



Central Nervous System

Lecture 13: Cerebral Meninges, CSF, Dural folds & Dural Venous Sinuses

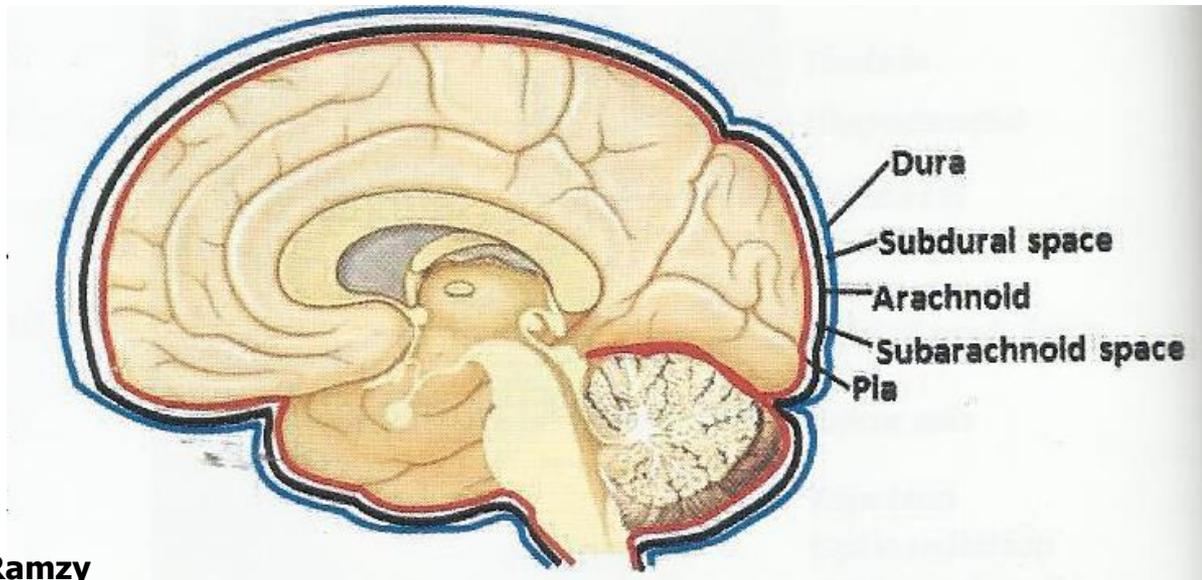
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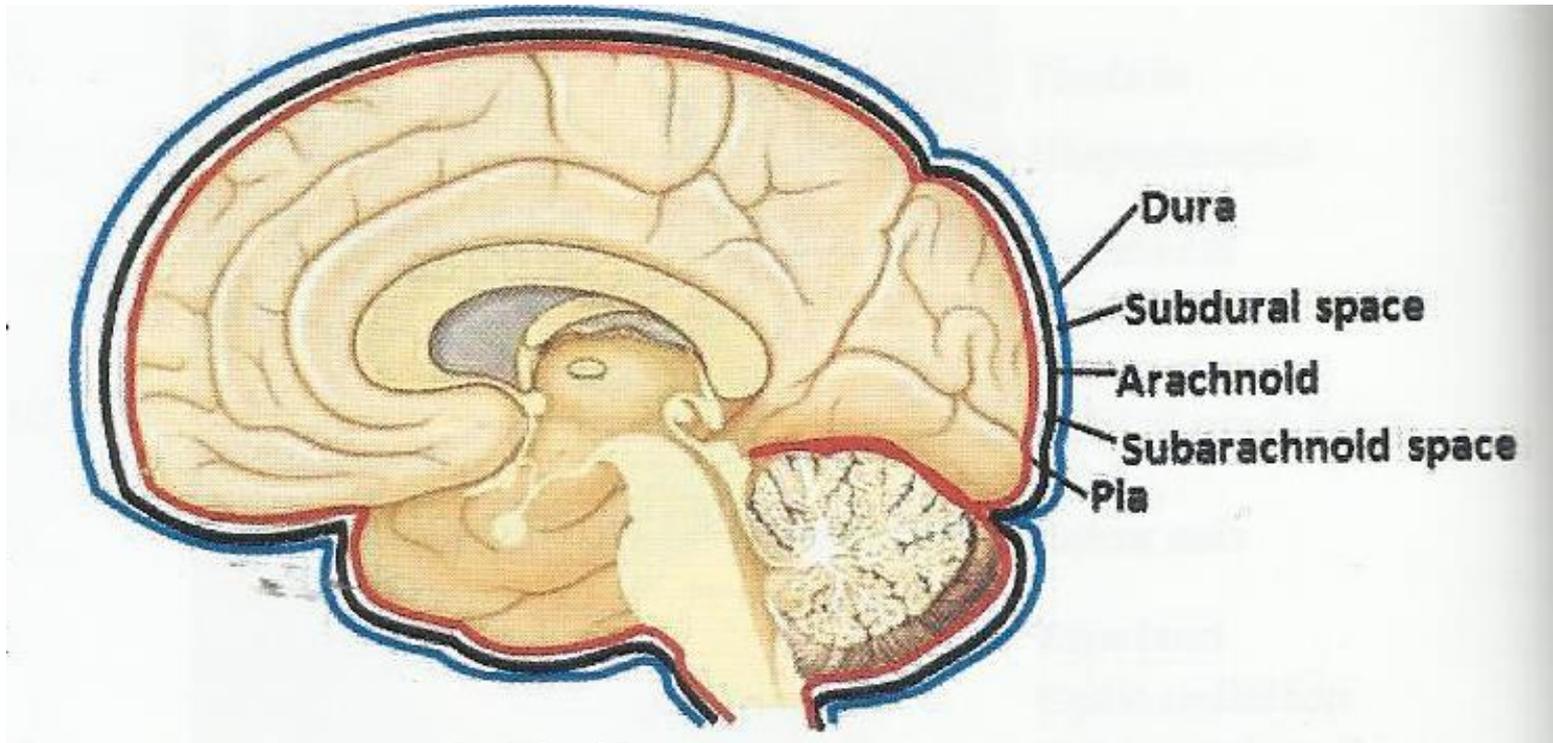
CEREBRAL MENINGES

- ** Similar to the spinal cord, the brain is also protected by three meninges: dura, arachnoid and pia.
- ** Dura Mater:
 - * It is the outer layer & is tough and fibrous.
 - * It is formed of two layers around the brain, the outer endosteal layer which is adherent to the skull and the inner meningeal layer which forms 4 dural folds.
 - * The two layers lie close together but separate to include a venous sinus or where the inner layer forms a fold.
 - * The inner layer is continuous with the spinal dura "one layer only".

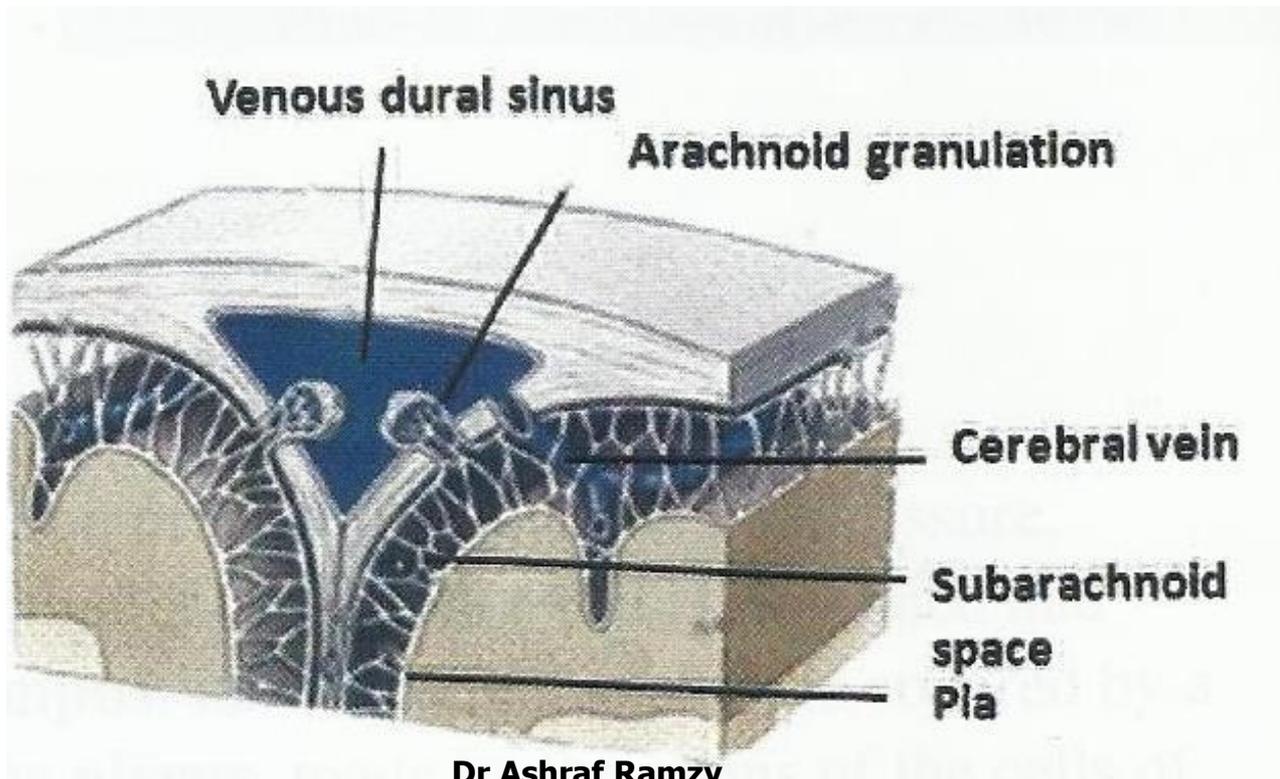


**** Arachnoid Mater:**

- * It is a delicate membrane that lies between dura and pia.**
- * It covers gyri & bridges over sulci of the brain.**
- * The space between dura & arachnoid is called the subdural space. It contains a thin film of fluid.**
- * The space between arachnoid and pia is called subarachnoid space. The later contains CSF and the arteries supplying the brain.**

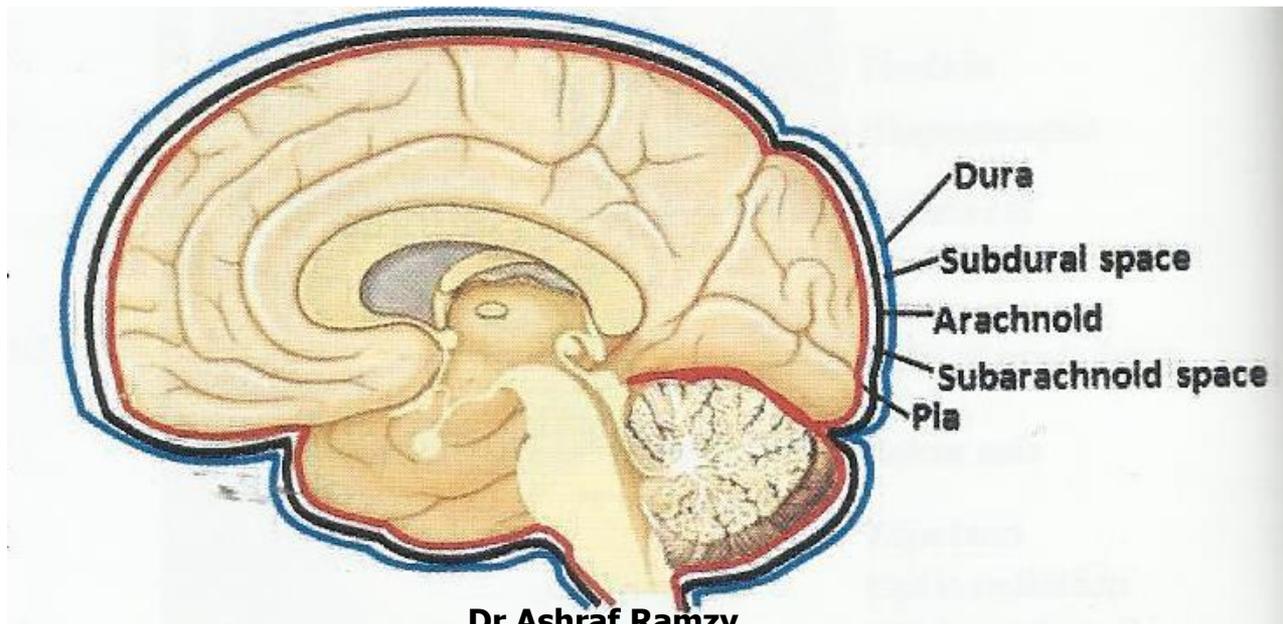


- * The outer surface of the arachnoid forms at certain sites the **arachnoid villi and granulations** through which CSF passes to the venous sinuses.
- * The inner surface of the arachnoid is connected to the pia by fine threads that transverse the subarachnoid space.



**** Pia Mater:**

- * It is a delicate vascular membrane that is adherent to the surface of brain
- * It covers gyri and dips into its sulci.
- * The pia mater + blood vessels + ependyma form the **choroid plexuses of the ventricles.**
- * The pia mater around the spinal cord forms the filum terminale at the level of lower border of 1st Lumbar vertebra where the spinal cord ends. On each side of the spinal cord, it forms the **denticulate ligaments** which pass through arachnoid to attach to dura. These denticulate ligaments help to suspend the cord within the vertebral canal.



Subarachnoid cisterns

- * They are wide parts of the subarachnoid space:

1. Cerebello medullary cistern = cisterna magna:

- * Lies below the cerebellum & behind the closed medulla.

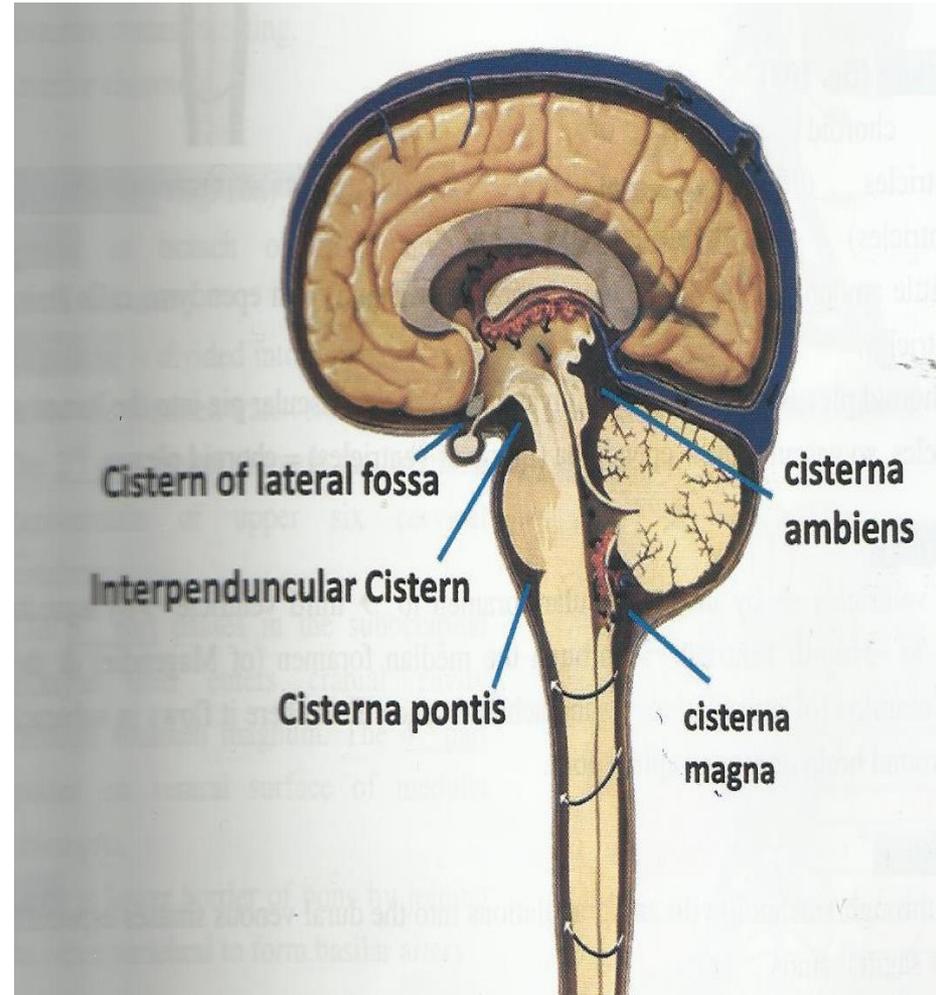
- * It is continuous with the subarachnoid space around the spinal cord.

- * It receives CSF from the fourth ventricles via three foramina: 1 median foramen of Magendi and 2 lateral foramina of Luschka.

2. Cistern of great Cerebral vein (cisterna ambiens):

- * Lies above the cerebellum & below the splenium of corpus callosum.

- * It contains the great cerebral vein.



