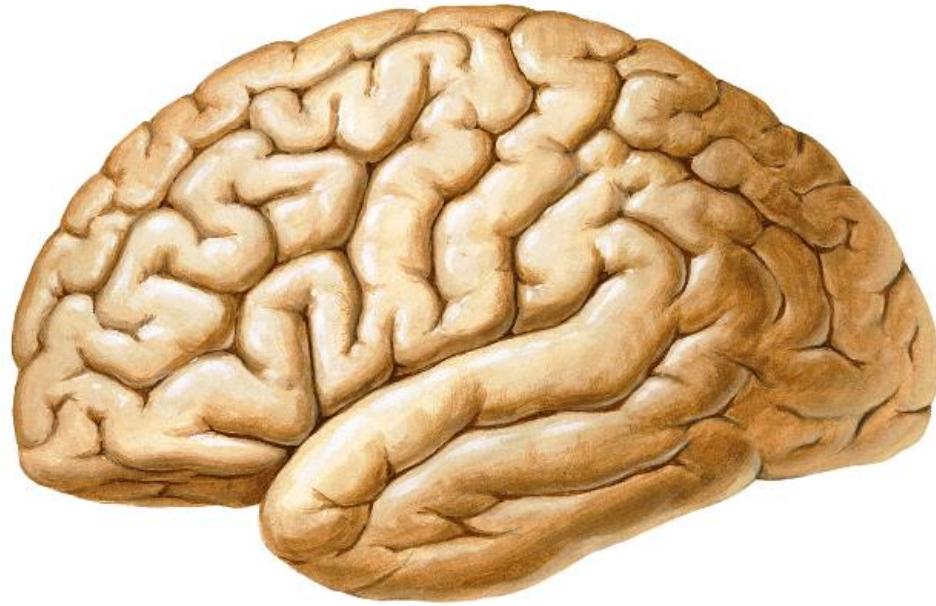
- 1. Primary motor area (Area 4)**
- 2. Premotor area (Area 6)**
- 3. Frontal eye field (Area 8)**
- 4. Broca's area (Areas 44 & 45)**



**** Primary motor area MI (Area 4):**

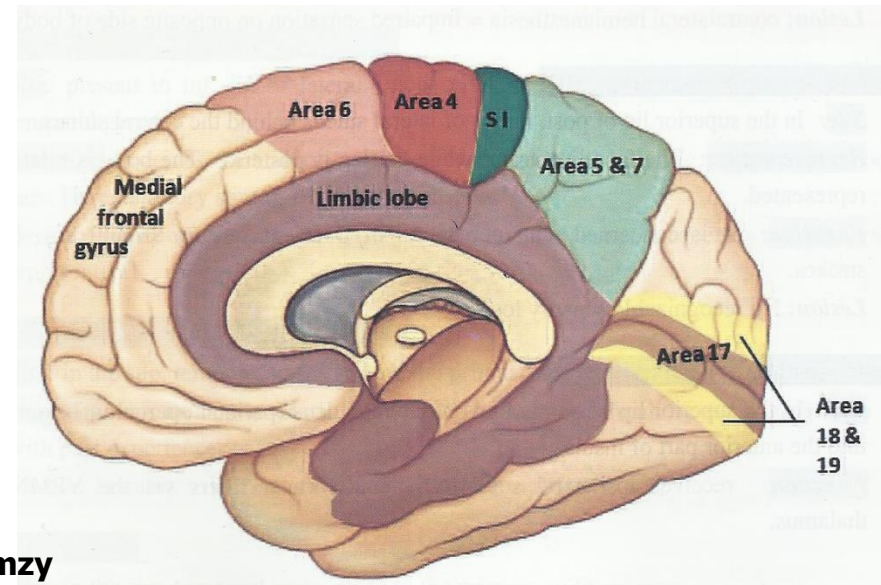
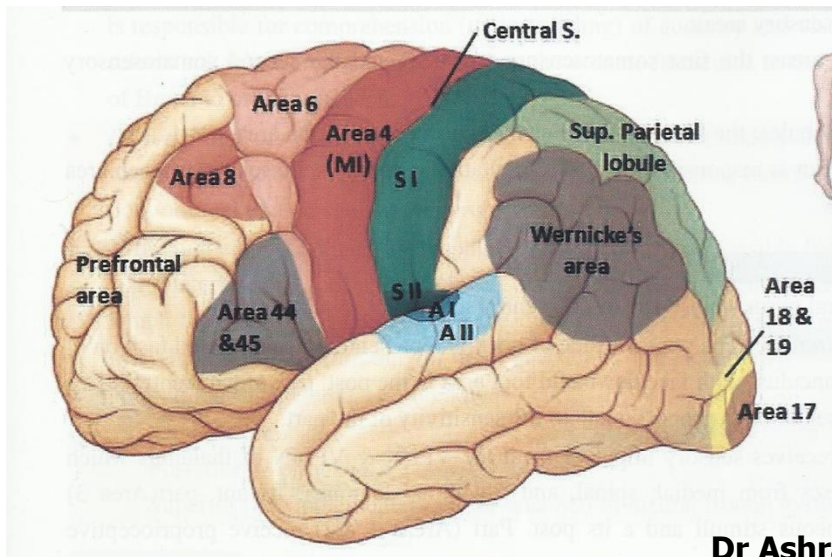
- * Site:** precentral gyrus and ant. part of paracentral lobule.
- * Body representation:** it contains a map of the contralateral ½ of the body represented upside down (motor homunculus) i.e., the face is lower down & the leg and foot in the paracentral lobule.
- * Representation is proportionate to skill;** i.e., parts with fine skilled movements (e.g. hands) occupy larger areas.
- * Function:** Initiates discrete voluntary movements (which were planned in area 6).
- * Lesion:** Contralateral hemiplegia especially skilled, fine movements.





**** Premotor area (Area 6):**

- ** Site:** in front of area 4 (in sup, mid, & inf. frontal gyri). It extends also on medial surface of cerebral hemisphere.
- ** Function:** Plans the movement and stores the plan. It adjusts the posture to start the movement. It inhibits muscle tone and grasp reflex.
- ** Lesion:** Awkwardness of movements “apraxia”, spasticity of muscles & reappearance of grasp reflex.



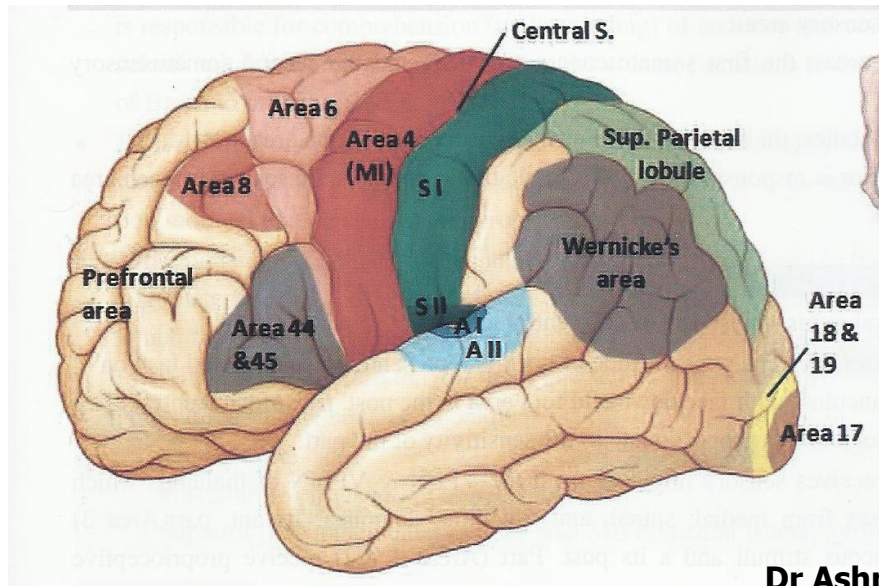
**** Frontal Eye Field I (Area 8):**

**** Site:** In front of area 6 (in superior & middle frontal gyri).

**** Function:** It is part of frontal eye field responsible for voluntary conjugate eye movements. Its stimulation leads to contralateral deviation of both eyes.

