# Cerebral Blood Circulation

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# OBJECTIVES

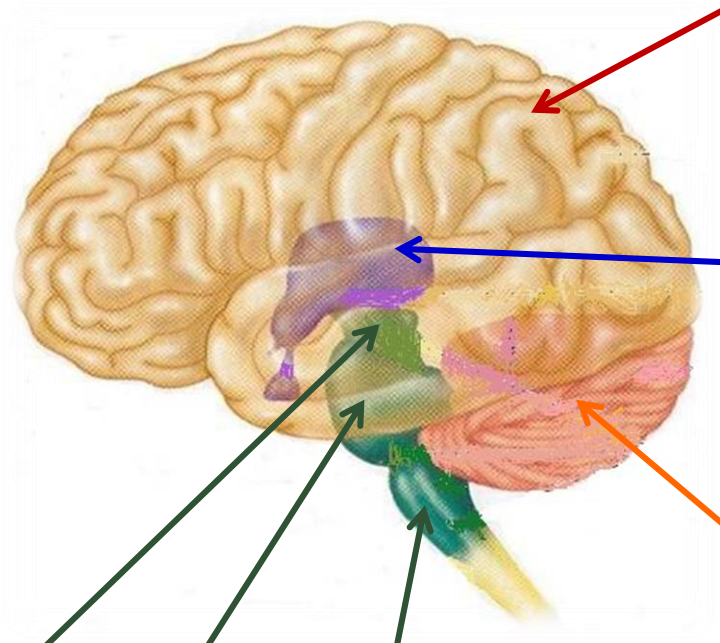
***At the end of the lecture, students should be able to:***

- **List the cerebral arteries.**
- **Describe the cerebral arterial supply regarding the origin, distribution and branches.**
- **Describe the arterial Circle of Willis .**
- **Describe the cerebral venous drainage and its termination.**
- **Describe arterial & venous vascular disorders and their clinical manifestations.**

# WATCH

# Review: THE BRAIN

- Large mass of nervous tissue located in cranial cavity.
- Has four major regions.



**Cerebrum**
(Cerebral hemispheres)

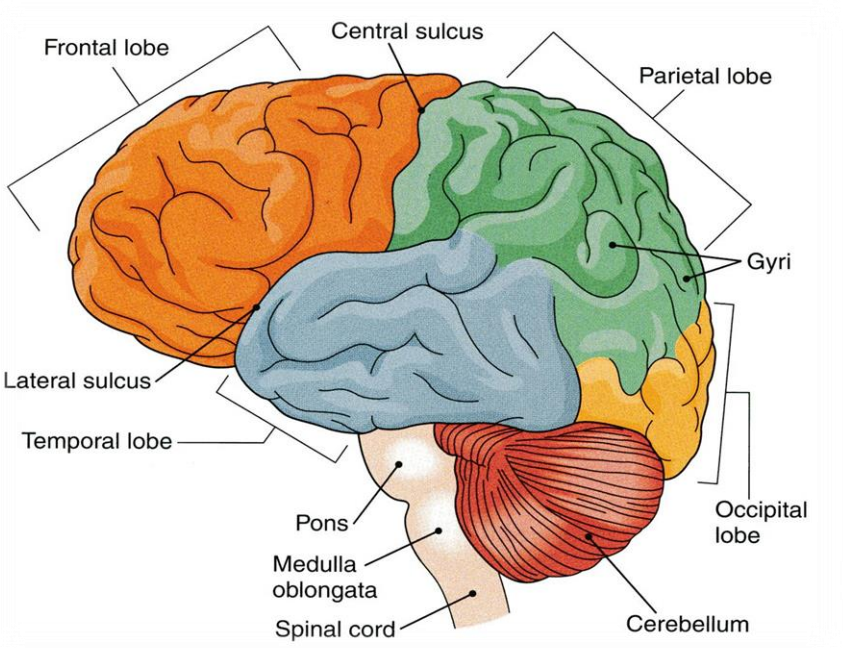
**Diencephalon:**
Thalamus,
Hypothalamus,
Subthalamus &
Epithalamus

**Cerebellum**

**Brainstem:** Midbrain, Pons & Medulla oblongata

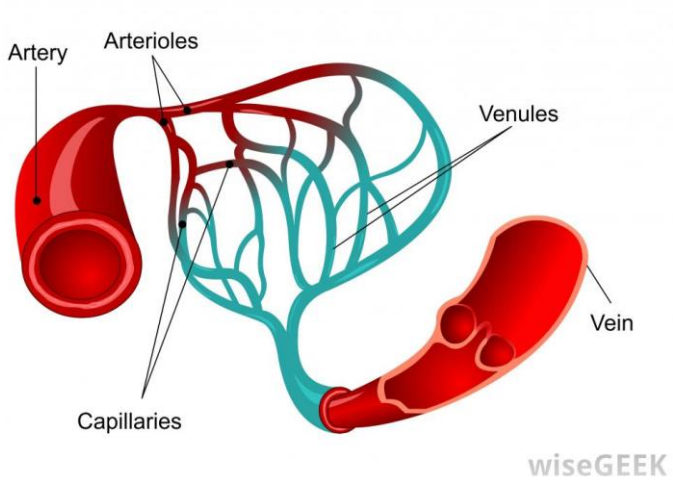
# Review: CEREBRUM

- The largest part of the brain, and has two hemispheres.
- The surface shows elevations called gyri, separated by depressions called sulci.
- Each hemispheres divided into four lobes by deeper grooves.
- Lobs are separated by deep grooves called fissures.



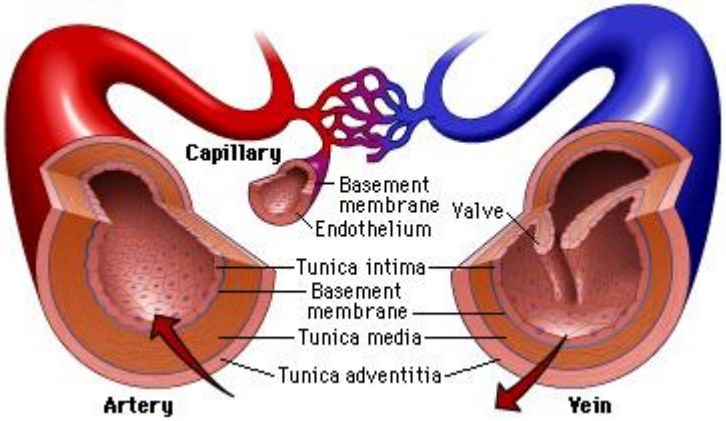
# Review: BLOOD VESSELS

- Blood vessels are the part of the circulatory system that transports blood throughout the human body.
- There are three major types of blood vessels:
  - **Arteries**, which carry the blood away from the heart.
  - **Capillaries**, which enable the actual exchange of water and chemicals between the blood and the tissues.
  - **Veins**, which carry blood from the capillaries back toward the heart.
- The word vascular, meaning relating to the blood vessels, is derived from the Latin vas, meaning vessel.
  - **Avascular refers to being without (blood) vessels.**



# Review: HISTOLOGY

- The arteries and veins have three layers, but the middle layer is thicker in the arteries than it is in the veins:
  - Tunica Intima (the thinnest layer): a single layer of simple squamous endothelial cells.
  - Tunica Media (the thickest layer in arteries): is made up of smooth muscle cells and elastic tissue.
  - Tunica Adventitia (the thickest layer in veins) entirely made of connective tissue.
- Capillaries consist of little more than a layer of endothelium and occasional connective tissue.

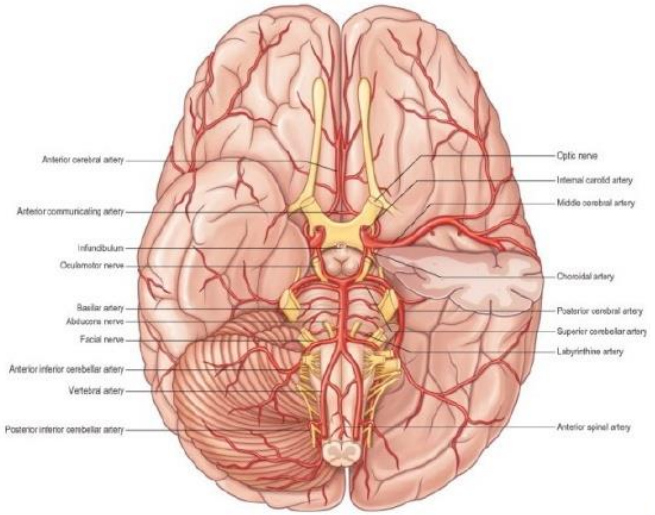


# Review: BLOOD

- Blood is the actual carrier of the oxygen and nutrients into arteries.
- Blood is made mostly of plasma, which is a yellowish liquid that is 90% water.
- Plasma contains also salts, glucose and other substances.
- Most important, plasma contains proteins that carry important nutrients to the body's cells and strengthen the body's immune system.
- Blood has main 3 types of blood cells that circulate with the plasma.

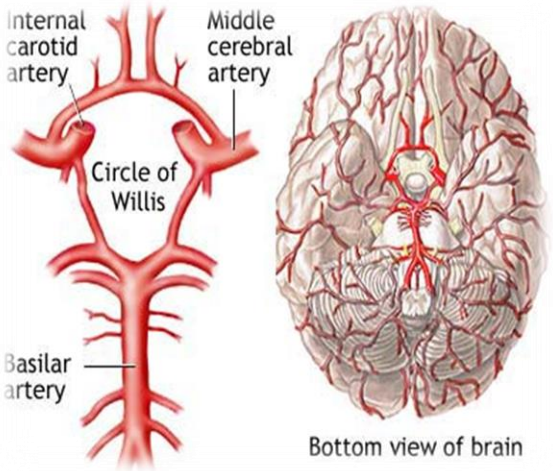
# CEREBRAL CIRCULATION

- The movement of blood through the network of blood vessels to supply the brain.
- The arteries carry oxygenated blood and other nutrients to the brain.
- The veins carry deoxygenated blood back to the heart removing carbon dioxide and other metabolic products.
- The movement of blood in the cerebral circulation is called cerebral blood flow.



