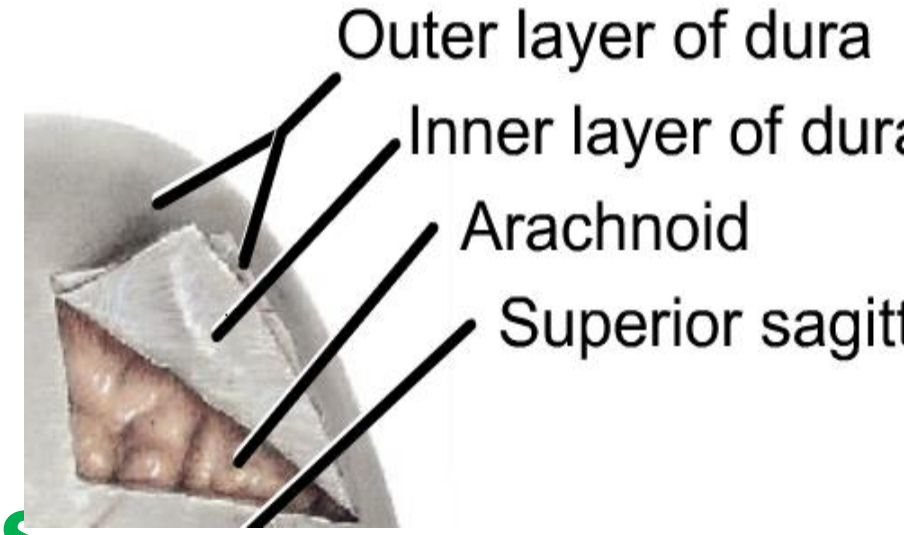
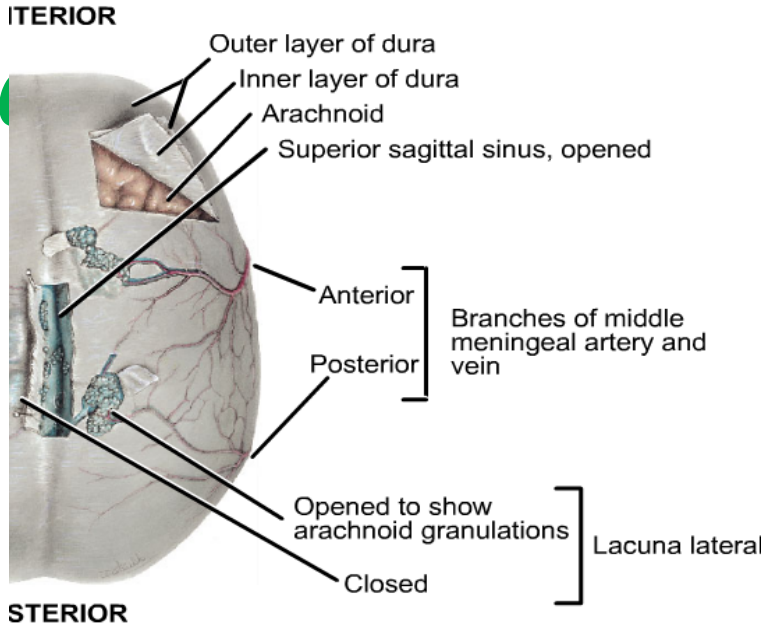
Meninges

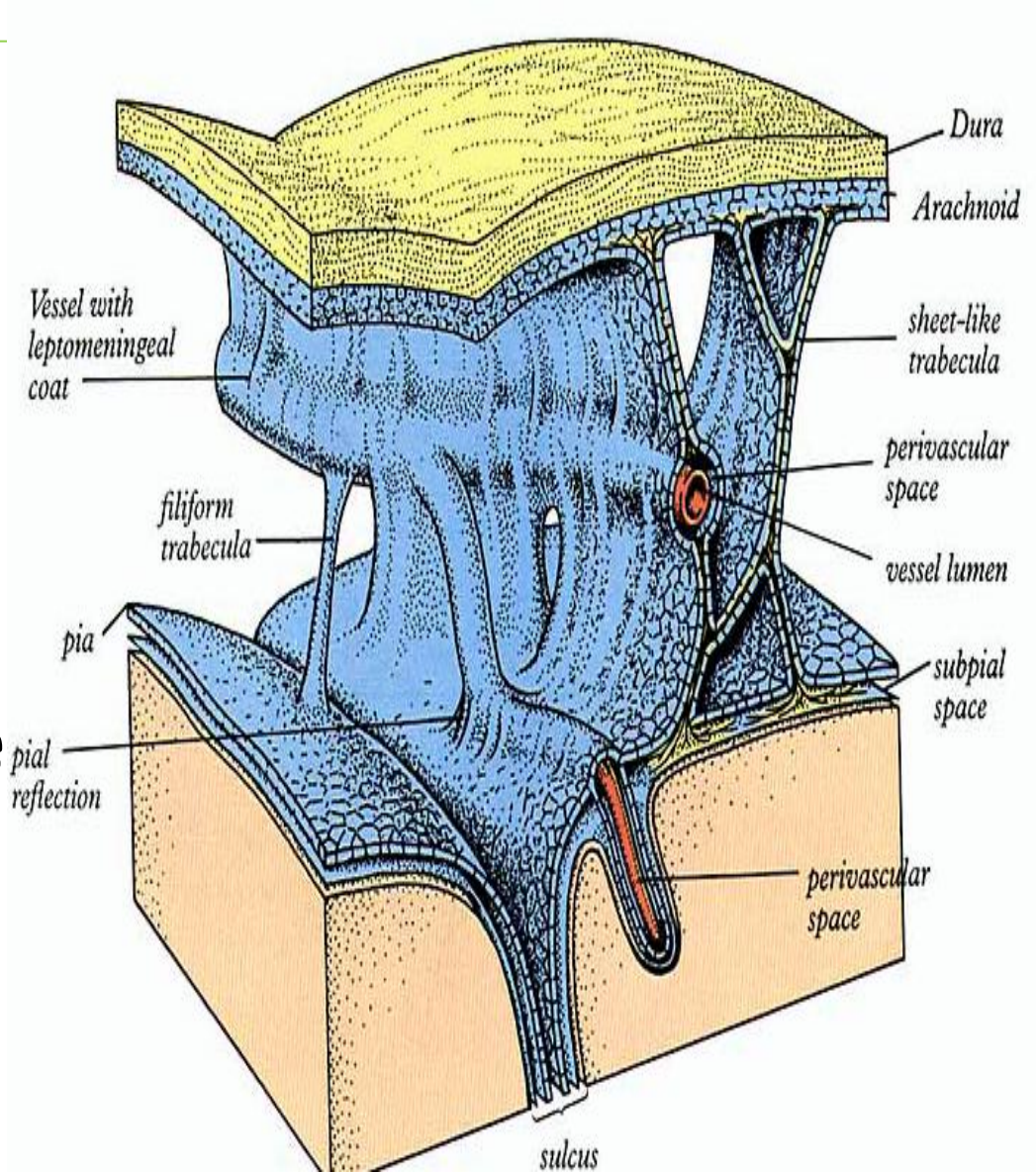
- ***The brain and spinal cord are enveloped by three membranes (meninges).***
- ***From without inwar***
  - ***dura mater (pachymenix)***
  - ***arachnoid mater and pia mater (leptomeninges)***





Pachymeninx—Dura Mater

- thick dense inelastic membrane
- most external.
- The cranial and spinal dura (meningeal) mater are continuous with each other at the foramen magnum.



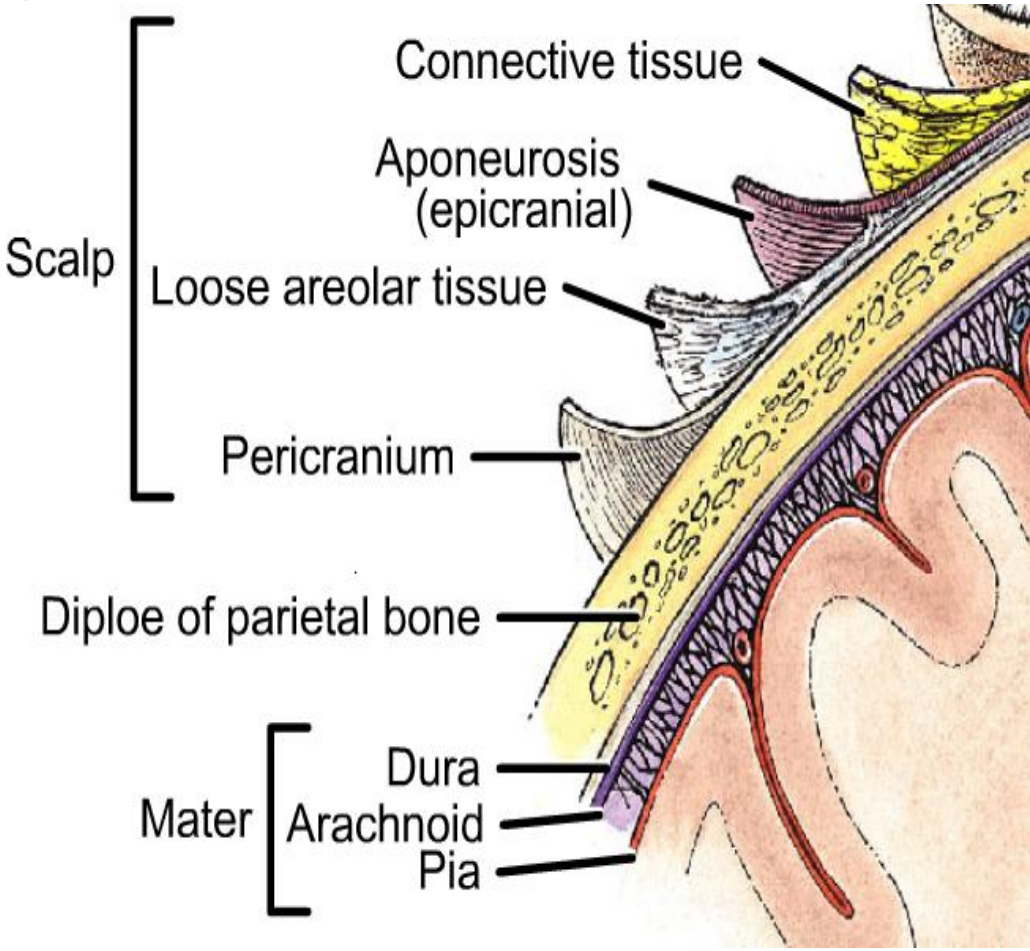
Cranial Dura Mater

- *lines the cranial cavity.*
  - ❑ *an inner or meningeal layer*
  - ❑ *outer or endosteal layer.*

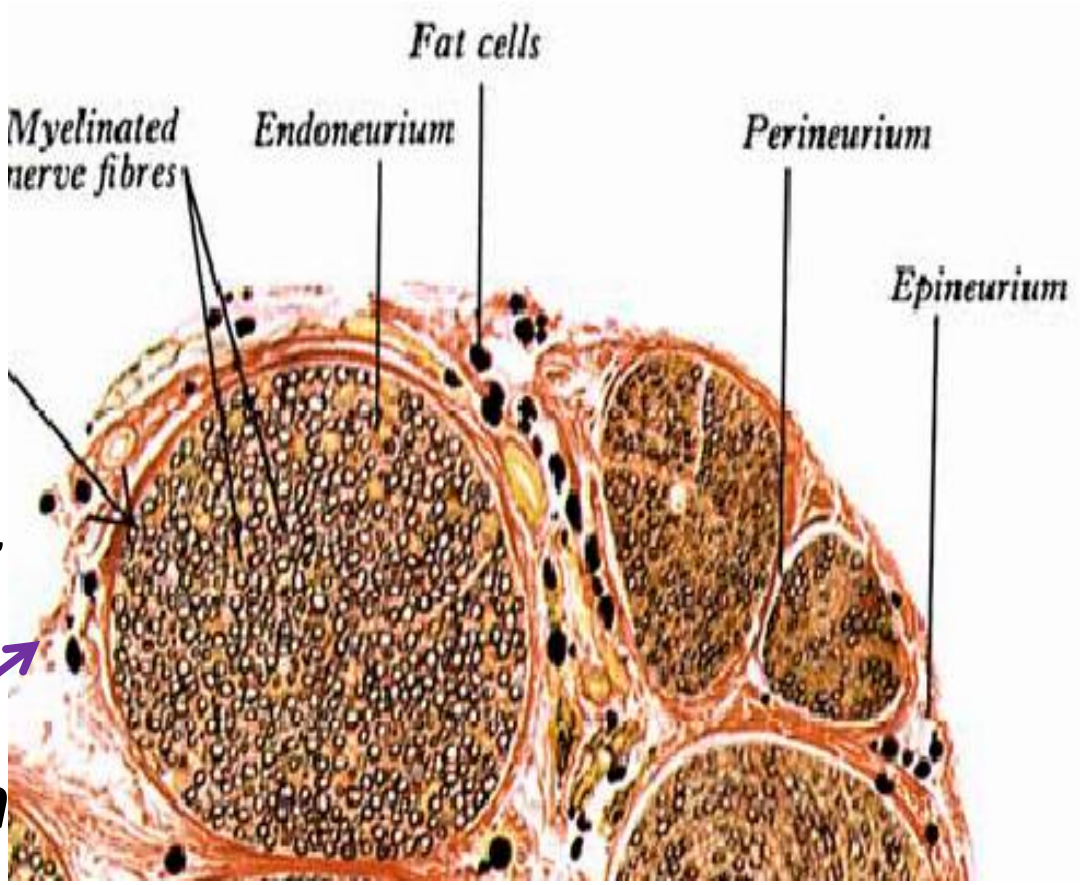
  These two layers are united except where they separate to enclose
  - ❑ *venous sinuses .*
  - ❑ *Pituitary gland*
  - ❑ *Meningeal vessels*
  - ❑ *Trigeminal ganglia*
- *Dura mater adheres to the internal surfaces of the cranial bones and blood vessels and fibrous bands pass from it into the bones.*