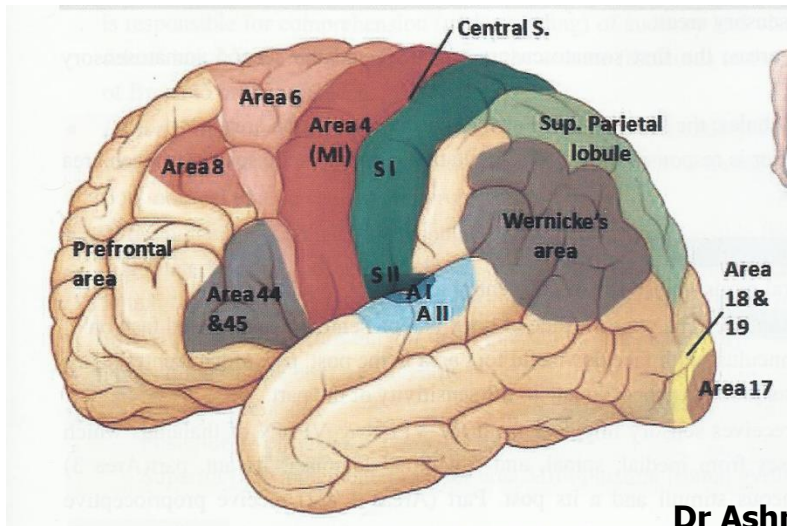
**** Lesion:**

- 1. Ipsilateral deviation of both eyes (towards side of lesion).**
- 2. Inability to turn eyes to opposite side. Note: (Reflex conjugate eye movement is not affected because it is controlled by occipital eye field).**



**** Broca's Area (Areas 44 & 45):**

- ** Site:** in the pars triangularis (area 45) and the pars opercularis (area 44) of the inferior frontal gyrus. It is present only in Dominant Hemisphere (usually the left hemisphere)
- ** Function:** contains the motor speech area (Anterior Speech Area). It receives data from the sensory speech “Wernicke’s” area. It programs a sequence of muscle contractions necessary to produce intelligible words & project these orders to the nearby area 4.
- ** Lesion:** Expressive (motor) Aphasia; in which the patient cannot pronounce the word easily, but selects proper words.

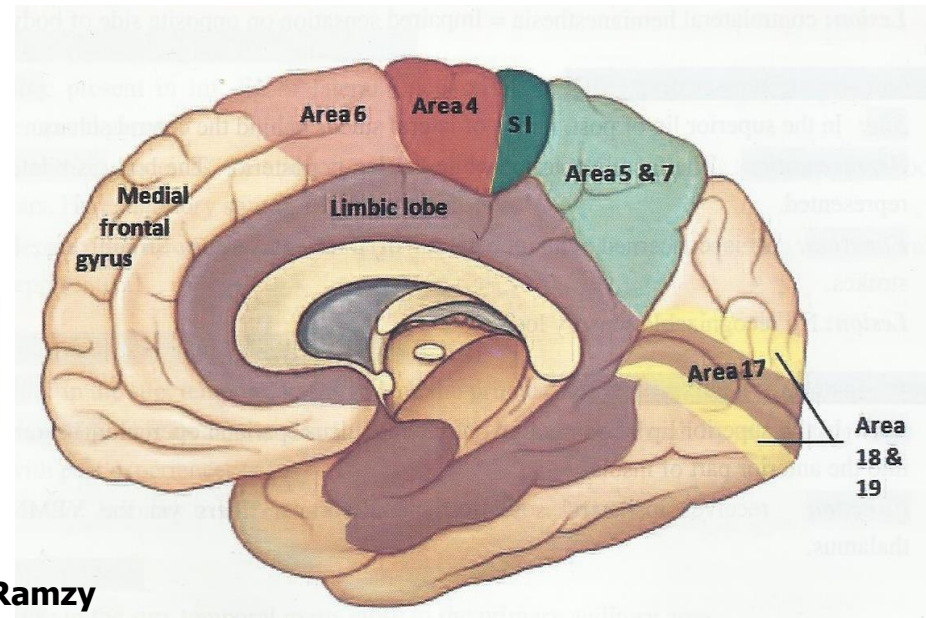
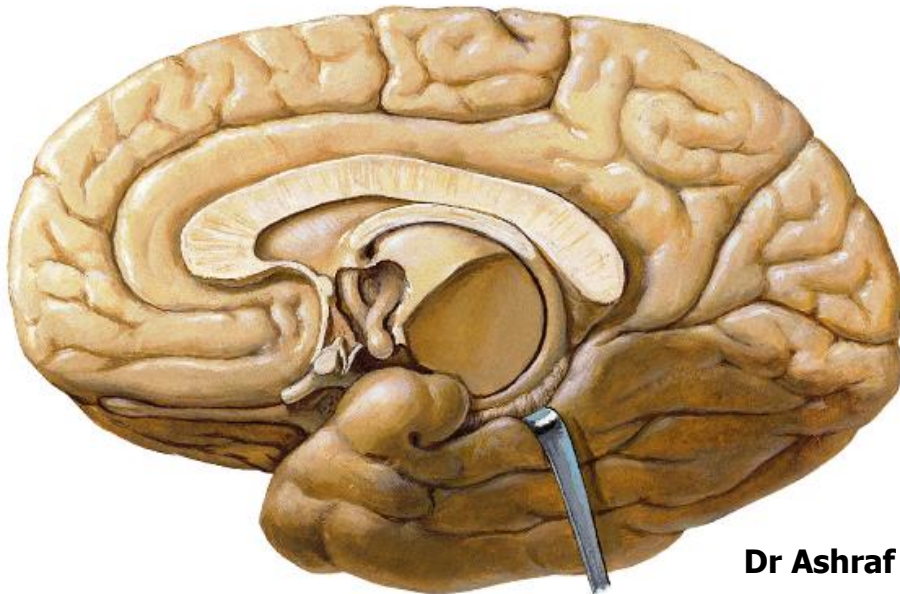