# CEREBRAL ARTERIAL SUPPLY

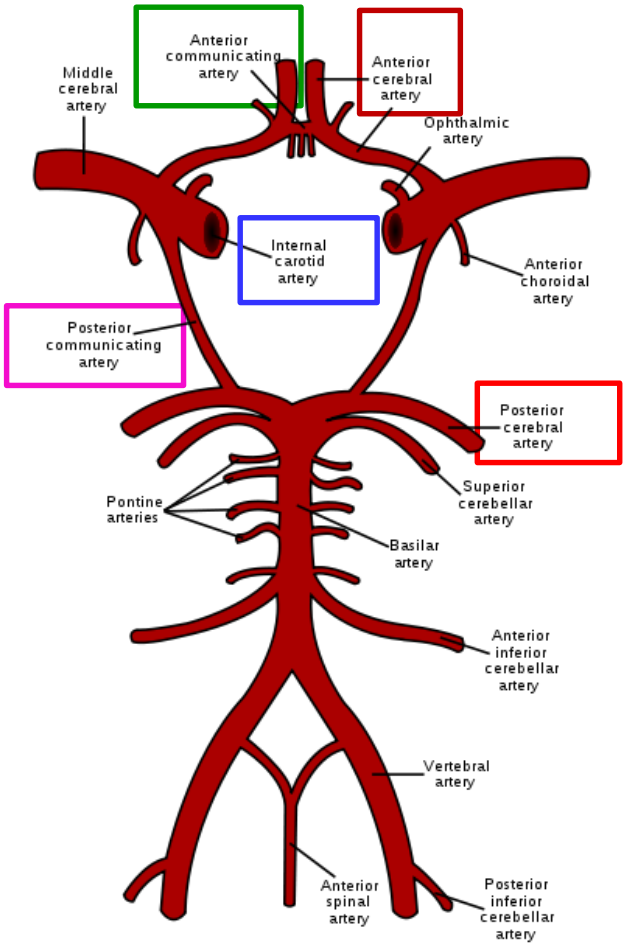
- The arterial cerebral circulation is divided into anterior and posterior cerebral circulations.
- The cerebral arterial supply is provided by two systems:
  - **Carotid System**
    - Supply anterior portion of the brain.
  - **Vertebro-Basilar System**
    - Supply posterior portion of the brain.
- The anterior and posterior cerebral circulations are interconnected via bilateral posterior communicating arteries.
  - **Posterior communicating arteries are part of Circle of Willis.**
    - ✓ **Located on the base of the brain.**
    - ✓ **It Encircles:**
      - Optic chiasma
      - Hypothalamus
      - Midbrain



# CIRCULUS ARTERIOSUS
## (CIRCLE OF WILLIS)

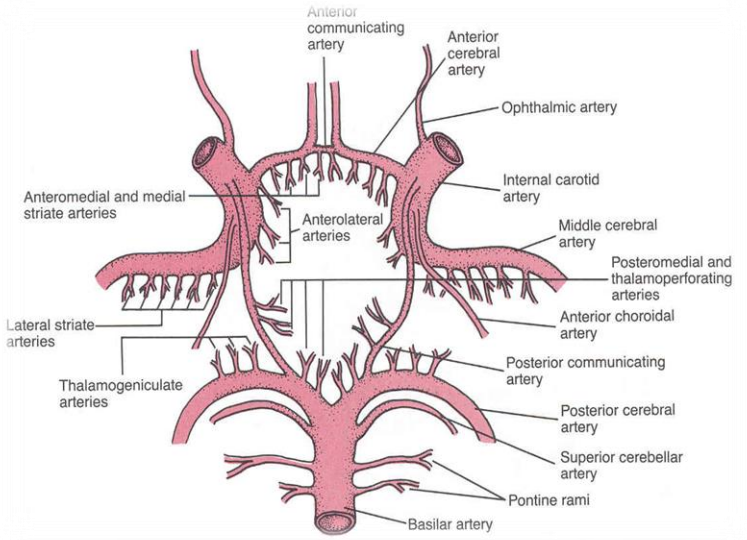
*Named after Thomas Willis (1621–1675), an English physician*

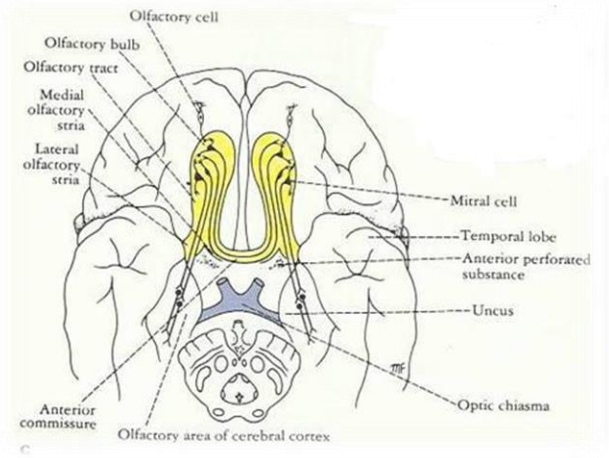
- It is Formed by:
  - Two Anterior cerebral arteries
  - Two Internal carotid arteries
  - Two Posterior cerebral arteries
  - Two Posterior communicating arteries
  - One Anterior communicating artery
- It Gives numerous small vessels that penetrate the surface of the brain
  - Perforating arteries
- **They are divided into:**
  - Anterior perforating arteries
  - Posterior perforating arteries



# ANTERIOR PERFORATING ARTERIES

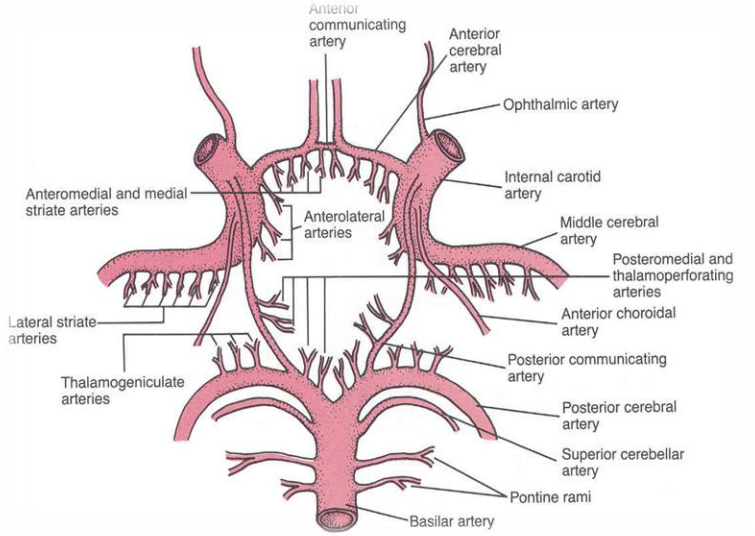
- **Arise from:**
  - Anterior cerebral artery
  - Anterior communicating artery
  - Middle cerebral artery
- **Enter brain through:**
  - **Anterior perforated substance**
    - irregularly quadrilateral area in front of the optic tract and behind the olfactory trigone.
- **Supply:**
  - Large part of basal ganglia
  - Optic chiasma
  - Internal capsule
  - Hypothalamus

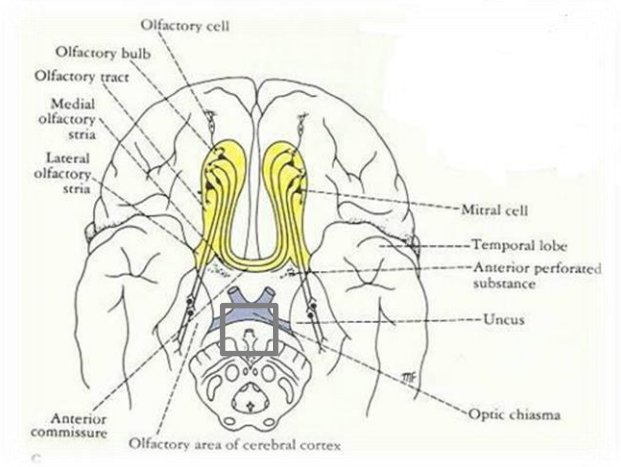


# POSTERIOR PERFORATING ARTERIES

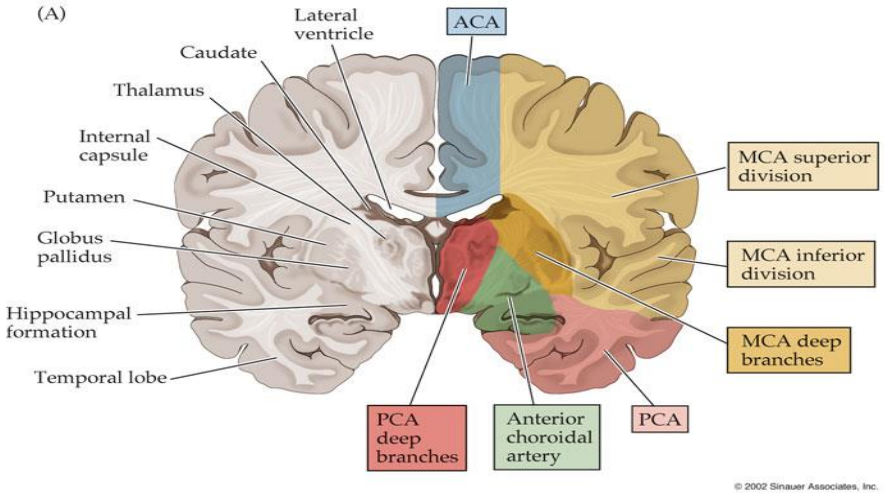
- **Arise from:**
  - Posterior cerebral artery
  - Posterior communicating artery
- **Enter brain through:**
  - Posterior Perforated substance
- **Supply:**
  - Ventral portion of Midbrain
  - Parts of Subthalamus and Hypothalamus

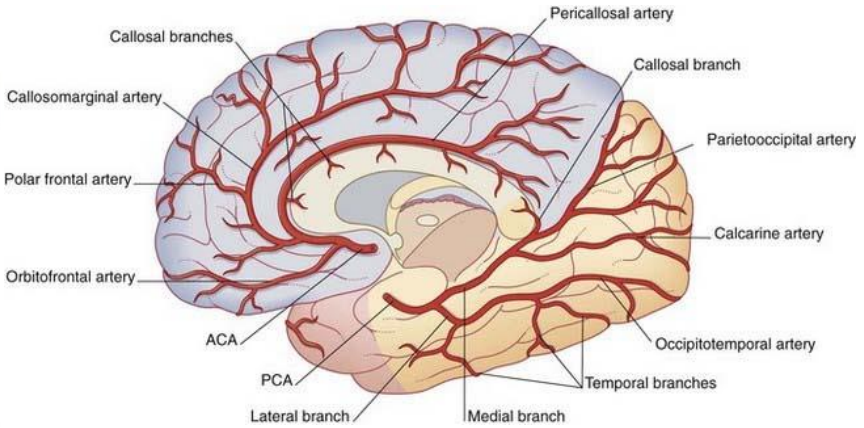


# ANTERIOR CEREBRAL ARTERY

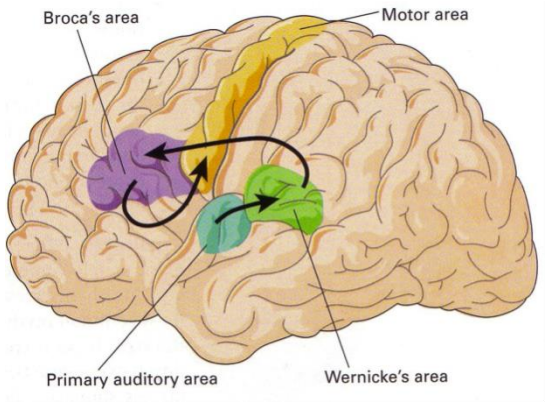
- **Supplies:** Orbital and medial surfaces of frontal and parietal lobes

