CEREBRAL BLOOD CIRCULATION

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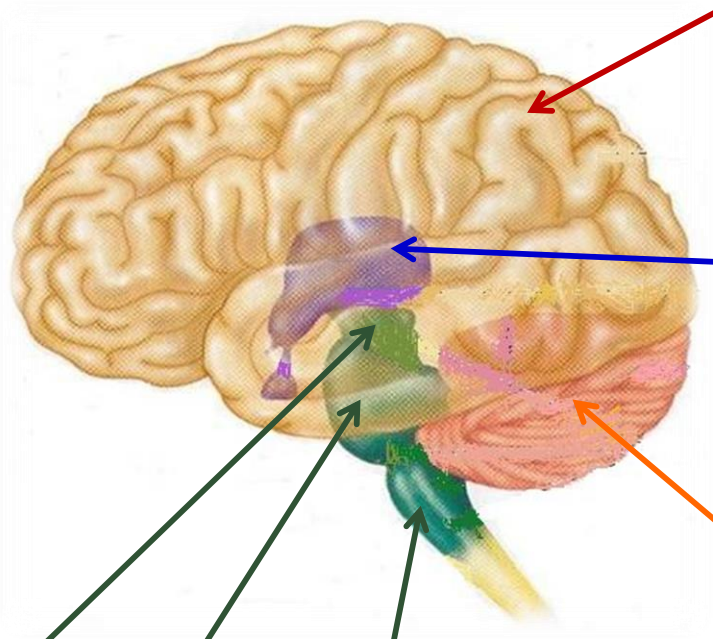
OBJECTIVES

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.

Review: THE BRAIN

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



Cerebrum
(Cerebral hemispheres)

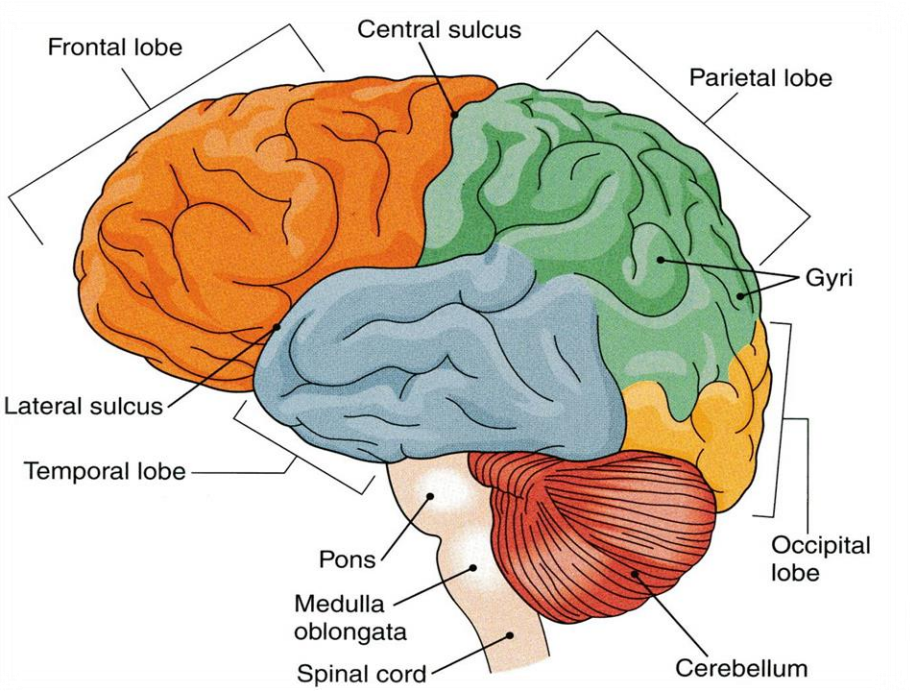
Diencephalon:
Thalamus,
Hypothalamus,
Subthalamus &
Epithalamus

Cerebellum

Brainstem: Midbrain, Pons & Medulla oblongata

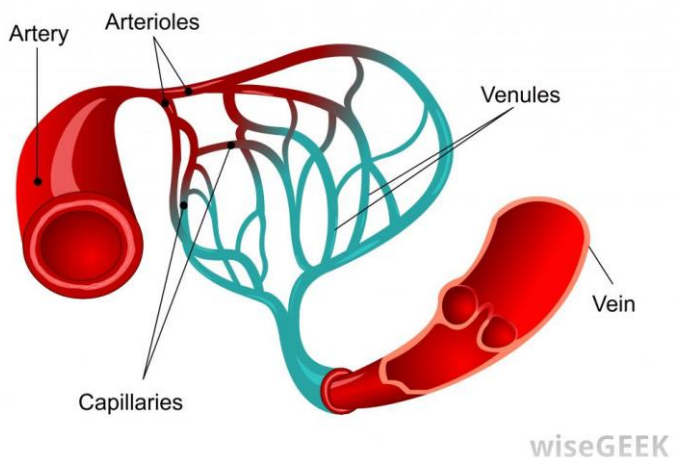
Review: CEREBRUM

- 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.



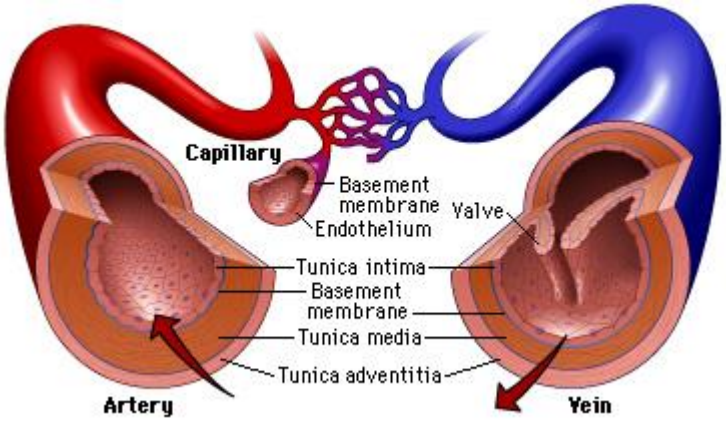
Review: BLOOD VESSELS

- 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.

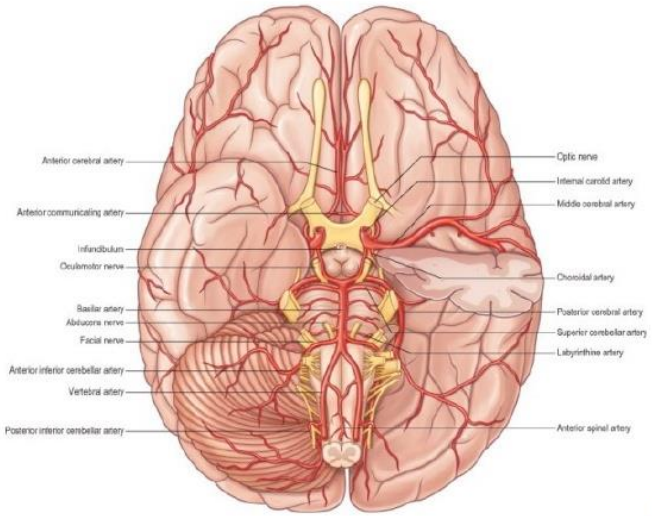


Review: BLOOD

- 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

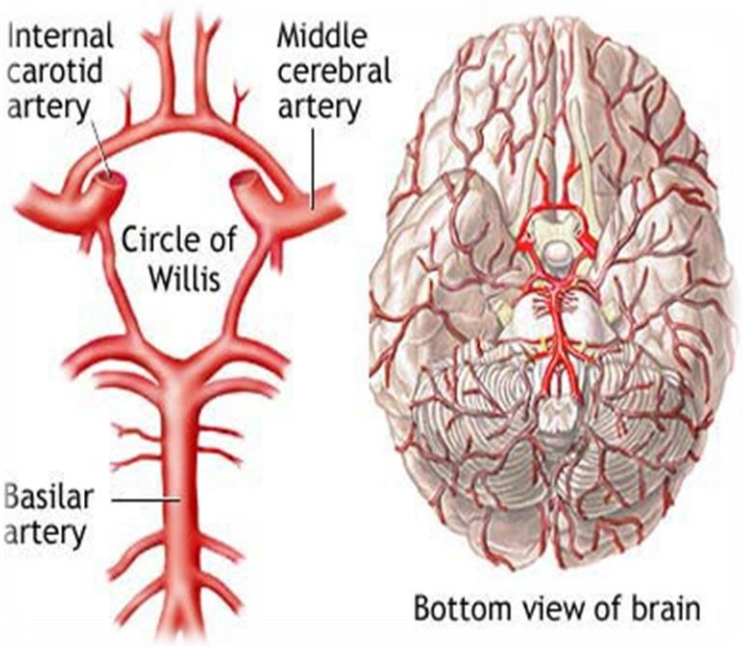
- The movement of blood through the network of blood vessels to supply the brain.
- The arteries carry oxygenated blood and other nutrients to the brain.
- The veins carry deoxygenated blood back to the heart removing carbon dioxide and other metabolic products.
- The movement of blood in the cerebral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