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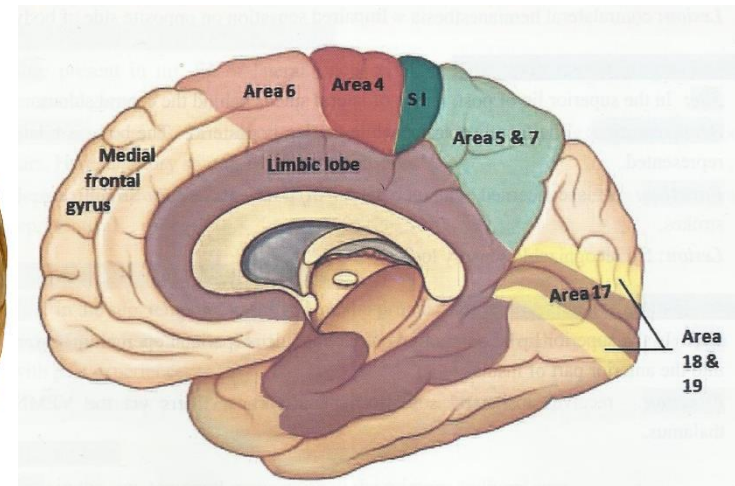
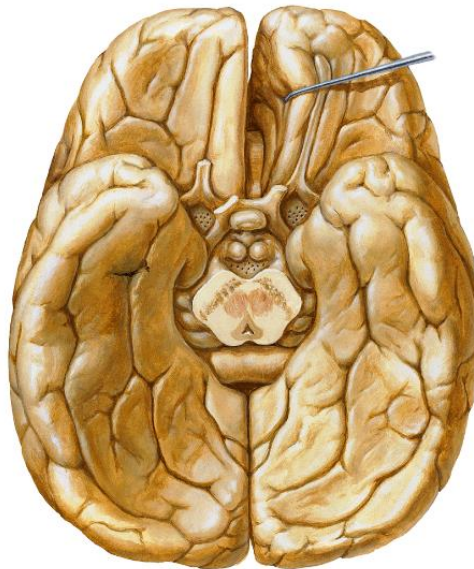
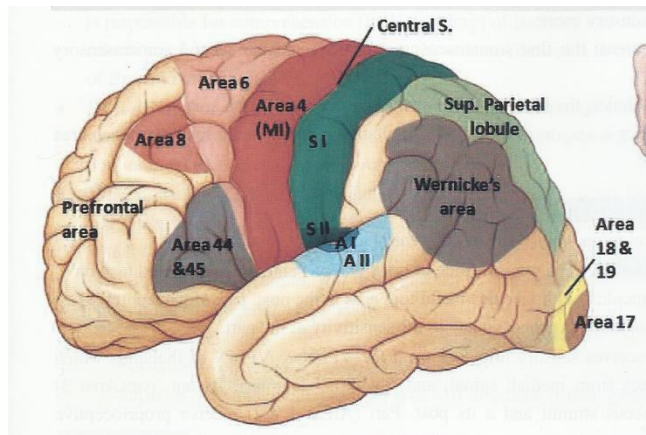
**** N.B.: Supplementary motor area (MII):**

- ** Site:** on the medial surface of hemisphere within the medial frontal gyrus.
- ** Body representation:** bilateral (its stimulation evokes movements in both contralateral and ipsilateral limbs). The head is anterior & the leg is posterior.
- ** Functions:** It stores programmed motor sequences for stereotyped movements. It also contains a superior speech center.
- ** Lesion:** leads to akinetic mutism (temporary inability to move & aphasia).



II. Prefrontal Area:

- ** Site: 1. Remainder of sup., middle, and inf. frontal gyri.**
 - 2. Orbital gyri.**
 - 3. Most of medial frontal gyrus.**
- ** Function: It has a role in intelligence, normal expression of emotion, ability to predict consequences of an action, so it affects behavior and personality.**
- ** Lesion: Changes in behavior, personality and mood.**



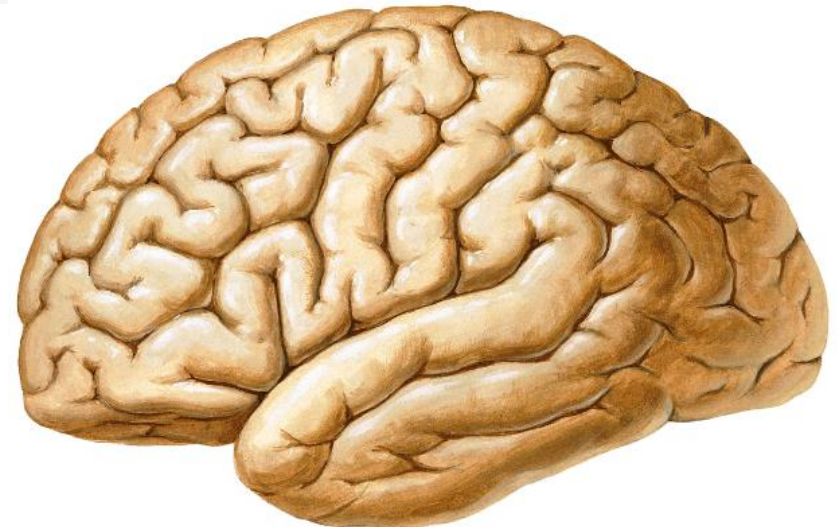
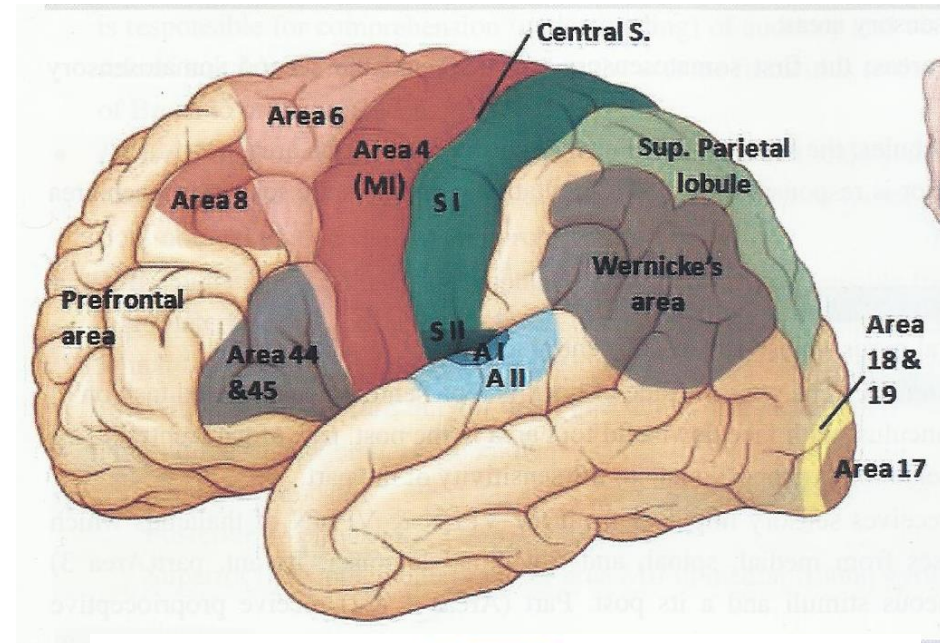
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B. Parietal Lobe

**** Contains general sensory areas:**

A. 2 sensory areas: the first somatosensory area (SI) and the second somatosensory area (SII).

B. 2 parietal lobules: the superior contains the sensory association area & the inferior is responsible for body orientation + contains the sensory speech area of Wernick.



