

Blood supply of the Brain

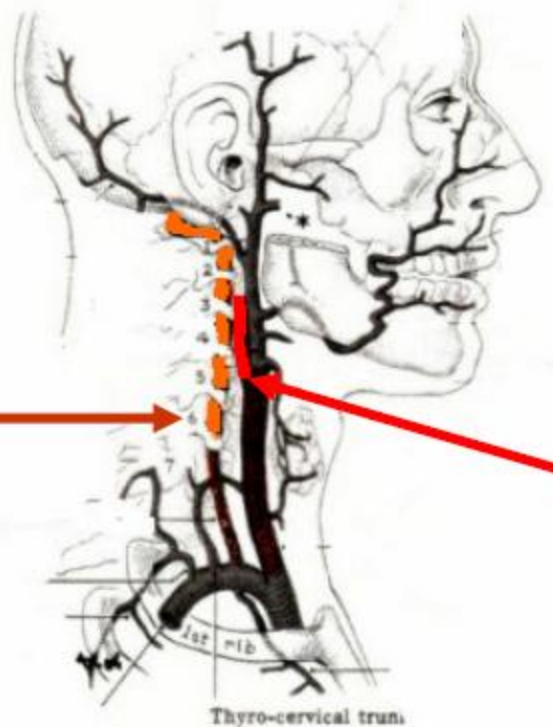
Arterial Blood Supply

- **Arterial blood supply of the brain**
- Brain is supplied by pairs of internal carotid artery and vertebral artery.
- The four arteries lie within the subarachnoid space
- Their branches anastomose on the inferior surface of the brain to form the **circle of Willis**

OVERVIEW OF BLOOD SUPPLY TO HEAD -

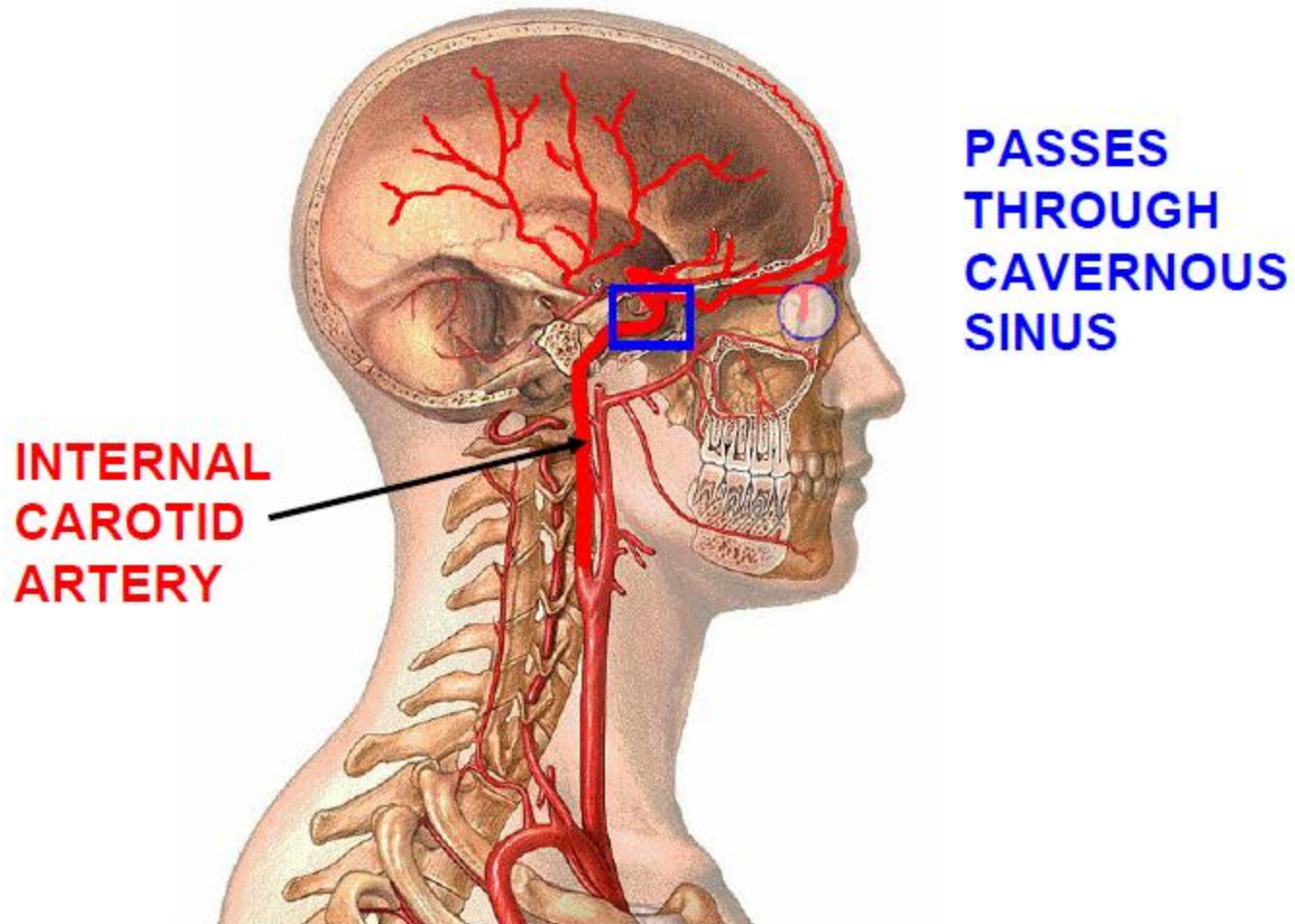
Internal Carotid supplies brain, also branches to eye, face

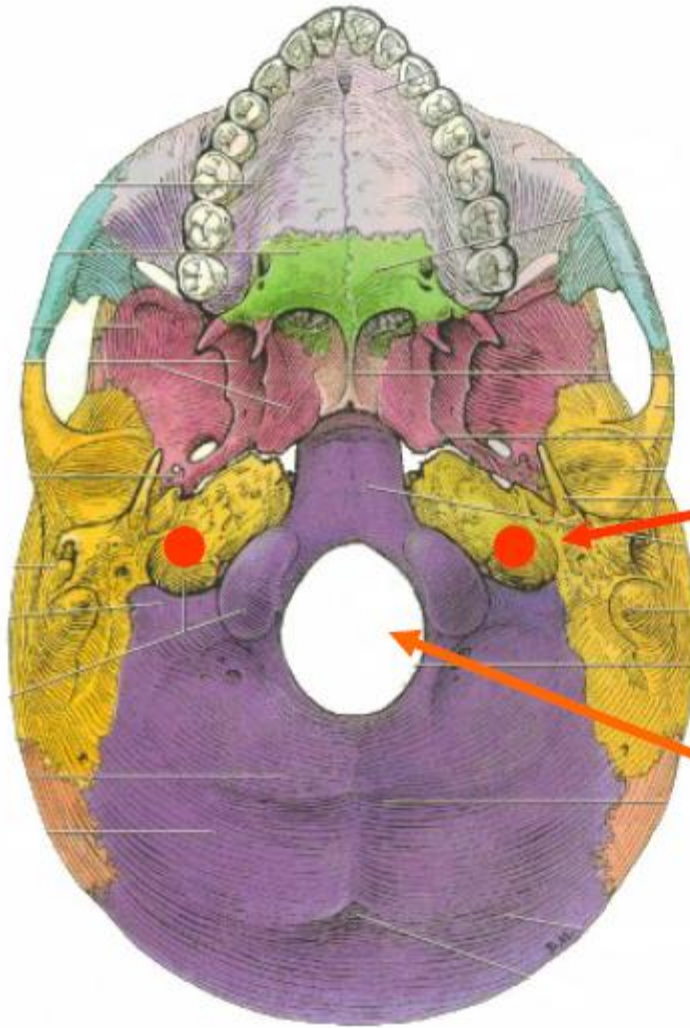
**Vertebral A.
Courses
Through
Foramina
Transversaria
C1-C6**



**Int. Carotid A.
Ascends
without
Branching
into Skull (via
Carotid
Canal)**

INTERNAL CAROTID ARTERY: ENTERS SKULL

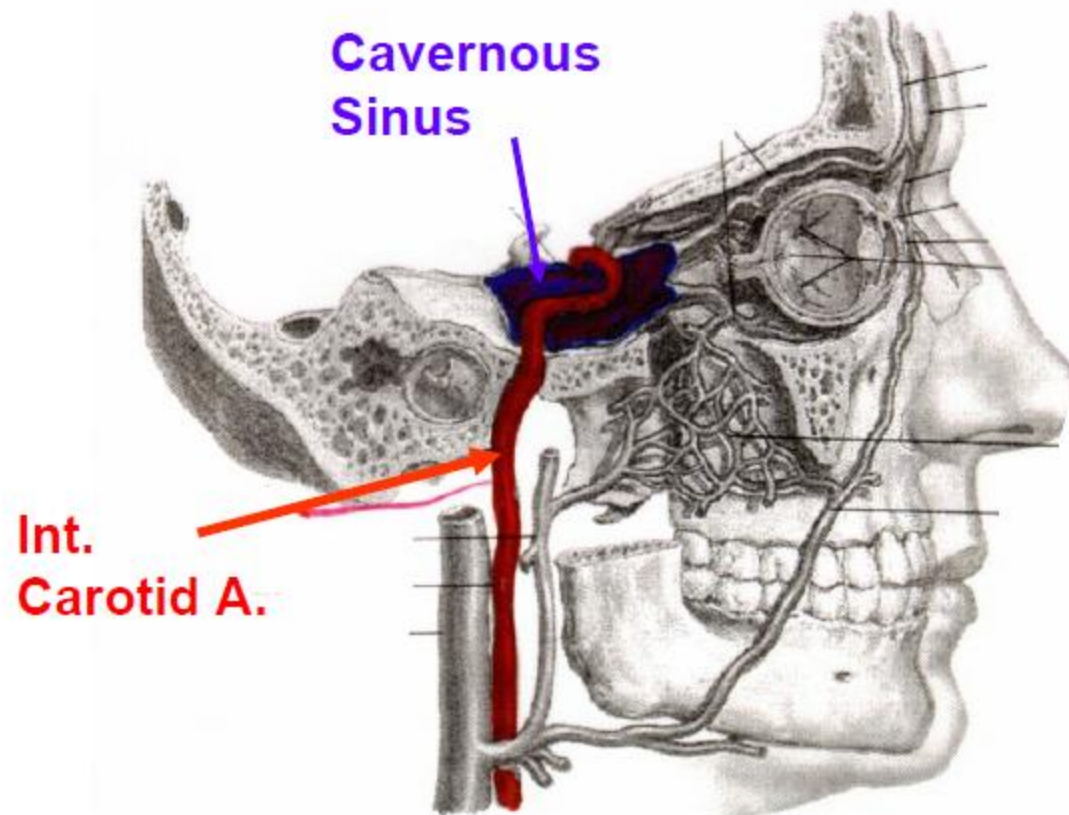




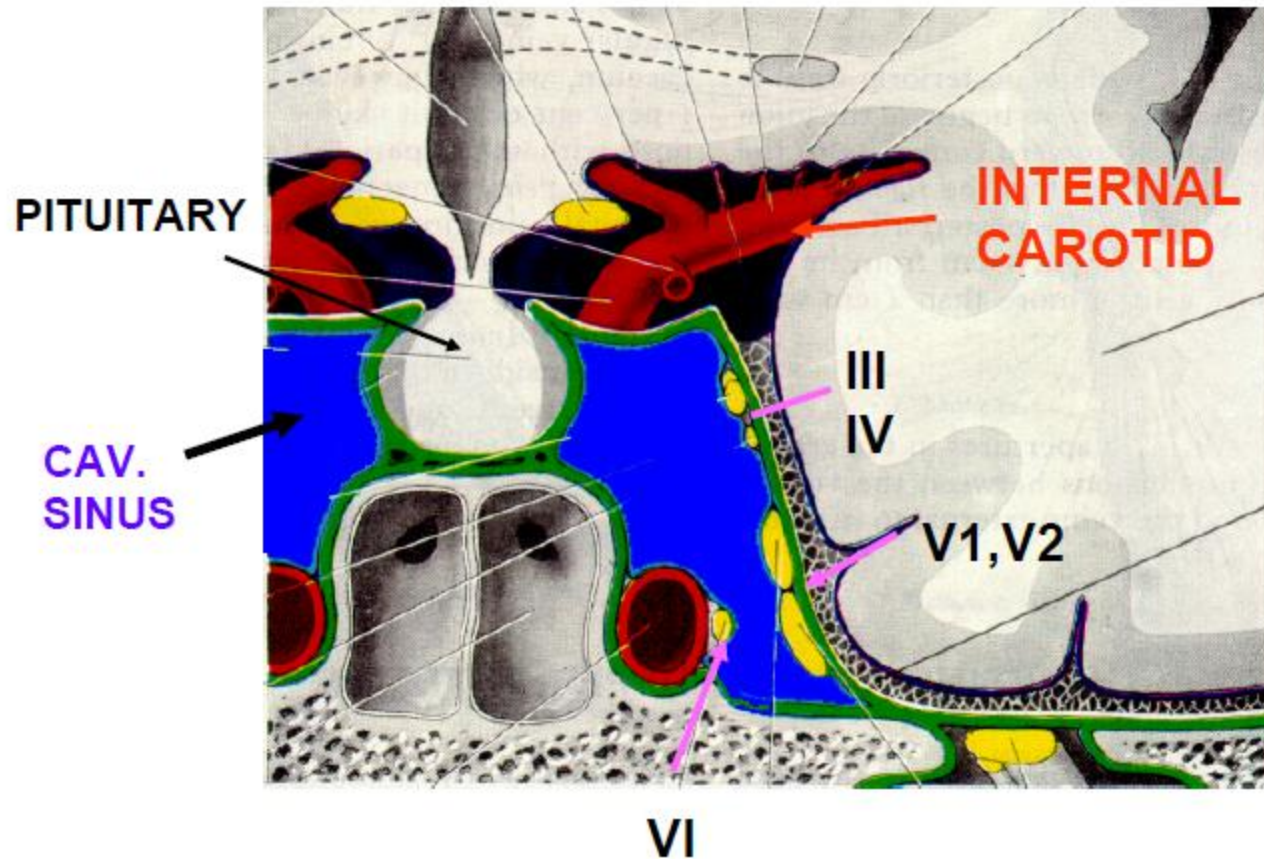
A. Internal Carotid Artery- enters skull via Carotid Canal And Foramen Lacerum

B. Vertebral artery- enters skull via Foramen Magnum

Internal Carotid Artery – Passes Through Cavernous Sinus



**STRUCTURES PASSING THROUGH WALL OF CAVERNOUS SINUS - Int. Carotid A., Cranial N.'s III, IV, V1, V2, VI;
Clinical sign of Infection in Sinus – 'BLURRED' VISION**



Internal Carotid Artery

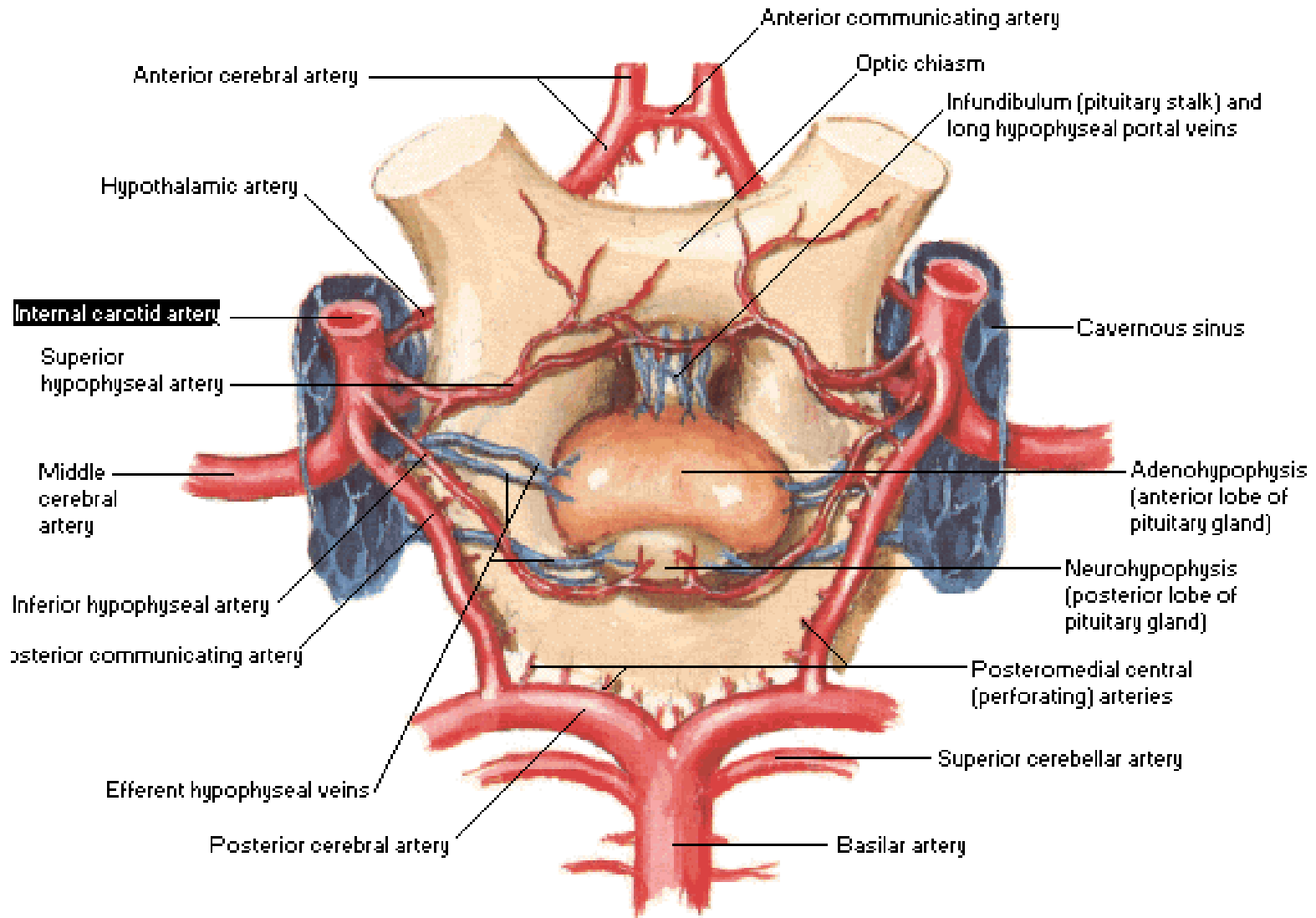
- Internal carotid artery: branch off from common carotid artery, enters brain from carotid canal, splits into *middle* and *anterior* cerebral artery under the anterior perforated substance
- Before internal carotid artery splits into the terminal branches, it gives off:

Branches from ICA

- 1). *Ophthalmic artery*: supply eyes, paranasal sinuses and parts of the nose
- 2). *Posterior communicating artery*: runs backward to join the posterior cerebral artery
- 3). *choroidal artery*: supply choroid plexus of lateral ventricles and other areas including optic tract, lateral geniculate nucleus, etc.

