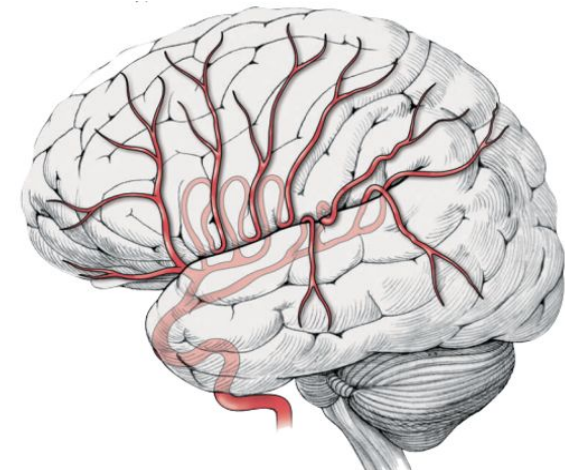


Lecture:



Anatomy and Physiology of the Cerebral Hemispheres - II

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الرجاء تحويل الجوال إلى وضع
الصامت مع الشكر

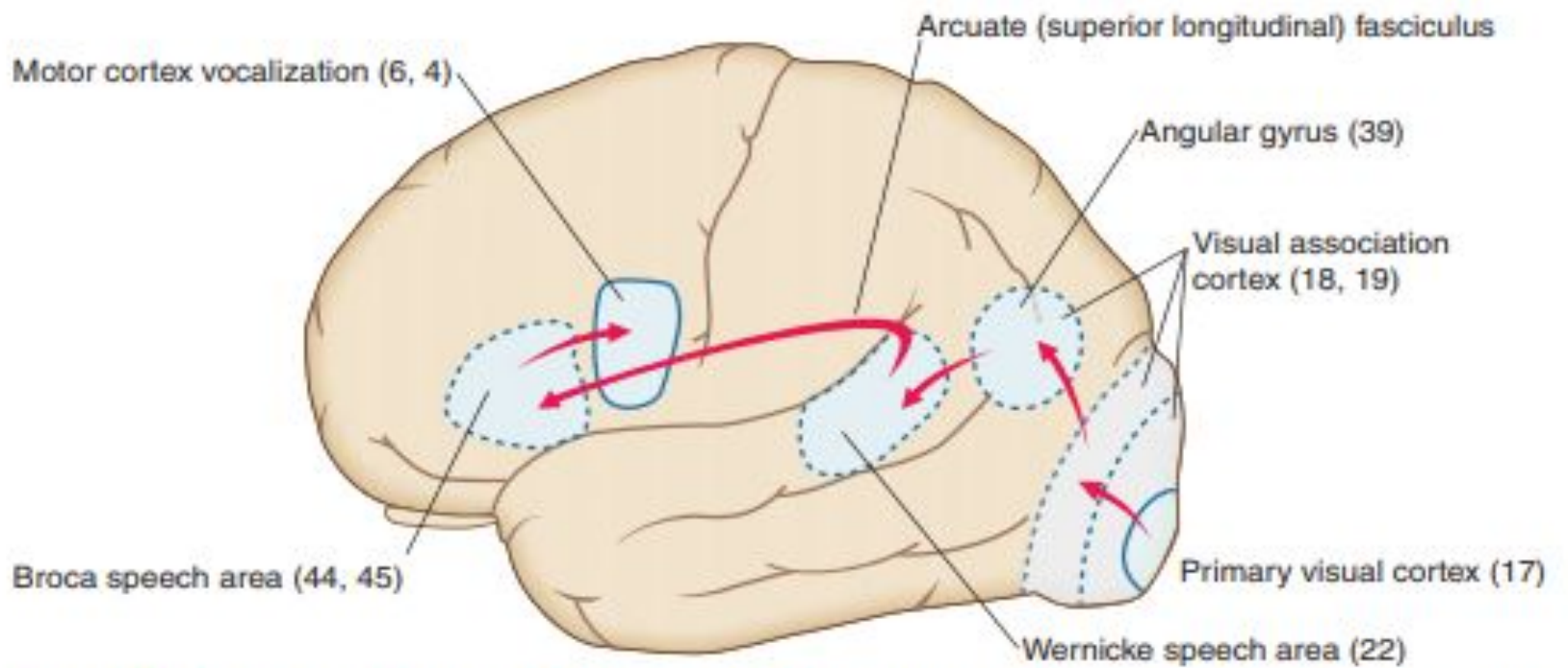


The Projection Fibers

- **Definition:** they are afferent and efferent fibers (tracts) of the cerebral cortex which connect **the cerebral cortex with the lower part of the brain and spinal cord** (e.g. pyramidal tract).
- **Types of the Projection Fibers:**
 1. **Ascending (afferent or sensory):** to the cerebral cortex from the thalamus and spinal cord.
 2. **Descending (efferent or motor):** from the cerebral cortex to lower centers and spinal cord.

The Association Fibers

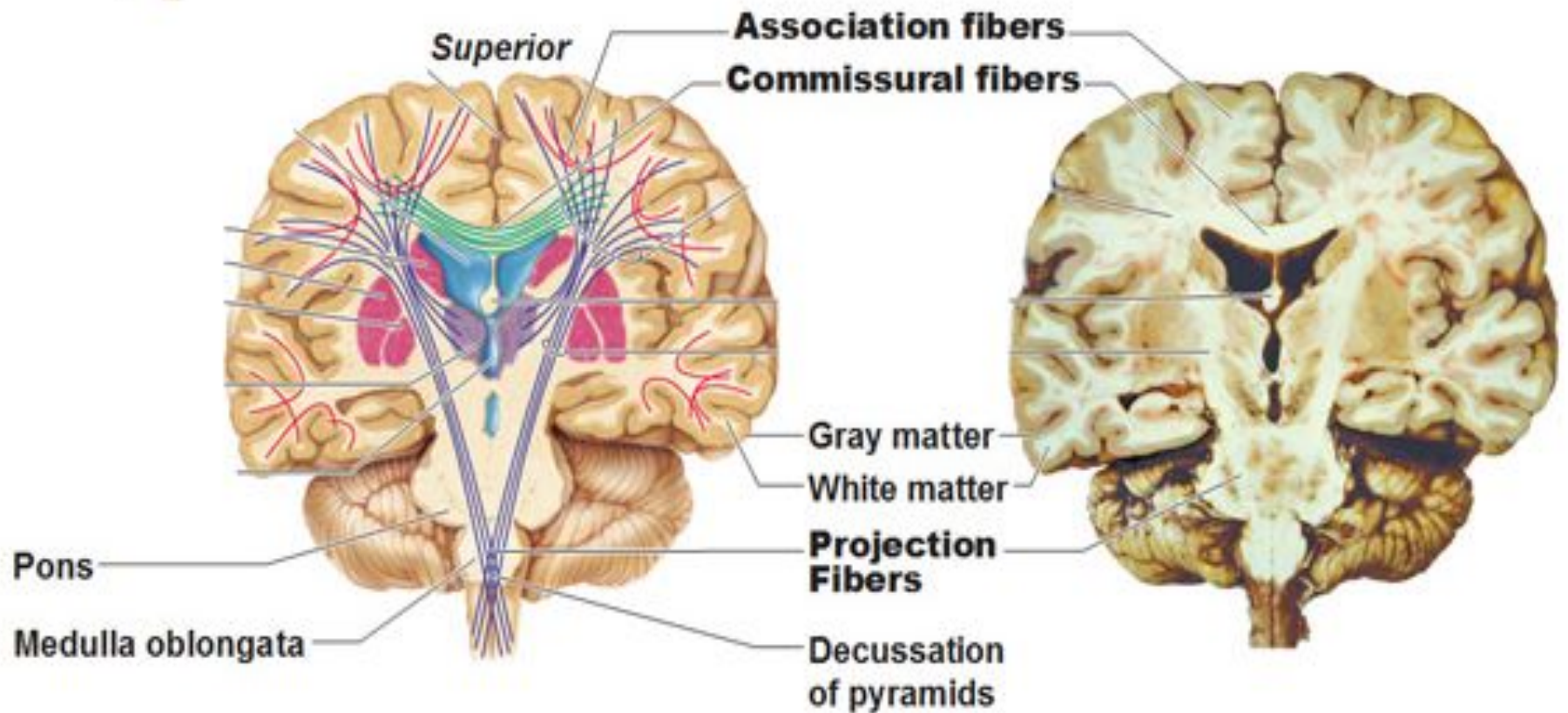
- **Definition:** they are fibers which connect the different cortical areas in the same hemisphere.
- **Types of Association Fibers:**
 1. **Short association fibers:** they connect adjacent gyri with one another (in the lobe).
 2. **Long association fibers:** connect the different lobes of the hemisphere together “Arcuate Fasciculus”.



Cerebral White Matter – 3 types of fibers



(a) Frontal section



The Commissural Fibers

Definition and function: is a band of white matter (nerve fibers) connecting and coordinating of activities of the right and left hemisphere.

The Commissural Fibers Include:

1. Corpus callosum.
2. Anterior commissure.
3. Posterior commissure.
4. Habenular commissure.
5. Hippocampal commissure.

1. Corpus Callosum

- It is the greatest commissure of the brain.
- Present in the floor of the middle part of the median longitudinal fissure.

Parts of the corpus callosum:

a. Rostrum:

- It is a thin part which is **connected to the lamina terminalis**.
- It forms the floor of the anterior horn of lateral ventricle.

b. Genu:

- It is the curved anterior part of corpus callosum.
- It forms the roof and anterior wall of the anterior horn of the lateral ventricle.
- Its fibers connect **the anterior part of the two frontal lobes together**.

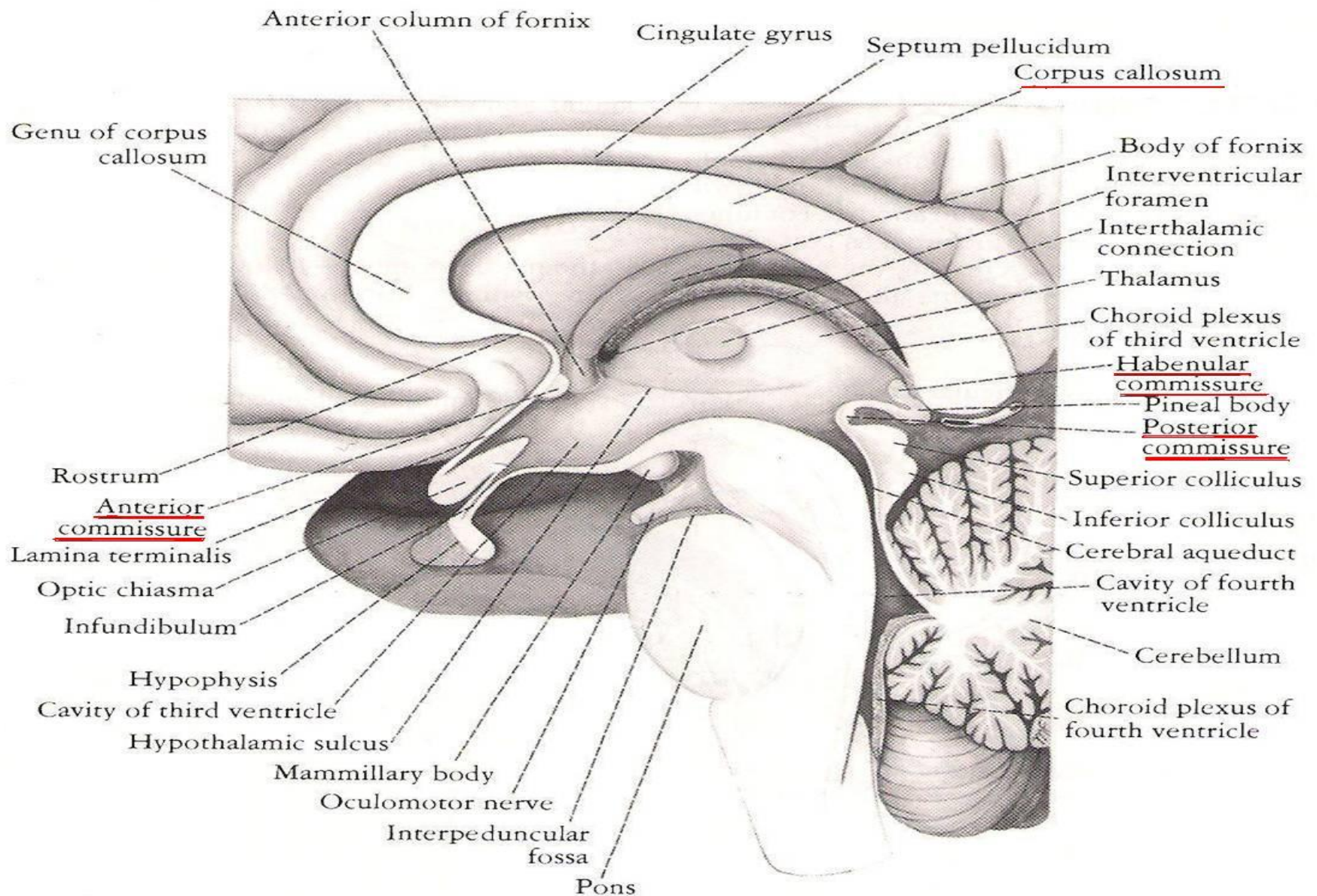
c. Trunk (body):

- It is the largest part of the corpus callosum.
- It forms the roof of the central part of the lateral ventricle.
- Its fibers connect the posterior part of the frontal lobe and parietal lobe of the two cerebral hemispheres together.

d. Splenium:

- It is the posterior end of the corpus callosum.
- It lies on the midbrain and posterior part of the third ventricle.
- It connects the occipital and temporal lobes of the two cerebral hemispheres together.

The Commissural Fibers



2. Anterior Commissure

- It is a rounded bundle that crosses the median plane behind the lamina terminalis.
- It connects the two olfactory bulbs with temporal lobes.

3. Posterior Commissure

- It is a rounded bundle that crosses the median plane and present below the pineal body.
- It connects the superior colliculus, pretectal nucleus and both medial longitudinal bundle of both sides together.