**** First Somatosensory area (SI):**

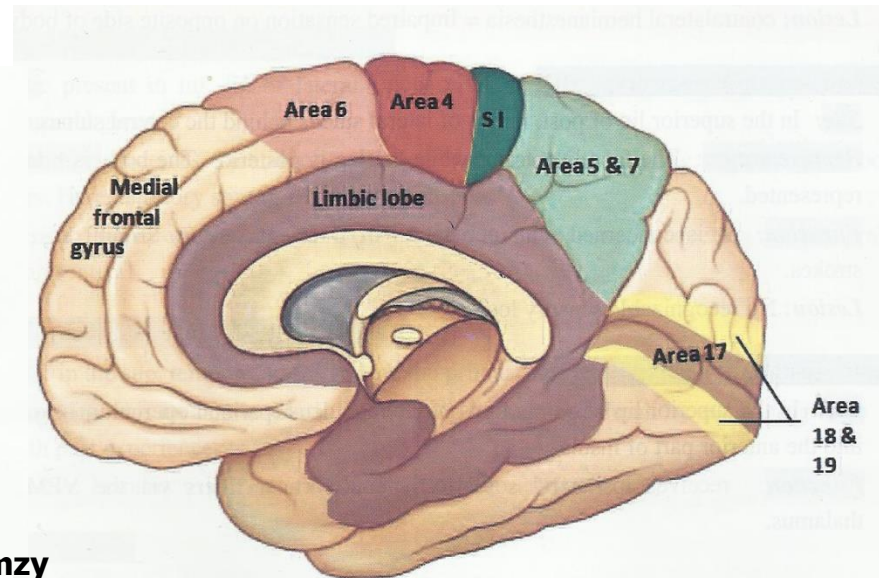
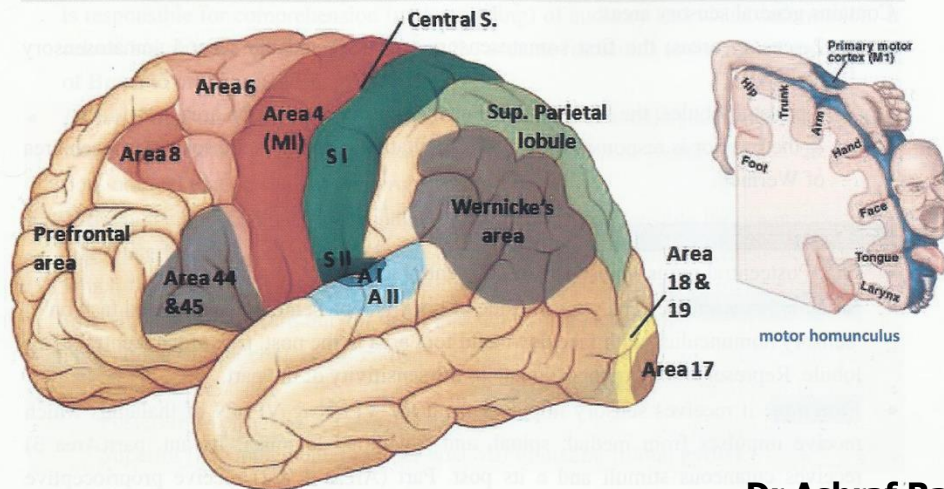
**** Site: Postcentral gyrus + post part of paracentral lobule.**

**** Body representation: The opposite side of body is represented in an inverted fashion (sensory homunculus) with face down and foot area in the post. part of paracentral lobule.**

**** Representation is proportionate to the sensitivity of the part.**

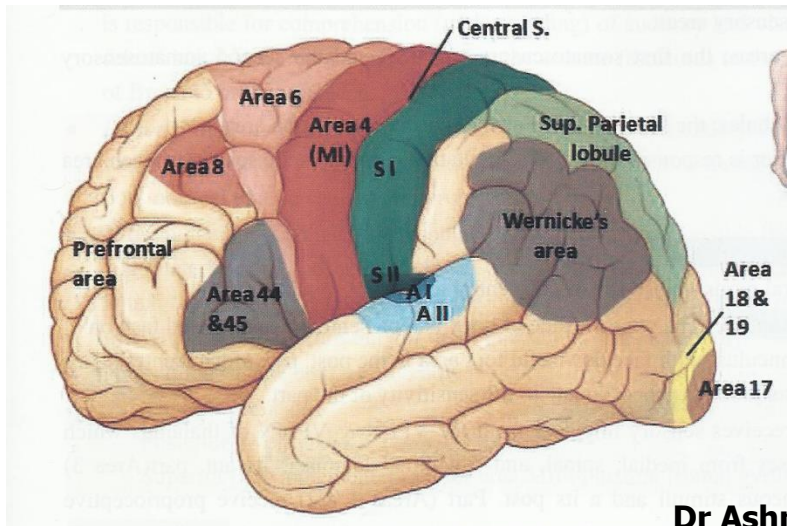
**** Function: it receives sensory impulses from the VPLN & VPMN of thalamus which receive impulses from medial, spinal, and trigeminal lemnisci. Its ant. Part (Area 3) receives cutaneous stimuli and a its post. part (Areas 1&2) receives proprioceptive stimuli.**

**** Lesion: contralateral hemianesthesia = Impaired sensation on opposite side of body.**



**** Second somatosensory area (SII):**

- * Site:** In the superior lip of post. ramus of lateral sulcus behind the central sulcus.
- * Representation:** The face is anterior while the leg is posterior. The body is bilaterally represented.
- * Function:** It is concerned with perception of transient sensory stimuli.
- * Lesion:** No recognizable sensory loss.

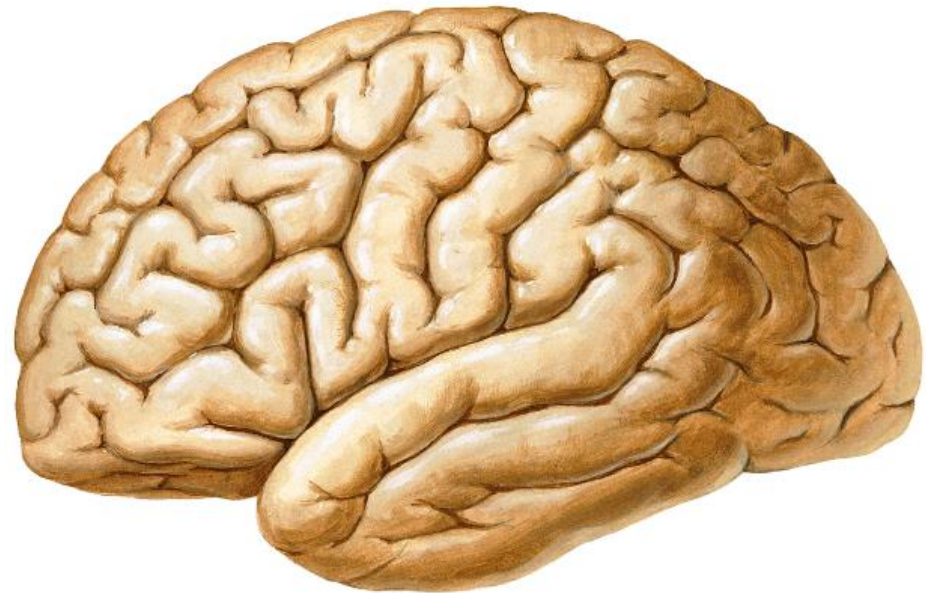
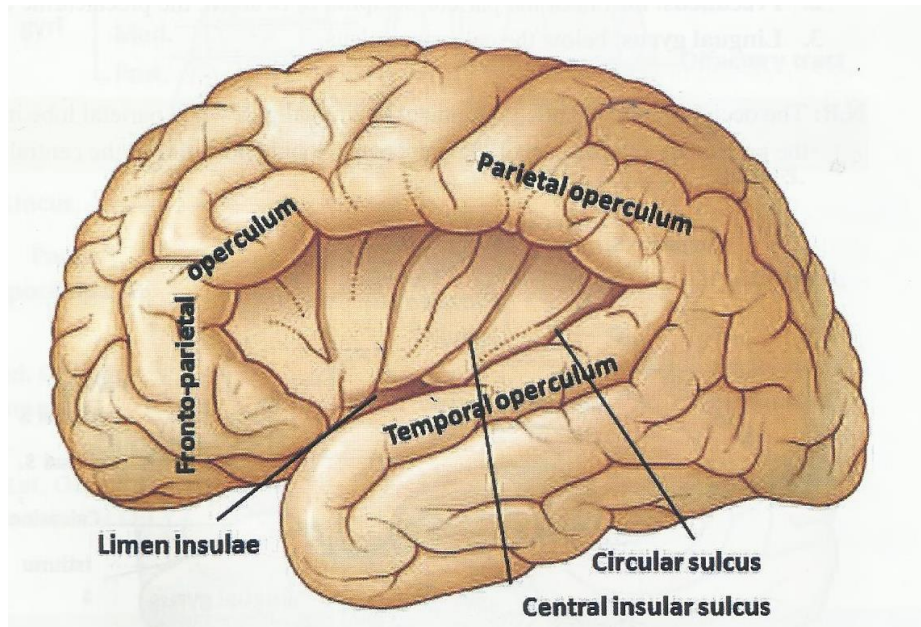


