

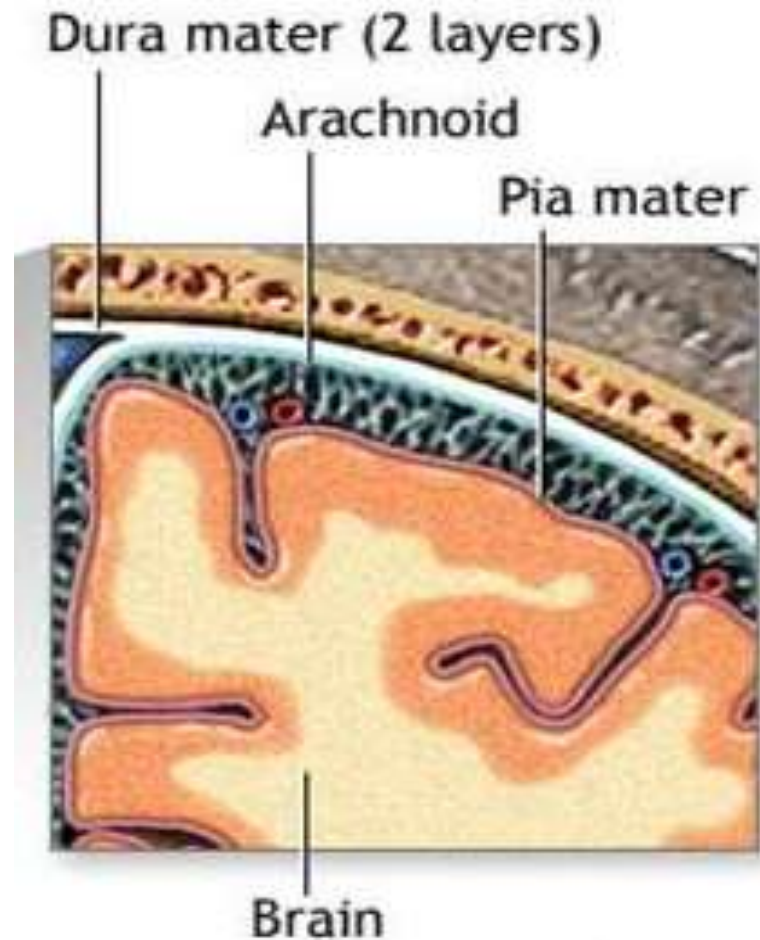
# **MENINGES AND CEREBROSPINAL FLUID**

Dr. Rajeev Kumar Mukhia

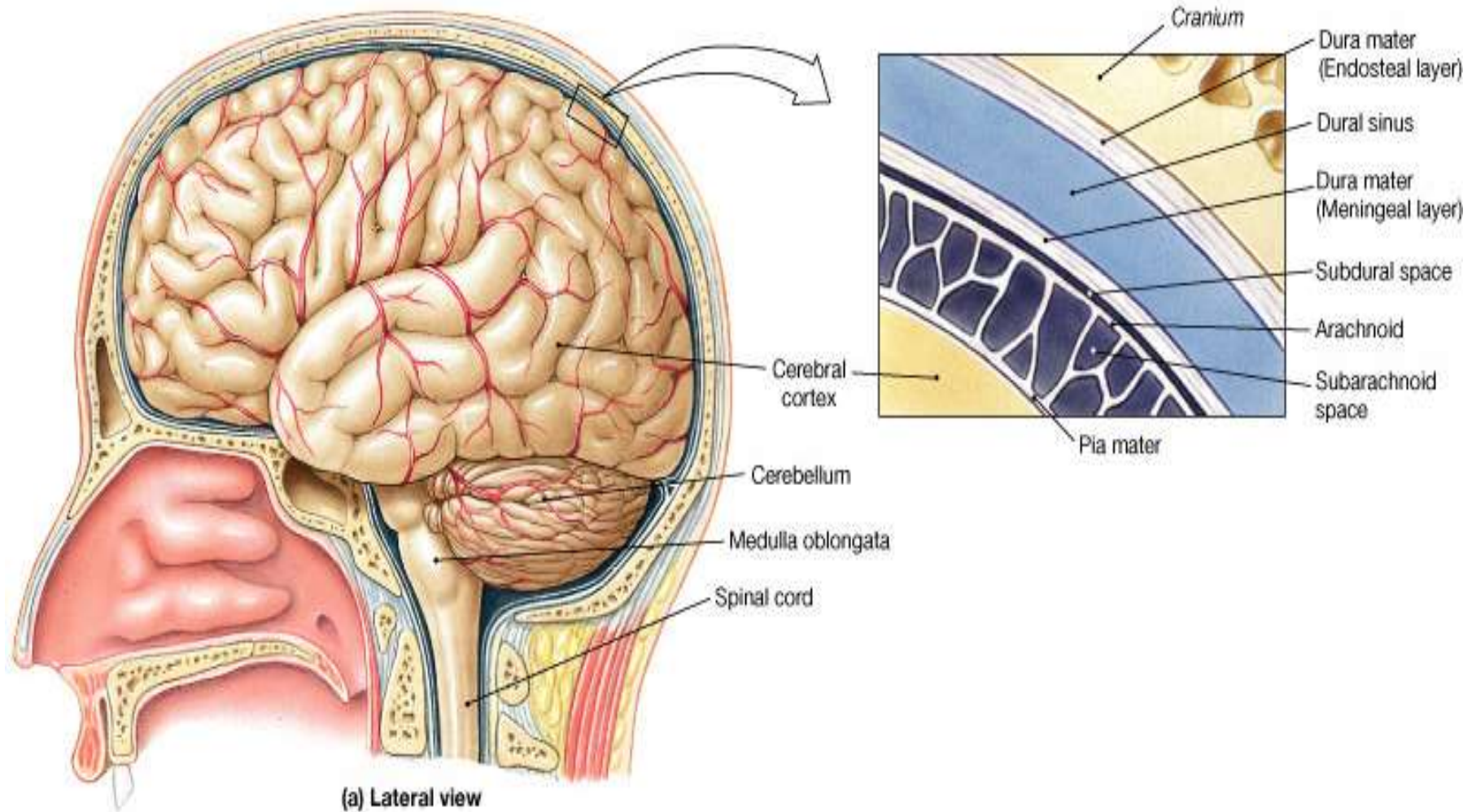
# The Meninges

- The Meninges are the protective membrane covering the brain and spinal cord.
- The Meninges consist of three membranes:
  1. The dura mater,
  2. The arachnoid mater,
  3. The pia mater.

The dura mater is mesodermal in origin whereas arachnoid & pia mater are ectodermal in origin.



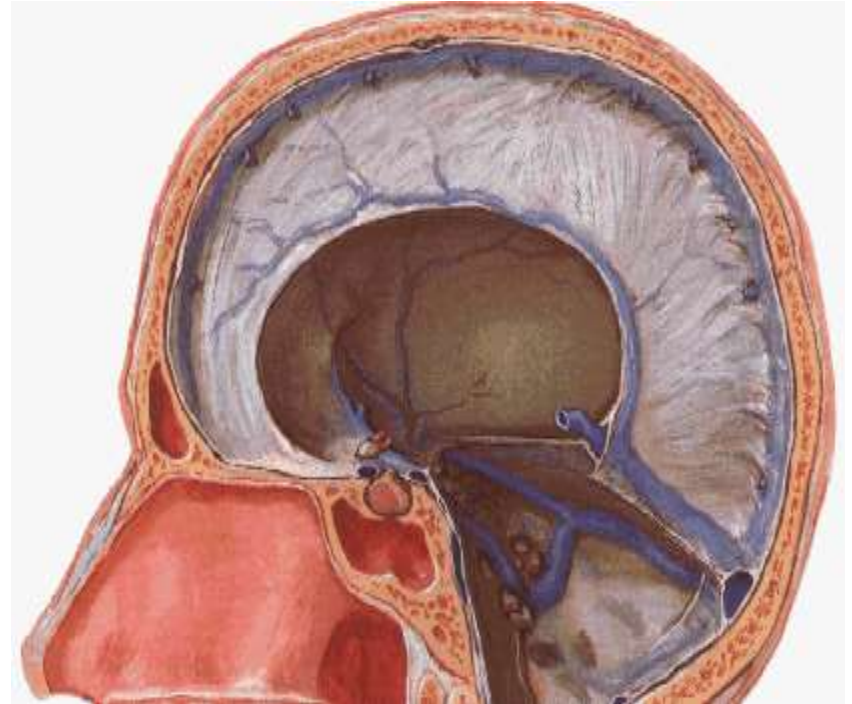
# The Meninges



# DURA MATER

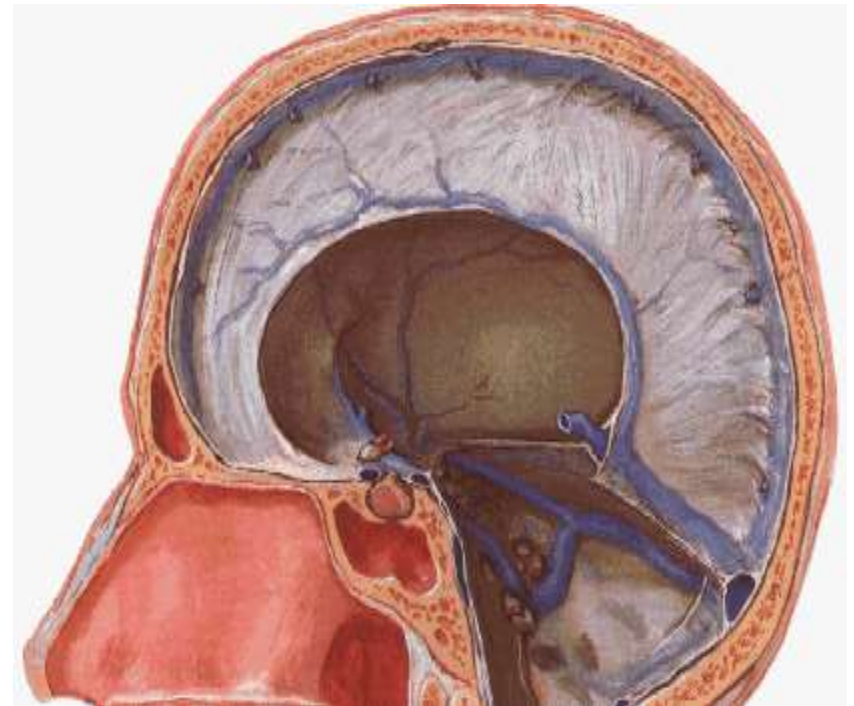
- ❑ The outermost layer of the meninges.
- ❑ Thick dense inelastic membrane covering the brain and spinal cord.
- ❑ The part enclosing the brain is called cranial dura and the part enclosing the spinal cord is called spinal dura.
- ❑ Cranial Dura
- ❑ Bilaminar:
  - Endosteal layer (outer)
  - Meningeal layer (inner)

These are closely united except along certain lines, where they separate to form venous sinuses.

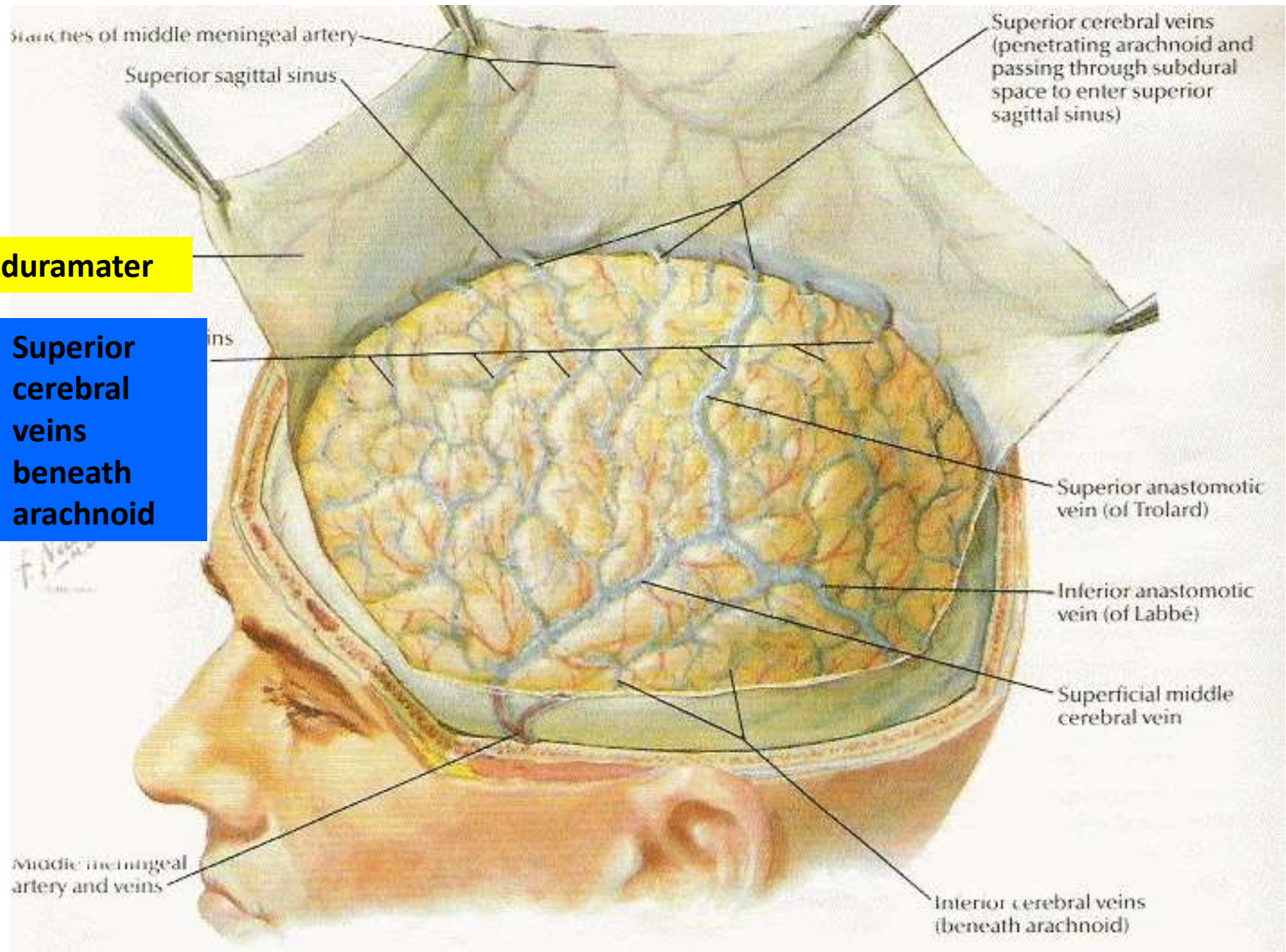


# DURA MATER

- ❑ Endosteal layer ;
  - o Attached to the inner surface of the cranial bones.
  - o Not continuous with dura mater of spinal cord
- ❑ Meningeal layer ;
  - o Dura mater proper is a strong fibrous membrane which covers the brain & becomes continuous with the spinal dura at the foramen magnum.
  - o Folded inwards as 4 septa between part of the brain
  - o The function of these septa is to restrict the rotatory displacement of the brain.