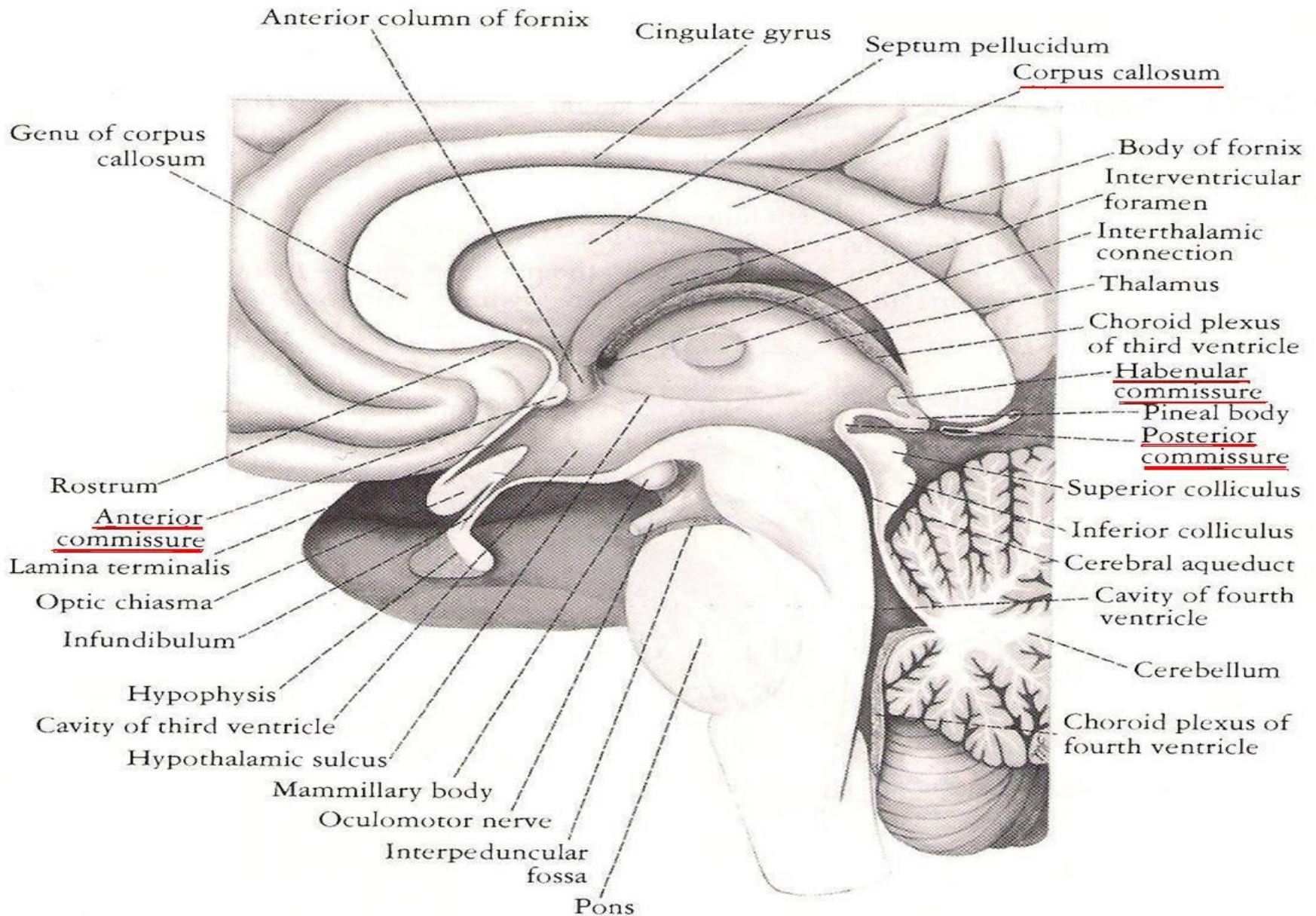
4. Habenular Commissure

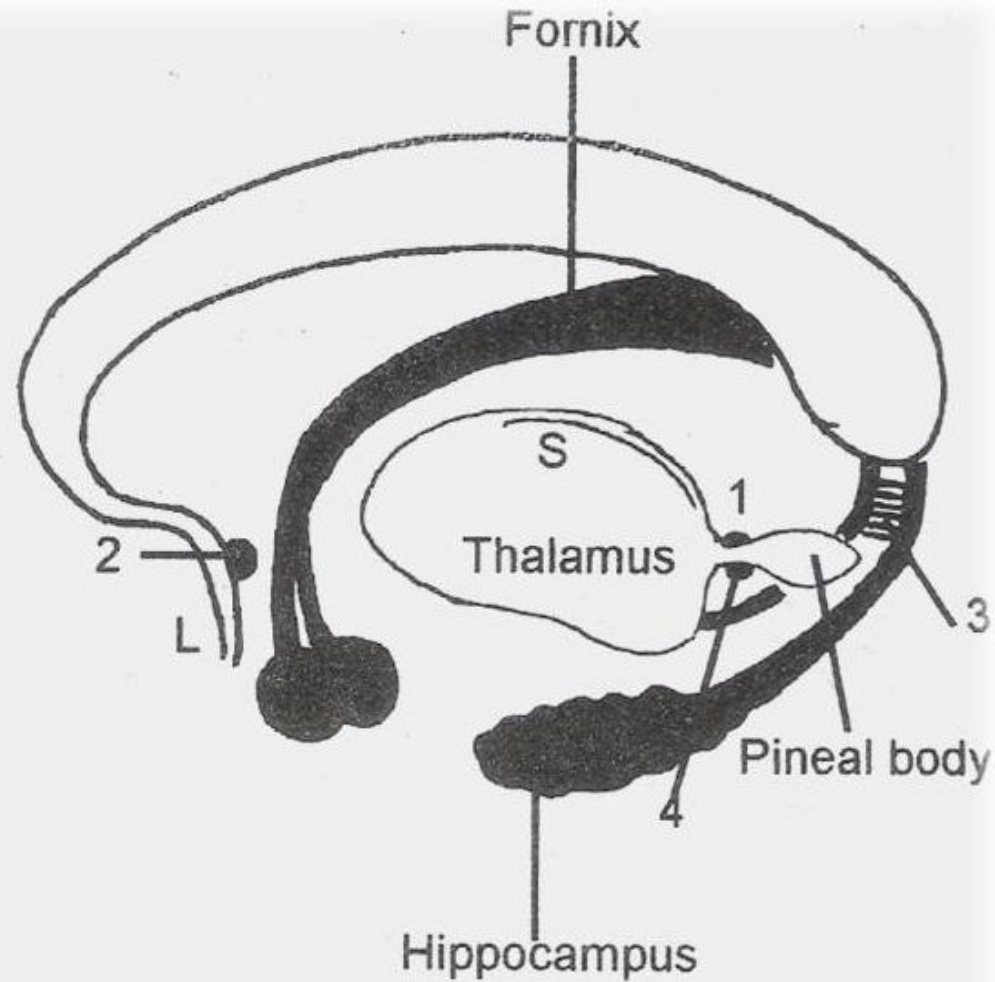
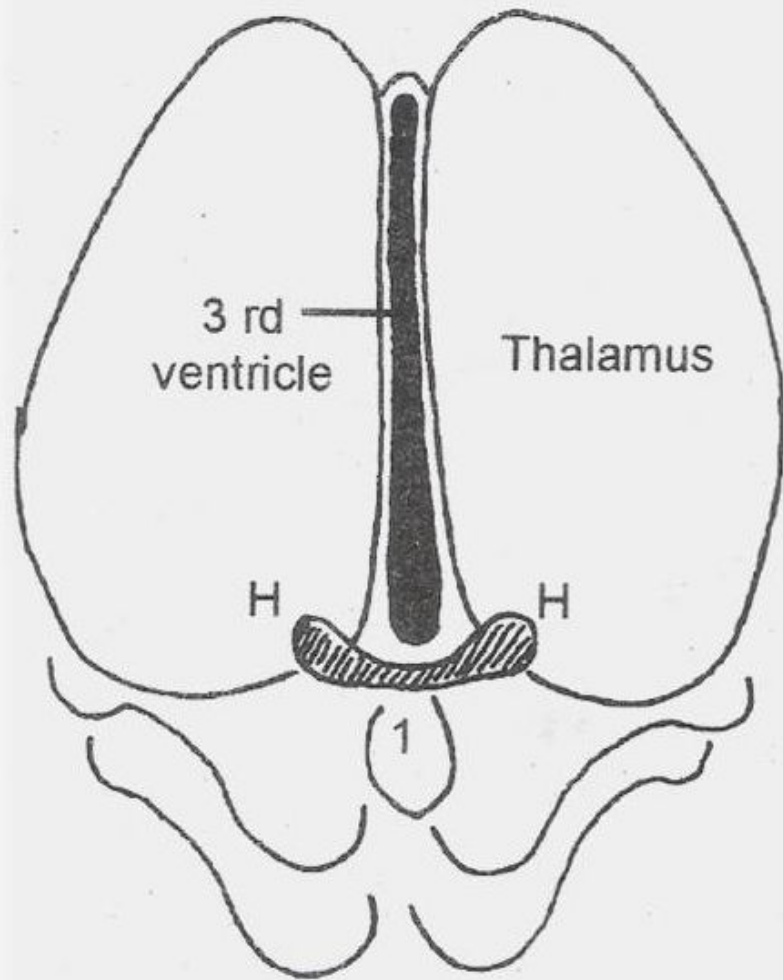
- It is present above the pineal body.
- It connects the habenular nuclei of the both sides together.

5. Hippocampal Commissure

- It connects the hippocampus and fornix of both side together.

The Commissural Fibers





H. : Habenular nucleus.
 S. : Stria medullaris thalami.
 L. : Lamina terminalis.

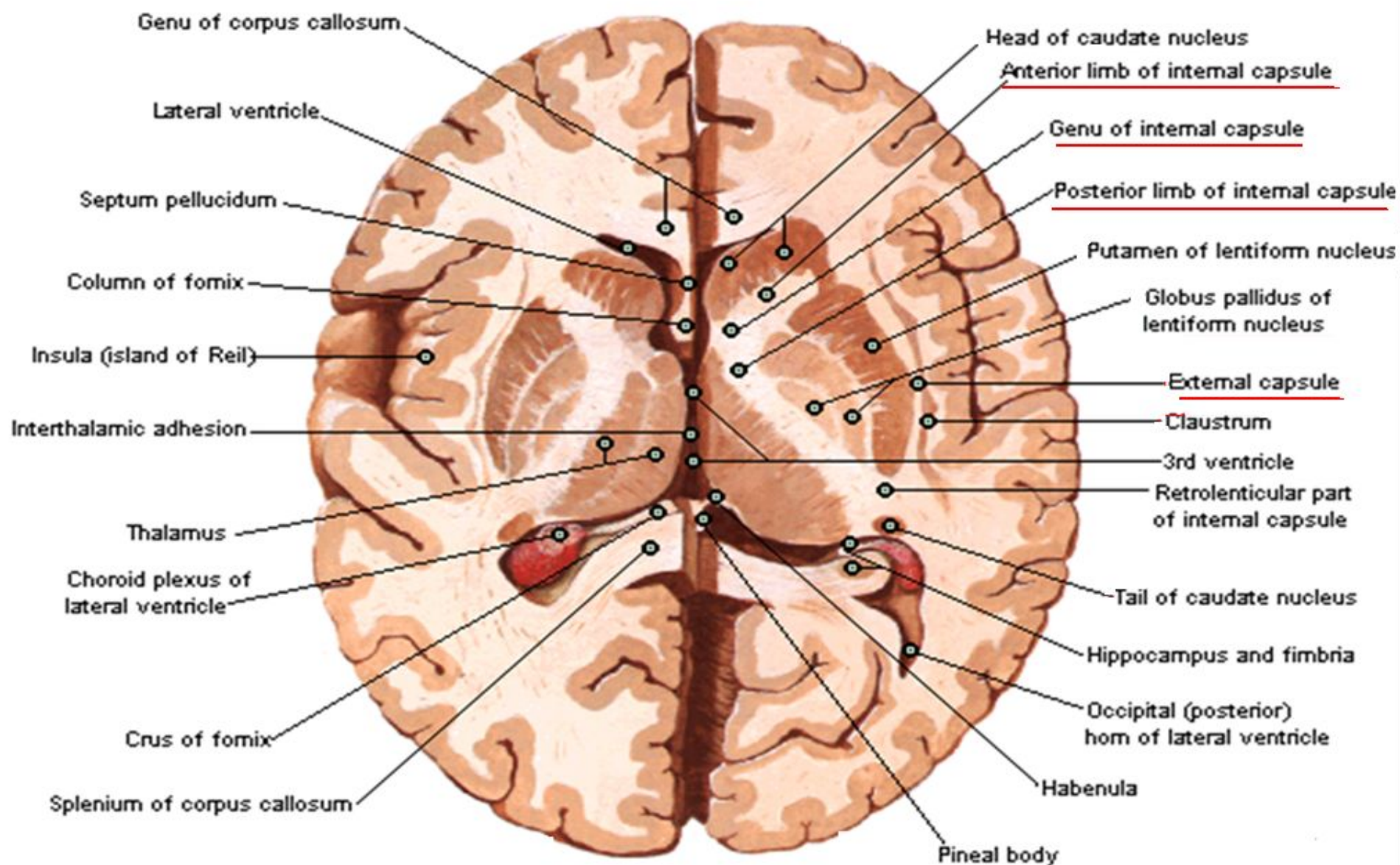
1. : Habenular commissure.
 2. : Anterior commissure.
 3. : Hippocampal commissure.
 4. : Posterior commissure.

Internal Capsule

- It is a thick lamina of white matter made up of projection fibers which pass to and from the cerebral cortex.
- Located between the basal nuclei and the thalamus.
- It is continuous superiorly with the corona radiata, optic radiation, and inferiorly with peduncles of midbrain.
- **Parts of Internal Capsule:**
 - A. Anterior limb.
 - B. Genu.
 - C. Posterior limb.
 - D. Sublentiform part.
 - E. Retrolentiform part.

Basal Ganglia

Horizontal Sections through Cerebrum



A. Anterior limb of Internal Capsule

- Located between the caudate nucleus and putamen.
- **It contains the following fibers:**
 - 1. Ascending fibers:** anterior thalamic radiation:
from thalamus to frontal lobe.
 - 2. Descending fibers:** fronto-pontine tract.

B. Genu of Internal Capsule

- It is present opposite the interval between the caudate nucleus and the thalamus (between the anterior and posterior limbs).
- **It contains the following fibers:**
 - ❖ **Descending fibers:** corticonuclear tract from the lower 1/3 of the precentral gyrus and descend to reach the motor nuclei of the cranial nerves in brain stem.

C. Posterior limb of Internal Capsule

- It is present lateral to the thalamus and medial to the lentiform nucleus.
 - **It contains the following fibers:**
 1. **Ascending fibers “Medially”:** superior thalamic (sensory) radiation (carries general sensation from the thalamus and ascend to reach the postcentral gyrus).
 2. **Descending fibers “Intermediate”:**
 - **Corticospinal tract** (part of pyramidal tract).
Anteriorly for the UL, in the middle for trunk, and posteriorly for the LL.
 - **Corticorubral tract “laterally”:** from area 6 of the frontal lobe to the red nucleus.
 - **Fronto-pontine tract “laterally”.**
 - **Corticostriate:** from area 6 of the frontal lobe to the corpus striatum.

D. Sublentiform Part of Internal Capsule

- It is present below the posterior end of the lentiform nucleus.
 - It contains the following fibers:
 1. **Ascending fibers:** auditory radiation (from the medial geniculate body, and ascend to reach the auditory cortex (Transverse temporal gyrus of Heschl)).
 2. **Descending fibers:** temporo-pontine tract (from the temporal lobe, and descend to reach the pontine nuclei).

E. Retrolentiform Part of Internal Capsule

- It is present behind the lentiform nucleus.

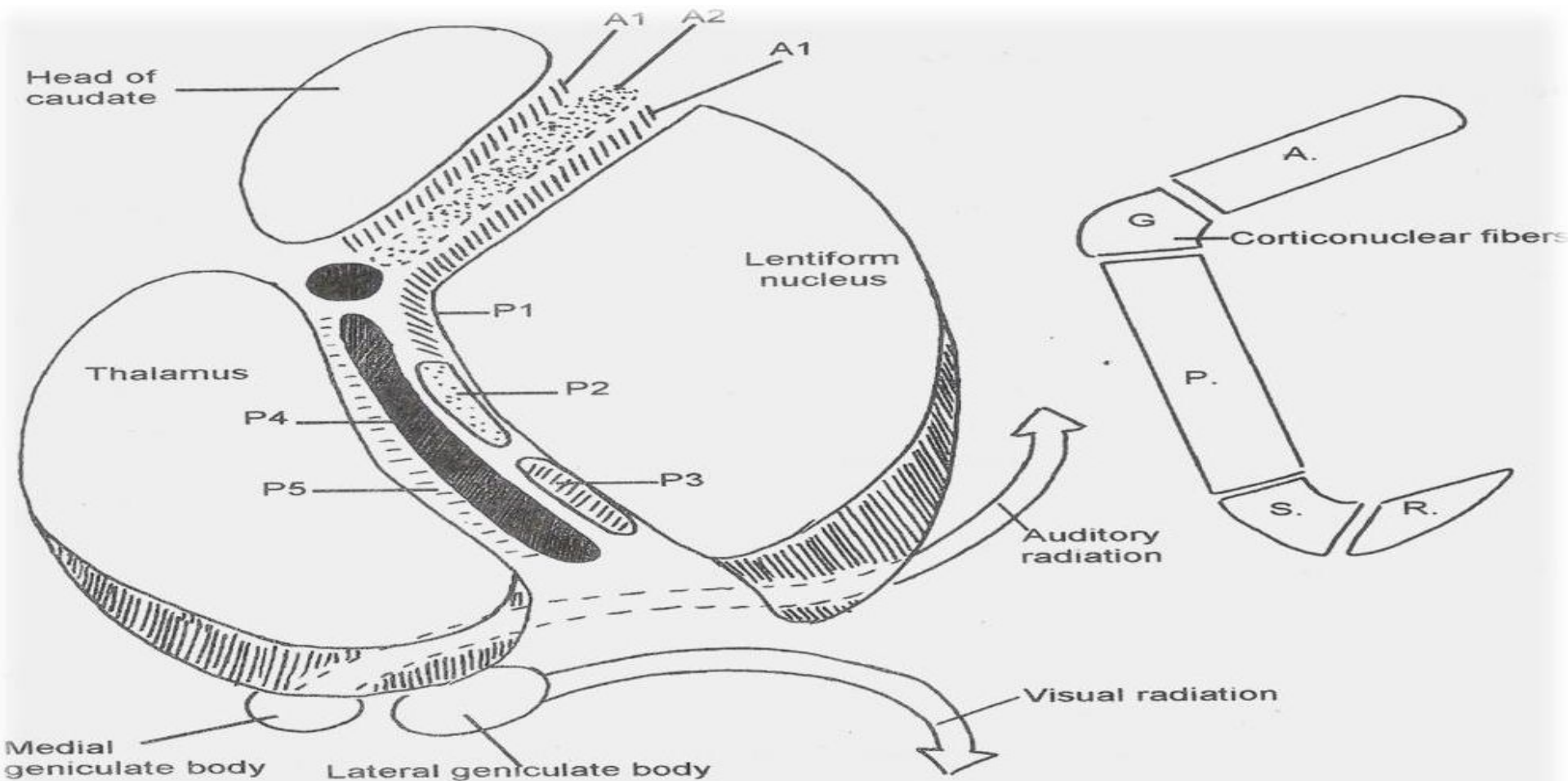
- **It contains the following fibers:**

- 1. Ascending fibers:**

- **Optic radiation** (from the lateral geniculate body, and ascend to reach the visual cortex of occipital lobe.
- **Posterior thalamic radiation:** from the thalamus, and ascend to reach cortex of occipital and temporal lobes

- 2. Descending fibers:** Parieto-pontine tract and occipito-pontine tract.

