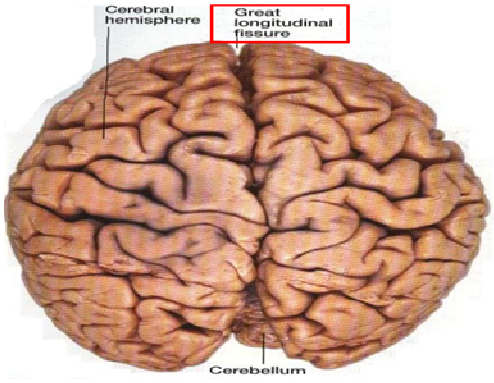
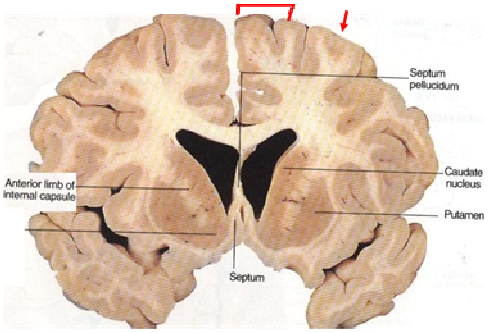
CEREBRUM I - FEATURES & FUNCTIONAL AREAS

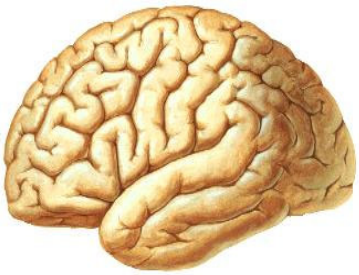
ANATOMY OF THE CEREBRUM :

- Cerebrum is the largest part of the forebrain & it reaches the greatest degree of development in the human.
- **Great longitudinal fissure** separates the cerebrum into two cerebral hemispheres & accommodates the falx cerebri.
- In the depth of the longitudinal fissure the hemispheres are united by the **corpus callosum**, an enormous sheet of commissural nerve fibres which run between corresponding areas of the two cortices.



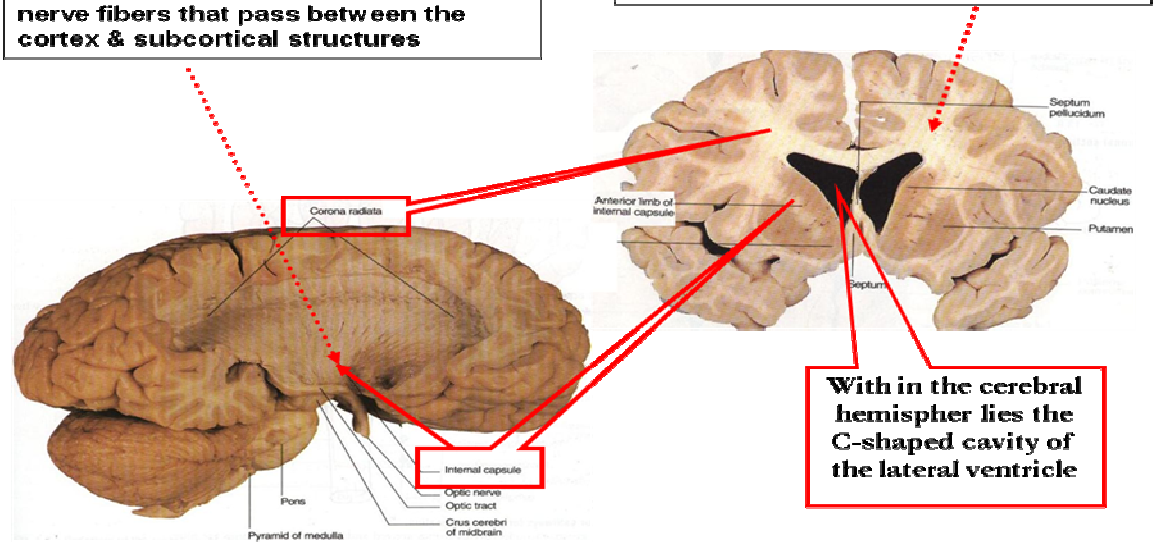
- Superficially the cerebral hemisphere consists of a layer of **gray matter** the cortex which is highly convoluted to form a complex pattern of ridges (**gyri**) and fissures (**sulci**).
- This serves to maximise the surface area of the cerebral cortex, about 70% of which is hidden within the depths of sulci.
- Beneath the surface axons running to & from the cells of the cortex form an extensive mass of **white matter**.





INTERNAL CAPSULE: Condensed nerve fibers that pass between the cortex & subcortical structures

Between the internal capsule & the cortex fibers radiate in & out to produce a fanlike *CORONA RADIATA*.



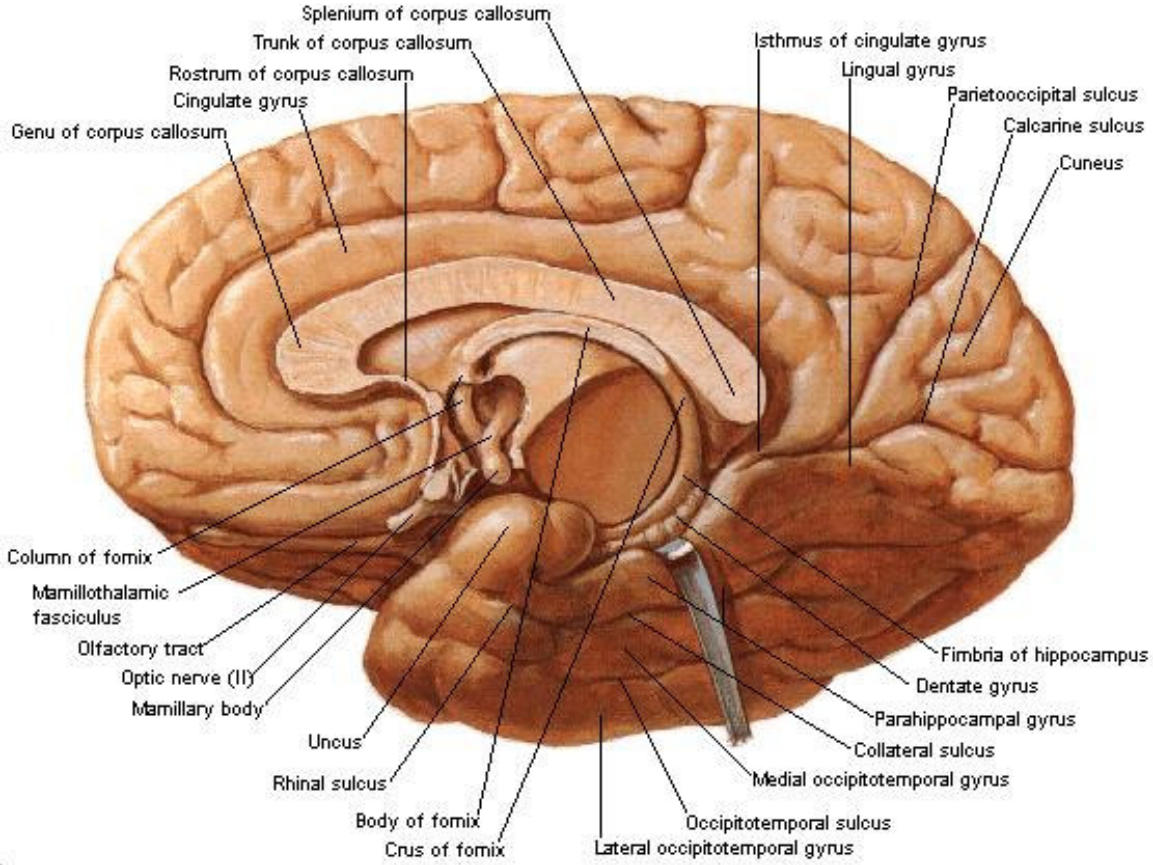
With in the cerebral hemispher lies the C-shaped cavity of the lateral ventricle