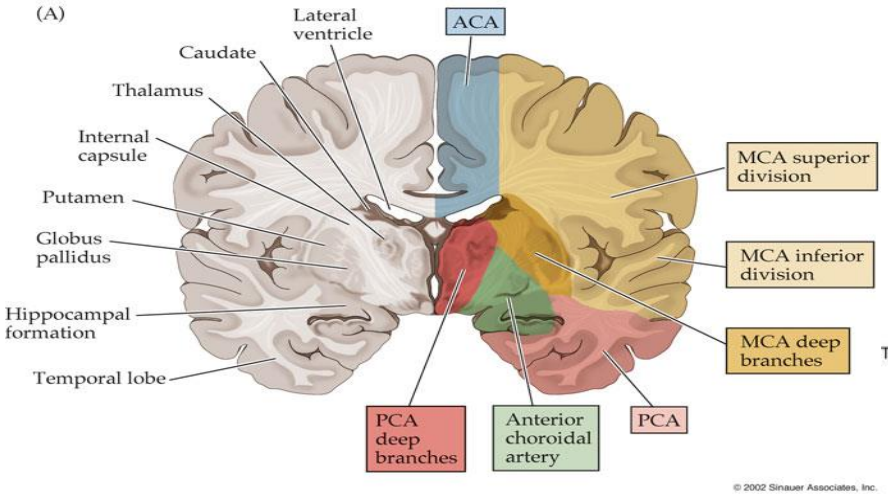


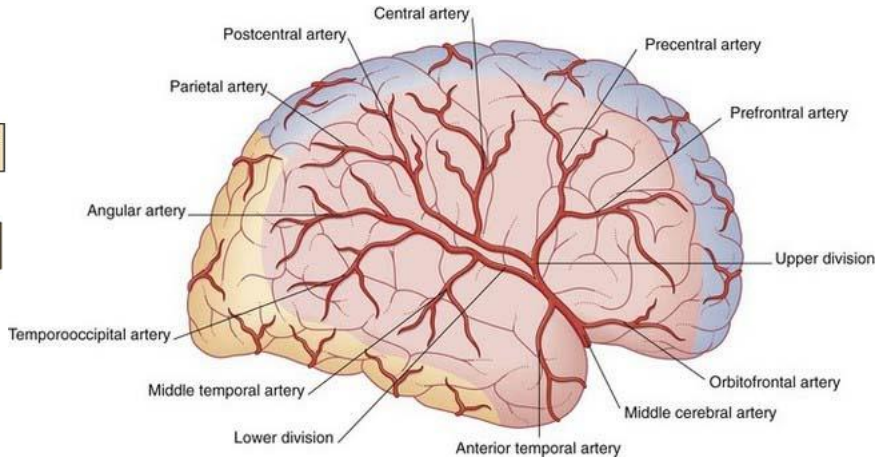



# MIDDLE CEREBRAL ARTERY

- **Supplies: Entire Superolateral surface:**
  - Somatosensory Cortex
  - Motor Cortex
  - Broca's Area
    - linked to speech production.
  - Heschl's Gyrus
    - to process incoming auditory information
  - Wernicke's Area
    - It is involved in the understanding of written and spoken language

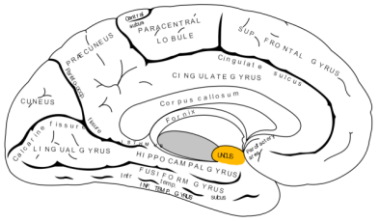


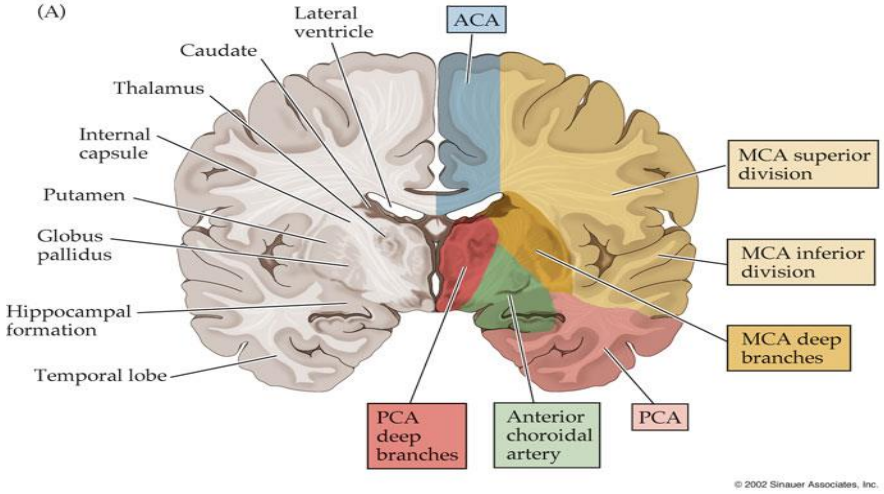



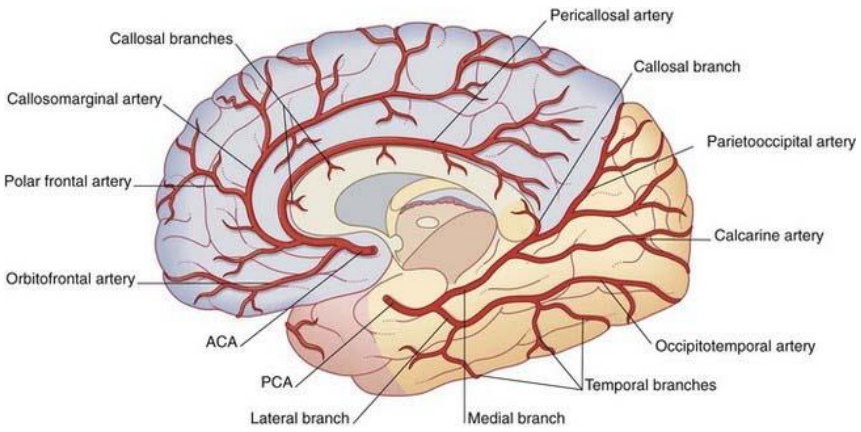



# POSTERIOR CEREBRAL ARTERY

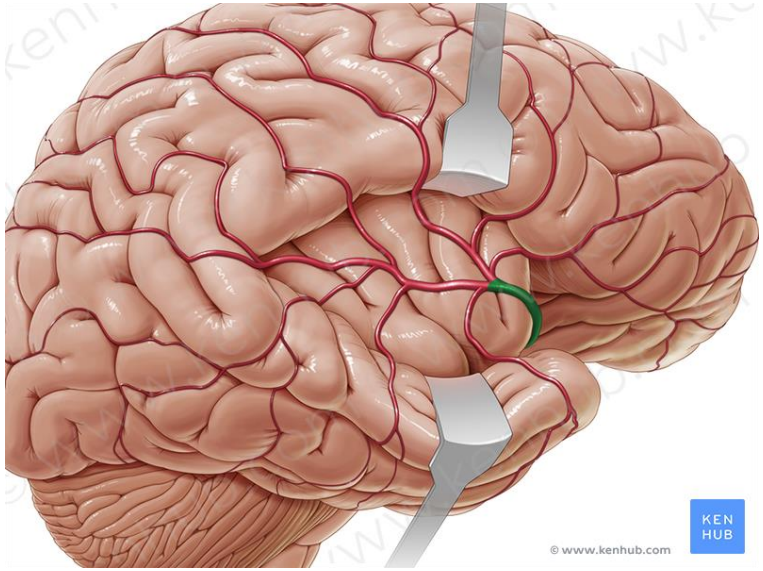
- **Supplies:**
  - Anterior and inferior temporal lobes
  - Uncus
    - Located on the tip end of the medial surface of the parahippocampal gyrus.
    - Part of the olfactory cortex that processes information from the sense of smell.
  - Inferior temporal gyri
  - Inferior and Medial Occipital lobe

