

# ***CNS Module***

*Dr. Gamal Taha Abdelhady*

*Assistant Professor of Anatomy & Embryology*



***Meninges  
and CSF***



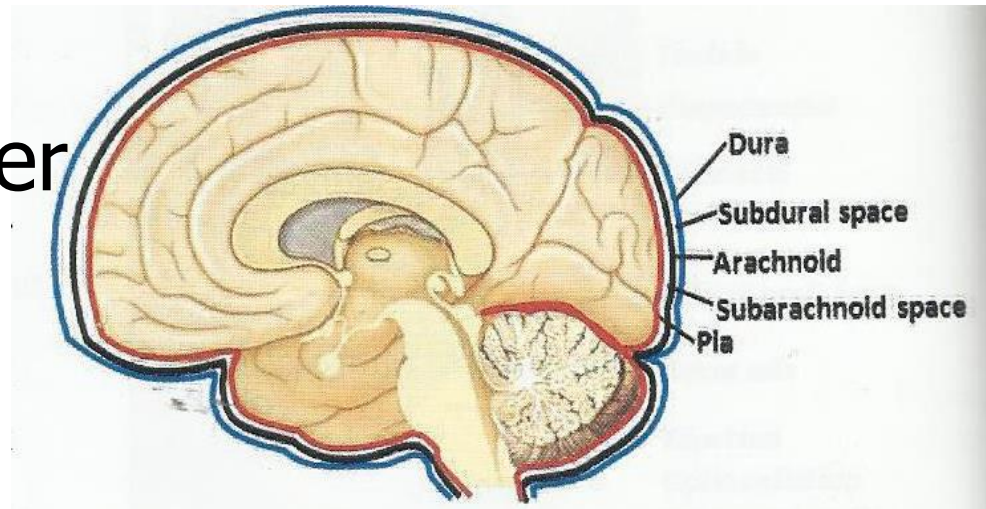
# ***Meninges and CSF***

---

- ***By the end of this lecture, the student should be able to:***
  1. Know the arrangements of the layers surrounding the brain in particular
  2. Identify the different characters for each of these layers
  3. Understand the process and formation of the CSF and follow its path

# *The Meninges*

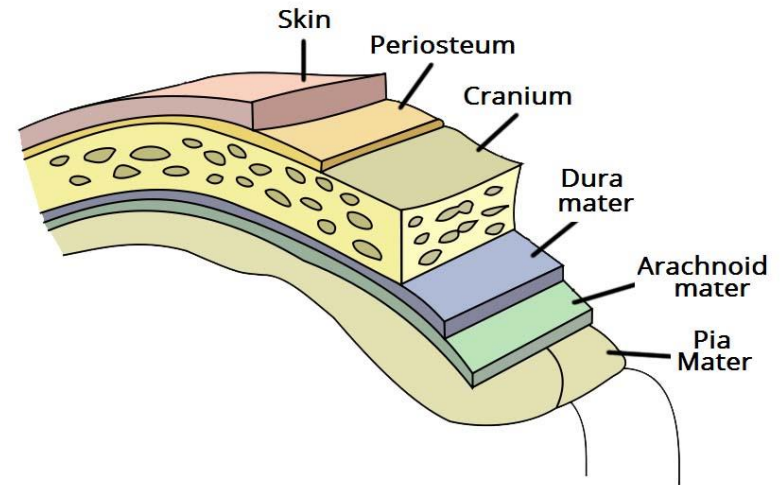
- The meninges are the membrane covering the brain and spinal cord.
- The Meninges consist of three membranes:
  1. The dura mater
  2. The arachnoid mater
  3. The pia mater