- Buried within the white matter lie a number of nuclear masses, most notably the caudate nucleus, putamen and globus pallidus, known collectively as the basal ganglia.

EXTRENAL FEATURES :

A) Surface : It consists of :

1. Superolateral Surface.
2. Medial Surface.
3. Inferior Surface having :
   - Orbital Surface.
   - Tentorial Surface.

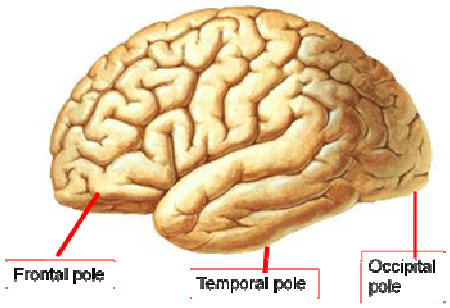


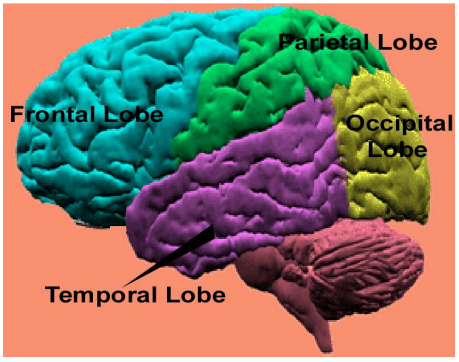
B) Poles :

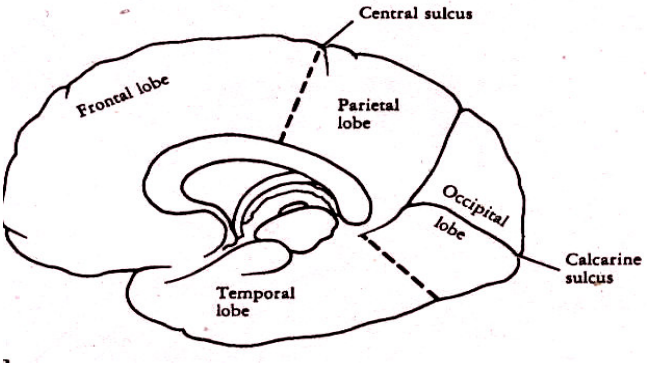
- Frontal
- Occipital
- Temporal.

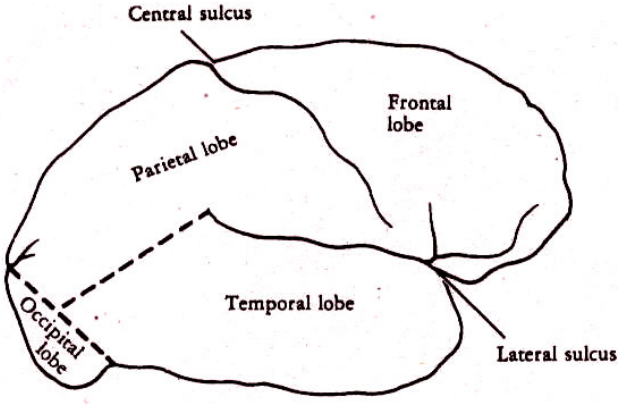
C) Lobes :

- Frontal
- Parietal
- Temporal
- Occipital.