- ***Adhesion of the dura to bone is firmest at the sutures, the cranial base and around the foramen magnum.***
- ***With increasing age, the dura becomes thicker, less pliable and more firmly adherent to the inner surface of the skull, particularly of the calvarium (القحف).***
- ***Vessels and fibrous bands connecting the dura mater to the skull are torn across when the dura is detached from the bone so the outer surface of the dura is rough and fibrillated, whereas the inner surface of the dura is smooth***

- ***The endosteal layer of the dura is continuous through the cranial sutures and foramina with the pericranium and through the superior orbital fissure with the orbital periosteum.***

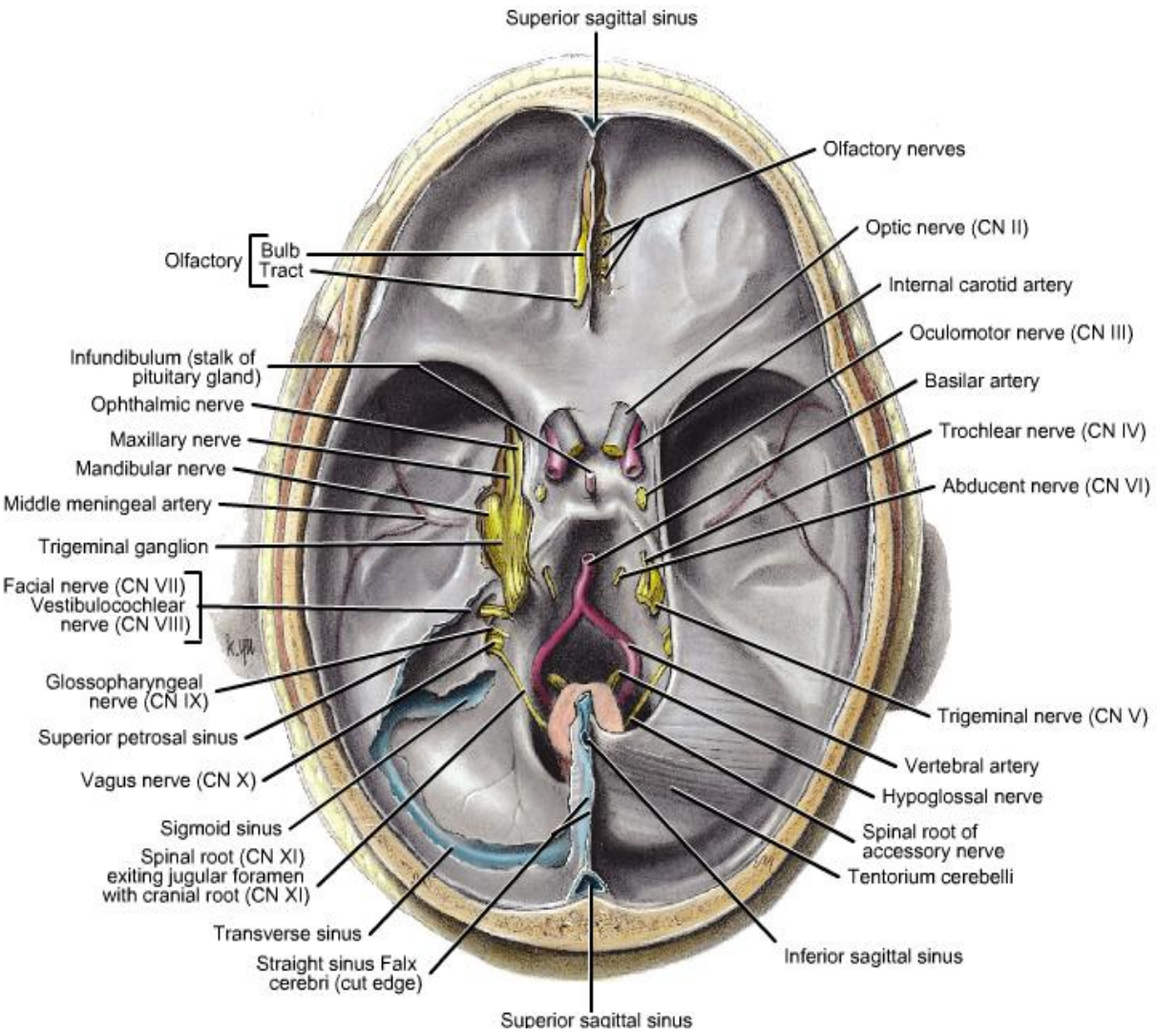


- ***The meningeal layer provides tubular sheaths for the cranial nerves as they pass out the cranial foramina; these sheaths fuse with the epineurium as nerves emerge from the skull.***

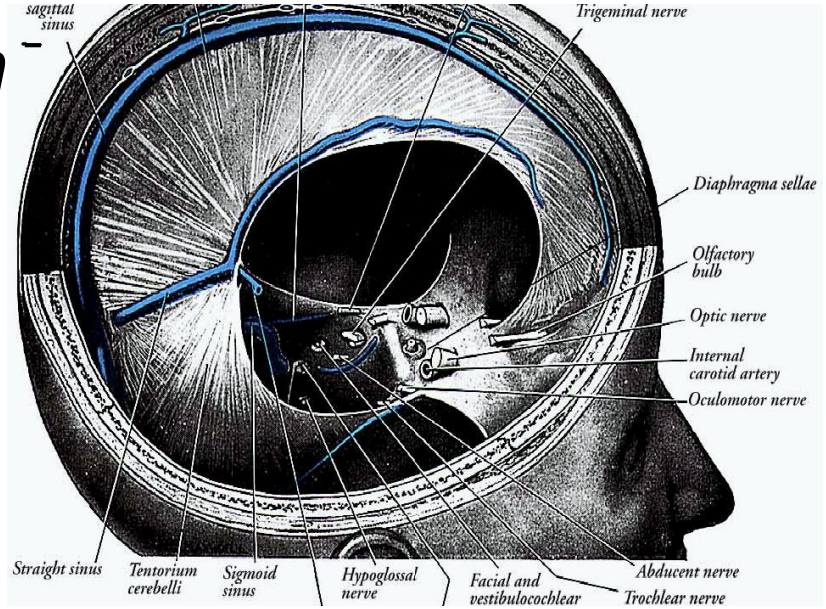


- ***The dural sheath of the optic nerve is continuous with the ocular sclera .***
- ***The meningeal***

layer of the dura is fo
inwards as four
septa
(as falx cerebra and
falx cerebelli) that
partially divide the
cranial cavity into
freely communicating
spaces in which
subdivisions of brain
are lodged.

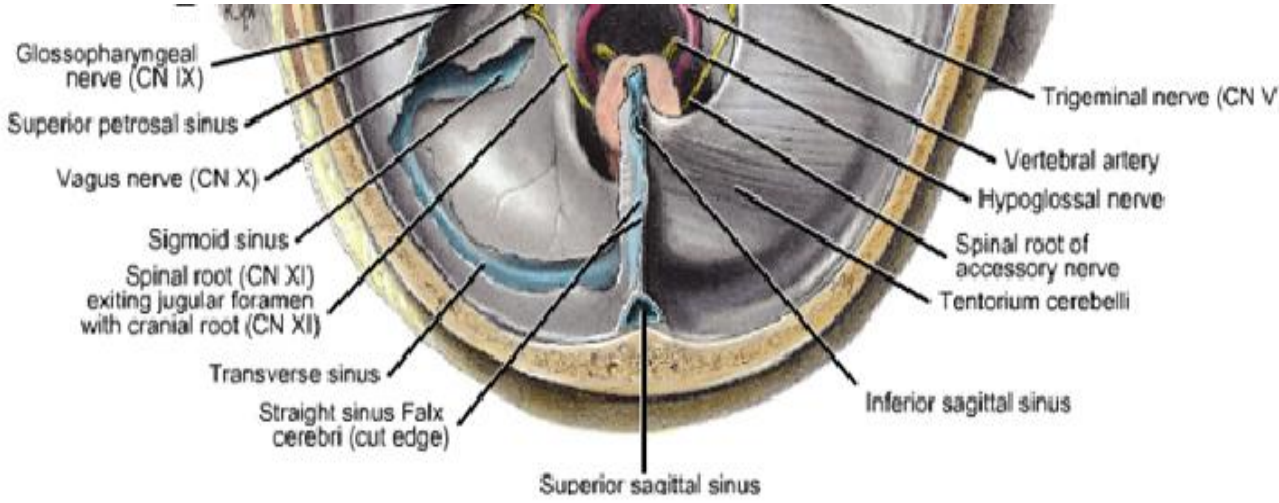


- ***The falx cerebri***
- ***a strong, crescentic sheet***
- ***descending vertically in the longitudinal (sagittal) fissure between the cerebral hemispheres .***
- ***it blends in the midline with the tentorium cerebelli;***
- ***the anterior part is thin an of irregular perforations.***



- ***Its convex upper margin is attached to the internal cranial surface on each side of the midline, as far back as the internal occipital protuberance;***
- ***the superior sagittal sinus runs along this margin.***
- ***lower edge, is free and concave and contains the inferior sagittal sinus;***
- ***the straight sinus***

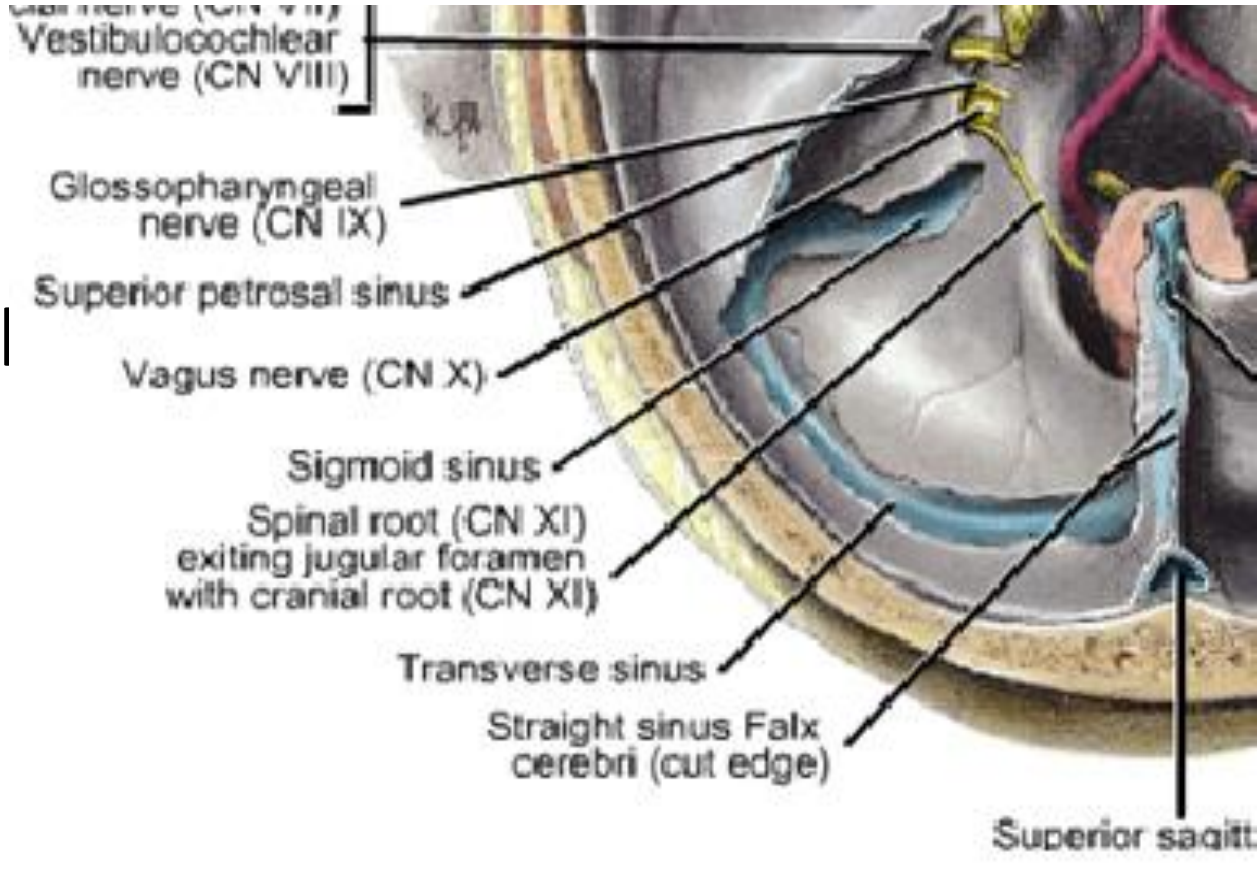
runs along its attachment to the tentorium cerebelli .