# *The Meninges*

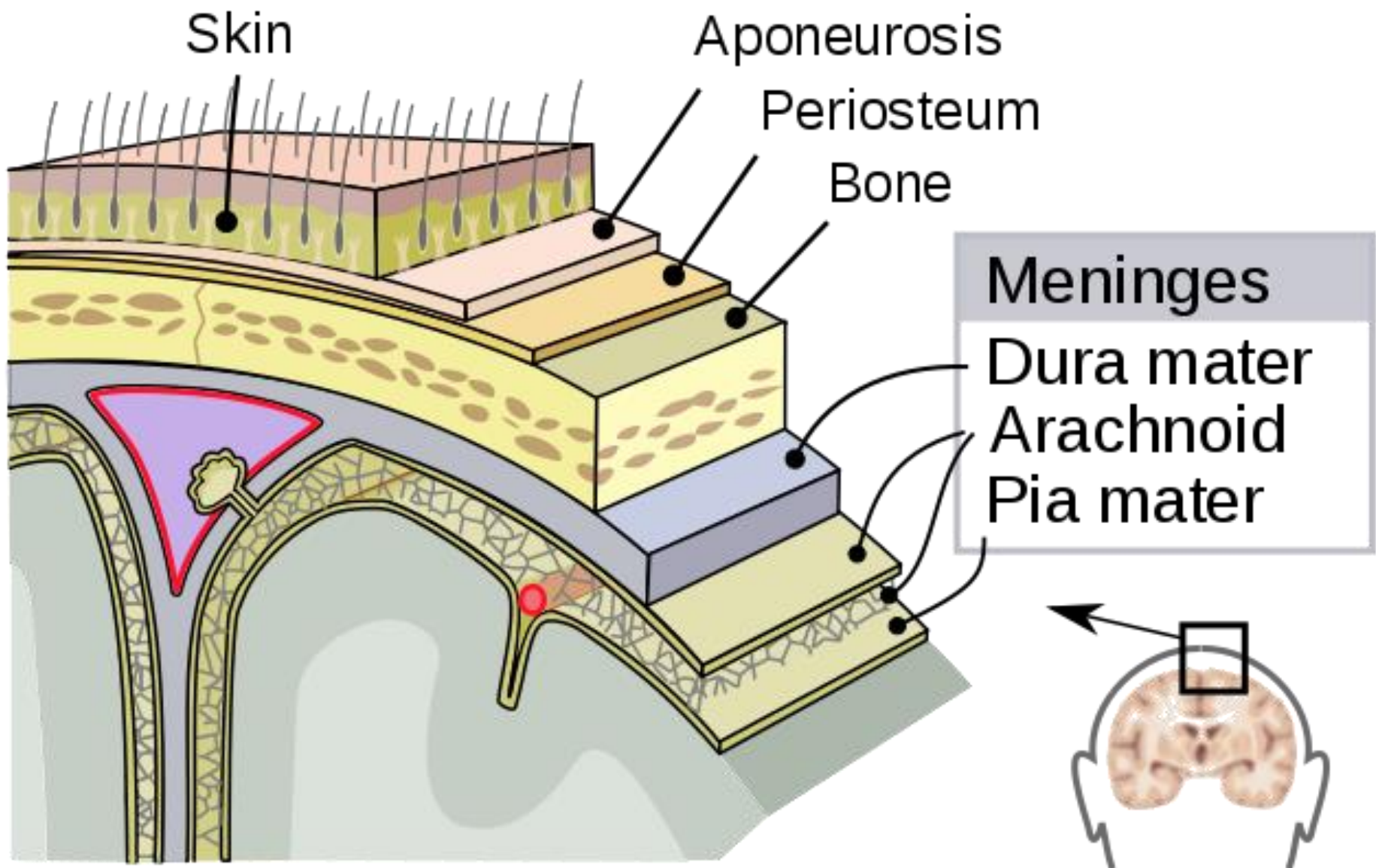
- **Dura mater** - strong, "Tough mother"

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



- **Arachnoid** - spidery, holds blood vessels

- **Pia mater** - "delicate mother"