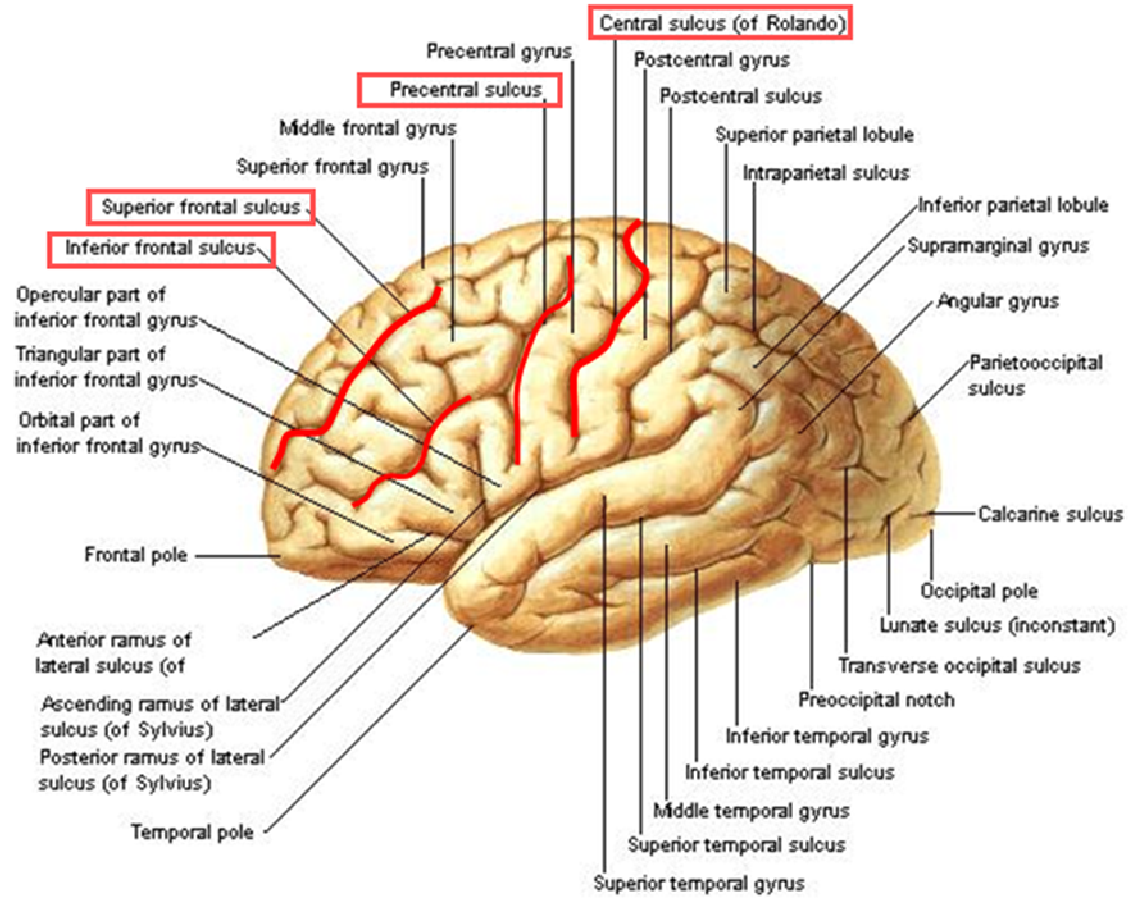




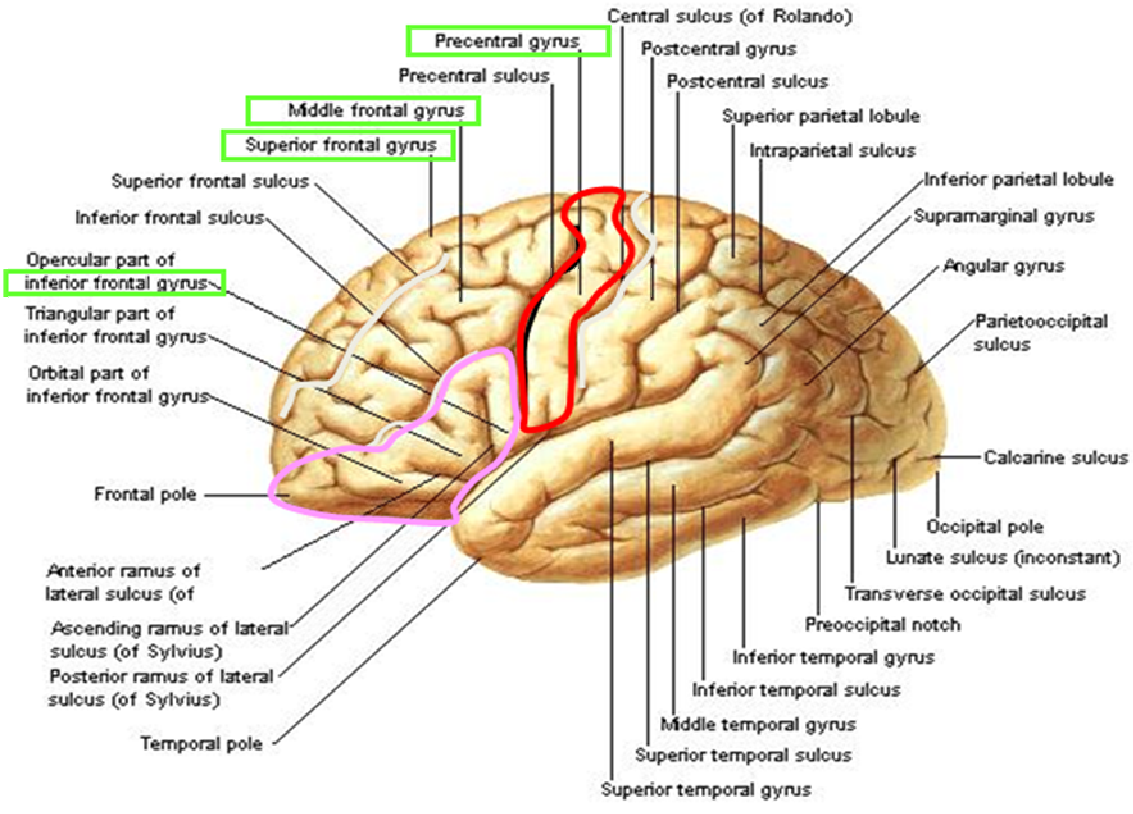


SULCI WITH THEIR SURFACES & LOBES :

- **Superior Surface** :
  - **A. Frontal lobe**
    - **Sulci** : Central + Precentral + Sup. Frontal + Inf. Frontal.

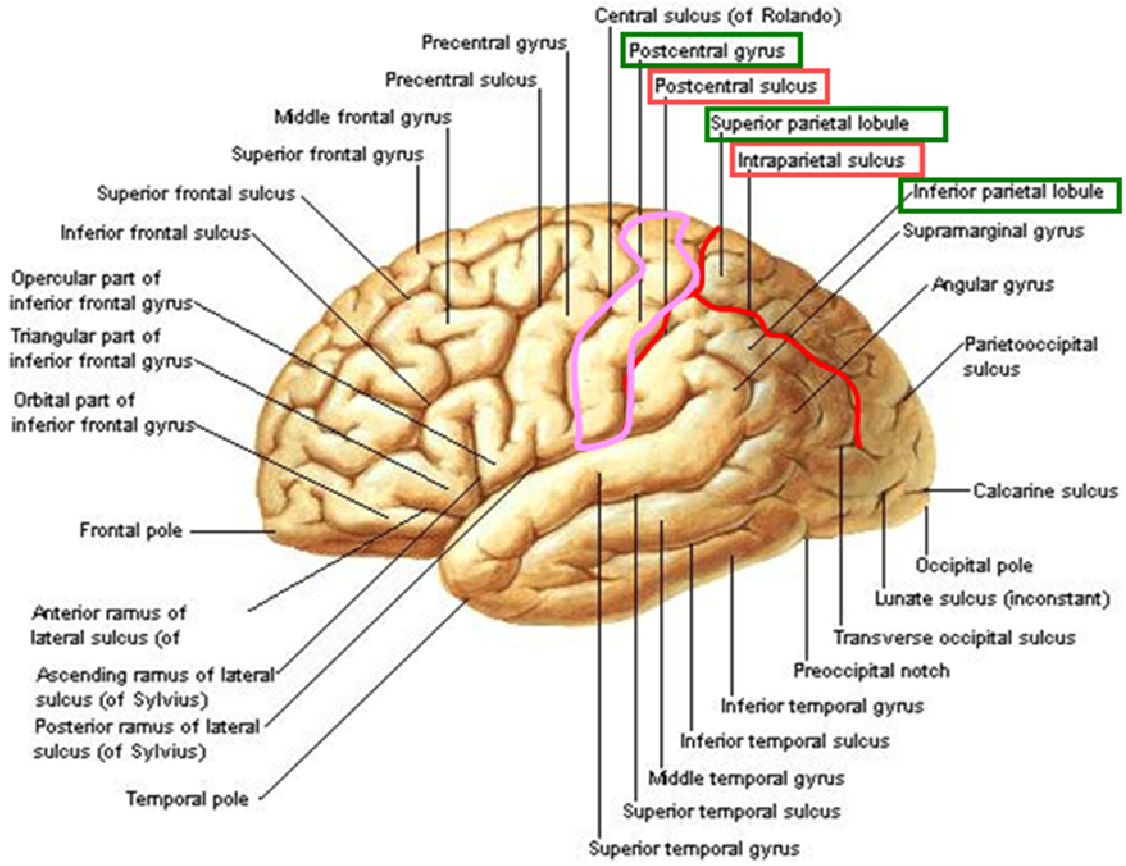


    - **Gyri** : Precentral + Middle Frontal + Sup. Frontal + Inf. Frontal.