WATCH

CEREBRAL ARTERIAL SUPPLY

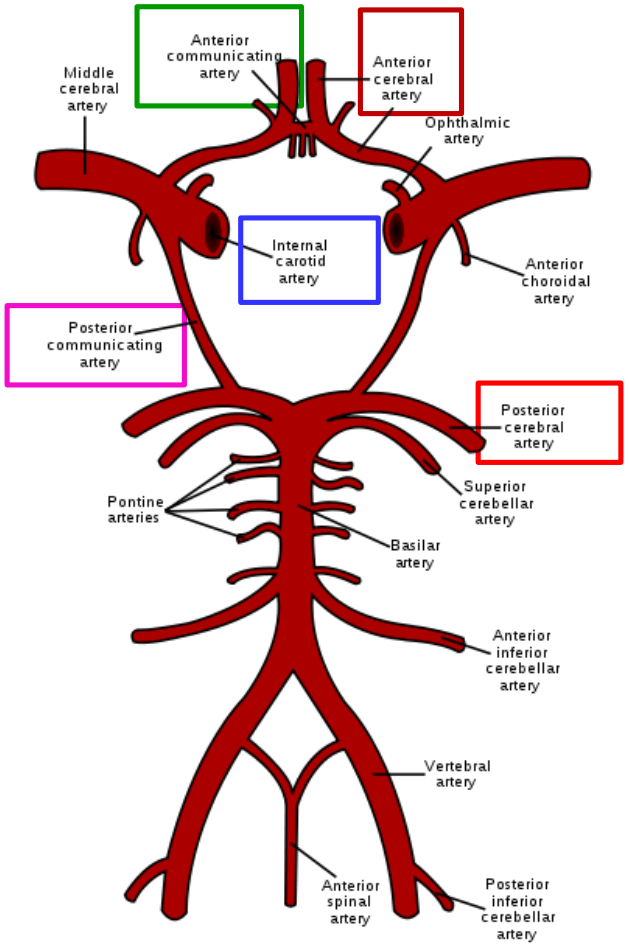
- The arterial cerebral circulation is divided into anterior and posterior cerebral circulations.
- The anterior and posterior cerebral circulations are interconnected via bilateral posterior communicating arteries.
  - Posterior communicating arteries are part of Circle of Willis.
    - ✓ Located on the base of the brain.
    - ✓ It Encircles:
      - Optic chiasma
      - Hypothalamus
      - Midbrain
- 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.



CIRCULUS ARTERIOSUS
(CIRCLE OF WILLIS)

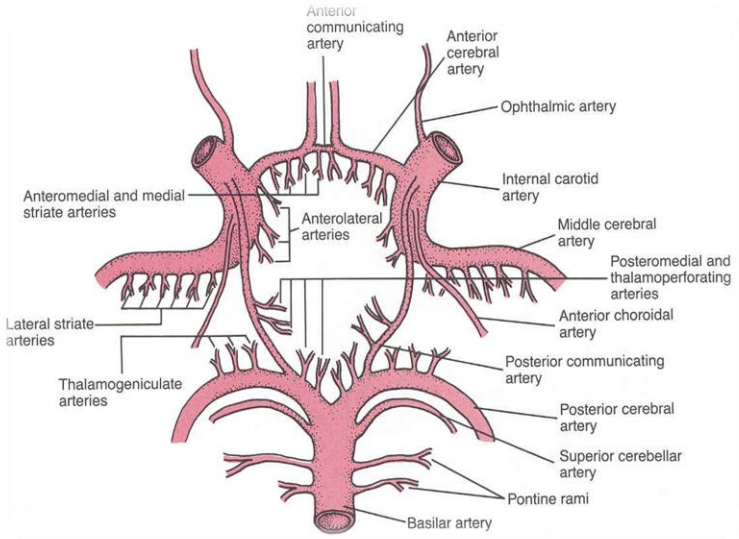
Named after Thomas Willis (1621–1675), an English physician

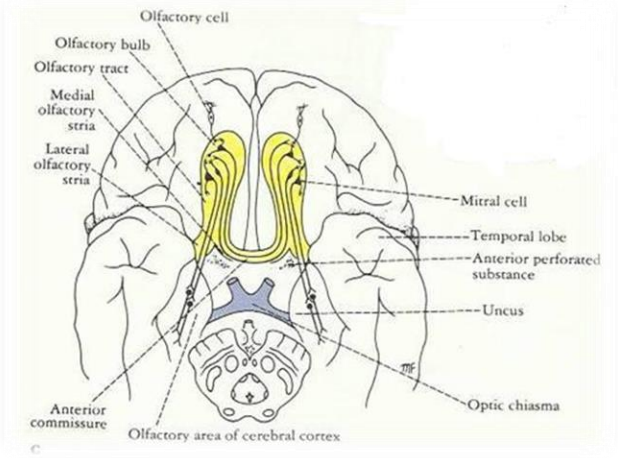
- It is Formed by:
  - Two Anterior cerebral arteries
  - Two Internal carotid arteries
  - Two Posterior cerebral arteries
  - Two Posterior communicating arteries
  - One Anterior communicating artery
- It Gives numerous small vessels that penetrate the surface of the brain
  - Perforating arteries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



ANTERIOR PERFORATING ARTERIES

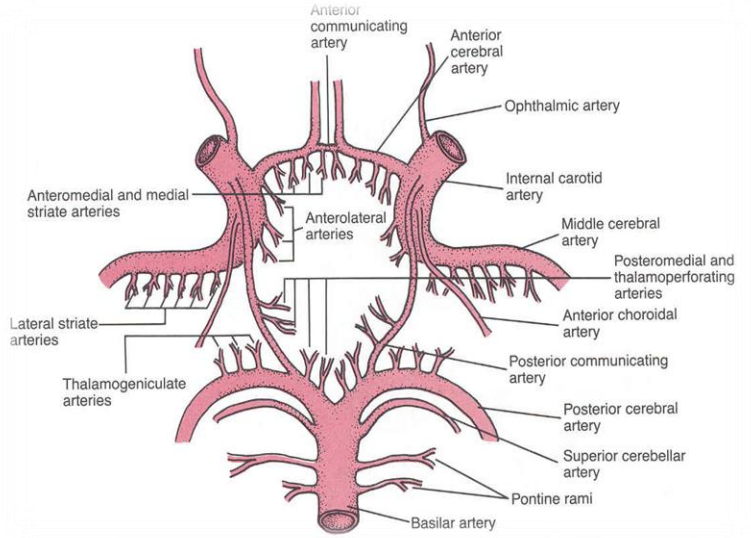
- Arise from:
  - Anterior cerebral artery
  - Anterior communicating artery
  - Middle cerebral artery
- Enter brain through:
  - Anterior perforated substance
    - irregularly quadrilateral area in front of the optic tract and behind the olfactory trigone.
- Supply:
  - Large part of basal ganglia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

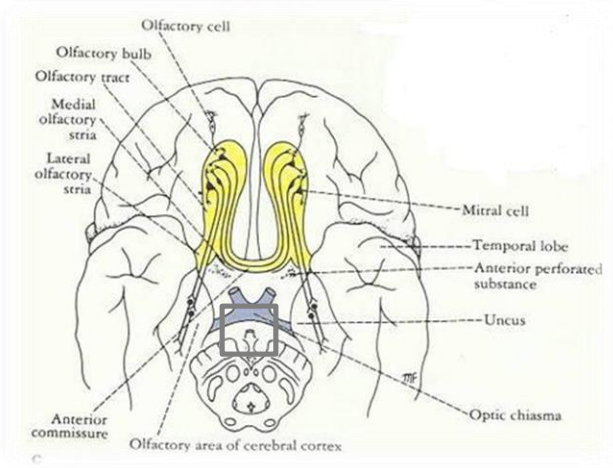




POSTERIOR PERFORATING ARTERIES

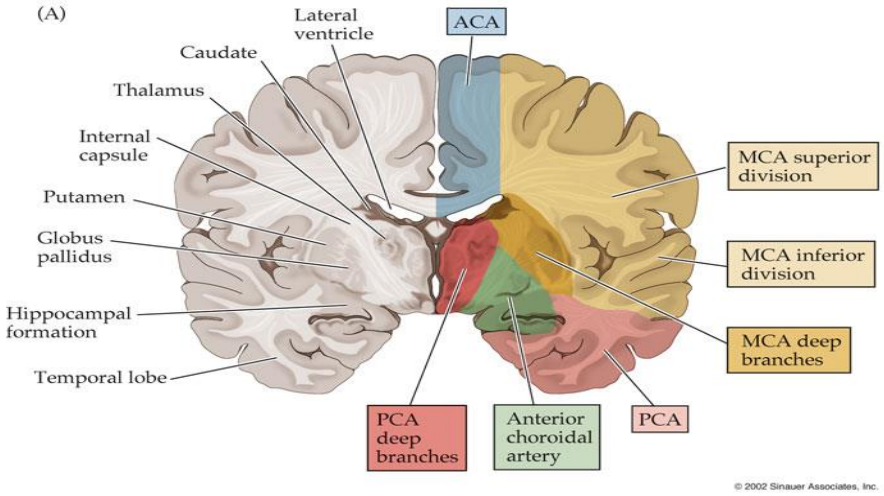
- Arise from:
  - Posterior cerebral artery
  - Posterior communicating artery
- Enter brain through:
  - Posterior Perforated substance
- Supply:
  - Ventral portion of Midbrain
  - Parts of Subthalamus and Hypothalamus