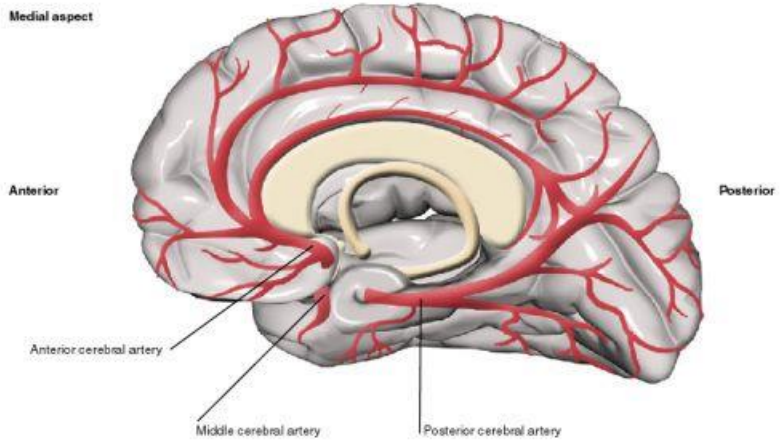


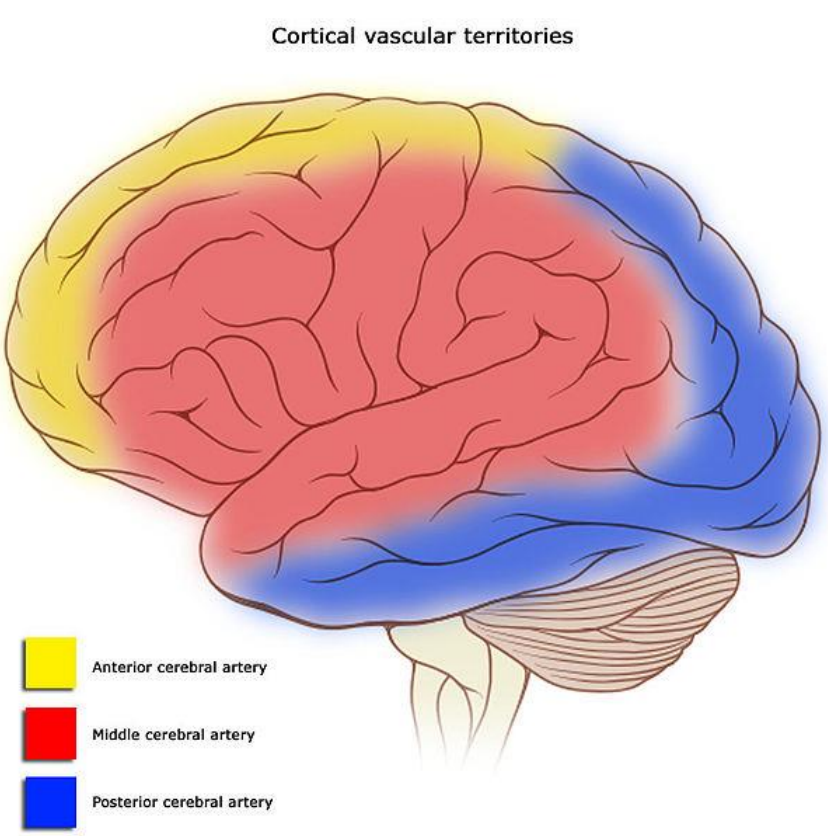



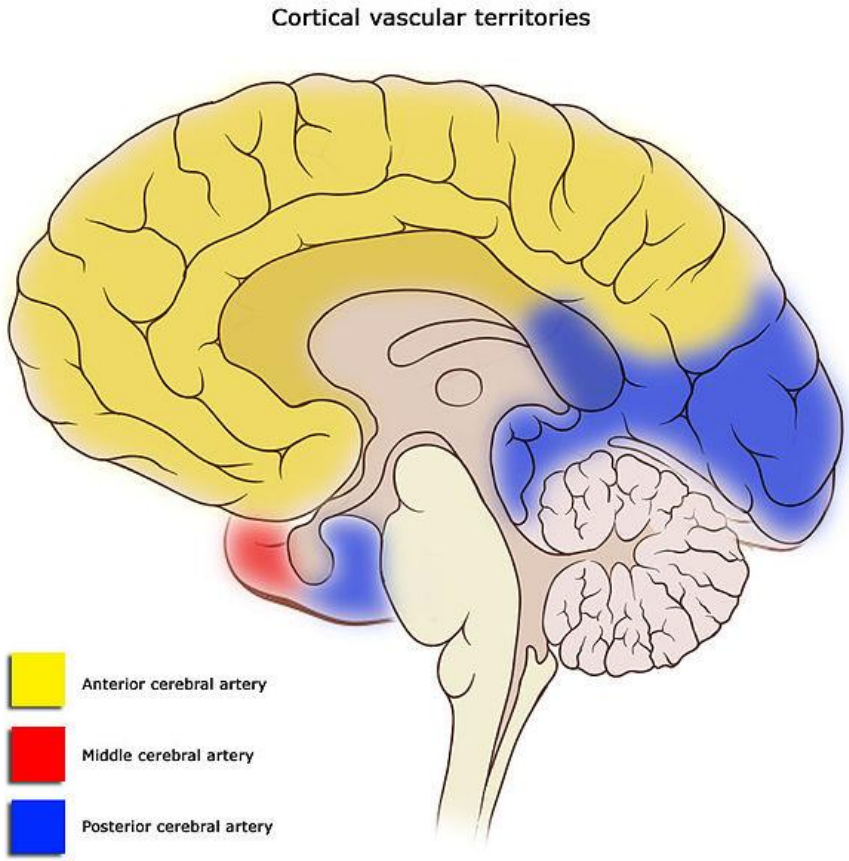
# CEREBRAL ARTERIES



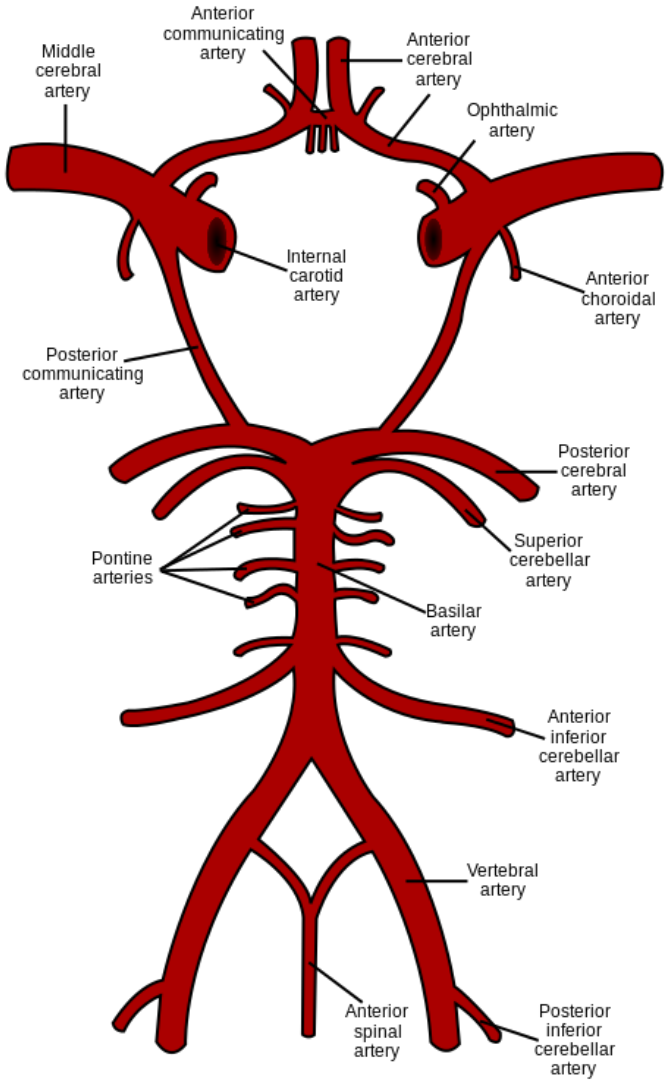
# DISTRIBUTION OF CEREBRAL ARTERIES



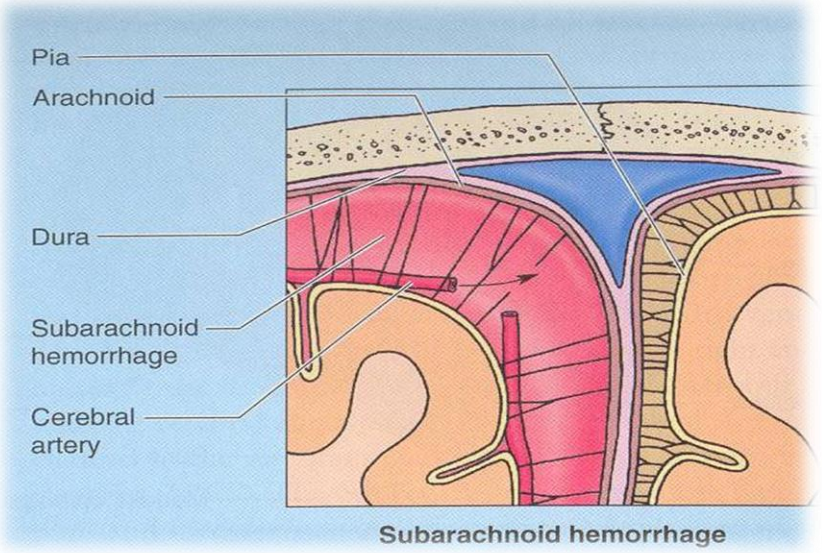
# BASILAR ARTERY

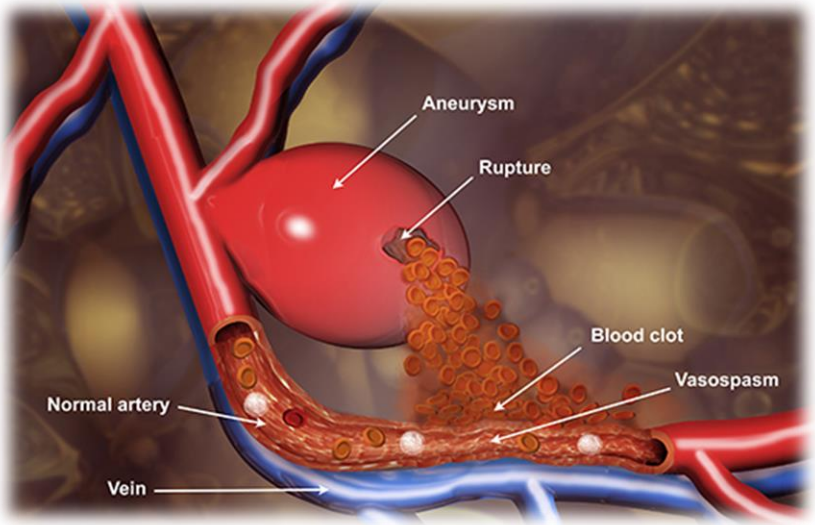
- **Supplies:** Midbrain and Cerebellum.
- **Branches:**
  - Anterior inferior cerebellar artery
  - Pontine branches
  - Superior cerebellar artery



# ARTERIAL DISORDER

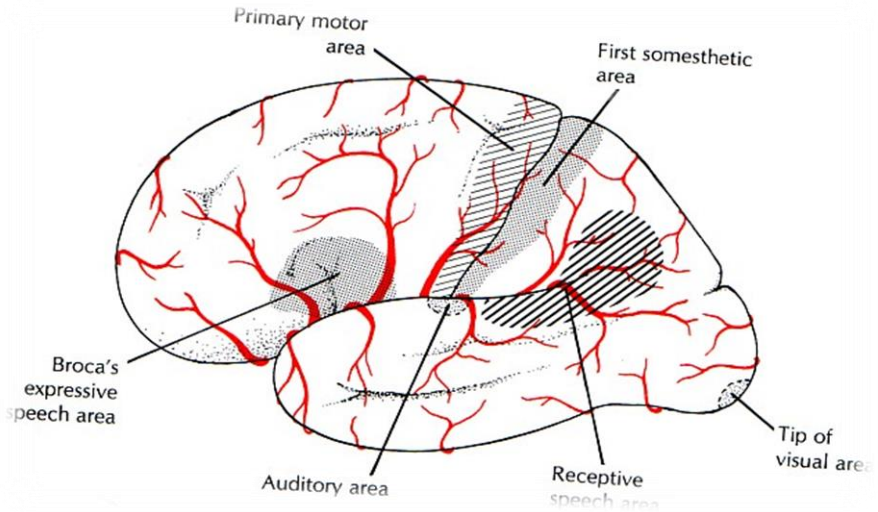
- **Stroke**
  - Sudden occlusion
  - Hemorrhage
- **Aneurysm**
  - localized, blood-filled balloon-like bulge in the wall of a blood vessel.
- **Angioma**
  - Benign tumors derived from cells of the vascular or lymphatic vessel walls (epithelium) or derived from cells of the tissues surrounding these vessels.