Cerebral Arterial Circle [Willis] - Vessels in Situ

Inferior View



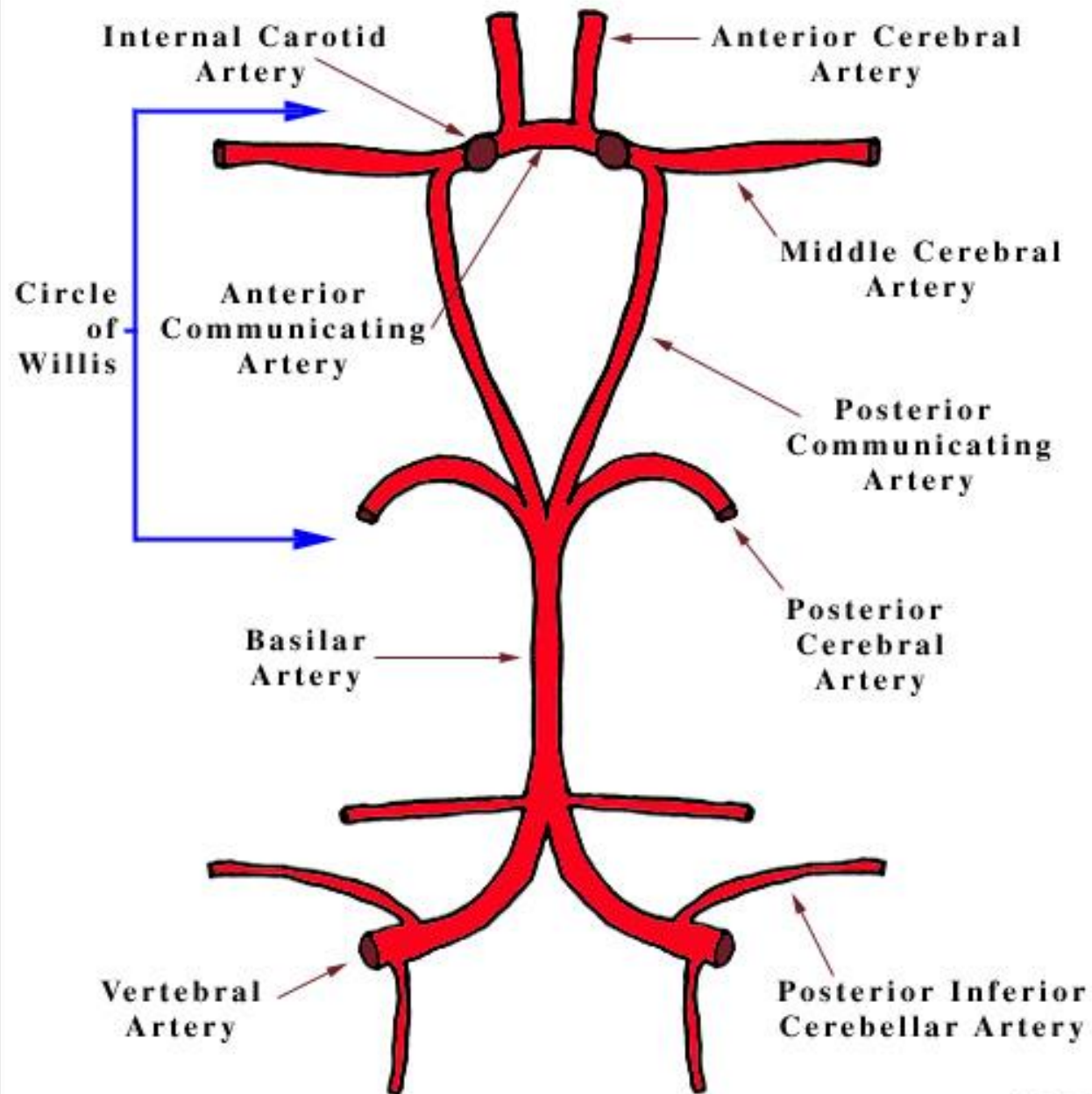
Occlusion of internal carotid artery

- 1. ipsilateral blindness (ophthalmic A)
2. half vision of the contralateral eye
(infarction of optic nerve, lateral geniculate body supplied by anterior choroidal A)

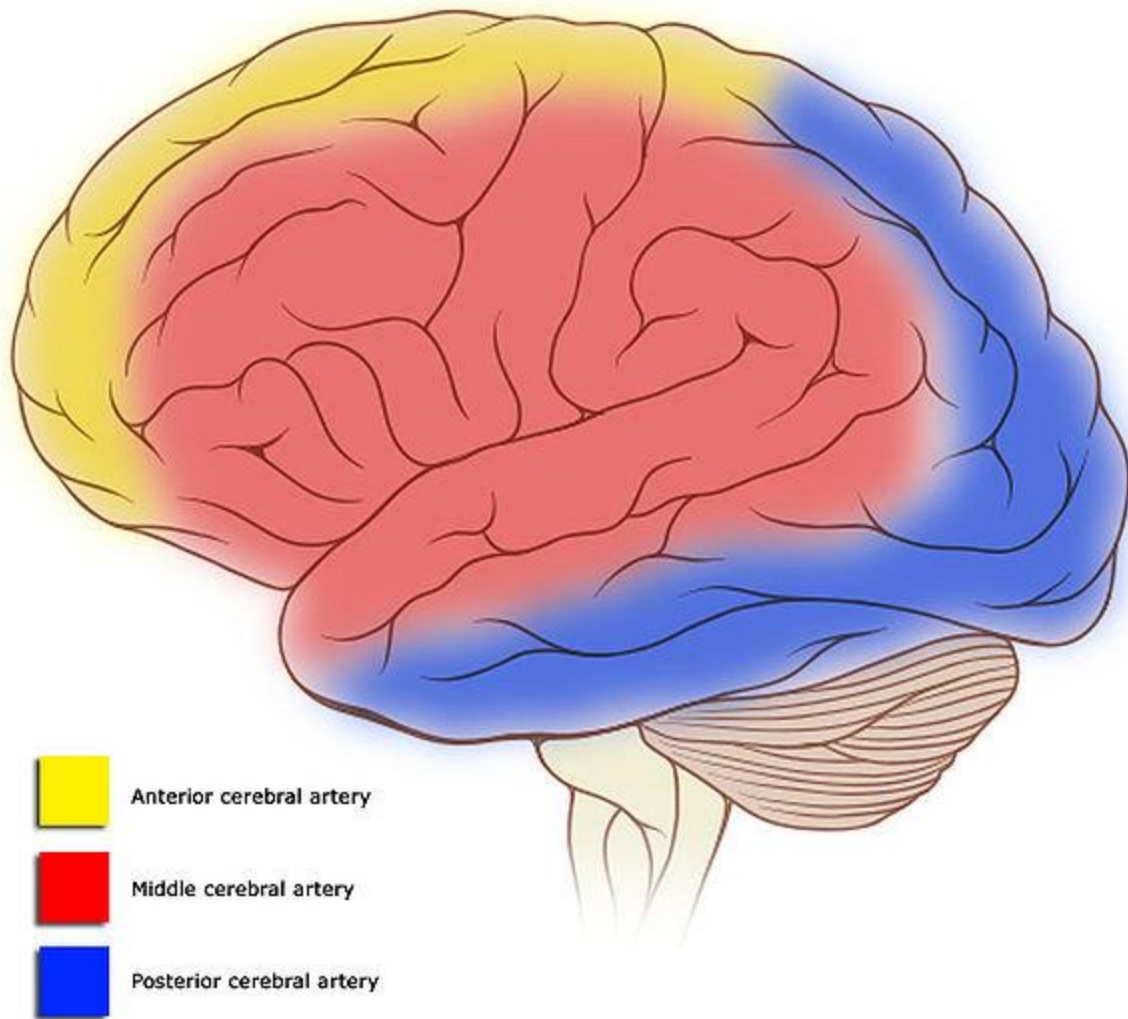
Terminal Branches

- Middle Cerebral Artery:
 - bigger branch of the two terminal branches
 - Supply the **lateral surface of the hemisphere** except for the narrow strip supplied by the ACA, the occipital lobe and the inferiorlateral surface of the hemisphere supplied by the PCA.
 - *supplies all motor area except the leg area*
 - Occlusion of middle cerebral artery: contralateral paralysis and sensory deficits of face, arm, aphasia (language center)
- Anterior Cerebral Artery:
 - Joined to the ACA of the opposite side by the anterior communicating artery
 - Supply all the medial surface of cerebral cortex as far as the parieto-occipital sulcus
 - Supply a strip of cortex(about 1 inch wide) on lateral surface
 - *supplies the leg area of precentral gyrus*
 - Occlusion of anterior cerebral artery: contralateral paralysis and sensory deficits in the leg/foot and perineum