3. Cisterna pontis:

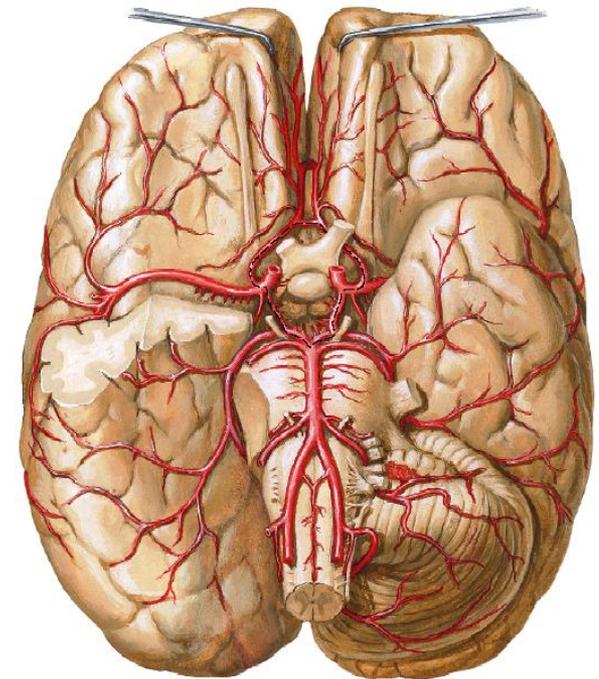
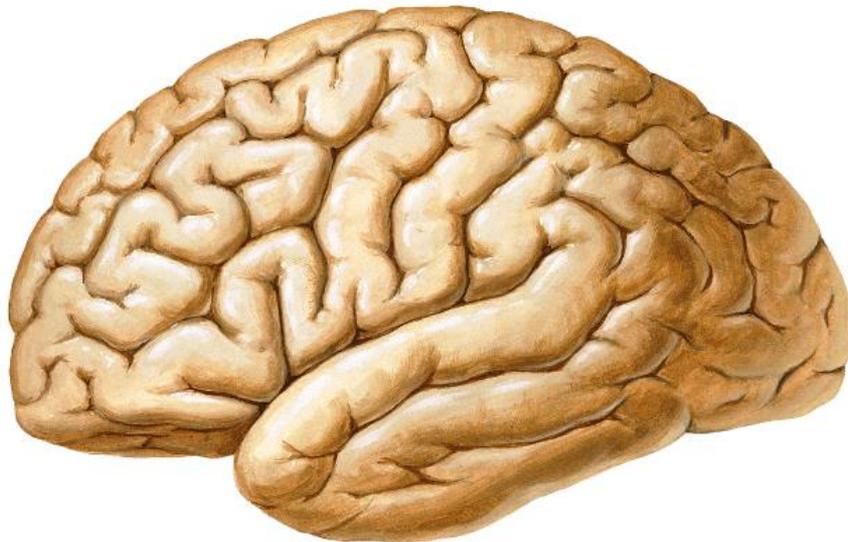
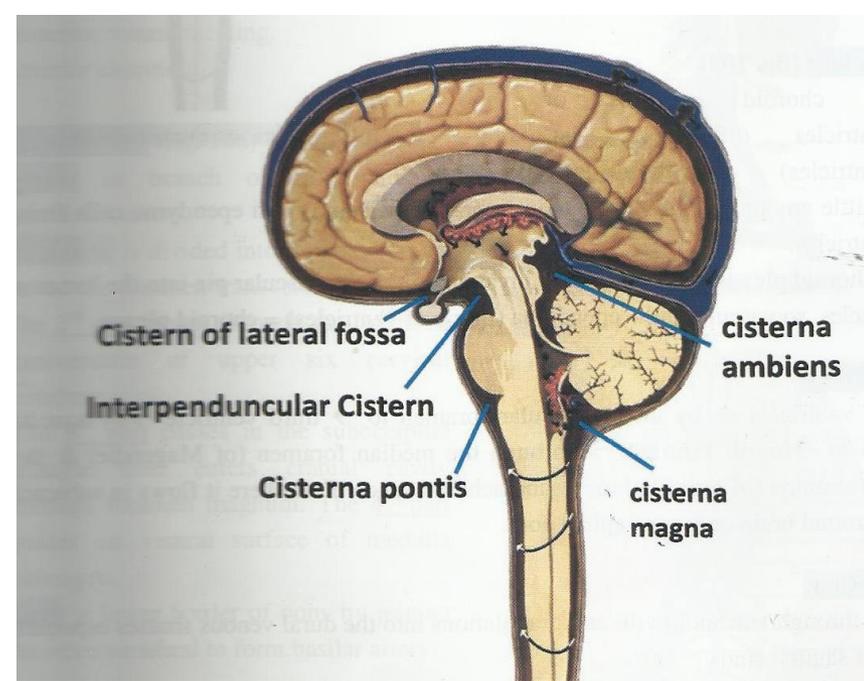
- * Lies on the ventral surface of pons.
- * Contains basilar artery.

4. Interpeduncular Cistern:

- * Lies ventral to the interpeduncular fossa.
- * Contains the circle of Willis.

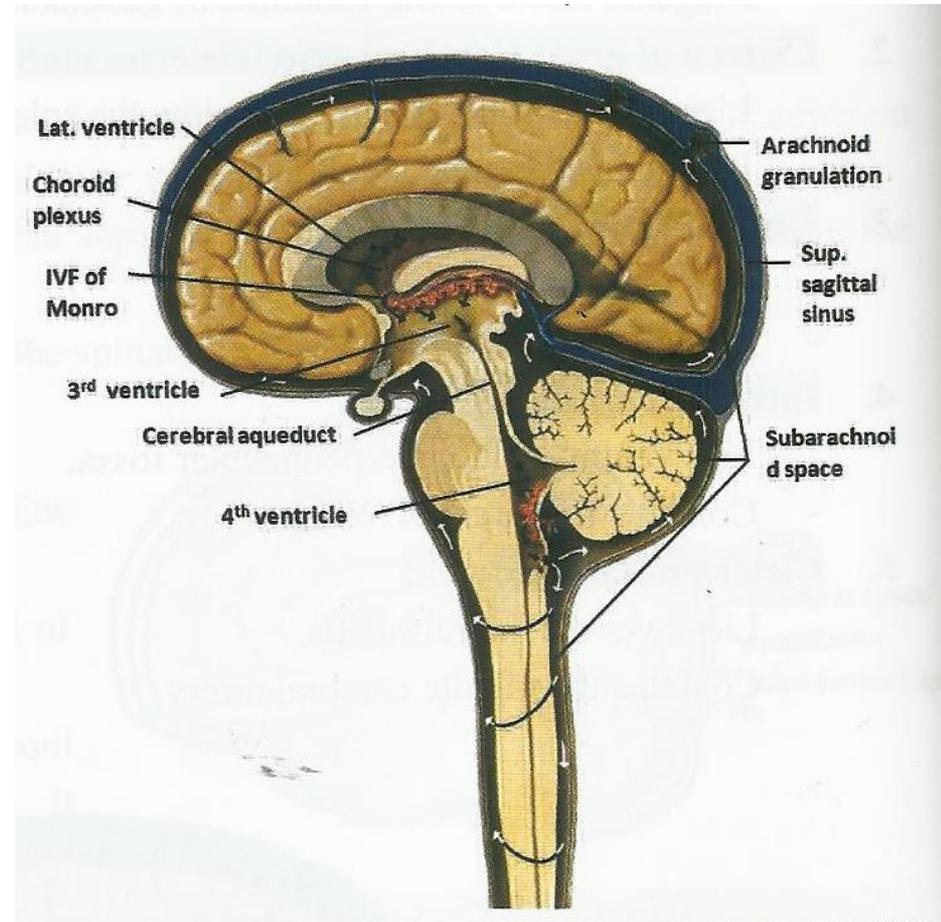
5. Cistern of lateral fossa:

- * Lies over the lateral sulcus.
- * Contains the middle cerebral artery.



CEREBROSPINAL FLUID (CSF)

- ** It is a clear, colorless & odorless fluid secreted by the choroid plexuses of the different ventricles.**
- ** The fluid circulates in the subarachnoid space and within the ventricles.**
- ** The total volume is about 130 to 150 ml.**
- ** About 300 ml are secreted every 24 hrs.**

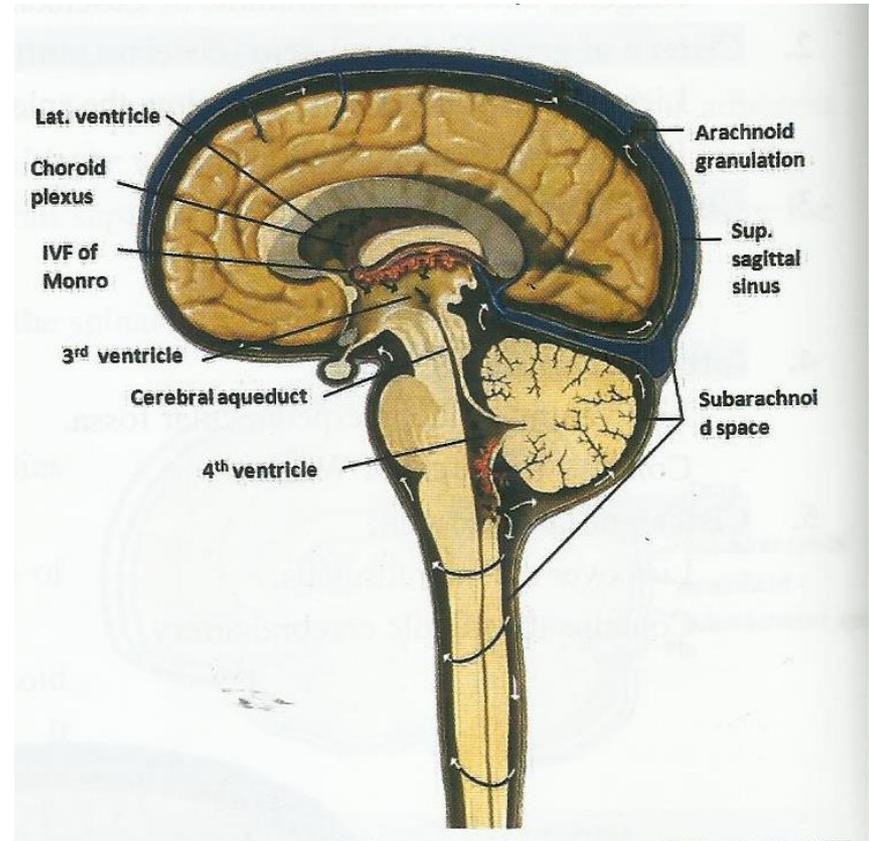


**** Function:**

- 1. Protects brain against trauma & acts as a water jacket around it.**
- 2. Helps to keep the volume of fluid inside skull constant; any increase in blood volume (or brain volume) is compensated for by a decrease in CSF volume.**

*** Therefore maintains a constant intracranial pressure.**

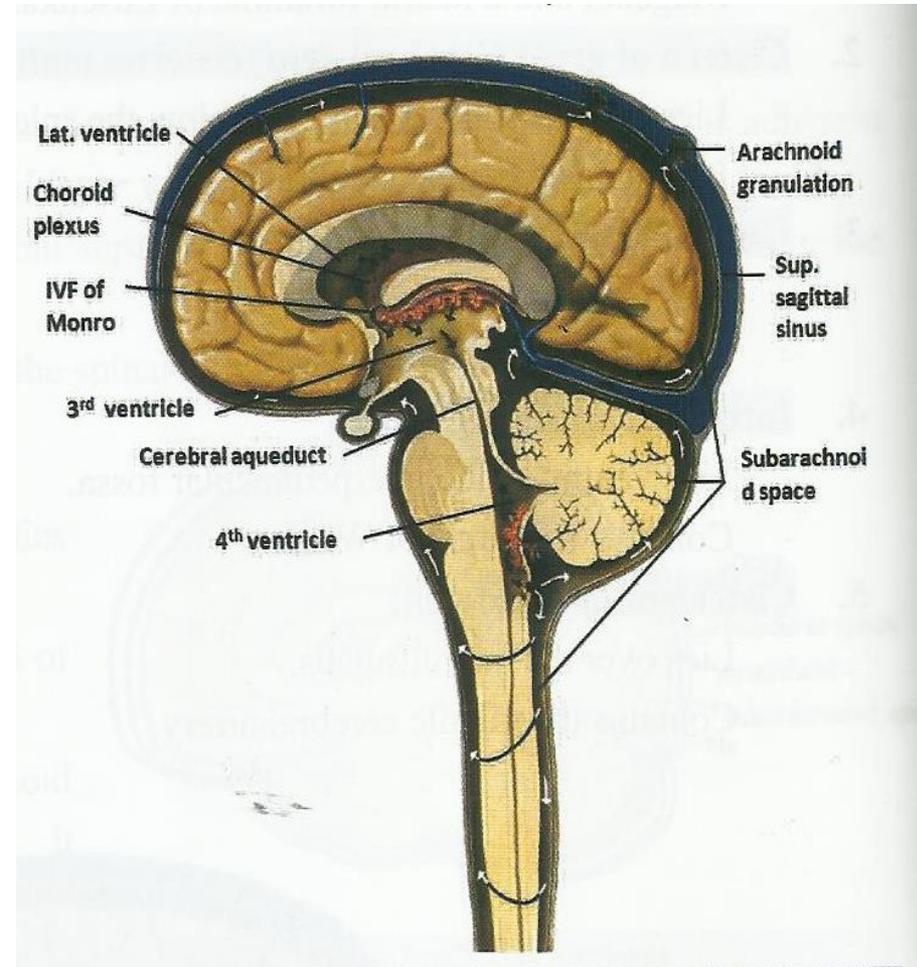
- 3. Removal of neuronal metabolites (no lymph in CNS).**



**** Formation:**

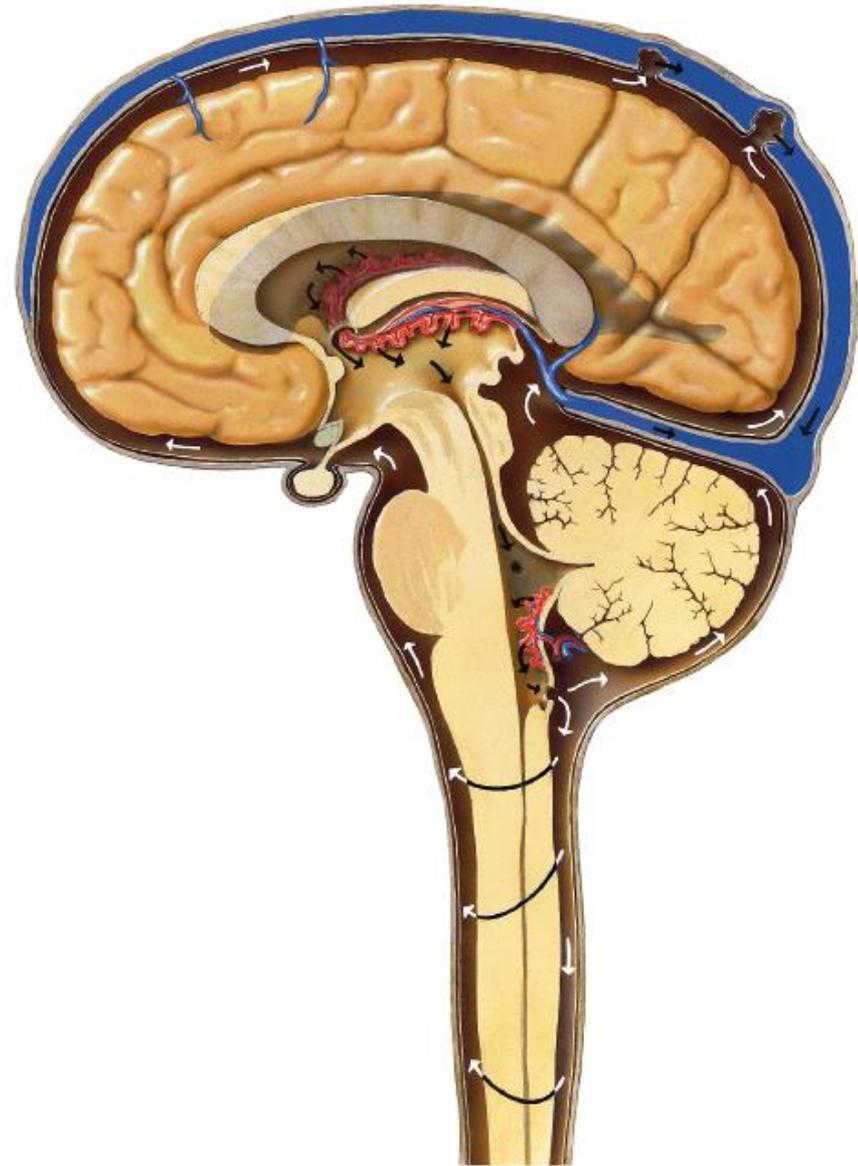
- 1. By choroid plexuses of ventricles (90% by lat. ventricles).**
- 2. A little amount is formed around cerebral vessels and from ependyma cells lining the ventricles.**

**** The choroid plexuses are formed by invagination of the vascular pia into the lumen of the ventricles, so vascular pia + ependyma (lining of ventricles) = choroid plexus.**