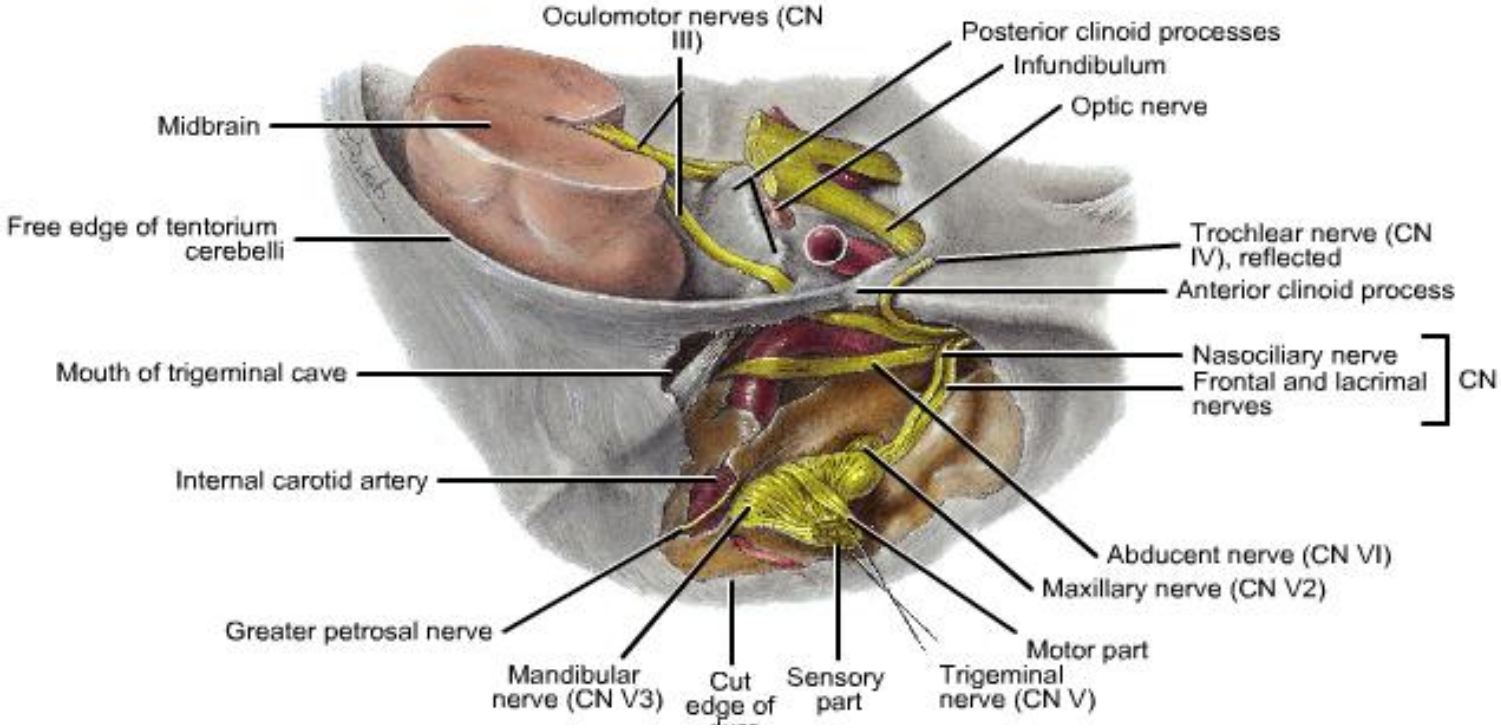


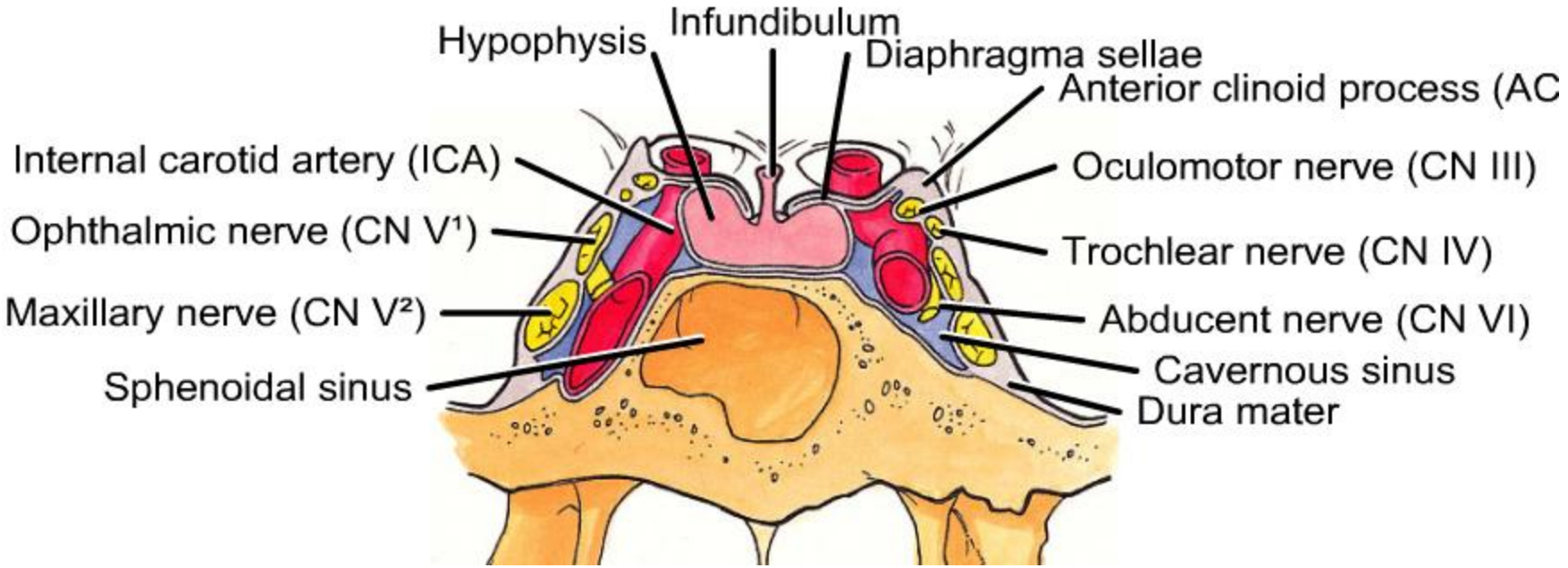
- (2) The tentorium cerebelli
- crescentic, sheet of dura mater covering the cerebellum and passing under the occipital lobes
- anterior edge is concave : free between it and the dorsum sellae of the sphenoid bone; is a large hiatus of the tentorium cerebelli (or tentorial incisure), occupied by the midbrain and the anterior part of the superior aspect of the cerebellar vermis

- The convex outer limit of the tentorium cerebelli is encloses the transverse sinuses; where it contains
- the superior petrosal sinuses ;in its anterio-lateral border ,

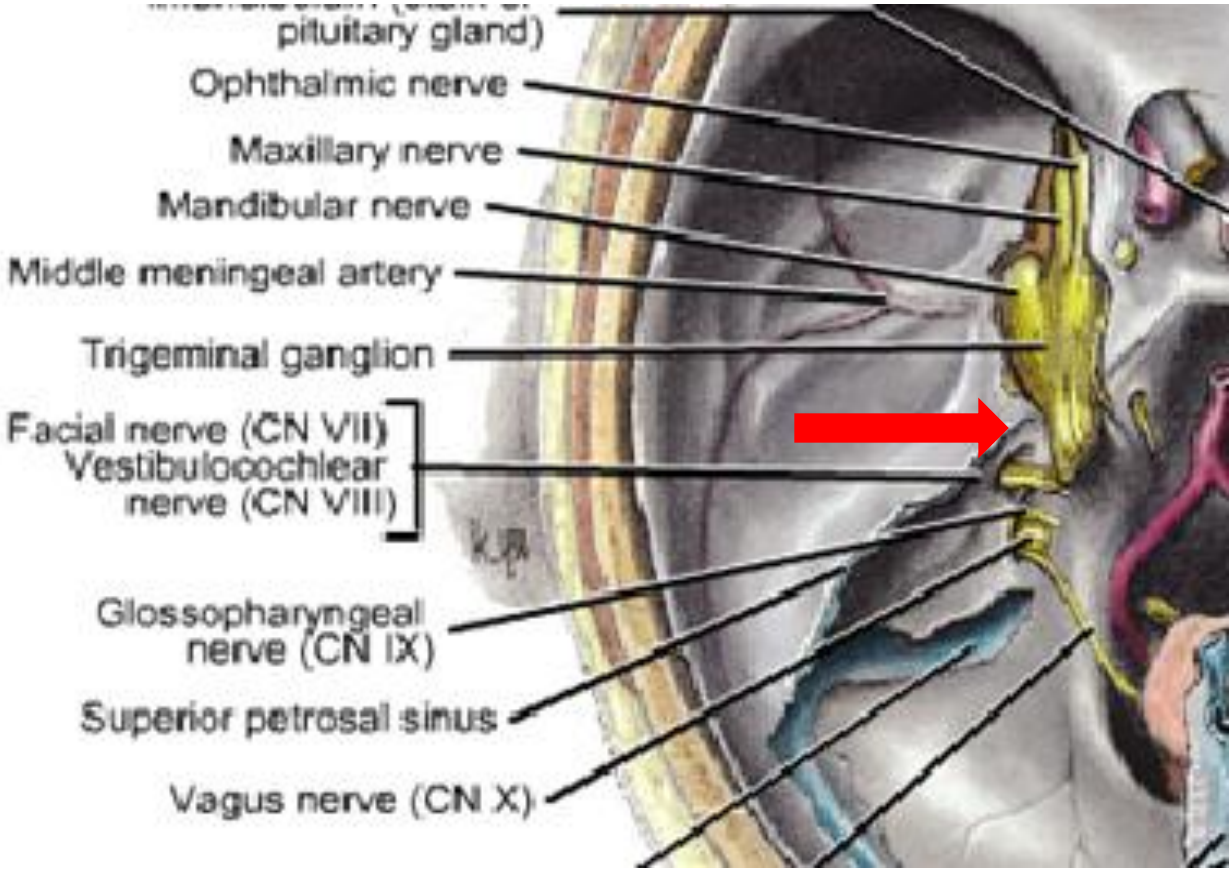
to the superior borders of the petrous temporal bones.




Oculomotor nerves (CN III)
Posterior clinoid processes
Infundibulum
Optic nerve
Midbrain
Free edge of tentorium cerebelli
Trochlear nerve (CN IV), reflected
Anterior clinoid process
Mouth of trigeminal cave
Nasociliary nerve
Frontal and lacrimal nerves
CN
Internal carotid artery
Abducent nerve (CN VI)
Maxillary nerve (CN V2)
Greater petrosal nerve
Motor part
Mandibular nerve (CN V3)
Cut edge of
Sensory part
Trigeminal nerve (CN V)

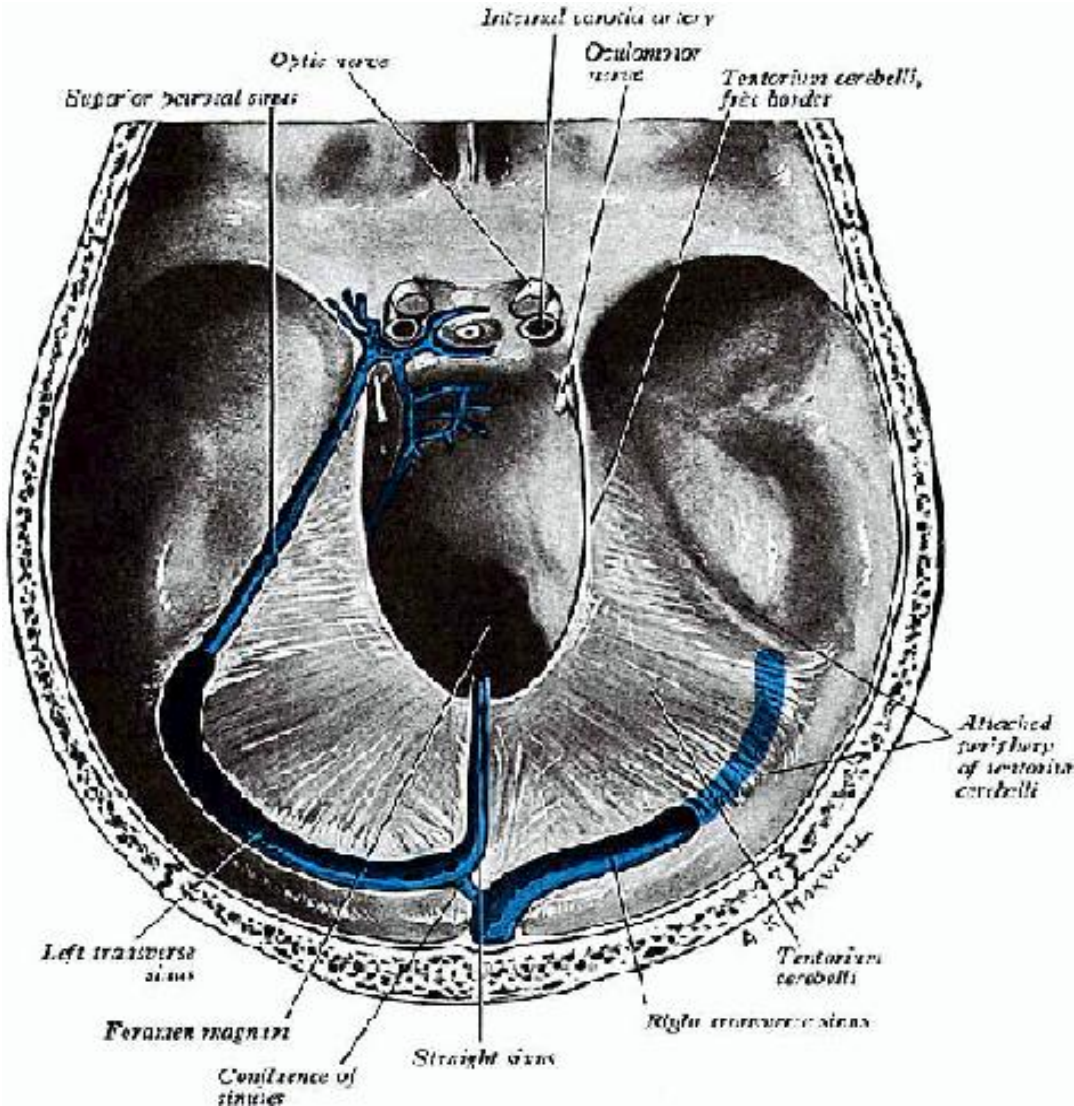

Hypophysis
Infundibulum
Diaphragma sellae
Anterior clinoid process (AC
Internal carotid artery (ICA)
Oculomotor nerve (CN III)
Ophthalmic nerve (CN V¹)
Trochlear nerve (CN IV)
Maxillary nerve (CN V²)
Abducent nerve (CN VI)
Cavernous sinus
Sphenoidal sinus
Dura mater

- Near the apex of the petrous temporal bone, the lower layer of the tentorium is ***evaginated anteriolaterally under the superior petrosal*** sinus to form a recess between the endosteal and meningeal layers in the middle cranial fossa. This recess is the trigeminal cave containing the roots and ganglion of the trigeminal nerve