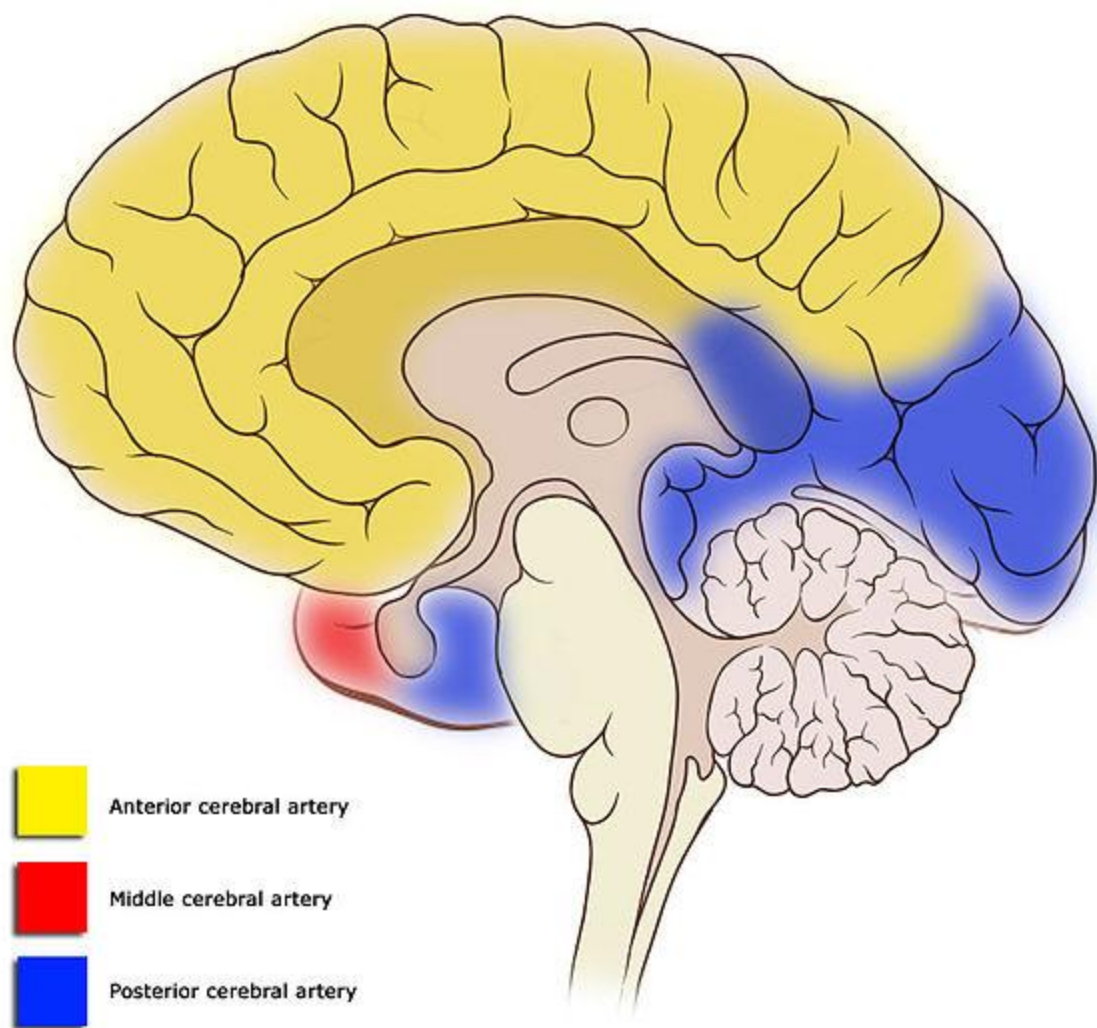
CIRCLE OF WILLIS

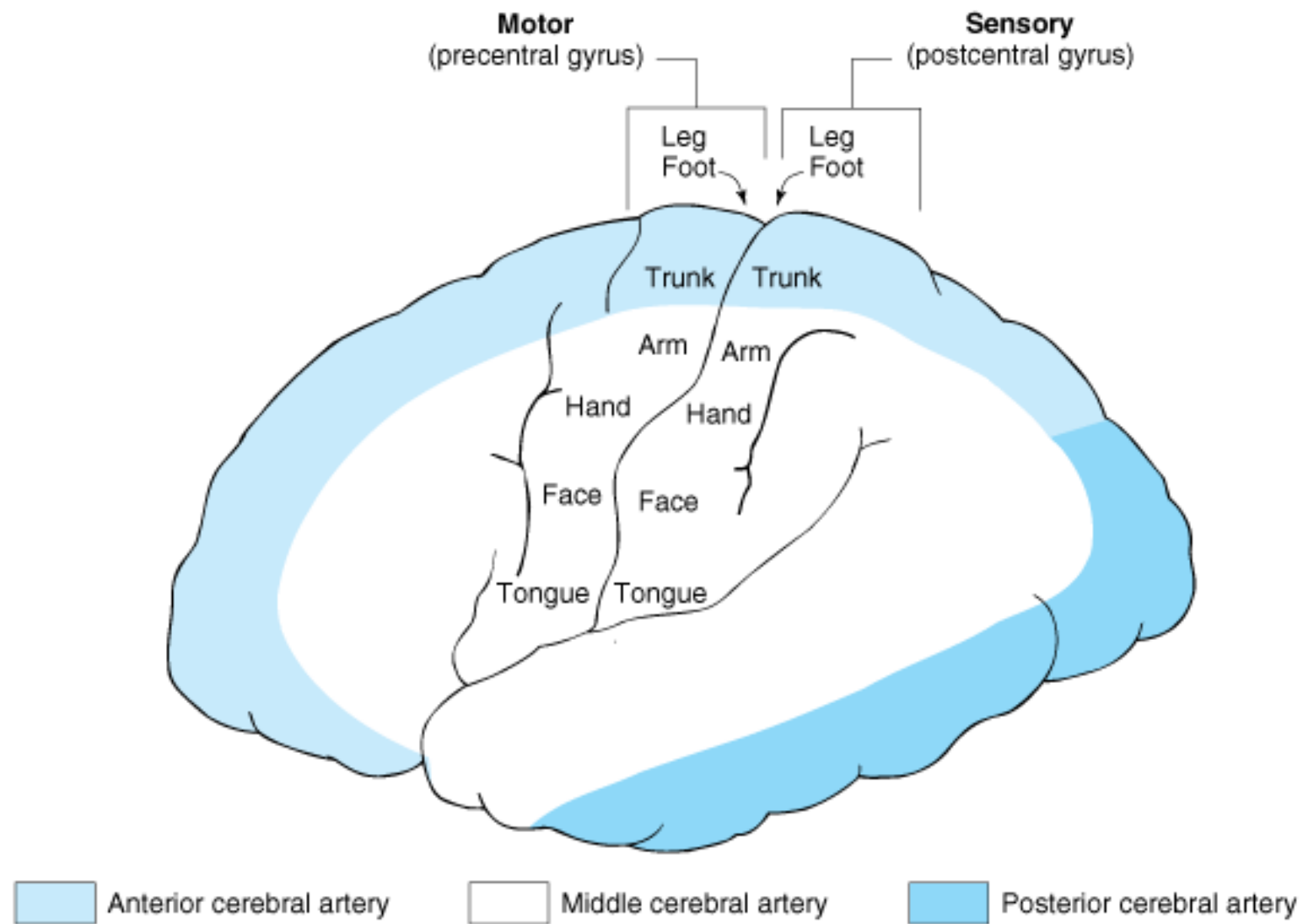


Cortical vascular territories

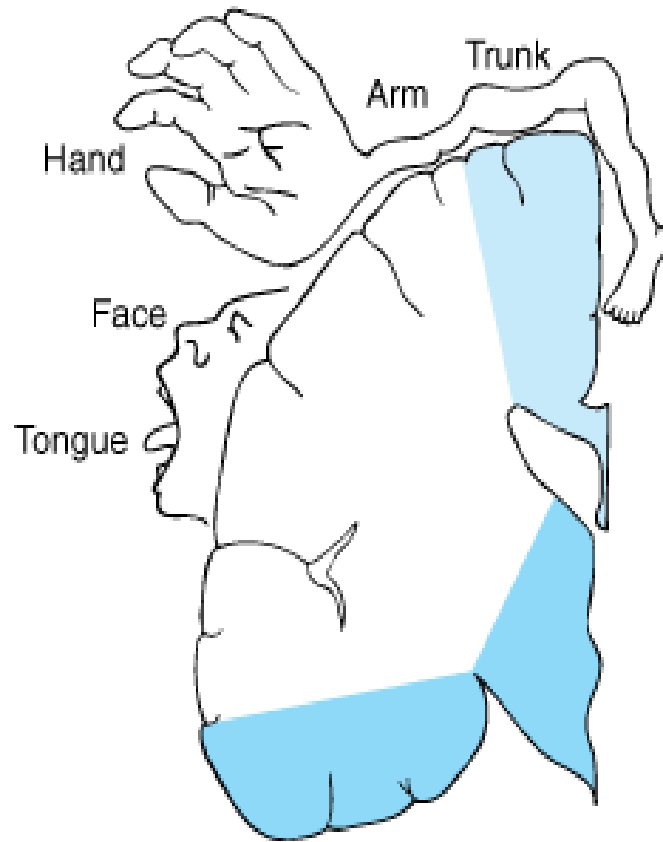


Cortical vascular territories

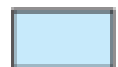
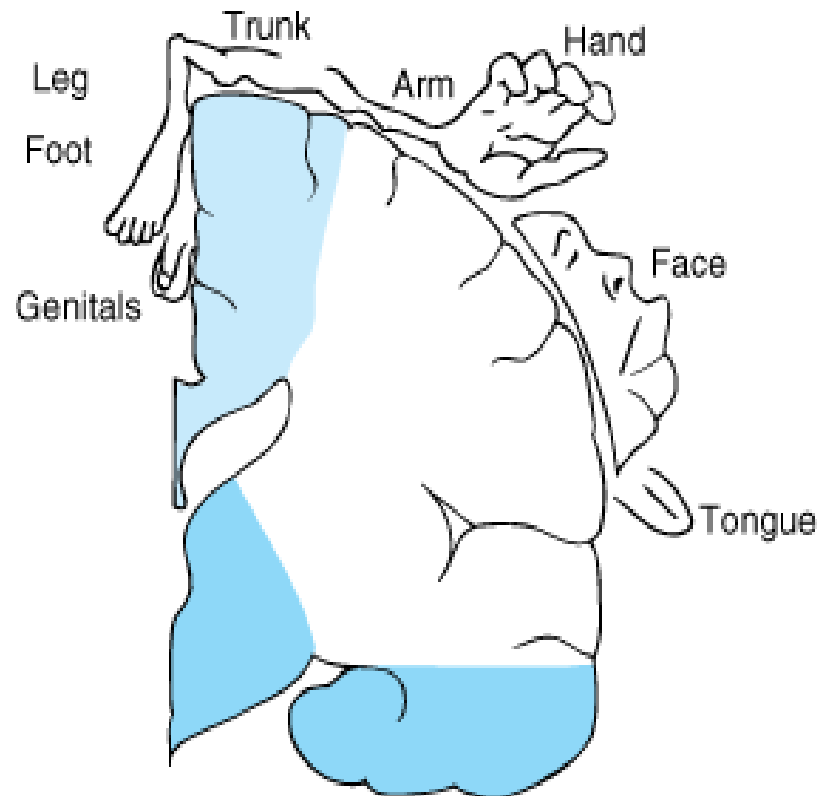




Motor
(precentral gyrus)



Sensory
(postcentral gyrus)



Anterior cerebral artery



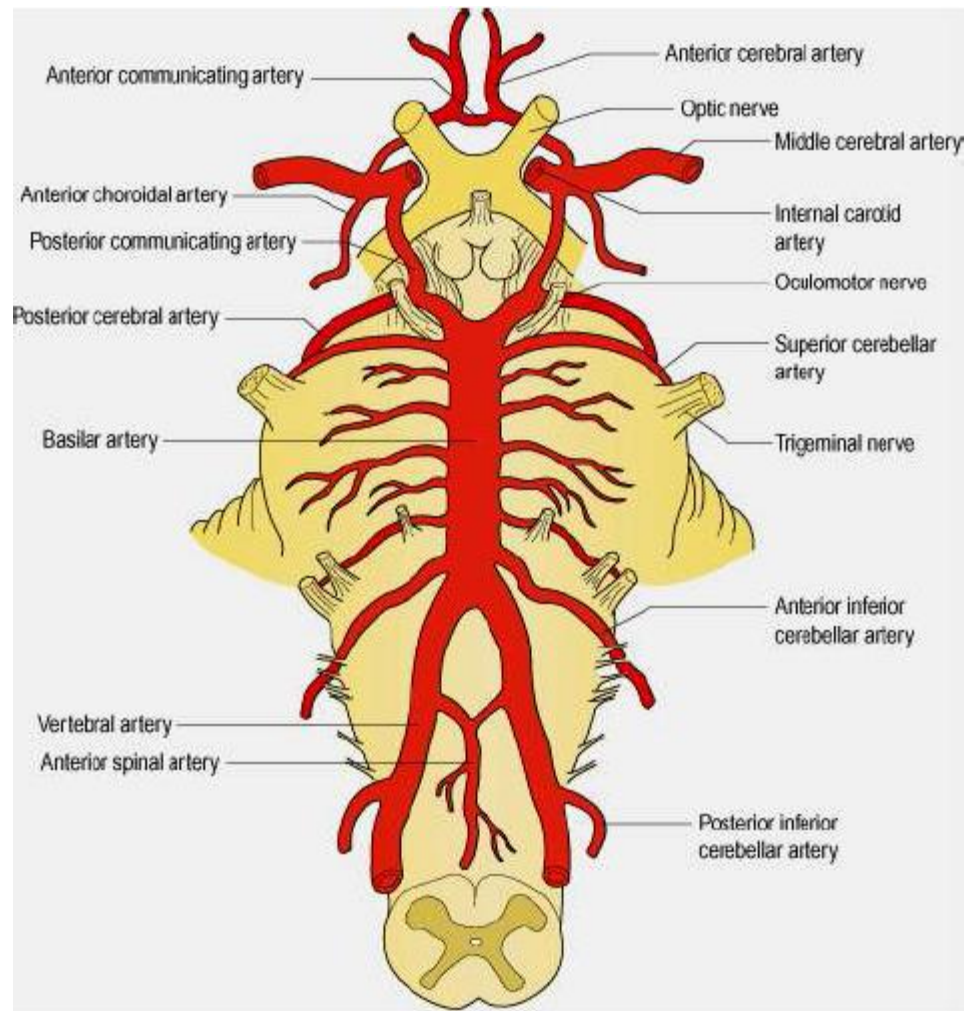
Middle cerebral artery



Posterior cerebral artery

Vertebrobasilar system

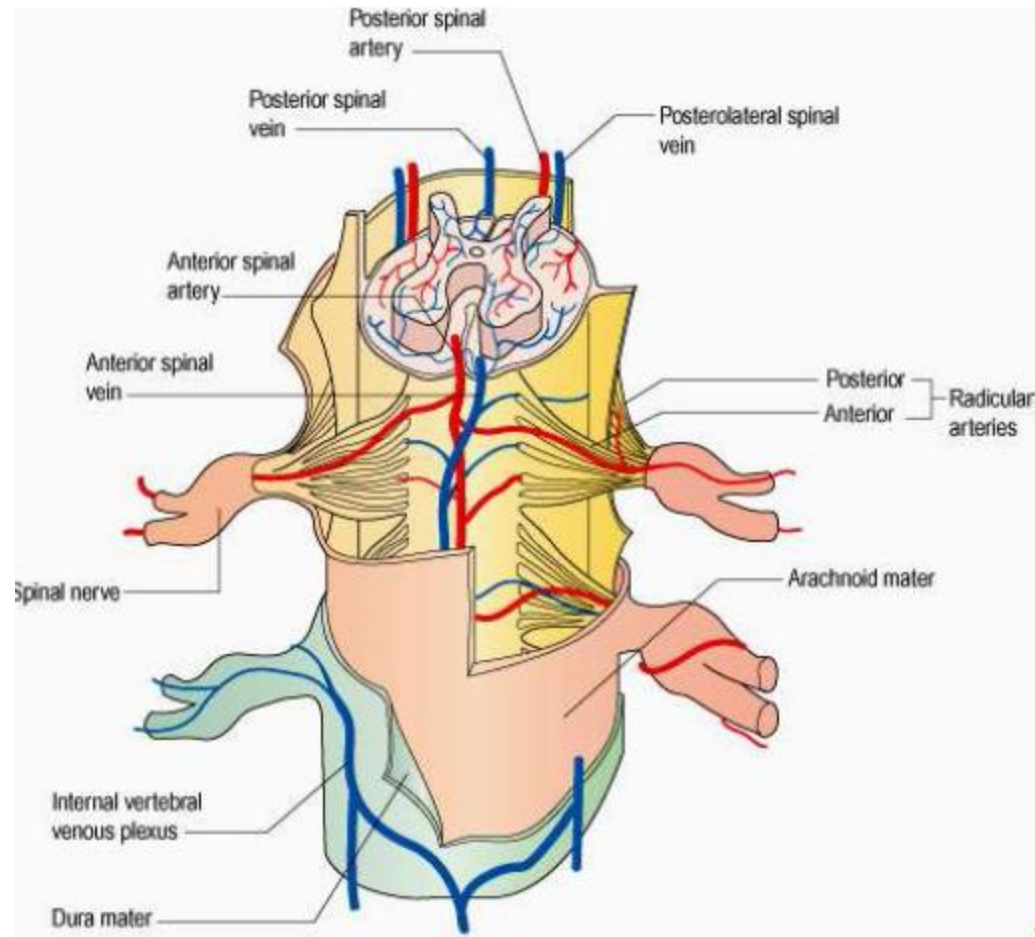
- Vertebral artery, branch from the 1st part of subclavian artery, joins together to form the basilar artery. The latter artery splits into posterior cerebral arteries.
- Branches off the vertebral artery
 1. anterior spinal artery: one formed by branches from each vertebral artery, descends along the anterior median fissure ,
supplies anterior two-thirds of the spinal cord
 2. posterior spinal artery: one on each side
supplies posterior one-third of the spinal cord
- 3 . posterior inferior cerebellar artery (PICA) largest branch off vertebral artery, supplies undersurface of cerebellar hemisphere, inferior vermis, deep nuclei



Vertebral Artery

- Branch of first part of subclavian A
- Passes – foramen transversarium C6 – C1
- Enters through foramen magnum – perforates dura & arachnoid mater – enters subarachnoid space
- Turns upward, forward, medially – medulla oblongata
- Lower border of pons – joins opposite side to form
 - *BASILAR* artery

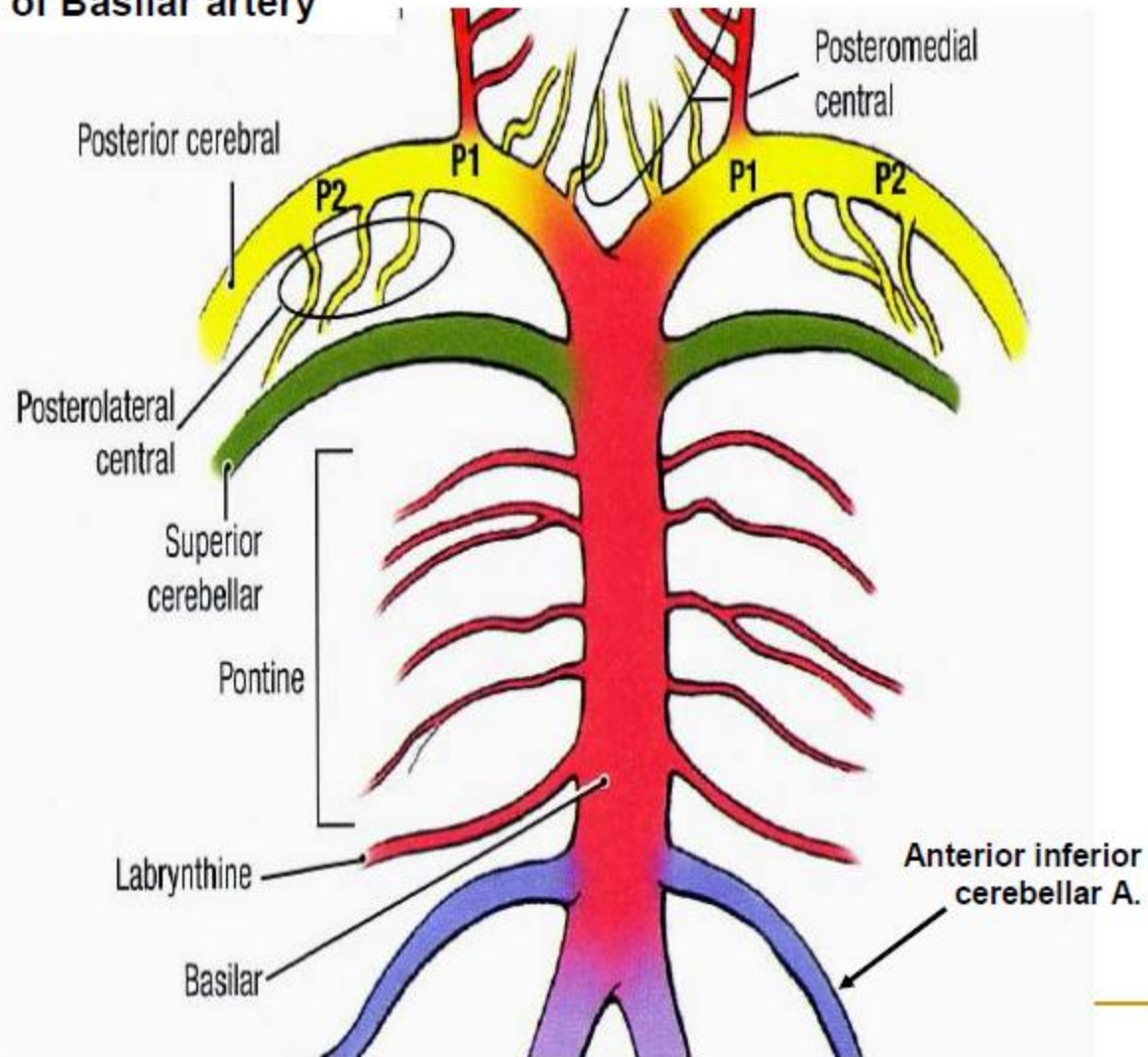
Blood supply of spinal cord



Basilar artery

- Formed by the **union** of the two vertebral arteries at the **lower border** of the **pons**
- Ascends on the front of the pons lodged in the **basilar groove**
- Ends at the **upper border** of the pons by dividing into 2 **Posterior cerebral arteries (PCA)**