**** Circulation:**

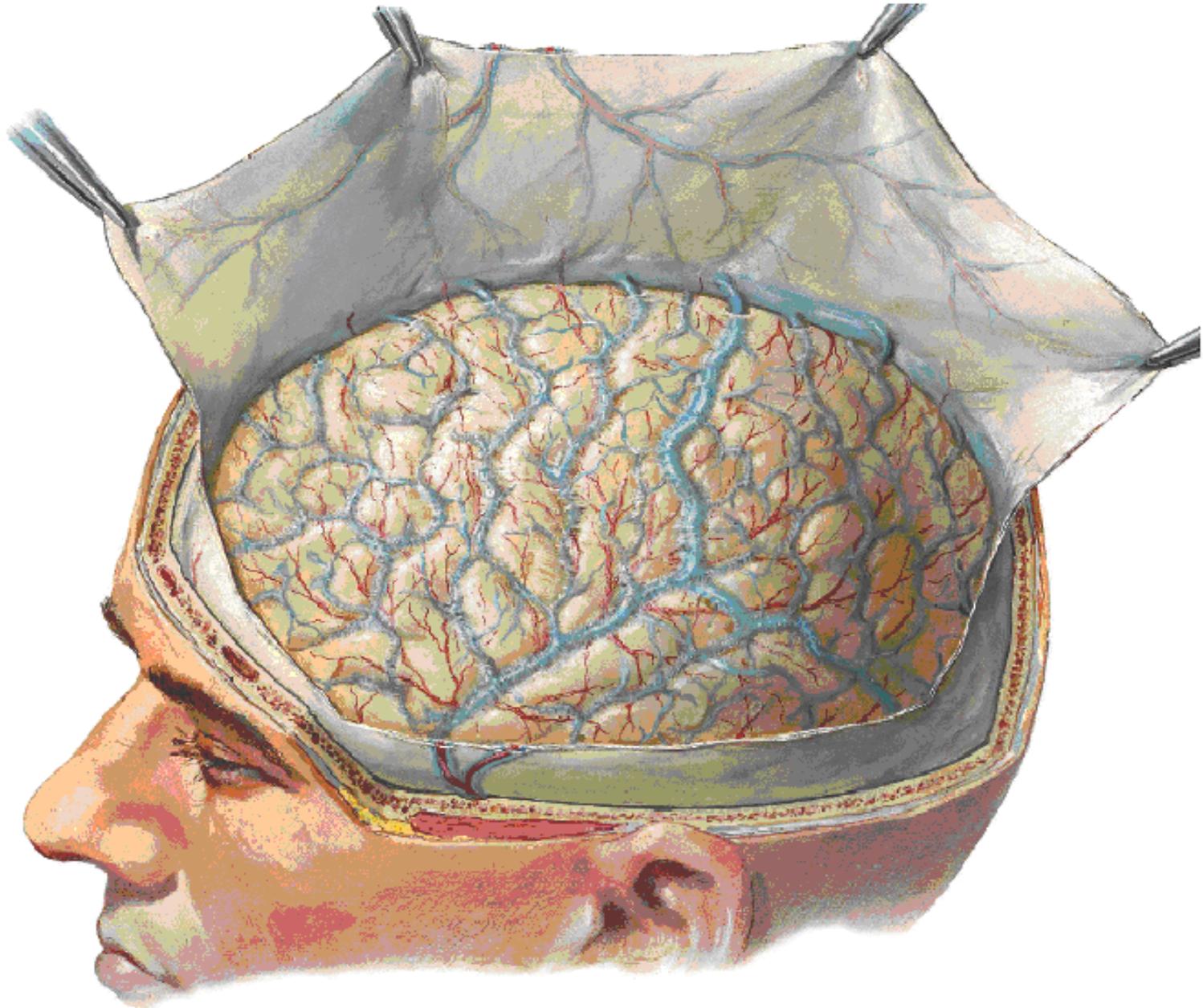
- * Lateral ventricles → by interventricular foramen to → third ventricle → by aqueduct of Sylvius to → fourth ventricle → through the median foramen (of Magendie) & the two lateral foramina (of Luschka) to → subarachnoid space.
- * From here it flows in subarachnoid space around brain or around spinal cord.
- ** **Absorption:** Mostly through arachnoid villi and granulations into the dural venous sinuses especially the superior sagittal sinus.
- ** **Hydrocephalus:** An increase in the volume of CSF within the skull due to ↑ formation or ↓ absorption or block in circulation of CSF. This excess fluid compresses the brain.



Meninges

@ The brain is surrounded by 3 meninges:

1. a tough outer layer; the dura mater.
 2. a delicate middle layer; the arachnoid mater.
 3. An inner layer which is firmly attached to the surface of the brain; the pia mater.
- @ The cranial meninges are continuous with the spinal meninges at the foramen magnum.
- @ The cranial dura mater consists of 2 layers.



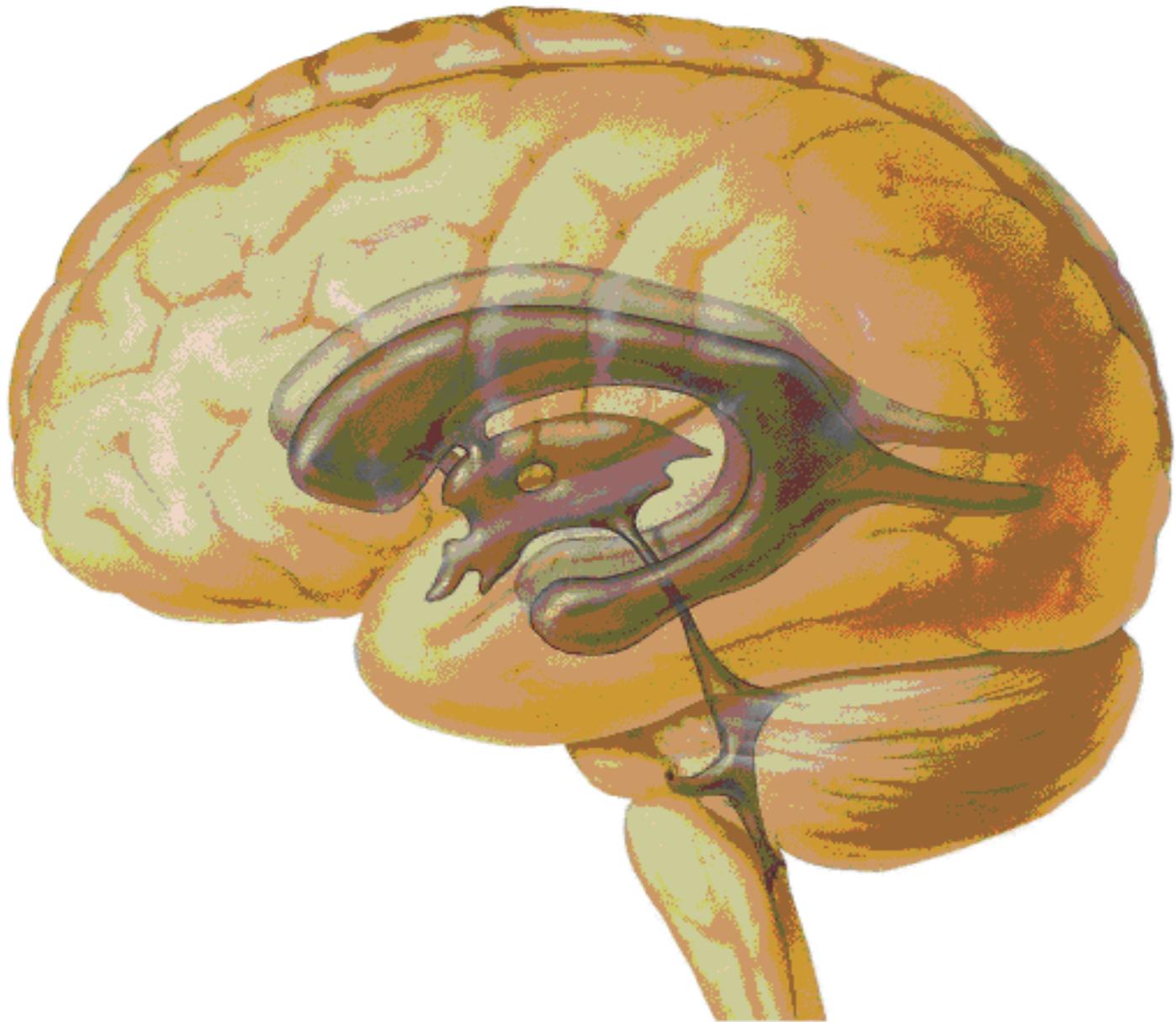
Cranial Dura Mater

1. Outer periosteal layer:

- @ Forms the inner periosteum of the skull.
- @ Called : endosteum or endocranium.
- @ Connected to the pericranium at the different foramina of the skull.

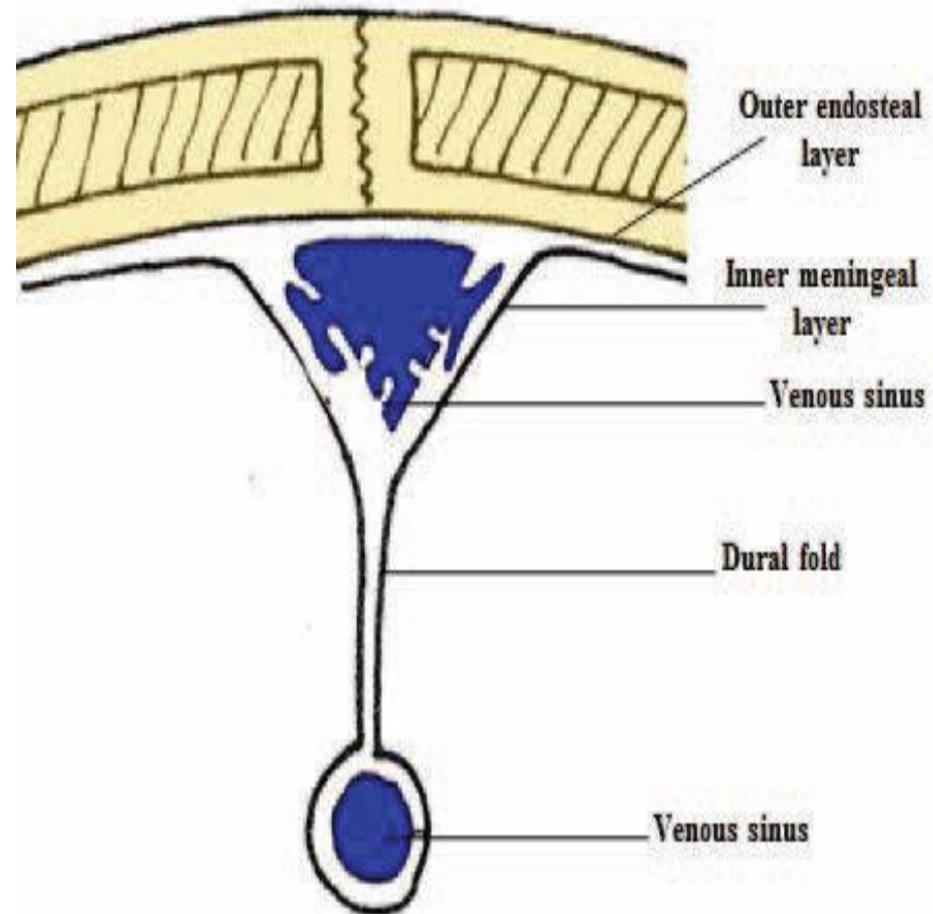
2. Inner meningeal layer:

- @ Called "Dura proper".
- @ Forms double-layered dural folds.



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**** The two layers are fused together except:**
in certain regions where the inner layer dips to form folds between different parts of the brain, or when the outer and inner layers separate to enclose a venous sinus between them.



Dural Folds

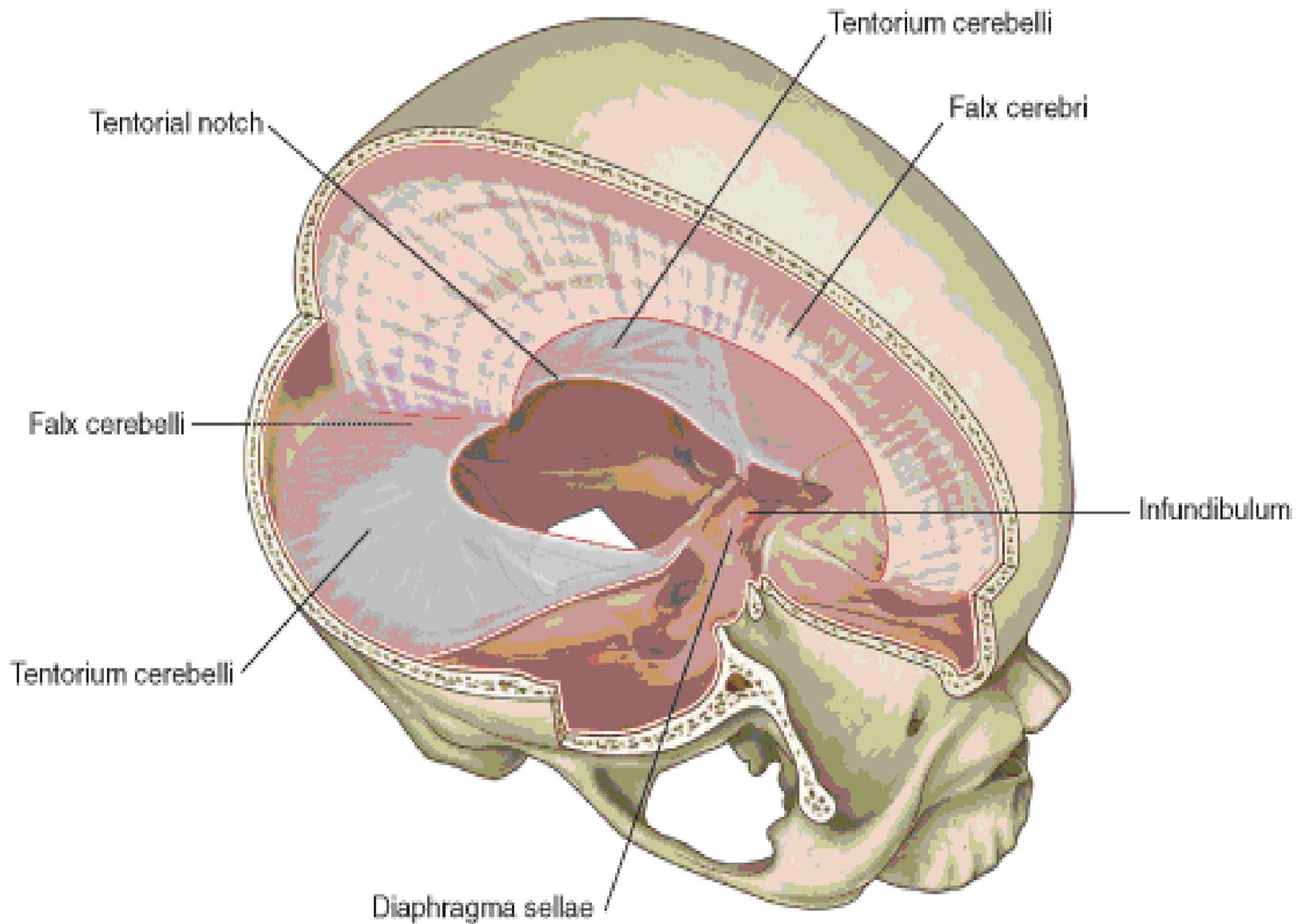
@ Definition:

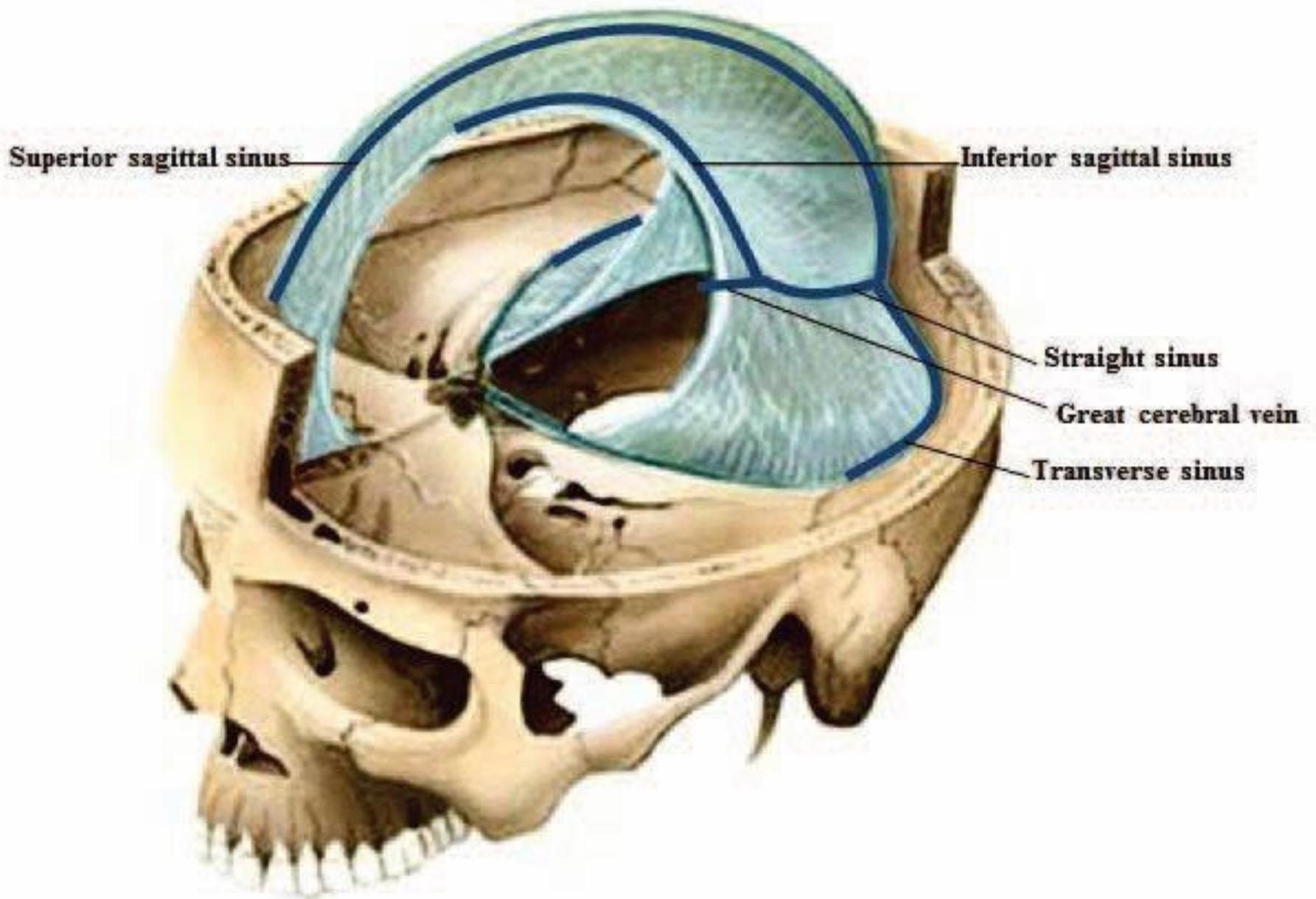
They are membranous folds inside the cranial cavity, produced by the inner layer of the dura mater between the different parts of the brain.