Superior sagittal sinus  
(Dural venous sinus)

**Dura mater**

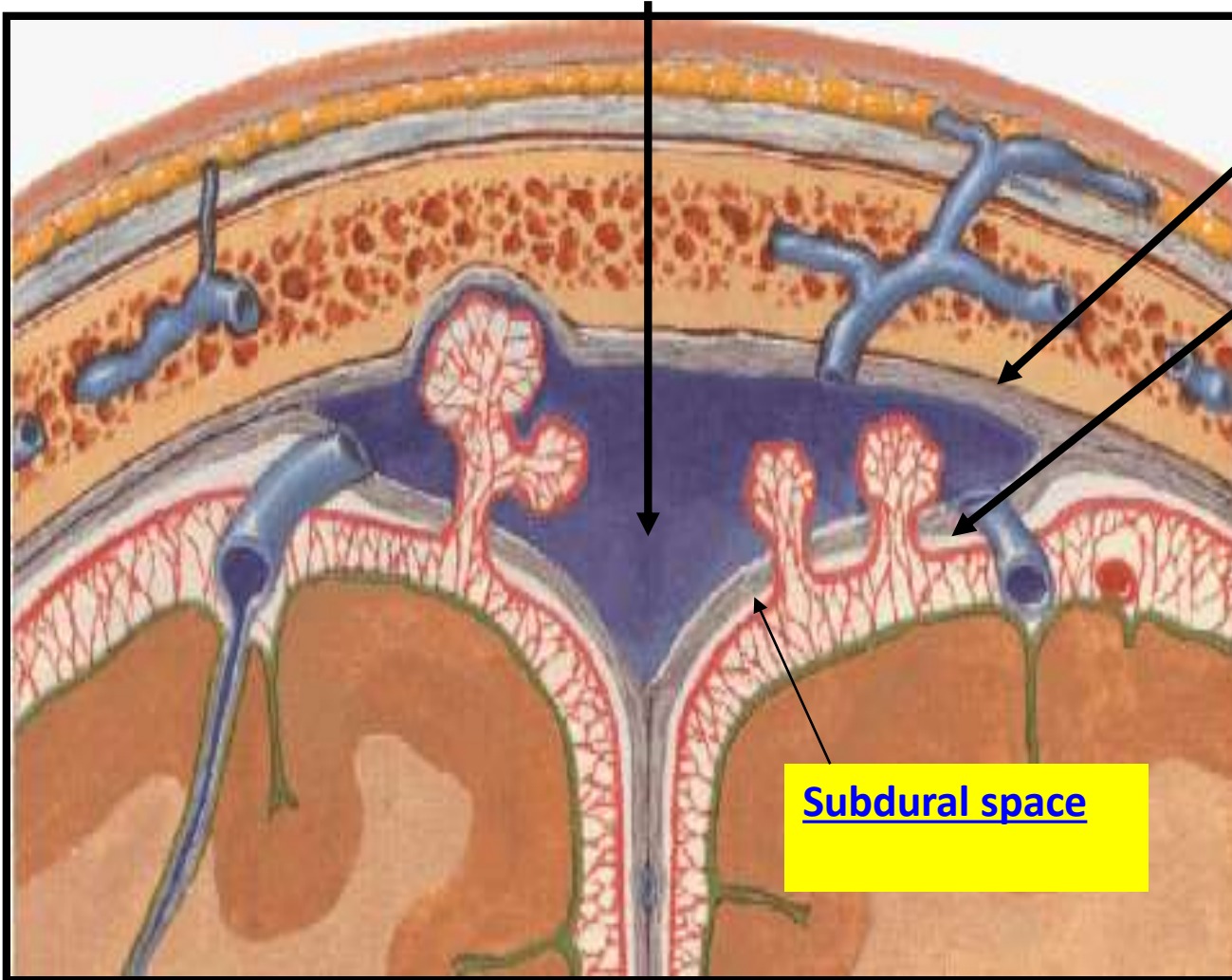
Endosteal layer

Meningeal layer

They are closely united except along certain lines; they are separated to form **venous sinuses**

Subdural space

Coronal section of the upper part of the head





# DURA MATER

Dural septa or folds:

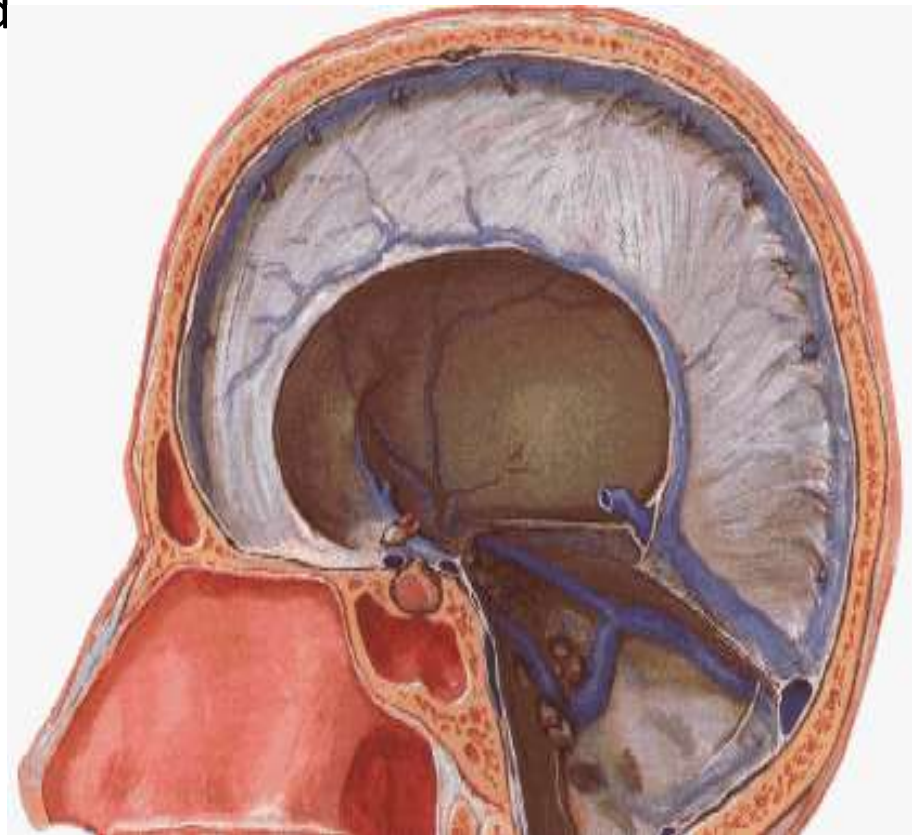
The meningeal layer gets infolded & forms septa or folds between the parts of the brain.

They are -

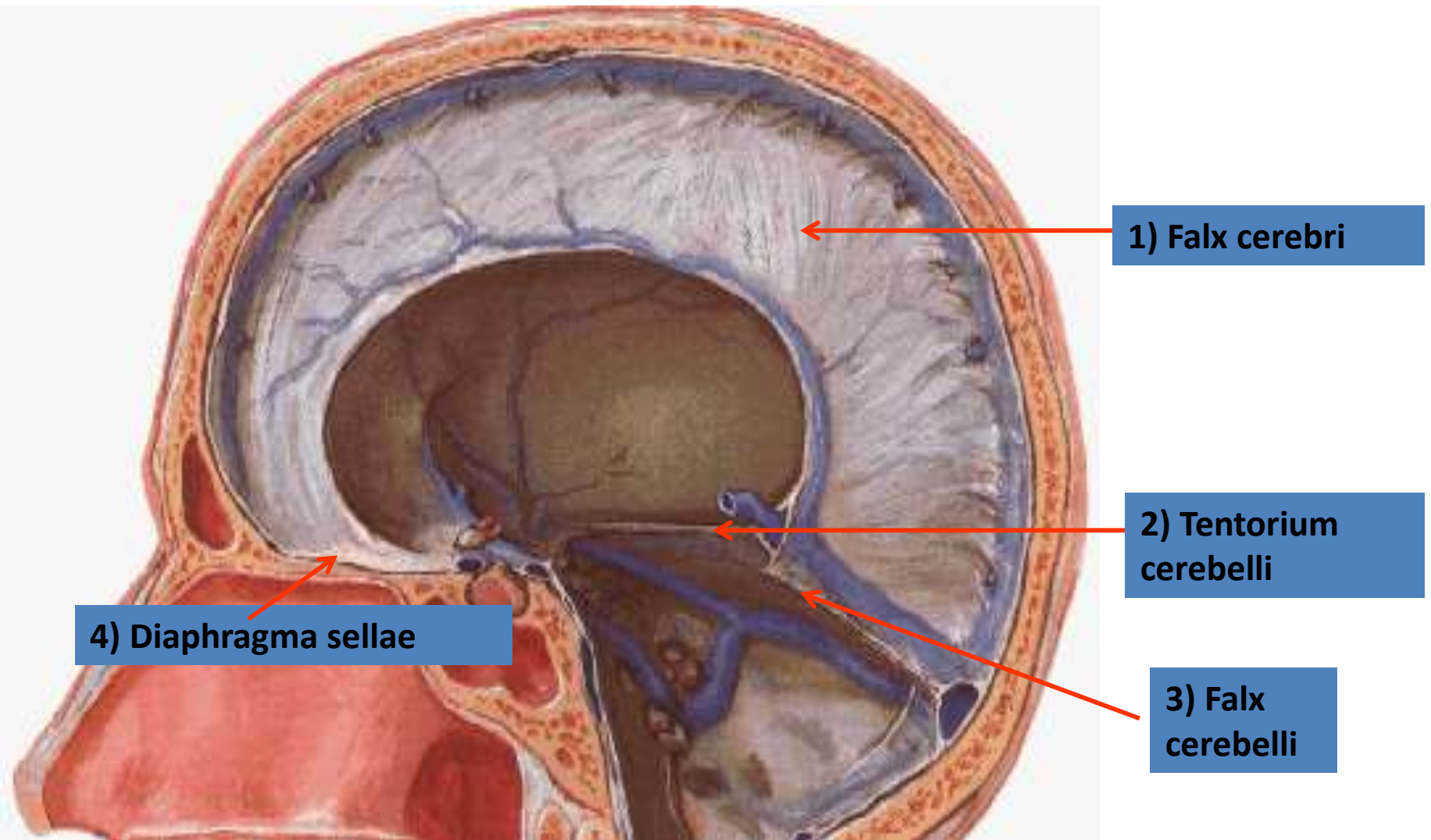
1. Falx cerebri
2. Falx cerebelli
3. Tentorium cerebelli
4. Diaphragma sella

Function –

- Dural septa divide the cranial cavity into compartments.
- They enclose intracranial dural venous sinuses.



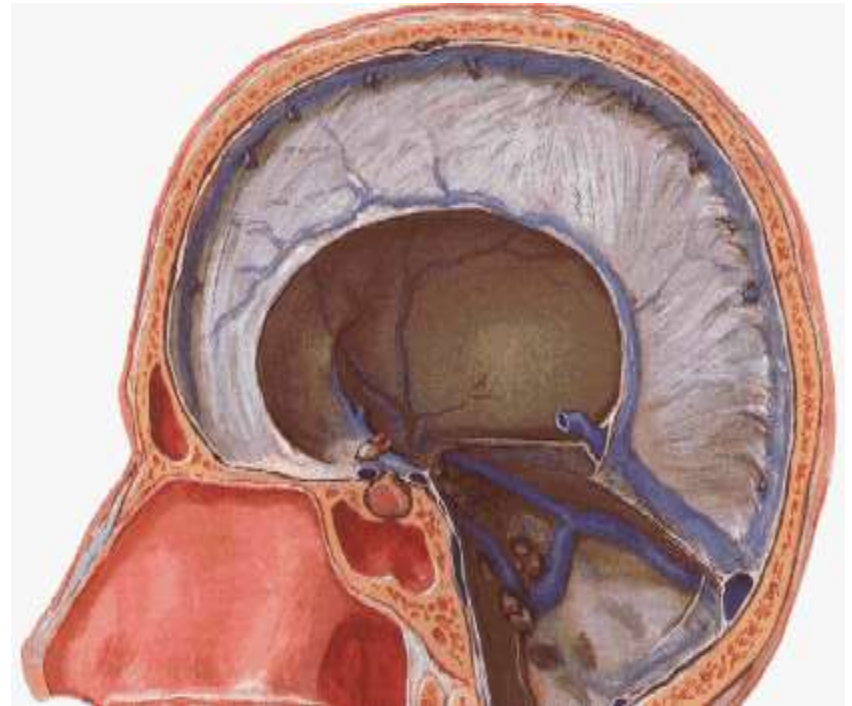




**Sagittal section showing the duramater**

# The Falx Cerebri

- It is a sickle-shaped fold of dura mater that lies in the midline between the two cerebral hemispheres.
- *The superior sagittal sinus* runs in its upper fixed margin, *the inferior sagittal sinus* runs in its lower concave free margin, and *the straight sinus* runs along its attachment to the tentorium cerebelli.