Branches of Basilar artery

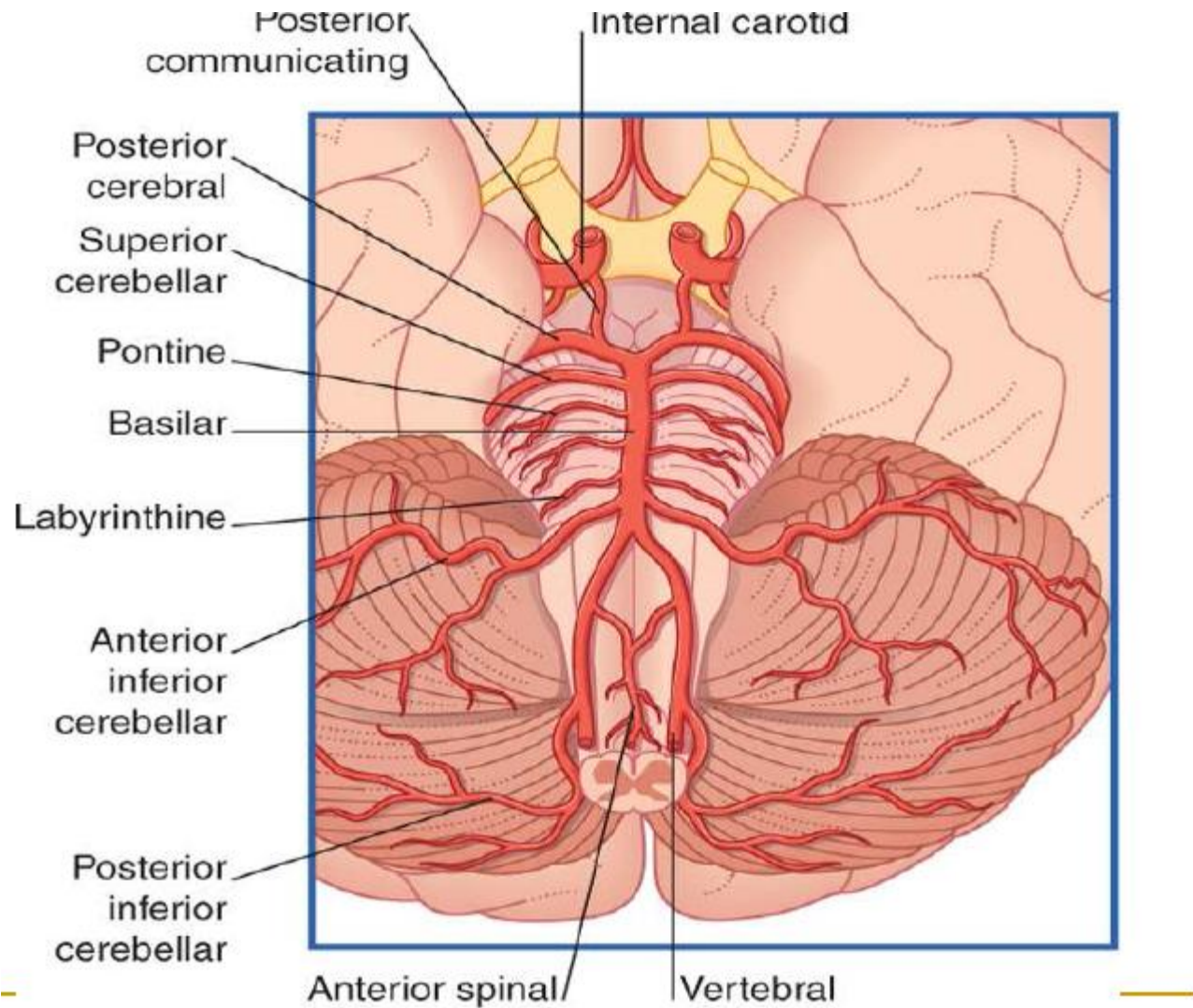


Basilar artery

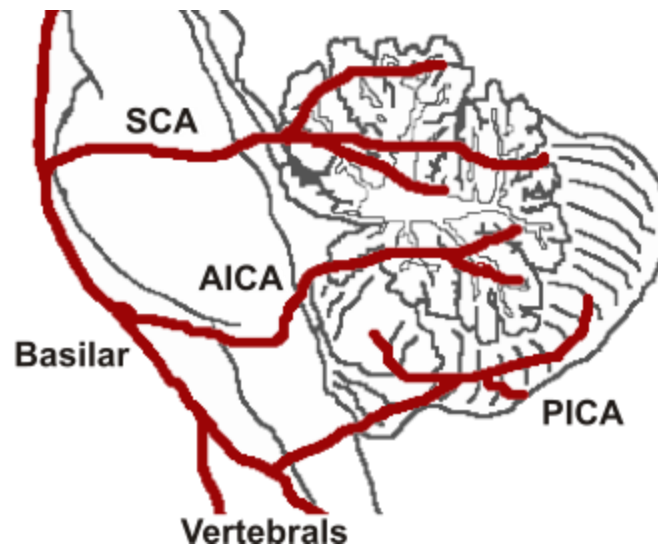
- Branches off basilar artery
- 1. anterior inferior cerebellar artery (AICA)
supplies inferior surface of the cerebellum
- 2. labyrinthine artery supplies the membranous labyrinth of the internal ear
- 3. Pontine arteries supply pons
- 4. superior cerebellar artery supplies superior surface of cerebellum and pons

Basilar artery

- Occlusion of basilar artery: coma, die soon, loss control of respiration center
labyrinthine artery: deaf, vestibular dysfunction (vertigo, fall)



Blood supply of cerebellum

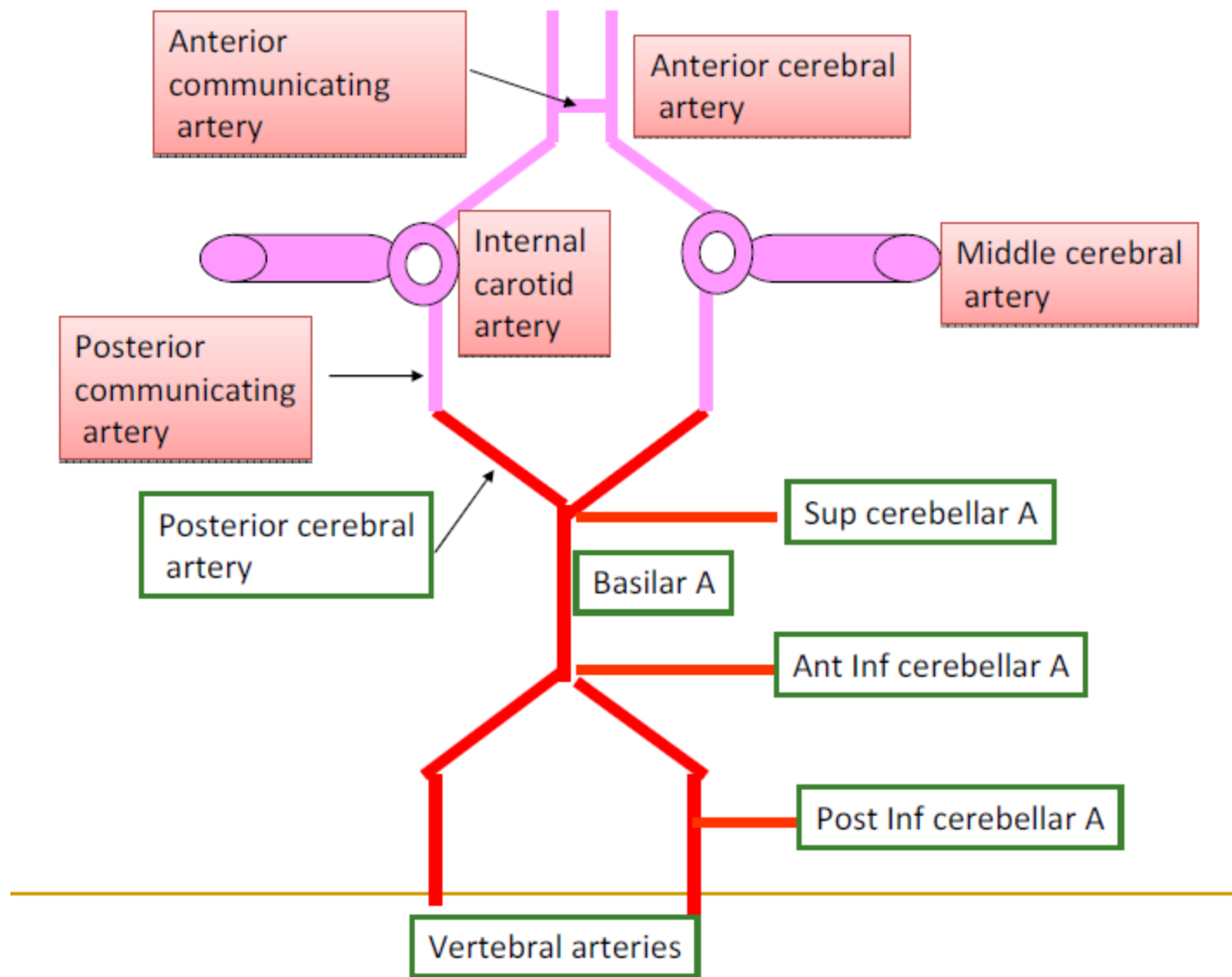


Posterior cerebral artery

- Supplies the inferiolateral and medial surfaces of the temporal lobe and the lateral and medial surfaces of occipital lobe (visual cortex)

Arterial Circle Of Willis

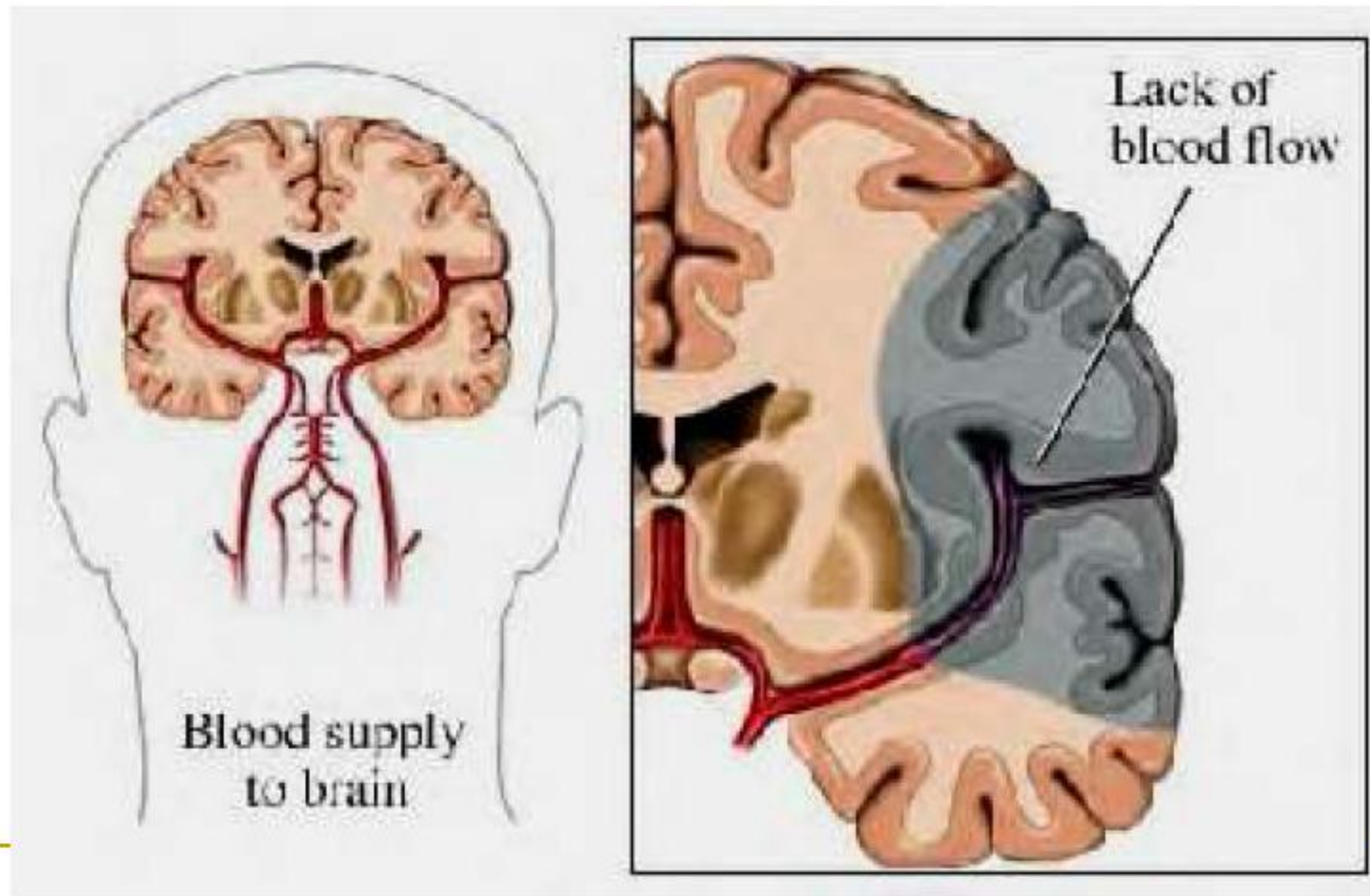
- **Site:** at the base of the brain around interpeduncular fossa.
- **Function:** Important anastomosis between the 2 internal carotid arteries in front & Vertebro-basilar system behind.
- **Arteries forming it:**
 - Rt. & Lt. internal carotid artery.
 - Rt. & Lt. anterior cerebral arteries.
 - Rt. & Lt. posterior cerebral arteries.
 - Rt. & Lt. posterior communicating arteries.
 - Anterior communicating artery.



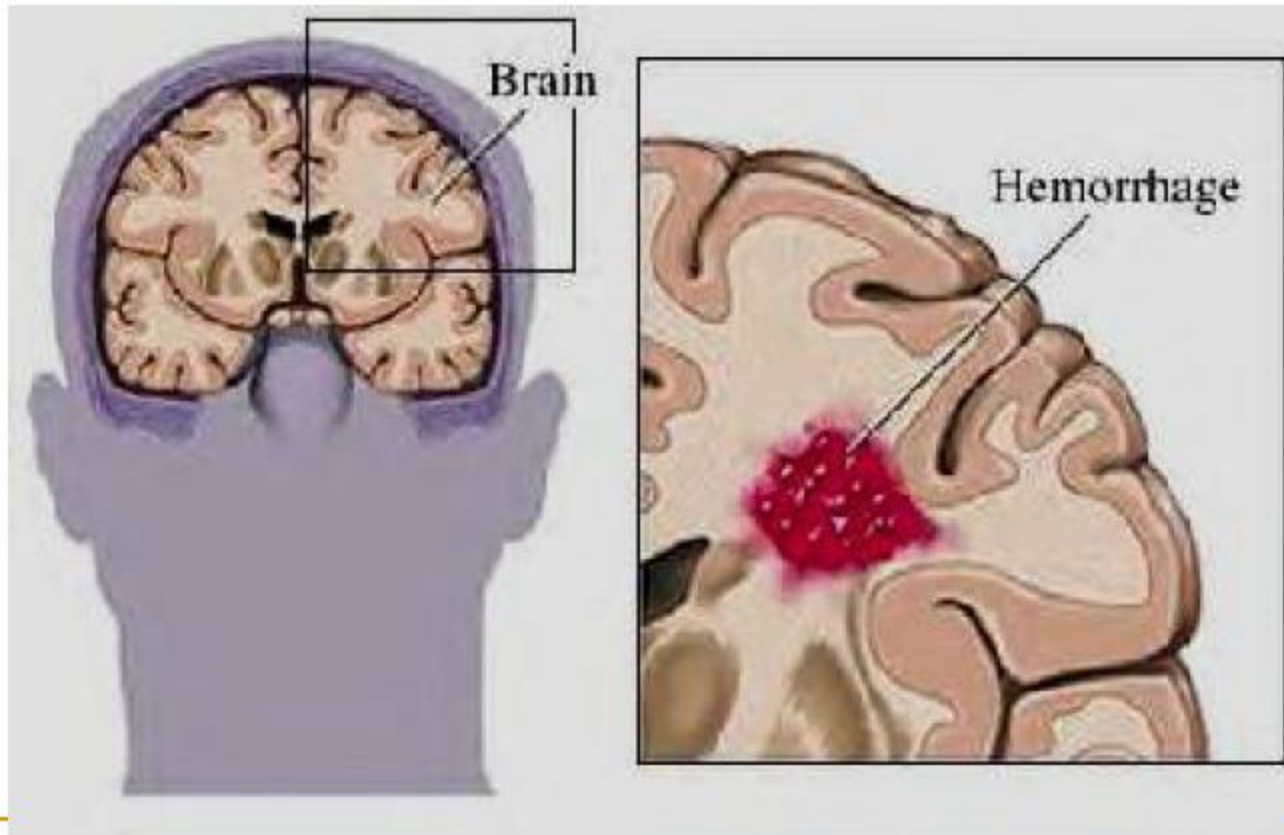
Clinical Application

- Stroke or cerebrovascular accident:-
 - Blockage in the artery – cerebral infarction
 - Carotid artery
 - Basilar artery
 - Bleeding within the brain – intracerebral haemorrhage
 - Aneurysm
 - Subarachnoid haemorrhage
 - Intracerebral haemorrhage - hypertension
 - Damages one side of the body - contralateral

CVA – due to blockage



CVA – due to haemorrhage



Cerebral ischemia:

- Unconsciousness occurs in 5-10 seconds if the blood flow to brain is completely cut off
- Neuronal function ceases after about one minute and irreversible changes start to occur after about 4 minutes

Veins of the brain

- The veins of the brain have no muscular tissue in their wall
- No valves
- Lie in subarachnoid space
- Pierce the arachnoid mater and the meningeal layer of the dura and drain into the cranial venous sinuses