@ Functions:

1. Divide the cranial cavity into compartments to minimize the effects of vibrations and shocks on the brain.
2. Support the different parts of the brain.

@ They include: Falx cerebri, Tentorium cerebelli, Falx cerebelli & Diaphragma sellae.



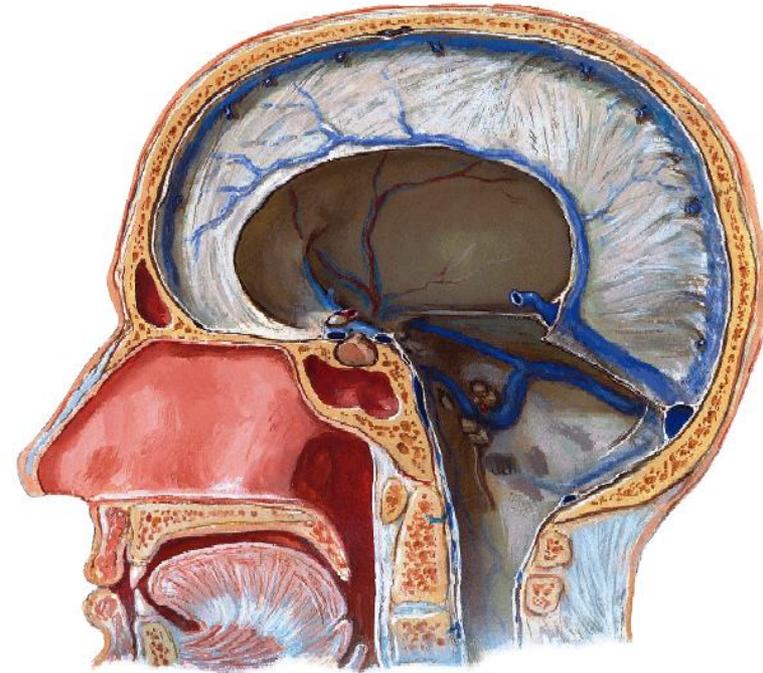


I. Falx Cerebri

@ **Shape:** large sickle shaped (crescent-shaped).

@ **Site:** It lies between the 2 cerebral hemispheres in the median longitudinal fissure.

@ It has **2 ends and 2 borders:**



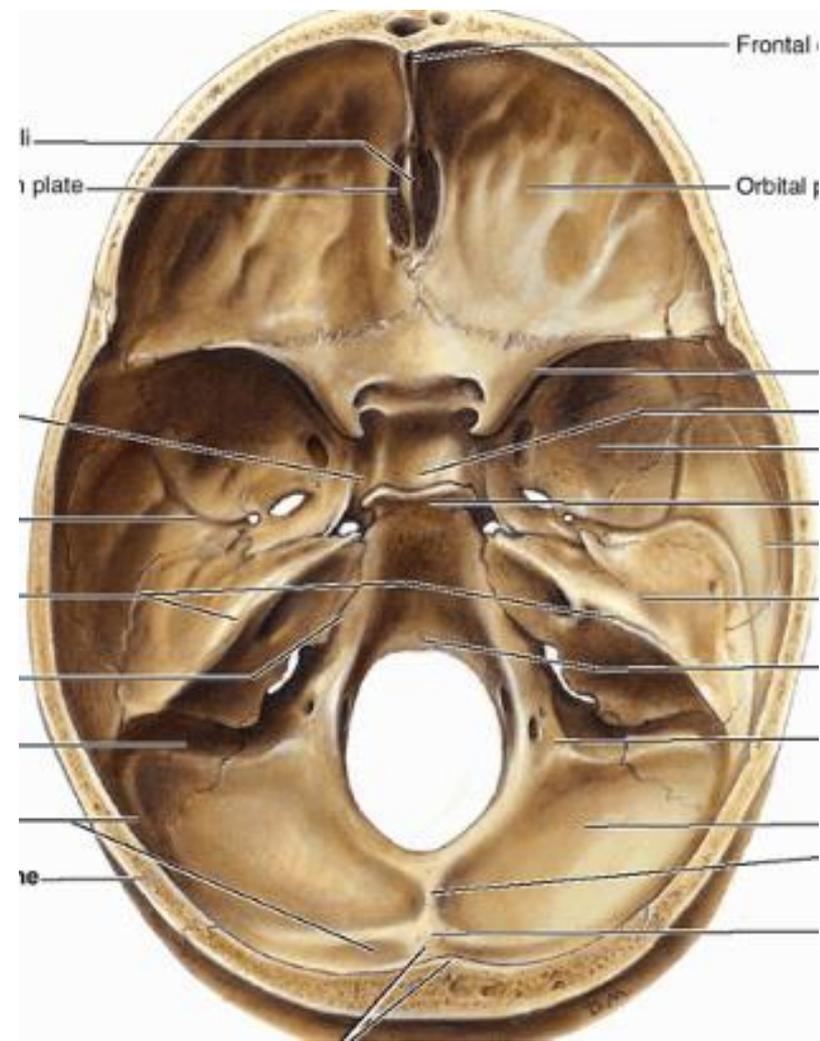
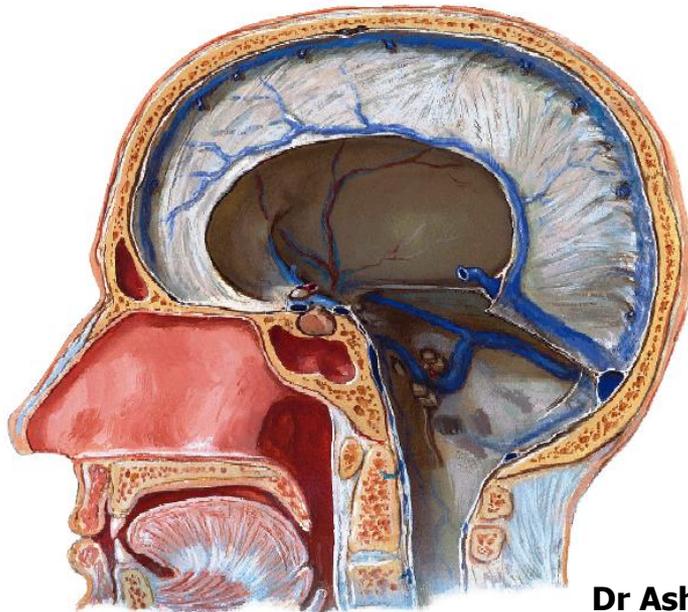
1. Upper convex border :
attached to the sagittal sulcus on the inner surface of the skull cap and encloses the **sup. sagittal sinus.**

2. Lower concave border:

is free and encloses **inf. sagittal sinus.**

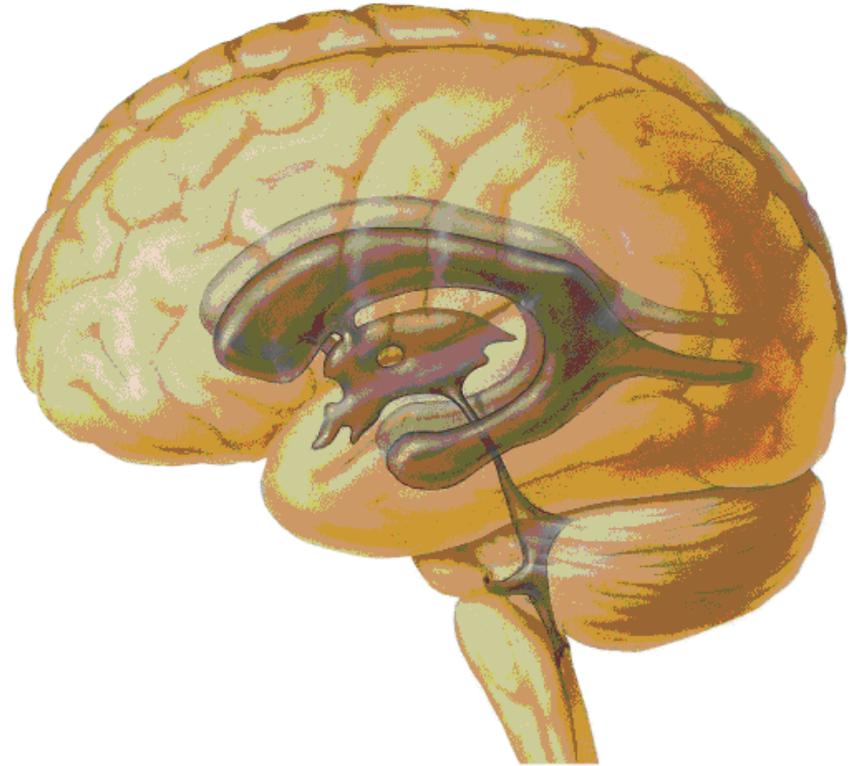
3. ant. end (apex) : attached to frontal crest and crista galli.

4. post. end (base): attached to the upper surface of the tentorium cerebelli enclosing the **straight sinus.**



**** Relations:**

- * Rt & Lt surfaces
→ facing medial
surfaces of both
cerebral hemispheres.**
- * Its free border rests
on corpus callosum.**



II. Falx Cerebelli

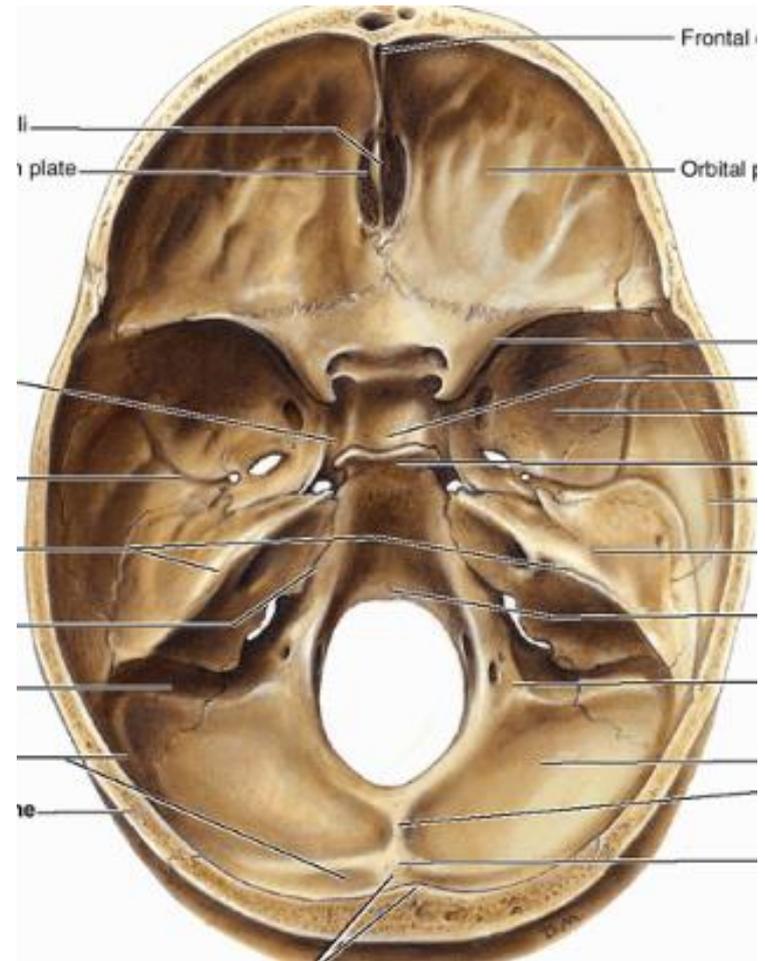
@ It is a small sickle-shaped fold that lies between the 2 cerebellar hemispheres.

* Base (superiorly): attached to tentorium cerebelli.

* Apex (inferiorly): narrow, attached to the margins of the Foramen magnum.

* Posterior border: attached to internal occipital crest & encloses the occipital sinus.

* Anterior border: free.



* Relations: Rt & Lt surfaces fit in the cerebellar sulcus, related to the cerebellar vermis

III. Tentorium Cerebelli

@ It is a horizontal (tent-shaped) fold that lies between the 2 cerebral hemispheres (above) and the 2 cerebellar hemispheres (below), forming a horizontal roof for post. cranial fossa.

@ It has 2 borders :

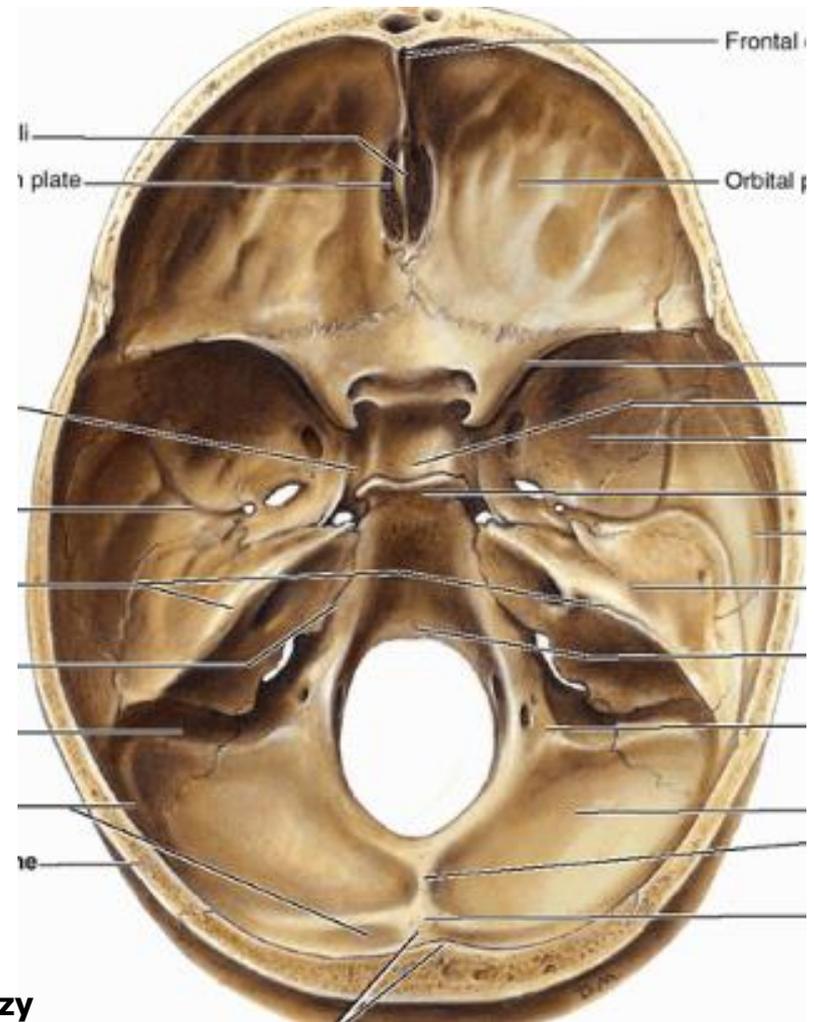
1. An attached margin :

attached on each side to:

**Margins of transverse sulcus (enclosing the transverse sinus).

**Upper border of petreous part of temporal bone (enclosing the sup. petrosal sinus).

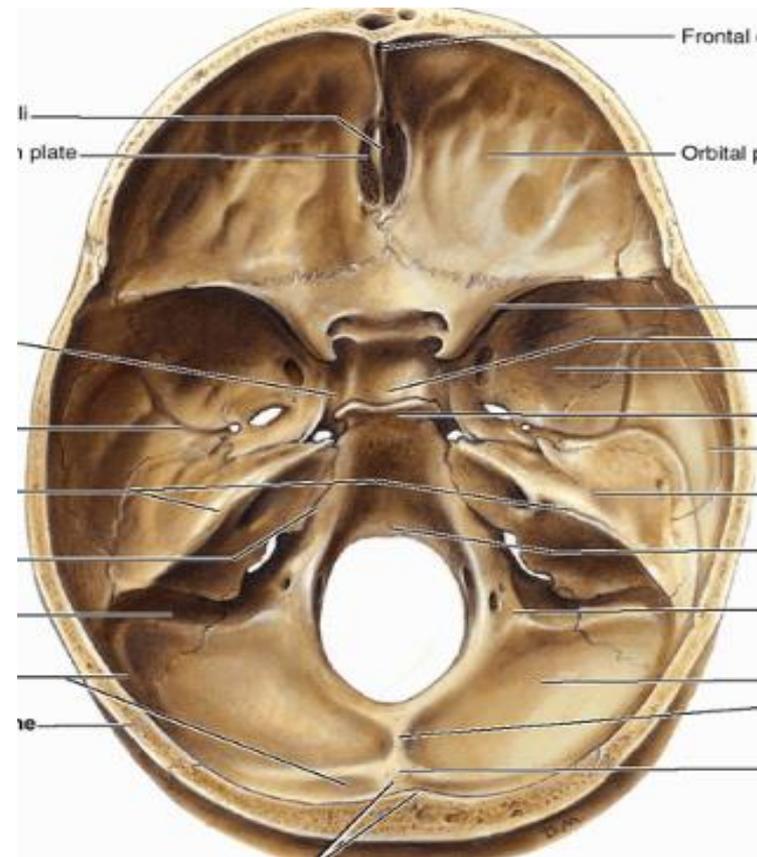
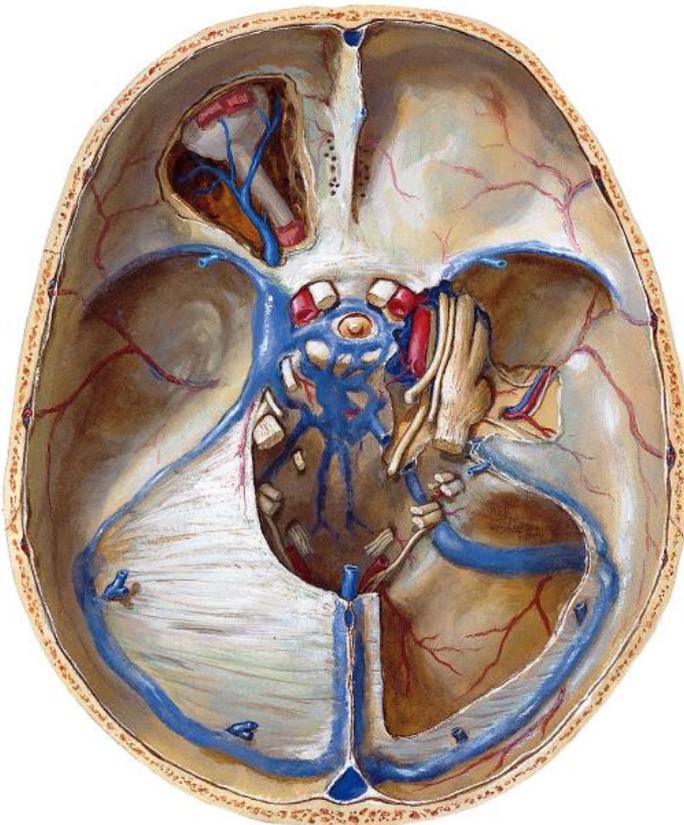
**Post. clinoid process.



III. Tentorium Cerebelli (contd)

2. A medial free margin :

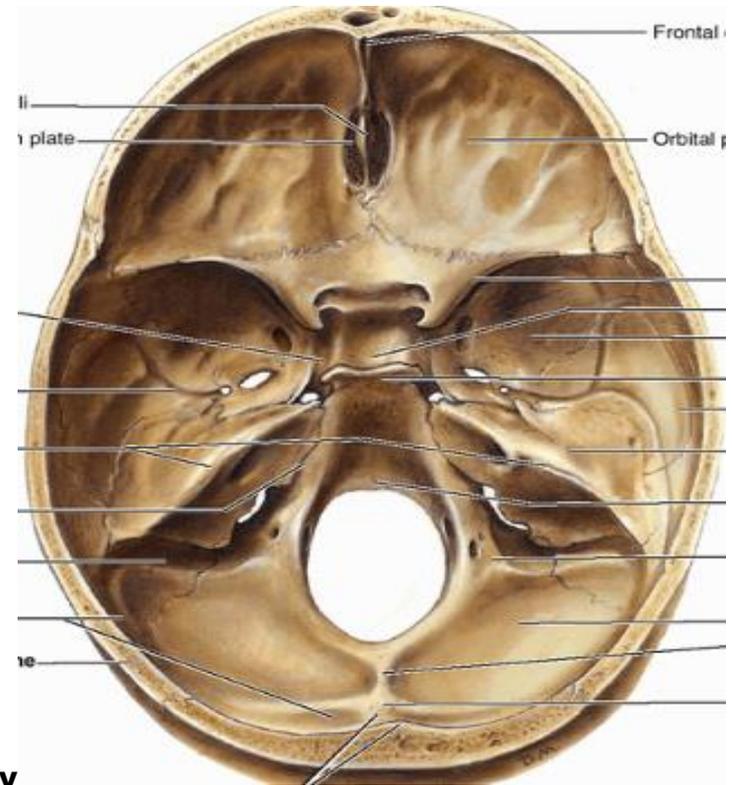
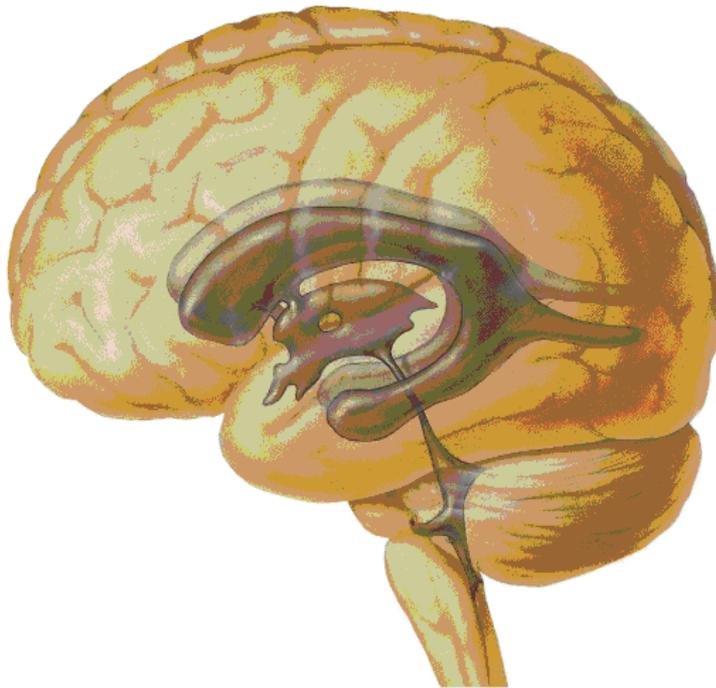
which bounds a U-shaped opening called the tentorial notch. It is attached to ant. clinoid processes & gives passage to midbrain.



III. Tentorium Cerebelli (contd)

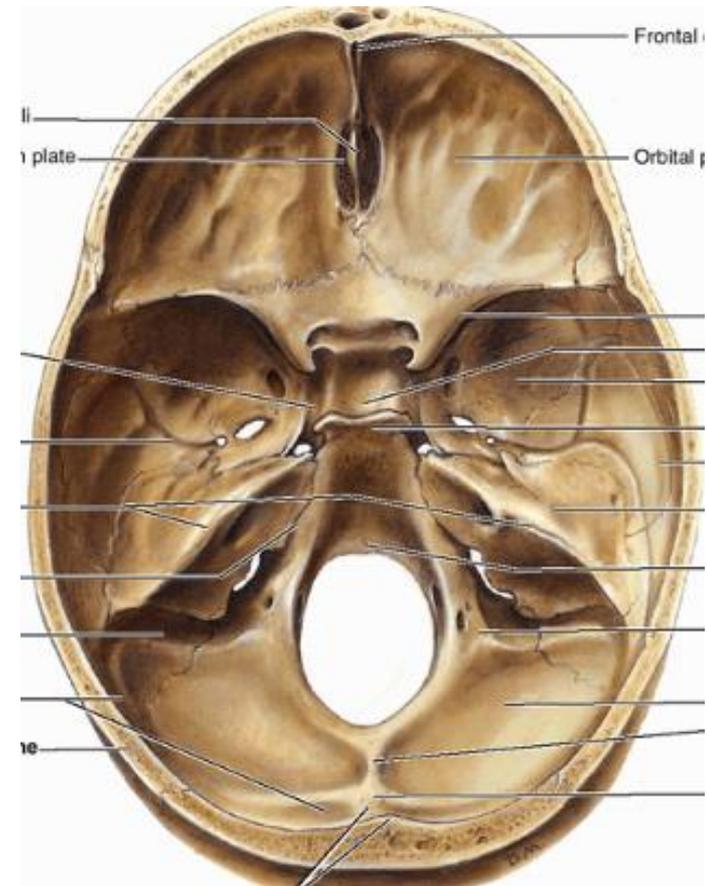
Relations:

1. Sup. surface is related to → occipital lobe of cerebral hemispheres.
2. Inf. surfaces is related to → superior surface of cerebellar hemispheres.
3. At point of crossing of its two margins: the 3rd & 4th cranial nerves are related (3rd in front of point of crossing & the 4th at the point of crossing).



IV. Diaphragma Sellae

- @ It is a transverse fold which separates the brain from the Pituitary gland.
- @ It is attached to the ant. and post. clinoid processes.
- @ It is pierced by the infundibulum of the pituitary gland which connects the gland with the base of the brain.
- @ It encloses the ant. and post. intercavernous sinuses.



Venous Drainage of Dura

1. Meningeal veins → venous dural sinuses.
2. Diploic veins.

Applied Anatomy

* Skull trauma may lead to some injuries such as:

1. Extradural hemorrhage: is less common, usually of **arterial origin** due to injury of middle meningeal vessels → leads to cerebral compression.
2. Subdural hemorrhage: is more common, usually of **venous origin**, also has → cerebral compression signs, RBCs are commonly present in CSF.

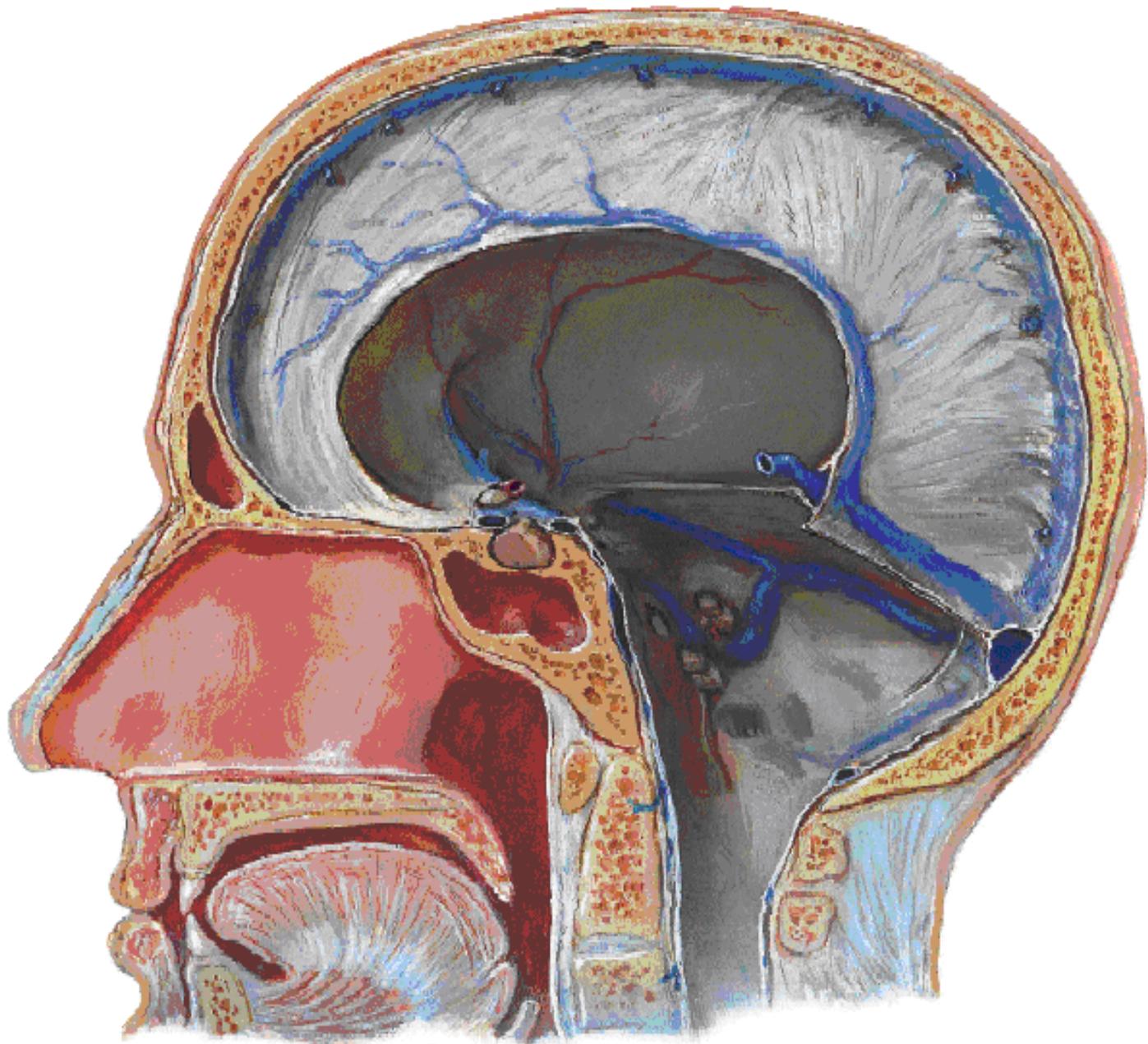
(B) Dural Venous Sinuses

@ Site : inside the cranial cavity between outer and inner layers of dura mater.

@ Definition: these are venous channels which contain venous blood.

@ Characters :

1. Have no muscular wall & are valveless.
2. Single or paired.
3. Its wall is formed of dura mater and lined by endothelium.
4. Its tributaries receive veins from : skull, orbit, brain, inner ear and meninges.
5. It Include : 4 single sinuses, 6 paired sinuses & 2 multiple sinuses.
6. They are connected to extracranial veins via emissary veins & drain finally into I.J.V.)



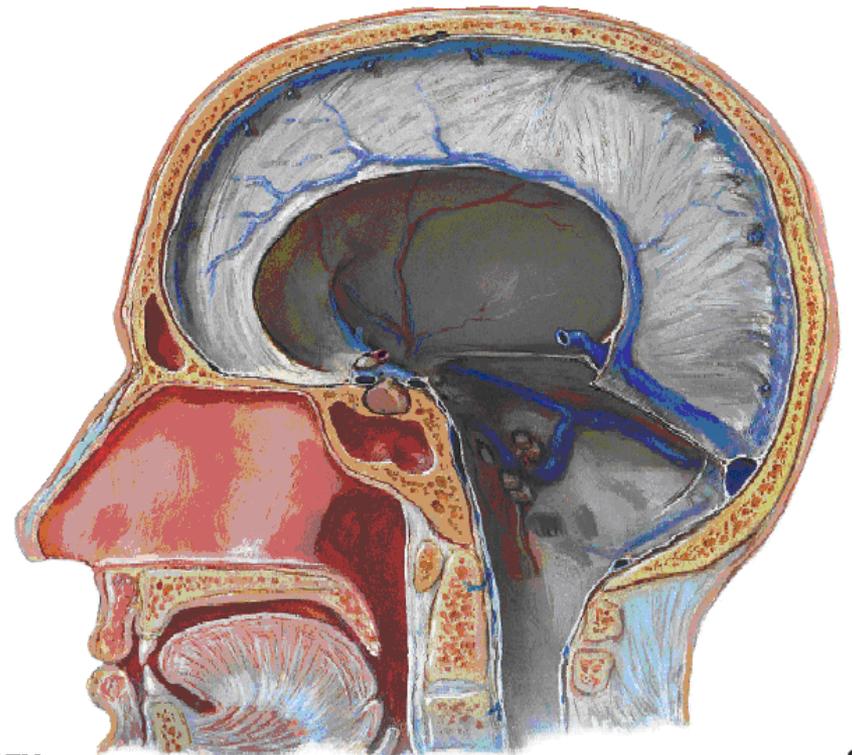
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I. Single Sinuses

* Are present mainly in the median plane.