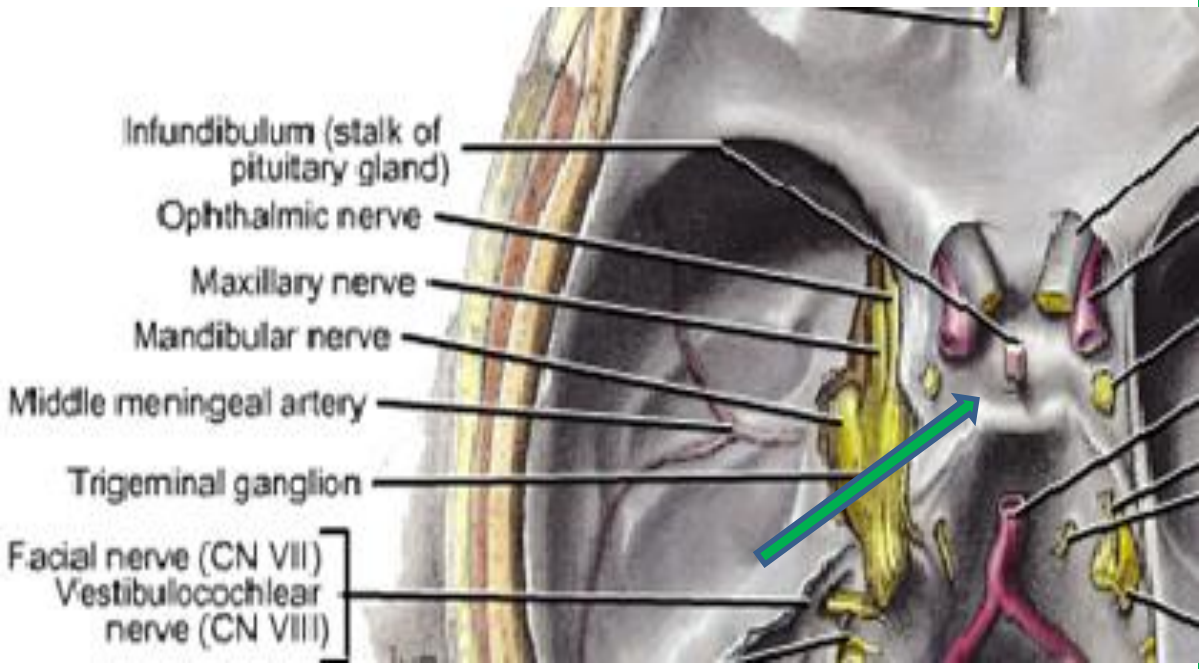


- the anterior ends of the free border are fixed to the anterior clinoid processes and
- the periphery attached to the posterior clinoid processes. In the groove between them, lies the oculomotor nerve

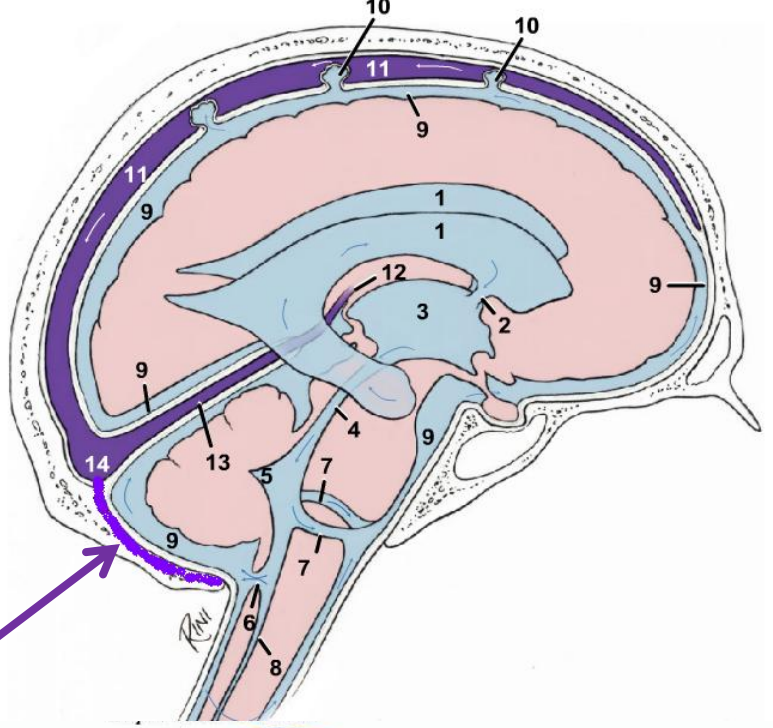
Tentorium cerebeli

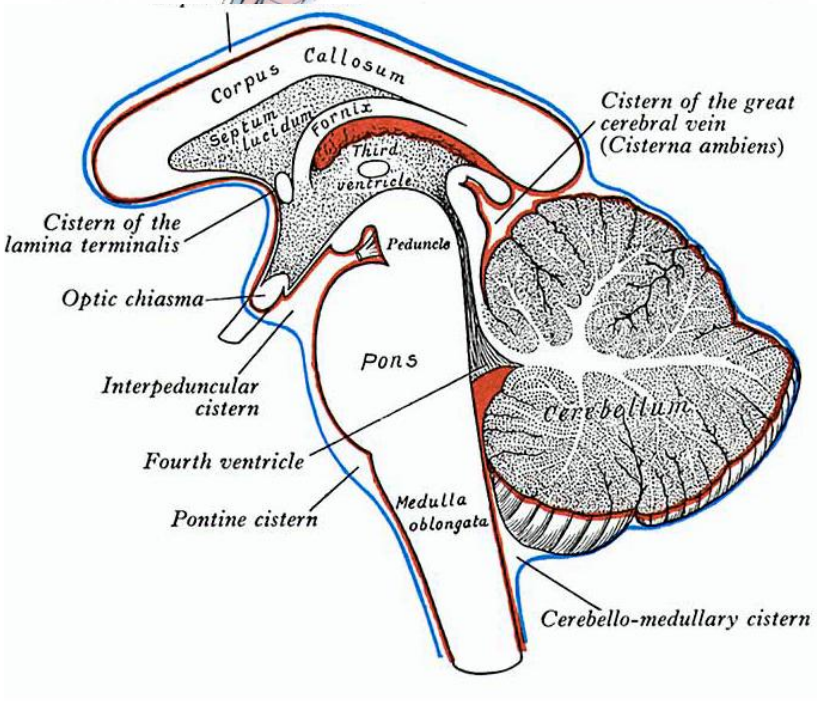


- ***(4) Diaphragma sellae***
- small, circular, horizontal sheet of dura mater which forms a ***roof*** to the sella turcica and, in many cases, almost completely covers the hypophysis (pituitary).
- The central opening in the diaphragma allows the infundibulum and pituitary stalk to pass into the pituitary fossa.
- The diaphragma has become an important surgical structure with the increase in in transphenoidal hypophysectomies.



- ***(3) The falx cerebelli :-***
- small crescentic fold below the tentorium cerebelli, which projects forward into the posterior cerebellar notch.
- its posterior margin is attached to the internal occipital crest and contains the ***occipital sinus***;
- its apex frequently divides into two small folds which disappear at the sides of the foramen magnum





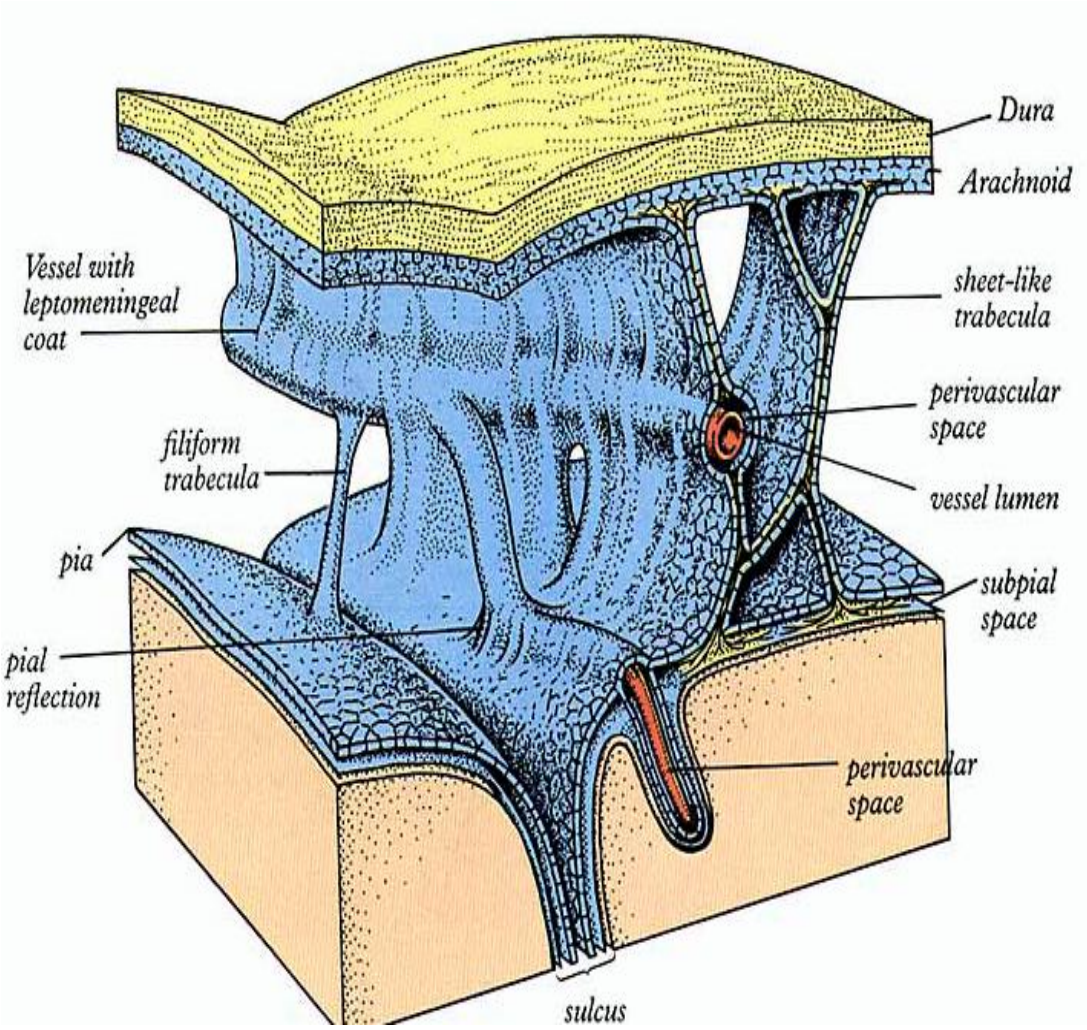
The arrangement of the dura

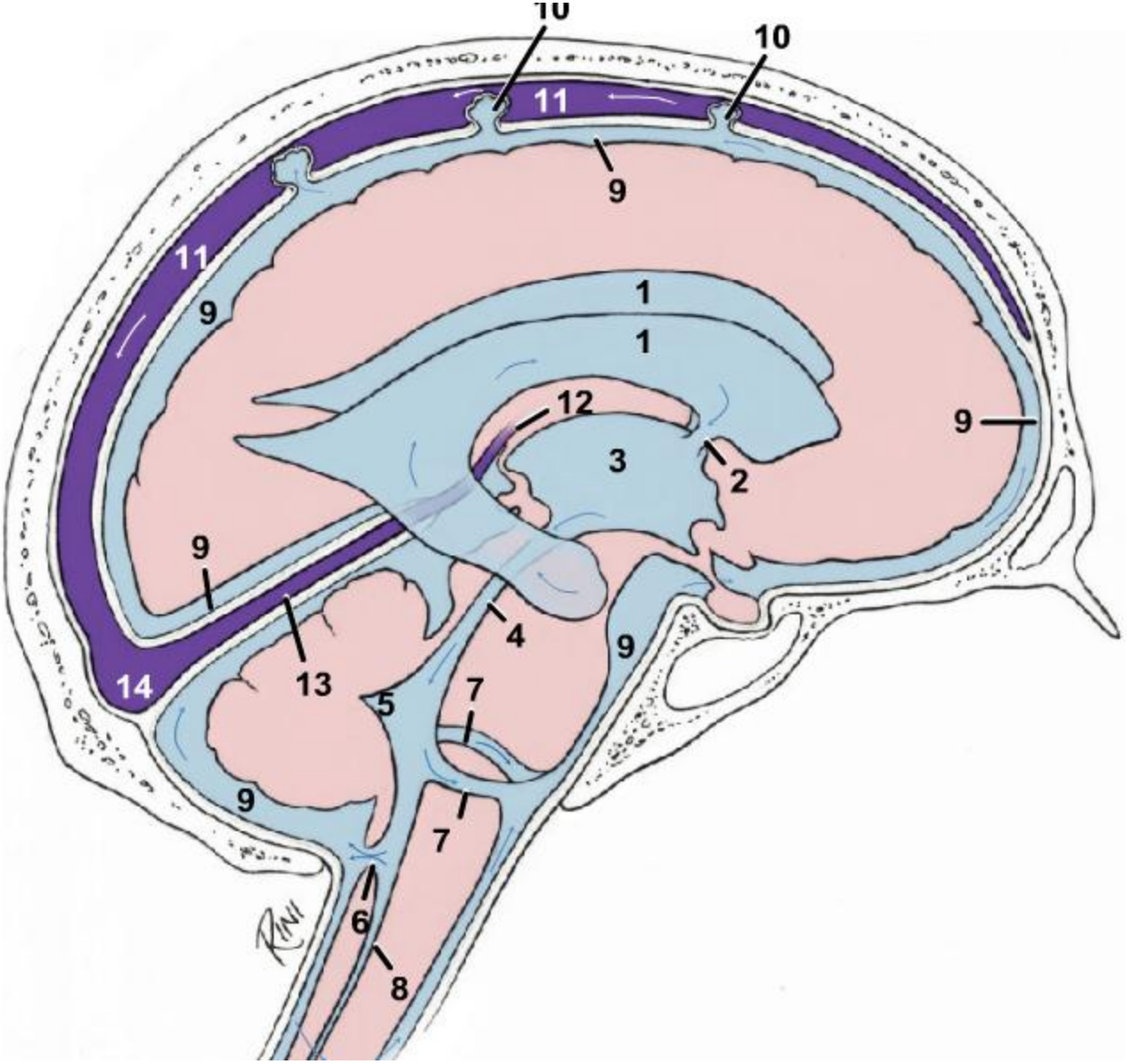
- **the lateral wall of the cavernous sinus.**
- **tentorium cerebelli forms a large part of the floor of the middle cranial**
- **The rim of the tentorial incisure is attached on both sides to the apex of the petrous temporal bones and anterior clinoid processes**
- **the roof of the cavernous sinus**
- **opening in the diaphragma for the infundibulum and pituitary stalk**
- **encloses the major venous sinuses**
- **stabilize the brain within the cranial cavity.**
- **The meningeal element is continuous with the dural sheaths of the spinal cord and the optic nerves;**

Structure of the Dura Mater

- ***It is that of a dense, fibrous sheet, composed of collagen but containing some elastic fibres. The collagen fibres are densely packed in fascicles, which are arranged in laminae. The fascicles run in different directions in adjacent laminae which results in a lattice-like appearance.***
- osteoblasts are confined to the endosteal layer.