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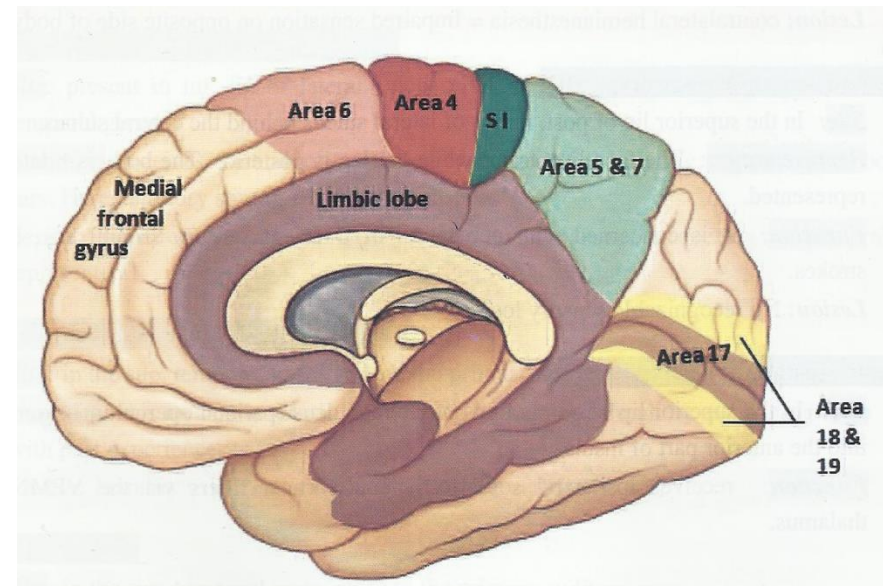
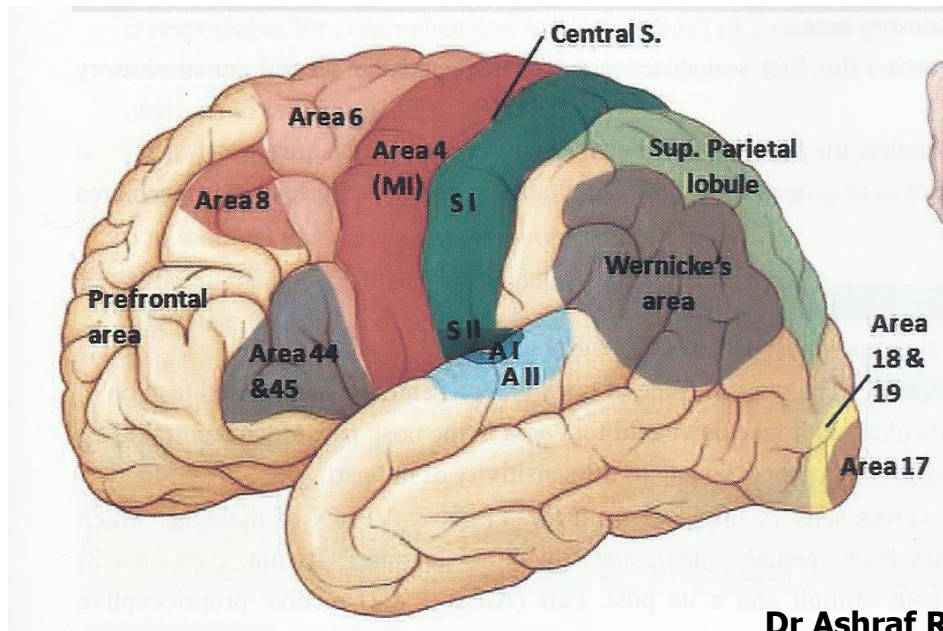
**** Taste (gustatory) area (Area 43):**

- * Site:** In the superior lip of post. ramus of lateral sulcus (parietal operculum) extending into the anterior part of insula.
- * Function:** receives ipsilateral solitario-thalamo-cortical fibers via the VPMN of thalamus.



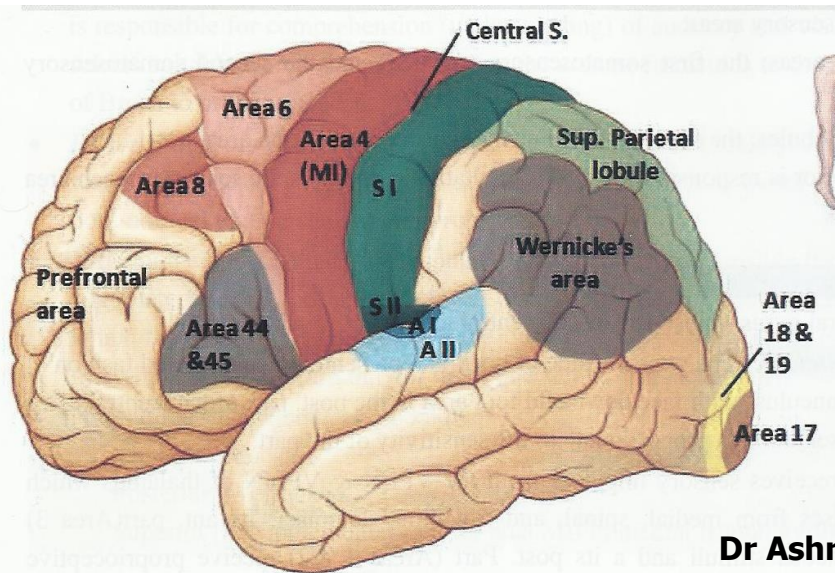
**** Superior Parietal Lobule & precuneus (Areas 5&7):**

- ** Function:** Receives impulses from SI, integrates the sensations & stores them as long-term memories of past experiences. It contains stereognosis center.
- ** Lesion:** astereognosis (inability to recognize familiar objects by touch).