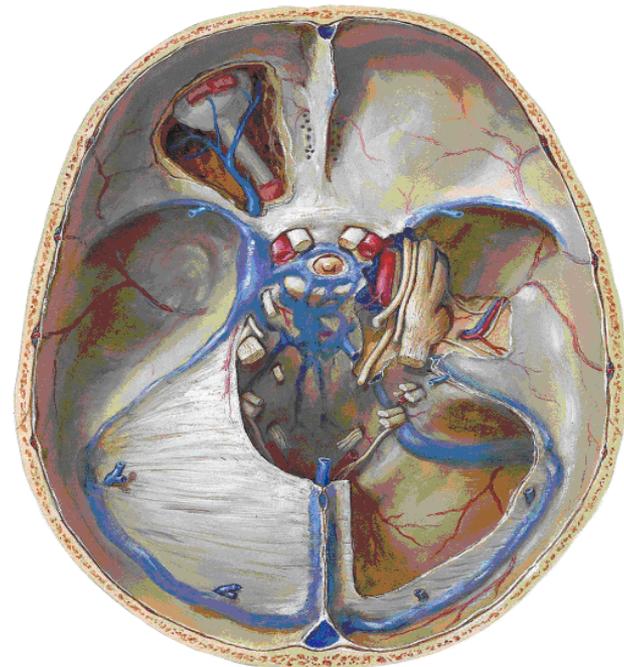
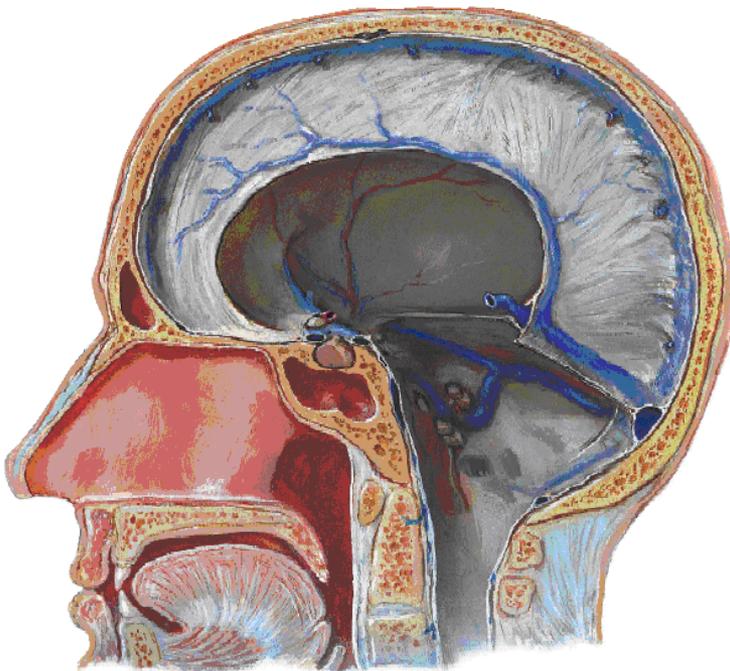
* Include:

1. Superior sagittal S. }
2. Inferior sagittal S. } are related to → **Falx cerebri**
3. Straight S. }
4. Occipital sinus:
is related to → **Falx cerebelli**



1. Superior Sagittal Sinus

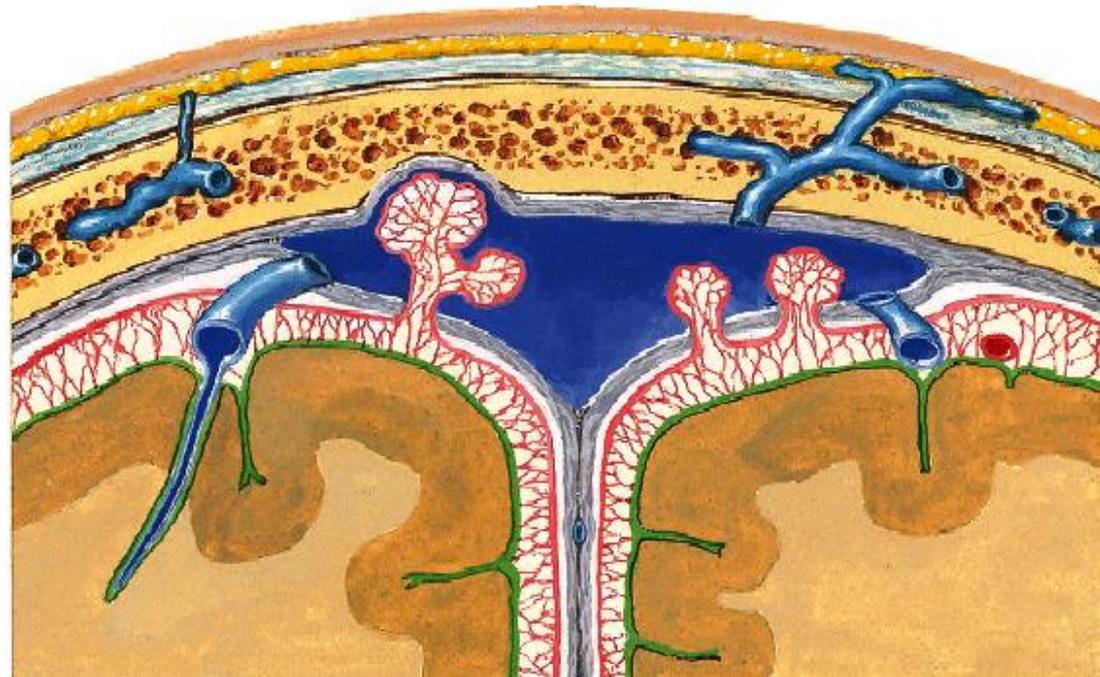
- @ It begins in front of crista galli.
- @ It runs along the upper convex border of the Falx cerebri.
- @ It ends at the internal occipital protuberance by forming the right transverse sinus. However, it may continue as left transverse sinus or may open into the confluence of sinuses at the int. occipital protuberance.

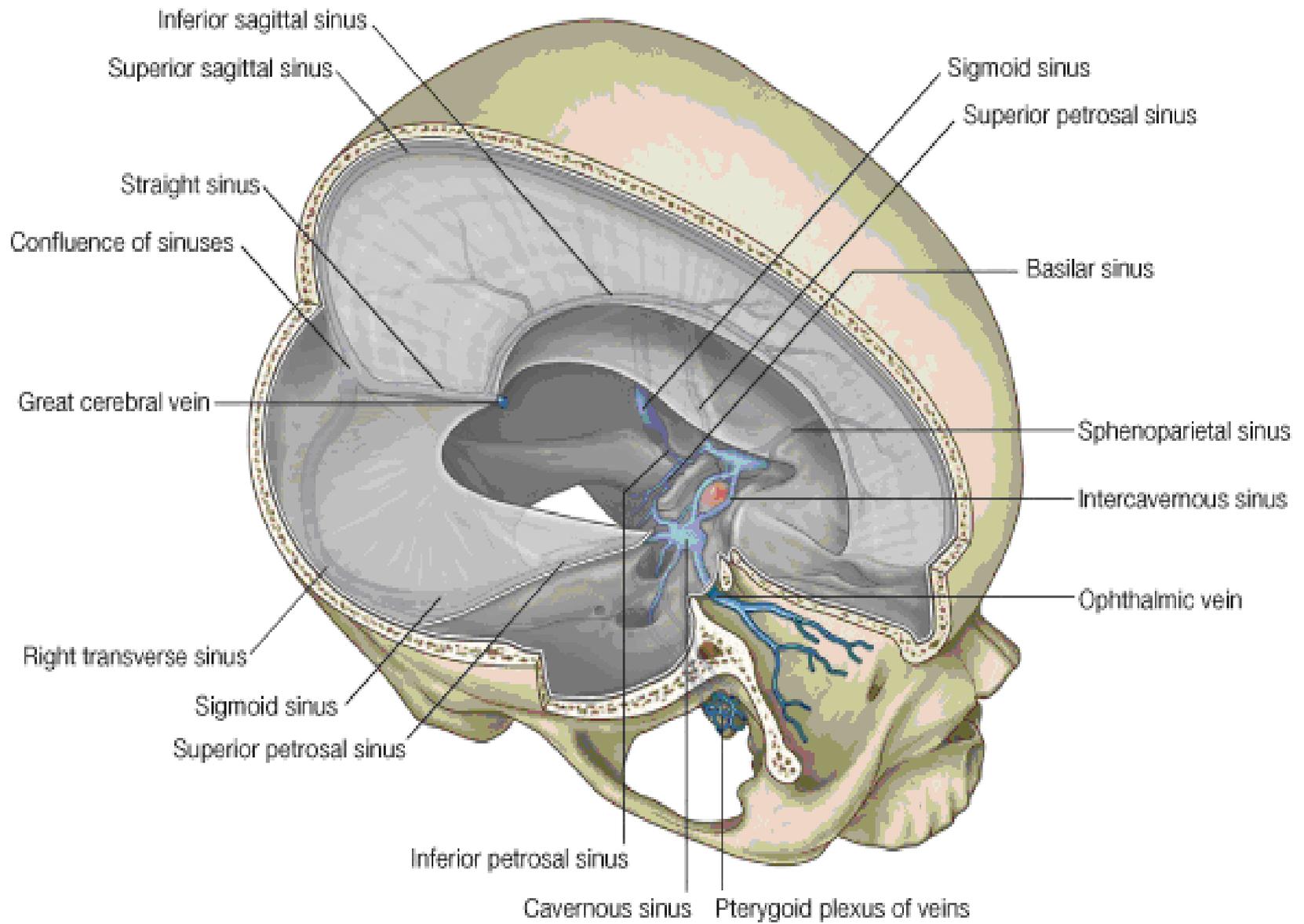


1. Superior Sagittal Sinus (contd)

@ It receives :

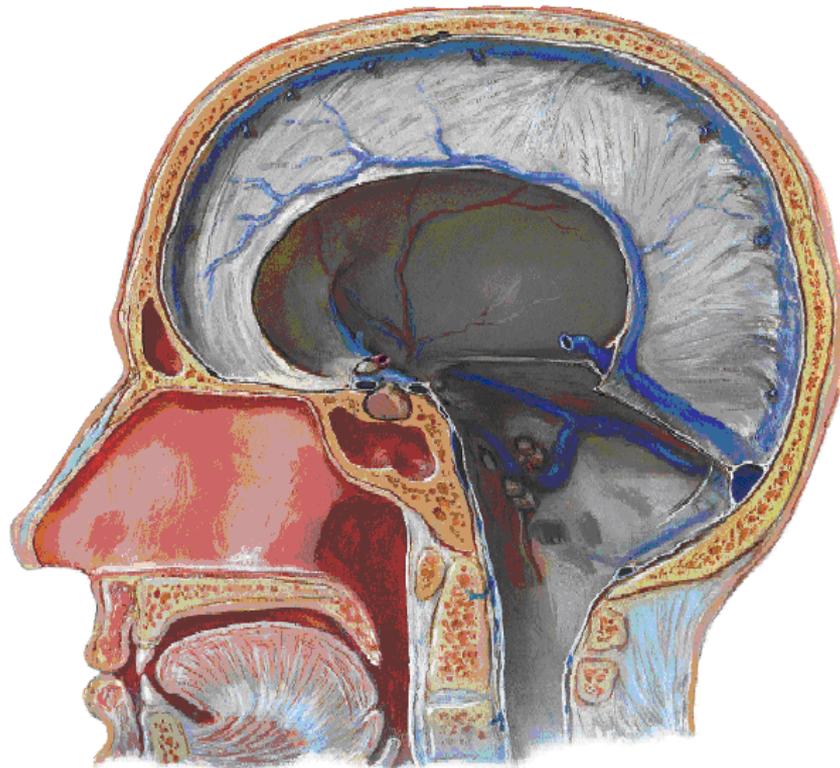
1. sup. cerebral veins.
2. Diploic veins from the skull bones.
3. Emissary veins and meningeal veins.
4. An emissary vein passing through the F. caecum (connecting it with veins of nose or frontal air sinus in 1-2% of people).
5. Arachnoid villi and granulations projecting into the sinus as well as into lacunae (which are 3 dilatations from the sinus





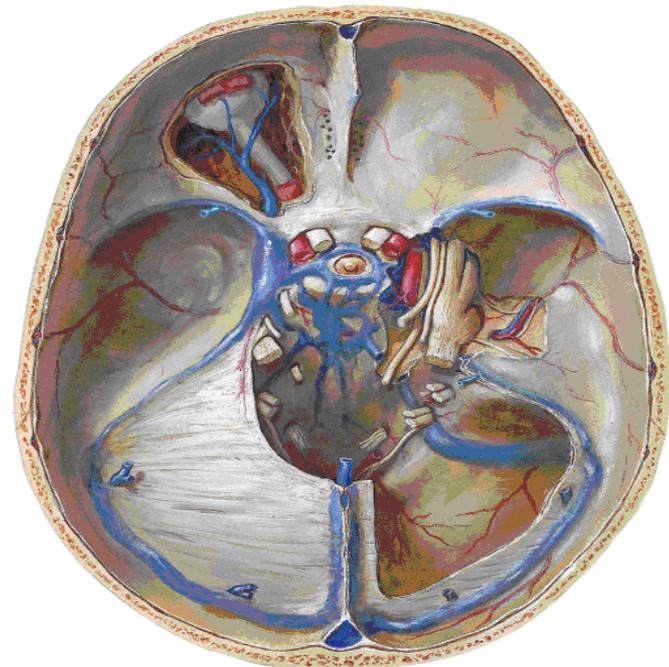
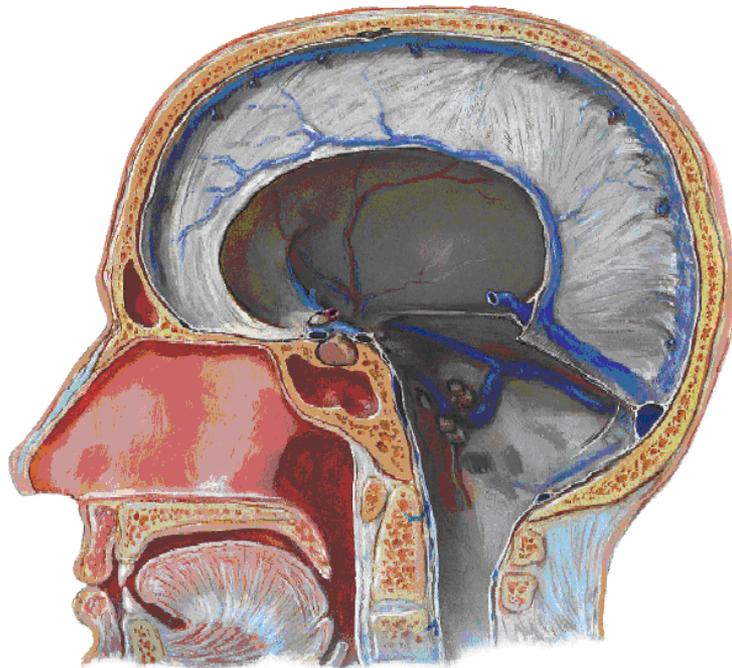
2. Inferior Sagittal Sinus

- @ It runs along the post. 2/3 of the lower free border of the falx cerebri.
- @ It unites with the great cerebral vein to form the straight sinus.



3. Straight Sinus

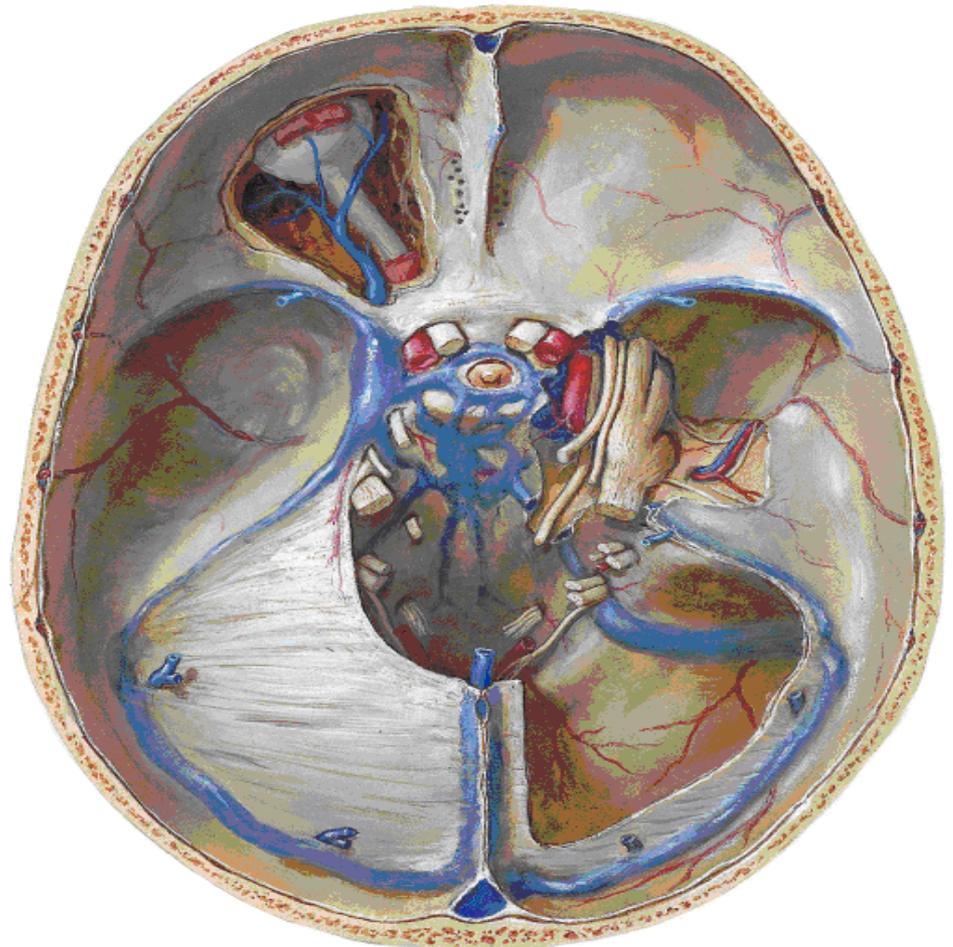
- @ It is formed by the union of the inf. sag. sinus and great cerebral v.
- @ It runs along the line of attachment of the falx cerebri with the tentorium cerebelli.
- @ It ends at the int. occipital protuberance by forming the left transverse sinus.