Internal Capsule

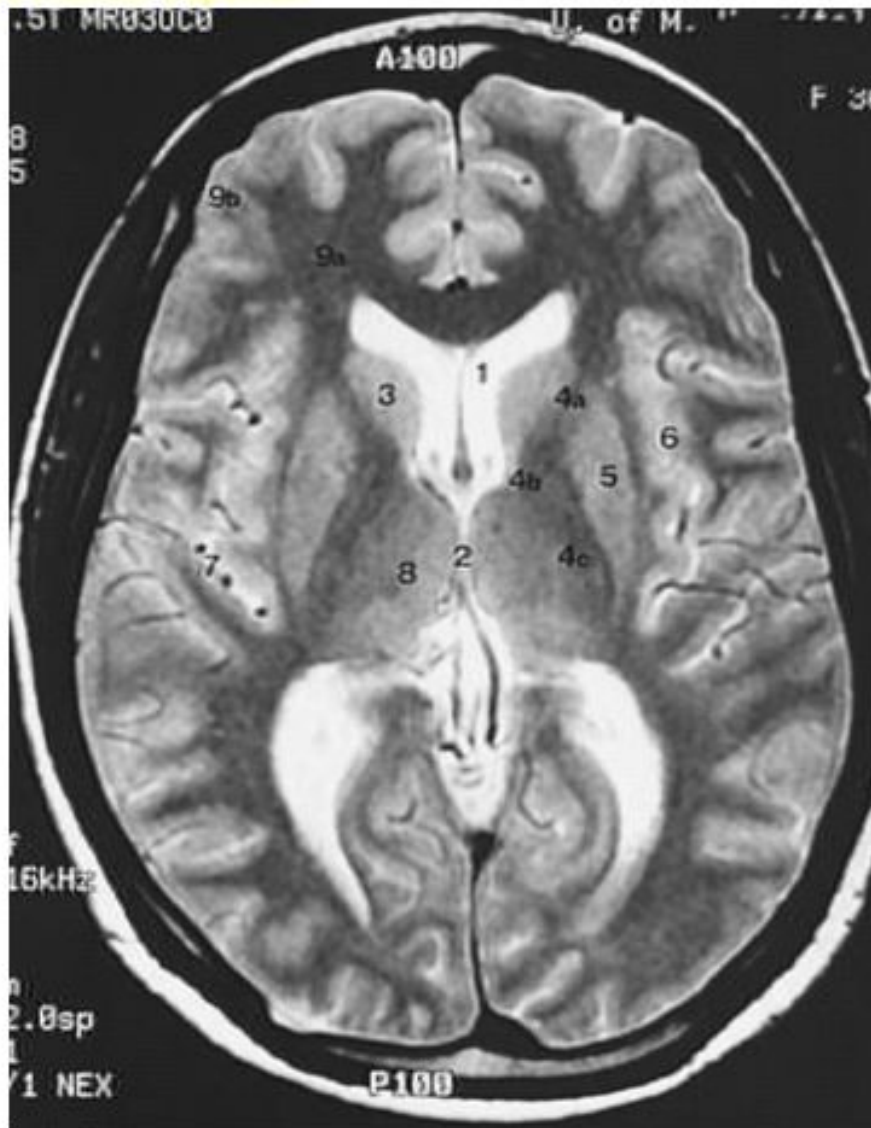


A : Anterior limb
 A1 Frontopontine fibers
 A2 Anterior thalamic radiation

G : Genu
 P : Posterior limb.

P1: Frontopontine fibers.
 P2: Corticorubral fibers.
 P3: Corticostriate fibers.
 P4: Corticospinal fibers.
 P5: Sensory radiation.

S : Sublenticular part.
 R : Retrolenticular part.



1. Lateral ventricle
2. Third ventricle
3. Caudate nucleus
4. a. Anterior limb of internal capsule
b. Genu of internal capsule
c. Posterior limb of internal capsule
5. Lentiform nucleus
6. Insula
7. Insular artery
8. Thalamus
9. a. White matter
b. Gray matter

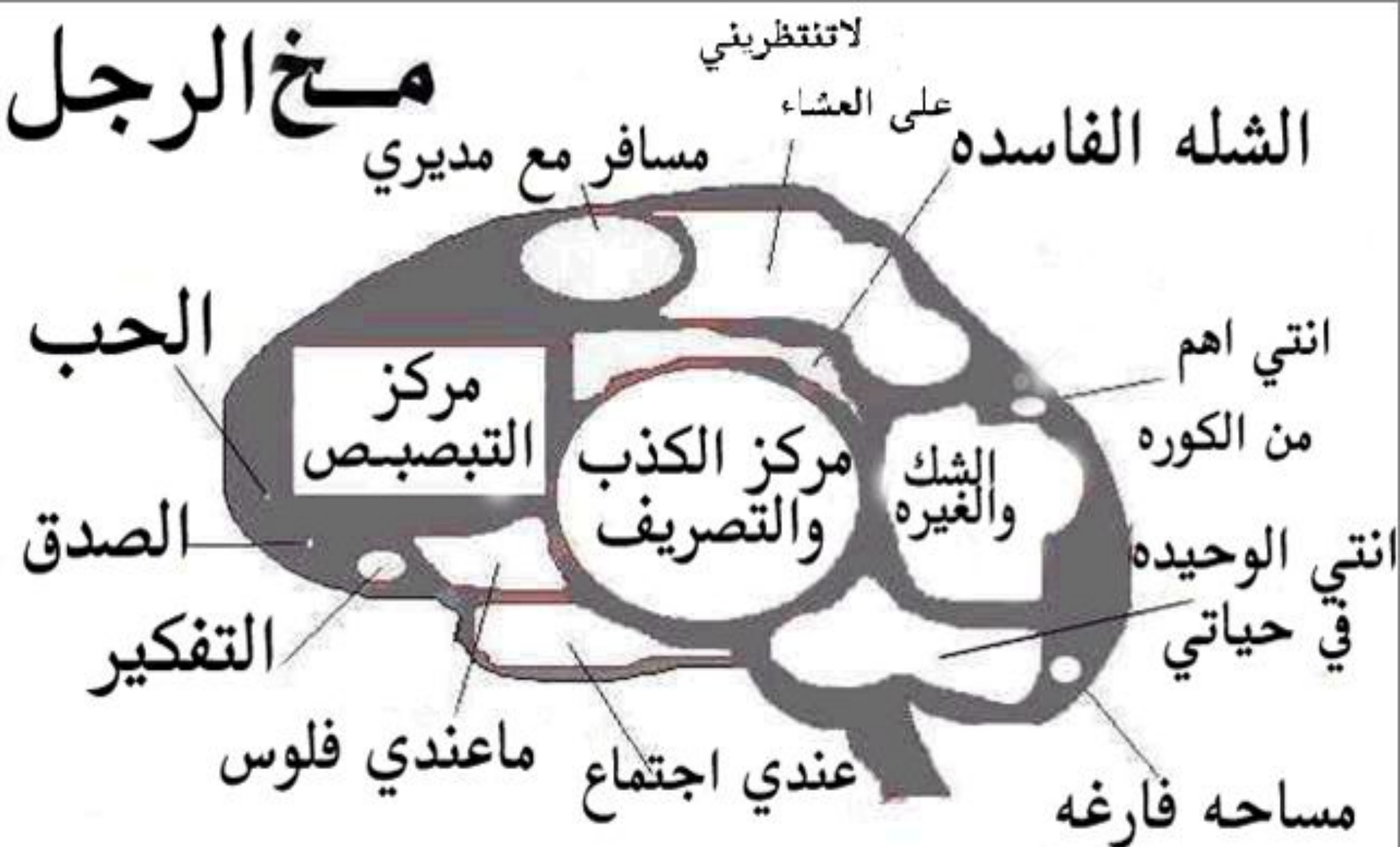
Lesion of the Internal Capsule

1. **Corticospinal fibers injury:** Leads to contralateral hemiplegia (UMNL).
2. **Corticonuclear fibers injury:** leads to contralateral facial palsy (UMNL) and hypoglossal palsy (UMNL).
3. **Sensory radiation injury:** leads to contralateral loss of pain, temperature, touch and proprioception.
4. **Optic radiation injury:** leads to contralateral homonymous hemianopia.

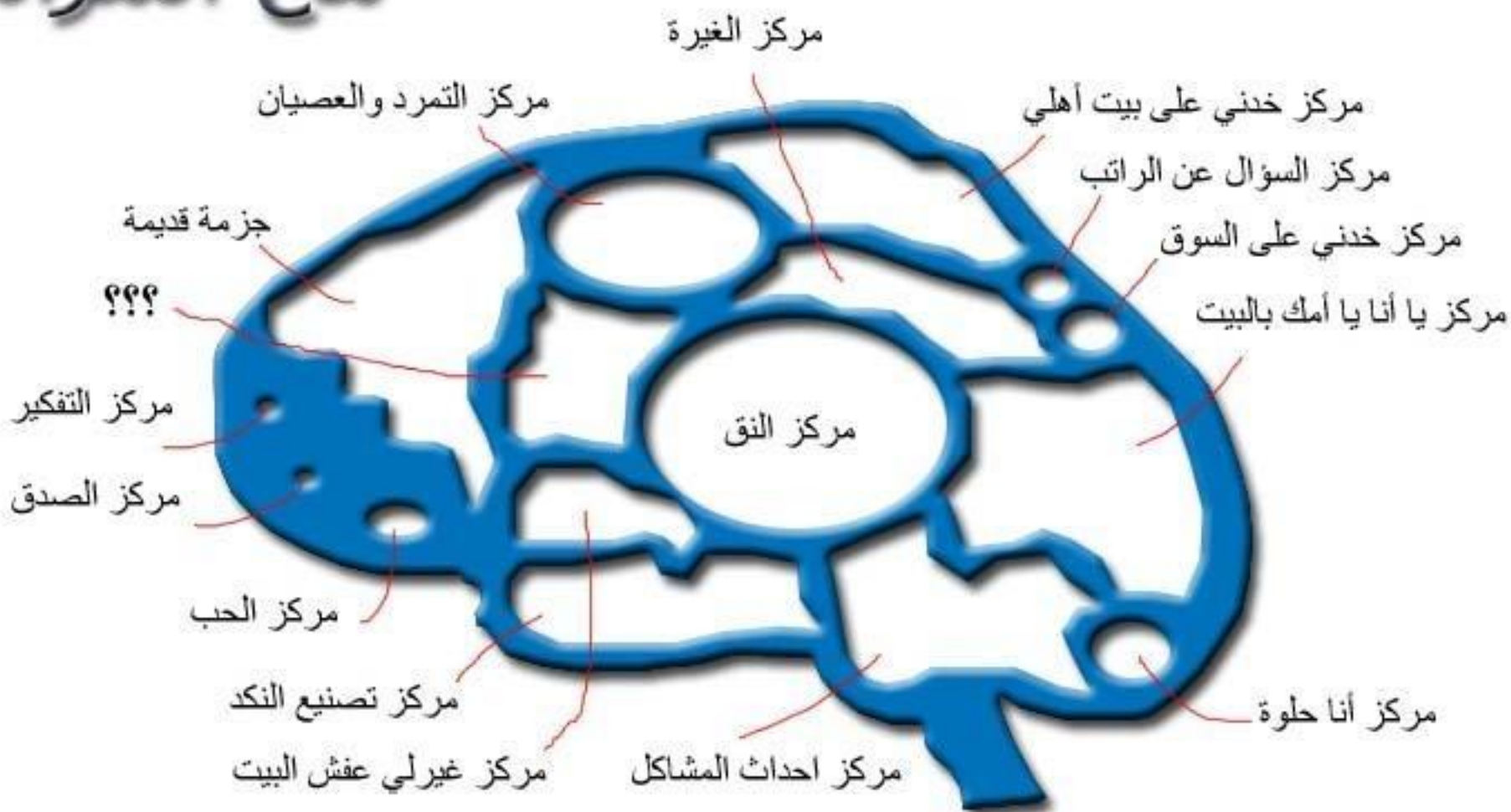
The Common and Most Significant Brodmann's Areas “Functional Areas” of Cerebral Hemisphere

- Each hemisphere is divided into 5 lobes: **frontal, parietal, temporal, and occipital and Insular gyrus (Insula or Island of Reil).**
- Brodmann's areas refer to 47 regions of the cerebral cortex that were identified in **1909** by **German Neurologist, Dr. Korbinian Brodmann's.**
- Based on studies of the cytoarchitecture differences (brain cell size, neurons density, and thickness of the 6 layers) using **nissl-stained sections.**

مخ الرجل



مخ المرأة



The Important Functional Areas of the Frontal Lobe

Areas	Site	Function	Lesion
Primary motor cortex (4)	Precentral gyrus & anterior paracentral lobule	Voluntary motor activity of opposite 1/2 of the body	Irritative: contralateral motor Jacksonian fit Destructive: contralateral motor paresis.
Secondary motor (Premotor) cortex (6)	Anterior part of precentral gyrus in the superior frontal gyrus	Gives extrapyramidal fibers	Contralateral muscle hypertonia & exaggerated deep reflexes +ve plantar reflex
Frontal eye conjugate (8)	Middle frontal gyrus	Voluntary conjugate deviation of eyes to opposite side	Irritative: conjugate deviation of eyes to the opposite side Destructive: conjugate deviation of eyes to the same side.
Broca's area (44 & 45)	Inferior frontal gyrus in domin. hemisphere	Motor center of speech.	Motor (Expressive or Broca's) aphasia: the pt. unable to express idea in spoken words
Prefrontal Areas (9-12, 32, 46 & 47)	Anterior pole	Higher center of memory, orientation, thinking and intelligence	Amnesia (impaired of memory), Dementia, gait apraxia Disorientation, behavior changes Loss of personal hygiene "careless" Sphincters dysfunction,

The Important Functional Areas of the Parietal Lobe

Areas	Site	Function	Lesion
Primary somatosensory cortex (1,2, 3)	Postcentral gyrus & posterior paracentral lobule	Perception of cortical sensation from opposite 1/2 of the body	Irritative: numbness and tingling “paresthesia” Destructive: contralateral sensory loss, usually affecting one limb
Secondary Sensory, or Sensory Association cortex (5, 7)	Posterior to the primary somatosensory cortex	Somatosensory processing “detailed discrimination and analysis of sensory information”	Neglect syndrome (Failure to recognize side of body contralateral to injury) and ignore objects in contralateral visual (area 7). Asteriognosis: inability to recognize the felt objects
Angular gyrus, (39)	Surround the upper end of superior temporal sulcus in the inferior parietal lobe	Visual association cortex (recognition of letters & numbers). Receives input from areas 18 and 19	Contralateral homonymous lower quadrantanopia Destruction in the dominant hemisphere results in Gerstmann syndrome: - Right–left confusion - Finger agnosia - Agraphia - Acalculia - Alexia - Anomia
Supramarginal gyrus, (40)	Surround the upper end of lateral sulcus	Associative area and center for complex movement.	Jargon’s aphasia Apraxia.
Primary Gustatory Cortex (43)	Anterior part of parietal operculum	Perception of taste sensation from opposite 1/2 of the tongue and epiglottis	Contralateral loss of taste sensation “Ageusia”