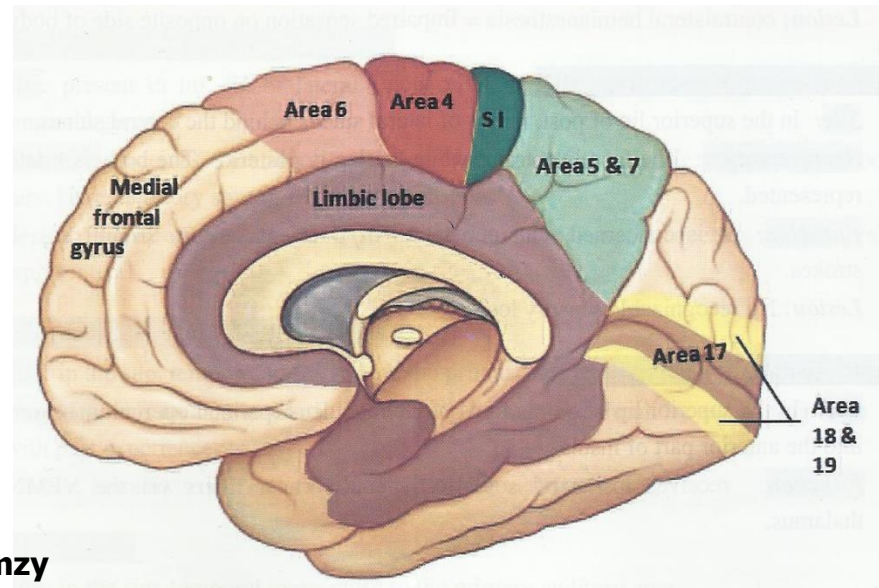
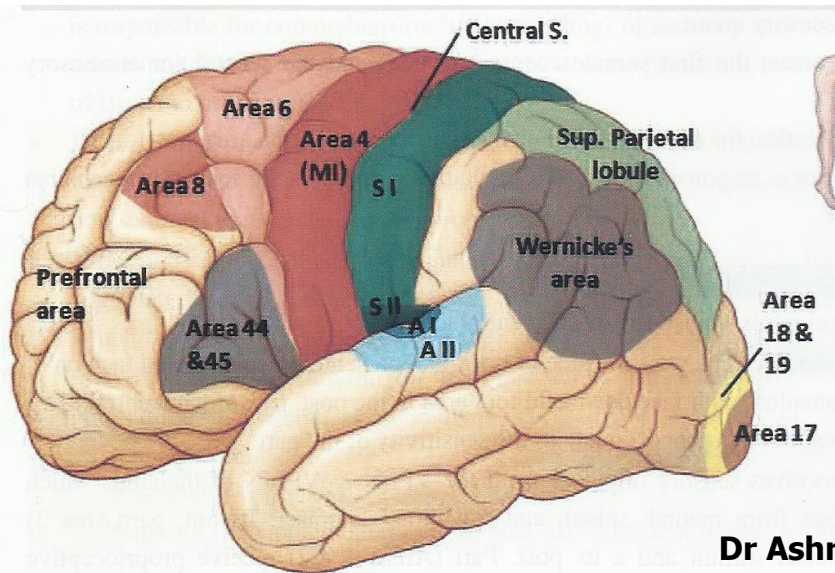
**** Inferior Parietal Lobule:**

- * **Site:** in supra marginal gyrus (Area 40) and angular gyrus (Area 39).
- * **Function:** They are parts of Wernicke's area (sensory speech area) which is present only in the dominant hemisphere. Wernicke's area includes also the posterior parts of sup. & middle temporal gyri, i.e. Wernicke's area lies in parietal and temporal lobes. It is responsible for comprehension (understanding) of auditory and visual information. It selects suitable words & sends them to the motor speech area of Broca to produce speech.
- * **Lesion: Sensory (Receptive) Aphasia.** The patient cannot understand spoken or written words, thus speaks wrong words but fluently; in contrast to motor aphasia, the patient does not feel that he has any problem.



**** N.B.: In the non-dominant hemisphere:** these areas are responsible for orientation of the contralateral ½ of the body in space. Its lesion leads to contralateral hemineglect in which the patient fails to recognize the opposite side of body as its own i.e. the person may shave half his beard only or dress one sleeve of a jacket only.

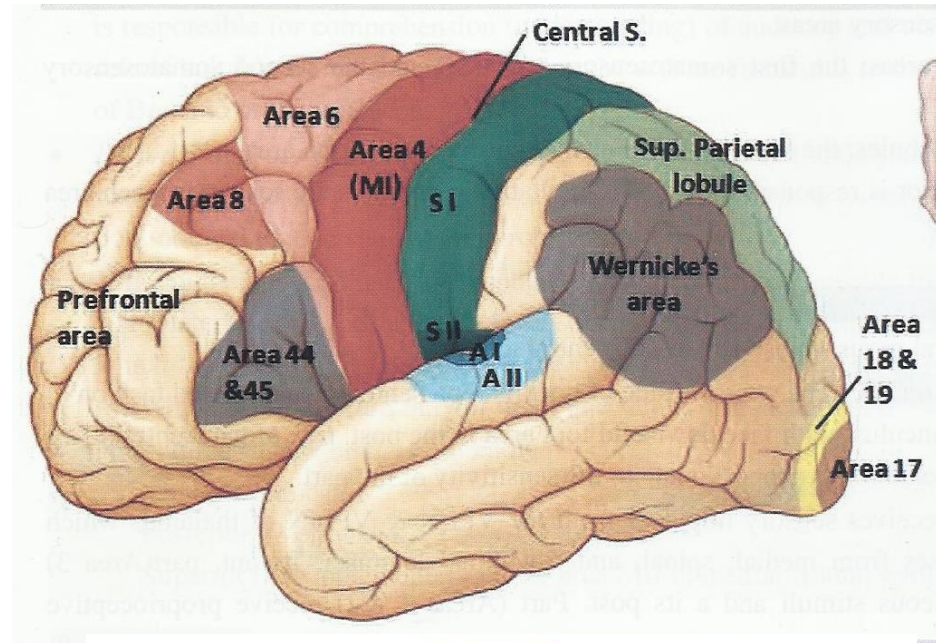
**** N.B.: Three speech centers are known:** 1. Anterior (Broca's), 2. Posterior (Wernicke's) & 3. Superior (in supplementary motor area MII in medial frontal gyrus).