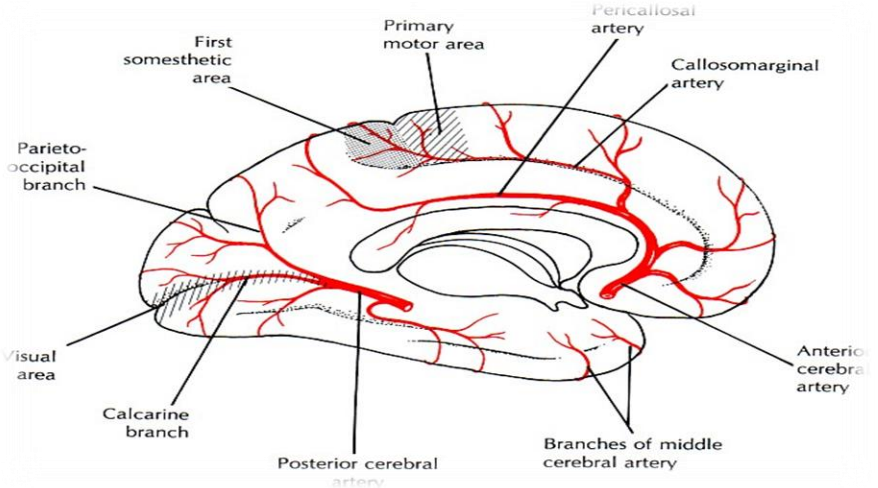


# ACCLUSION OF ACA

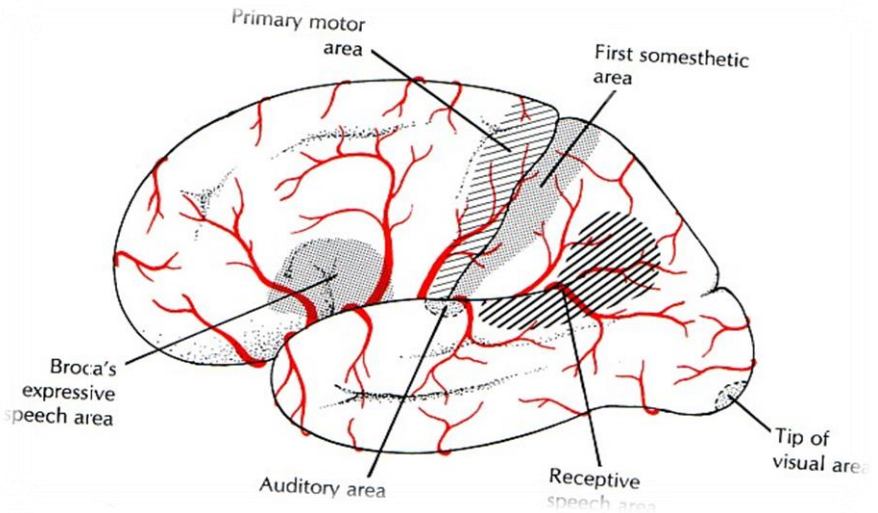
- **Manifestations:**
  - Motor disturbance in contralateral distal leg
  - Difficulty in Prefrontal lobe Functions:
    - Cognitive thinking
    - Judgment
    - Motor initiation
    - Self monitoring

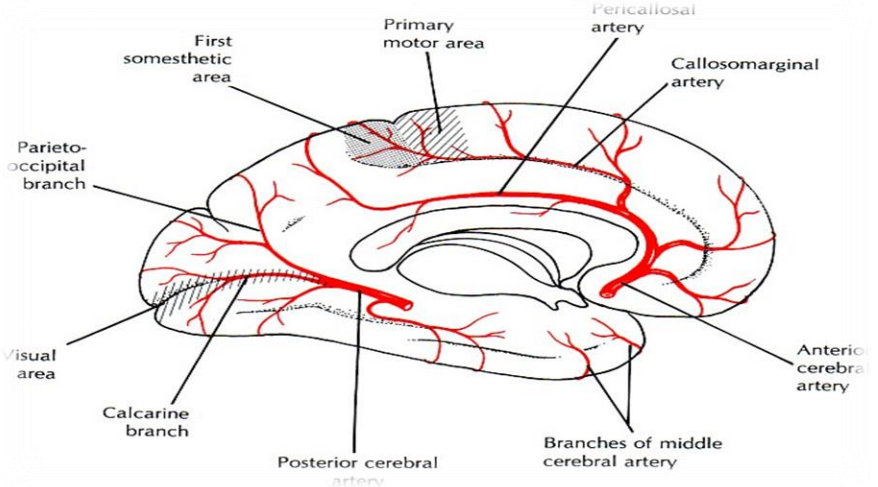


# ACCLUSION OF MCA

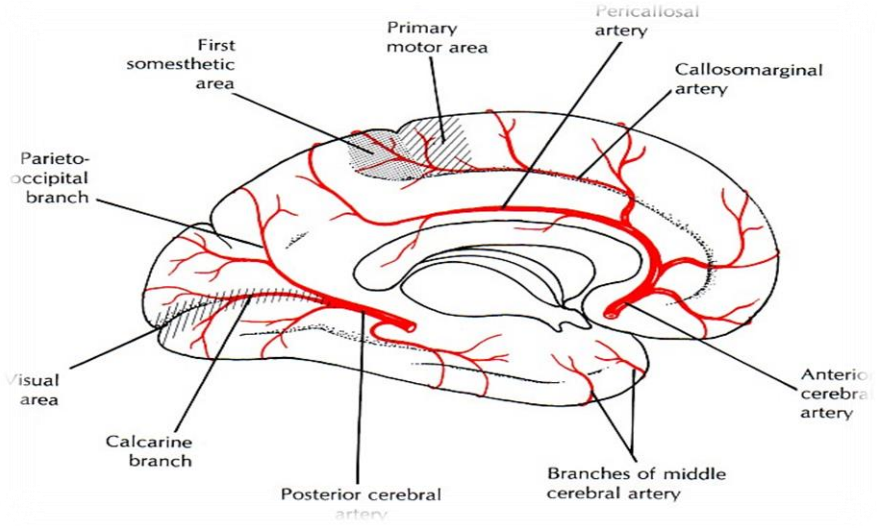
- **Manifestations:**
  - Contralateral weakness of:
    - face, arm, and hand more than legs
  - Contralateral sensory loss of:
    - face, arm, and hand more than legs
    - visual field cut (damage to optic radiation)
  - Aphasia: language disturbances
    - Broca's: production
    - Wernicke's: comprehension

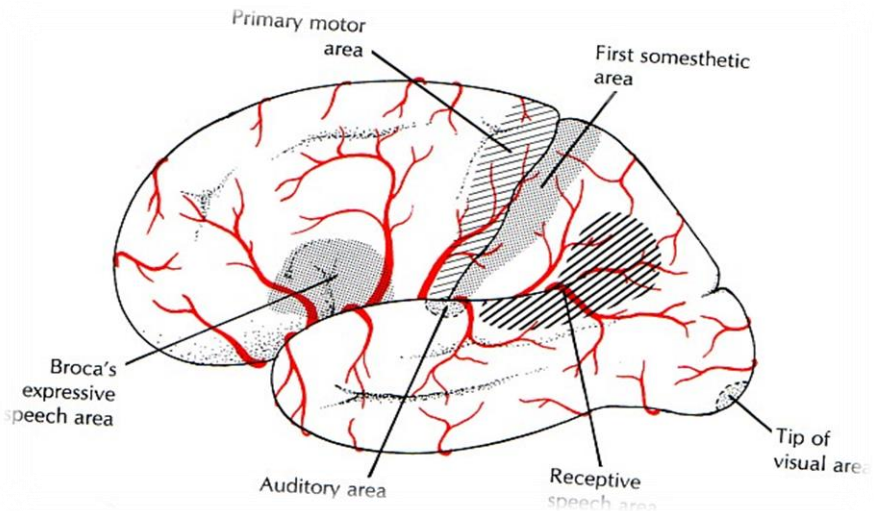


# ACCLUSION OF PCA

- **Manifestations:**
  - Visual disturbances
    - Contralateral homonymous hemianopsia
    - Bilateral lesions: cortical blindness
      - ✓ patients unaware they cannot see (Anton's syndrome)
  - Memory impairment
    - If temporal lobe is affected



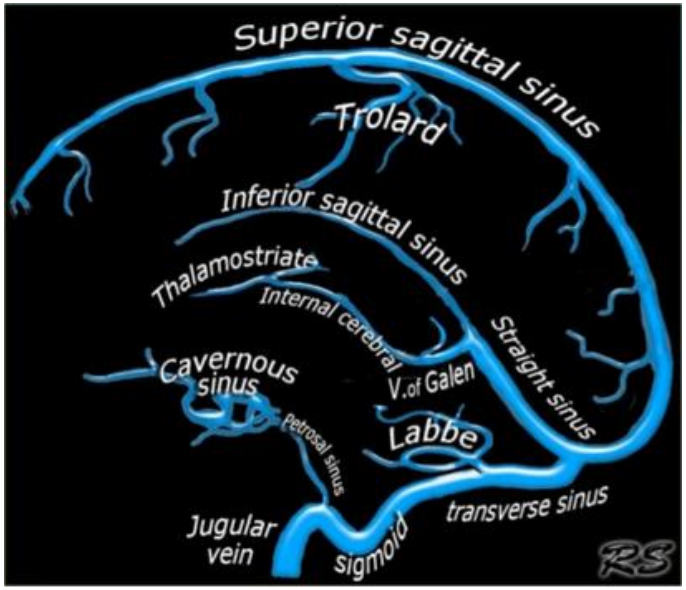
# HOW WE ARE DOING ..?

- Which statement(s) of the following is NOT Wrong?

- Anterior cerebral arteries supply Broca's and Wernicke's Area..!!
- Occlusion of MCA causes difficulty in Prefrontal lobe's functions..!!
- Middle cerebral arteries are part of Willis Circle..!!
- Aneurysm is benign tumors derived from cells of the vascular or lymphatic vessel walls..!!
- Posterior cerebral arteries supply anterior and inferior temporal lobes..!!