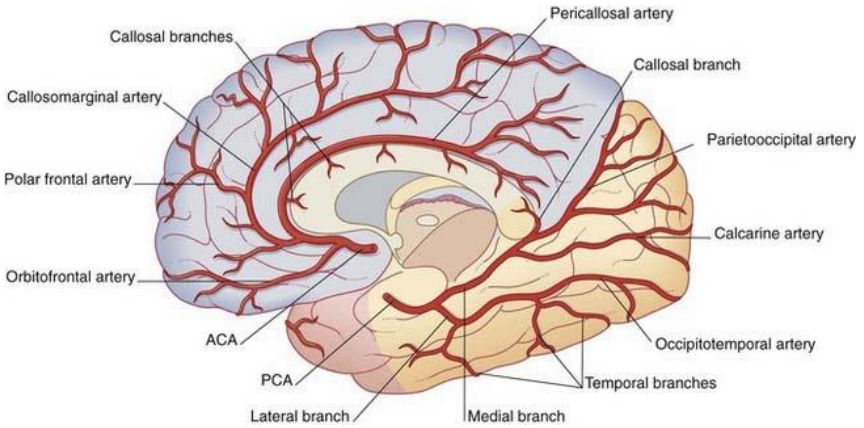




ANTERIOR CEREBRAL ARTERY

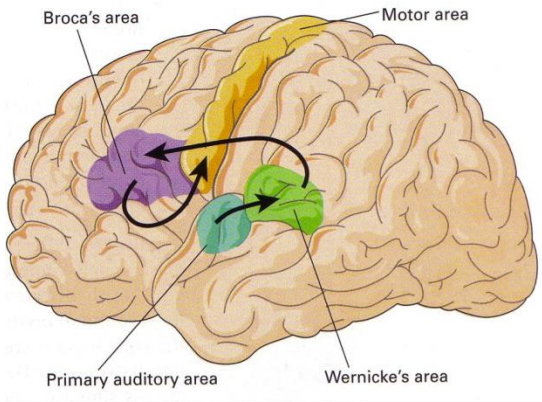
- Supplies: Orbital and medial surfaces of frontal and parietal lobes

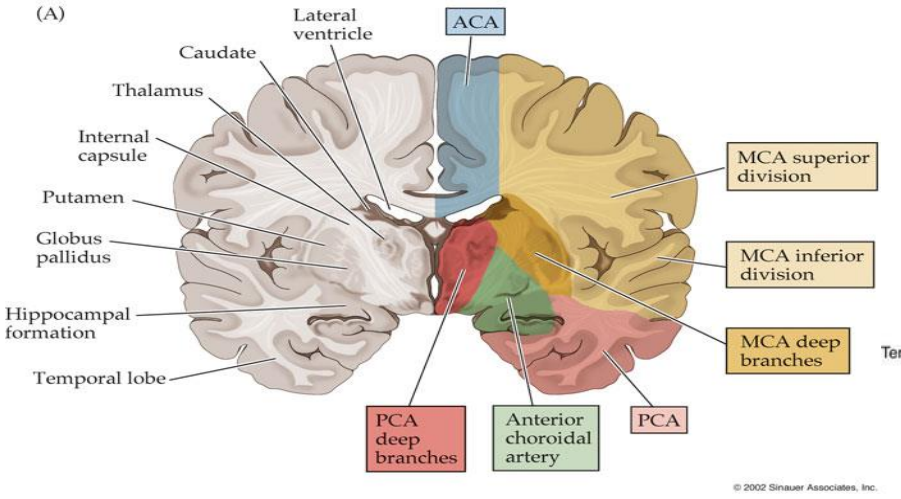


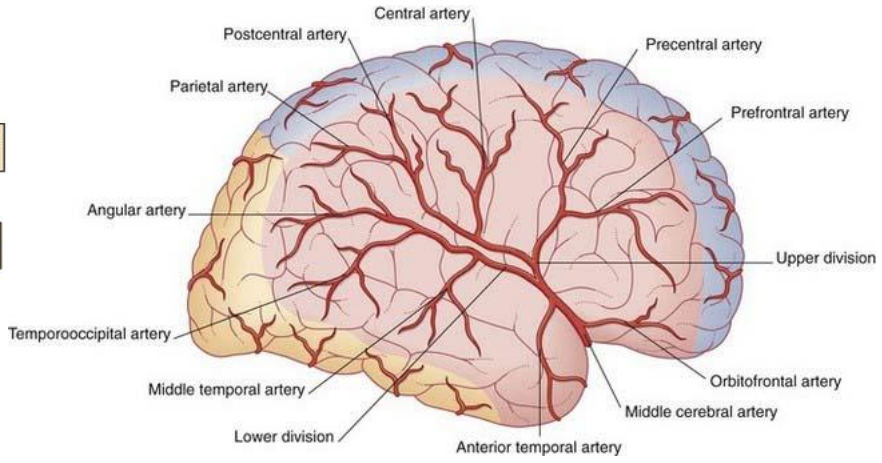


MIDDLE CEREBRAL ARTERY

- 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

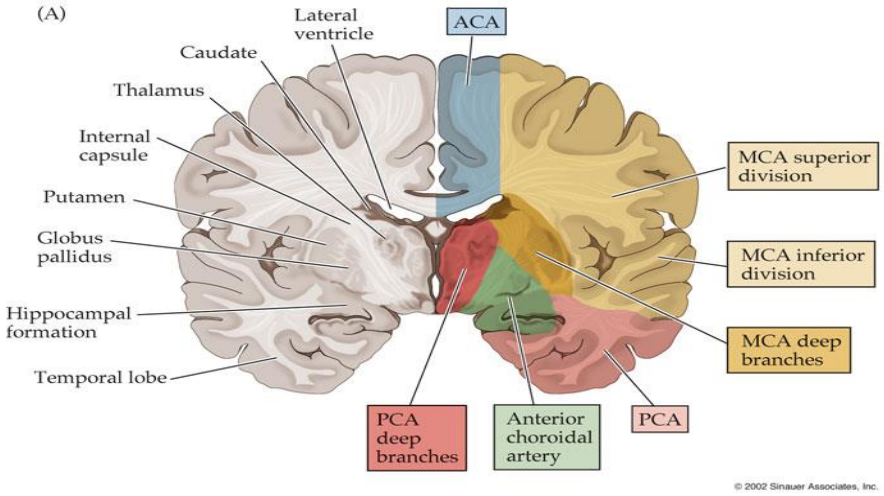


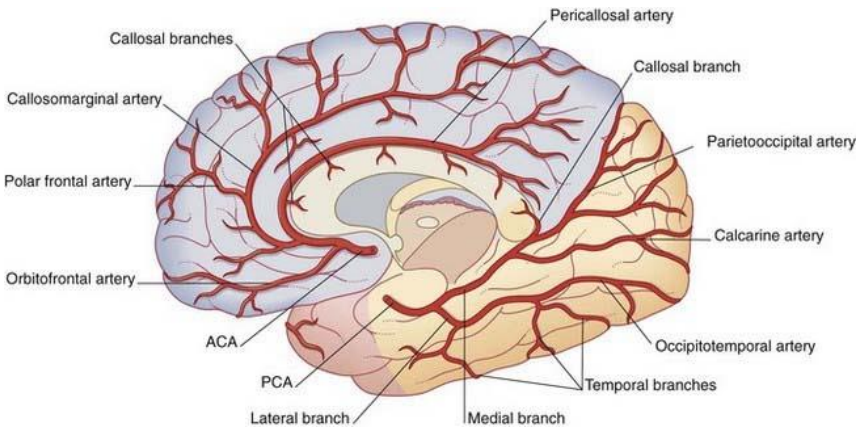




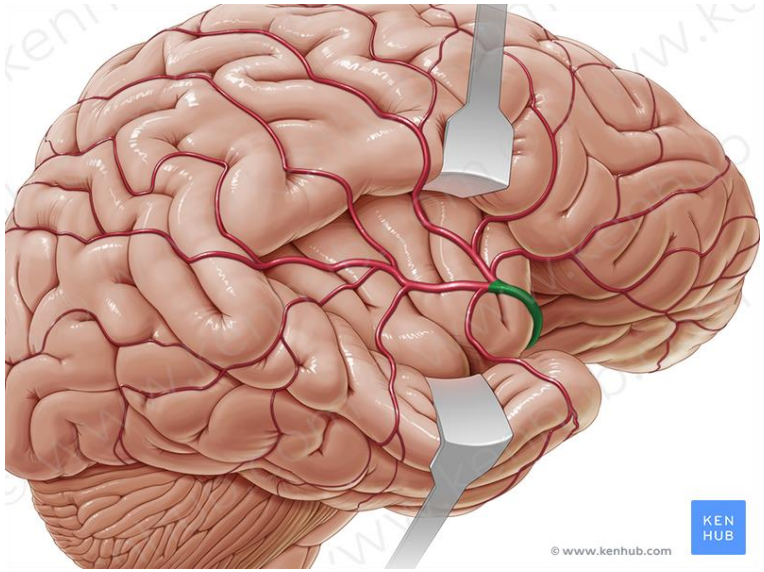
POSTERIOR CEREBRAL ARTERY

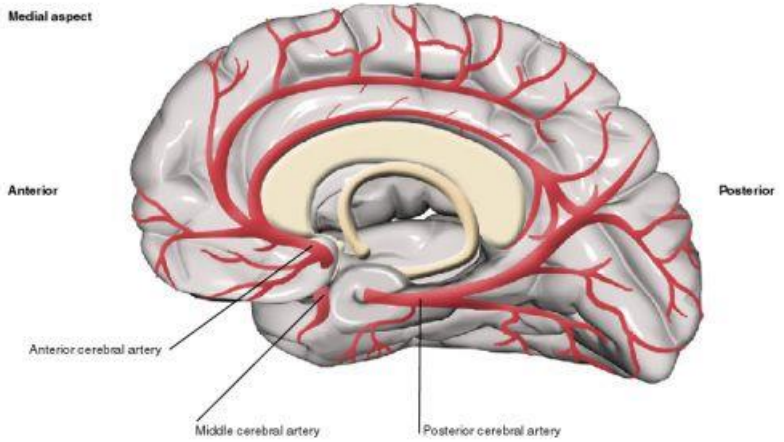
- Supplies:
  - Anterior and inferior temporal lobes
  - Uncus
    - Located on the tip end of the medial surface of the parahippocampal gyrus.
    - Part of the olfactory cortex that processes information from the sense of smell.
  - Inferior temporal gyri
  - Inferior and Medial Occipital lobe