**Superior sagittal sinus**

**Falx cerebri**

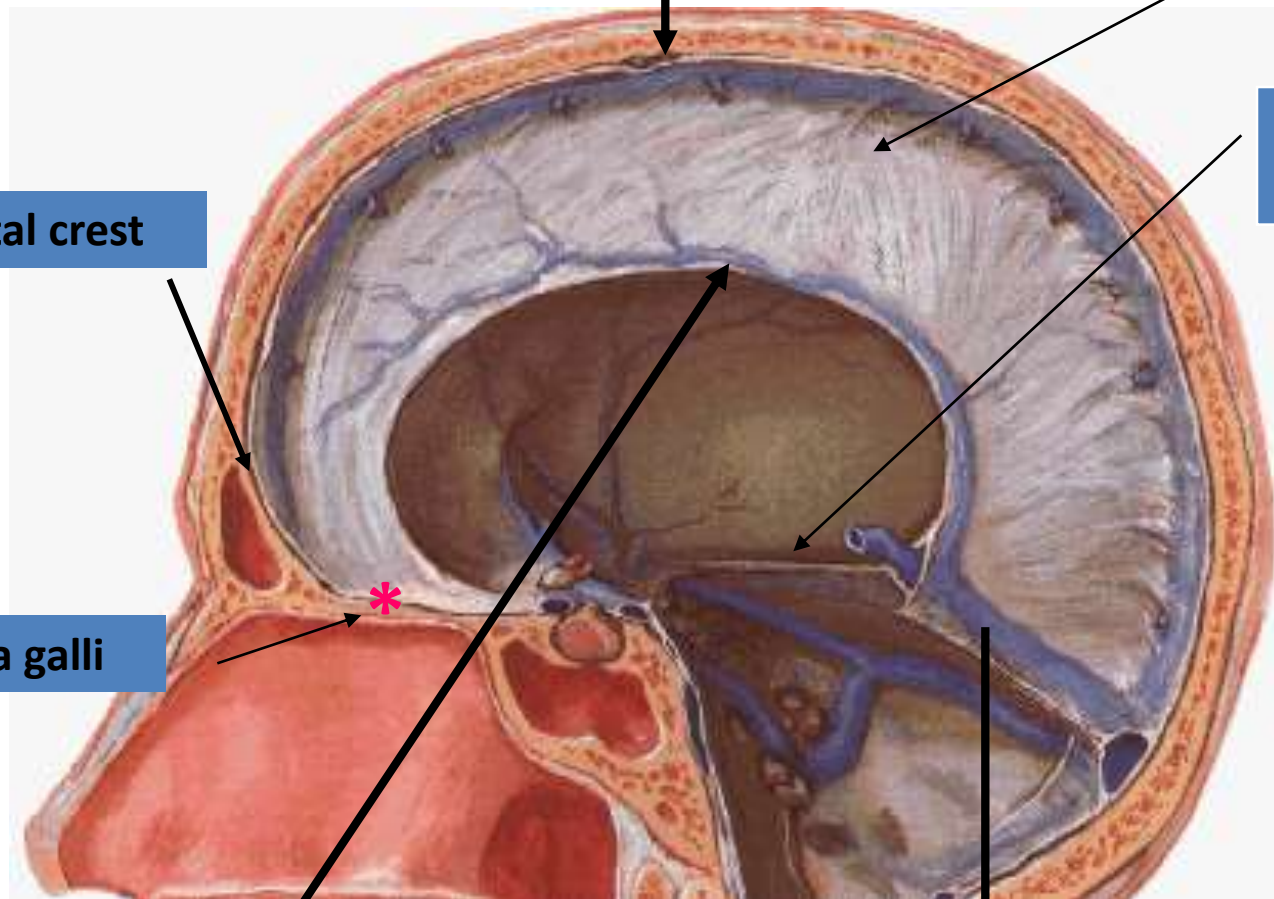
**Frontal crest**

**Tentorium cerebelli**

**Crista galli**

**Inferior  
sagittal sinus**

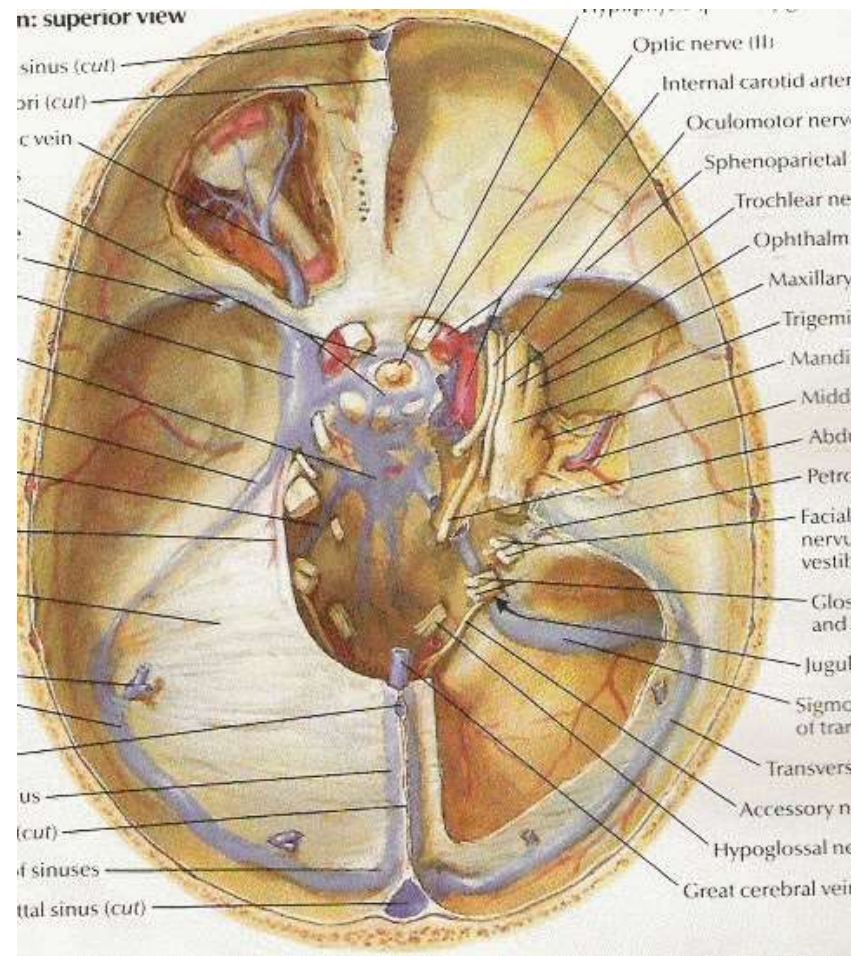
**Straight  
sinus**





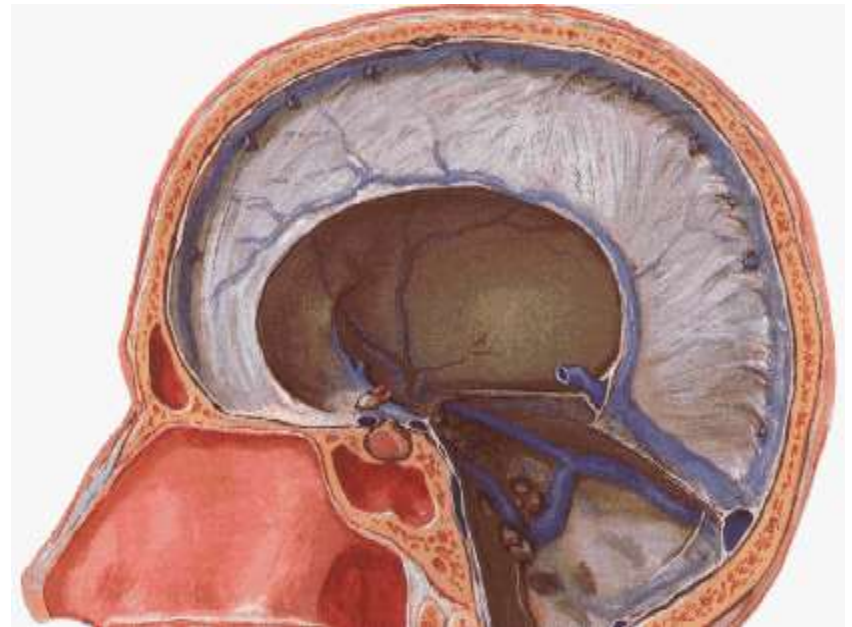
# The Tentorium Cerebelli

- The tentorium cerebelli is a crescent-shaped or tent-like semilunar fold of dura mater which forms the roof of the posterior cranial fossa, between the cerebellum & cerebrum.
- It covers the upper surface of the cerebellum and contains transverse sinus.



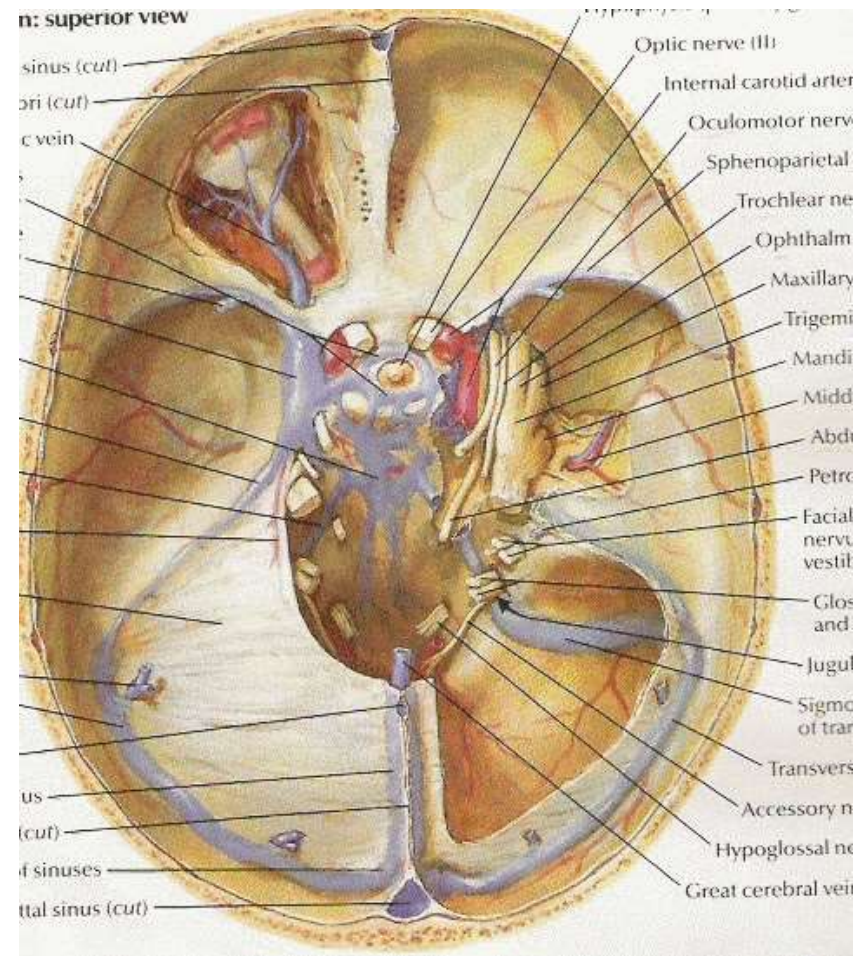
# The Falx Cerebelli

- The falx cerebelli is a small sickle-shaped fold of dura mater between the two cerebellar hemispheres.
- Its posterior fixed margin contains the occipital sinus.



# The Diaphragma Sellae

- The diaphragma sellae is a small circular fold of dura mater that forms the roof for the sella turcica.
- A small opening in its center allows passage of the stalk of the pituitary gland.





# Difference between spinal and cranial dura

- Spinal dura

1. Singled layered and consist of meningeal layer only
2. Does not form dural folds
3. Epidural space is present
4. Does not contain dural venous sinuses

- Cranial dura

1. Doubled layered and consist of an inner meningeal layer and outer endosteal layer
2. Forms dural folds
3. Epidural space is absent
4. Contains dural venous sinuses

# Dural Nerve Supply

- Three division of trigeminal nerve.
- First three cervical spinal nerves.
- Cervical sympathetic trunk.

# Dural Blood Supply

## Dural Arterial Supply

- The dura mater is supplied by numerous branches from the internal carotid, external carotid, and vertebral arteries.
- From a clinical standpoint, the most important is the *middle meningeal artery*, which is commonly damaged in head injuries.