The Important Functional Areas of the Temporal Lobe

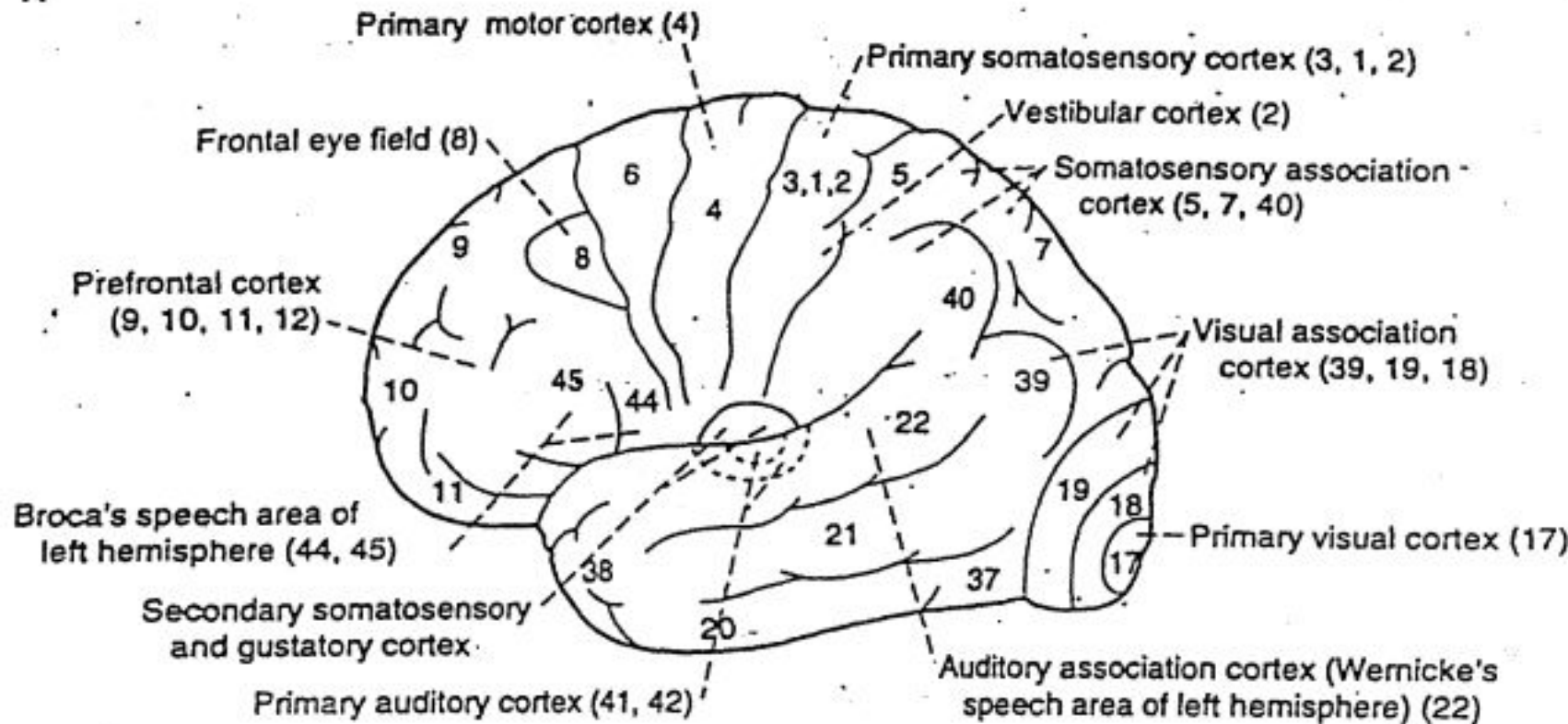
Areas	Site	Function	Lesion
Primary auditory cortex (41 , 42)	Transverse temporal gyrus of Heschl	Auditory sensory area	Irritative: aud. hallucination Destructive: Unilateral lesion results in only partial deafness (due to bilateral cochlear representation).
Sensory speech or Wernicke's center (21 , 22)	In the superior temporal lobe of dominant hemisphere	Auditory association area (recognition & recall of sounds).	Sensory or Wernicke's aphasia): the pt. hears but does not understand sound.
Area 37	posterior-inferior part of temporal lobe.	recall its name of persons and objects	Anomia: difficulty with word-finding or naming the persons or objects (but can list functions of an object & explain its meaning).
Entorhinal area: Uncus, Hippocampus (28 , 34)	Inferio-medial surface of the temporal lobe	Sense of smell Memory, Navigation, and perception of time	Irritative: olfactory hallucination Destructive: Unilateral lesion of temporal lobe does not cause anosmia as the sense of smell is bilateral represented Dementia Alzheimer disease Temporal lobe epilepsy

The Important Functional Areas of the Occipital Lobe

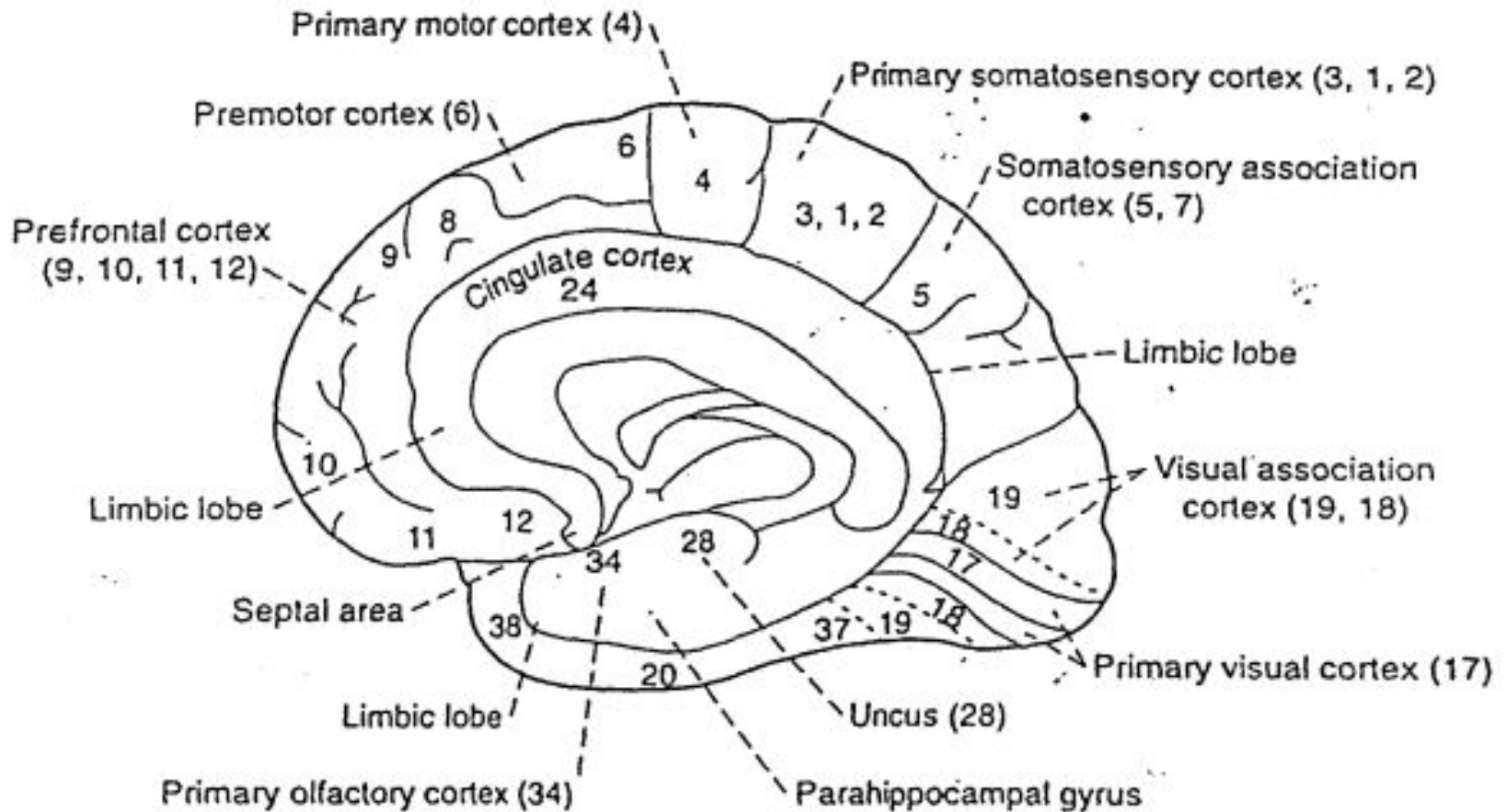
Areas	Site	Function	Lesion
Primary visual sensory cortex (17)	Posterior medial part of occipital lobe (surrounds calcarine sulcus)	Visual sensory area (Receives visual input from the lateral geniculate body)	Irritative: visual hallucination Destructive: contralateral homonymous hemianopia with macular sparing
Secondary & Tertiary Visual cortex or Association visual cortex (18, 19)	Anterior to area 17	Visual association or processing area (Recognition & recall of image).	Visual agnosia: patient can see but does not recognize objects Visual hallucinations