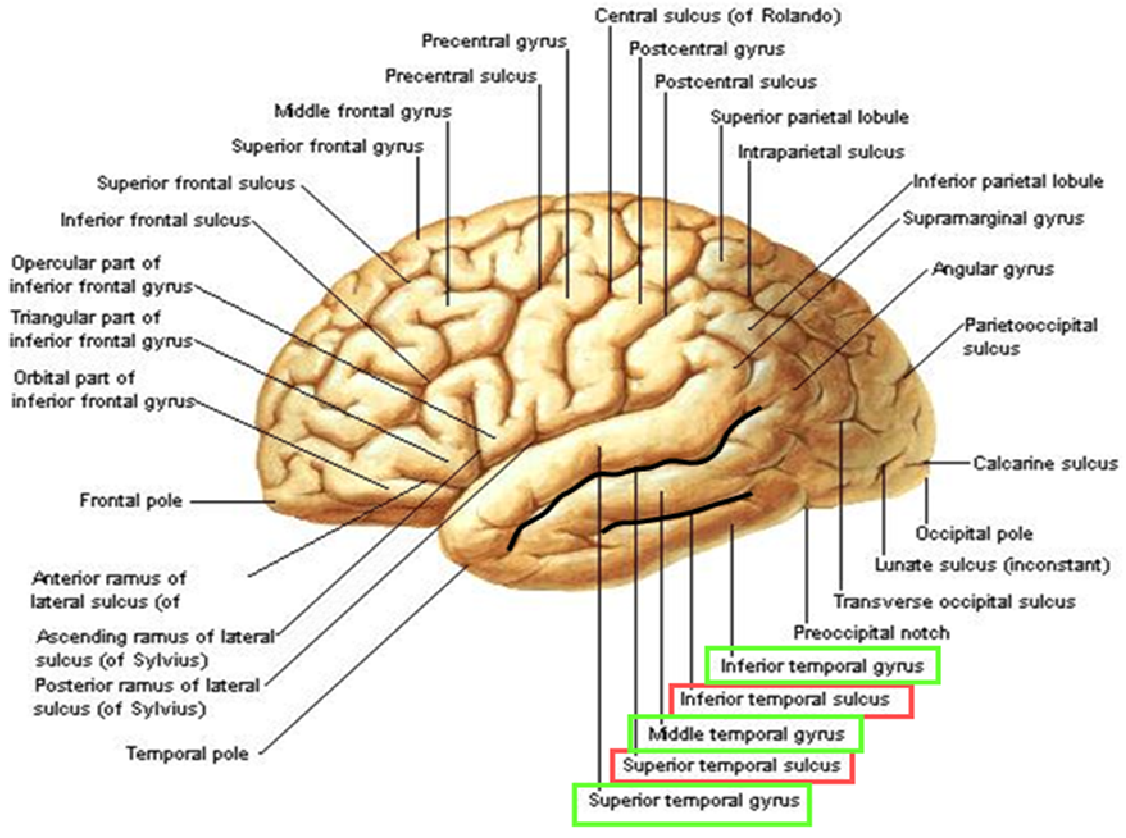
B. Parietal lobe

- **Sulci :** Postcentral + Intraparietal.
- **Gyri** : Postcentral + Sup. Parietal lobule + Inf. Parietal lobule.



C. Temporal lobe

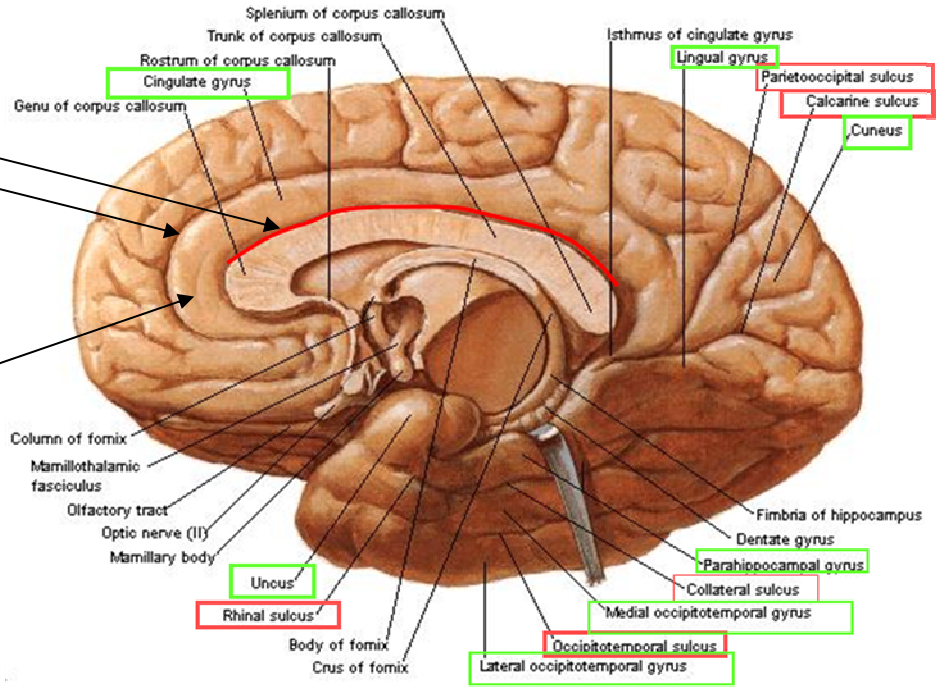
- **Sulci :** Sup. Temporal + Inf. Temporal.
- **Gyri** : Sup. Temporal + Inf. Temporal + Middle Temporal.



- **<u>Medial Surfaces</u> :**

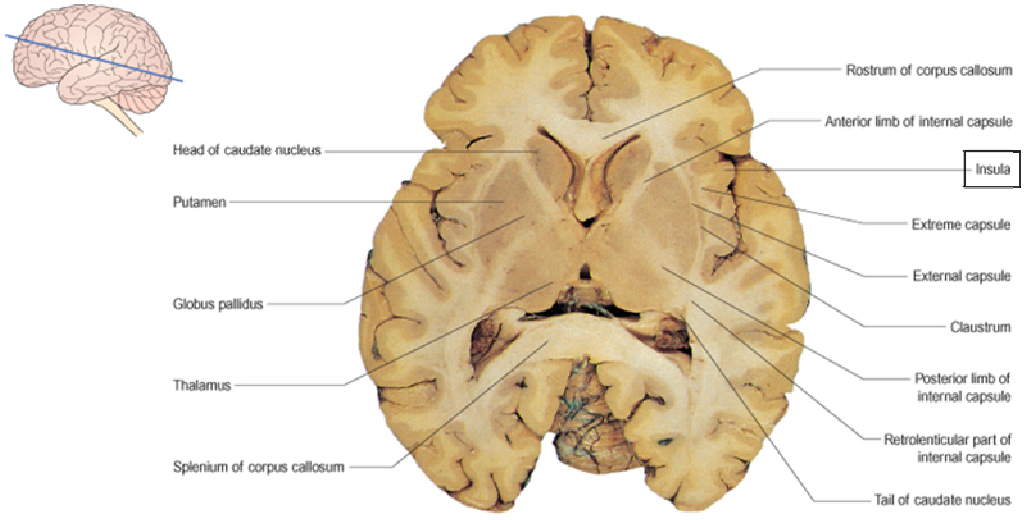
- **Sulci :**
  1. **Callosal**
  2. **Cingulate**
  3. Parieto-occipital
  4. Calcarine
  5. Collateral
  6. Occipito-temoral
  7. Rhinal.