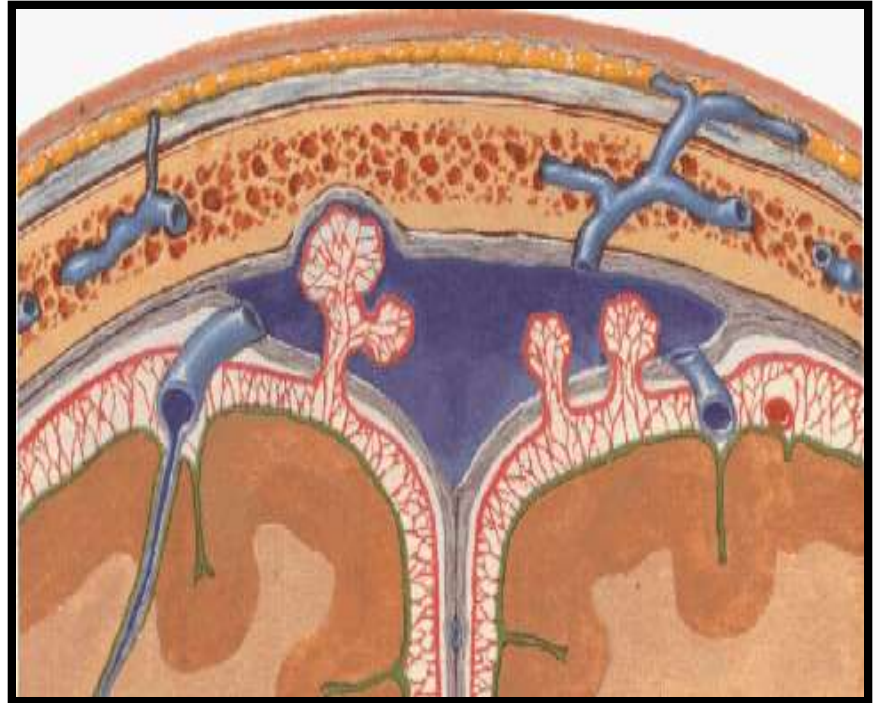
## Dural Venous Drainage

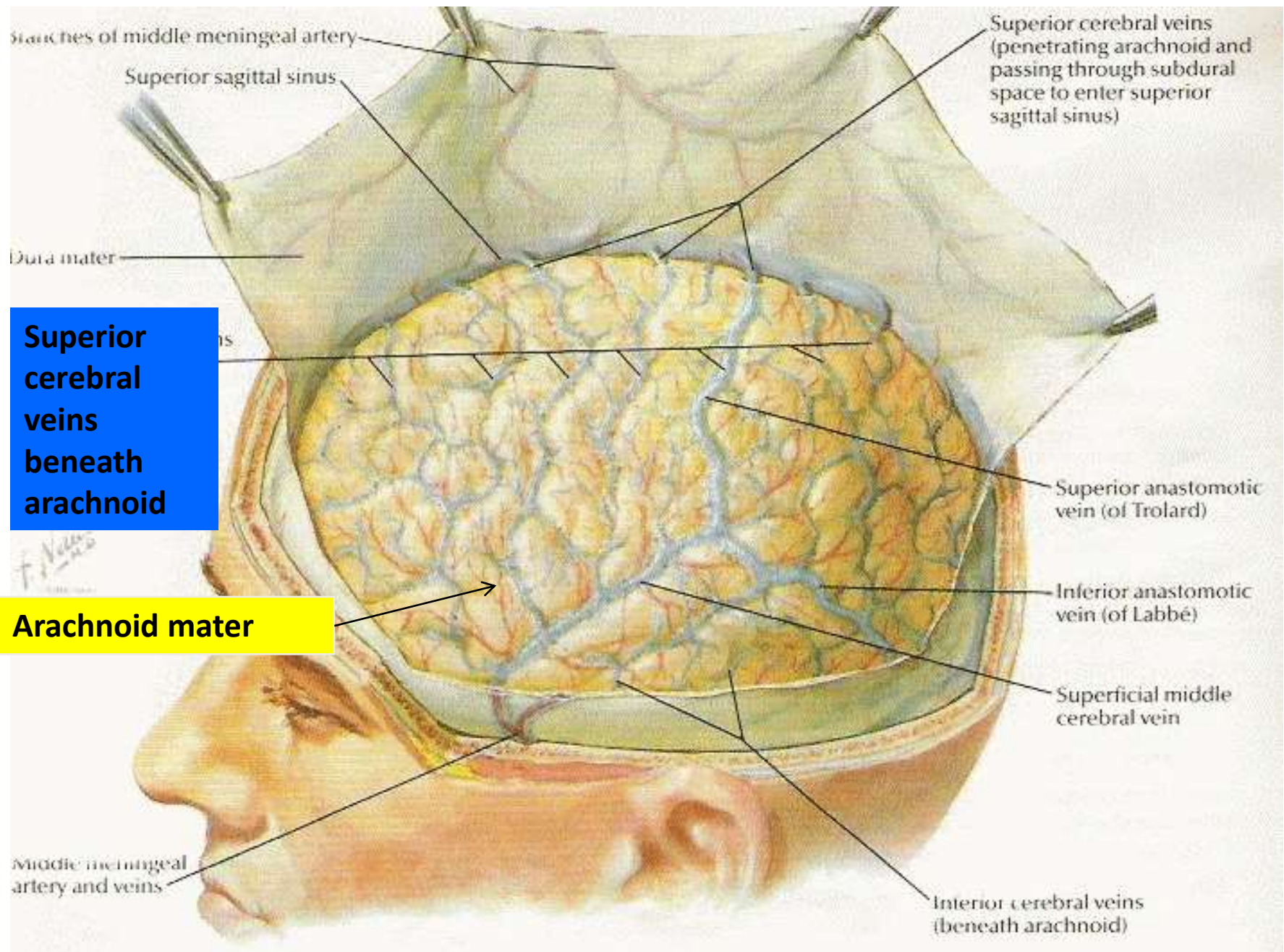
- The meningeal veins lie in the endosteal layer of dura.
- The middle meningeal vein follows the branches of the middle meningeal artery and drains into the pterygoid venous plexus or the sphenoparietal sinus.



# Arachnoid Mater

- ✓ It is a thin, avascular transparent membrane covering the brain.
- ✓ Lying between Pia mater (internally) & dura mater (externally)
- ✓ Separated from dura mater by a potential space, the **subdural space** (filled by a film of fluid)
- ✓ Separated from pia mater by **the subarachnoid space** (filled with CSF)







# Arachnoid mater

Arachnoid projects into venous sinuses

- sites for CSF diffuses into bloodstream

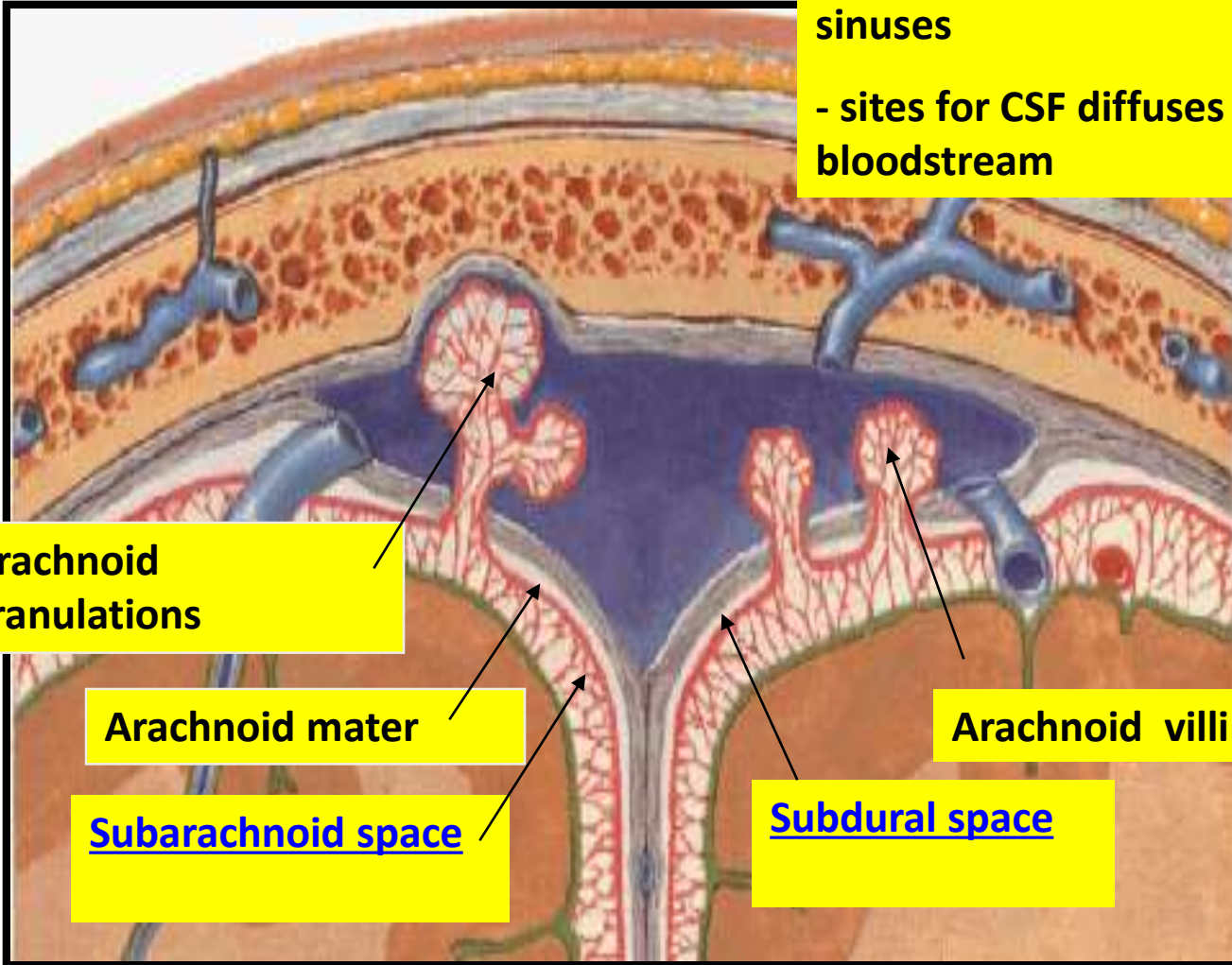
Arachnoid granulations

Arachnoid mater

Subarachnoid space

Arachnoid villi

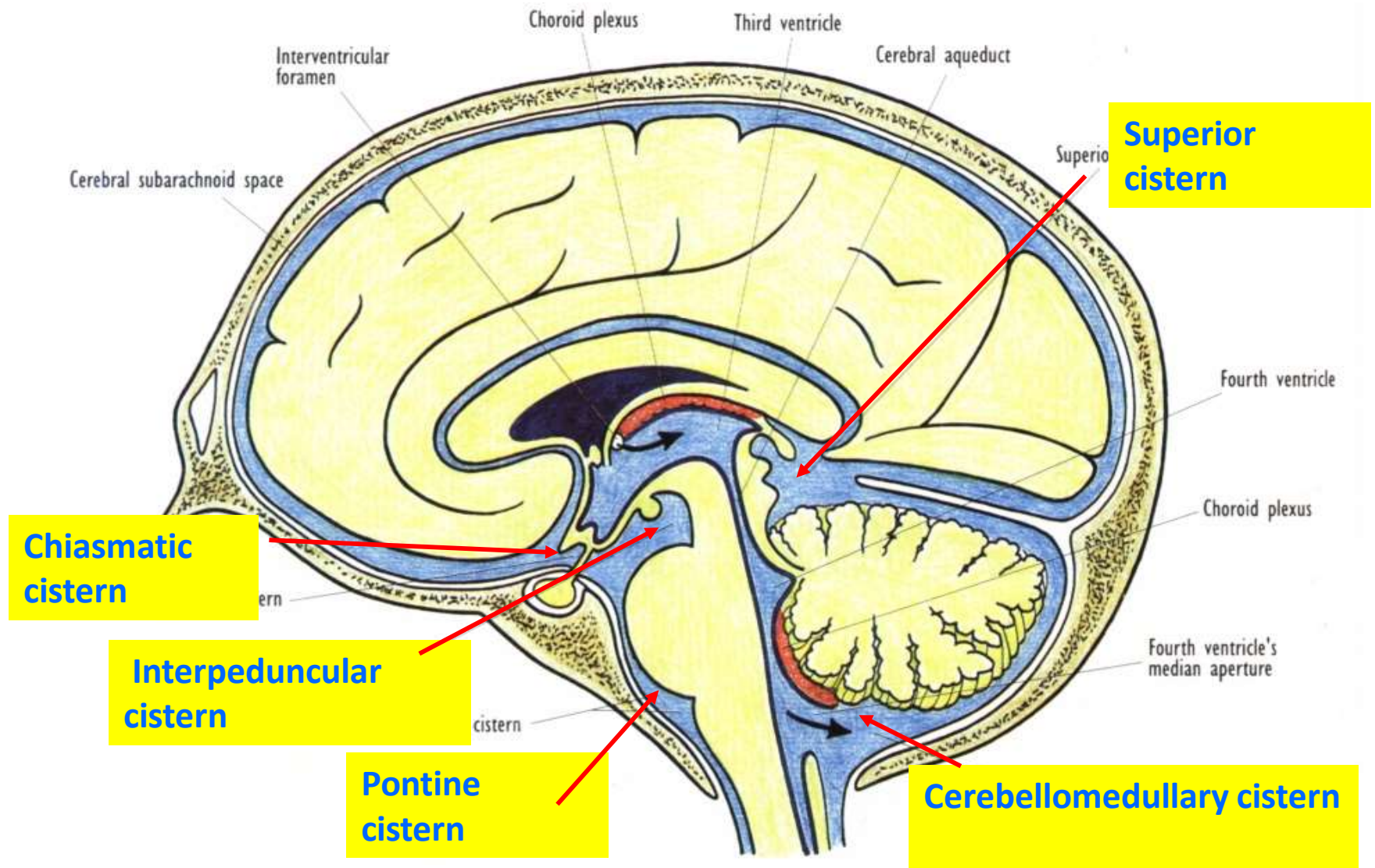
Subdural space





# Subarachnoid Space (SP) :

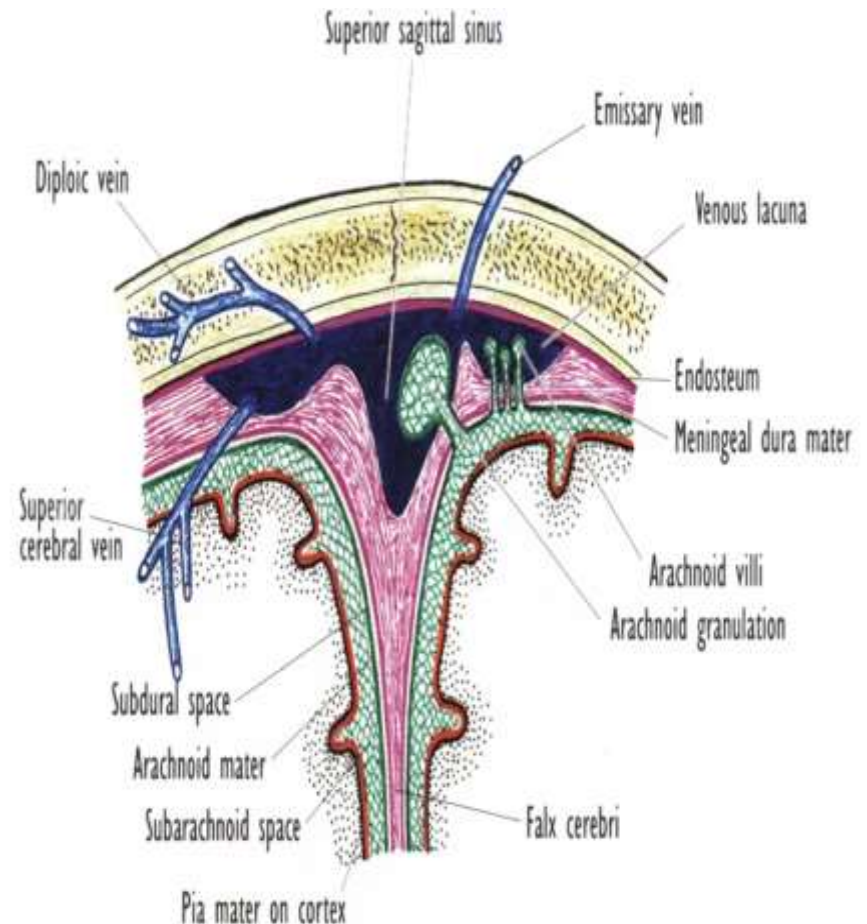
- Space between the arachnoid mater & pia mater.
- It is filled with CSF.
- It is relatively narrow over the surface of cerebral hemisphere, but sometimes it becomes much wider in areas at the base of the brain, the widest space is called subarachnoid cisterns.
- These cisterns are large pools of CSF & act as water-bed to the brain.
- The cisterna magna/cerebellomedullary cistern lies between inferior surface of the cerebellum and roof of 4<sup>th</sup> ventricle.