The Important Functional Areas of the Frontal Lobe

A

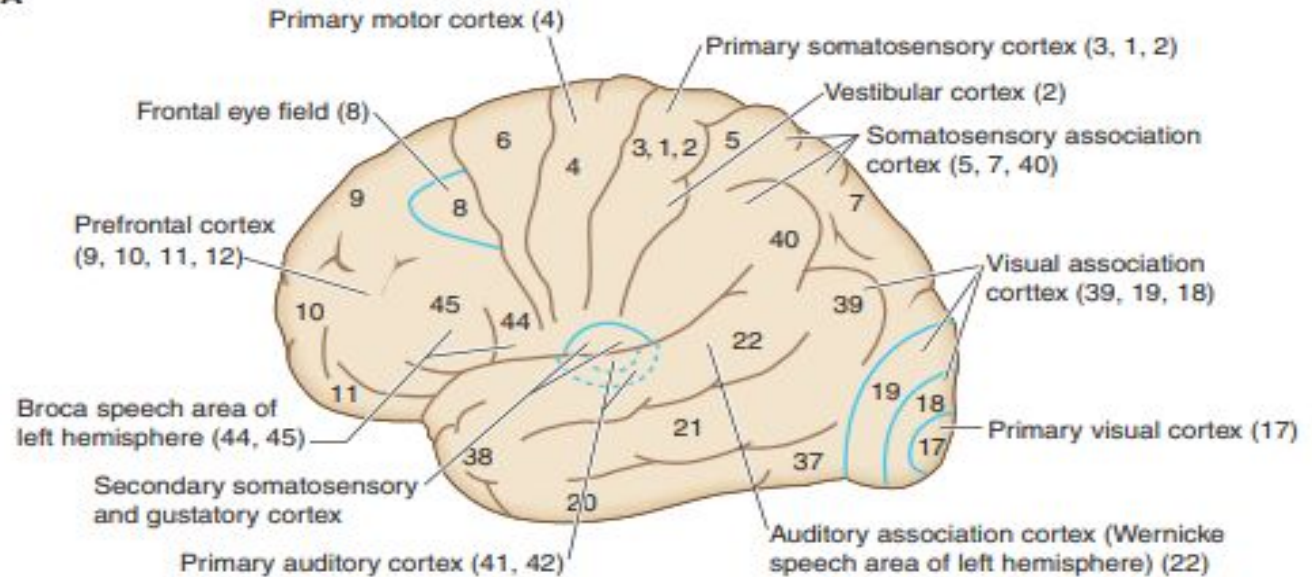


The Important Functional Areas of the Frontal Lobe

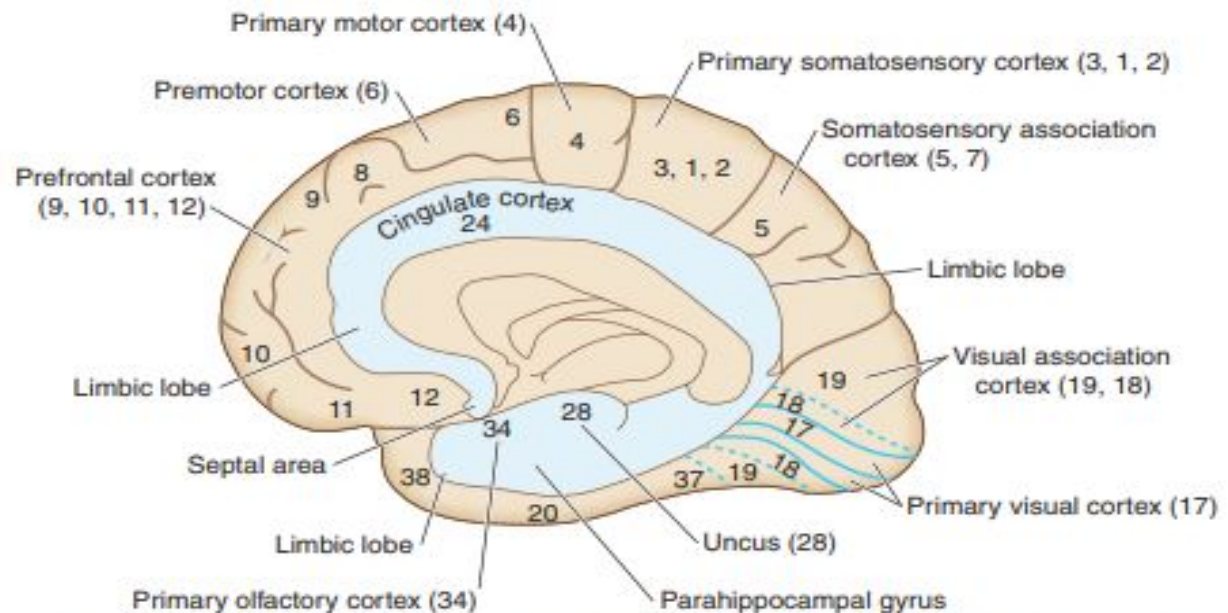


The Important Functional Areas of the Frontal Lobe

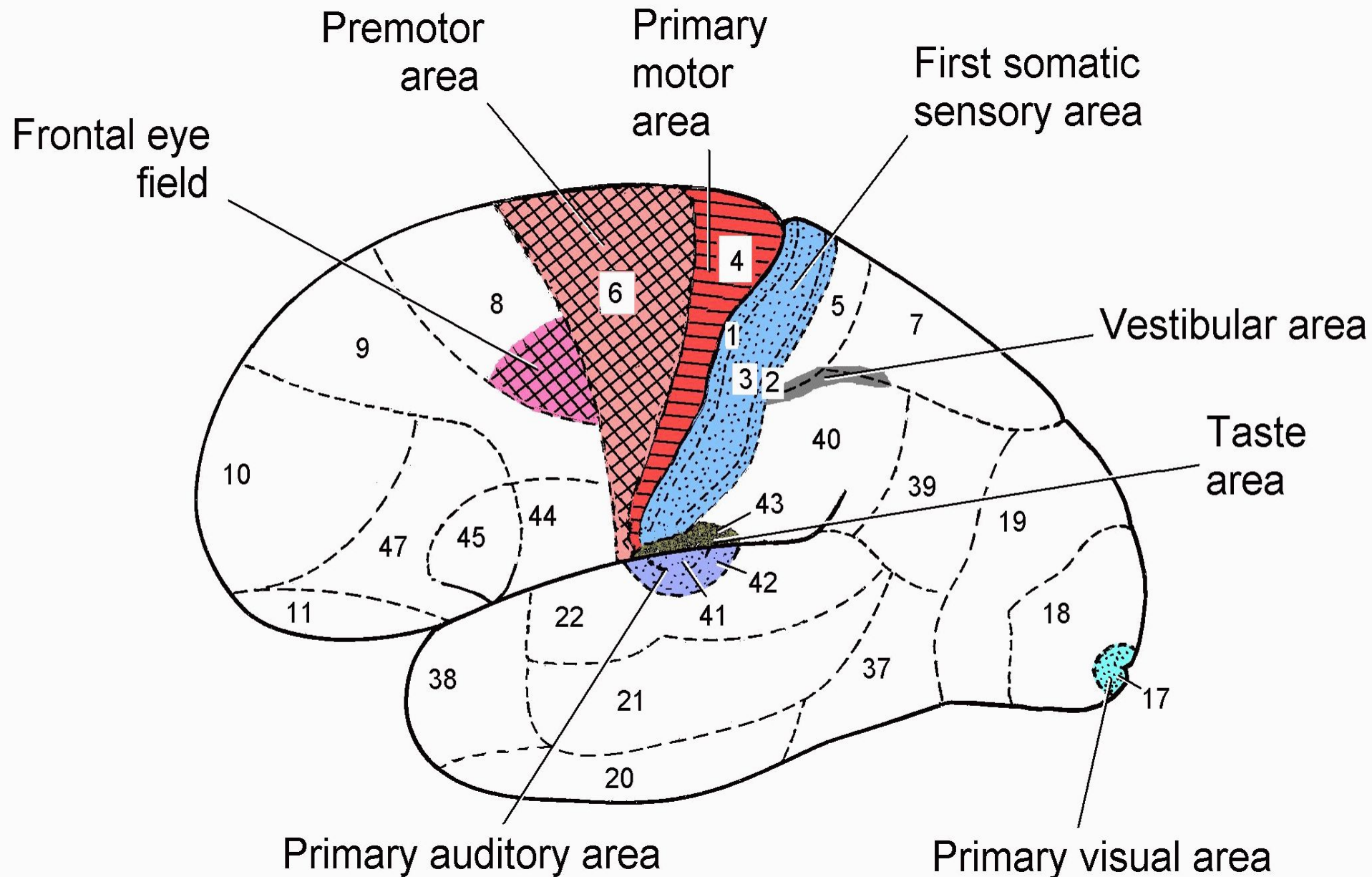
A



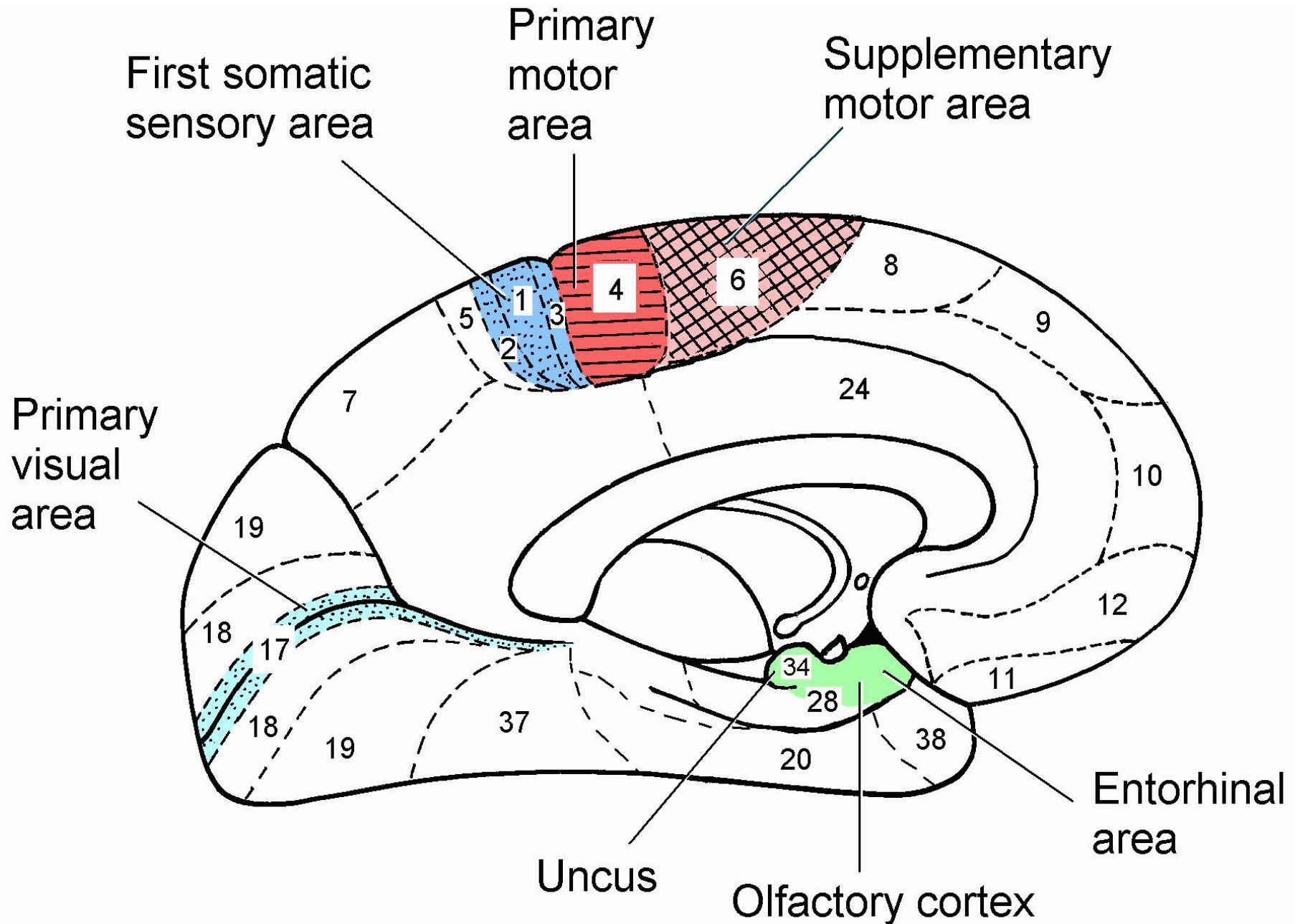
B



The Important Functional Areas of the Frontal Lobe



The Important Functional Areas of the Frontal Lobe



Cerebral Dominance

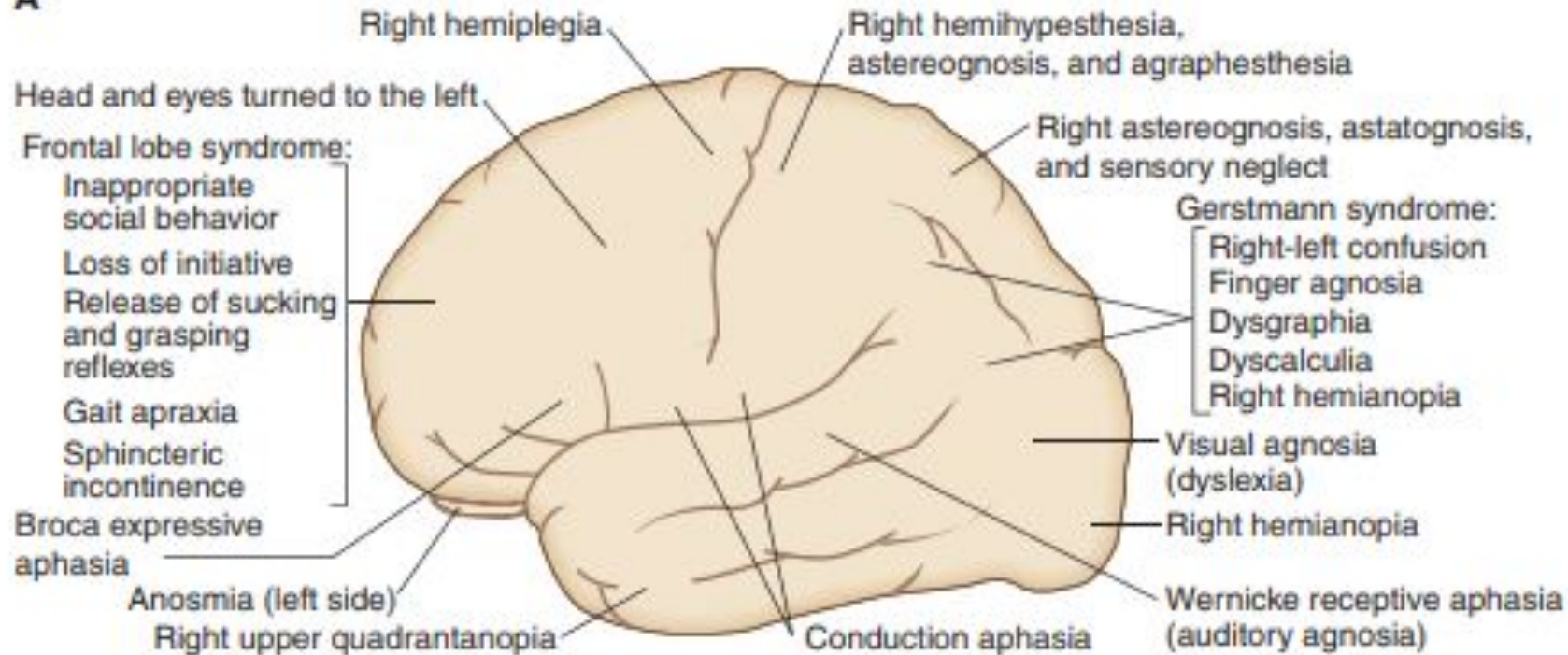
- The left hemisphere is **dominant in 95% of cases.**
- Responsible for language, speech and calculation.
- 75% of the population is **right handed** with language center on the left side of the brain .
- About 50-70% of the **left handed** people also with their language center on the left side.

Lesion of Dominant Cerebral Hemisphere

- **Lesion of dominant superior parietal lobe (areas 5, 7):**
Astereognosis and contralateral neglect (area 7).
- **Lesions of the dominant inferior parietal lobe (supramarginal and angular gyri “areas 40 & 39”):**
Gerstmann syndrome, apraxia and Jargon’s aphasia.
- **Sensory speech or Wernicke’s center (area 22):** Sensory aphasia.
- **Motor speech or Broca’s area (area 44 & 45):** Motor (Expressive or Broca's) aphasia

Lesion of Dominant Cerebral Hemisphere

A



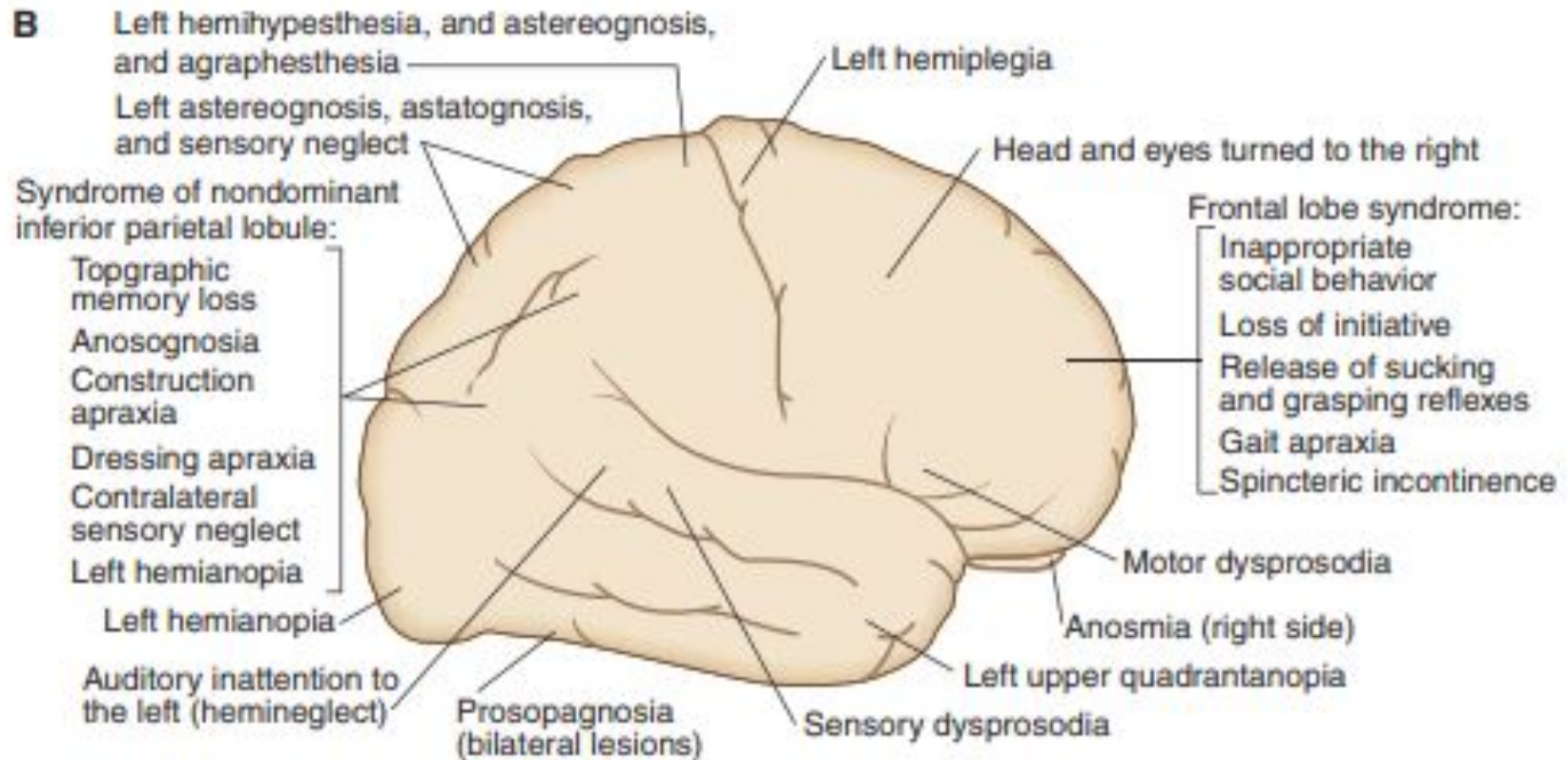
Lesion of Nondominant Cerebral Hemisphere

- **Lesion of nondominant superior parietal lobe (areas 5 , 7):** contralateral loss of sensory discrimination (**area 5**) and contralateral neglect (**area 7**).
- **Lesion of the nondominant inferior parietal lobe:** (supramarginal and angular gyri “**areas 40 & 39**”):
 - Left-sided hemineglect
 - Topographic memory loss
 - Anosognosia
 - **Constructional apraxia:** inability to draw simple designs
 - **Dressing apraxia:** in the inability to dress oneself

Lesion of Nondominant Cerebral Hemisphere

- **Lesion of the nondominant inferior frontal gyrus (areas 44 and 45):** correspond to Broca's speech area:
 - ✓ **Expressive dysprosody** (the inability to articulate the pitch and rhythm of speech).
- **Lesions of the nondominant superior temporal gyrus (area 22):** correspond to Wernicke speech area:
 - ✓ **Receptive dysprosody** (the inability to perceive pitch and rhythm of speech).