II. Paired Sinuses

* Are usually peripheral in position & are arranged antero-posteriorly as follows:

- 1- Sphenoparietal
- 2- Cavernous
- 3- Superior petrosal
- 4- Inferior petrosal
- 5- Sigmoid
- 6- Transverse



II. Paired Sinuses

1. Spheno-parietal Sinus:

@ Runs along the free border of the lesser wing of the sphenoid.

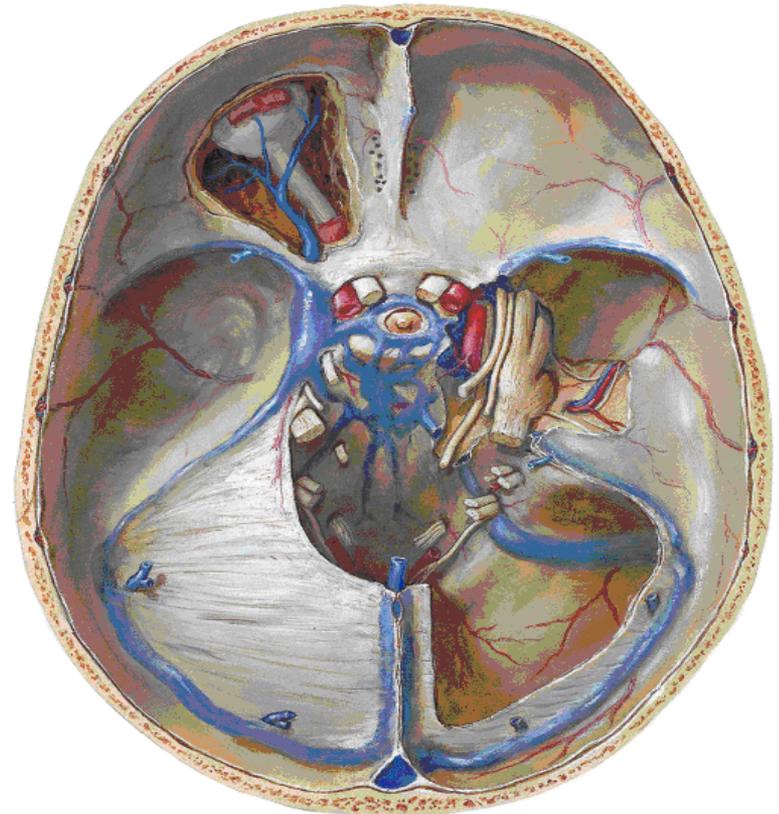
@ Ends in the cavernous sinus.

2. Superior Petrosal Sinus:

@ Begins from the cavernous sinus.

@ Runs along the upper border of the petreous temporal bone (inside the attached margin of the tentorium cerebelli).

@ Ends in the transverse sinus.

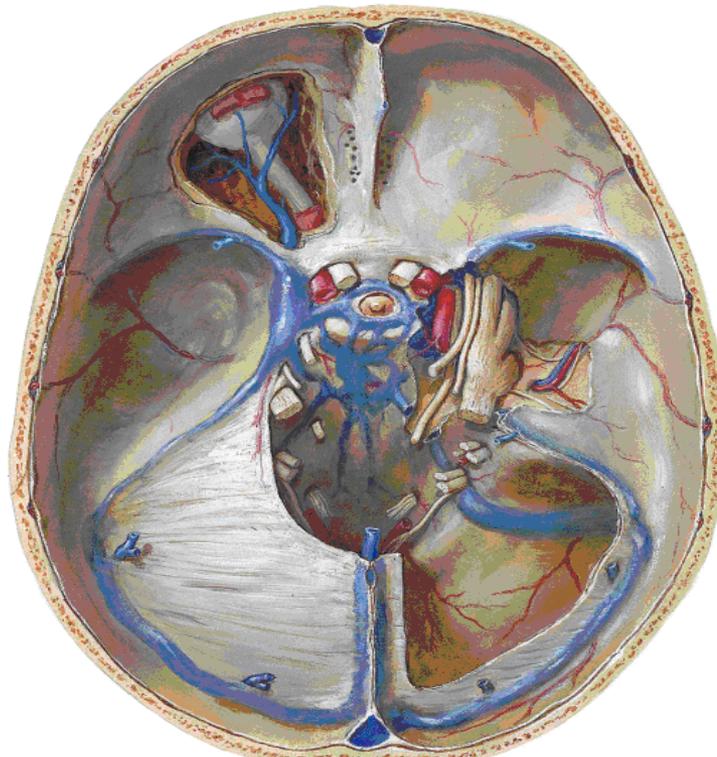


3. Inferior Petrosal Sinus

@ Begins from the cavernous sinus.

@ Runs along the inf. petrosal sulcus (or petro-occipital fissure) and then through the ant. compartment of the jugular foramen.

@ Ends in the internal jugular vein (therefore considered as an emissary vein).



4. Transverse Sinus

@ Begins at the int. occipital protuberance.

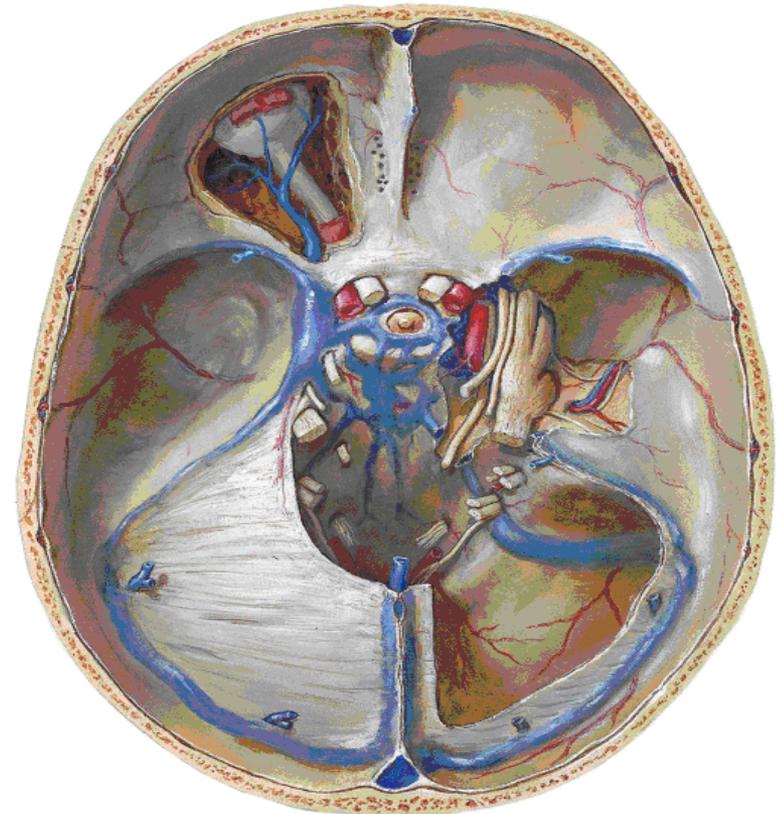
**The Rt. Sinus is the continuation of the sup. sagittal sinus.

**The Lt. sinus is the continuation of the straight sinus.

**N.B.: sometimes the 4 sinuses (i.e. Sup. sag. S. + straight S. + the 2 trans. Sinuses) meet at the confluence of sinuses.

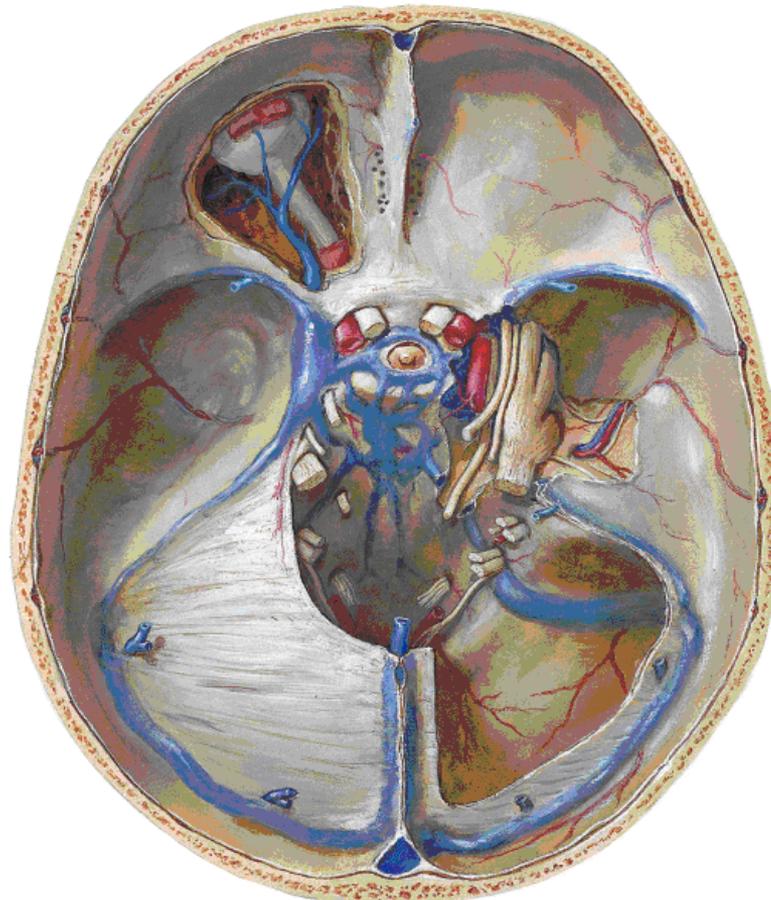
@ Runs along the transverse sulcus (in the attached margin of the tentorium cerebelli).

@ Ends by forming the sigmoid sinus.



5. Sigmoid Sinus

- @ Begins from the transverse sinus.
- @ Runs along the sigmoid sulcus.
- @ Passes through the post. compartment of the jugular F. to form the int. jugular vein.



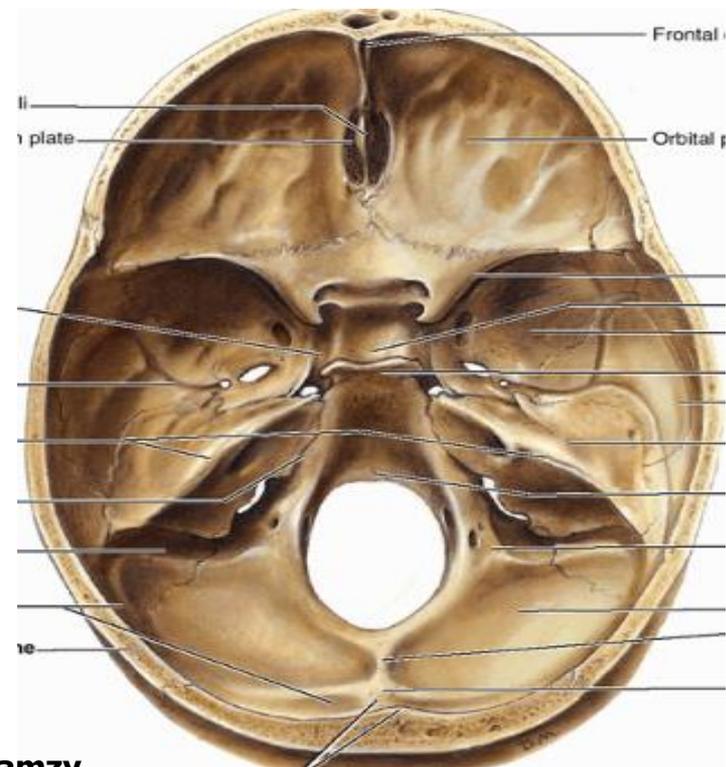
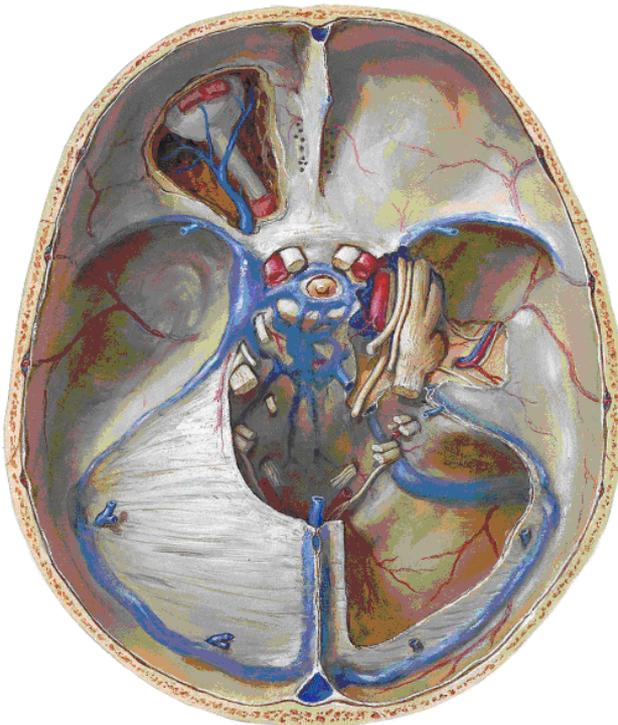
6. Cavernous Sinus

@ **Size** : 2 cm long and 1 cm wide.

@ **Position** : it lies on the side of the body of the sphenoid.

**It extends from the med. end of the sup. orbital fissure to the apex of the petreous temporal bone.

**It is divided by trabeculae into spaces (caverns). That is why it is called cavernous (spongy).



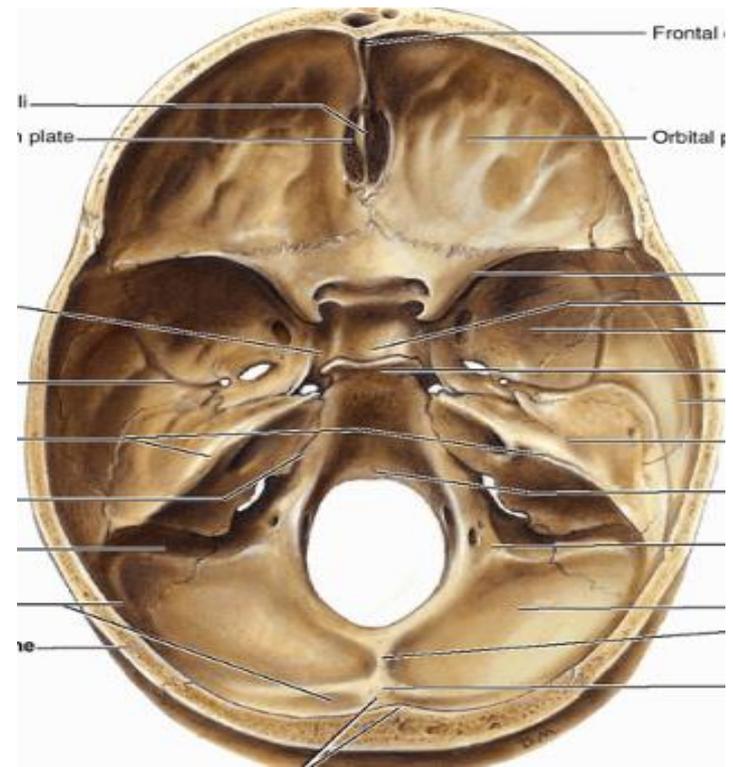
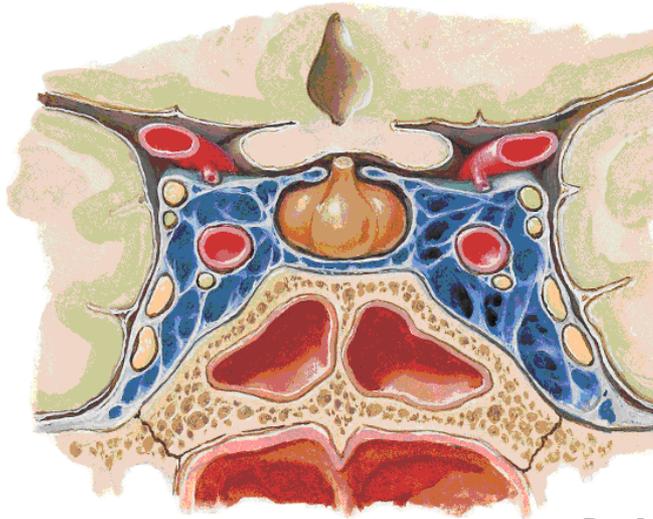
6. Cavernous Sinus (contd)

* Structure: It is formed of the 2 layers of dura mater:

- a) Endosteal dura forms the floor.
- b) Meningeal dura forms its roof, medial & lateral walls.