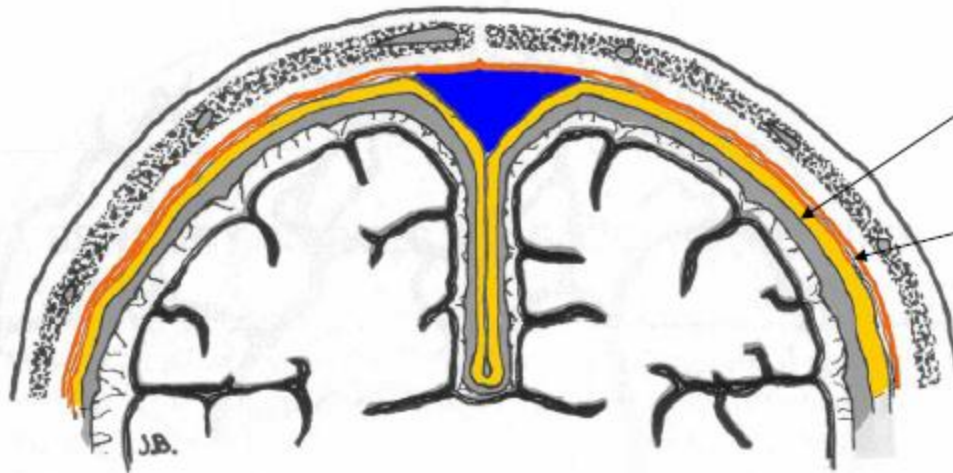
The cerebral veins are usually divided into the *superficial* cerebral veins and the *deep* cerebral veins

The **superficial** system is composed of dural venous sinuses

The **deep** venous drainage is primarily composed of traditional veins inside the deep structures of the brain, which join behind the midbrain to form the vein of Galen (great cerebral vein). This vein merges with the inferior sagittal sinus to form the straight sinus which then joins the superficial venous system at the confluence of sinuses

II. MENINGES OF BRAIN

3 layers, like spinal cord; Dura Mater – tough mother; Arachnoid = spiderlike; Pia Mater = tender mother; arrangement different



A. DURA MATER -
tough connective
tissue layer, composed
of two layers -

**INNER MEMBRANE
LAYER (true dura)**

**OUTER ENDOSTEAL
LAYER - periosteum on
inner side of calvarium**

**Two layers - fused in
most places - separate
to form DURAL
REFLECTIONS**

DURA - 2 LAYERS ARE FUSED IN MOST PLACES

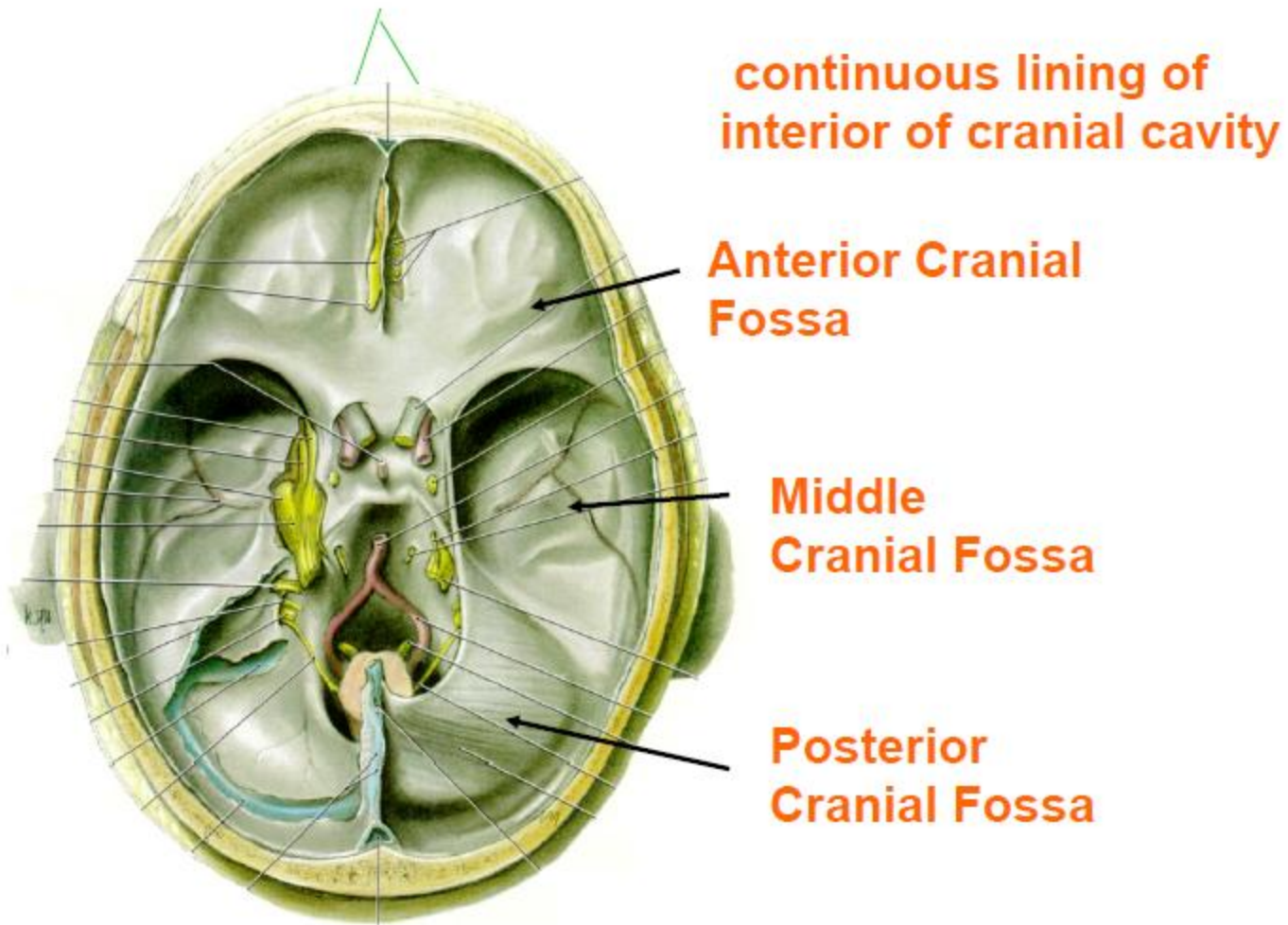


- Dura is tightly attached to inner side of calvarium

- Normally No Epidural Space (unlike spinal cord)

Calvarium removed by pulling away bone from dura

DURA MATER INSIDE SKULL



DURAL REFLECTIONS

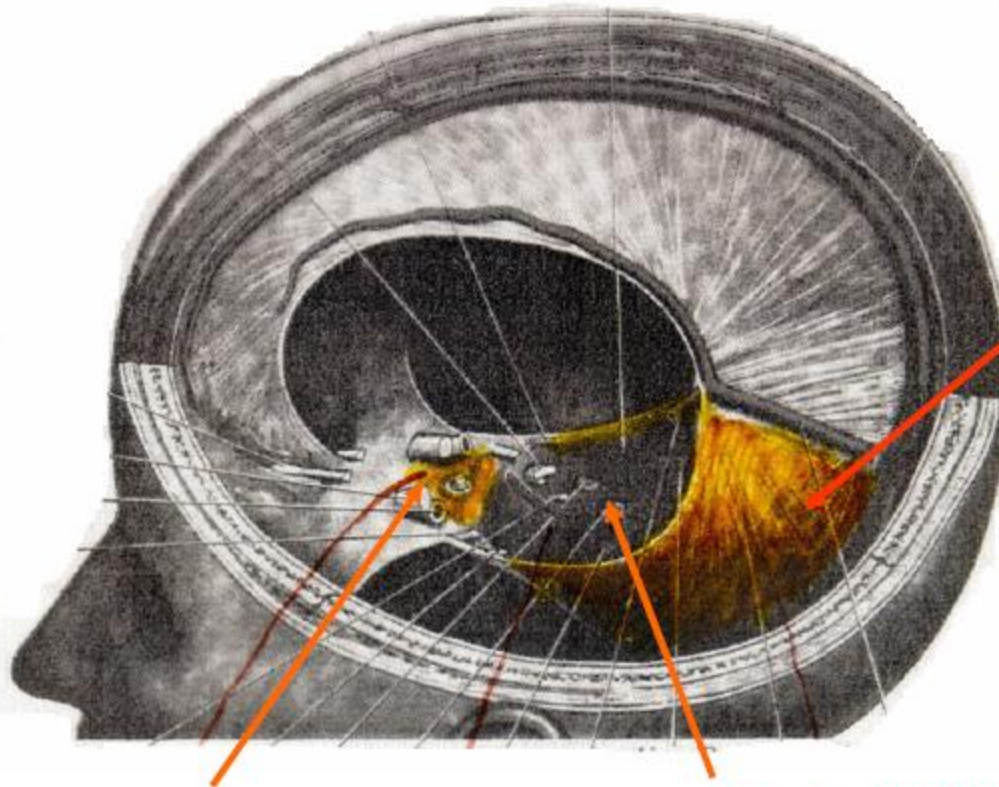
2 Layers of Dura separate form Inward Folds - Stabilize brain
- contain venous sinuses



1. Falx Cerebri - sickle shaped - between cerebral hemispheres; attached ant. to crista galli of ethmoid; post. blends into tentorium cerebelli

2. Falx Cerebelli - smaller between cerebellar hemispheres along post. wall of post. cran. fossa

DURAL REFLECTIONS

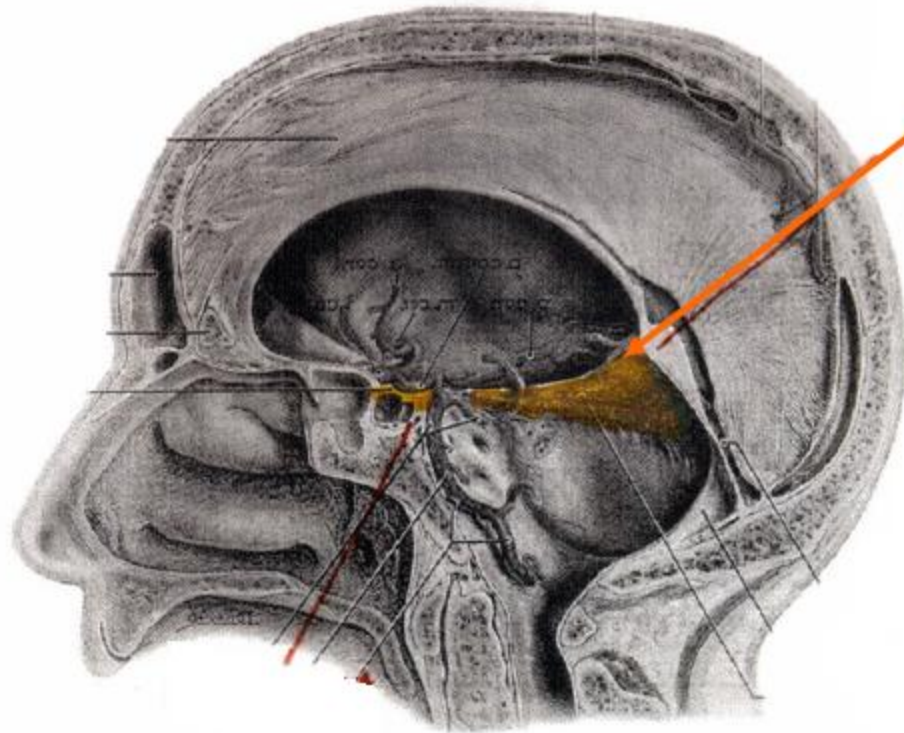


3. Tentorium Cerebelli – forms roof of post. cran. fossa

4. Diaphragma Sella – fold over sella turcica

Tentorial Notch – opening for brainstem

DURAL REFLECTIONS

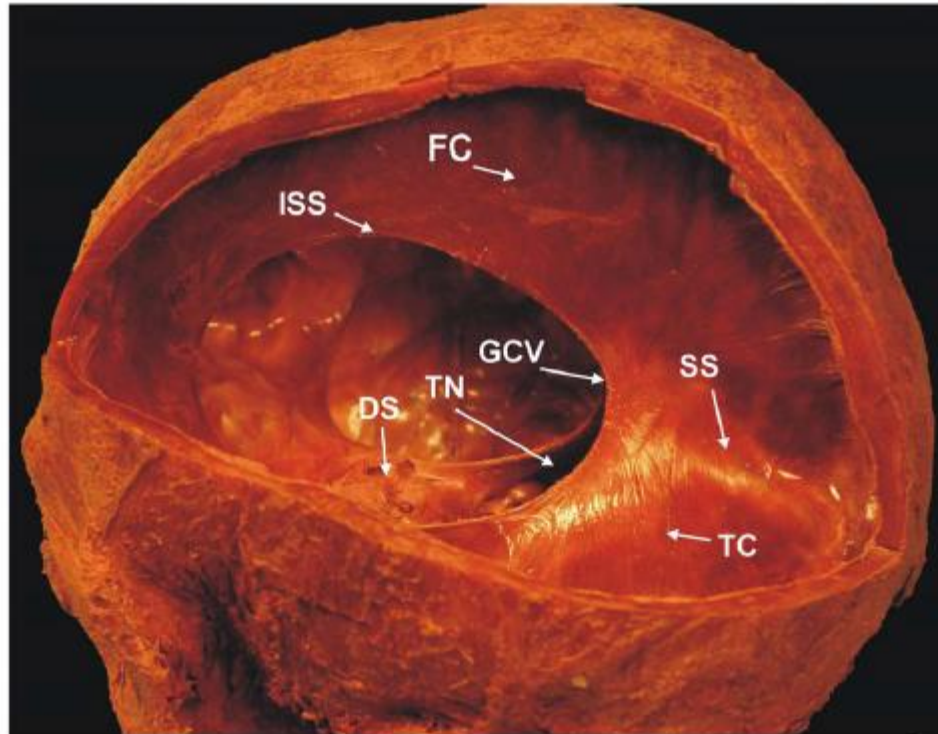


3. Tentorium
Cerebelli – crescent shaped, forms roof of post. cranial fossa, has gap- tentorial notch for pass of brainstem

4. Diaphragma
Sella – circular fold over sella turcica, has opening for stalk of pituitary

Diaphragma
Sella

DURAL REFLECTIONS AND VENOUS SINUSES



FC - FALX CEREBRI

TC - TENTORIUM CEREBELLI

ISS - LOCATION OF INFERIOR SAGITTAL SINUS

SS - LOCATION OF STRAIGHT SINUS

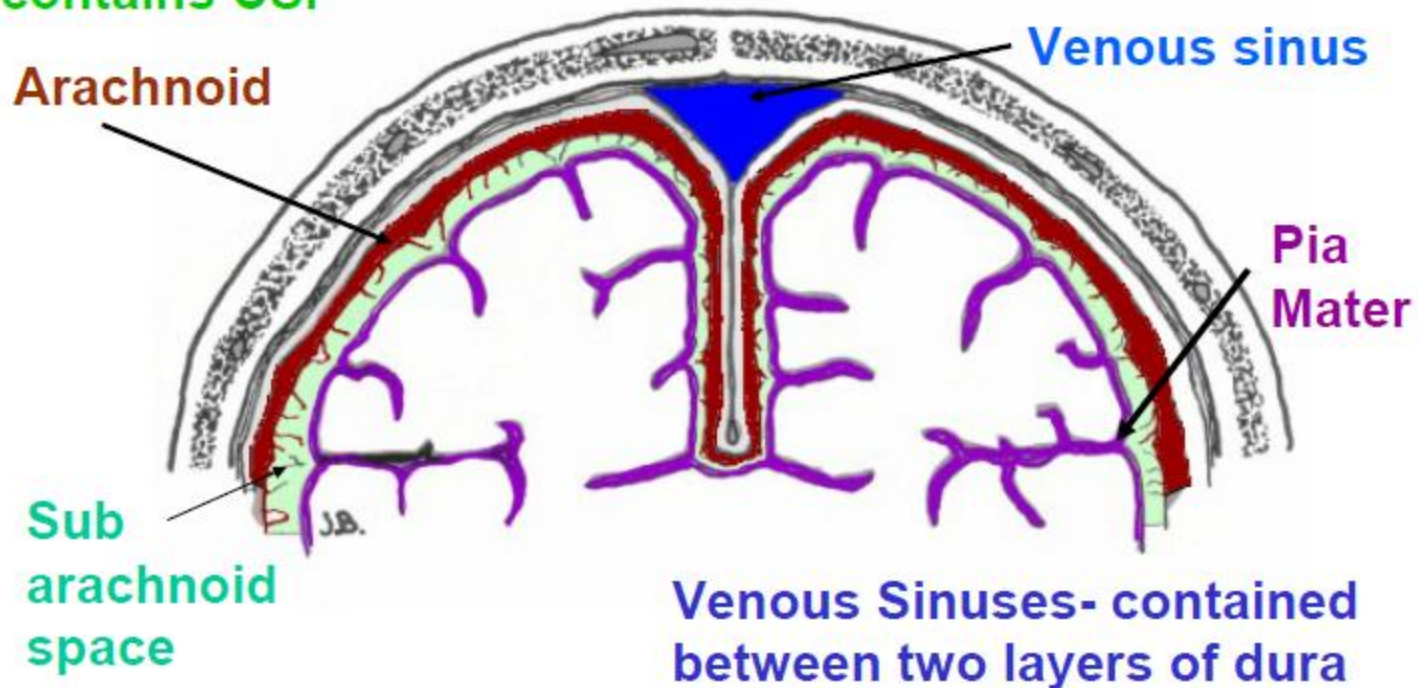
GCV - OPENING OF GREAT CEREBRAL VEIN OF GALEN