- **Gyri :**
  1. **Cingulate**
  2. Lingual
  3. Cuneus
  4. **Parahippocampal**
  5. Medial Occipitotemporal
  6. Lateral Occipitotemporal
  7. Uncus.

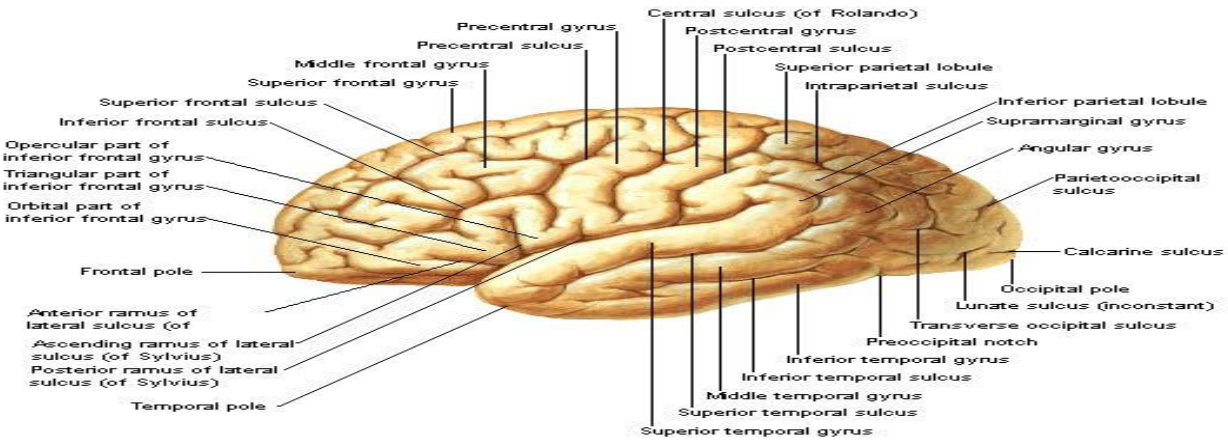


- **The cingulate gyrus, parahippocampal gyrus & hippocampus are sometimes called as <u>limbic lobe</u>.**

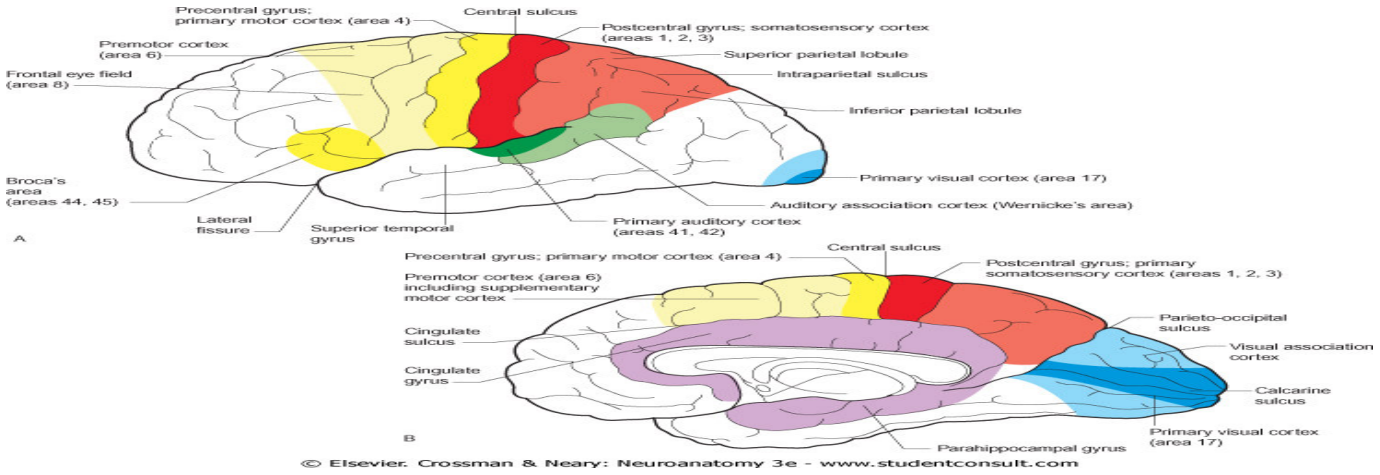
- The cerebral hemisphere is dividing into four lobes, namely the **frontal**, **parietal**, **temporal** and **occipital lobes,** their principal topographical features and functional significance.
- The most conspicuous and deepest cleft on the lateral surface of the hemisphere is the **lateral fissure**.
  This separates the temporal lobe below, from the frontal and parietal lobes above.
  Within the depths of the lateral fissure lies a cortical area known as the **<u>insula</u>**.



- The parts of the frontal, parietal and temporal lobes that overlie the insula are called the **opercula**.
  Also on the lateral surface of the hemisphere, a single, uninterrupted sulcus can usually be identified, running continuously between the great longitudinal fissure and the lateral fissure.
- This is the **central sulcus**, which marks the boundary between the frontal and parietal lobes.
- The central sulcus extends for a short distance on to the medial surface of the hemisphere, within the great longitudinal fissure.
- The frontal lobe constitutes the entire region in front of the central sulcus.
  Immediately in front of the sulcus, and running parallel to it, lies the **precentral gyrus**, which is the primary motor region of the cerebral cortex.
  In front of the precentral gyrus, the rest of the frontal lobe consists of a more variable pattern of convolutions, of which the **superior**, **middle** and **inferior frontal gyri** can usually be identified.



- Behind the central sulcus, and above the lateral fissure, lies the parietal lobe.
- Its most anterior part is the **postcentral gyrus**, which is the site of the primary somatosensory cortex.
- Behind the postcentral gyrus, on the lateral surface of the hemisphere, the **intraparietal sulcus** divides the rest of the parietal lobe into superior and inferior parietal lobules.