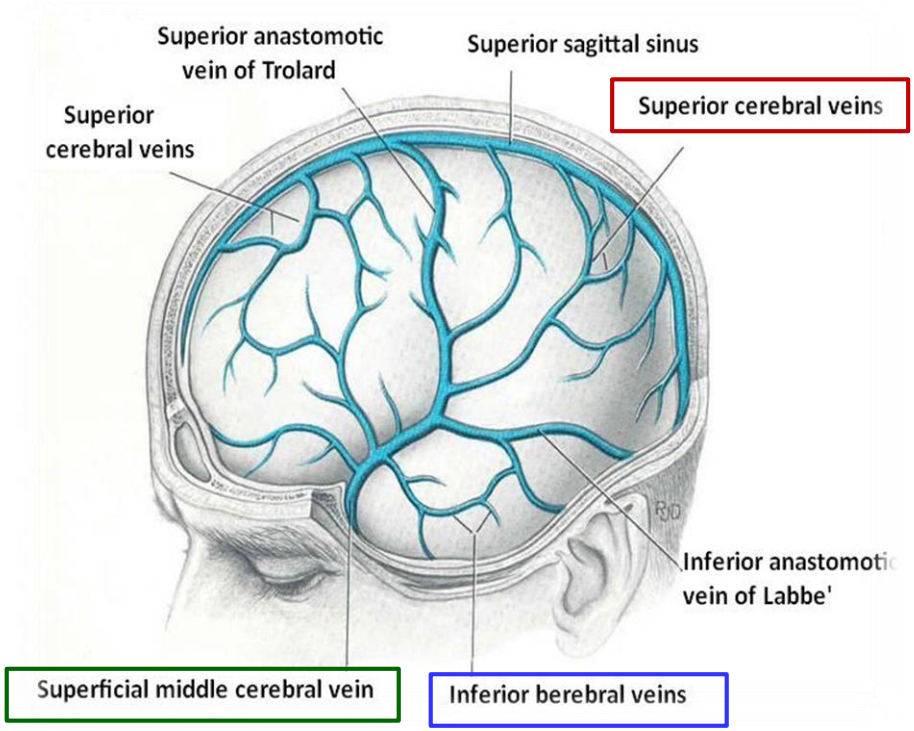
# CEREBRAL VENOUS DRAINAGE

- **It involves:**
  - Superficial (cortical) veins:
    - Drain the cortical surface
  - Deep veins:
    - Drain the deep structures
- These veins ultimately drain into:
  - Dural Venous Sinuses
- The Veins are thin walled and are devoid of valves.



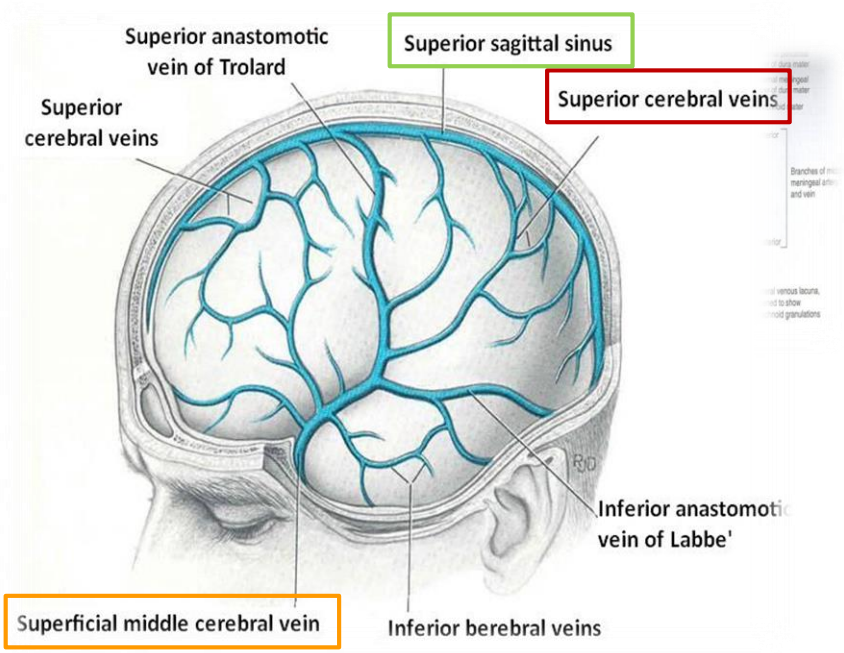
# SUPERFICIAL CORTICAL VEINS

- Lie on the brain surface, in the Subarchnoid space.
- They are divided into:
  - Superior cerebral veins
  - Inferior cerebral veins
  - Superficial middle cerebral vein



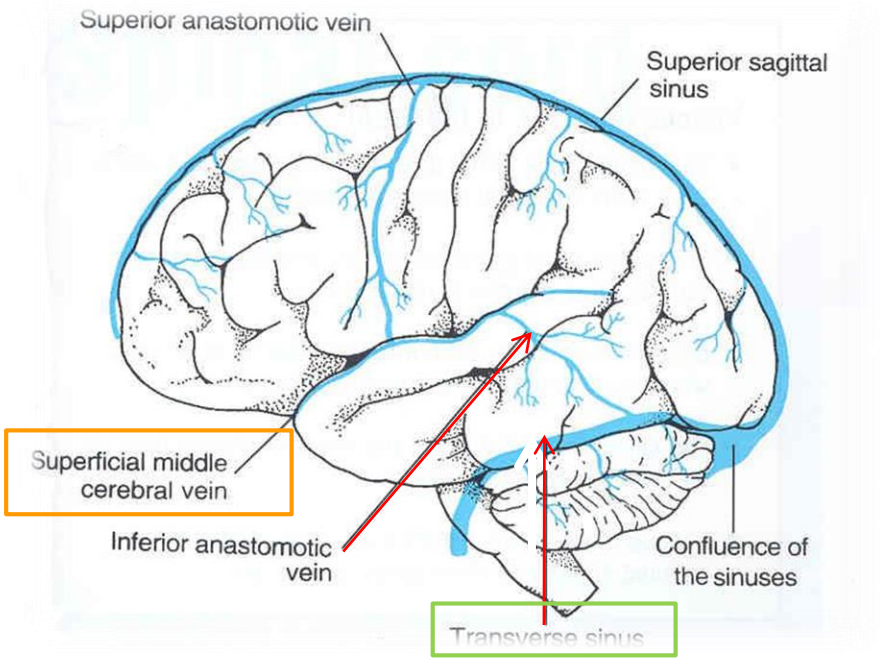
# SUPERFICIAL CORTICAL VEINS

- **Superior Cerebral Veins**
  - 6 to 12 veins
  - Drain lateral surface of brain above the lateral sulcus
  - Terminate mainly into the Superior Sagittal sinus, and partly into superficial middle cerebral vein.



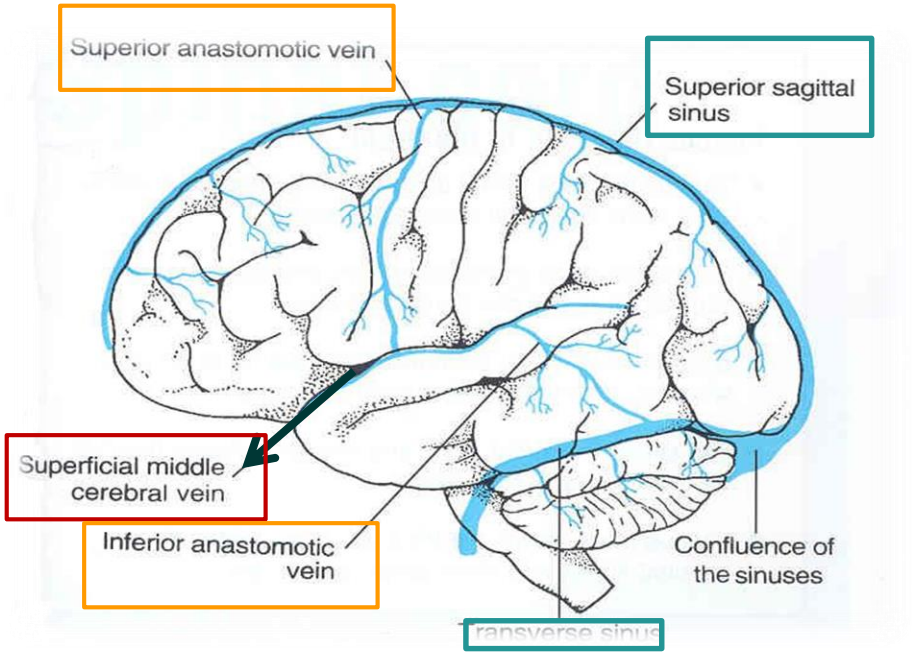
# SUPERFICIAL CORTICAL VEINS

- **Inferior Cerebral Veins**
  - **Run below the lateral sulcus**
  - **Drain the lateral surface of the temporal lobe**
  - **Terminate partly into superficial middle cerebral vein & partly into Transverse sinus.**



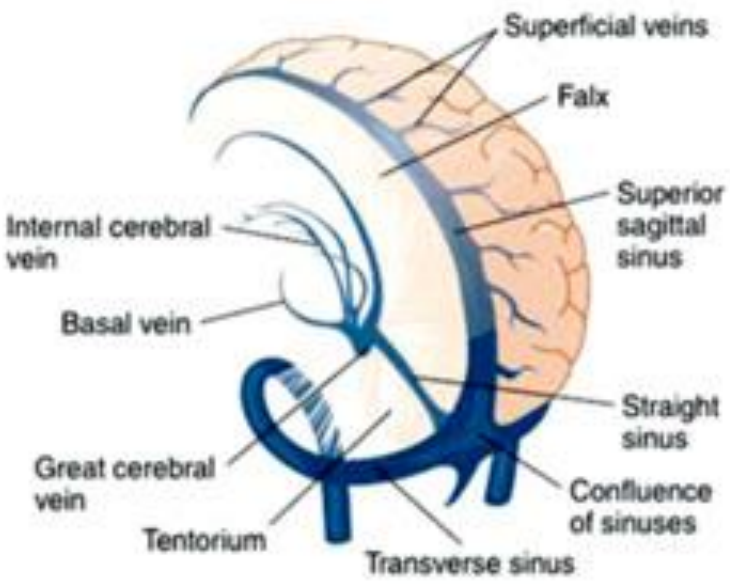
# SUPERFICIAL CORTICAL VEINS

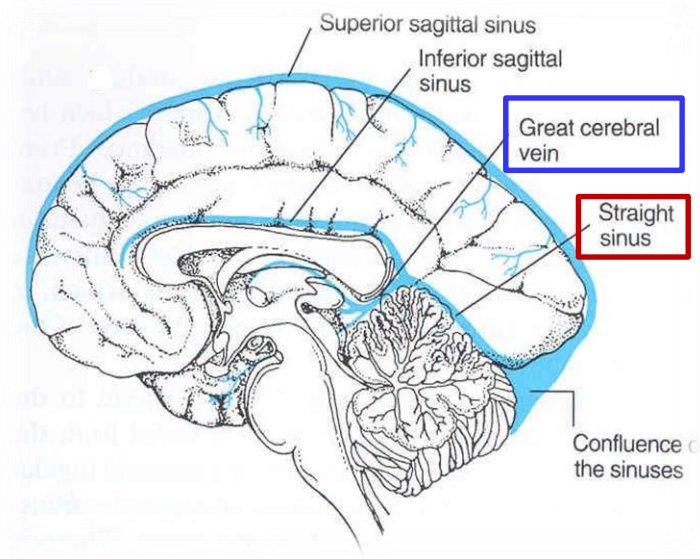
- **Superficial Middle Cerebral Vein**
  - Runs along the lateral sulcus
  - Terminates into the Cavernous sinus
  - Connected by Superior anastomotic veins to Superior Sagittal Sinus.
  - Connected by Inferior anastomotic veins to Transverse Sinuses.