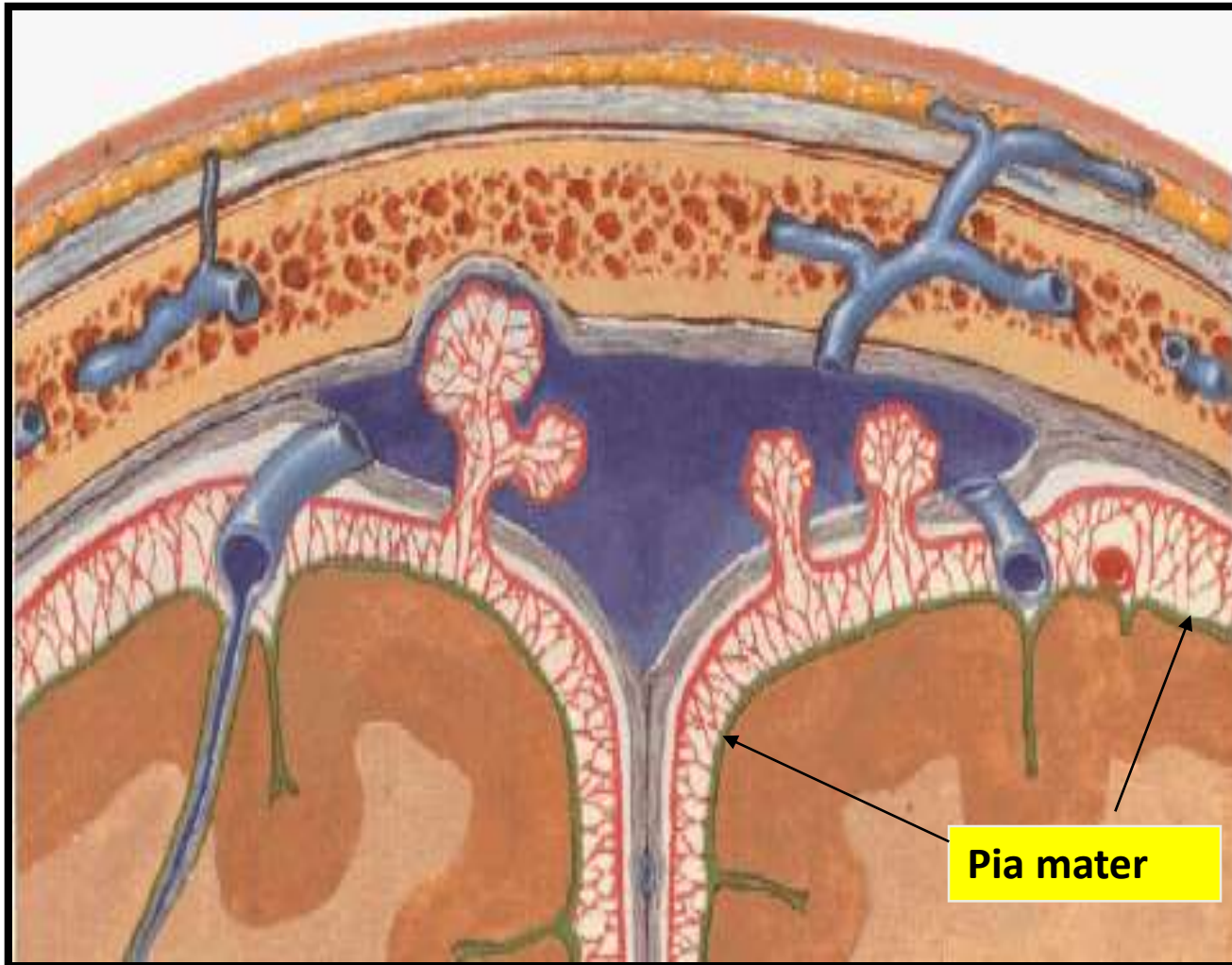
**Median sagittal section to show the subarachnoid cisterns & circulation of CSF**

- Pia mater is thin transparent vascular membrane which closely invests the surface of brain & is covered by mesothelial cells.
- All blood vessels to brain run on it before entering the brain.
- The pia mater forms the TELA CHOROIDEA .
- Tela choroidea is thin, highly vascularised, loose connective tissue, portion of pia mater that gives rise to the choroid plexus. I.e. The tela choroidea fuse with ependyma to form the choroid plexus .
- Choroid plexus forms CSF.

# Pia Mater



# Pia mater



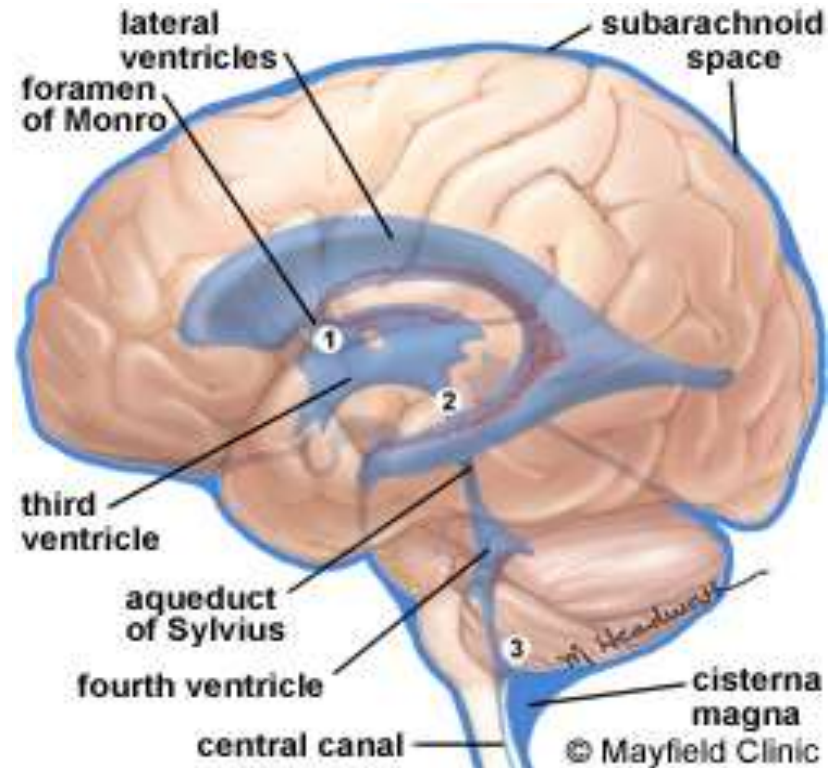


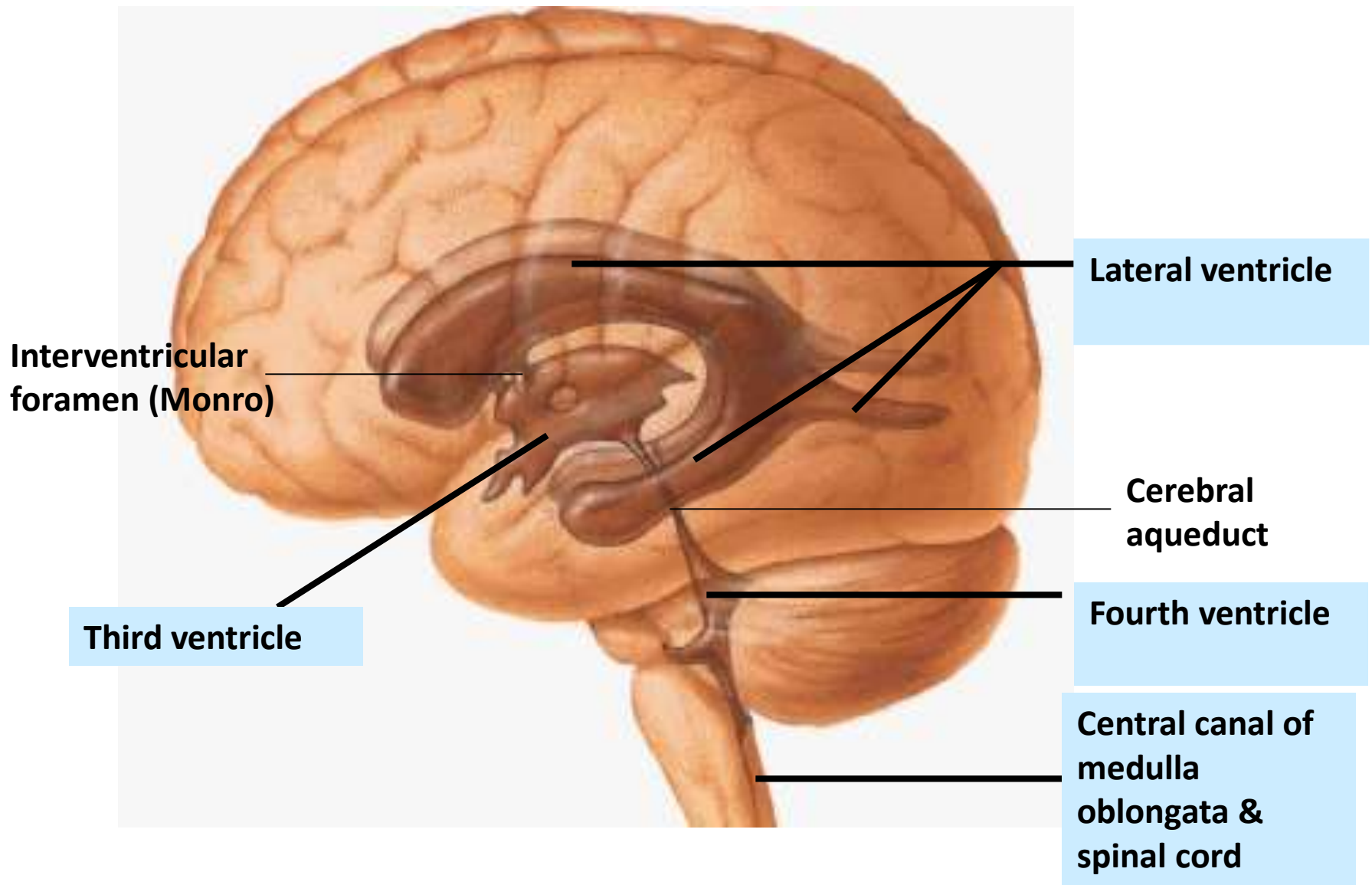
# VENTRICLES (Ventricular System)

A ventricle is an internal cavity of the brain. Within the brain, which is filled with cerebrospinal fluid (CSF).

## CONSISTS OF :

- 1) Lateral ventricle
- 2) Third ventricle
- 3) Fourth ventricle





**Lateral view to show the ventricular system of the CNS**

# What is cerebrospinal fluid (CSF) ?

- CSF is clear, colorless & slightly alkaline fluid.
- Produced by the choroid plexus in the lateral, third & fourth ventricle.
- It is formed by invaginating of vascular *pia mater* into the ventricular cavity
- Found in the :
  - Ventricles of the brain
  - Subarachnoid space (between Arachnoid + Pia mater) around the brain & spinal cord.

## Physical characteristics and composition of the CSF

Appearance	Clear and colourless
Volume	150 ml
Rate of production	0.5 ml/min
Pressure	60-150 mm of water
Composition	
protein	25 mg/100ml
glucose	50 mg/ 100ml
chloride	120 mg/ 100 ml
No. of cells	0-5 lymphocytes/cu mm



# Function of the CSF :

1. It serves as cushions between the CNS & surrounding bones & protects the CNS from trauma.
2. CSF acts as shock absorber.
3. Support the brain & spinal cord, & maintains a uniform pressure upon them.
4. Nourishes the CNS.
5. Removes metabolites (waste products) from the CNS.

# CSF Circulation

- The CSF is formed in the lateral ventricles ,from where it passes through the ***foramen of Monro/interventricular foramina*** into the third ventricle.
- From the 3<sup>rd</sup> ventricle into the 4<sup>th</sup> ventricle via cerebral aqueduct.
- Then from the fourth ventricle the fluid is poured into the subarachnoid spaces through the medial ***foramen of Magendie*** and the two lateral ***foramina of Luschka***.
- From these sites the fluid flows slowly in the subarachnoid space over the brain & spinal cord.