DS - DIAPHRAGMA SELLA

TN - TENTORIAL NOTCH

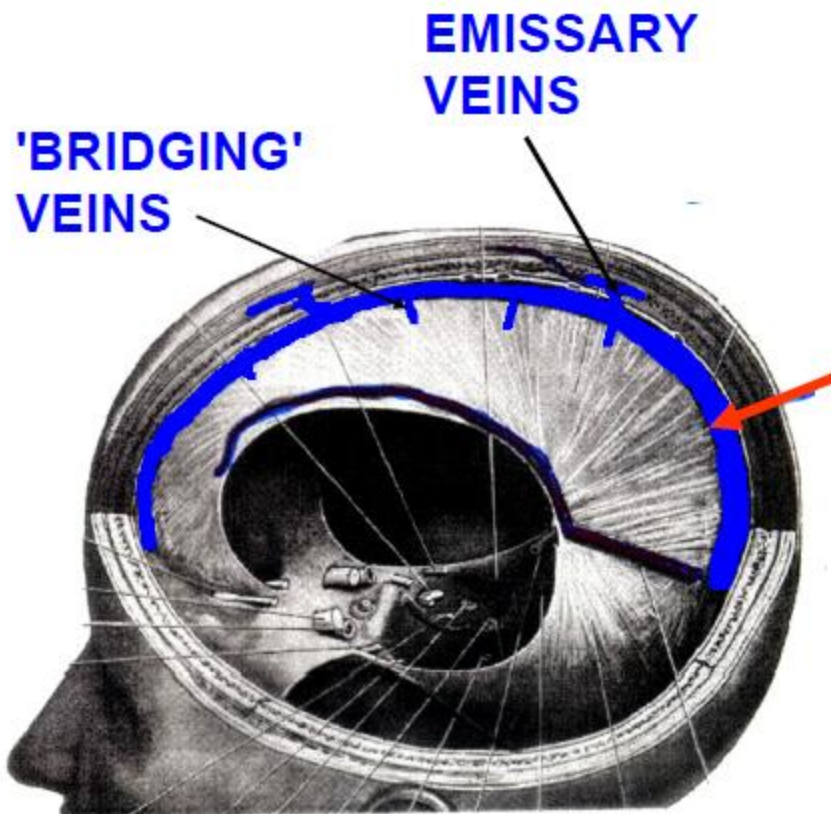
MENINGES OF BRAIN

Other layers like spinal cord: **B. Arachnoid**- attached to inner side dura (potential space= Subdural Space); **C. Pia Mater**-adheres to brain; **Subarachnoid Space**- real space contains **CSF**



III. VENOUS SINUSES – BETWEEN 2 LAYERS OF DURA

Receive blood from brain, orbit, emissary veins



Brain removed

1. Superior Sagittal Sinus – in upper border of falx cerebri; ant. - foramen cecum; post-transverse sinus; - communicates laterally with venous lacunae; blood from Superior Cerebral veins through 'bridging veins'; blood from emissary veins

Brain not removed

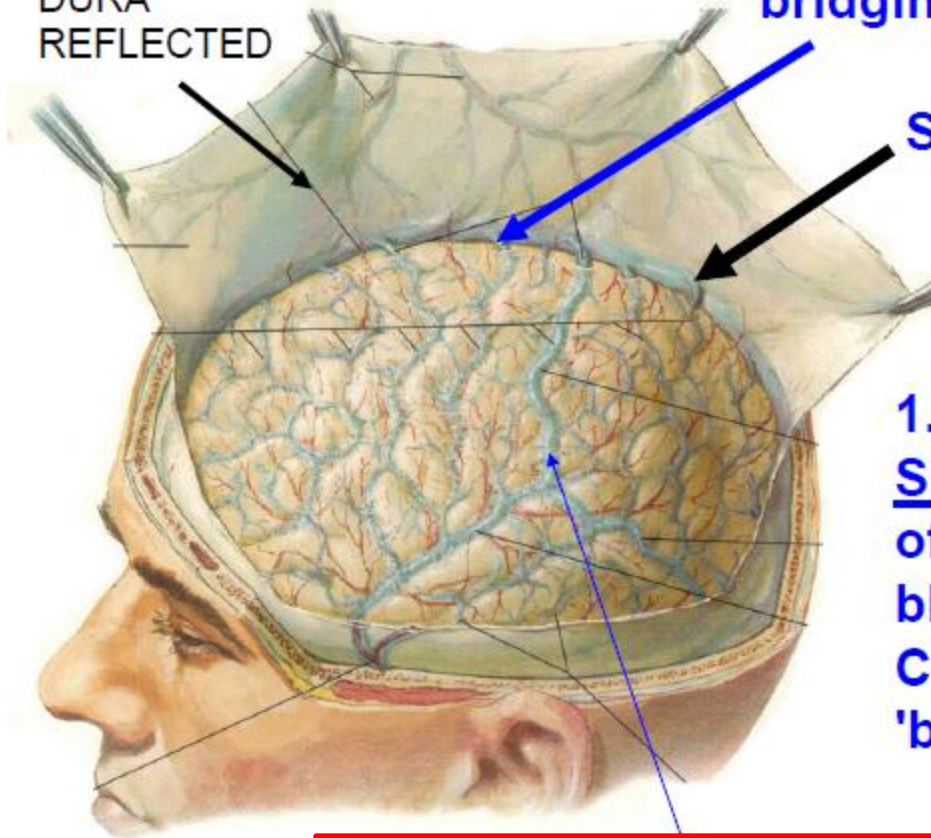
DURA
REFLECTED

'bridging veins'

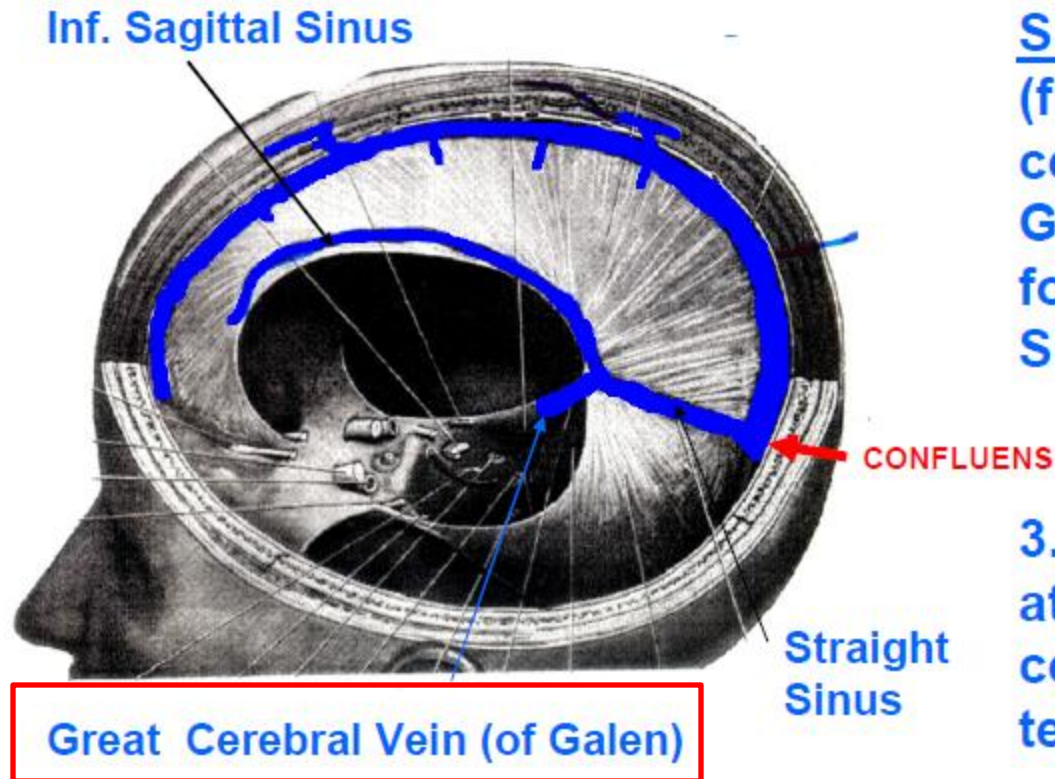
Superior Sagittal Sinus

1. Superior Sagittal Sinus – in upper border of falx cerebri; receives blood from Superior Cerebral veins through 'bridging veins'

Superior Cerebral veins



VENOUS SINUSES



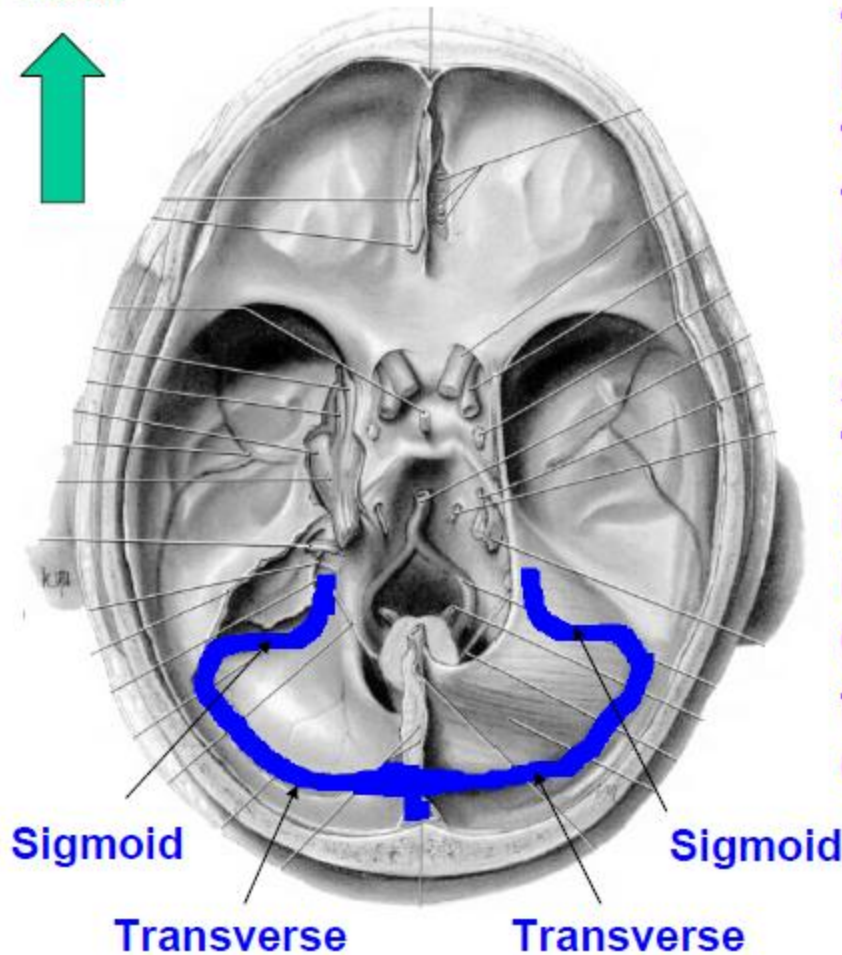
2. Inferior Sagittal Sinus - in lower (free) border of falx cerebri; - joins Great Cerebral V. form Straight Sinus

3. Straight sinus - at junction of falx cerebri and tentorium

Straight Sinus can join Superior Sagittal Sinus at Confluens of Sinuses or turn left

VENOUS SINUSES

NOSE

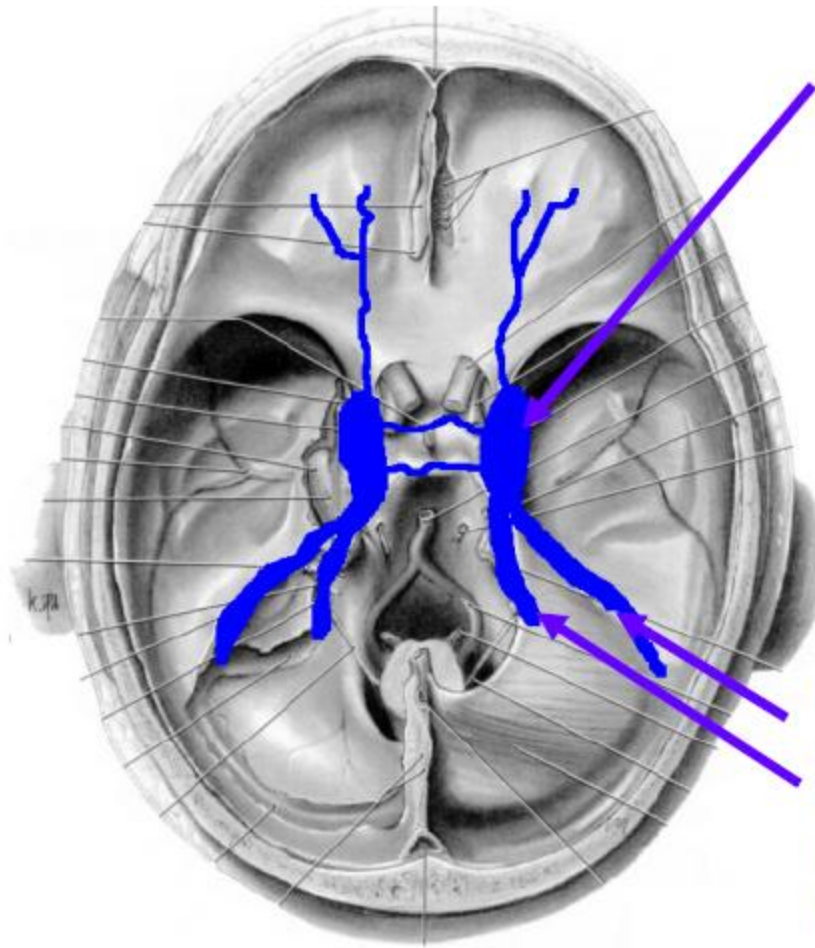


4. Transverse sinuses - in lateral fixed part of tentorium; receive blood from Sup. Sagittal or Confluens

5. Sigmoid sinuses - S-shaped continuation of Transverse; end in Jugular Foramen; form Internal Jugular Vein

6. Occipital Sinuses - in falx cerebelli; drain to Confluens

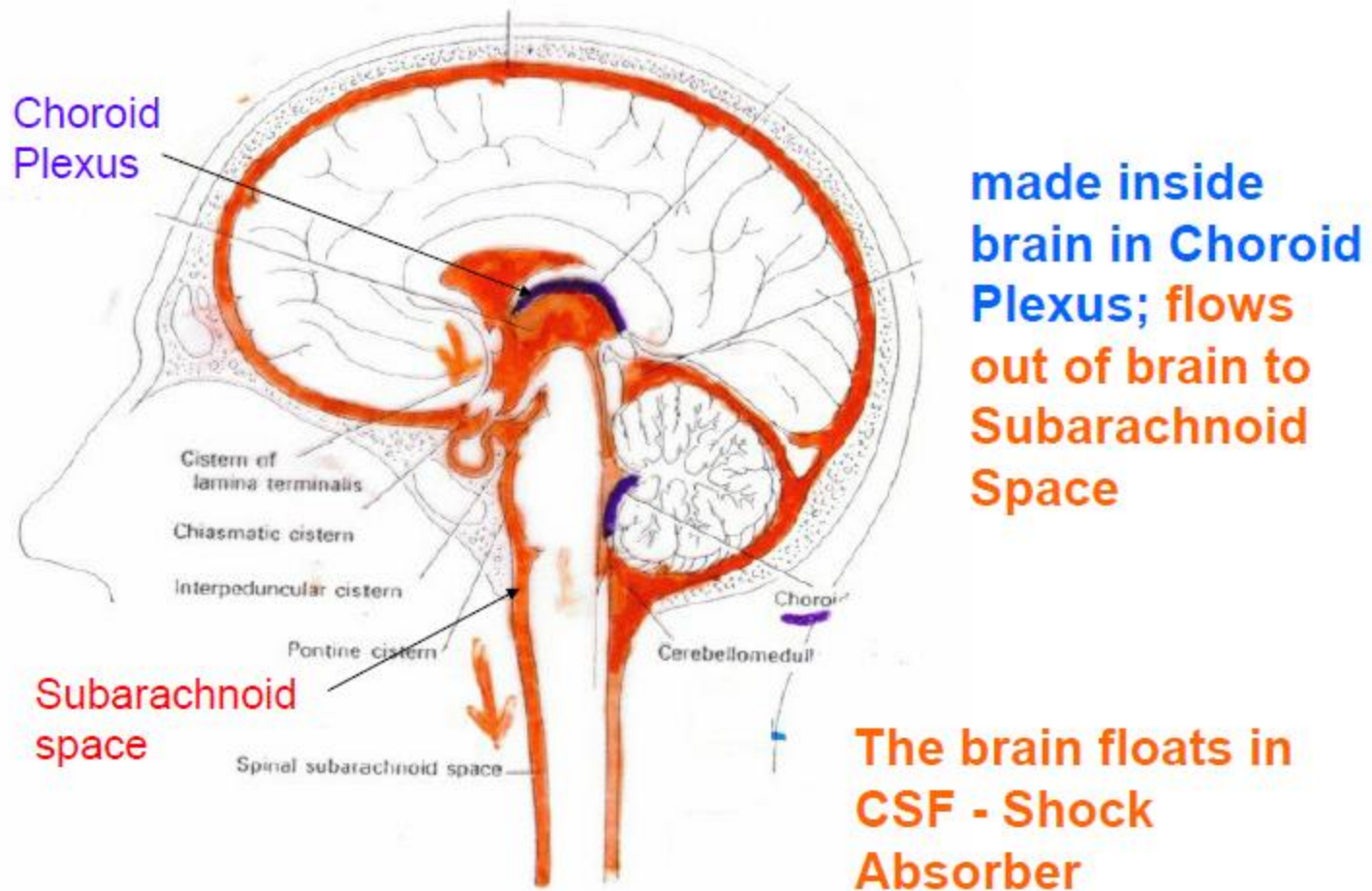
VENOUS SINUSES



7. Cavernous sinuses - in middle cranial fossa; on side of the body of the sphenoid bone; connected by Intercavernous sinus; receive blood from Sup. and Inf. Ophthalmic veins, Cerebral veins; drain to Sup. and Inf. Petrosal sinuses