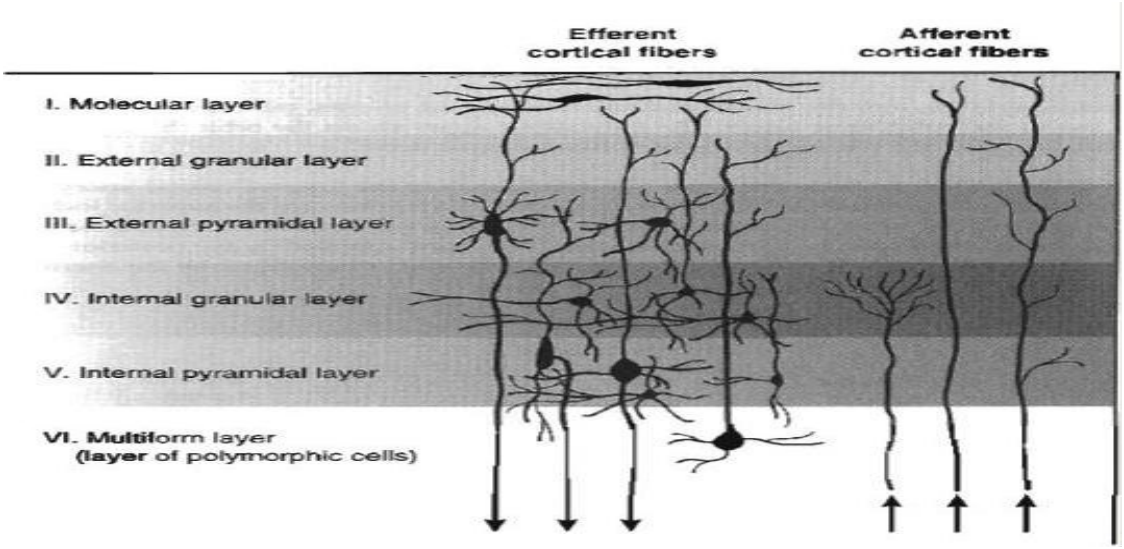


- The boundary between the parietal lobe and the posteriorly located occipital lobe is not coincident with a single sulcus on the lateral surface of the hemisphere; however, it is clearly marked by the deep **parieto-occipital sulcus** on the medial surface.
- The occipital lobe does not bear any important landmarks on its lateral surface but, on the medial surface, the prominent **calcarine sulcus** indicates the location of the primary visual cortex.
- The temporal lobe lies beneath the lateral fissure, merging posteriorly with the parietal and occipital lobes. On its lateral surface the temporal lobe is divided into three principal gyri that run roughly parallel to the lateral fissure : the superior, middle and inferior temporal gyri.
- The superior temporal gyrus includes the primary auditory cortex.
  Most of this functional region is situated on the superior bank of the gyrus, within the lateral fissure, where the **transverse temporal gyri**, or **Heschl's convolutions**, provide a more precise localization.
- On the medial surface of the hemisphere, certain portions of the frontal, parietal and temporal lobes also constitute components of the limbic system.
- Curving around the corpus callosum, and running parallel to it, lies the **cingulate gyrus** separated from the rest of the hemisphere by the **cingulate sulcus**.
- The cingulate gyrus passes posteriorly and inferiorly round the posterior portion, or splenium, of the corpus callosum to become continuous with the **parahippocampal gyrus** of the temporal lobe.
  Deep to the parahippocampal gyrus, within the temporal lobe, lies the **hippocampus**.
- This structure is formed by an in-curling of the inferomedial part of the temporal lobe. The cingulate gyrus, parahippocampal gyrus and hippocampus are sometimes referred to as the **limbic lobe** of the cerebral hemisphere.

HISTOLOGICAL STRUCTURE OF CEREBRAL CORTEX :

- Contains nerve **cell bodies**, **dendritic arborizations**, **synapses**, **neuroglia**, **blood vessels.**
- **Brodmann** produced a numbered, cytological map of cerebral cortex based upon its regional histological characteristics**.**
- ***Archicortex*** and ***Paleocortex*** (hippocampus and parts of temporal lobe associated with olfactory functions) have three layered structure.
  These regions have important functions in the emotional aspects of behaviour and memory.
  Together with other parts of the cortex and certain subcortical nuclei they constitute the limbic system.
- ***Neocortex***, generally consists of **six layers**, although the detailed cytological structure varies from region to region**.**

- **Layer I :** is the most superficial layer few nerve cells, many processes and synaptic interactions**.**
- **Layer II :** contains many small neuron, which establish intercortical connections**.**
- **Layer III :** contains medium sized neurons giving rise to association & commissural fibers**.**
- **Layer IV :** is the site of termination of afferent fibers from the specific thalamic nuclei.
- **Layer V :** is the origin of projection fibers to extracortical targets, such as basal ganglia, thalamus, brain stem, and spinal cord.
  In primary motor cortex of the frontal lobe, this layer contains giant Betz cells which give rise to pyramidal fibers**.**
- **Layer VI :** contain association and projection neurones.

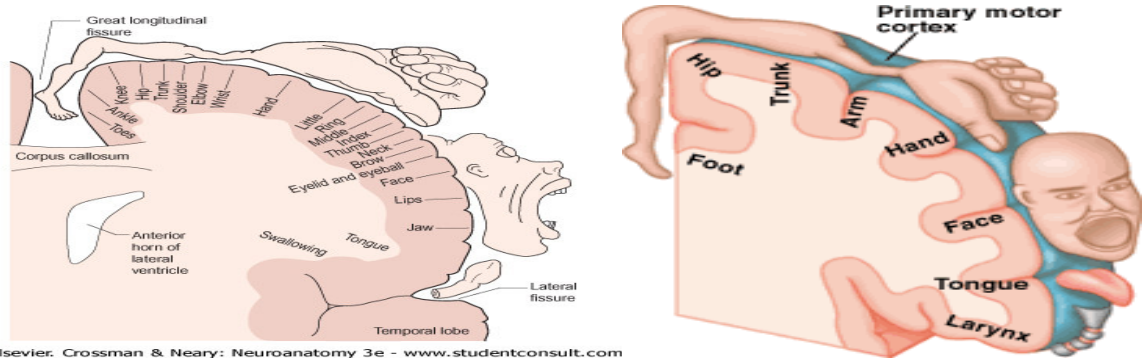


FUNCTIONAL ORGANISATION :

- The cerebral cortex is necessary for conscious awareness & thought, memory & intellect.
- All sensory modalities ascend, are perceived & interpreted in light of previous experience.
- It is also the highest level of at which the motor system is represented.
- The posterior part of the cerebrum receives sensory information from the outside world in the primary sensory areas of the parietal lobe (somatosensory), occipital lobe (vision) & temporal lobe (hearing).
- Areas of cortex at the junction of the three lobes, known as **associated cortex** that permits identification of objects by touch, sight & hearing.
- The medial portions of the cerebral hemisphere (limbic system) enable the storage and retrieval of information processed in the posterior hemispheric regions.
- The anterior part of the cerebrum (frontal lobe) is concerned with the organisation of movement (primary motor area; premotor and supplementary motor areas) and the strategic guidance of complex motor behaviour over time (prefrontal area).
- In the majority of individuals, areas of association cortex in frontal, parietal and temporal lobes of the left hemisphere are responsible for the comprehension and expression of language.
  The **left hemisphere** is, therefore, said to be **dominant** for language.