## Site of formation

Choroid plexus of the lateral ventricle

### 1. Lateral ventricle

*Interventricular foramina*

### 2. Third ventricle

*Cerebral aqueduct*

### 3. Fourth ventricle

3.2 Lateral foramina (Luschka)

3.1 Median foramen (Magendie)

3.2 Lateral foramina (Luschka)

### 4. Subarachnoid space

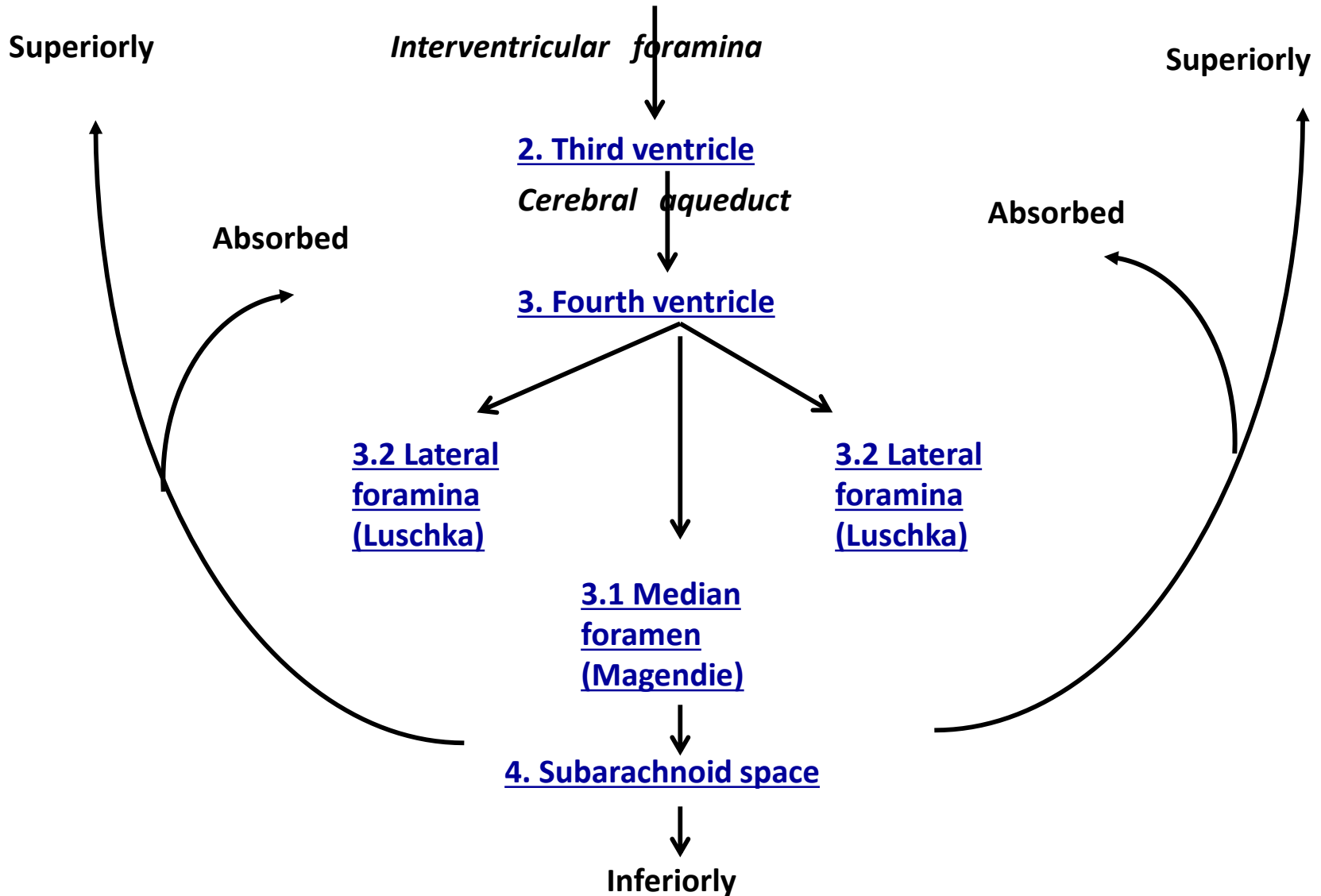
Inferiorly

Superiorly

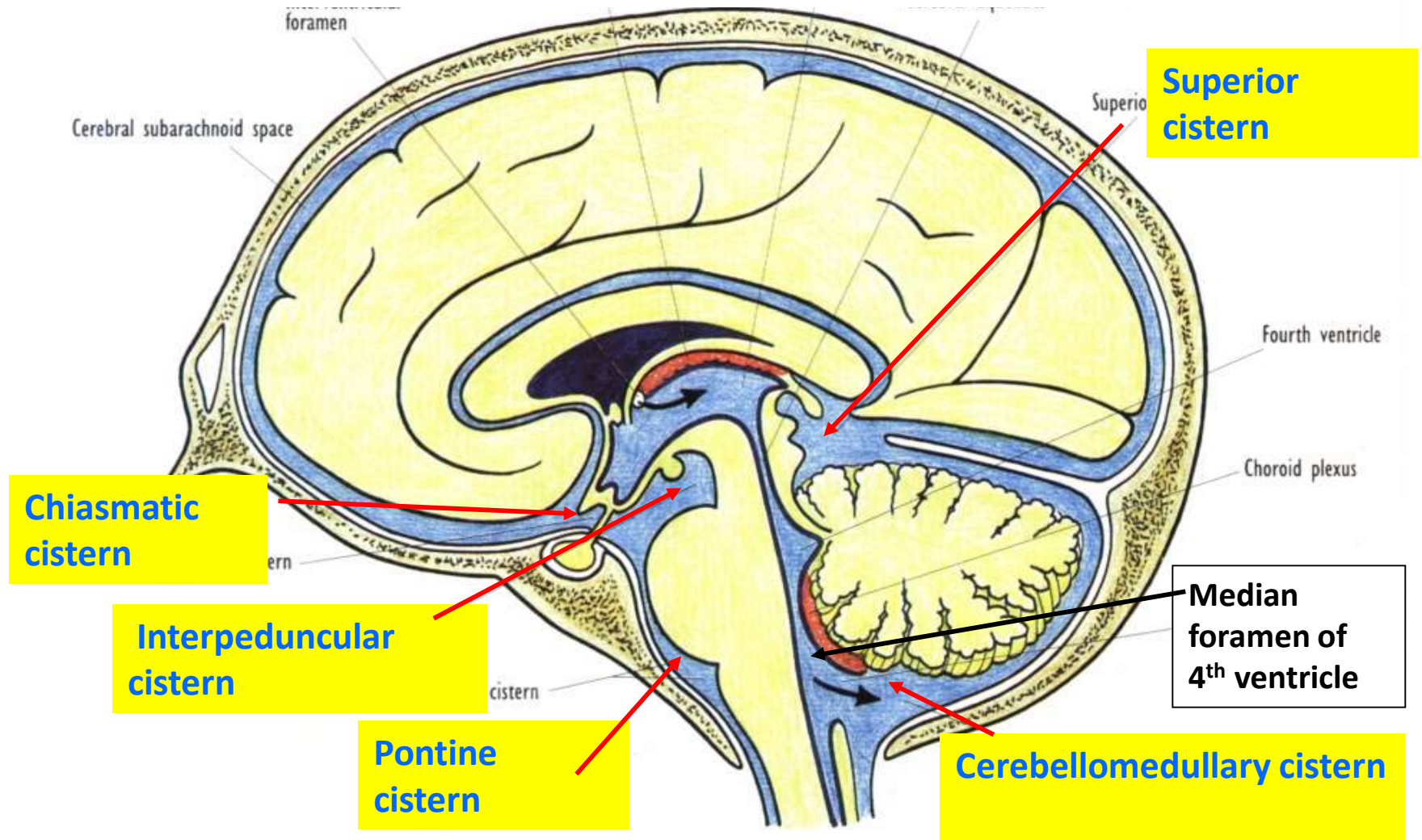
Superiorly

Absorbed

Absorbed



# Circulation of CSF in subarachnoid space :



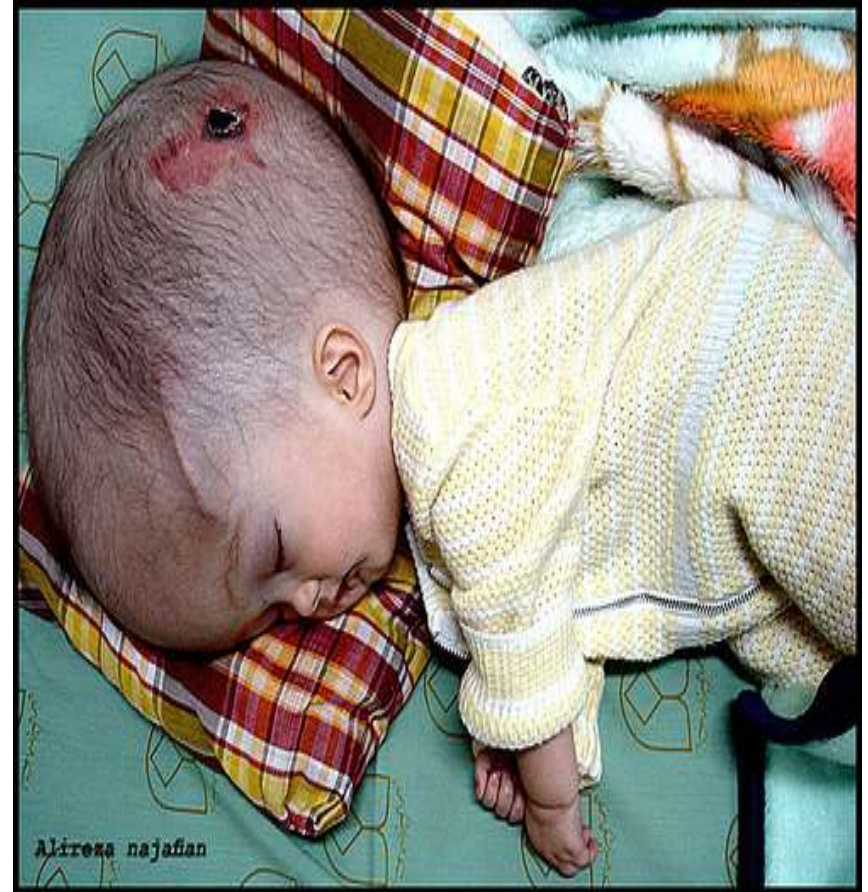
Median sagittal section to show the subarachnoid cisterns & circulation of CSF



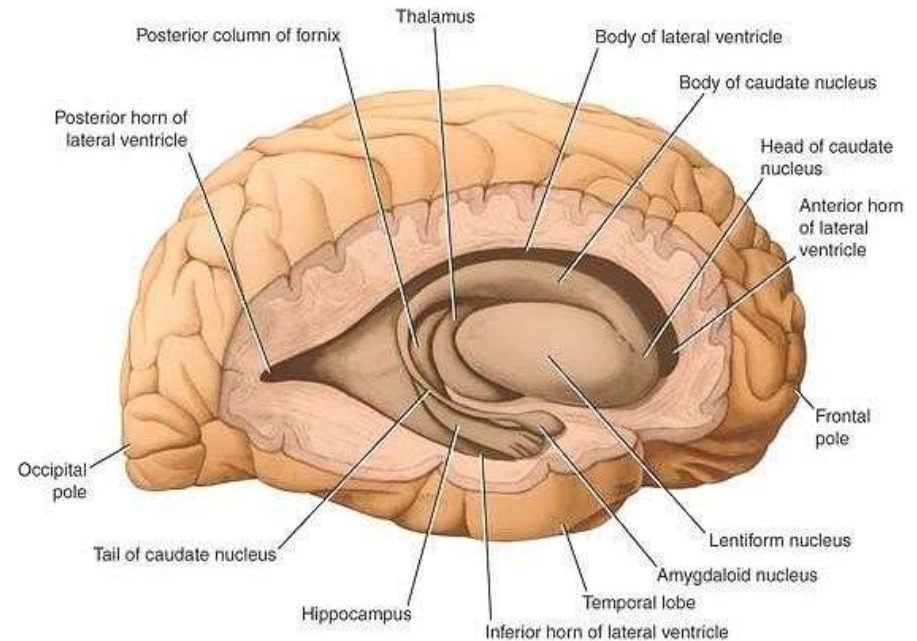
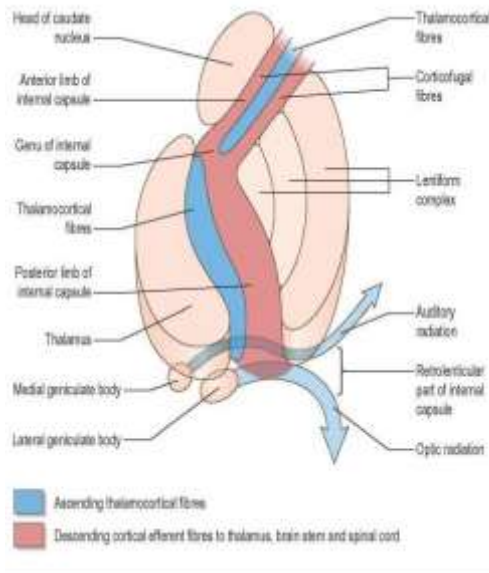
# CLINICAL APPLICATION

## Hydrocephalus

- The term hydrocephalus is derived from the Greek words "hydro" meaning water and "cephalus" meaning head.
- It is an abnormal increase in the volume of CSF within the skull.