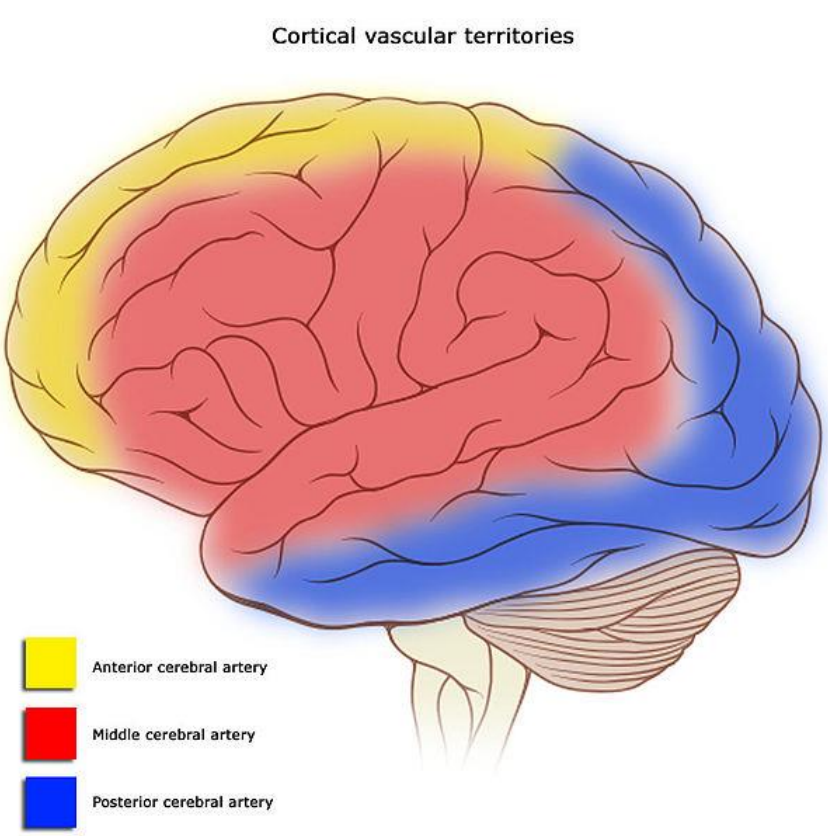


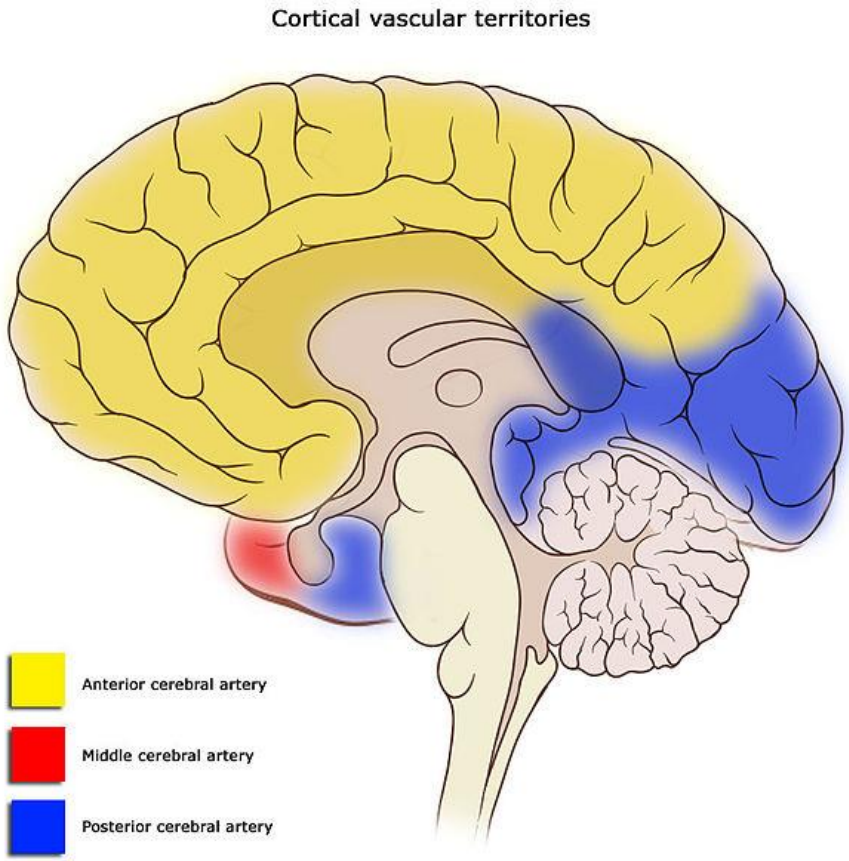
CEREBRAL ARTERIES





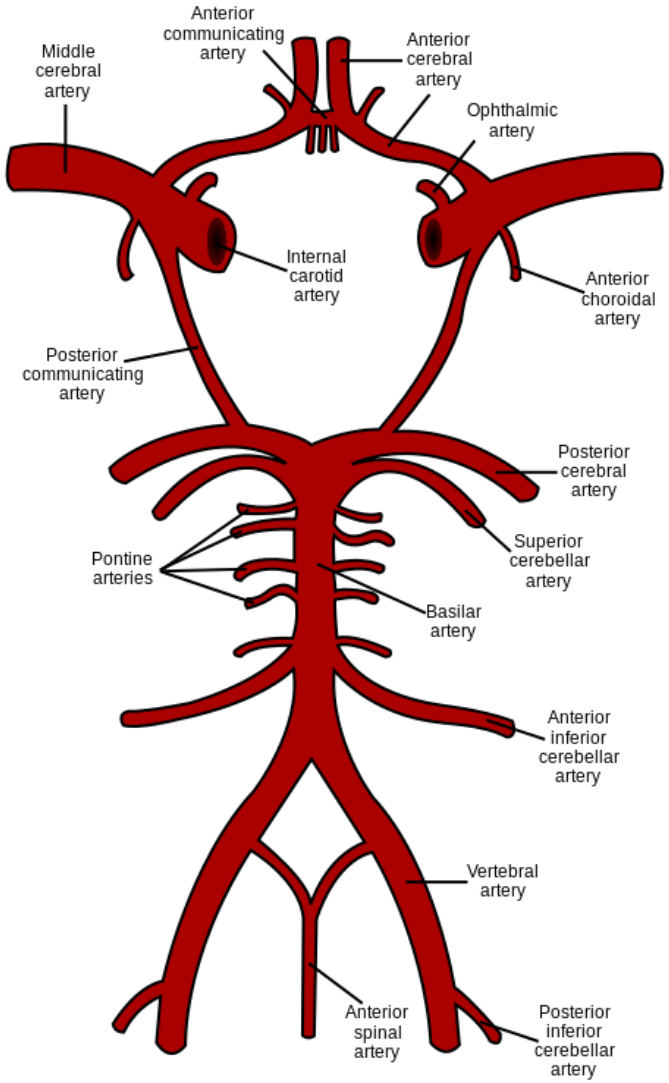
DISTRIBUTION OF CEREBRAL ARTERIES



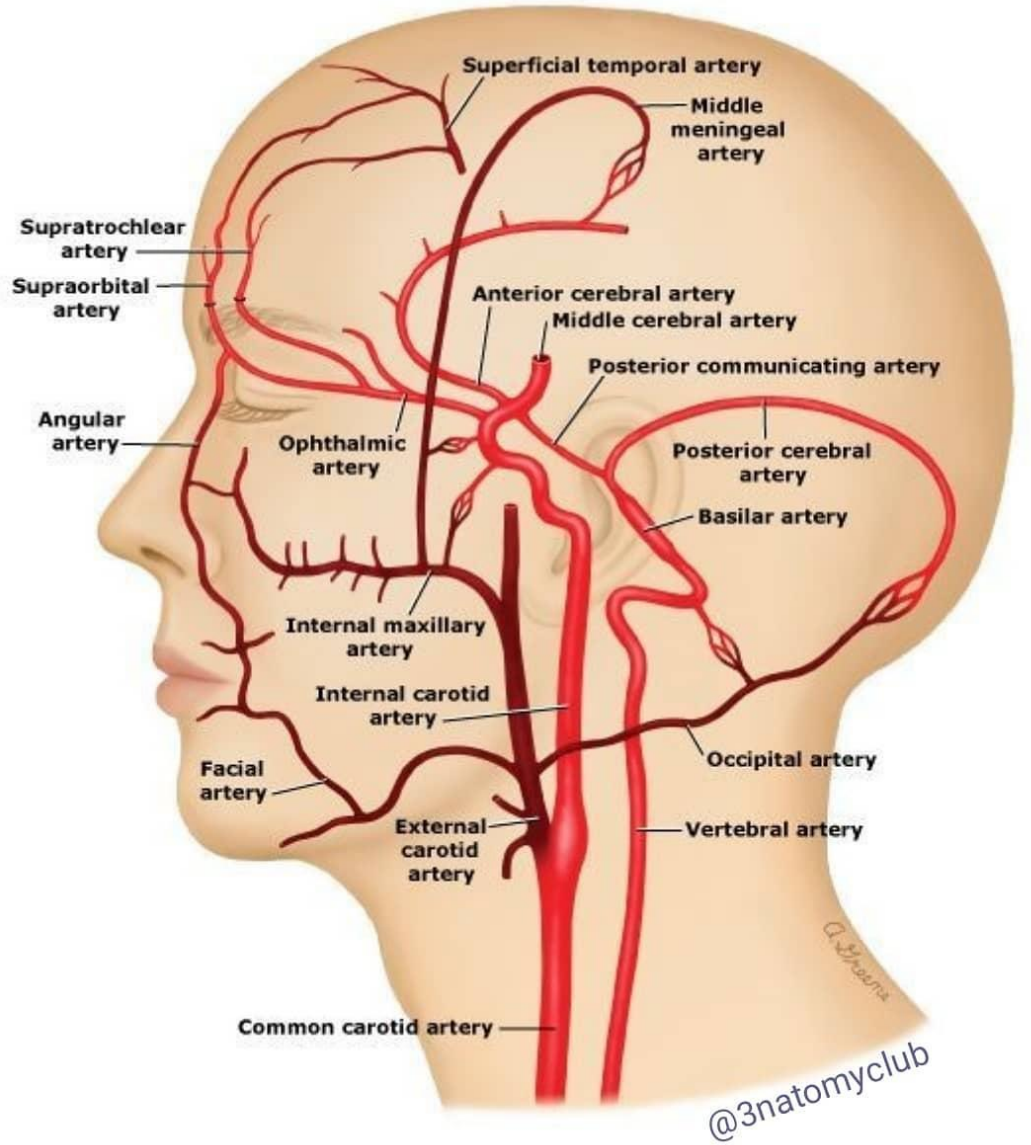


BASILAR ARTERY

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

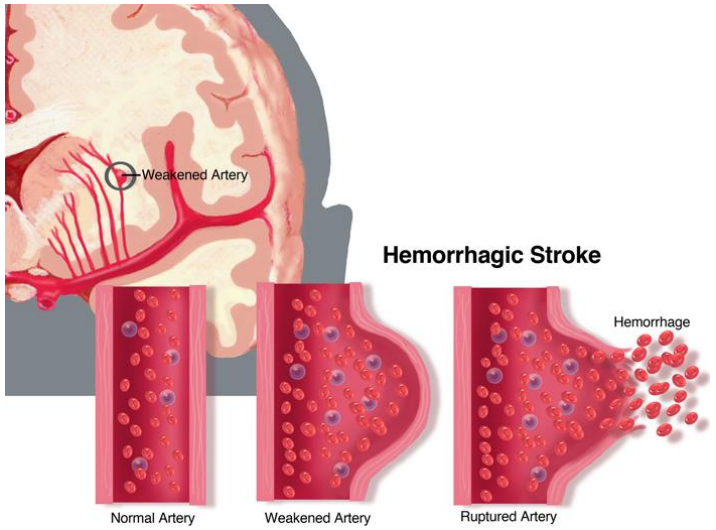


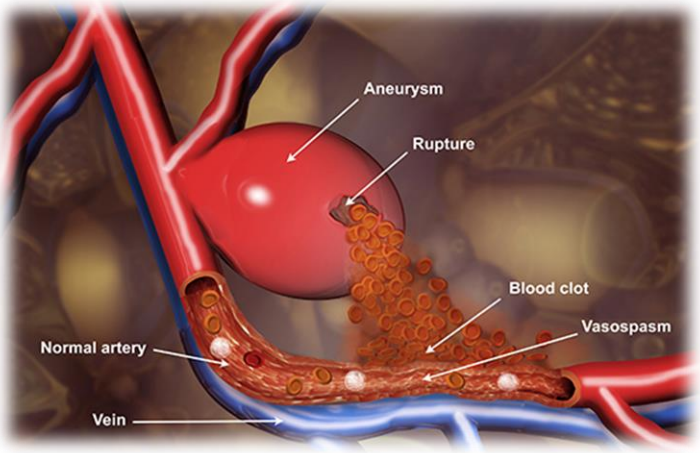
CEREBRAL BLOOD FLOW



ARTERIAL DISORDER

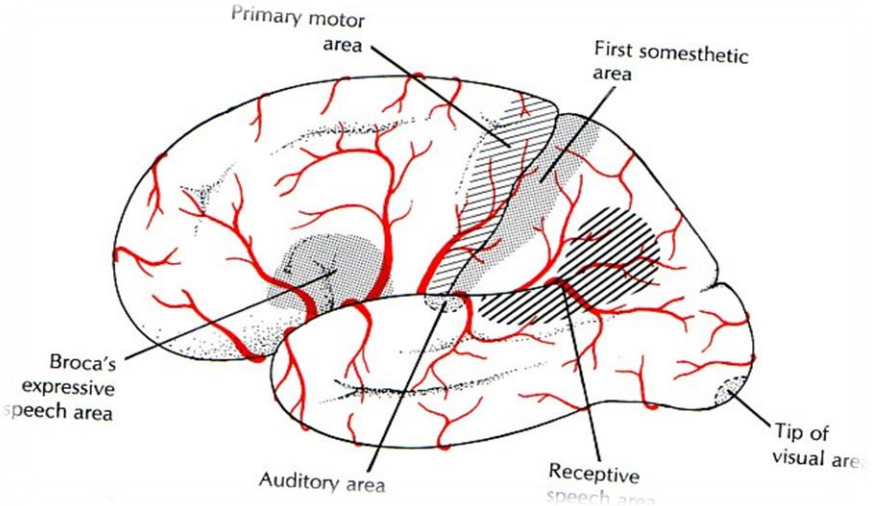
- Stroke
  - Sudden occlusion
  - Hemorrhage
- Aneurysm