THE FRONTAL LOBE (PRIMARY MOTOR CORTEX AREA 4) :

- Is concerned with the movement (primary motor, premotor & supplementary motor areas).
- The frontal lobe lies anterior to the central sulcus.
  Immediately anterior to the central sulcus, and running parallel to it, is the precentral gyrus.
- Within the cortex of the precentral gyrus, the contralateral half of the body is represented in a precise ***somatotopic*** fashion, often pictorially depicted as a '**motor homunculus**'. The representation of the body is inverted, with the head area located in the most inferior part of the precentral gyrus, just above the lateral fissure.
- Progressing superiorly, successive areas of cortex represent the digits, hand, arm, shoulder and trunk.
- The lower limb is represented on the medial surface of the hemisphere, above the corpus callosum.
- The area of cortex devoted to a particular body part is proportional, not to its size, but to the degree of precision with which movements can be executed.
  Therefore, the larynx, tongue, face and digits of the hand are represented by relatively large regions.
- Stimulation of primary motor cortex elicits contraction of discrete muscle groups on the opposite side of the body.



- The function of this region is the control of voluntary, skilled movements, sometimes referred to as fractionated movements; 30% of corticospinal (pyramidal tract) and corticobulbar fibres arise from neurones of the primary motor cortex, about 3% originating from giant pyramidal (Betz) cells.
- The principal subcortical afferents to the primary motor cortex originate from the ventral lateral nucleus of the thalamus, which in turn receives input mainly from the dentate nucleus of the cerebellum and from the globus pallidus of the basal ganglia.
- The region immediately anterior to the primary motor cortex is known as the **premotor cortex** (Brodmann's area 6).
- On the lateral surface of the hemisphere, this includes the posterior portions of the superior, middle and inferior frontal gyri.
- On the medial surface of the hemisphere, the premotor cortex includes a region referred to as the **supplementary motor cortex**. Here, like the primary motor cortex, there is somatotopic representation of the body although, unlike the primary motor cortex, representation appears to be bilateral in both hemispheres.
- Stimulation of premotor cortical areas induces movements that are less focused than those elicited from the primary motor cortex and that involve groups of functionally related muscles.
- Movements evoked from the supplementary motor cortex tend to be postural in nature, involving axial and proximal musculature.
- Premotor cortical areas are thought to function in the programming of, and preparation for, movement and in the control of posture.
- The premotor cortex exerts its actions partly via the primary motor cortex, with which it is connected by short association fibres, and partly via corticospinal and corticobulbar fibres.
- About 30% of the latter originate in the premotor cortex although, unlike the primary motor cortex, giant Betz cells are absent from premotor areas.
- The principal subcortical input to premotor cortical regions, including the supplementary motor cortex, is the ventral anterior nucleus of the thalamus. This, in turn, receives fibres from the globus pallidus and substantia nigra.
- Immediately in front of the premotor cortex, on the lateral surface of the hemisphere, are located two other important regions.

- In the middle frontal gyrus lies the **frontal eye field** (Brodmann's area 8) this region controls voluntary conjugate deviation of the eyes, as occur when scanning the visual field.
- Unilateral damage to this area causes conjugate deviation of the eyes towards the side of the lesion.
- In the inferior frontal gyrus of the dominant hemisphere (usually the left) lies the motor speech area, also known as **Broca's area** (Brodmann's areas 44 and 45).
- Broca's area has important interconnections with parts of the ipsilateral temporal, parietal and occipital lobes that are involved in language function. The extensive regions of the cortex of the frontal lobe that lie anterior to premotor areas are referred to as **prefrontal cortex**.
- The prefrontal cortex has rich connections with parietal, temporal and occipital cortex through long association fibres running in the subcortical white matter.
- Subcortical afferents arise mainly in the mediodorsal and anterior nuclei of the thalamus.
  The prefrontal cortex has cognitive functions of a high order.
- These include intellectual, judgemental and predictive faculties and the planning of behaviour.

MOTOR HOMUNCULUS :

- Every part of the body is represented in the primary motor cortex, and these representations are arranged **somatotopically** -- the foot is next to the leg which is next to the trunk which is next to the arm and the hand. The amount of brain matter devoted to any particular body part represents the amount of control that the primary motor cortex has over that body part.
- For example, a lot of cortical space is required to control the complex movements of the hand and fingers, and these body parts have larger representations in motor cortex than the trunk or legs, whose muscle patterns are relatively simple. This disproportionate map of the body in the motor cortex is called the motor homunculus.

THE PARIETAL LOBE (PRIMARY SOMATOSENSORY CORTEX AREA 1, 2 & 3) :

- The parietal lobe lies behind the frontal lobe and is bounded posteriorly and inferiorly by the occipital and temporal lobes, respectively.
  The most anterior part of the parietal lobe is the postcentral gyrus, running parallel to the central sulcus.
- Functionally, this region is the **primary somatosensory cortex** (Brodmann's areas 1, 2 and 3).
- It is here that thalamocortical neurones terminate; these constitute the third and final relay in the chain from peripheral receptors for general sensation (TPT) to a conscious level.
- The thalamic origin of these neurones is the ventral posterior nucleus, which in turn receives fibres of the medial lemniscus (fine touch and proprioception), spinal lemniscus (coarse touch and pressure), spinothalamic tracts (pain and temperature) and trigeminothalamic tracts (general sensation from the head).
- Within the somatosensory cortex, the contralateral half of the body is represented in an inverted, somatotopic pattern that resembles that in the primary motor cortex of the frontal lobe.
- Once again, the area of cortex devoted to a particular body part is disproportionate to the size of the latter; in the case of the sensory cortex it reflects rather the richness of sensory innervation. Therefore, the pharynx, tongue, face, lips and the palmar surface of the hands and digits are particularly well represented. Adjacent to the mouth area is a region where taste is perceived. The surface of the parietal lobe posterior to the primary somatosensory cortex constitutes the parietal **association cortex**.
- The superior parietal lobule is responsible for the interpretation of general sensory information and for conscious awareness of the contralateral half of the body.
  Lesions here impair the interpretation and understanding of sensory input and may cause neglect of the opposite side of the body.
- The inferior parietal lobule interfaces between somatosensory cortex and the visual and auditory association cortices of the occipital and temporal lobes, respectively, and in the dominant hemisphere it contributes to language functions.

SENSORY HOMUNCULUS :

- The body half on the right is *sensory homunculus*. It is similar to the motor homunculus except that it tell how much brain power is dedicated for sensing different body parts.
- Once again the area of cortex devoted to a particular body part is disproportionate to its size & reflects the richness of sensory innervation. Therefore the pharynx, face, lips & the palmar surface of hand & digits are well represented.