# BASAL GANGLIA/NUCLEI & WHITE MATTER OF CEREBRUM



# BASAL GANGLIA/NUCLEI

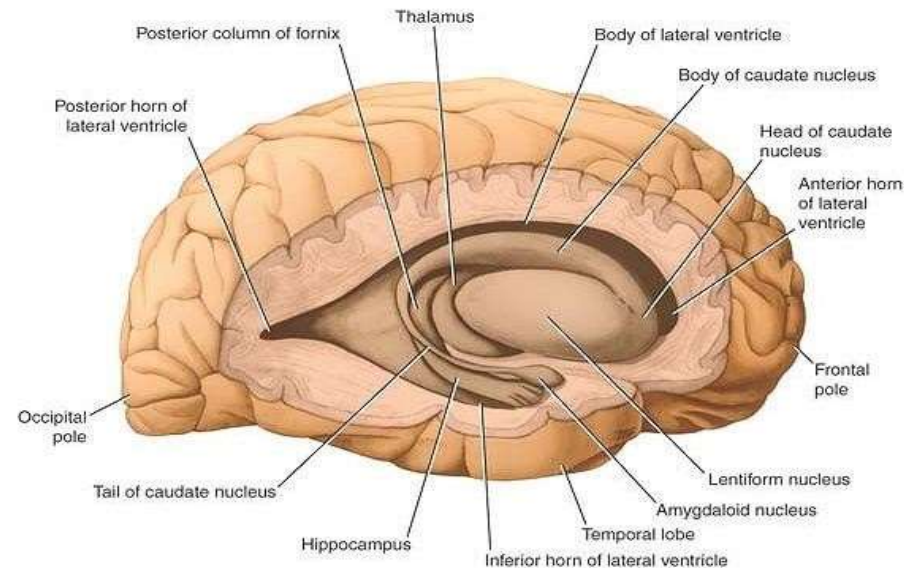
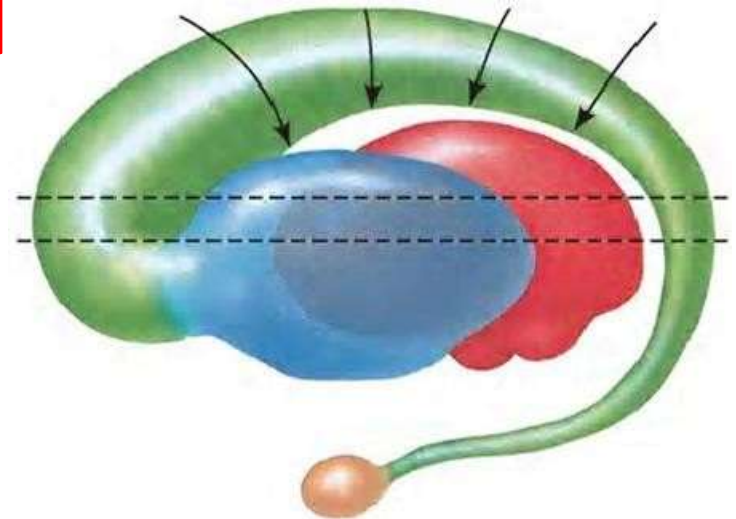
Collection of masses of grey matter within the cerebral hemisphere

- Constituents:

***1. Corpus striatum***

***2. Claustrum and***

***3. Amygdaloid body***



# CORPUS STRIATUM

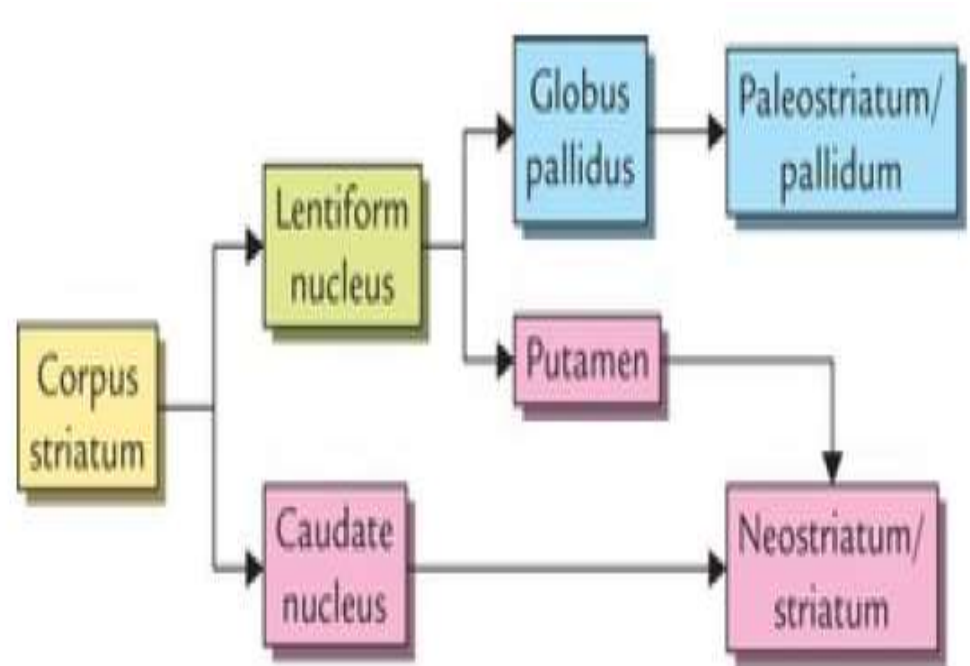
Forms 2 units-

- Neostriatum
- Paleostriatum
- Neostriatum includes

- Caudate nucleus
- Putamen

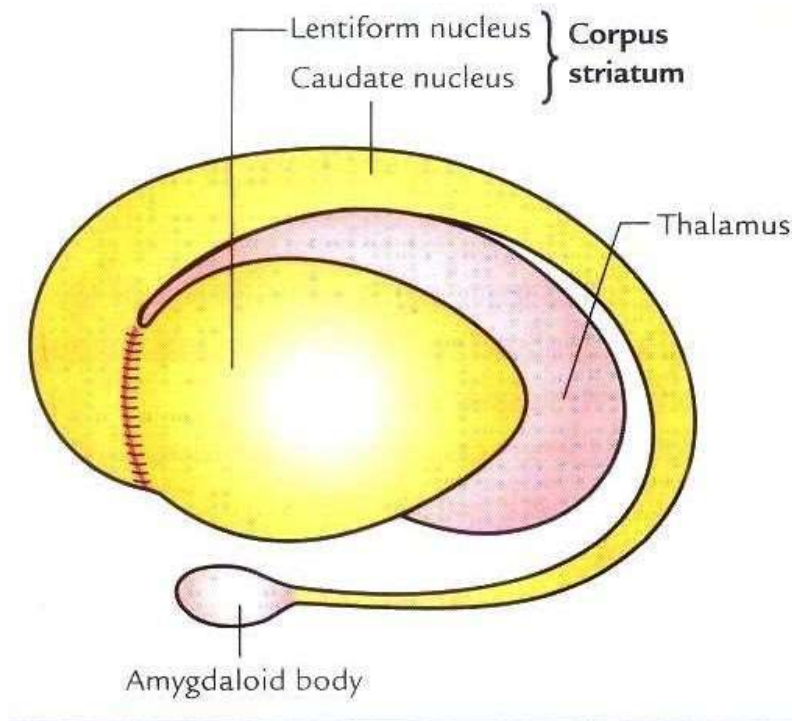
- Paleostriatum includes-

- Globus pallidus

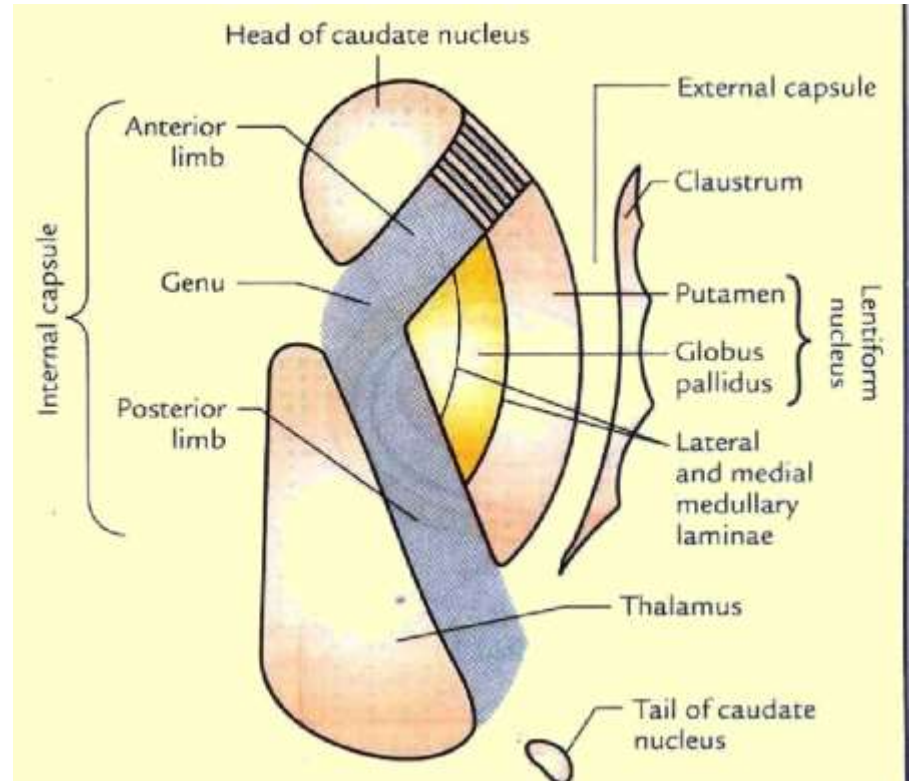




- ✓ Situated lateral to the thalamus.
- ✓ Divided into the *caudate nucleus* and *lentiform nucleus* by the internal capsule.



Lateral aspect of the left corpus striatum.



# CAUDATE NUCLEUS

- ✓ Large comma-shaped mass of grey matter
- ✓ Consists 3 parts-

## Head:

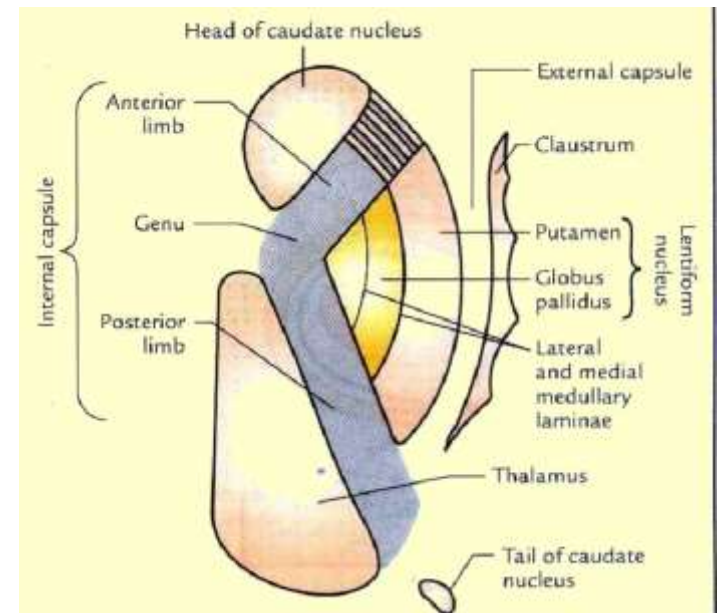
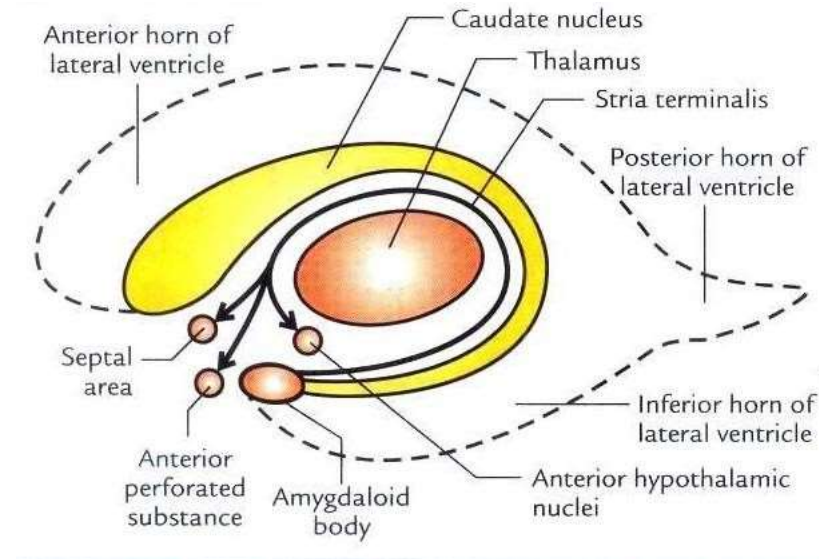
- ✓ Large, rounded
- ✓ Forms the floor and lateral wall of anterior horn of lateral ventricle
- ✓ Related laterally to- anterior limb of internal capsule, lentiform nucleus

## Body:

- ✓ Long and narrow
- ✓ Forms the floor of the central part of lateral ventricle

## Tail:

- ✓ Forms the roof of inferior horn of lateral ventricle
- ✓ Terminates in the amygdaloid body



## LENTIFORM NUCLEUS

- Large lens shaped (biconvex) mass of grey matter
- Beneath the insula and lateral to internal capsule

Parts: External medullary lamina divides it into:

- a. Putamen: Lateral part, small cells, darker in color
- b. Globus pallidus: Medial part, large (motor) cells, lighter in color



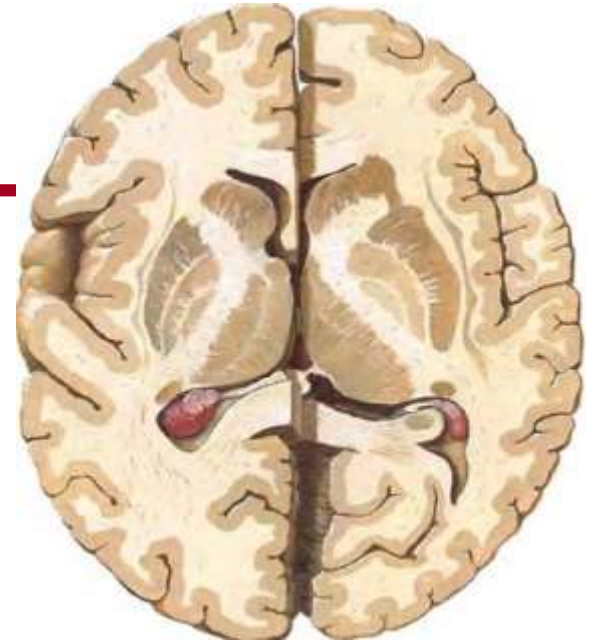
## **CLAUSTRUM:**

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- Thin sheet of grey matter
- Intervenes between putamen and insula