  - It localized, blood-filled balloon-like bulge in the wall of a blood vessel.
- Angioma
  - It is benign tumors derived from cells of the vascular or lymphatic vessel walls (epithelium) or derived from cells of the tissues surrounding these vessels.

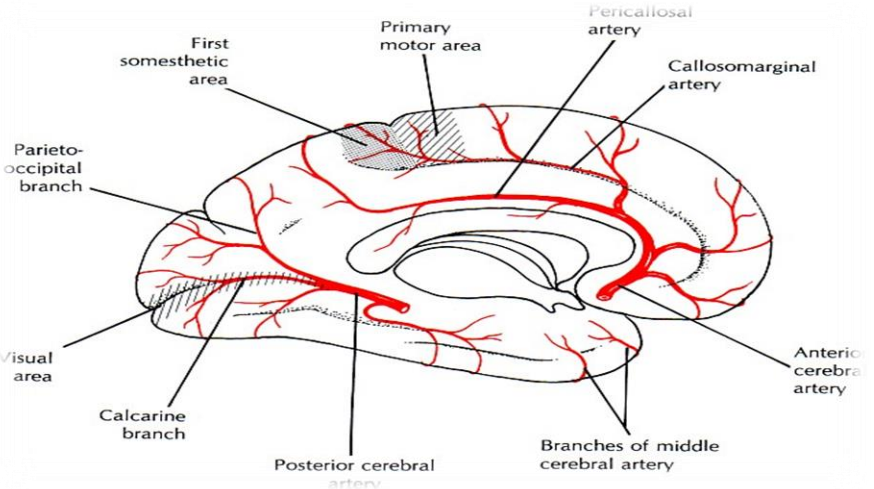




ACCLUSION OF ACA

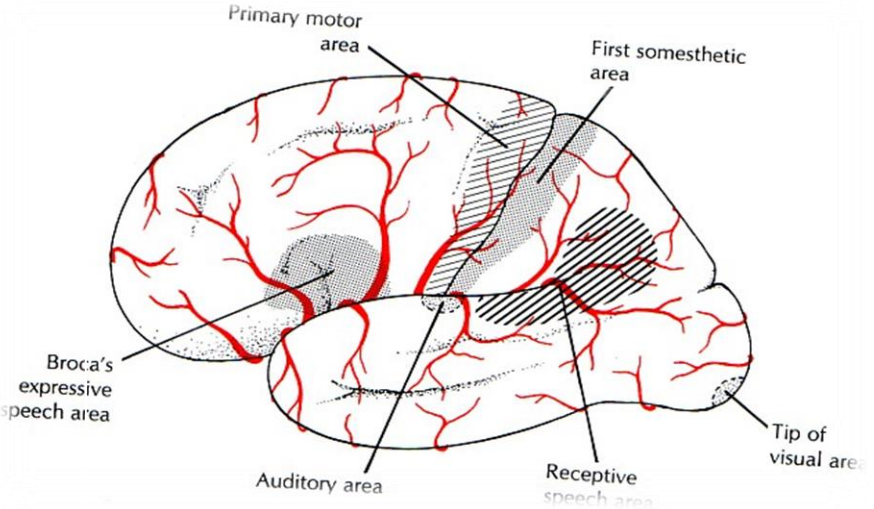
- Manifestations:
  - Motor disturbance in contralateral distal leg
  - Difficulty in Prefrontal lobe Functions:
    - Cognitive thinking
    - Judgment
    - Motor initiation
    - Self monitoring