- Although the inner aspect of the dura is closely applied to the arachnoid over the surface of the brain, the two layers are easily separated and are joined only at sites where veins pass from the brain into venous sinuses, especially the superior sagittal sinus, or connect brain to dura as at the anterior pole of the temporal lobe.




10
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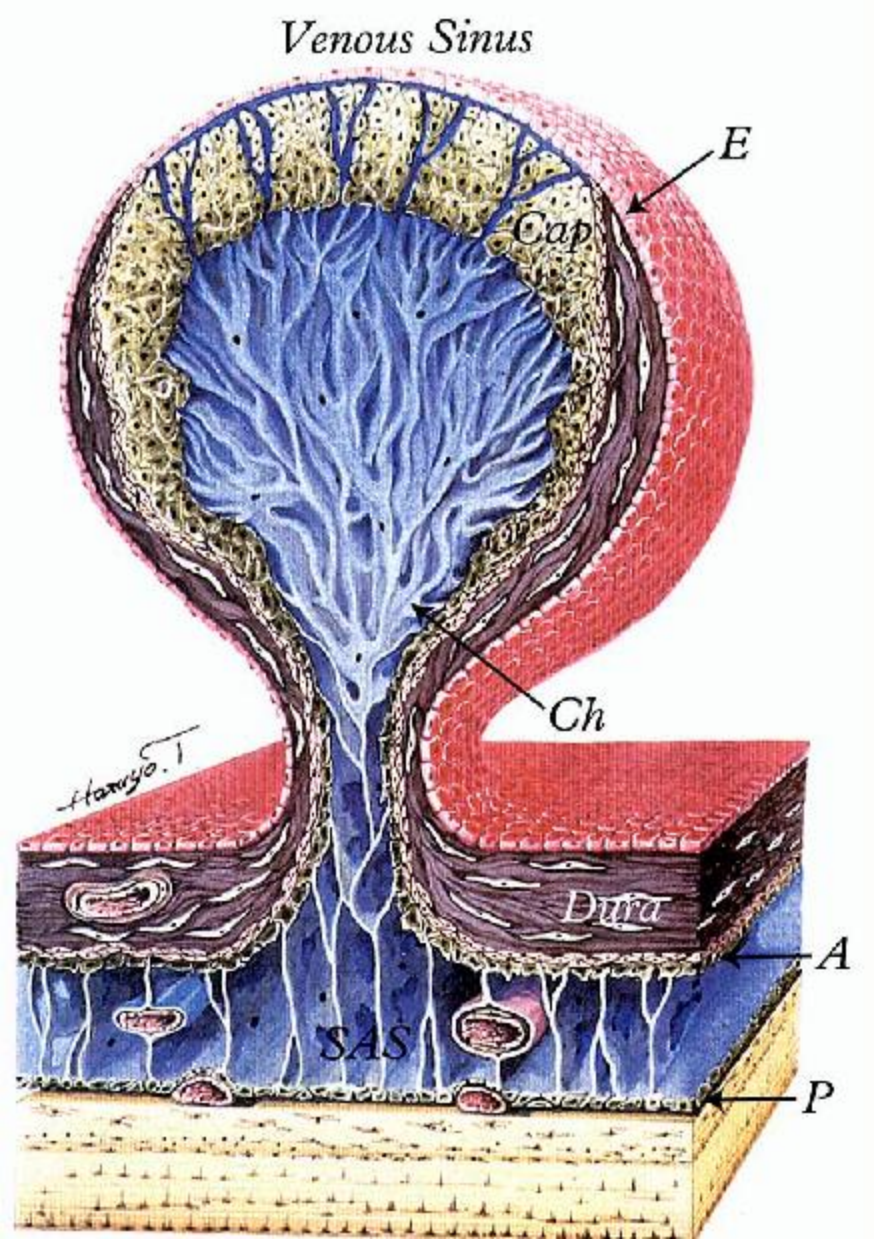
8

- **The subarachnoid space (SAS) between**
- **the arachnoid (A) and pia mater (P) is highly trabeculated and is continuous with**
- **the channel (Ch) in the centre of the granulation. Narrow channels traverse the cap region of the granulation to come into contact with the *endothelium (E)* of the**
- ***venous sinus*. It is through the endothelium that the fluid finally drains.**

Diagram of an arachnoid granulation.



Arterial Supply and Venous Drainage of the Cranial Dura Mater

- In the anterior cranial fossa
- anterior meningeal branches of
  - anterior and posterior ethmoidal
  - internal carotid arteries
  - middle meningeal artery.

- **In the middle cranial fossa,**

  the middle and accessory meningeal from

- **maxillary artery,**
- **ascending pharyngeal artery (entering via the foramen lacerum)**
- **internal carotid**
- **recurrent branch of the lacrimal .**

In the posterior fossa

- ***occipital artery (external carotid ; one entering the skull by the jugular foramen and another by the mastoid foramen).***
- ***vertebral artery and occasional small branches of the ascending pharyngeal artery which enter by the jugular foramen and hypoglossal canal.***

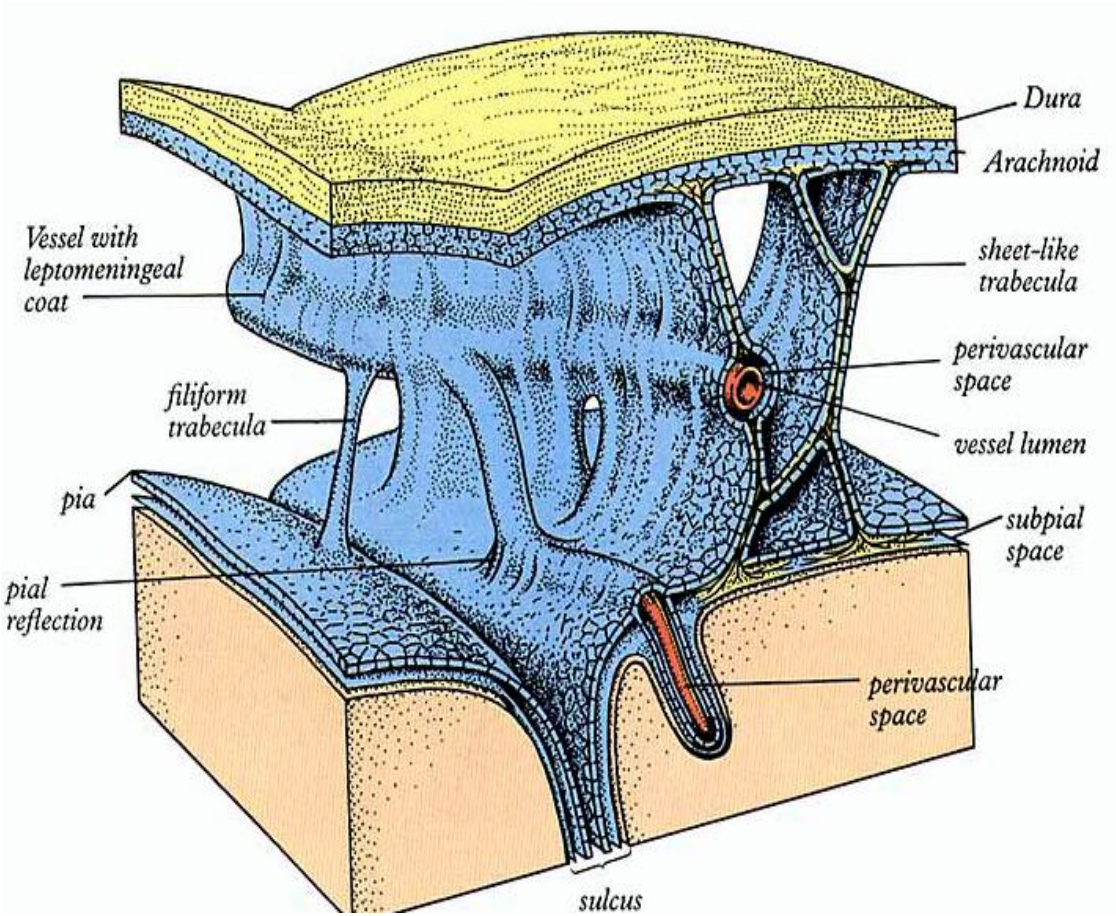
Nerves of the Cranial Dura Mater

- **These are derived mostly from**
- **3 divisions of (V)** **A recurrent tentorial nerve (a branch of the ophthalmic division**
- **C1,2,3**
- **Cervical sympathetic trunk.**
- **Less well-established meningeal branches :**
- **(X), (XII), (VII) and (IX) nerves**
- **Anterior and posterior ethmoidal nerves**
- **Ascending meningeal branches of the upper cervical nerves which enter it through the anterior part of the foramen magnum**
- All meningeal nerves contain a postganglionic sympathetic component

- **Various dural receptor terminals, including *simple end-bulbs and Meissner's and Pacinian* corpuscles , have been described in various mammals, but there is little information available concerning man. The roles of the sensory and autonomic nerve supply of the cranial dura mater remain uncertain.**

Arachnoid and Pia Mater

- **Thin transparent.**
- **There are two major layers of leptomeninges, the *arachnoid* mater and the *pia mater*.**
- **separated by the subarachnoid space and joined by trabeculae.**

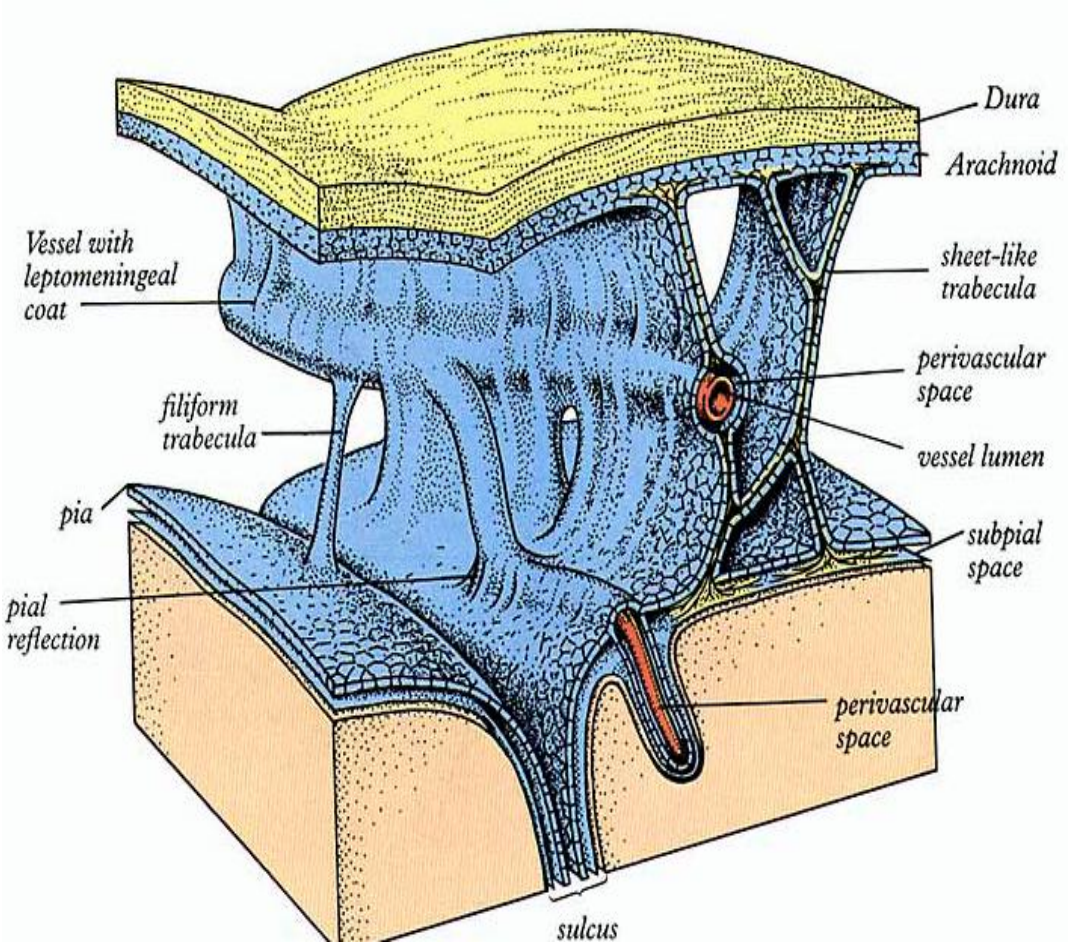


Cranial Arachnoid Mater

- *invests the brain but does not enter the sulci or fissures, except for the longitudinal fissure.*
- *easily separated from the dura over the surface of the brain.*
- *adherent to the adventitia of the vessel.*
- *coats the superior surface of the pituitary fossa*