# DEEP CEREBRAL VEINS

- They drain the internal structures;
  - Basal ganglia
  - Internal capsule
  - Thalamus
- They merge to form the Internal Cerebral Veins.
- The two veins unite in the midline to form the Great Cerebral vein.
- This short vessel is continuous with the Straight Sinus.



# CEREBRAL SINUSES

## The Superior Sagittal Sinus

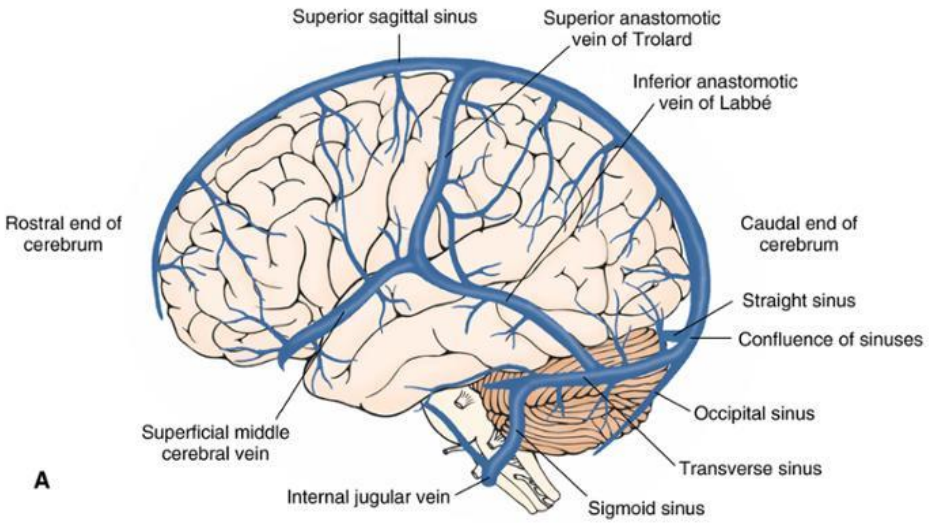
- Lies along the superior border of the falx cerebri and empties into the confluence of sinuses.

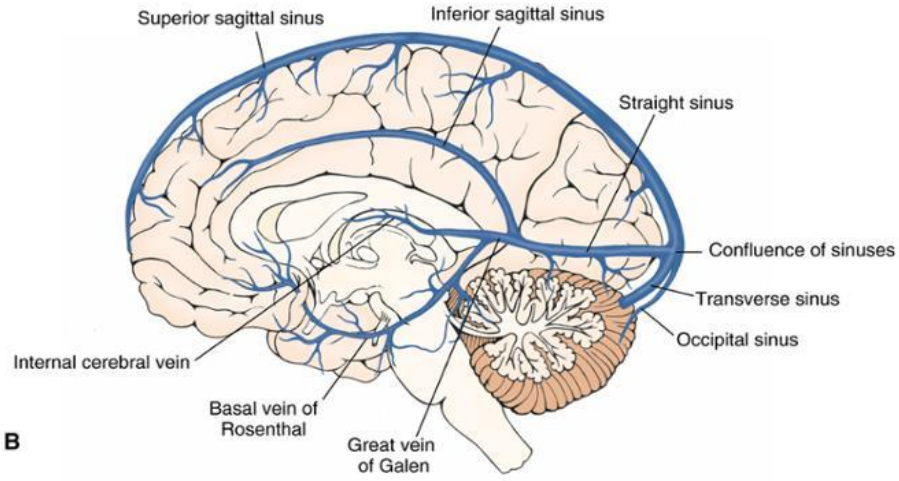
## The Inferior Sagittal Sinus

- Lies in the inferior border of the falx cerebri.
- The great cerebral vein of Galen joins the inferior sagittal sinus to form the straight sinus.

## The Transverse Sinuses

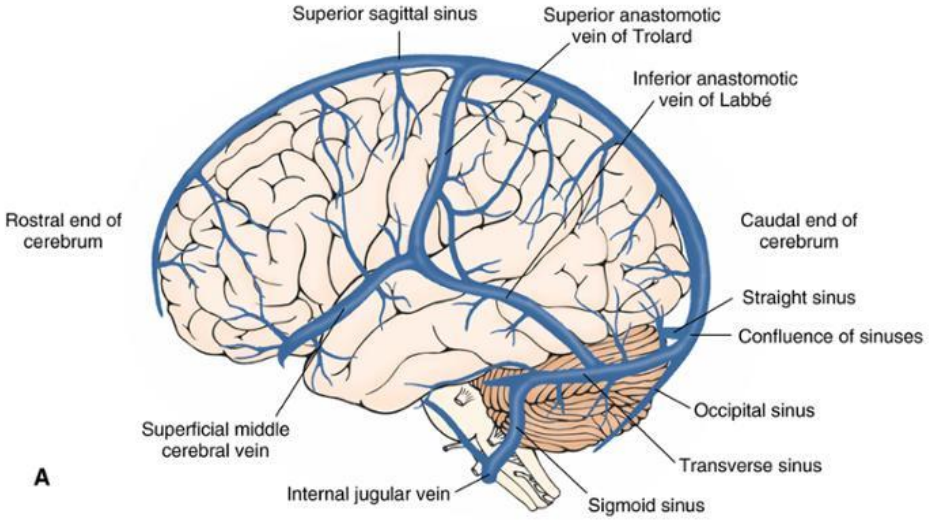
- Originate on each side of the confluence of sinuses.
- Each transverse sinus travels laterally, and curves downward to form the sigmoid sinus that empties into the internal jugular vein on the same side.

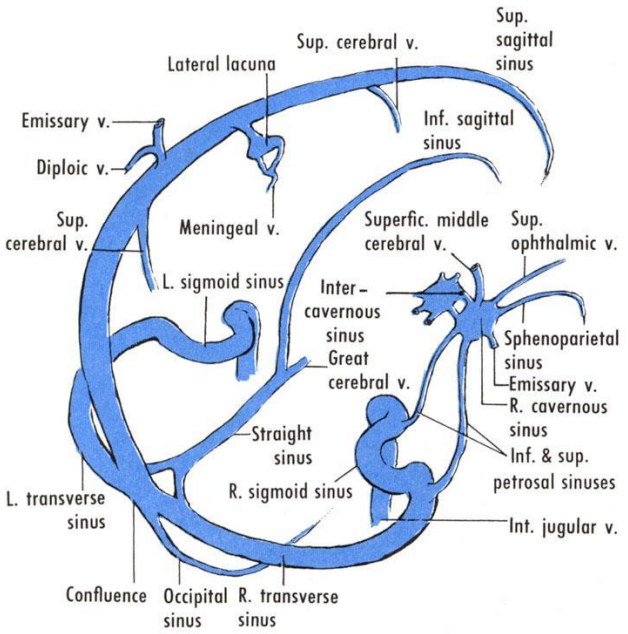


# CEREBRAL SINUSES

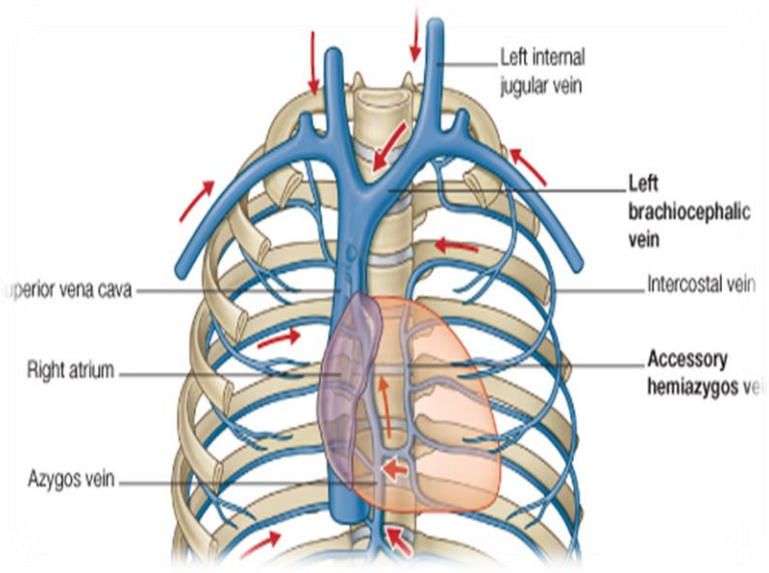
- **The Confluence of Sinuses**
  - At the confluence of sinuses, the superior sagittal, straight, transverse, and occipital sinuses join.
- **The Cavernous Sinuses**
  - Located on each side of the sphenoid bone.
  - Ophthalmic and superficial middle cerebral veins drain into these sinuses.
- **The Sphenoparietal Sinuses**
  - Located below the sphenoid bone and drain into the cavernous sinus.
- **The Sigmoid Sinuses**
  - Receive blood from posterior dural venous sinus veins.