THE TEMPORAL LOBE (PRIMARY AUDITORY CORTEX AREAS 41 & 42) :

- The lateral surface of the temporal lobe is divided into superior, middle and inferior temporal gyri, which run parallel to the lateral fissure.
- Within the superior temporal gyrus is located the **primary auditory cortex** (Brodmann's areas 41 and 42).
- More exactly, most of this functional zone lies in the superior bank of the gyrus, normally hidden within the lateral fissure.
- Its precise location is marked by the small transverse temporal gyri, or Heschl's convolutions.
  The primary auditory cortex is responsible for the conscious perception of sound (voice) and within it there is so-called 'tonotopical' representation of the cochlear duct.
  The primary auditory cortex receives input from the medial geniculate nucleus of the thalamus.
- The ascending acoustic projection undergoes partial decussation in the brain stem on its way to the medial geniculate nucleus.
- At the cortical level, therefore, the organs of hearing are bilaterally represented so that unilateral lesions of the primary auditory cortex cause partial deafness in both ears.
- Auditory information is further processed and interpreted in the **auditory association cortex**, which lies surrounding and immediately posterior to the primary auditory cortex.
- In the dominant hemisphere, this region is also known as **Wernicke's area**. It is crucial for understanding of the spoken word and has important connections with other language areas of the brain.
- The location of the cortical representation of the vestibular system is uncertain. There is evidence that it lies in the superior temporal gyrus anterior to the primary auditory cortex, or in the inferior parietal lobule.
- The inferomedial part of the temporal lobe is curled inwards to form the **hippocampus**.
- This structure lies in the floor of the inferior horn of the lateral ventricle, deep to the parahippocampal gyrus.
- As part of the limbic system, the principal functions of the hippocampus are in relation to memory and the emotional aspects of behaviour.
- Close to the anterior end of the hippocampus and the temporal pole lies a mass of subcortical grey matter, the **amygdala**, which is also part of the limbic system.
- The amygdala and adjacent parts of the inferomedial temporal cortex receive fibres from the olfactory tract and are responsible for the conscious appreciation of the sense of smell.

THE OCCIPITAL LOBE :

- The occipital lobe lies behind the parietal and temporal lobes.
- On the medial surface of the hemisphere, the boundary with the parietal lobe is marked by the deep parieto-occipital sulcus. Also on the medial surface, the calcarine sulcus marks the location of the **primary visual cortex** (Brodmann's area 17) , which is responsible for visual perception.
- It occupies the gyri immediately above and below the calcarine sulcus, much of it being hidden in the depths of the sulci. This region receives fibres from the lateral geniculate nucleus of the thalamus by way of the optic radiation of the internal capsule.
- Each lateral half of the visual field is represented in the primary visual cortex of the contralateral hemisphere.

- The upper half of the visual field is represented below the calcarine sulcus, and the lower half is represented above the sulcus.
- The rest of the occipital lobe constitutes the **visual association cortex**. This region is concerned with the interpretation of visual images.
- Lesions of the primary visual cortex cause blindness in the corresponding part of the visual field, while damage to the visual association cortex causes deficits in visual interpretation and recognition.

LANGUAGE AREAS OF THE CEREBRAL 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.
- In the great majority of people the left hemisphere is dominant for language and mathematical ability.
- The right hemisphere excels at spatial perception and musical proficiency.
- Cerebral dominance becomes established during the first few years after birth.
  During this formative period, both hemispheres exhibit linguistic ability and if one hemisphere sustains damage it may be compensated for by the plasticity of the developing brain and the child learns to speak normally.
- Later in life, this flexibility becomes greatly diminished and damage to the dominant hemisphere often causes loss of speech in addition to the other deficits produced by hemispheric lesions.
- The language areas of the brain are organised around the lateral fissure of the cerebral hemisphere.
- In the frontal lobe, Broca's area occupies the posterior part of the inferior frontal gyrus, adjacent to the motor cortical area for the head and neck. This region is concerned with expressive aspects of language (articulation).
- In the temporal lobe, the auditory association cortex, or Wernicke's area, is responsible for comprehension of the spoken word. Nearby regions of the temporal lobe and parietal lobe, most notably the angular gyrus and supramarginal gyrus of the inferior parietal lobule, provide a functional interface between auditory and visual association areas important in naming, reading, writing and calculation.

REMEMBER ...

- The precentral gyrus is the primary motor region of the cerebral cortex and is located within the frontal lobe, immediately in front of the central sulcus. Anterior to this lie the premotor and supplementary motor cortices and, in the left hemisphere, Broca's (motor speech) area. The prefrontal cortex is concerned with complex cognitive functions.
- The postcentral gyrus is the primary somatosensory region of the cerebral cortex and lies within the parietal lobe, immediately posterior to the central sulcus.
  It receives afferents from the ventral posterior nucleus of the thalamus, which is the site of termination of the spinothalamic tracts, trigeminothalamic tract and the medial lemniscus.
  Behind this region lies the sensory association cortex, which is responsible for the interpretation of general sensory information.
- The temporal lobe lies beneath the lateral fissure. On the superior surface of the superior temporal gyrus, the transverse temporal gyri (Heschl's convolutions) mark the location of the primary auditory cortex, which receives input from the medial geniculate nucleus of the thalamus. Adjacent lies the auditory association cortex, which is responsible for the interpretation of auditory information and which, in the left hemisphere, constitutes Wernicke's area.
- The occipital lobe makes up the posterior part of the hemisphere. On the medial surface, the calcarine sulcus indicates the location of the primary visual cortex, which receives afferents from the lateral geniculate nucleus of the thalamus. The rest of the occipital lobe is the visual association cortex, which is responsible for the interpretation of visual information.

SELF QUIZ

1- One of the following statements is INCORRECT :

a. Lesion in the premotor area 6 causes apraxia.
b. Lesion in parietal and temporal lobes cause Alzheimer's disease.
c. Lesion in area 8 causes contralateral conjugate deviation of both eyes.
d. Occipitl lobe lesions cause visual disturbances.
e. Lesion in Broca's area in the dominant hemisphere causes motor aphasia.

2- Language areas are located in all of the following EXCEPT :

a. Supramarginal gyrus.
b. Middle frontal gyrus.
c. Superior temporal gyrus.
d. Angular gyrus.
e. Inferior frontal gyrus.

3- Regarding the cortical areas of the cerebral cortex, one is INCORRECT :

a. All the motor areas are present in the frontal lobe.
b. Broca's area is motor speech.
c. The primary visual area (area 17) is Located on the medial surface of the hemispheres.
d. The prefrontal cortex (frontal pole) has cognitive functions of high order.
e. The auditory association area (area 22) lies in the middle temporal gyrus.

4- This cortical area is present in the frontal lobe of the cerebral hemisphere :

a. Gustatory (taste) area (area 43).
b. Primary auditory area (areas 41 and 42).
c. Primary visual area (area 17).
d. Broca's area (motor speech area).
e. Somatosensory association area (area 5 and 7).

5- One of the following cortical areas of the brain is present in the parietal lobe :

a. Primary motor area (area 4).
b. Primary auditory area (area 41, 42).
c. Motor eye field area (area 8).
d. Primary visual area (area 17).
e. General sensory area (area 3, 1, 2).

1. c	2. b	3. e	4. d	5. e

THE END

LoveTomy Team 426

Team leader : Dr. hams

Dr. S Dr. noop Omar H

ابتسم !! همي بروحي

M.A.M Abo Slo7 Cute Killer