Subarachnoid Space

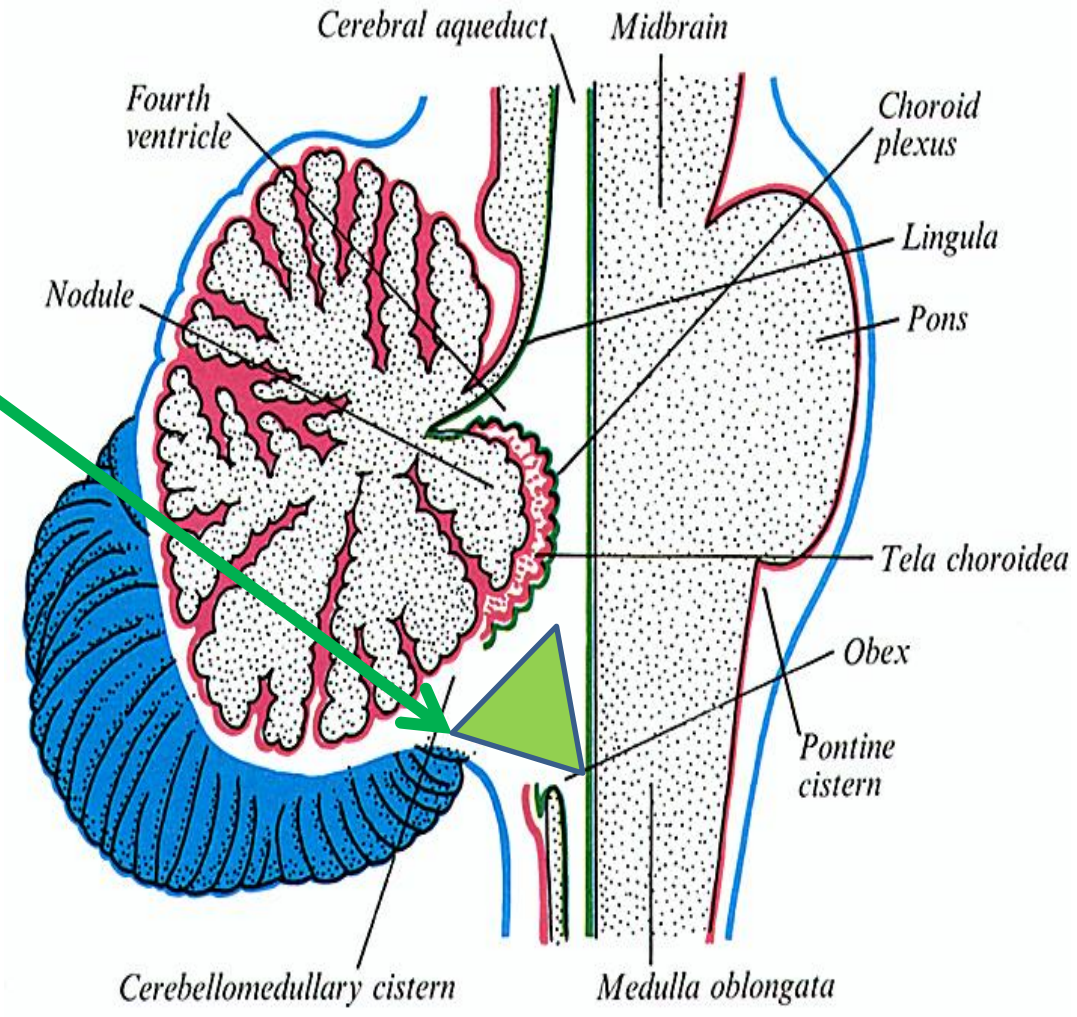
- between the arachnoid and the pia mater, which contains CSF and the larger arteries and veins which traverse the surface of the brain. Arteries and veins are coated by a thin layer of leptomeninges,
- only one cell thick.



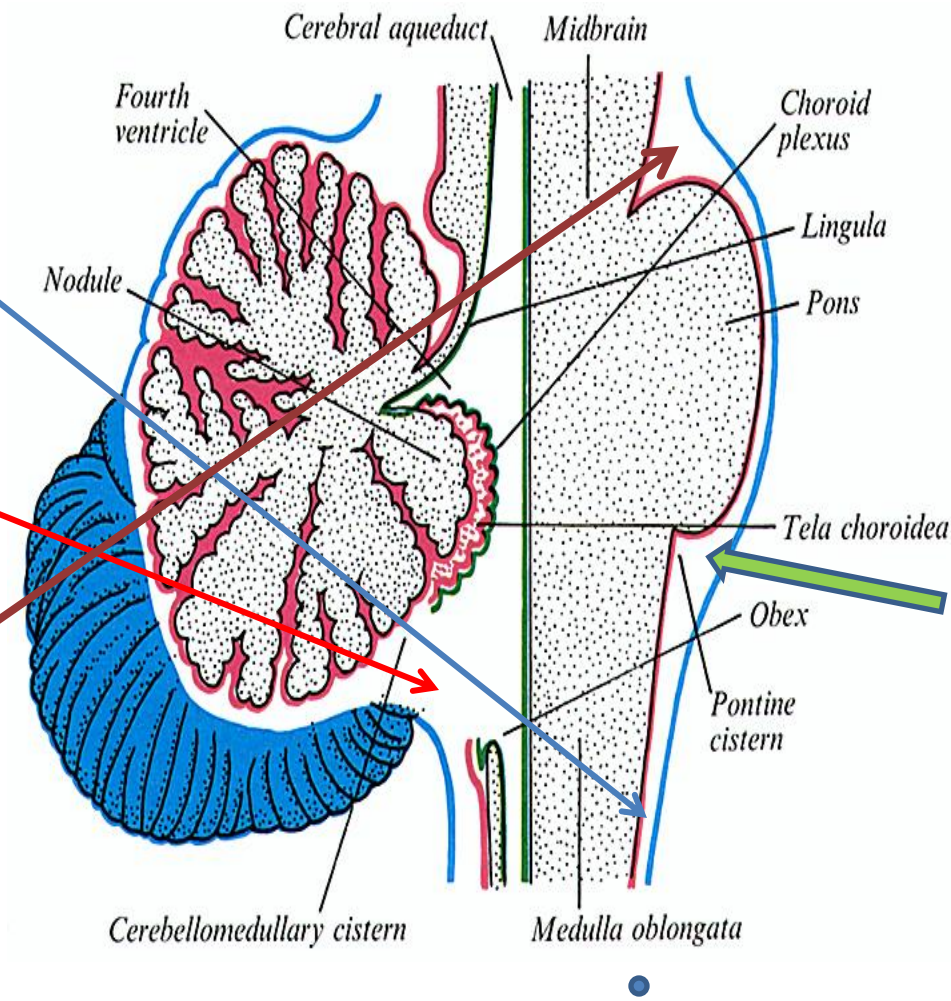
- collagenous trabeculae and sheets the
- arachnoid is separated from the pia by a wide interval to form subarachnoid cisterns which continuous with each other through the general subarachnoid space of which they are dilatations.
- ***Subarachnoid Cisterns***
- The cerebellomedullary cistern (cisterna cerebellomedullaris, or cisterna magna) (8.314) is formed as the arachnoid bridges the interval between the medulla oblongata and the inferior cerebellar surface.

Subarachnoid Cisterns

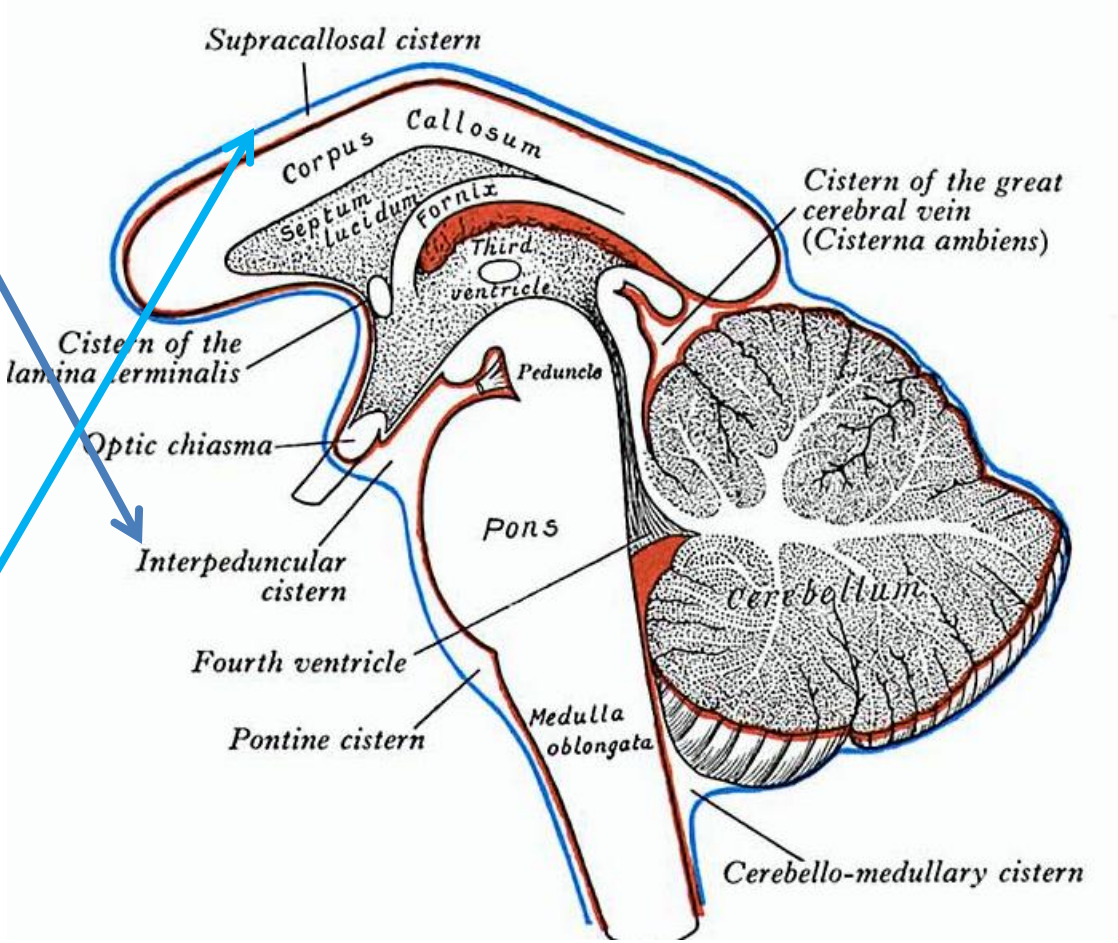
- **Cerebellomedullary cistern** (**cisterna cerebellomedullaris** or cisterna magna) Δ in shape is formed as the arachnoid bridges the interval between the medulla oblongata and the inferior **cerebellar surface.**
- continuous below with Sub.ar.sp. of spinal cord and with the fourth ventricle through the foramen of ***Magendie***



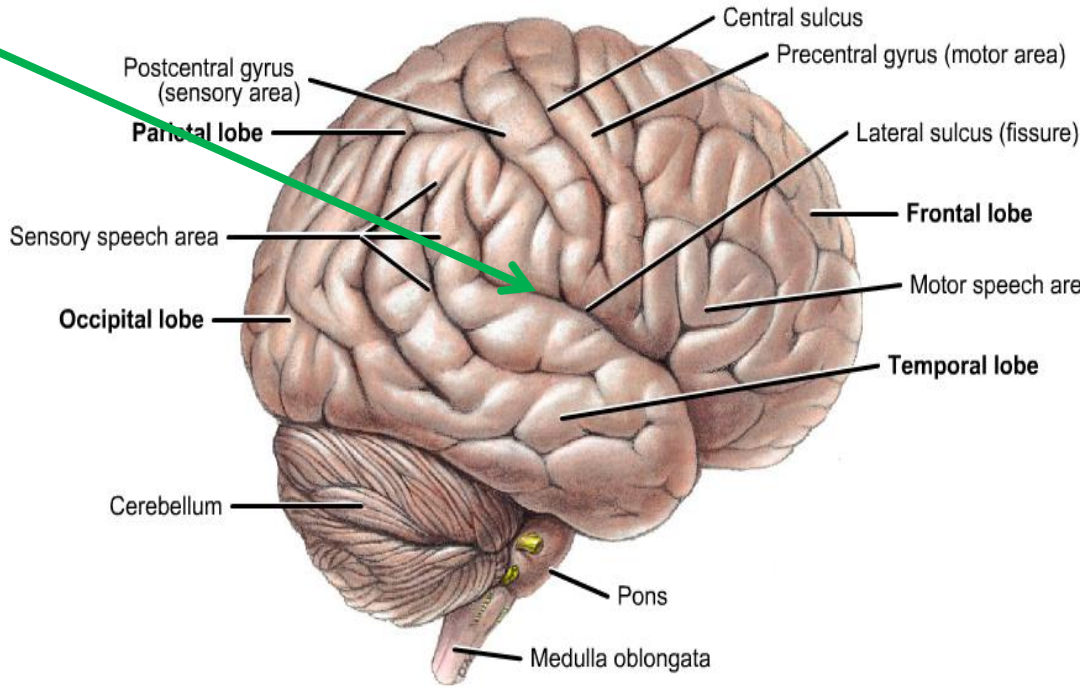
- ***The pontine cistern***
- ventral to the pons,
- continuous **below** with the ***spinal subarachnoid space, behind*** with the ***cerebellomedullary cistern*** and, **rostral** to the pons, with the ***interpeduncular cistern.***
- The basilar artery runs through the pontine cistern into the interpeduncular cistern.



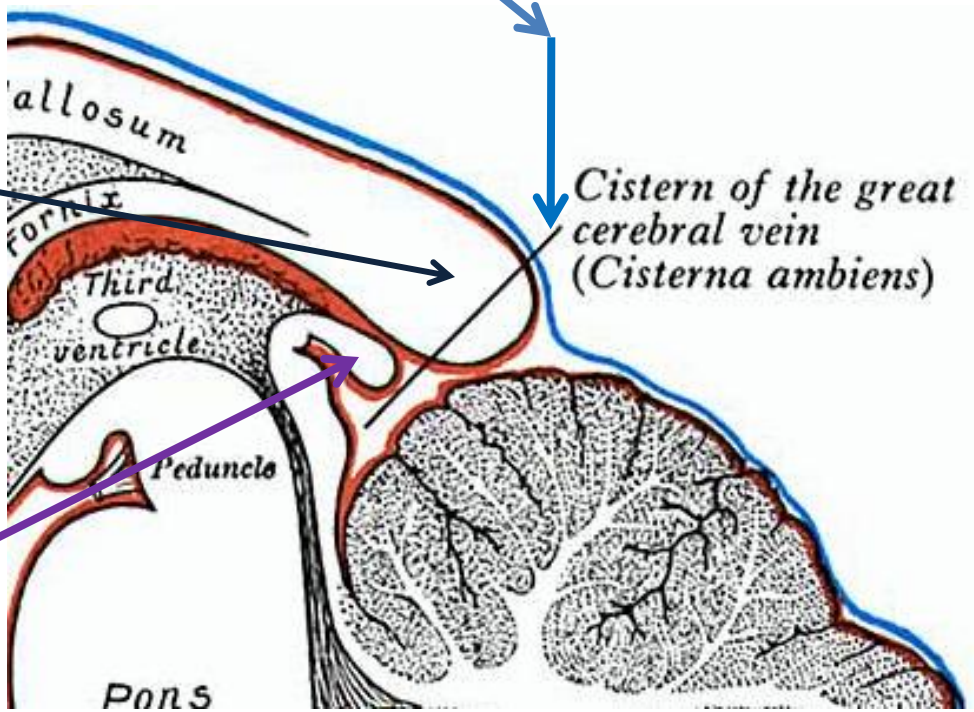
- ***Interpeduncular cistern;***
- which contains the **circulus arteriosus (circle of Willis).**
- continues rostrally to the optic chiasm + **supracallosal cistern** over the superior surface of the corpus callosum .
- The anterior cerebral arteries are contained within this cistern.