# SUPERIOR VENA CAVA

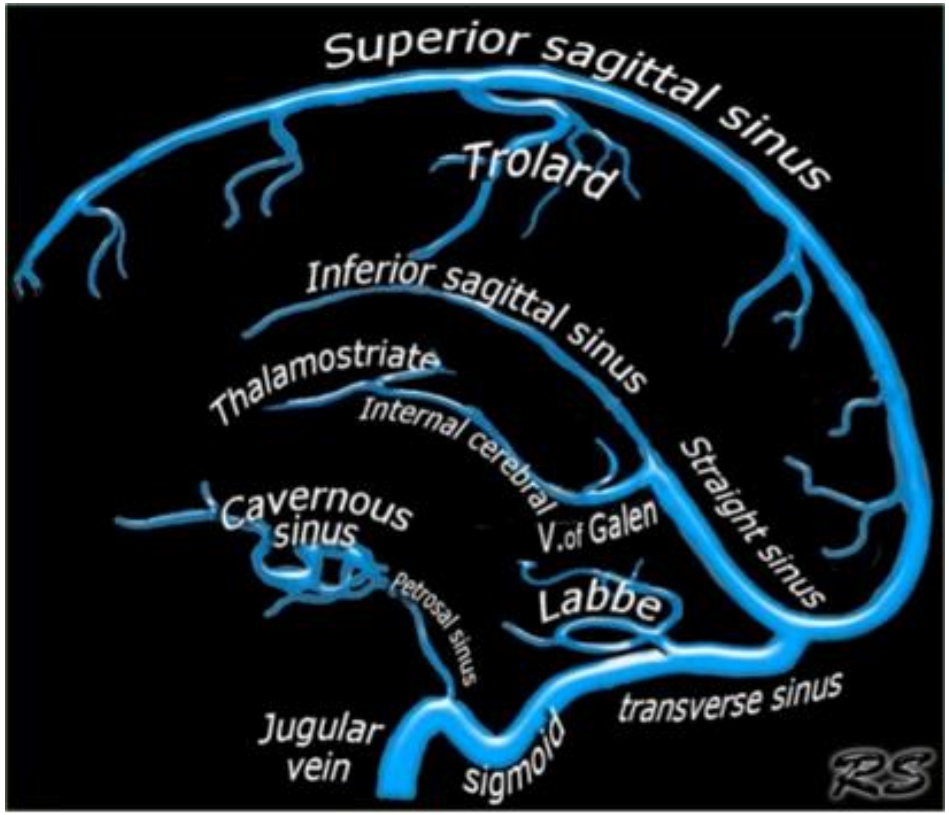
- Formed by the union of the right and left brachiocephalic veins.
- Brachiocephalic veins are formed by the union of internal jugular and subclavian veins.
- Drains venous blood from:
- Head, neck, thoracic wall & upper limbs
- It Passes downward and enter the right atrium.



# DURAL VENOUS SINUSES

**Paired**

- Transverse
- Sigmoid
- Cavernous
- Petrosal

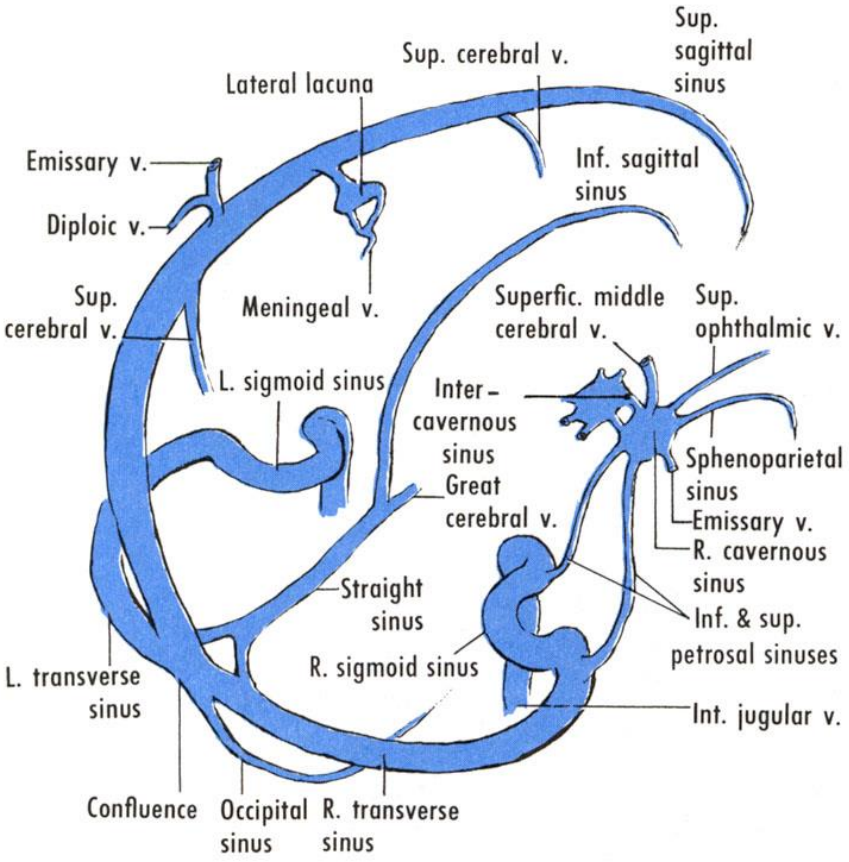


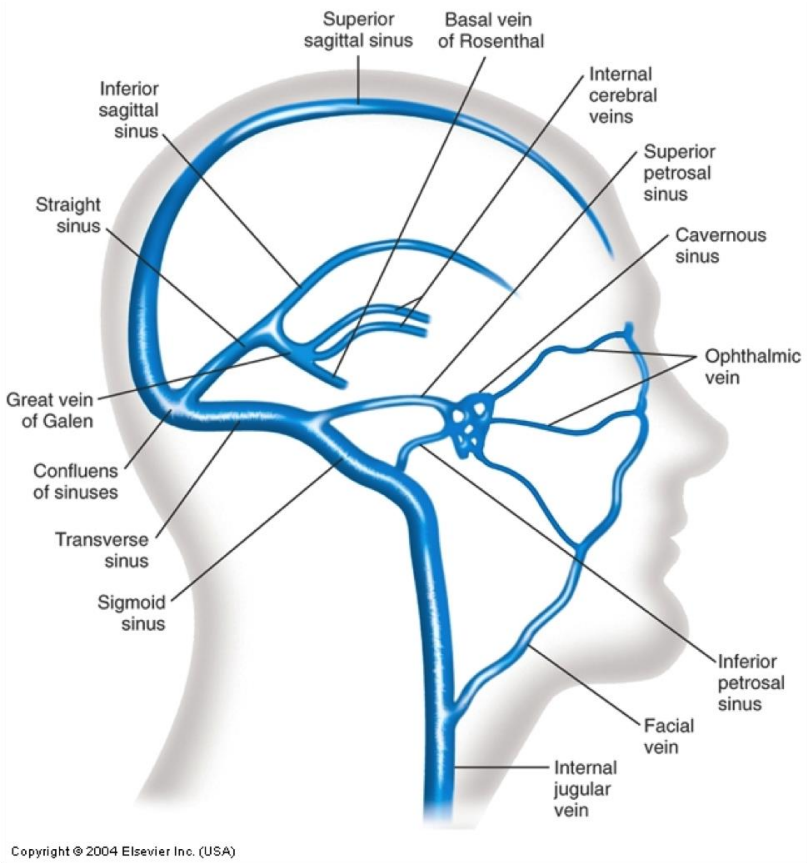

**Single**

- Superior sagittal
- Inferior sagittal
- Straight
- Occipital

Blood flows from transverse & sigmoid sinuses into IJV

# DURAL VENOUS SINUSES



# WATCH

# VENOUS DISORDER

- **Infarction**
  - refers to tissue death (necrosis) that is caused by a local lack of oxygen due to obstruction of the tissue's blood supply

- **Sinus thrombosis:**
  - Superior Sagittal Sinus thrombosis
    - Can complicates ear infection
  - Cavernous Sinus thrombosis
    - As a complication of infection in the dangerous area of the face
  - Obstruction of venous drainage of the brain leads to Cerebral swelling (edema) and raised Intracranial Pressure.

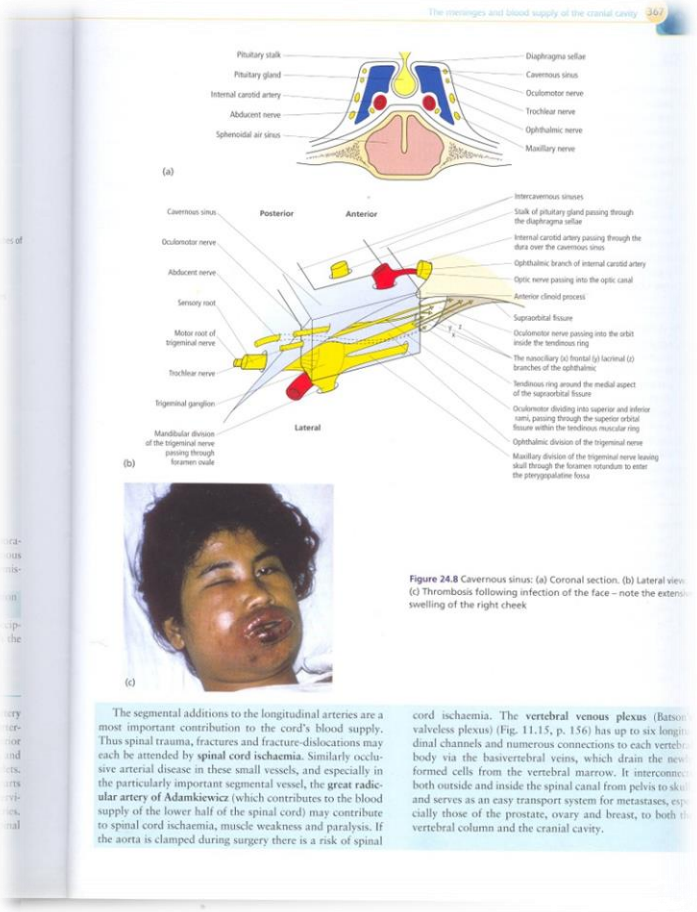



Figure 24.8 Cavernous sinus: (a) Coronal section. (b) Lateral view. (c) Thrombosis following infection of the face – note the extensive swelling of the right cheek

The segmental additions to the longitudinal arteries are a most important contribution to the cord's blood supply. Thus spinal trauma, fractures and fracture-dislocations may each be attended by **spinal cord ischaemia**. Similarly occlusive arterial disease in these small vessels, and especially in the particularly important segmental vessel, the **great radicular artery of Adamkiewicz** (which contributes to the blood supply of the lower half of the spinal cord) may contribute to spinal cord ischaemia, muscle weakness and paralysis. If the aorta is clamped during surgery there is a risk of spinal cord ischaemia. The **vertebral venous plexus** (Batson's valveless plexus) (Fig. 11.15, p. 156) has up to six longitudinal channels and numerous connections to each vertebral body via the basivertebral veins, which drain the newly formed cells from the vertebral marrow. It interconnects both outside and inside the spinal canal from pelvis to skull and serves as an easy transport system for metastases, especially those of the prostate, ovary and breast, to both the vertebral column and the cranial cavity.

# ALSO, HOW WE ARE DOING ..?

- **Which statement(s) of the following is Wrong?**

1. Superior Cerebral Veins terminate mainly into the Superior Sagittal sinus, and partly into superficial middle cerebral vein..!!
2. Infarction refers to tissue death (necrosis)..!!
3. Superior Cerebral Veins drain lateral surface of brain above the lateral sulcus..!!
4. Inferior Cerebral Veins terminate partly into superficial middle cerebral vein & partly into Transverse sinus..!!
5. Superficial Middle Cerebral Vein drains the lateral surface of the temporal lobe..!!

# QUESTIONS!