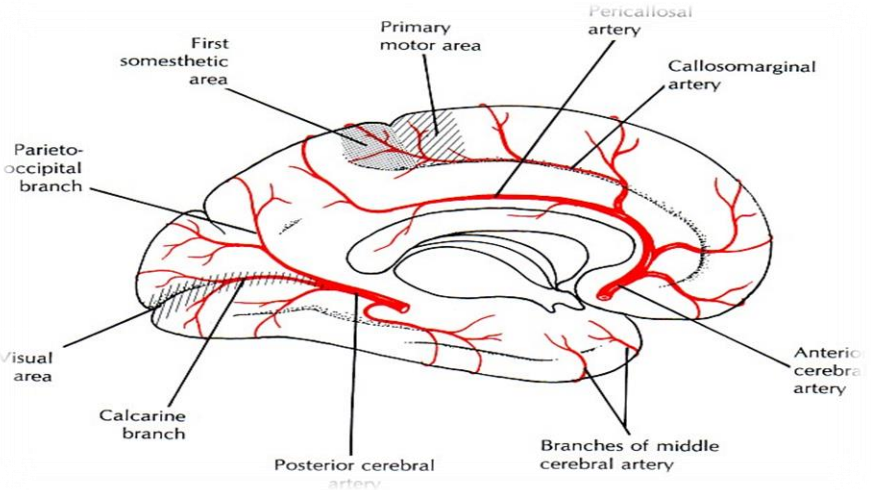




ACCLUSION OF MCA

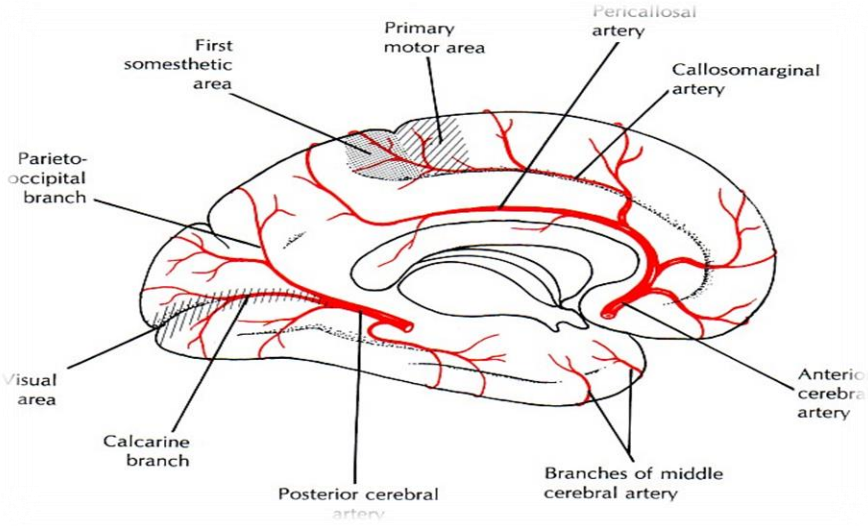
- Manifestations:
  - Contralateral weakness of:
    - face, arm, and hand more than legs
  - Contralateral sensory loss of:
    - face, arm, and hand more than legs
    - visual field cut (damage to optic radiation)
  - Aphasia: language disturbances
    - Broca's: production
    - Wernicke's: comprehension

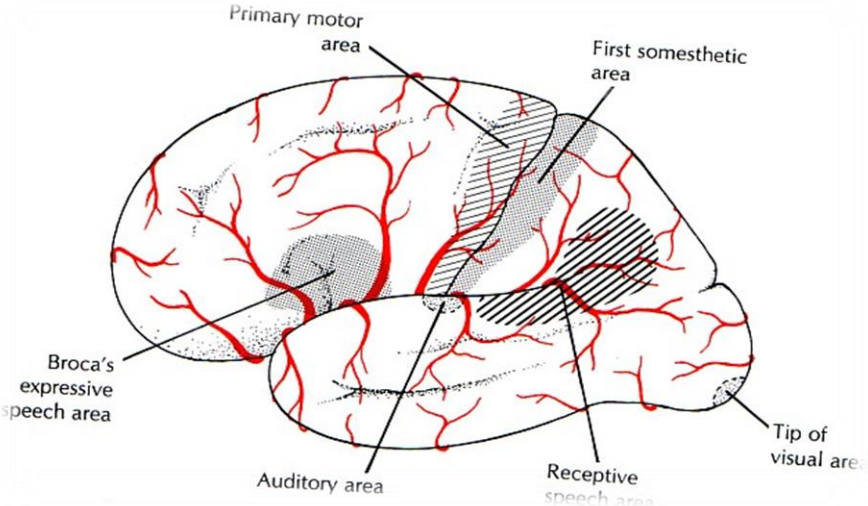




ACCLUSION OF PCA

- 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





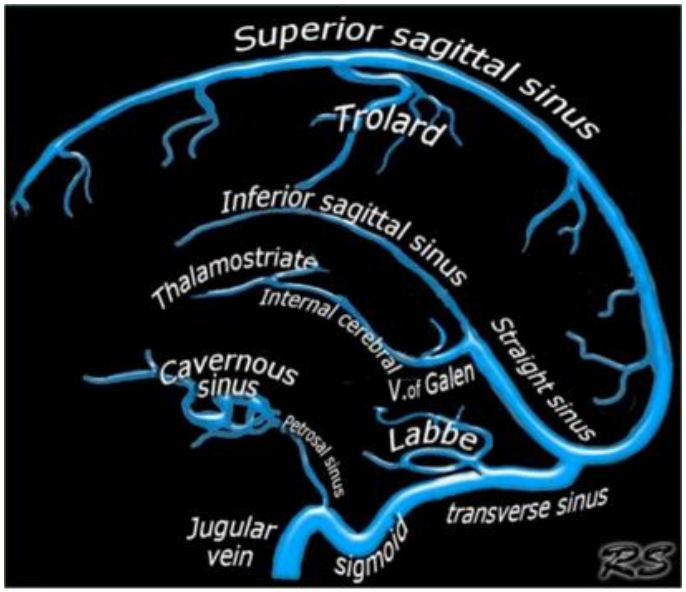
HOW WE ARE DOING ..?

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..!!

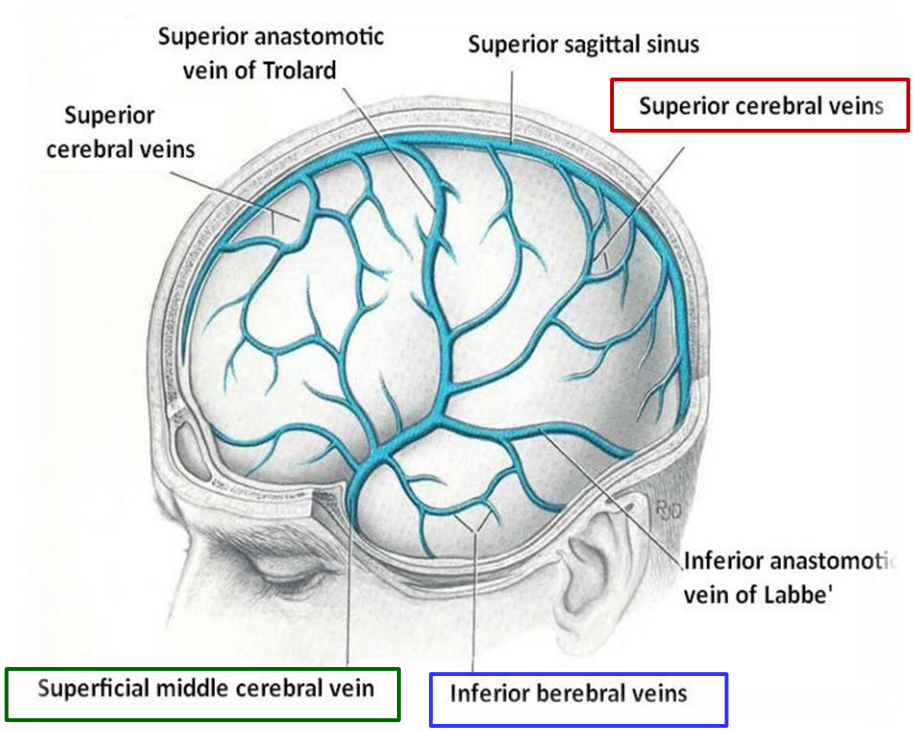
CEREBRAL VENOUS DRAINAGE

- 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.



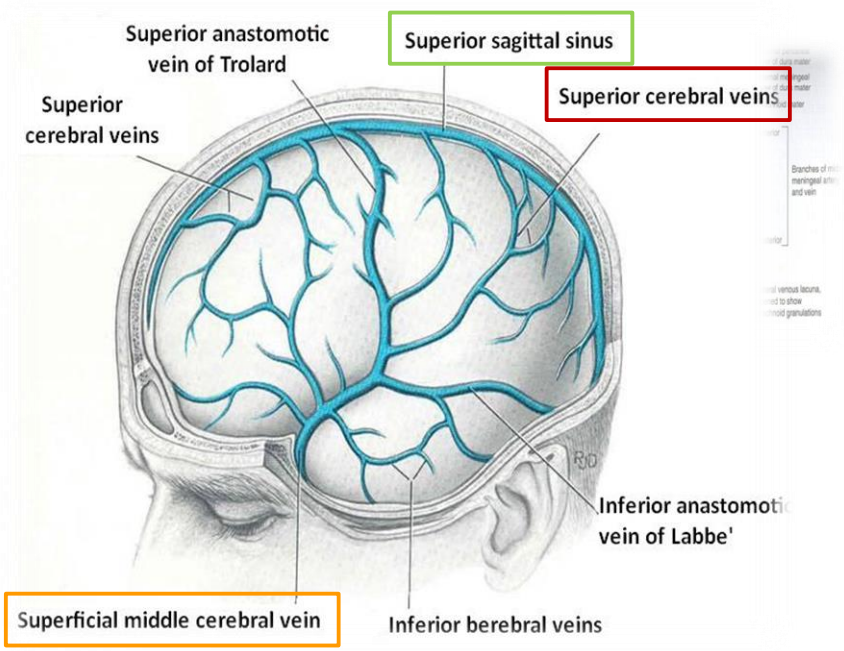
SUPERFICIAL CORTICAL VEINS

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



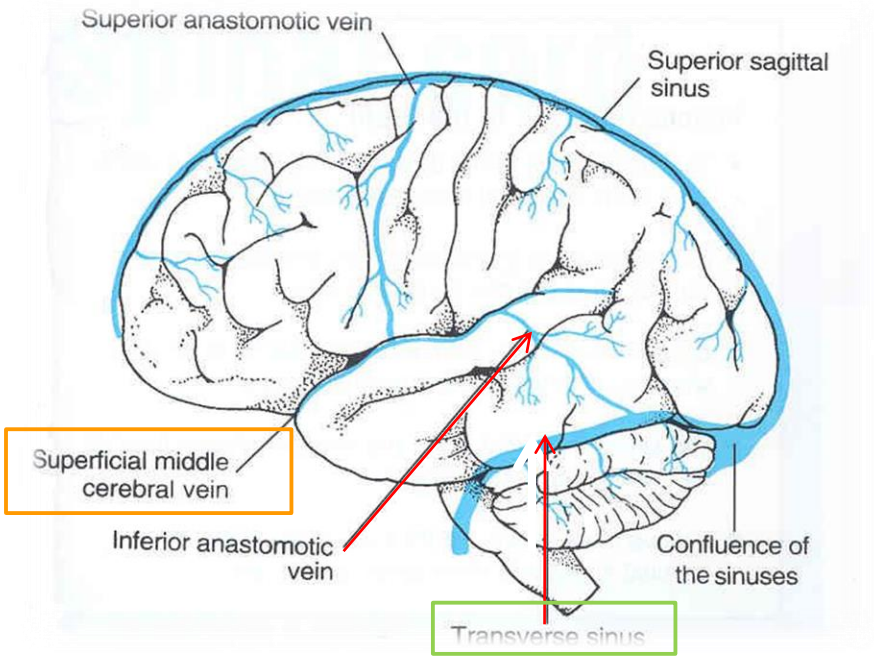
SUPERFICIAL CORTICAL VEINS

- 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.