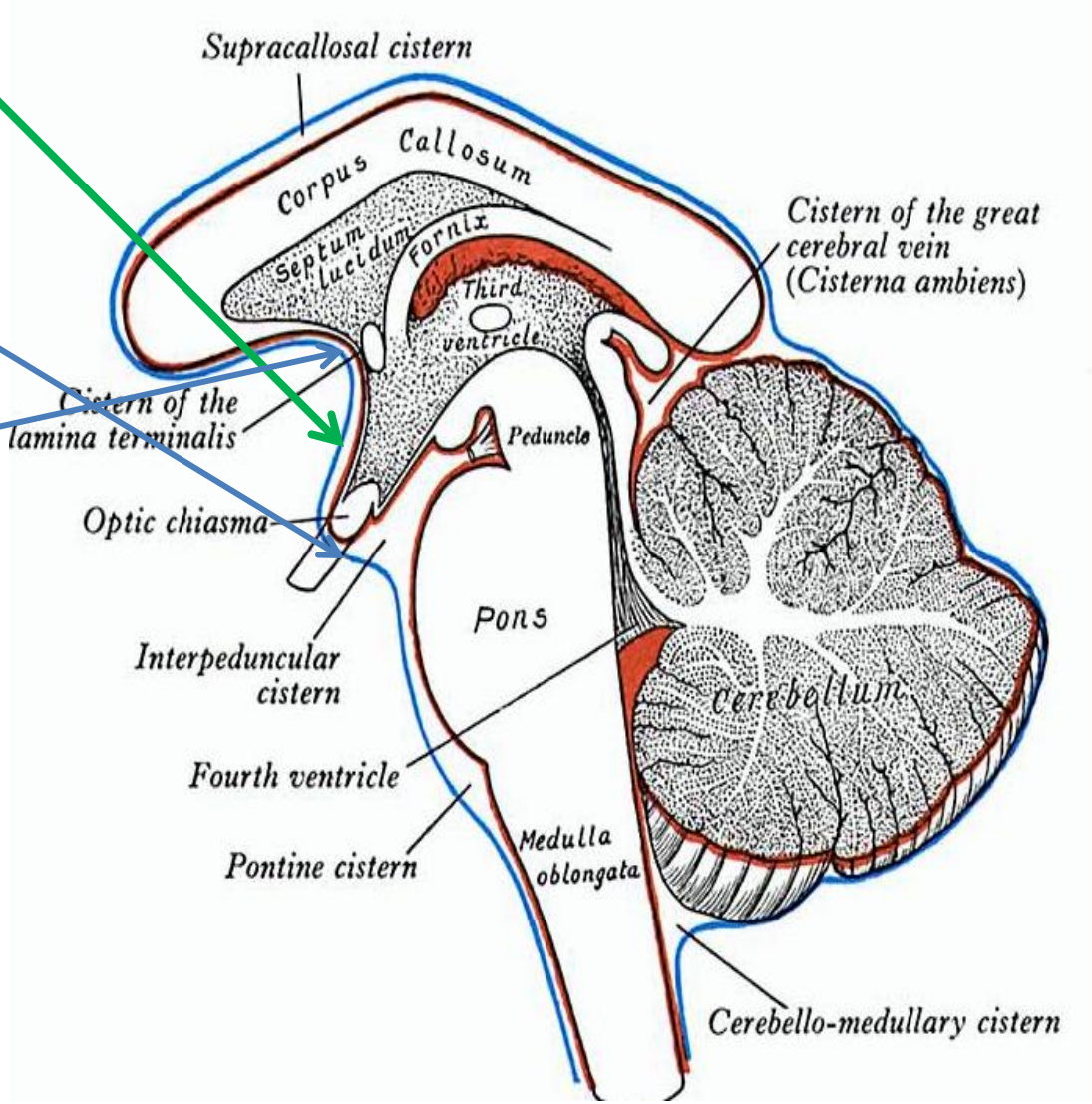
- ***Cistern of the lateral fossa***
- **formed by the arachnoid bridging the lateral sulcus.**
- **contains the middle cerebral artery and is**



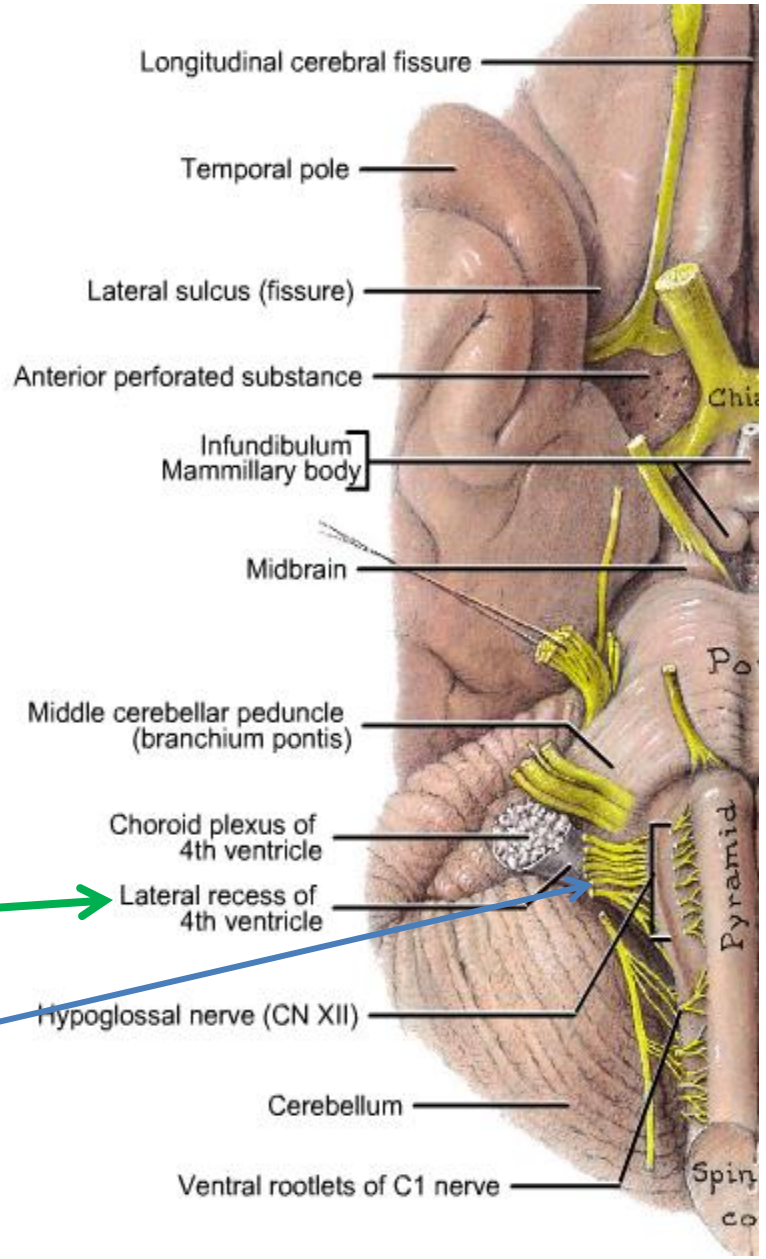
- ***Cistern of the great cerebral vein (cisterna ambiens or superior cistern),***
- **Posterior to the brain stem and third ventricle is the which occupies the interval between the splenium of the corpus callosum and the superior cerebellar surface**
- **great cerebral vein traverses this cistern and the pineal gland protrudes into it.**



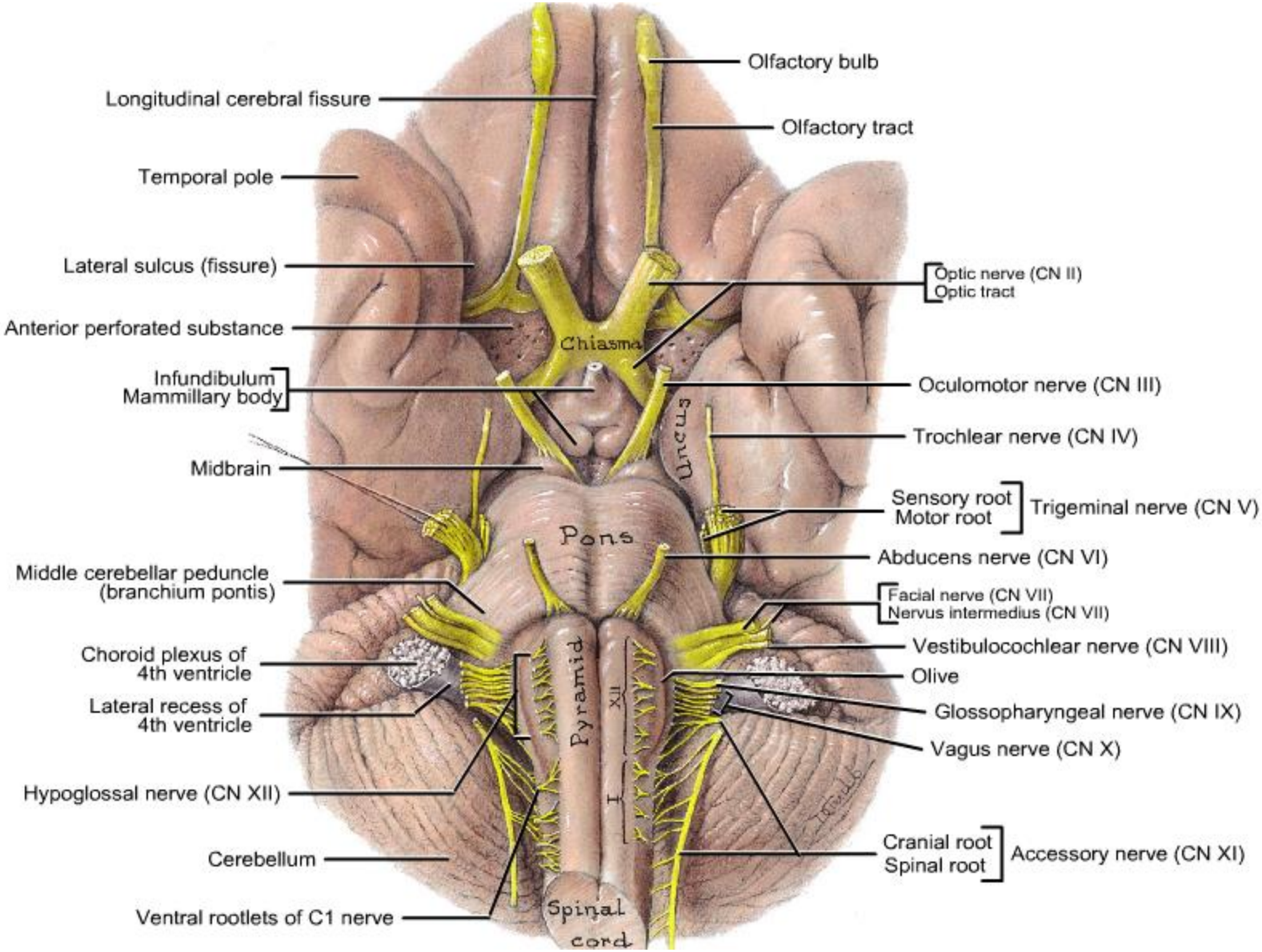
- **Prechiasmatic and postchiasmatic cisterns :**
- Smaller cisternae
- related to the optic chiasm,
- **Cisterna of the lamina terminalis and the supracallosal** cistern; all are extensions of the interpeduncular cistern and contain the anterior cerebral arteries.



- The cerebral subarachnoid space connects with the ventricles of the brain by ***three openings***:
- ***Median aperture (foramen of Magendie) drainage from the fourth ventricle into the cerebellomedullary cistern.***
- ***two lateral apertures (foramina of Luschka) at the ends of the lateral recesses, behind the upper roots of the glossopharyngeal nerves***.