C. Temporal Lobe

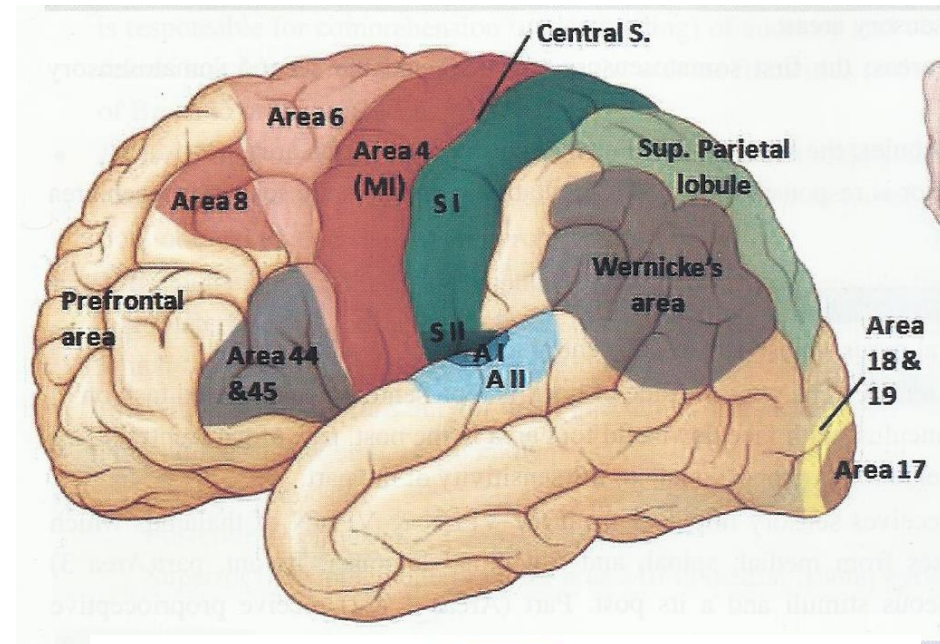
**** Primary Auditory area AI** **(Area 41, 42):**

- * **Site:** present in inf. lip of lateral sulcus (Heschl gyrus) + the adjacent part of sup. temporal gyrus.
- * **Function:** receives the auditory radiation from the MGB bringing impulses from both ears. Here, auditory stimuli reach consciousness.
- * **Lesion:** impaired hearing not loss of hearing because the cochlea is bilaterally represented.



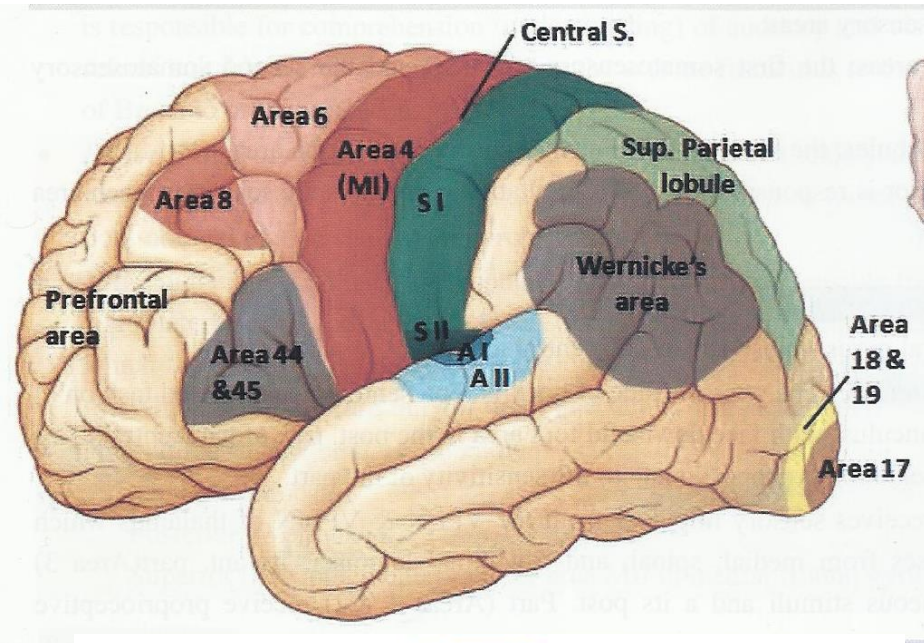
**** Secondary Auditory area** **All (Area 22):**

- * Site: in the sup. temporal gyrus around the primary auditory area.**
- * Function: this area understands the meaning of auditory stimuli by associating them with past experience.**
- * Lesion: Inability to understand sounds (auditory verbal agnosia).**



**** Vestibular area:**

- * **Site:** in the sup. temporal gyrus close to the primary auditory area.
- * **Function:** receives information about the head position & movements from the vestibular nuclei after relaying on the VPMN of thalamus.



**** Part of Wernicke's area.**

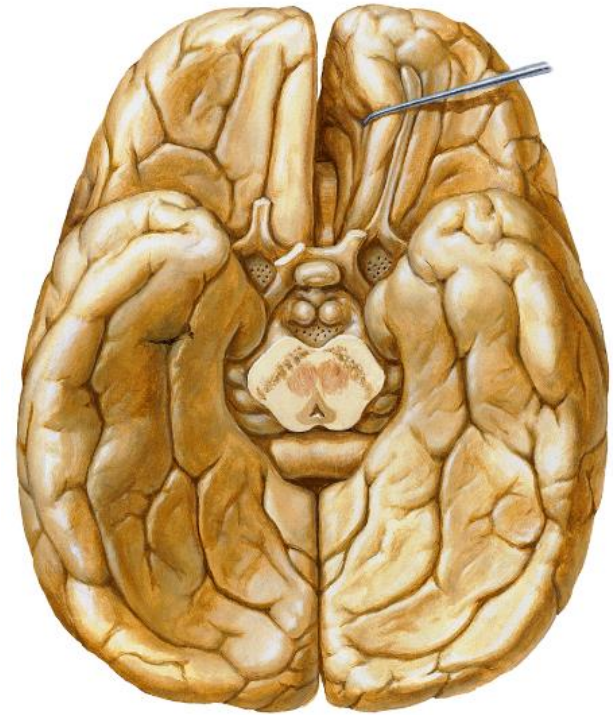
**** Facial Recognition Area :**

- * **Site:** on inferior surface of temporal and occipital lobes.
- * **Lesion:** Bilateral lesion: prosopagnosia = inability to recognize people by faces.

**** Olfactory areas (piriform cortex):**

1. **1ry olfactory area:** in 3 regions: uncus + part of amygdala + apex of insula.
2. **2ry olfactory area:** in para hippocampal gyrus which also contains center for memory and learning.

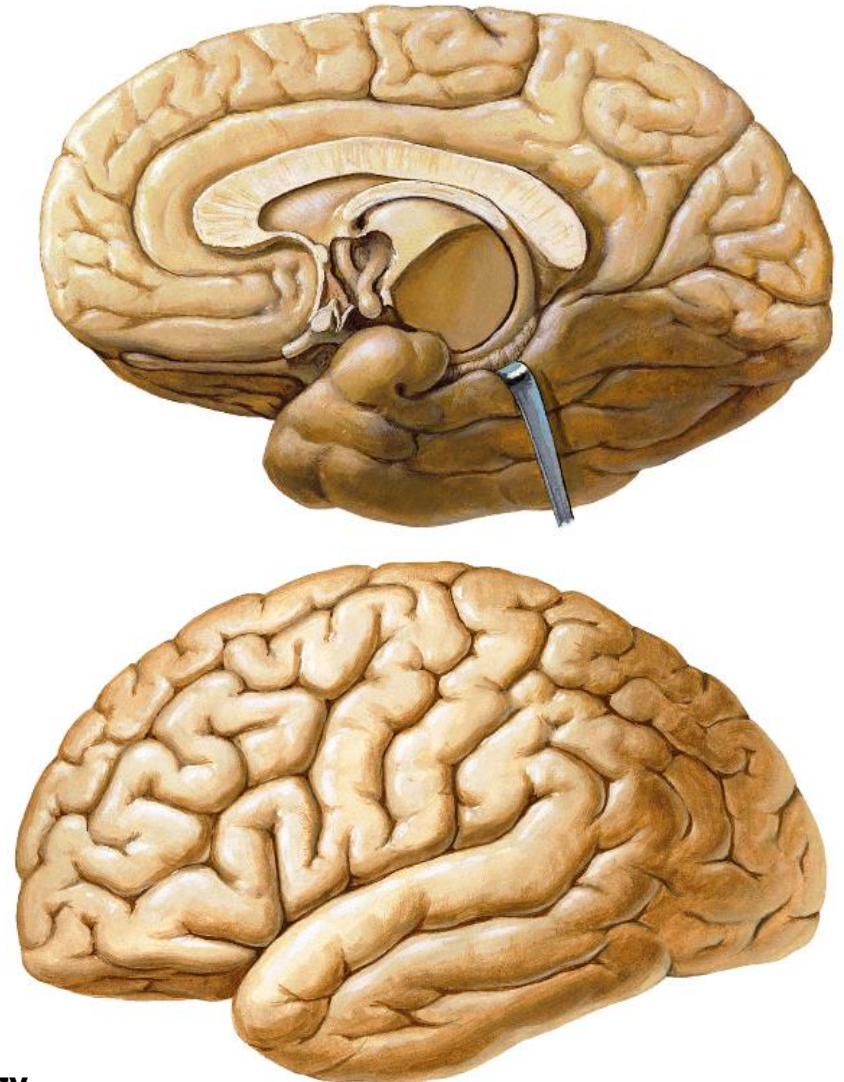
**** Visual association areas: in middle & inferior temporal gyri.**