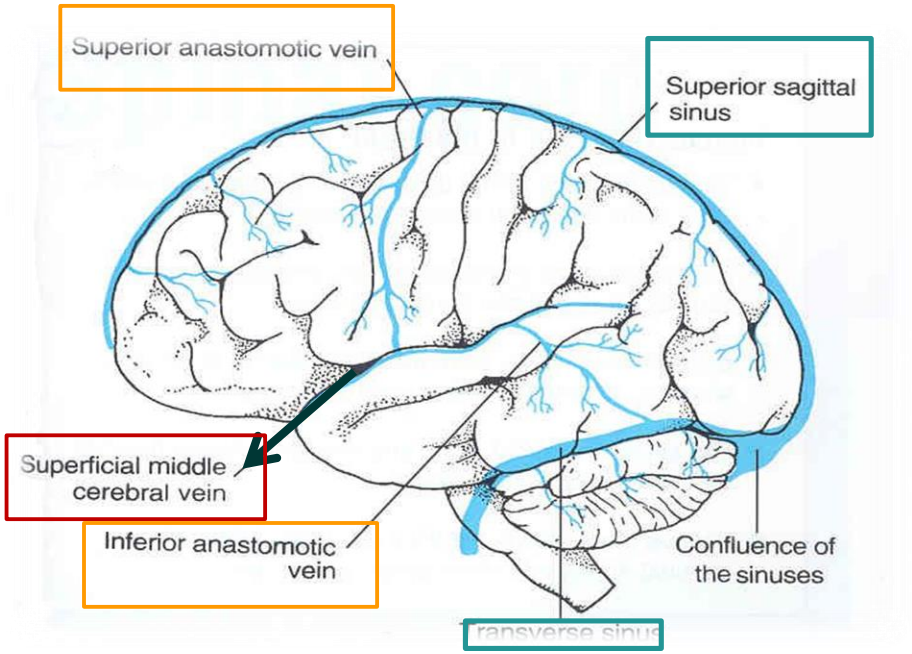
SUPERFICIAL CORTICAL VEINS

- 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.



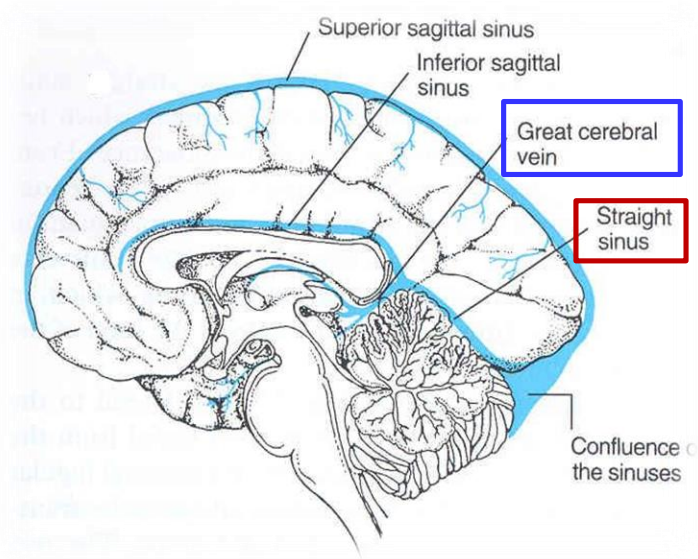
SUPERFICIAL CORTICAL VEINS

- Superficial Middle Cerebral Vein
  - Runs along the lateral sulcus
  - Terminates into the Cavernous sinus
  - Connected posteriorly by Superior & Inferior anastomotic veins to Superior Sagittal & Transverse sinuses respectively.



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

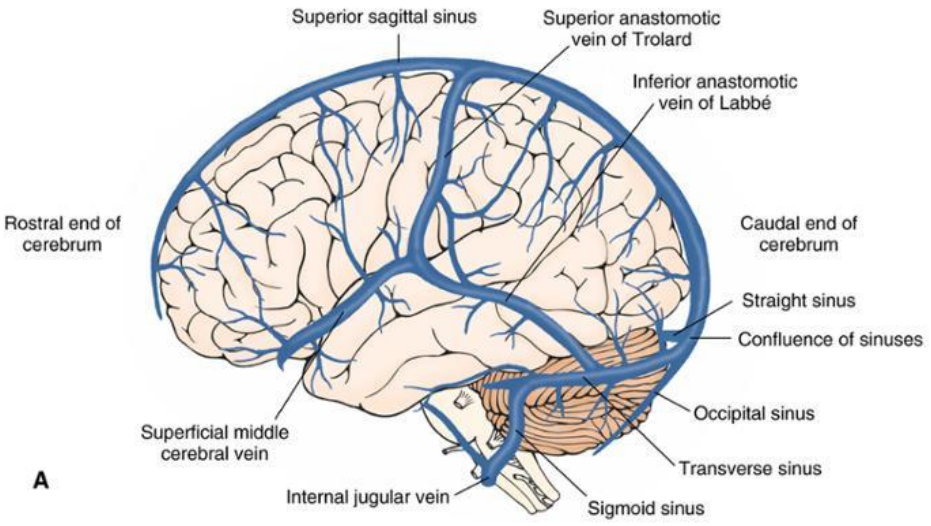
- Lies along the superior border of the falx cerebri and empties into the confluence of sinuses.

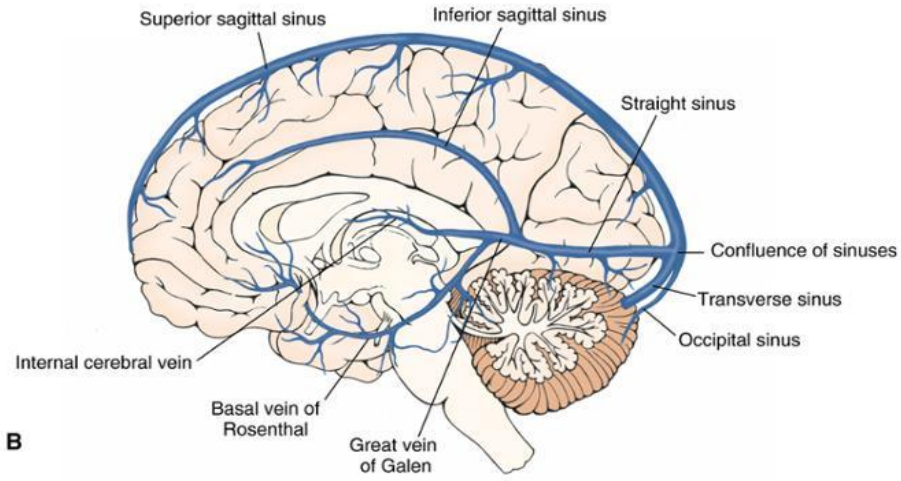
The Inferior Sagittal Sinus

- 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

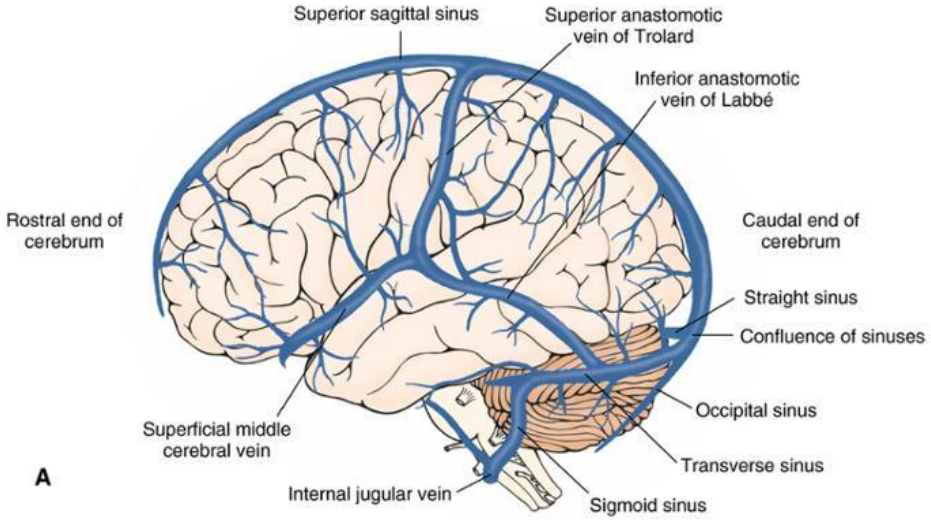
- Originate on each side of the confluence of sinuses.
- Each transverse sinus travels laterally, and curves downward to form the sigmoid sinus that empties into the internal jugular vein on the same side.