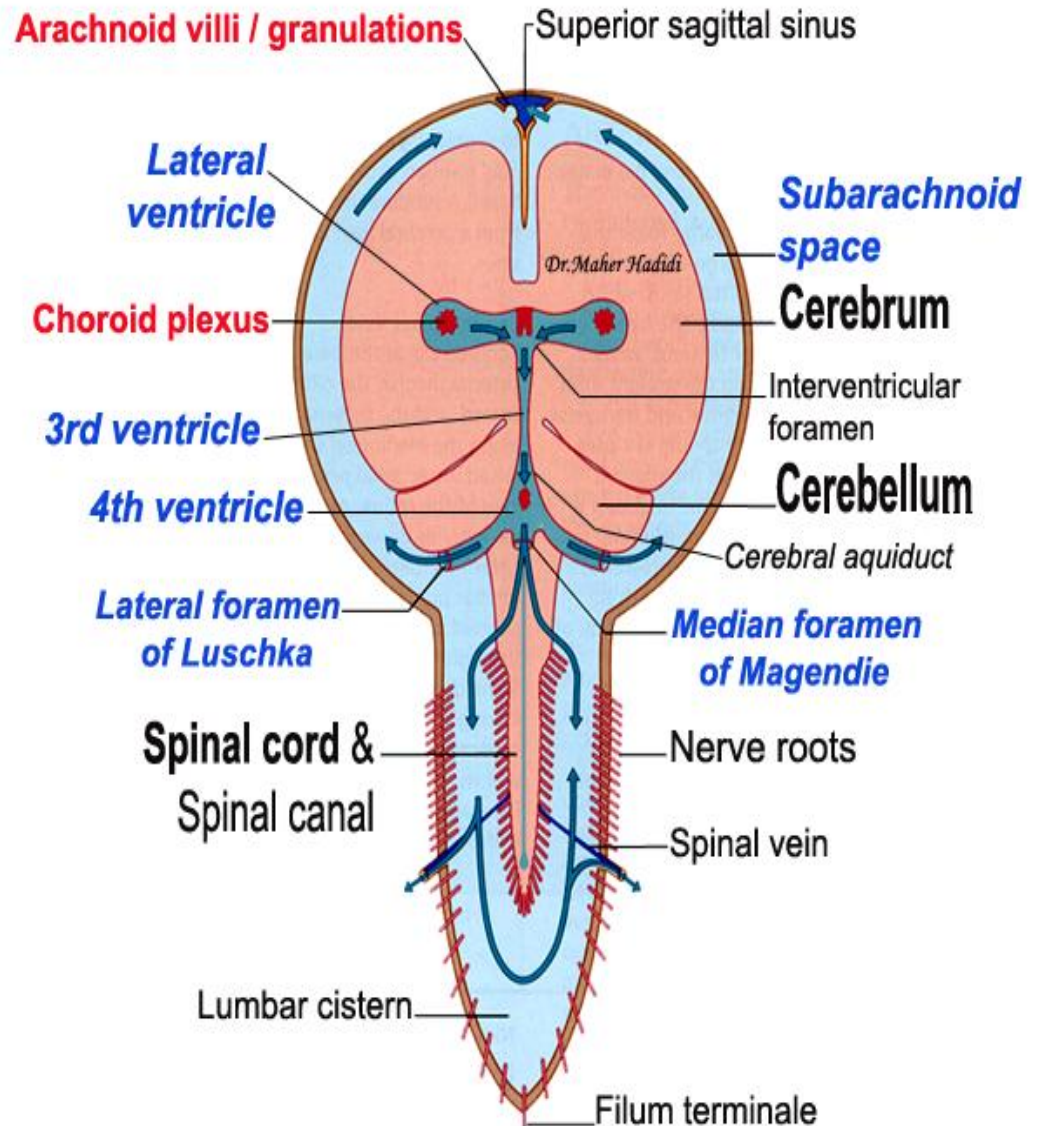
8. Sup. and Inf. Petrosal sinuses - on petrous part of temporal bone
Sup. drains to Transverse
Inf. Drains to Internal Jugular

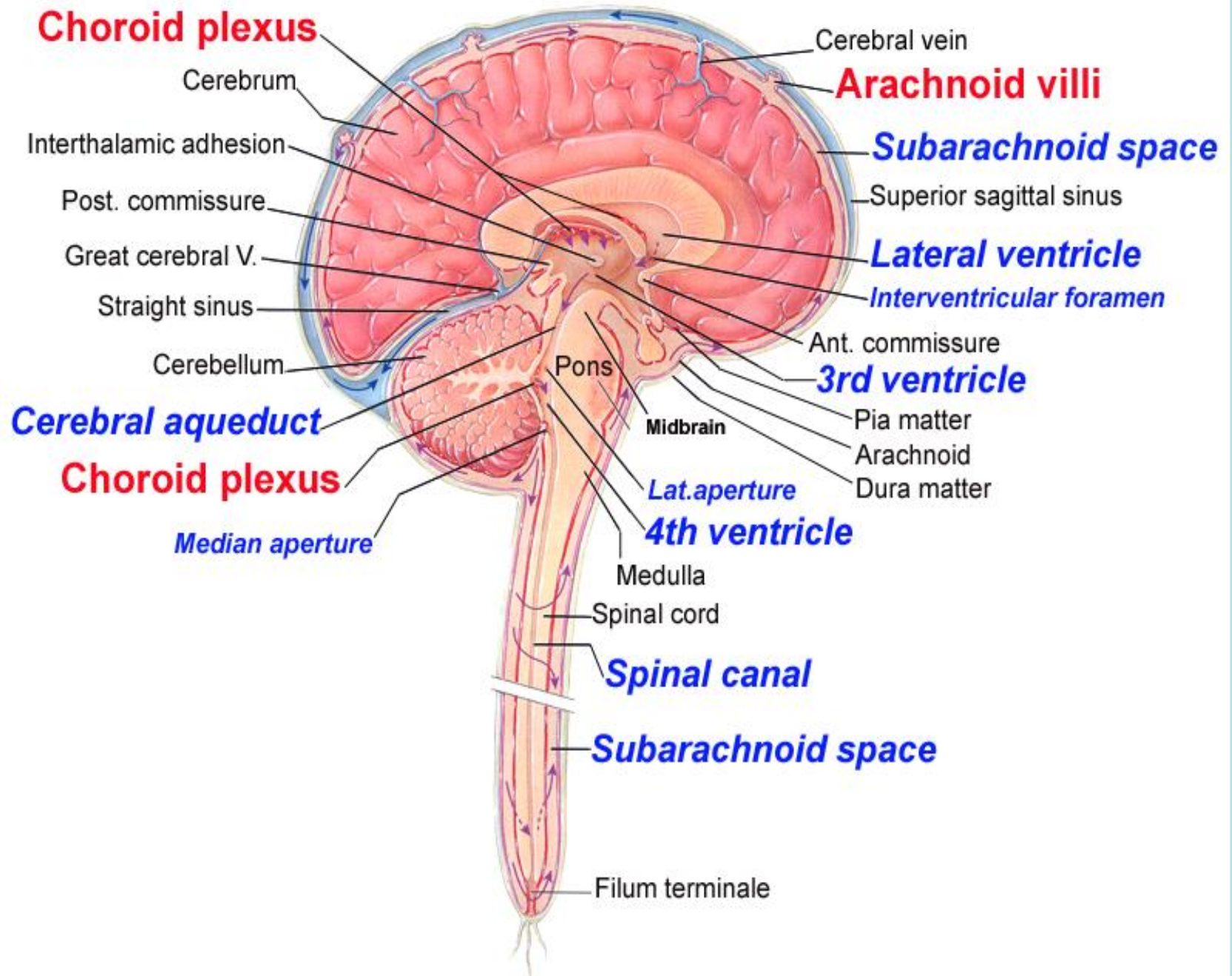
IV. CEREBRO-SPINAL FLUID (CSF)



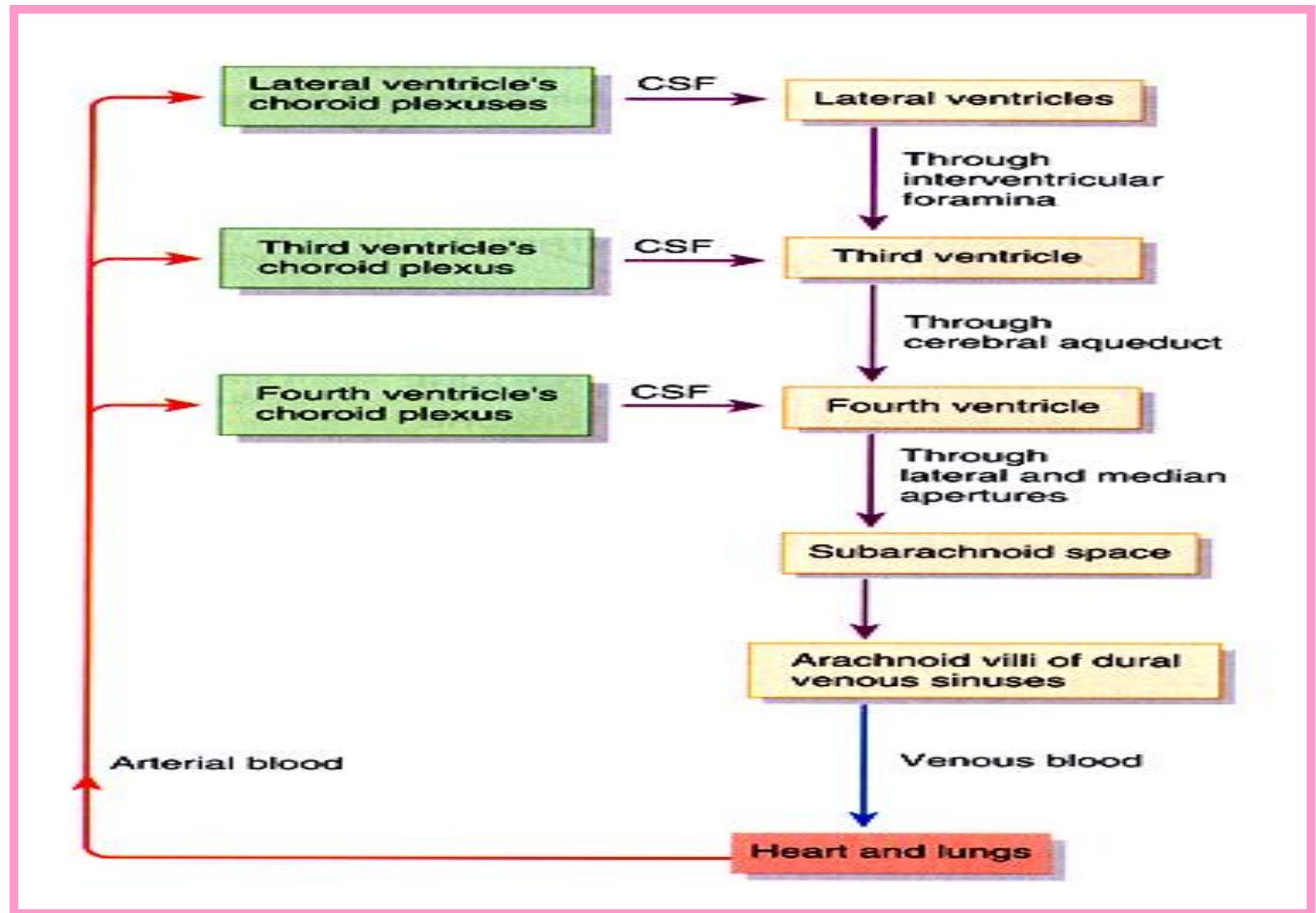
Cerebrospinal Fluid

- A clear, colorless, acellular fluid found in the ventricles and subarachnoid space.
- Produced by **choroid plexuses** within ventricles at a rate of **500ml/day**. Total volume **140ml**.
- Circulates via 3 openings of the 4th ventricle to subarachnoid space
- Absorbed by **arachnoid villi** which drain it into SSS and venous circulation.
- CSF circulation is venous pressure dependant.