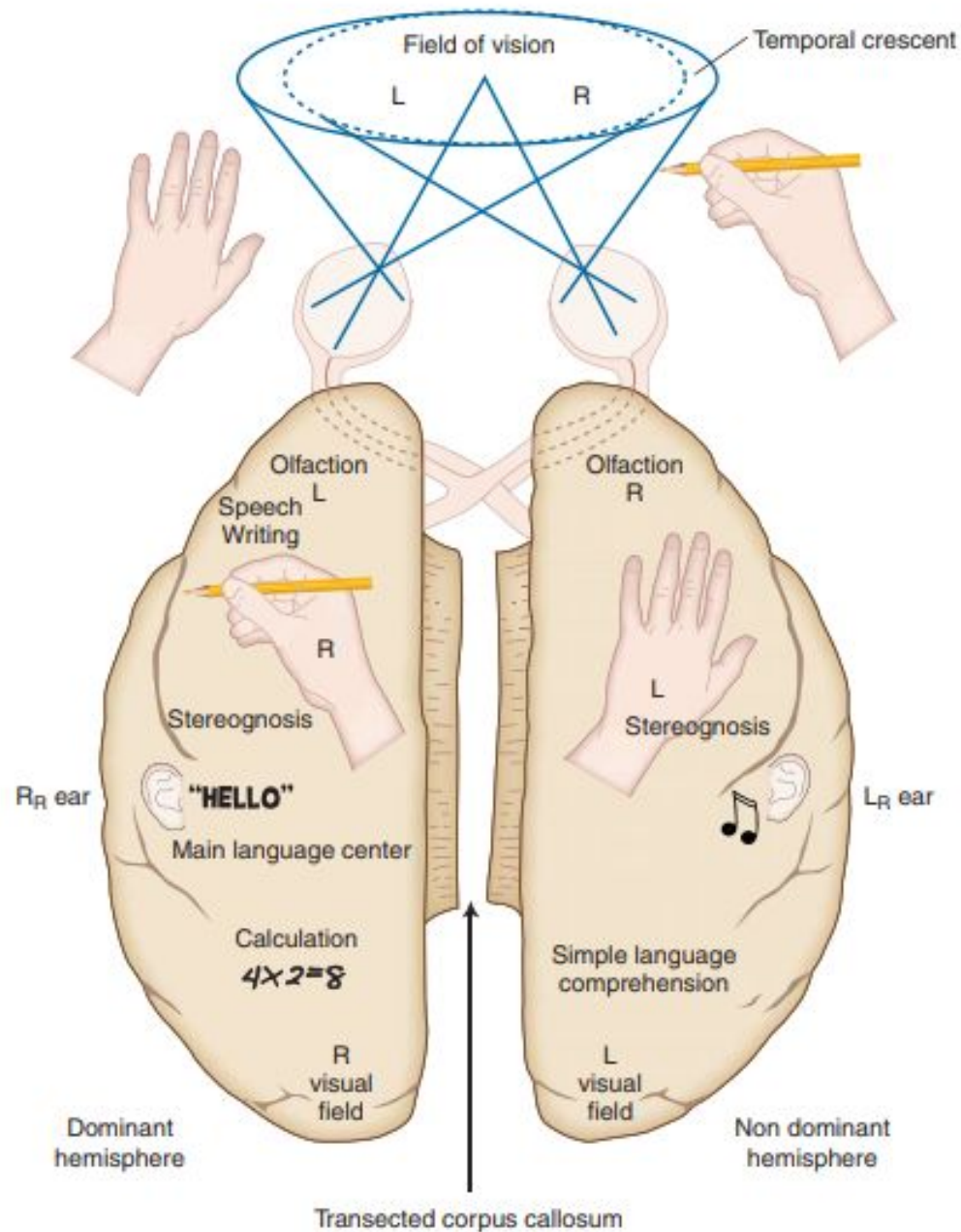
Lesion of Nondominant Cerebral Hemisphere



Split-Brain Syndrome

- **Split-brain syndrome (Brain disconnection syndrome):** results from transection (commissurotomy) of the corpus callosum.
- **Deficits:**
 - ✓ **Anomia:** Inability to correctly name objects placed in the left hand.
 - ✓ **Alexia:** in the left visual fields (the right visual cortex have no access to the language centers of the left hemisphere).
 - ✓ Inability to match an object held in one hand with that held in the other hand.

Split-Brain Syndrome



Blood Supply to the Major Functional Cortical Areas

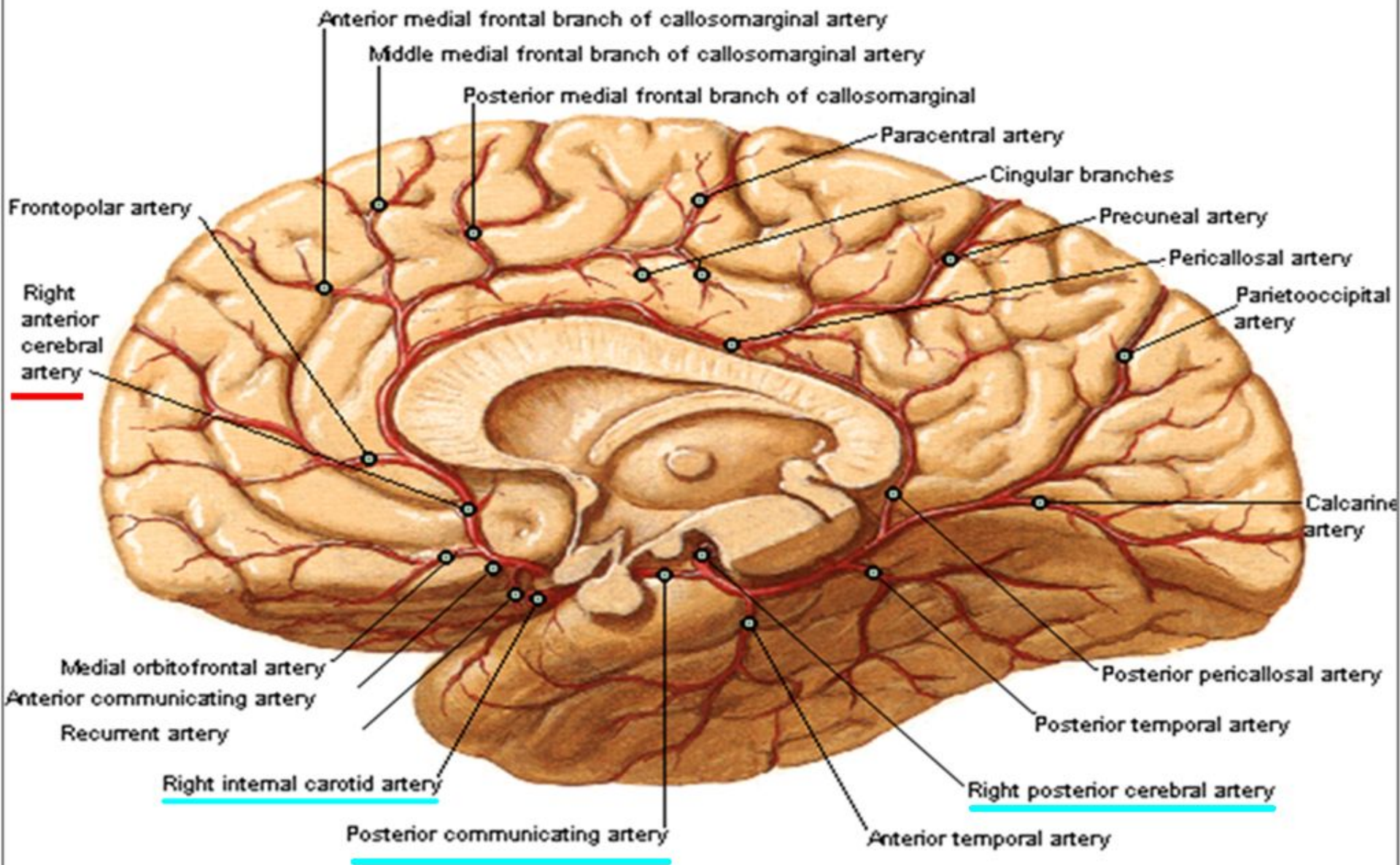
A. Territory of Anterior Cerebral Artery (ACA):

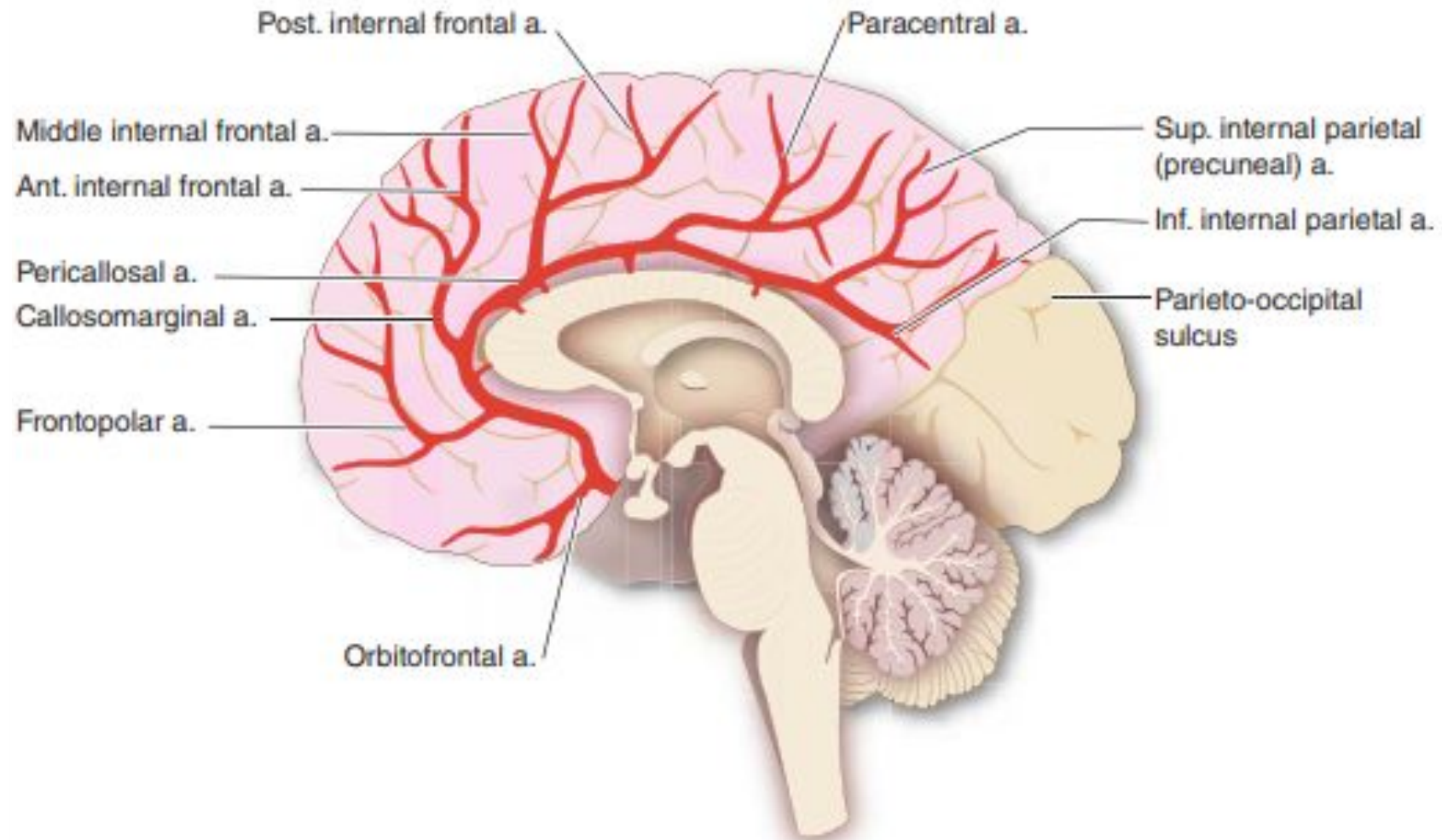
- Medial surface of the cerebral hemisphere from frontal pole to the parieto-occipital sulcus.
 - Medial 1/3 of the orbital surface of the frontal lobe.
 - Superior lateral surface of cerebral hemisphere (except occipital lobe).
 - Part of the corpus callosum.
 - Anterior part of lentiform nucleus.
 - Head of caudate nucleus.
 - Anterior part of anterior limb of internal capsule.

N.B.: The ACA supplies motor and sensory areas of the LL.

Arteries of Brain

Medial View





Occlusion of the main Anterior Cerebral Artery

1. Paracentral lobule lesion:

- Contralateral somatosensory loss in the lower extremity with paresthesia, numbness, and loss of vibration sensation.
- Contralateral weakness and hyperreflexia in the lower extremity with the Babinski sign.
- Urinary incontinence with bilateral infarction.

2. Corpus Callosum lesion:

- Apraxia.

3. Frontal pole lesion:

- Mentality and personality changes.

B. Territory of Middle Cerebral Artery (MCA)

1. Cortical branches: supply:

- Lateral 2/3 of the orbital part of frontal lobe.
- Temporal pole and insula.
- Most of the lateral surface of cerebral hemisphere

Except:

- **The upper part (superior inch):** supplied by the ACA.
- **Lower part of temporal lobe:** supplied by the PCA.
- **Occipital lobe:** supplied by the PCA .

2. Central Branches: are many branches called striate arteries:

a. Medial striate arteries: supply:

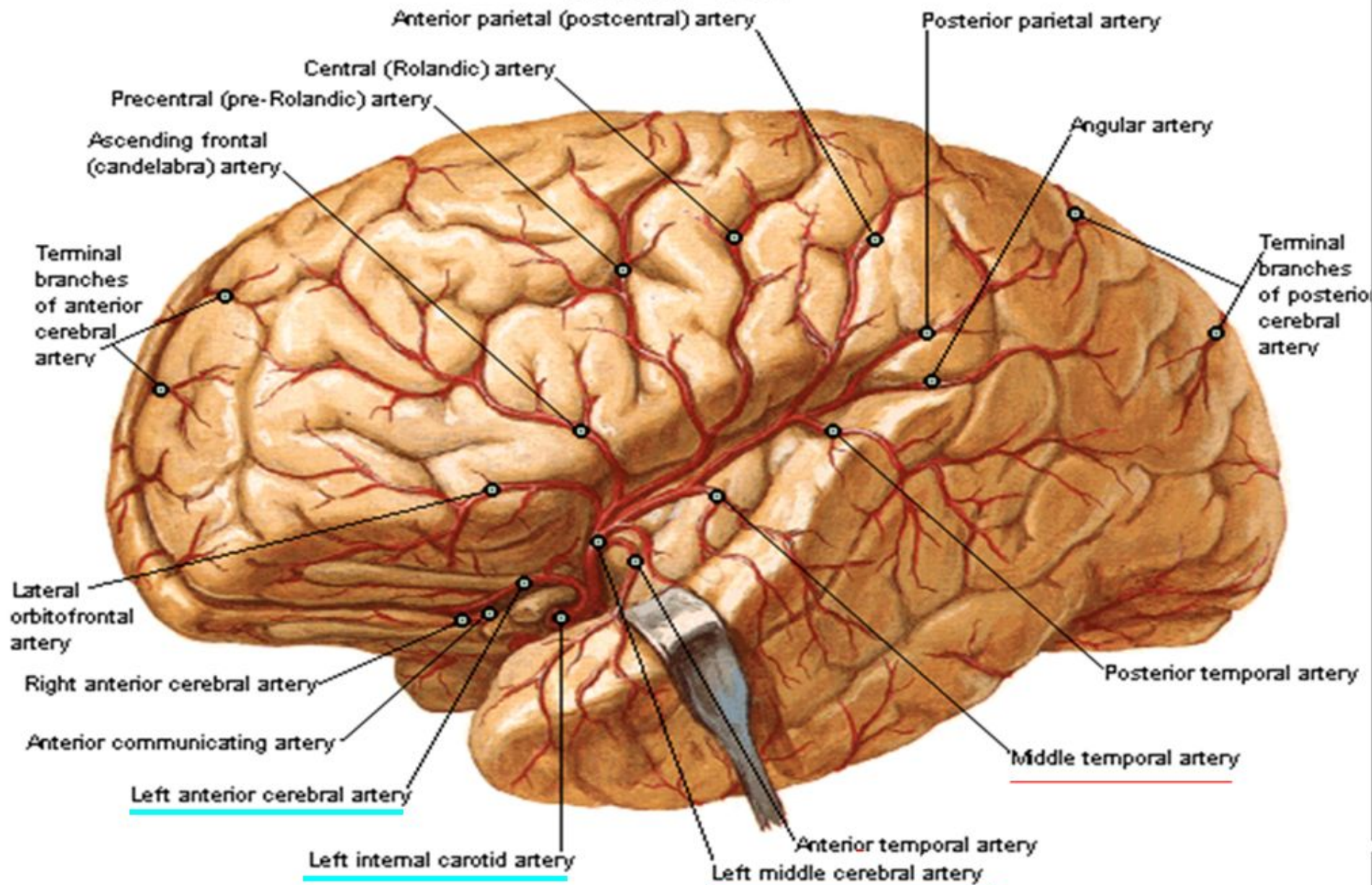
- Posterior part of lentiform nucleus.
- Body of caudate nucleus.
- The most of the internal capsule (posterior limb, genu, and posterior part of anterior limb).