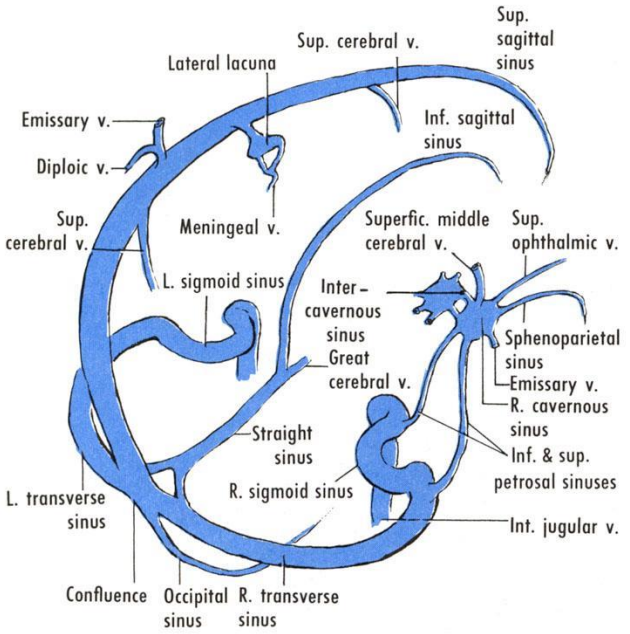




CEREBRAL SINUSES

- 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.

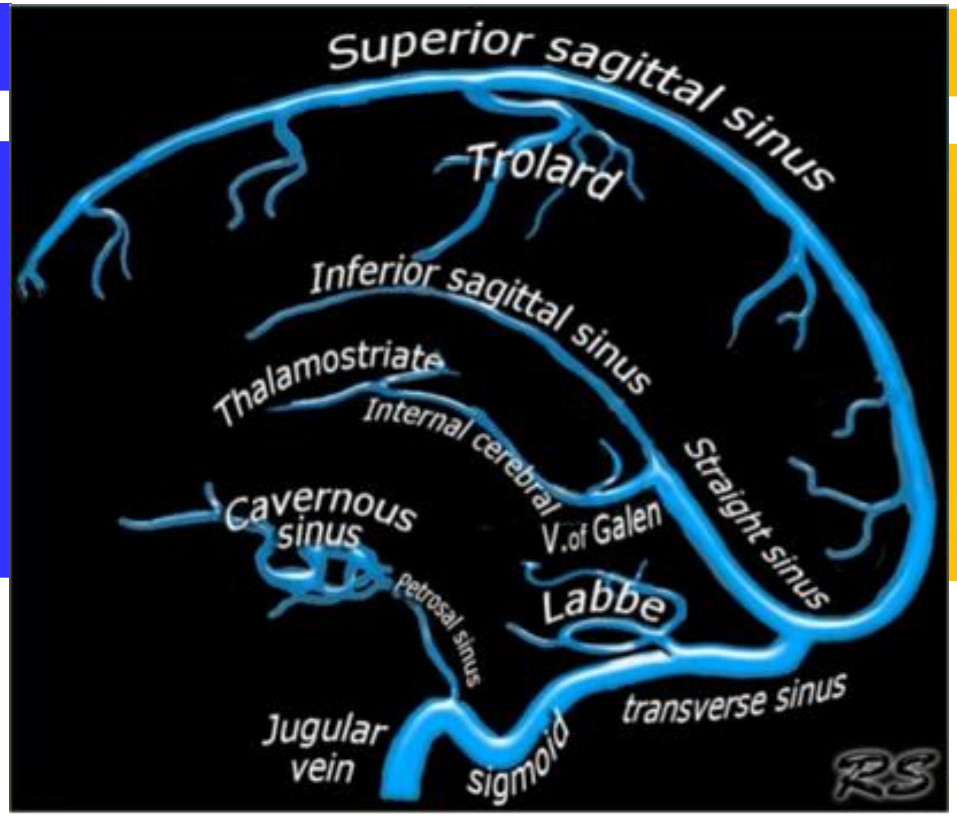




DURAL VENOUS SINUSES

Paired

- Transverse
- Sigmoid
- Cavernous
- Petrosal

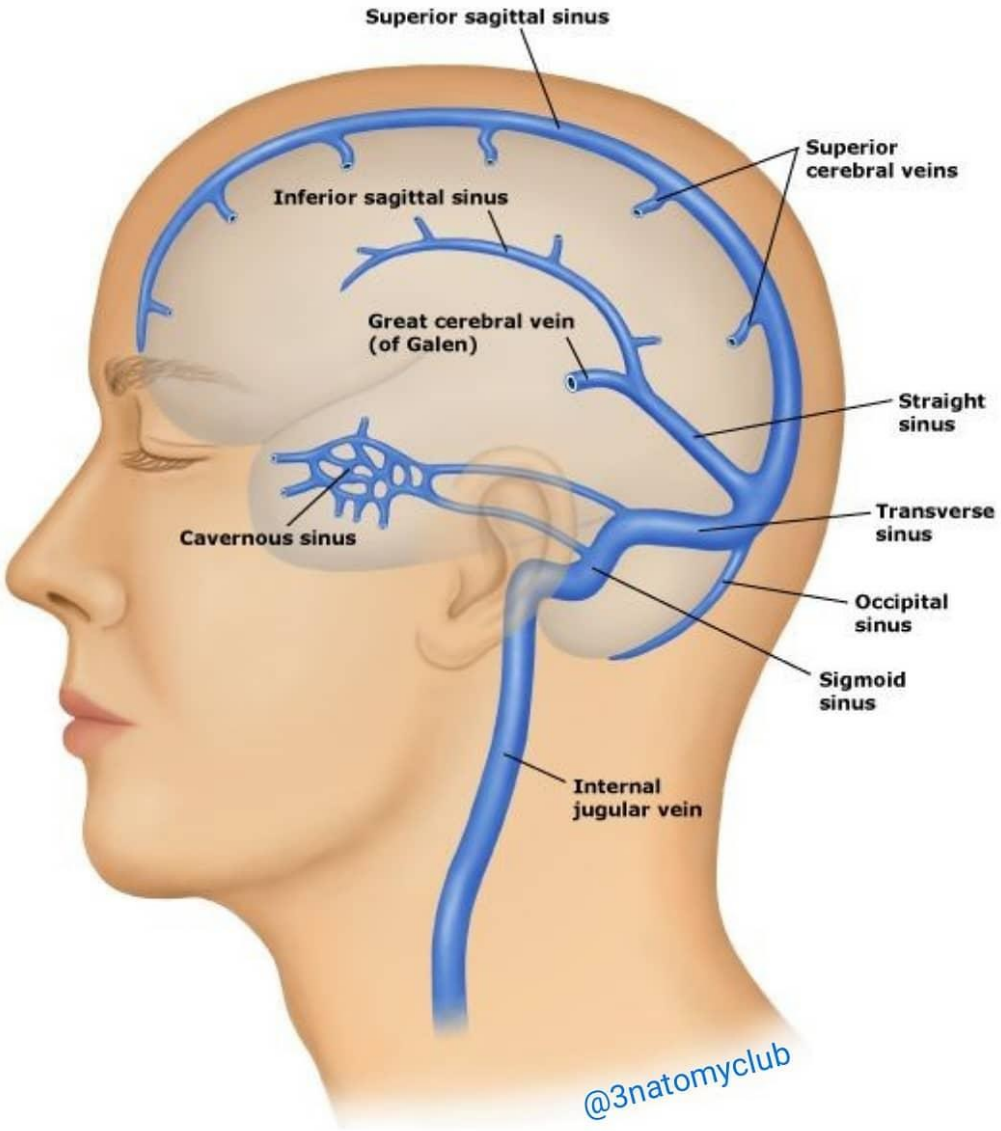


Single

- Superior sagittal
- Inferior sagittal
- Straight
- Occipital

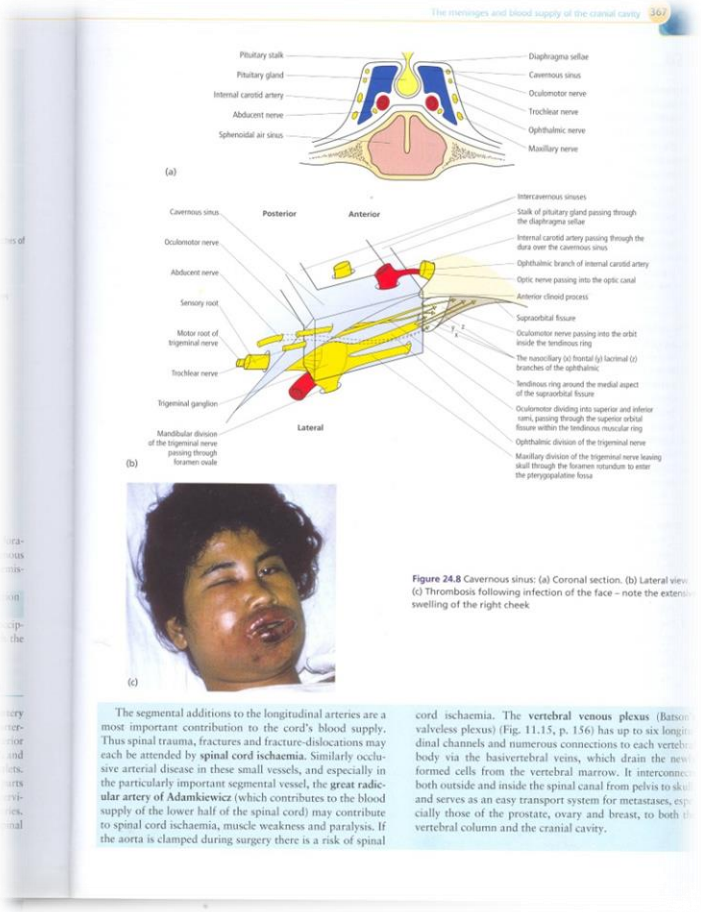
Blood flows from transverse & sigmoid sinuses into IJV

DURAL VENOUS SINUSES



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:
  - SSS thrombosis
    - Superior Sagittal Sinus.
    - 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.



ALSO, HOW WE ARE DOING ..?

Which statement(s) of the following is Wrong?

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

QUESTIONS?