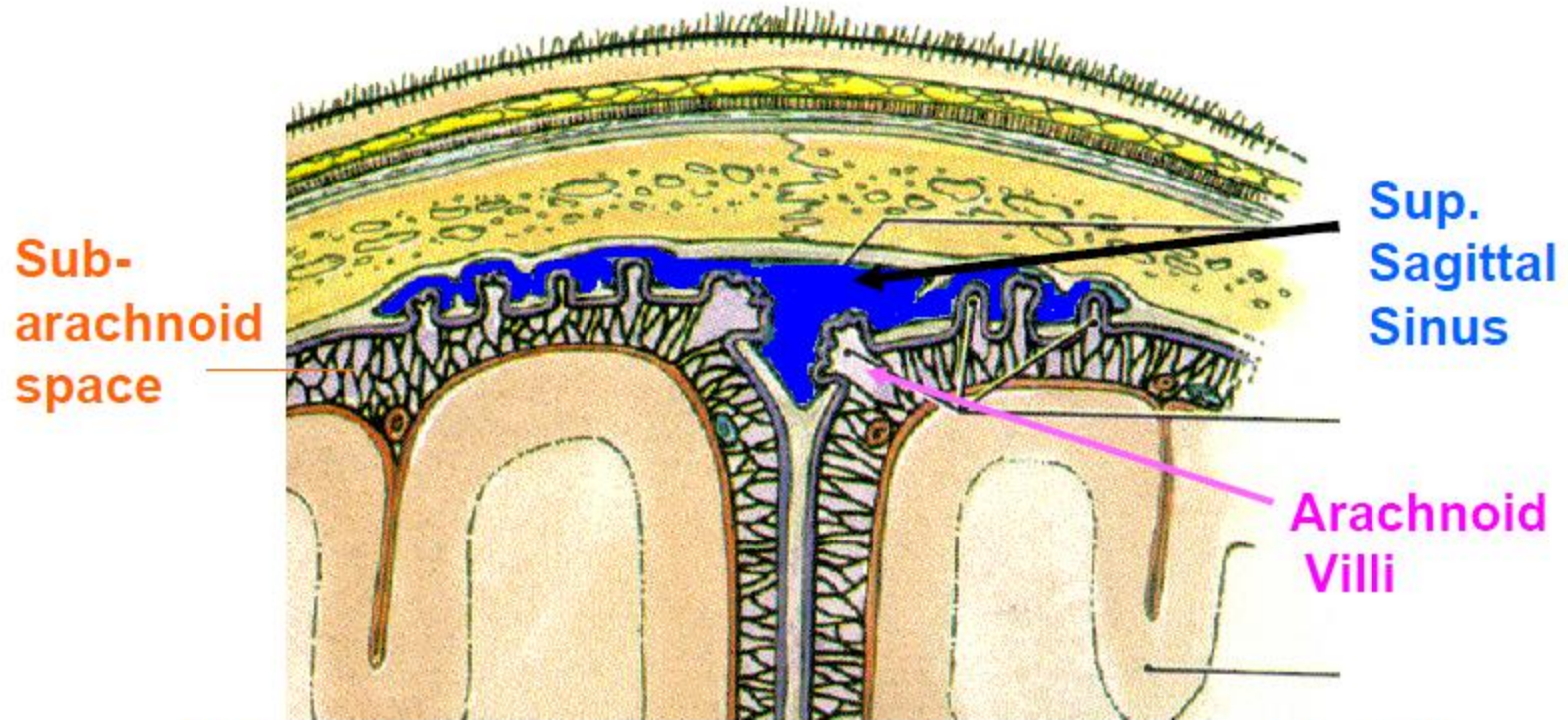




CSF Circulation

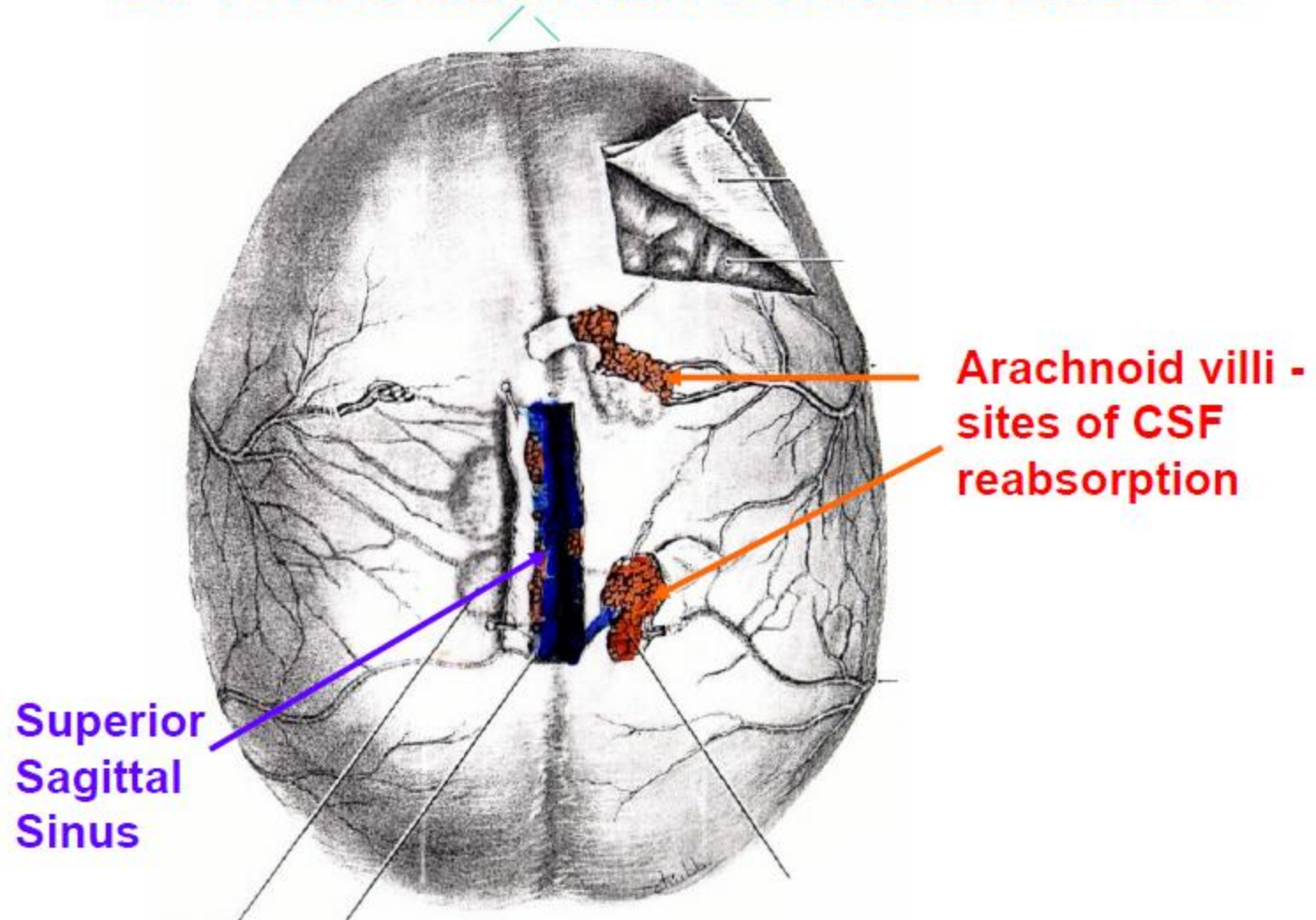


CSF REABSORBED INTO VENOUS SINUSES



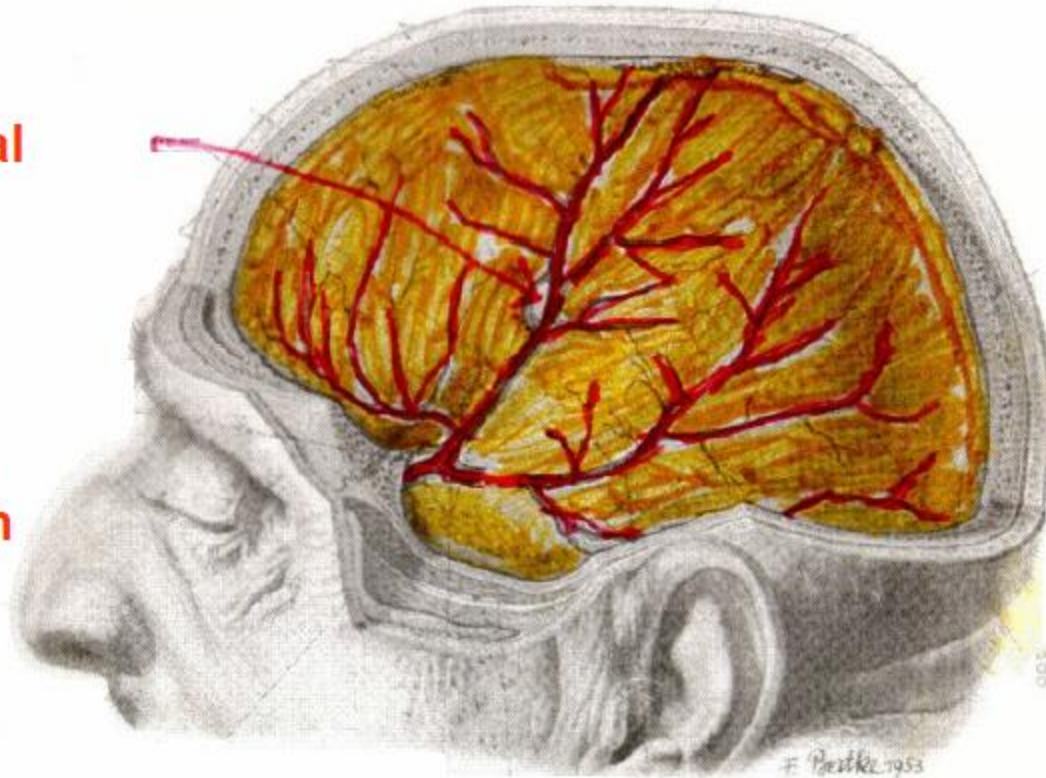
CSF reabsorbs into venous sinuses at Arachnoid Villi; Reduced Re-Absorption – Hydrocephalus
- In elderly arachnoid villi can become calcified-
Arachnoid Granulations

CSF REABSORBED INTO VENOUS SINUSES



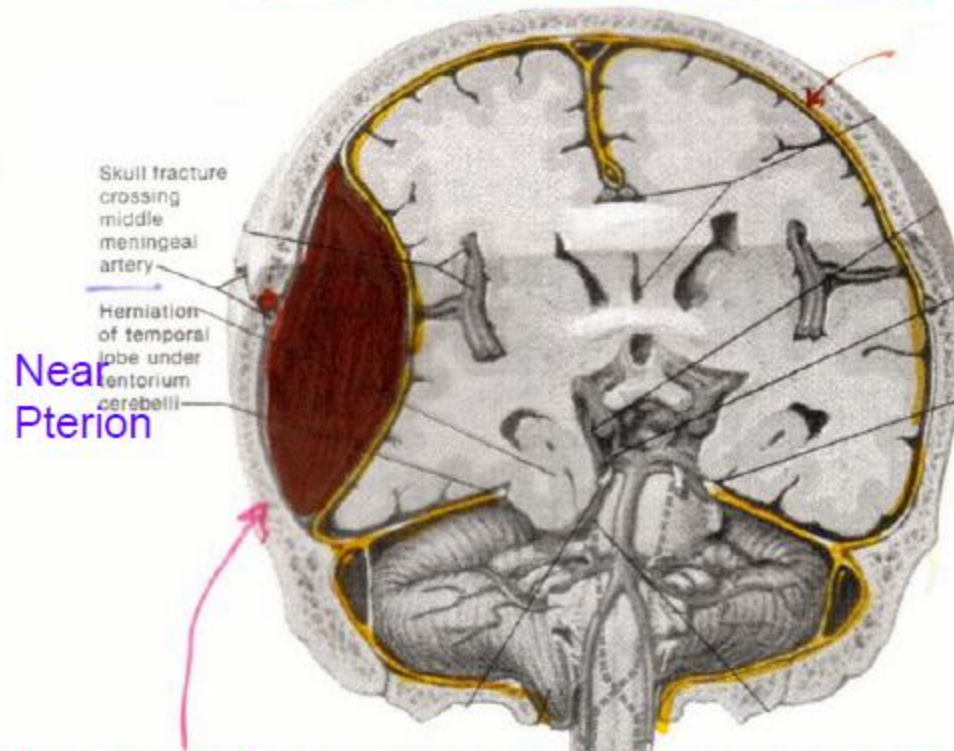
V. HEMATOMAS - INTERNAL BLEEDS

Middle
Meningeal
Artery –
courses
outside
dura –
supplies
calvarium



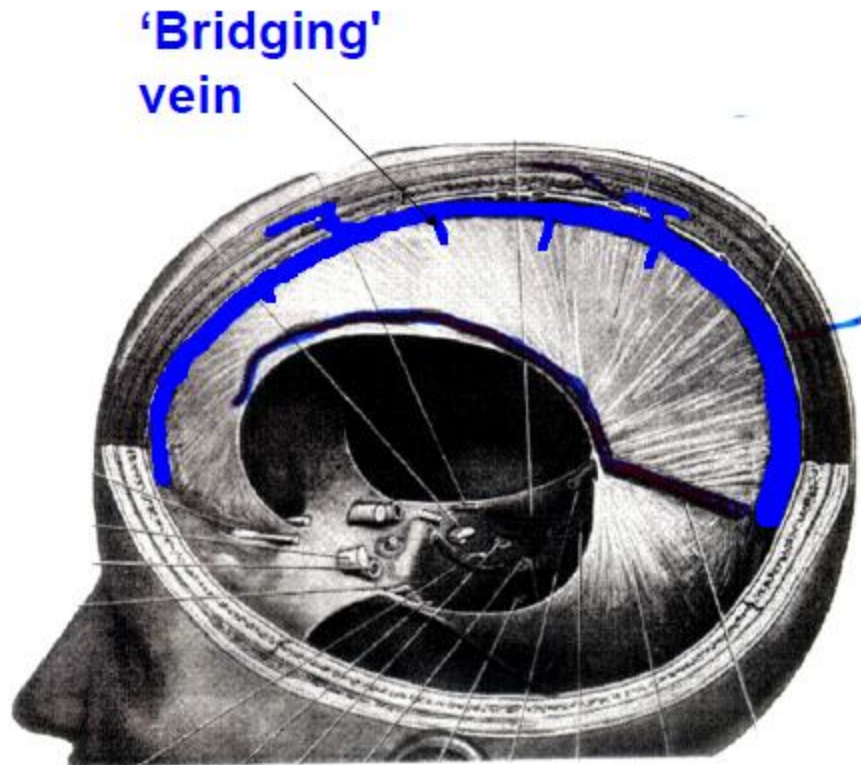
A. EPIDURAL HEMATOMA - bleeding
between dura & bone

EPIDURAL HEMATOMA



often tearing of meningeal artery (middle meningeal torn in fracture of skull at pterion); bleeding is arterial – can be profuse & rapid; - ex, car accident – patient lucid at first - can be fatal within hours

B. SUBDURAL HEMATOMA

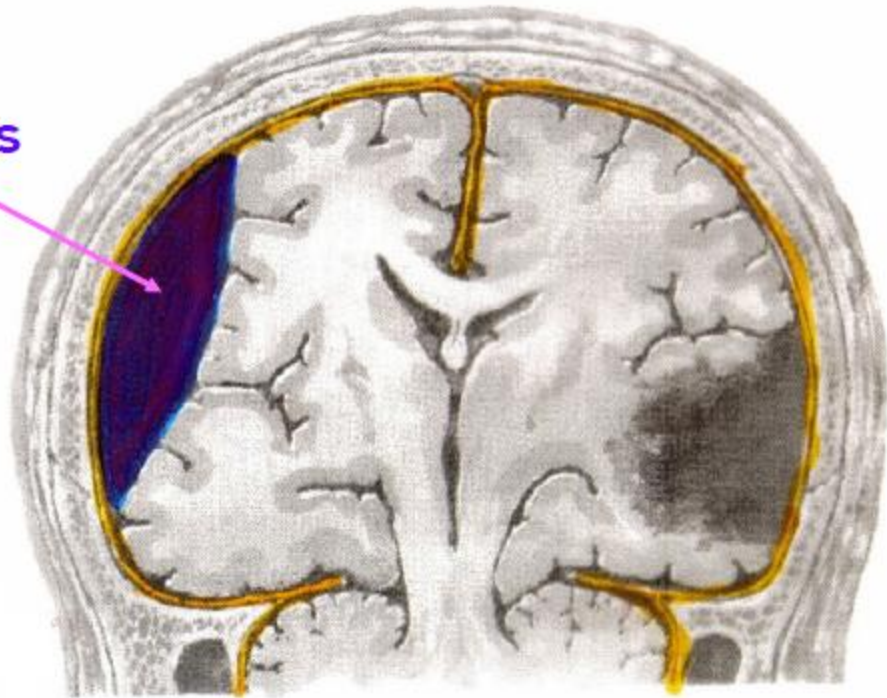


- bleed into potential space between Dura & Arachnoid
- from tear 'Bridging' vein or sinus
- bleeding often slow
- chronic subdural hematomas can remain undetected

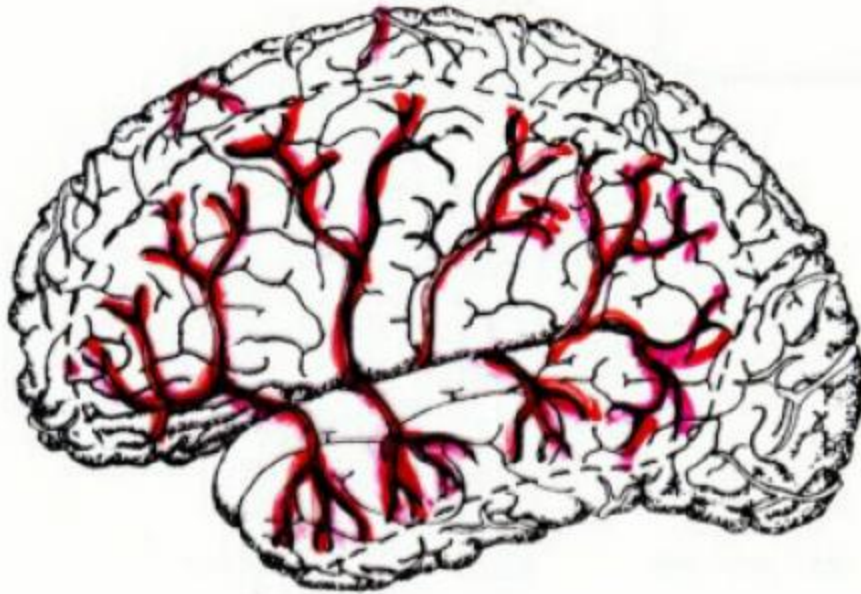
Tearing of the ***superior cerebral veins*** at their point of entrance into the superior sagittal sinus

SUBDURAL HEMATOMA

Subdural Hematomas
- bleeding slow
(venous)
- Chronic Subdural
Hematomas
can remain
undetected



C. SUBARACHNOID HEMATOMA



tearing
cerebral artery
or aneurysm
(swelling of
vessel wall)

If arterial can be rapid and fatal

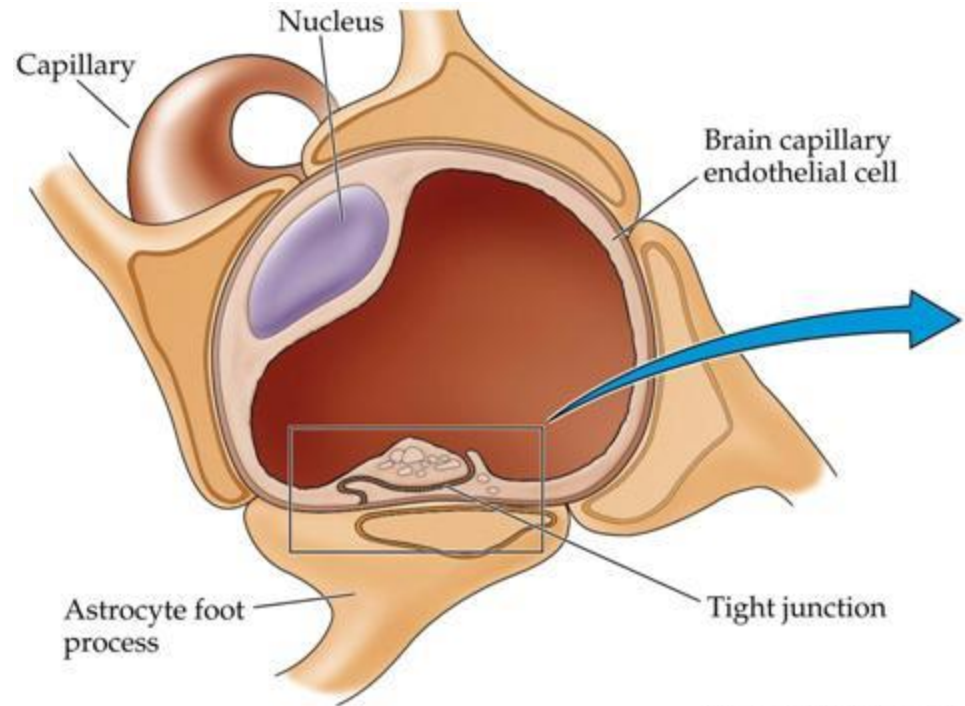
The BBB is semi-permeable; that is, it allows some materials to cross, but prevents others from crossing.

The blood-brain barrier occurs along all capillaries and consists of tight junctions around the capillaries that do not exist in normal circulation. Endothelial cells restrict the diffusion of microscopic objects (e.g., bacteria) and large or hydrophilic molecules into the cerebrospinal fluid (CSF), while allowing the diffusion of small hydrophobic molecules (O_2 , CO_2 , hormones).

This barrier also includes a thick basement membrane and astrocytic endfeet

Protects the brain from "foreign substances" in the blood that may injure the brain

Astrocyte



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Endothelial cells with
tight junctions