## **AMYGDALOID BODY:**

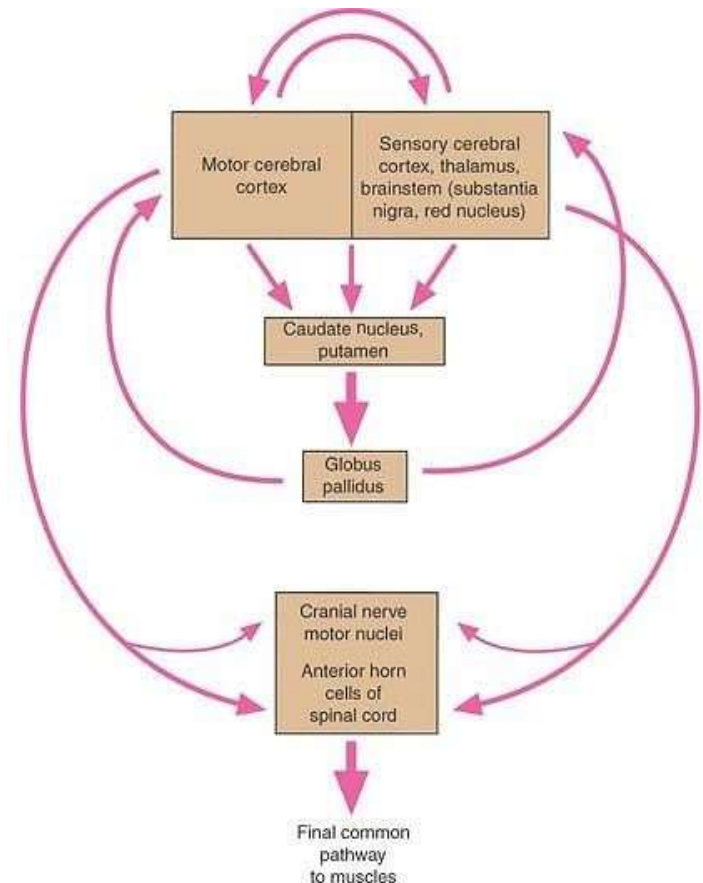
- ✚ An almond shaped mass of grey matter temporal lobe deeper to uncus
- Lies anterosuperior to the tip of inferior horn of lateral ventricle
- Part of limbic system





# Functions of Basal Nuclei

- Planning & programming of the voluntary movements
- Regulate the muscle tone to smoothen the voluntary motor activities
- Determining the rapidity of the movements
- Control automatic associated movements
- Examples:
  - ✓ Skillful acts of hands
  - ✓ Writing letters
  - ✓ Drawing diagrams
  - ✓ Passing football
  - ✓ Throwing volleyball



# WHITE MATTER OF CEREBRUM

3 Groups:

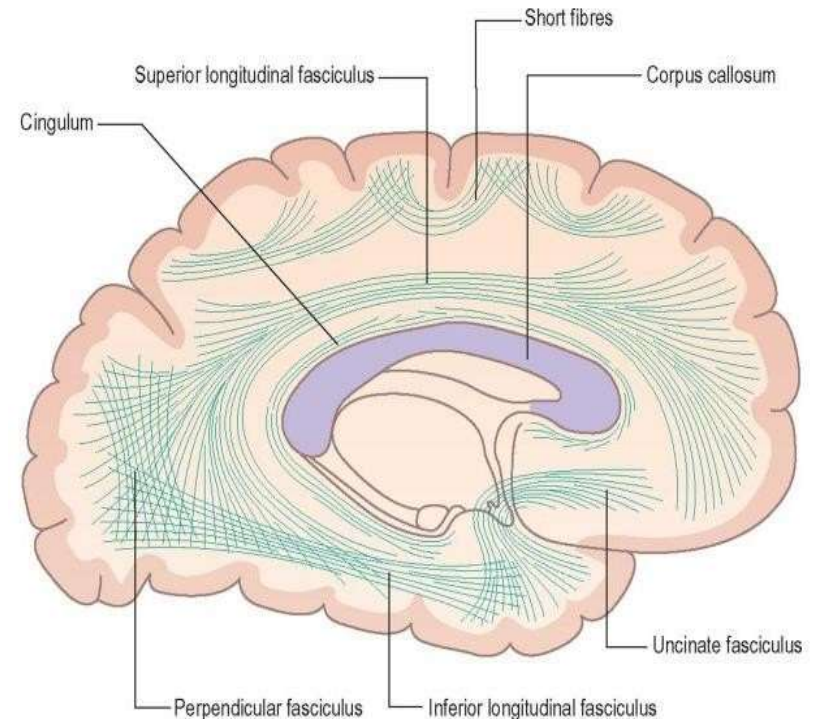
1. Association Fibres
2. Commissural Fibres
3. Projection Fibres

## A. Association fibers

- ❖ Connect several areas of same cerebral hemisphere
- ❖ Two types

i. Short fibers-

ii. Long fibers-

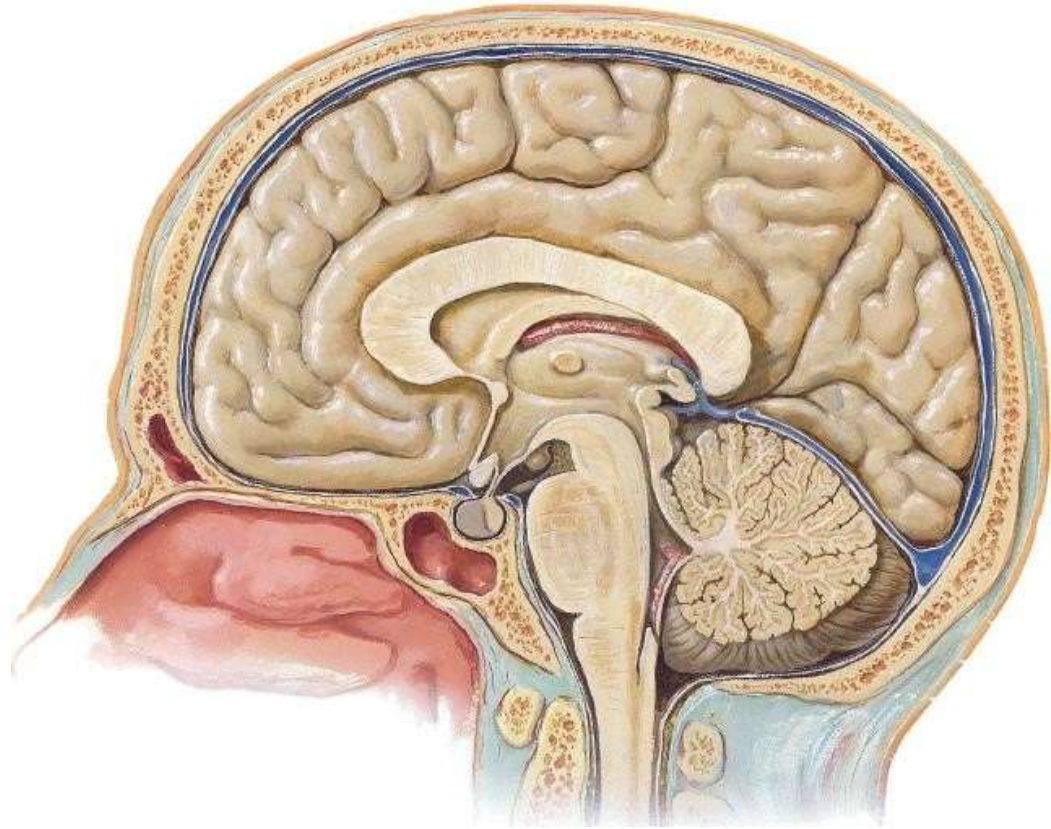


# B. Commissural fibers

- ❖ interconnect the identical areas of two cerebral hemispheres

## 1. Corpus callosum

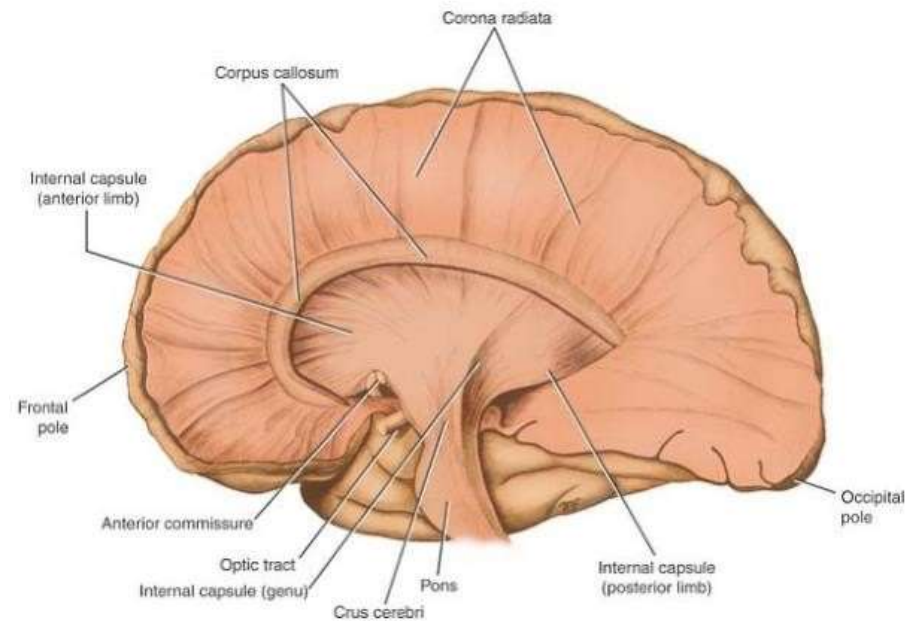
- ❖ Largest commissure
- ❖ Connects two cerebral hemispheres
- ❖ Arched band
- ❖ Convex- above
- ❖ Concave- below
- ❖ Parts: Anterior to posterior
  1. Rostrum
  2. Genu
  3. Body/trunk
  4. Splenium



## C. Projection fibers

❖ Connect cerebral cortex with subcortical grey mater (basal ganglia, thalamus, brain stem and spinal cord)

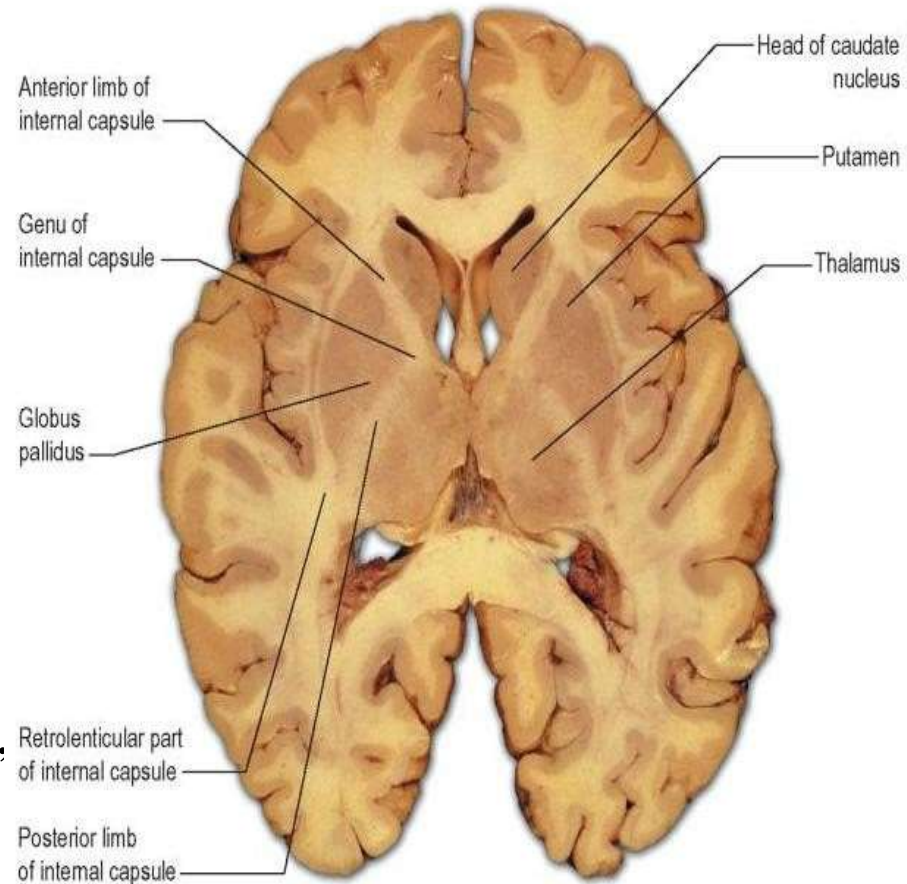
### 1. Internal capsule





# INTERNAL CAPSULE

- ❖ Contains incoming & outgoing fibers of cerebrum
- ❖ V-shaped in horizontal section
- ❖ Convex- medial
- ❖ Concave- lateral
- ❖ Parts:
  1. **Anterior limb**
  2. **Genu**
  3. **Posterior limb**
  4. **Sublenticular part**
  5. **Retrolenticular part**
- ❖ Relations:
  - Medial- head of caudate nucleus, thalamus
  - Lateral- lentiform nucleus



Damage to the internal capsule, due to haemorrhage or infarction leads to loss of sensations and spastic paralysis of the opposite half of the body (**contralateral hemiplegia**).

**THANK YOU**

**CLASS DISMISS**