D. Occipital Lobe

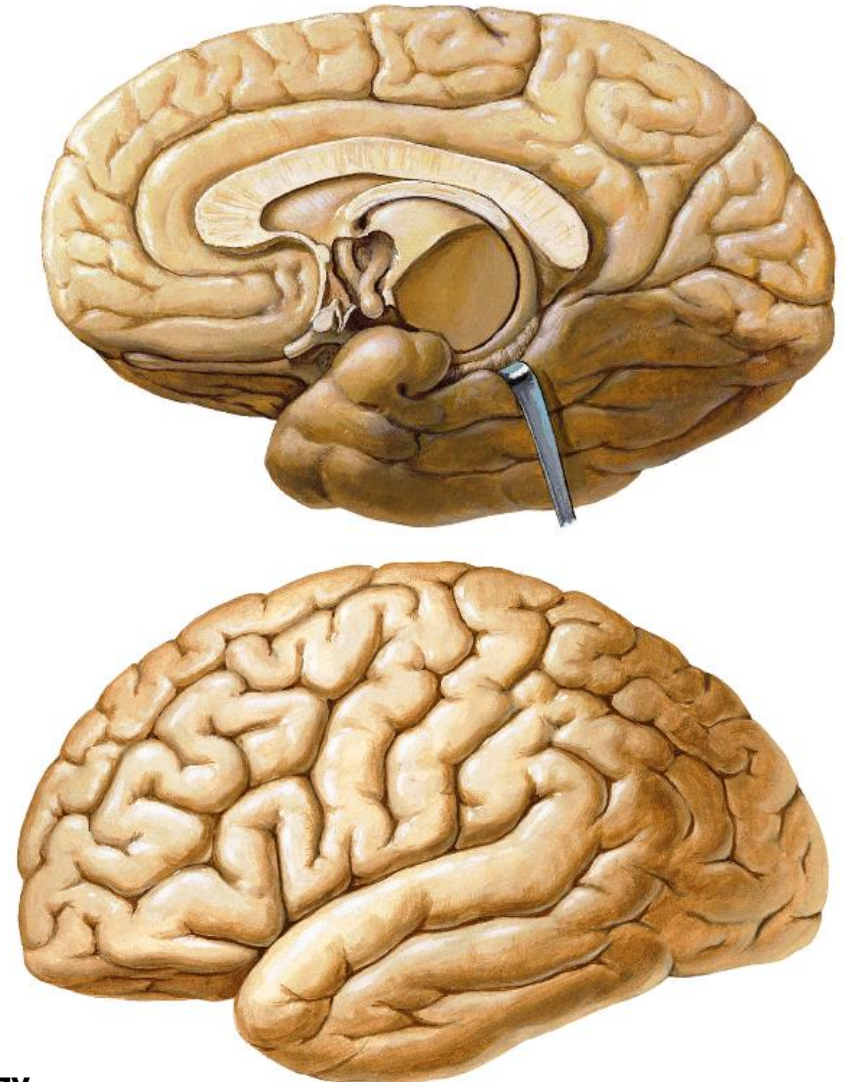
**** Primary Visual area (Area 17):**

- * Site:** extends below precalcarine sulcus and on both sides of post-calcarine sulcus. It extends on lateral surface of cerebral hemisphere only till lunate sulcus.
- * Function:** Receives Visual stimuli from lateral geniculate body (LGB).
- * Lesion:** homonymous hemianopia (loss of opposite field of vision).



**** Visual Association Areas (Areas 18 & 19):**

- * Site: lie around area 17.**
- * Function:**
 - 1. Store past visual experience to identify objects and help discriminate color.**
 - 2. Occipital eye field is present within areas 17&18. It controls involuntary (reflex) conjugate eye movement.**
- * Lesion: visual agnosia: the patient cannot understand the meaning of what is seen.**

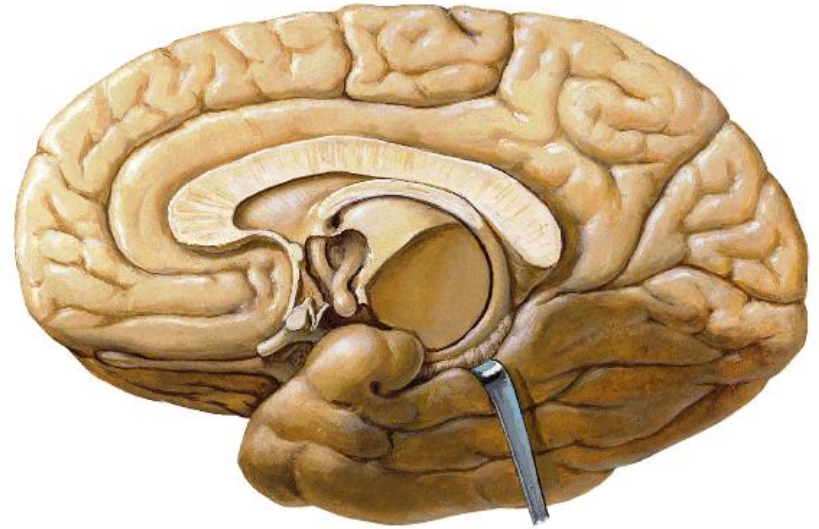


**** N.B.:**

- 1. Other visual association areas:** are present in temporal & parietal lobes.
- 2. The occipital lobe:** also contains a part of Facial recognition Area.

3. Cerebral Asymmetry:

- * The presence of Broca's area and Wernicke's area in one cerebral hemisphere only "the dominant hemisphere" proves the asymmetry of the two cerebral hemispheres.
- * The left hemisphere is usually the dominant hemisphere (80% of people) as it is concerned with speech.
- * The right hemisphere however is more involved in music and emotions. This dominance applies to right-handed people. However left-handed persons (10%) or mixed handedness (10%) may have the right or left hemisphere as dominant.
- * Asymmetry in shape of sulci, gyri or in area size may also occur.



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