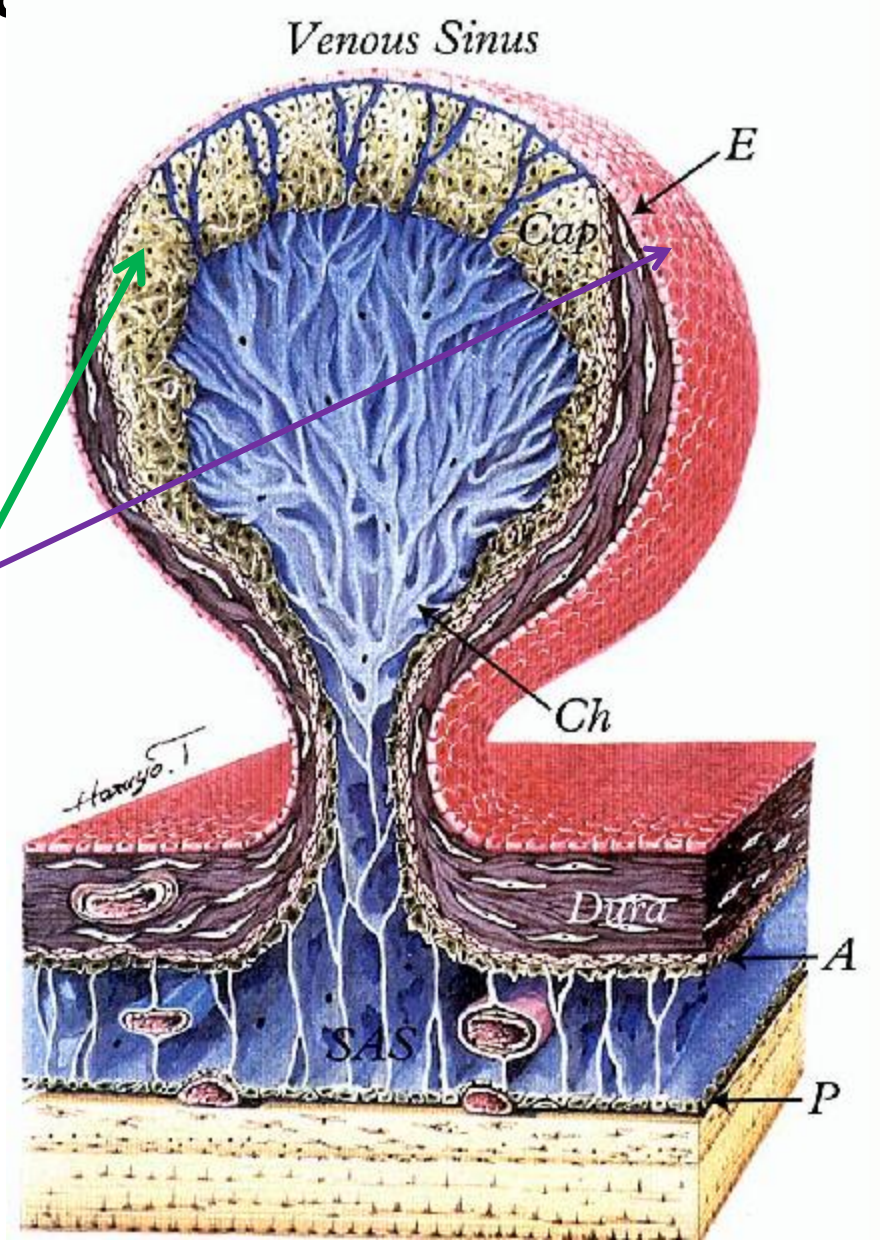


- There is normally no communication between the subdural and subarachnoid spaces as the tight junctions (zonulae occludentes) between the cells of the outer layer of the arachnoid prevent the escape of CSF from the subarachnoid space


Olfactory bulb
Longitudinal cerebral fissure
Olfactory tract
Temporal pole
Lateral sulcus (fissure)
Optic nerve (CN II)
Optic tract
Anterior perforated substance
Chiasma
Infundibulum
Mammillary body
Oculomotor nerve (CN III)
Uncus
Trochlear nerve (CN IV)
Midbrain
Sensory root
Motor root
Trigeminal nerve (CN V)
Pons
Abducens nerve (CN VI)
Middle cerebellar peduncle
(branchium pontis)
Facial nerve (CN VII)
Nervus intermedius (CN VII)
Vestibulocochlear nerve (CN VIII)
Choroid plexus of
4th ventricle
Olive
Lateral recess of
4th ventricle
Pyramid
XII
Glossopharyngeal nerve (CN IX)
Vagus nerve (CN X)
Hypoglossal nerve (CN XII)
Cranial root
Spinal root
Accessory nerve (CN XI)
Cerebellum
Spinal
cord
Ventral rootlets of C1 nerve

Arachnoid Granulations and Villi

- the major pathways for the bulk flow of CSF back into the blood in man.
- promnent along the margins of the longitudinal fissure from which they project into the superior sagittal sinus.
- An apical cap of **arachnoid cells,** some 150 mm thick, surmounts the **collagenous core** and channels extend through the cap to reach the subendothelial regions of the granulation



Importance of arachnoids' granulations

- flow of CSF through the channels of the collagenous core of the granulations is by either macrovesicular or microvesicular transport across the sinus endothelium into the blood.
- particulate matter through this pathway has also been suggested

Cranial Pia Mater

- delicate membrane
- closely invests the surface of the brain and the spinal cord.
- follows the contours of the brain into the sulci and also.
- Fromed of a layer of leptomeningeal cells often only 1–2 cells thick
- desmosomes and gap junctions but few

- Pia mater is separated from the brain by the subpial space;
- between the basement membrane of the glia limitans on the surface of the brain and the pia mater are fine bundles of collagen and small arteries and veins which are entering and leaving the surface of the brain
- subpial space containing blood vessels and the collagen
- pia forms an effective barrier to pharmacological agents
- particulate matter in the subarachnoid space is for the most part prevented by the pia mater from entering the perivascular spaces of the brain

- a layer of leptomeningeal cells separates arteries from the surrounding brain and may form a regulatory interface between blood vessels and brain' limiting the spread of neurotransmitters from nerves supplying the vessels. No similar layer of leptomeninges surrounds veins The outer layer of the arachnoid—the dura–arachnoid interface—is formed from five or six layers of cells joined by numerous desmosomes and tight junctions
- Lymphatic Drainage of the Brain
- Some 50% of the CSF in a number of mammalian species drains to the cervical lymph nodes Simple arachnoid villi and distinct arachnoid lymphatic channels are present in the rat.

- Pia Mater
- Mostly composed of a membrane one-cell thick, the pia mater cells are flattened and joined by desmosomes and gap junctions. They are continuous with the coating of the subarachnoid trabeculae and separated from the basal lamina of the glia limitans by the collagen bundles, fibroblast-like cells, arteries and veins of the subpial space

Venous sinuses

- Superior sagittal; venous lacunae, superior cerebral veins, confluence of sinuses, occipital sinuses.
- inferior sagittal sinus; great cerebral vein,
- Striaght sinus;
- Transvers sinus
- Segmoid sinuses
- Occipital sinus

- Cavernous sinus;

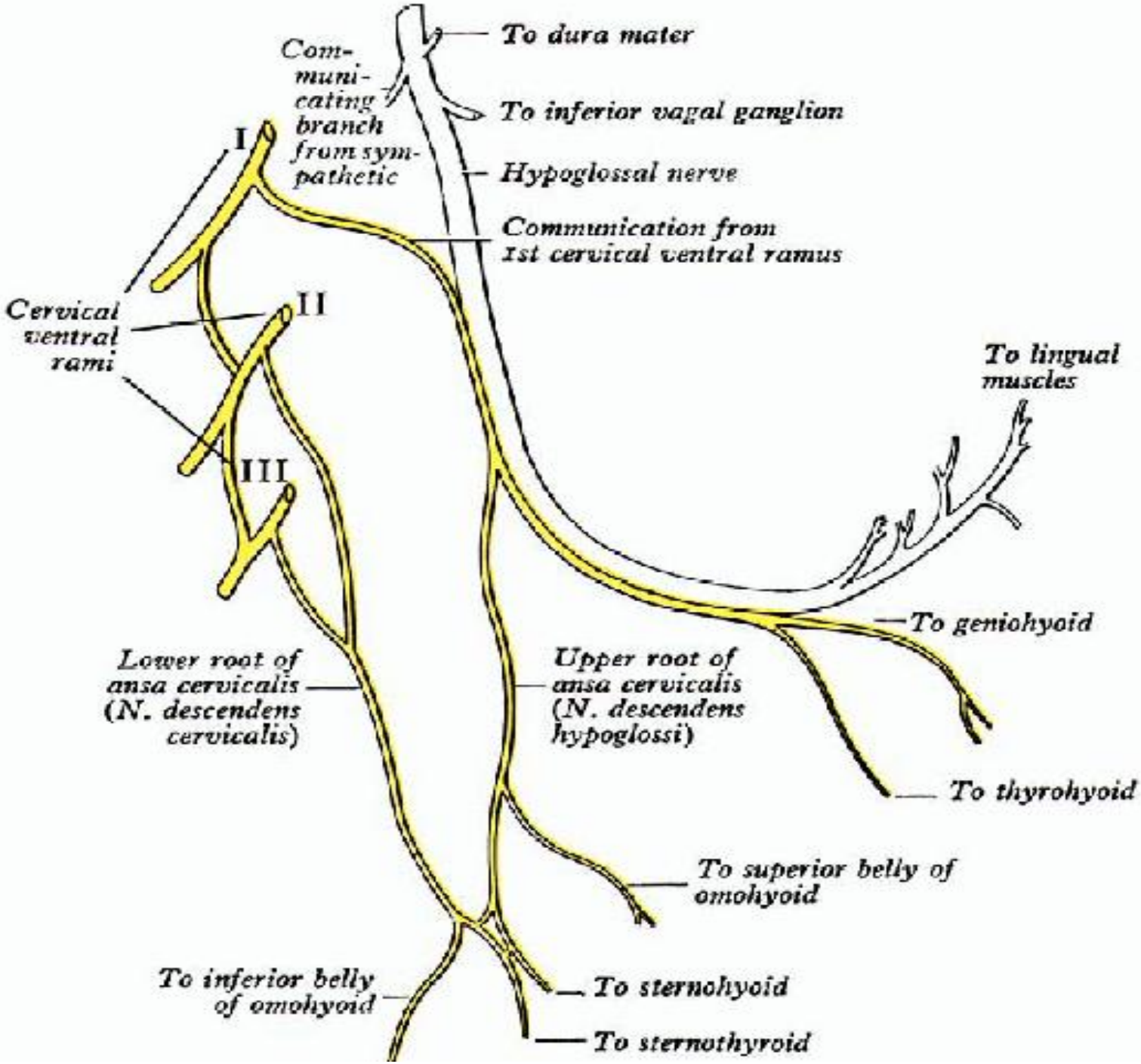
- middle cranial fossa from superior orbital fissure to the apex of petrous temporal bone.

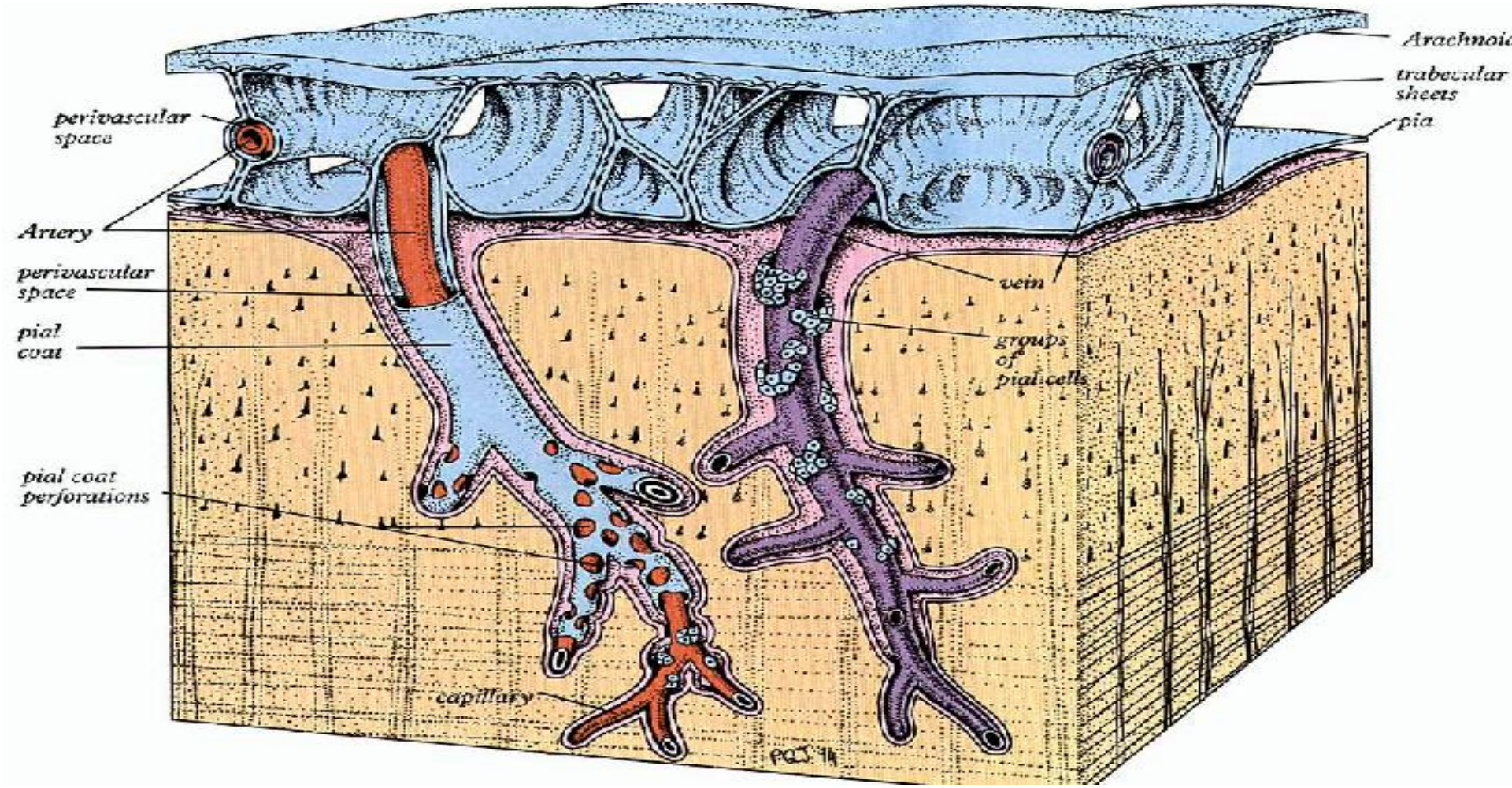
  superior and inferior opthalmic veins, cerebral , sphenoparietal sinus, and central vein of retina are tributeries of the sinus. The sinus drain to superior and inferior petrosal sinus and inferior ptregoid venous plexus

- the two sinuses communicates at anterior and posterior intercavernous sinuses inside diaphragmatic sellae.

- Communicates with superior and inferior opthalmic veins.

- Superior and inferior petrosal sinuses
  - superior drain cavernous sinus to transvers sinus
  - inferior drain cavernous sinus to internal jugular sinus


To dura mater
Com-
muni-
cating
branch
from sym-
pathetic
To inferior vagal ganglion
I
Hypoglossal nerve
Communication from
1st cervical ventral ramus
Cervical
ventral
rami
II
To lingual
muscles
III
To geniohyoid
Lower root of
ansa cervicalis
(N. descendens
cervicalis)
Upper root of
ansa cervicalis
(N. descendens
hypoglossi)
To thyrohyoid
To superior belly of
omohyoid
To inferior belly
of omohyoid
To sternohyoid
To sternothyroid


Arachnoid
trabecular sheets
pia
perivascular space
Artery
perivascular space
pial coat
pial coat perforations
vein
groups of pial cells
capillary