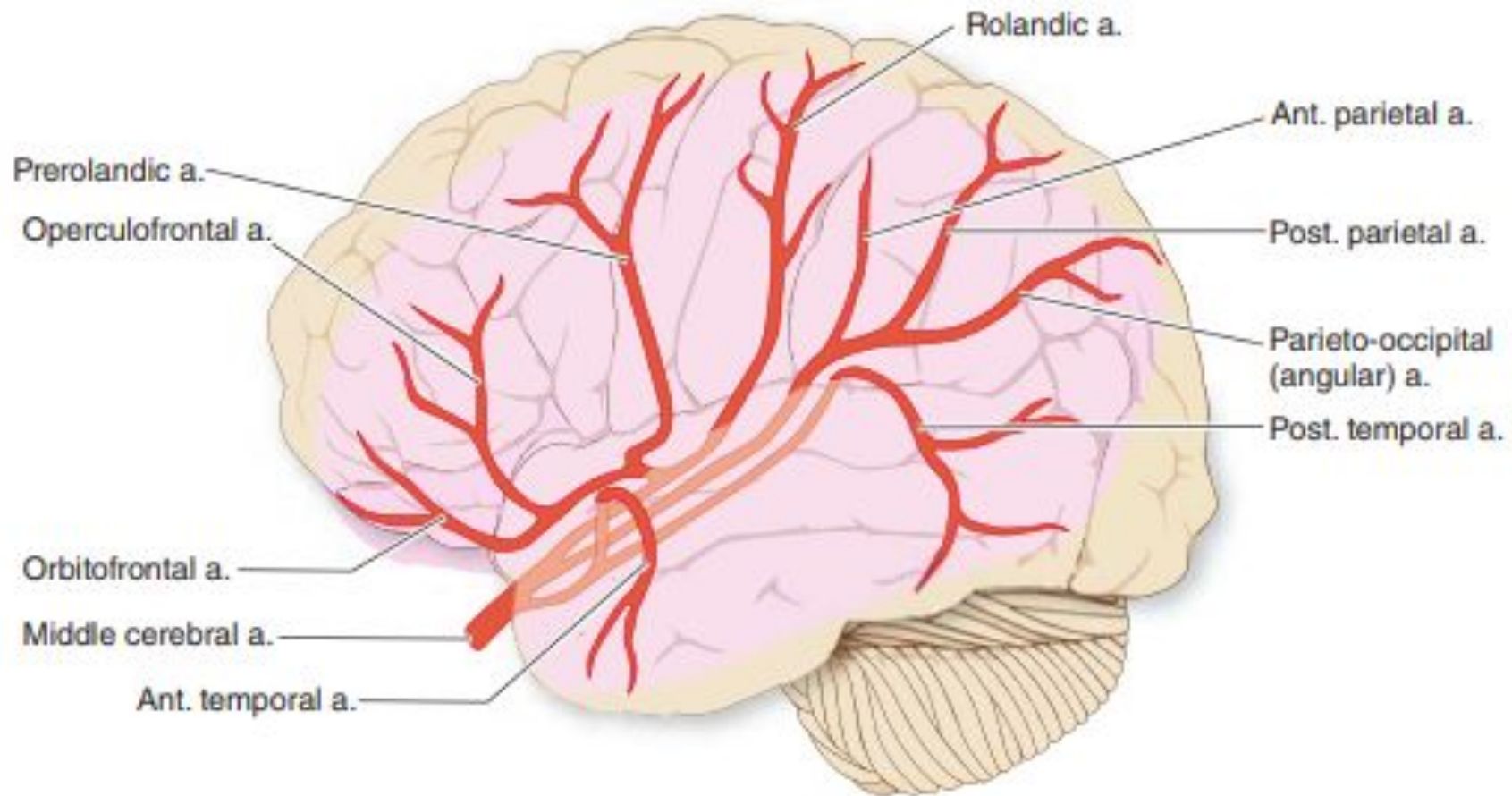
b. Lateral striate arteries: supply the:

- Corpus striatum (lentiform & caudate).
- Most of the internal capsule.
- One of these arteries is large and is liable to hemorrhage it is called the artery of cerebral hemorrhage (**Charcot's artery**).

Arteries of Brain

Lateral View





Occlusion of the main Middle Cerebral Artery

1. Frontal Lobe:

- A. Precentral gyrus:** contralateral facial weakness and weakness in the upper extremity “Contralateral faciobrachial type hemiplegia”.
- B. Frontal eye field:** conjugate deviation of the eyes to the affected side
- C. Prefrontal cortex:** frontal lobe syndrome.
- D. Inferior frontal gyrus of the dominant side:** Broca’s expressive aphasia, agraphia and contralateral weakness of the lower face and arm.



2. Temporal Lobe:

- A. Transverse temporal gyri:** deafness with bilateral destruction.
- B. Superior temporal gyrus of the dominant side:**
Wernicke receptive aphasia.
- C. Superior and middle temporal gyri (superolateral parts):** auditory hallucinations.

3. Parietal Lobe:

A. Postcentral gyrus and superior parietal lobule:

- Loss of sensory discrimination and stereognosis.
- Hemineglect (may occur with either left or right parietal lesions).

B. Inferior parietal lobule of the dominant hemisphere:

- Apraxia.
- Gerstmann syndrome.

C. Inferior parietal lobule of the nondominant hemisphere:

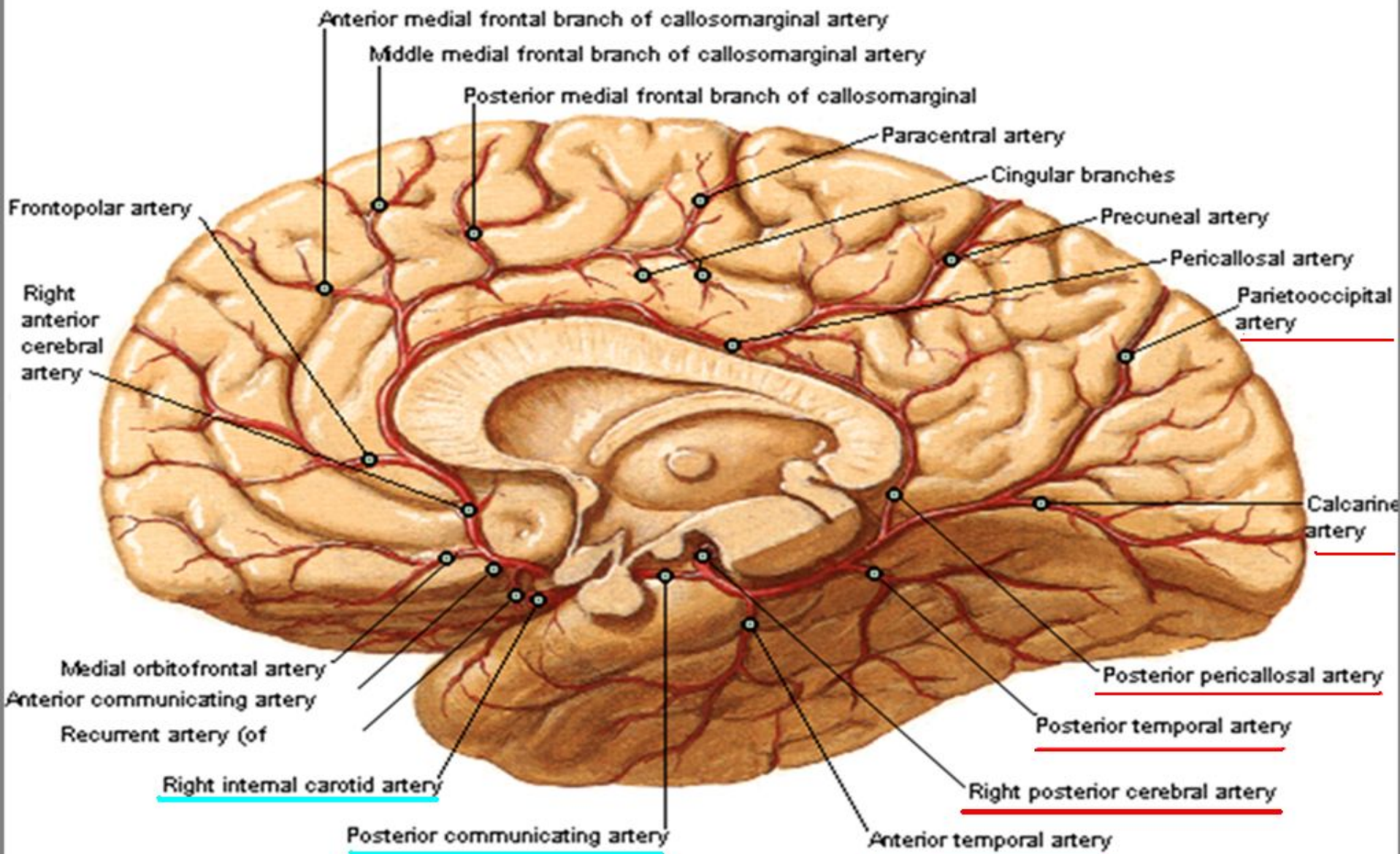
- Hemineglect syndrome.
- Topographic memory loss.
- Anosognosia.
- Dressing apraxia.

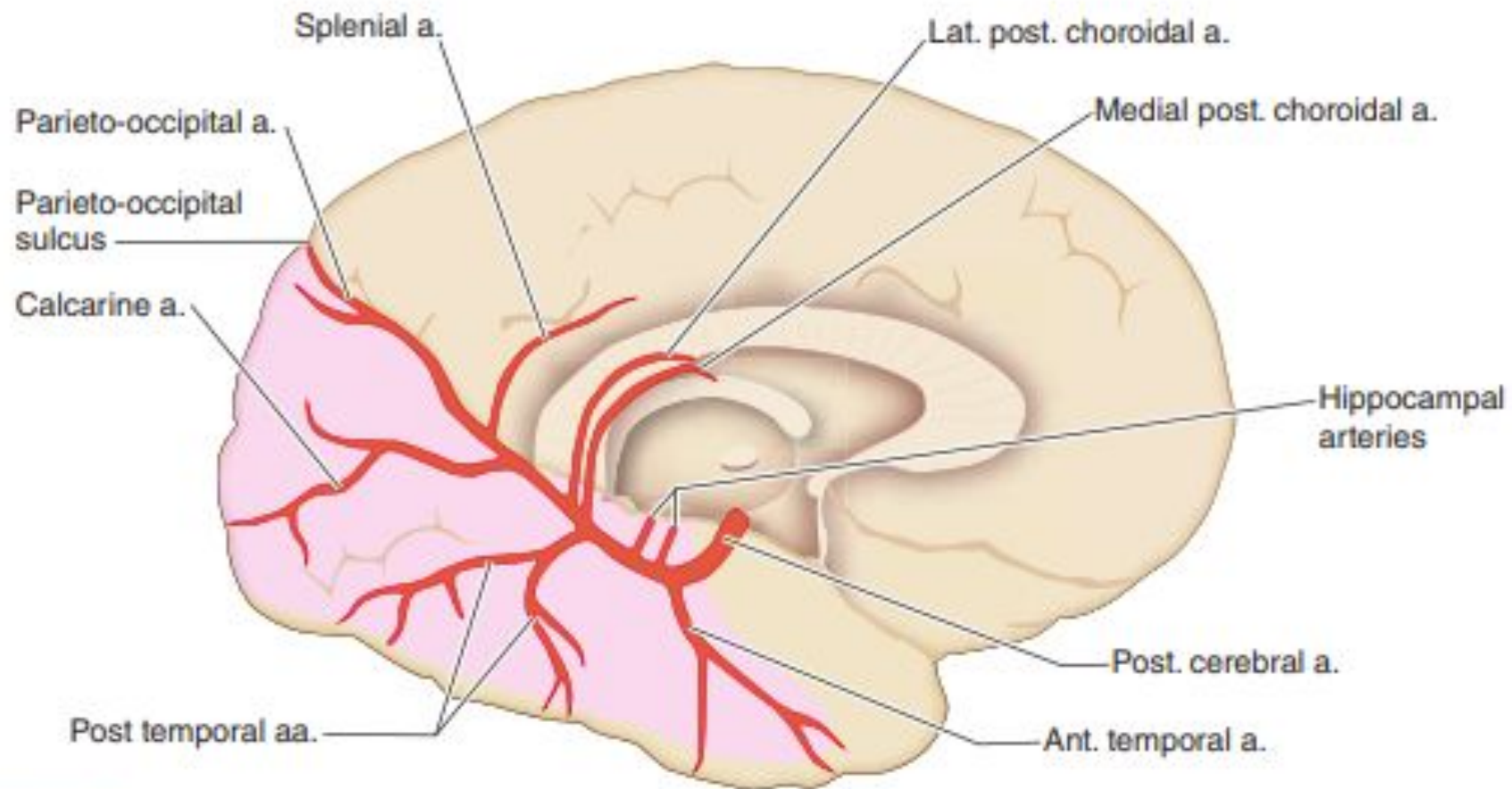
B. Territory of Posterior Cerebral Artery (PCA)

- Inferolateral part of temporal lobe.
- Occipital lobe.
- Splenium of the corpus callosum.
- Diencephalon
- Midbrain.
- Choroid plexuses of lateral and third ventricles.

Arteries of Brain

Medial View





Occlusion of the main Posterior Cerebral Artery

A. Occipital lobe (visual cortex):

- **Unilateral Lesion:** contralateral homonymous hemianopia with macular sparing.
- **Bilateral Lesion:** cortical blindness (pupils are reactive to light).

B. Temporal lobe (inferomedial aspect): hippocampal formation and amygdala.

- Memory deficit (amnesia).

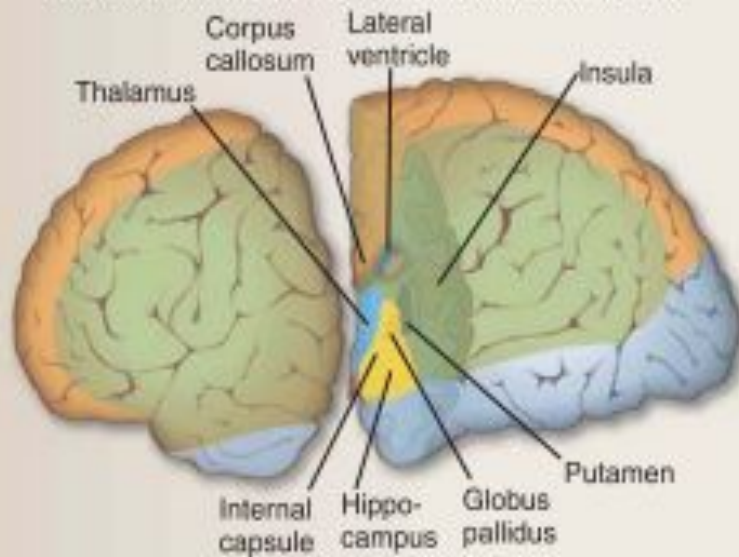
C. Occipitotemporal region:

- Bilateral lesions may result in **prosopagnosia** (the inability to identify a familiar face) and acquired color blindness.

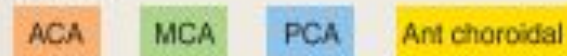
D. Splenium of the corpus callosum and the left visual cortex:

- Visual input from the right visual cortex cannot reach the parietal language centers of the dominant hemisphere, may cause alexia without agraphia and aphasia.