* Factors controlling passage of blood outside the sinus:

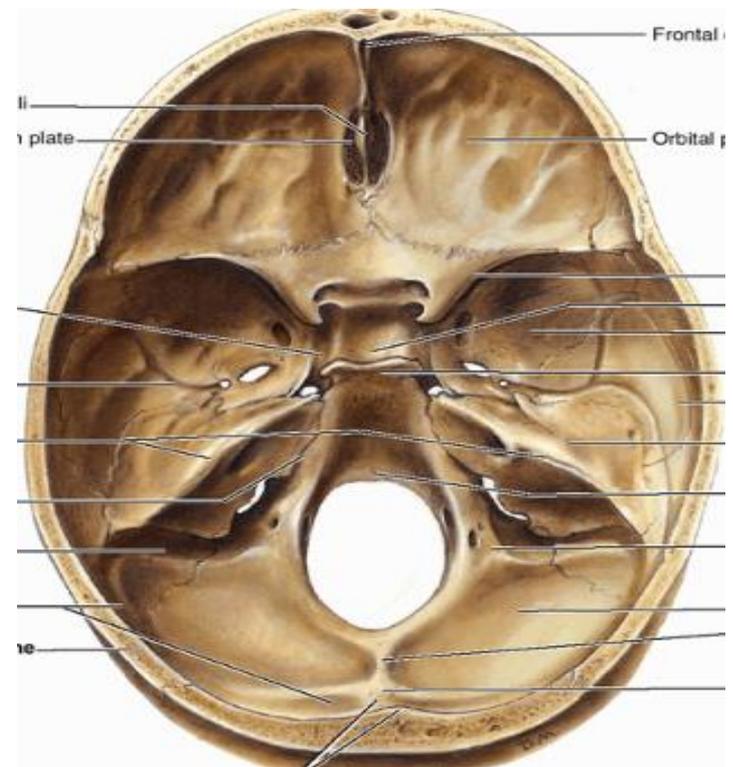
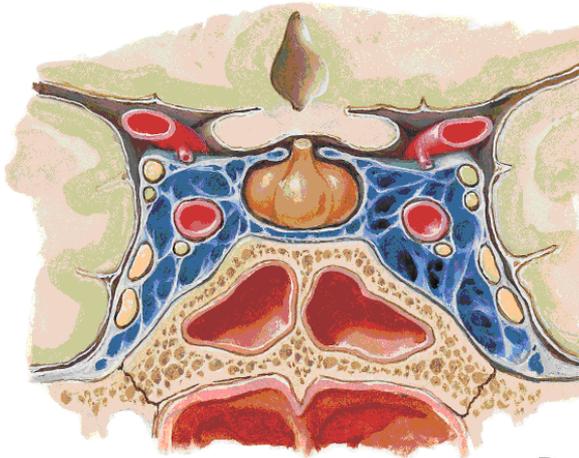
- (a) Expansile pulsations of ICA within the sinus.
- (b) Gravity.
- (c) Position of the head.



6. Cavernous Sinus (contd)

@ External relations :

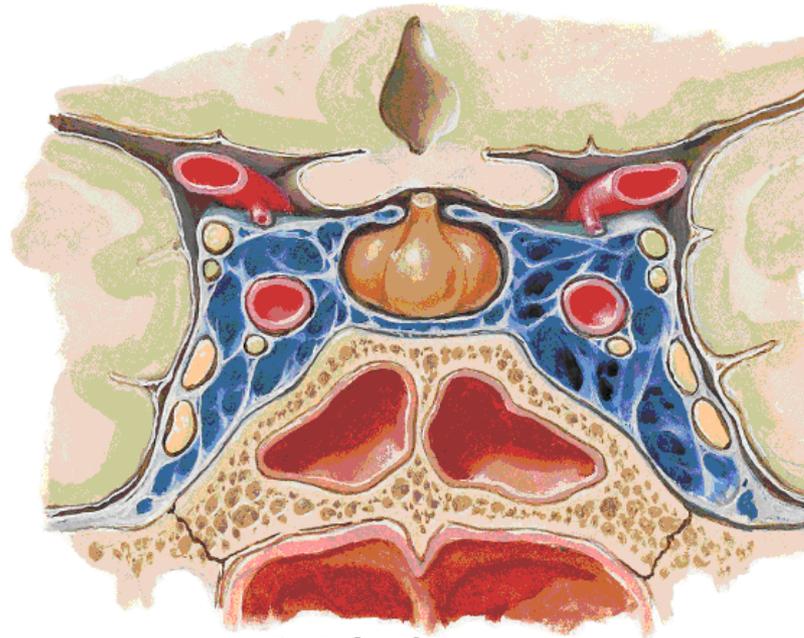
1. **Anteriorly:** Superior orbital fissure & the apex of orbit.
2. **Posteriorly:** Apex of petrous temporal bone & crus cerebri of midbrain.
3. **Medially:** Pituitary gland & sphenoidal air sinus.
4. **Laterally:** Temporal lobe.
5. **Superiorly:** Optic tract & I.CA.
6. **Inferiorly:** Foramen lacerum.



6. Cavernous Sinus (contd)

* Structures in the lateral wall of the sinus from above downwards (OTOM):

1. **Oculomotor N.:** In its ant. part, it divides into its 2 divisions.
2. **Trochlear N.**
3. **Ophthalmic N.:** In its ant. part, it divides into its 3 divisions.
4. **Maxillary nerve:** leaves the sinus through foramen rotundum.

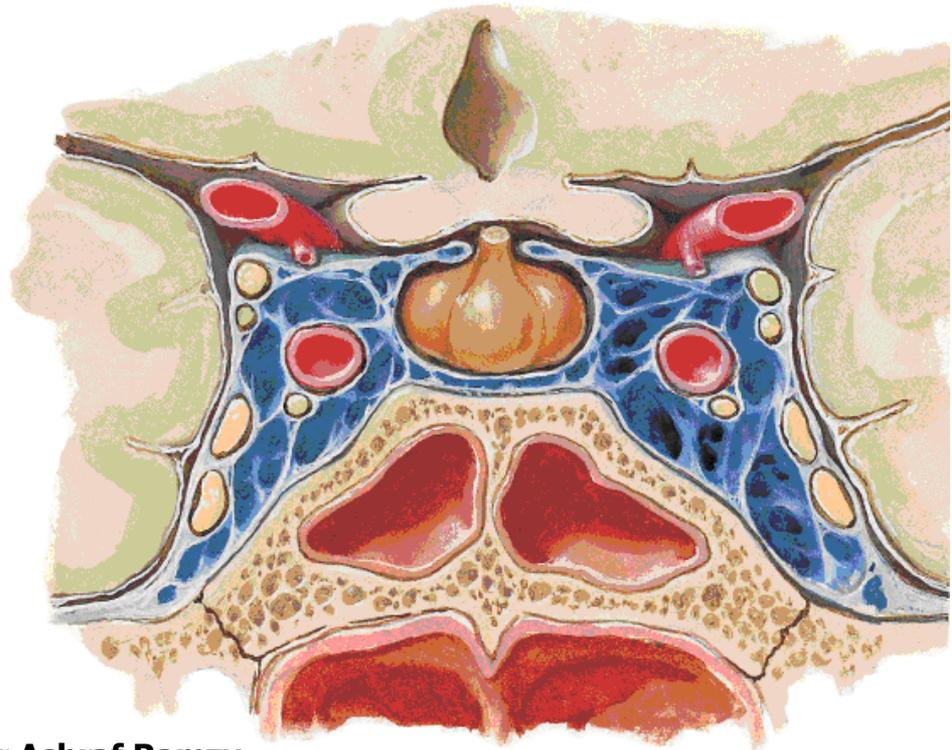


6. Cavernous Sinus (contd)

* Structures passing through the sinus:

1. Int. Carotid A. (with its sympathetic plexus).
2. Abducent nerve (inferolateral to the artery).

* N.B.: The structures in the lateral wall & center of the sinus are separated from the blood by the endothelial lining of the sinus.



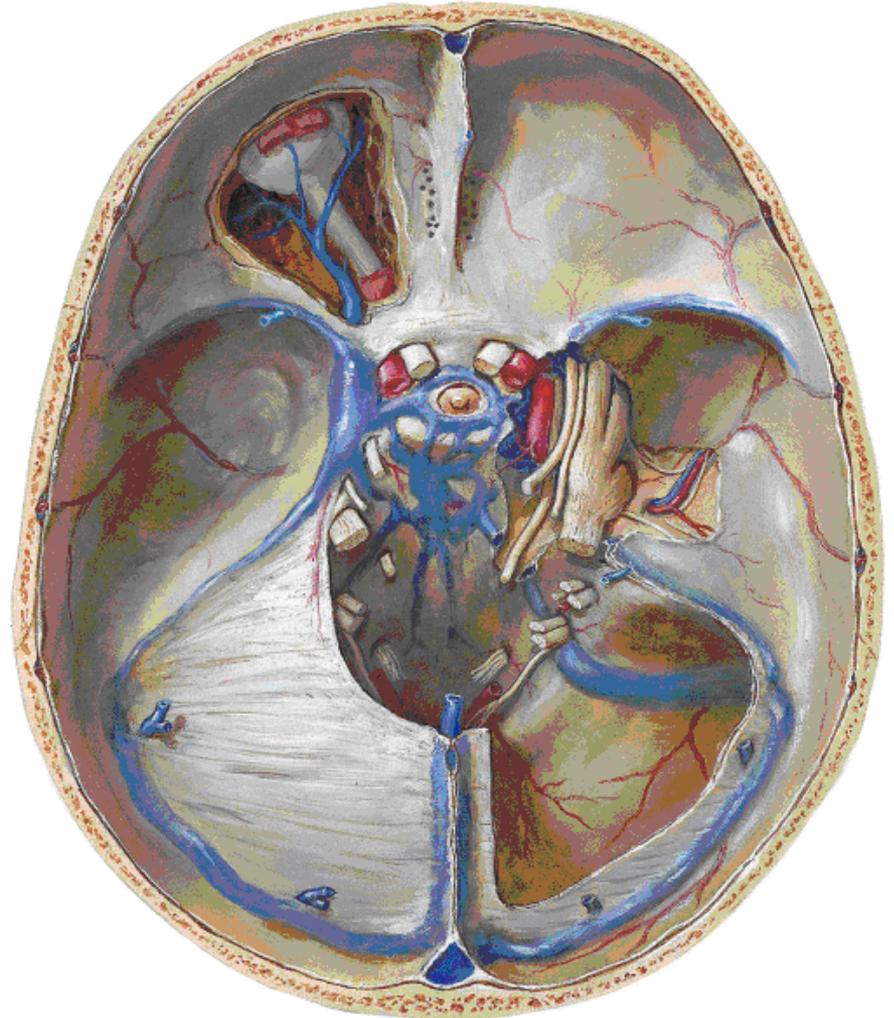
@ Tributaries and Communications.

** Anteriorly :

- * Ophthalmic veins.
- * Central retinal vein.
- * Spheno-parietal sinus.

** Posteriorly :

- * Sup. and inf. petrosal sinuses (considered as the drainage of the sinus).



@ Tributaries and Communications.

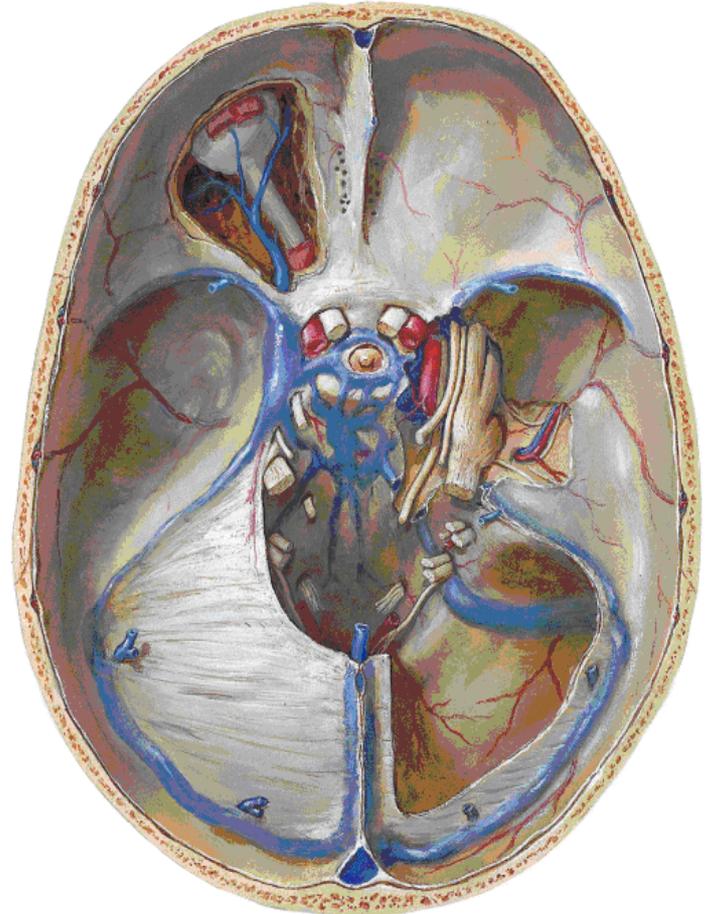
** Medially:

- * Intercavernous sinuses.
- * Veins from pituitary gland.

** Superiorly:

- * Superficial middle cerebral vein.
- * Inf. cerebral veins.

** Inferiorly: Emissary veins of cavernous sinus (connecting it with pterygoid plexus of veins)



Tributaries of Cavernous Sinus

A. From the orbit:

1. Superior ophthalmic vein
2. Inferior ophthalmic vein
3. Central vein of retina.

B. From the brain:

1. Superficial middle cerebral vein.
2. Inferior cerebral vs. from temporal lobe.

C. From the meninges:

1. Sphenoparietal sinus.
2. Frontal trunk of middle meningeal vein.

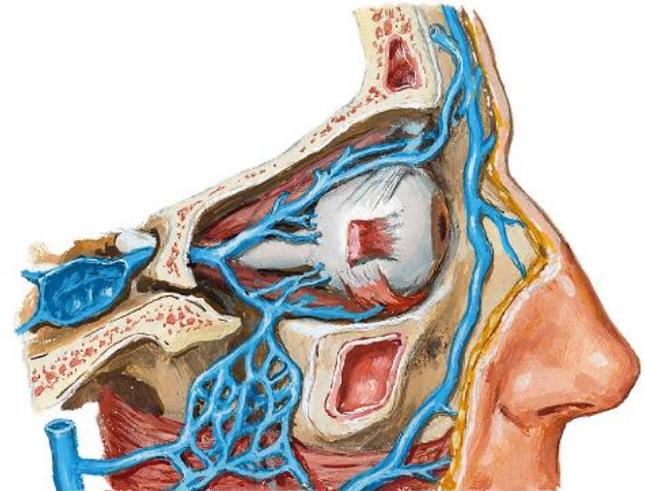
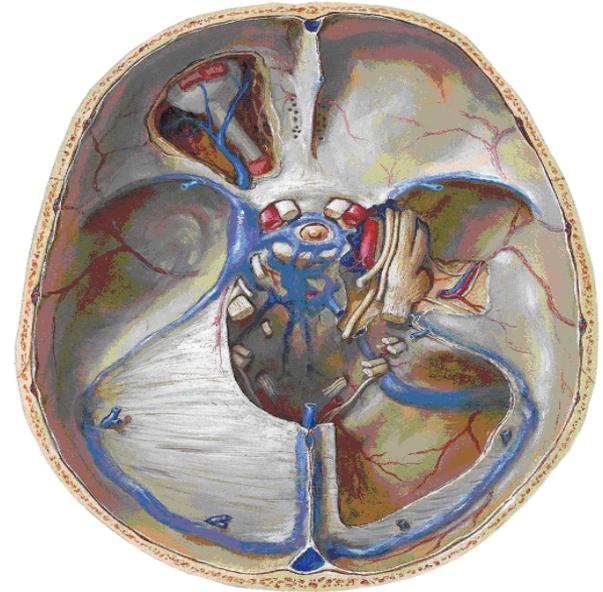
**** Drainage:** The cavernous sinus drains into:

1. Superior petrosal sinus → Transverse sinus.
2. Inferior petrosal sinus → IJV.

**** Communications with:**

1. Pterygoid venous plexus via emissary vs.
2. Facial v. via superior ophthalmic v.
3. Its fellow on the opposite side via the 3 intercavernous sinuses.

**** N.B.:** All these communications are valveless and allow blood flow in either direction.



@ Applied Anatomy : Dangerous area of face

1. Thrombosis of cavernous sinus: Is caused by spread of infection from the dangerous area of face.

* This affects cranial nerves III, IV & VI.

2. Carotid-cavernous sinus fistula: An arterio-venous communication resulting from head injuries; or rupture of aneurysm of ICA into the cavernous sinus, leading to unilateral pulsating exophthalmos.

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