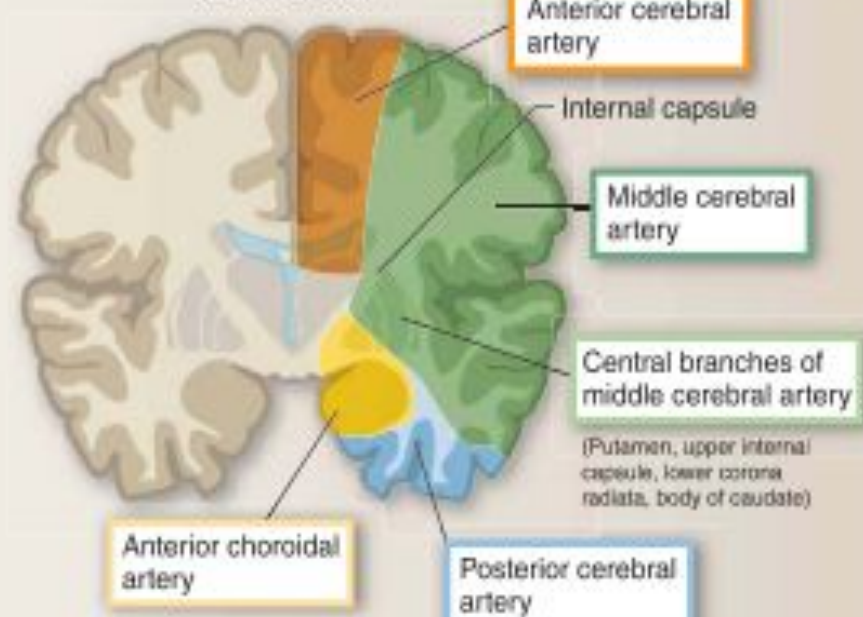
Lateral view Coronal section through left cerebral hemisphere



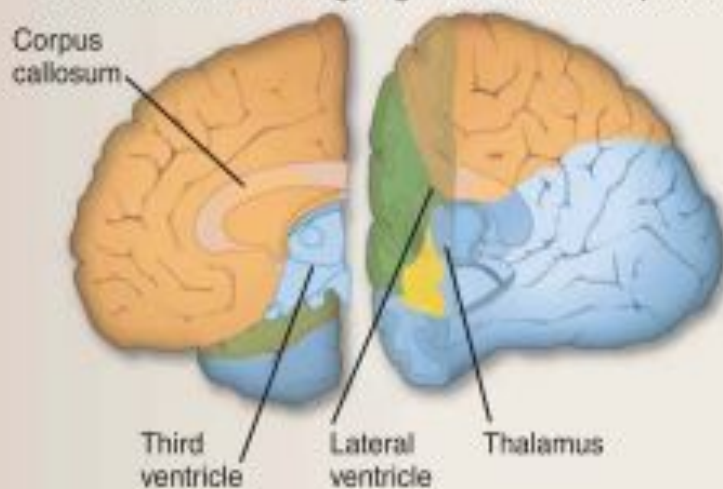
Arteries



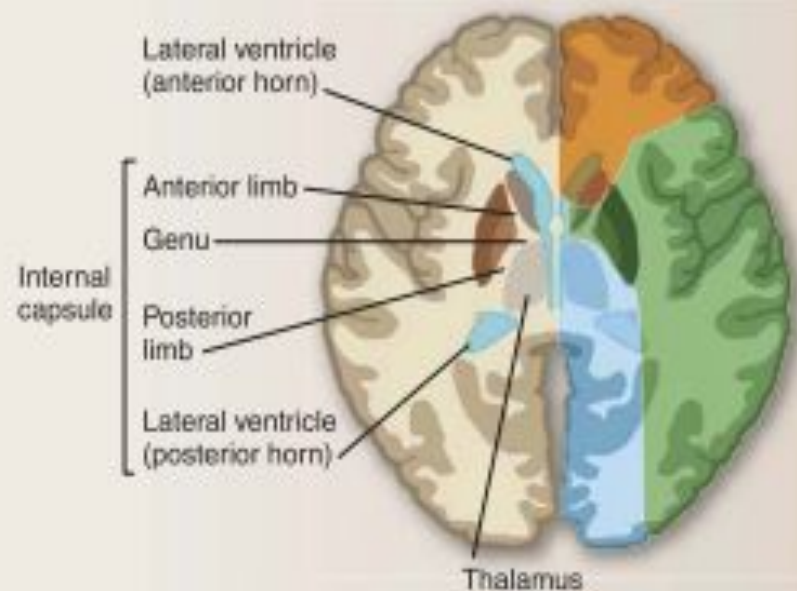
Coronal view



Medial view Coronal section through right cerebral hemisphere



Horizontal view



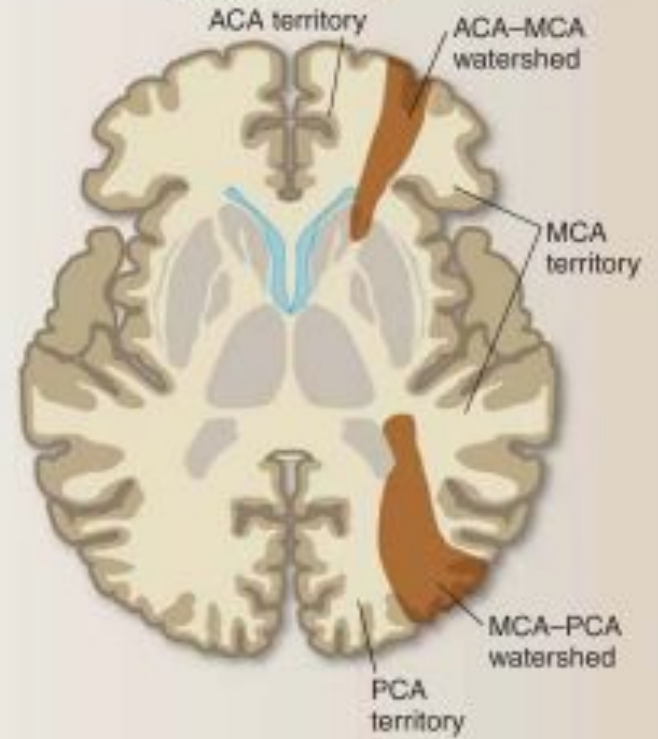
Lateral view of left hemisphere



Medial view of left hemisphere



Horizontal view



MCA

ACA

PCA

Inferior view



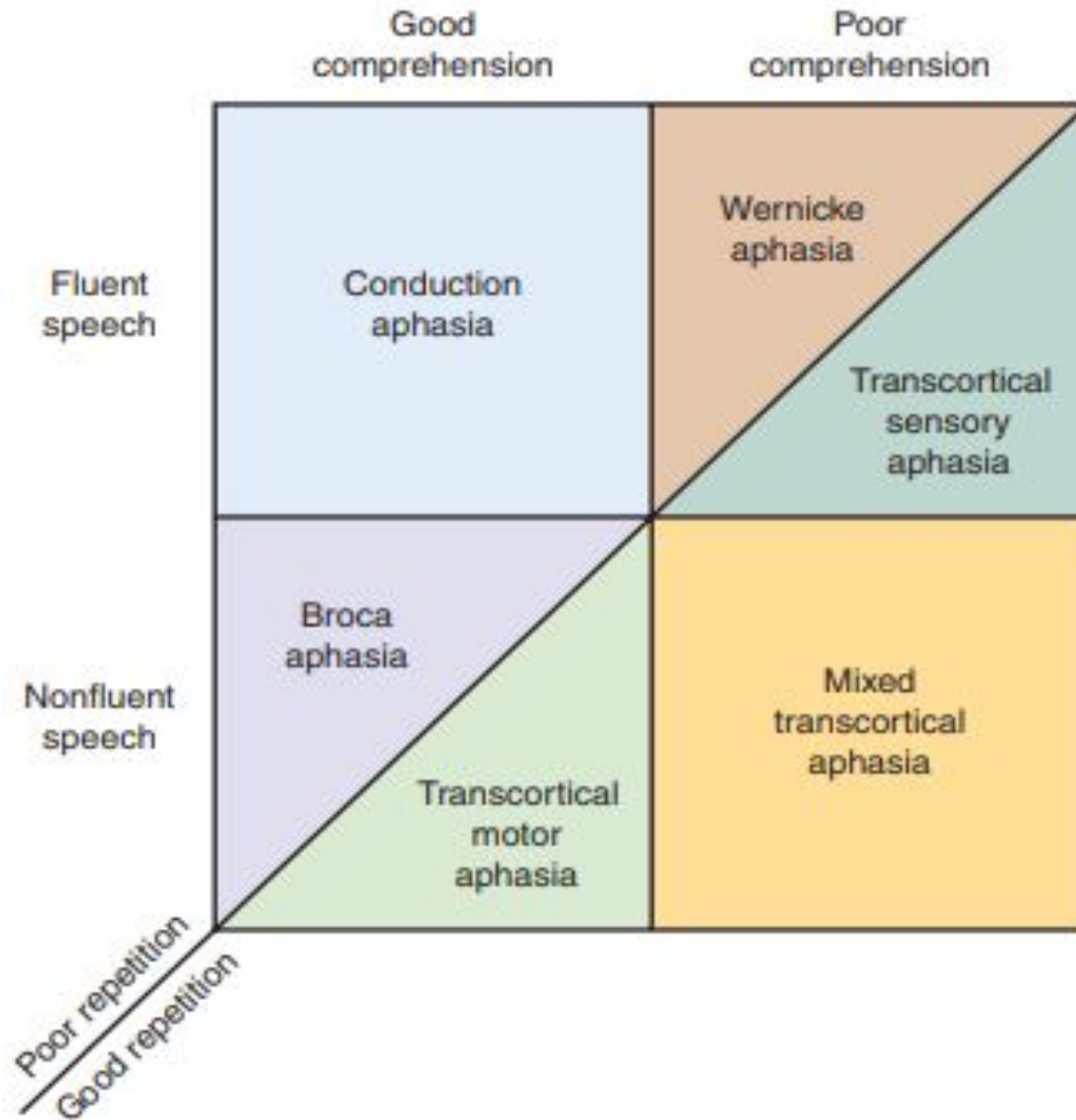
Aphasia

- **Aphasia**: impaired or absent communication by speech, writing, or signs (but without sense organs lesion or mental defect).
- Results from lesions in **the dominant hemisphere**.

Types of Aphasia:

- Broca's (Verbal, motor, expressive or non fluent) aphasia.
- Wernicke's (sensory, perceptive or fluent) aphasia.
- Conduction aphasia.
- Transcortical motor aphasia.
- Transcortical mixed aphasia.
- Transcortical sensory aphasia.
- Jargon's aphasia (word salad).
- Global aphasia.
- Thalamic aphasia.

Types of Aphasia



Types of Aphasia

1. Broca's (Verbal, motor, expressive or nonfluent) aphasia:

- The patient can not express his ideas in spoken word but the patient understand what ever told him.
- Characterized by good comprehension, nonfluent speech and poor repetition.
- Lesion in Broca's area or Brodmann 44 & 45 in the inferior frontal gyrus of dominant hemisphere.

2. Wernicke's (sensory, perceptive or fluent) aphasia:

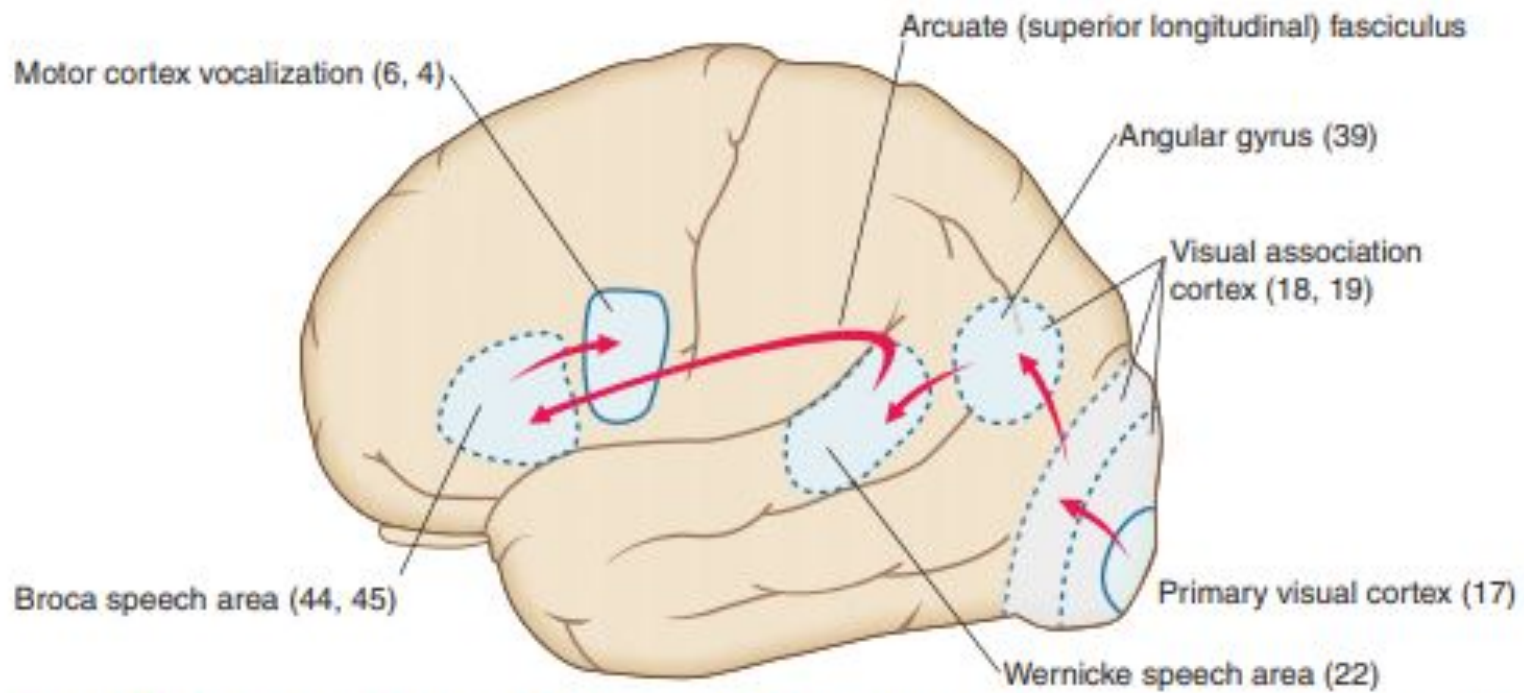
- The patient hears but does not understand sound.
- Characterized by poor comprehension, fluent speech, poor repetition.
- Results from a lesion in the superior temporal gyrus “posterior part” of dominant hemisphere (Brodmann 22 or Wernicke's center).

3. Conduction aphasia:

- Characterized by good comprehension, fluent speech and poor repetition, due to damage of the arcuate fasciculus.
- The arcuate fasciculus interconnects Broca's area with Wernicke's area.

4. Global aphasia:

- Combines all the symptoms of Broca's and Wernicke aphasias.



5. Transcortical motor aphasia:

- Characterized by good comprehension, nonfluent speech and good repetition.

6. Transcortical mixed aphasia:

- Characterized by poor comprehension, nonfluent speech and good repetition.

7. Transcortical sensory aphasia:

- Characterized by poor comprehension, fluent speech and good repetition.

Apraxia

- **Apraxia:** is the inability to perform complex motor activity in the presence of intact motor and sensory systems and normal comprehension.
- **Types of Apraxia:**
 - A. Ideomotor Apraxia.
 - B. Ideational Apraxia.
 - C. Construction Apraxia.
 - D. Gait Apraxia.

Types of Apraxia

A. Ideomotor Apraxia:

- Inability in response to verbal command to perform ease motor activity (e.g., protrude out the tongue).
- Results from a lesion in **dominant hemisphere**.

B. Ideational Apraxia:

- The inability to demonstrate the use of real objects (e.g., smoke a cigarette).
- Results from a lesion in **dominant hemisphere**.

C. Construction Apraxia:

- The inability to draw or construct a geometric figure (e.g., the face of a clock).
- **Called hemineglect** if the patient draws only the right half of the clock.
- The lesion is located in **the right inferior parietal gyrus.**

B. Gait Apraxia:

- Characterized by bradykinesia, wide base, short steps, and shuffling progression.
- Seen in normal-pressure hydrocephalus (gait apraxia, dementia, and incontinence).
- **The lesion is located in the prefrontal areas.**

Dysprosodies

- **Dysprosodies:** nondominant hemispheric language deficits that affect the emotionality or inflection of speech.
- **Dysprosodies:**
 - A. Expressive dysprosody:**
 - Results from a lesion that corresponds to the Brocca's area but is located in the **nondominant hemisphere**.
 - Patients cannot express emotion or inflection in their speech.
 - B. Receptive dysprosody:**
 - Results from a lesion that corresponds to the Wernicke's area but is located in the nondominant hemisphere.
 - Patients cannot comprehend the emotionality or inflection in the speech they hear.

Thank You