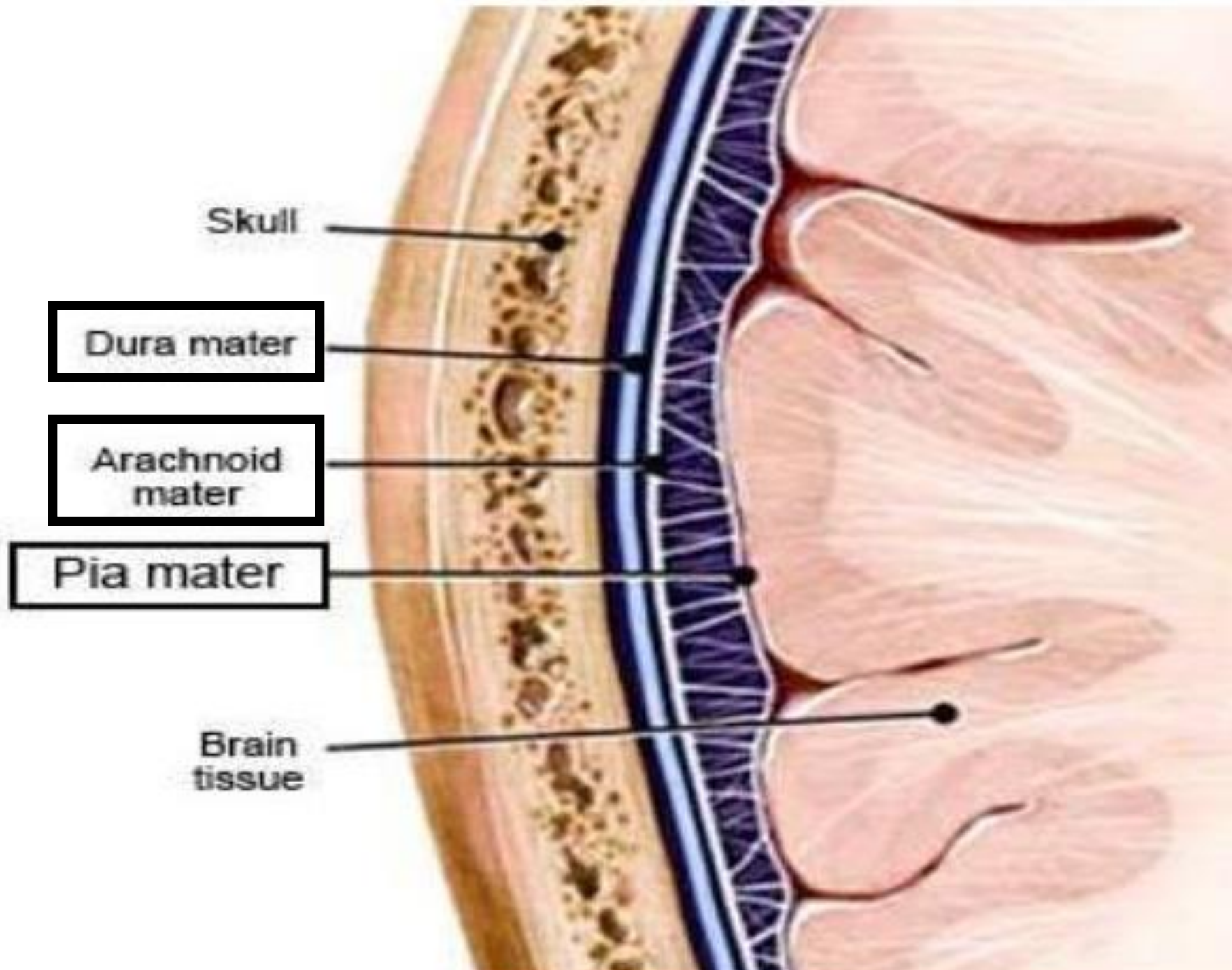




# ***Dura Mater***

---

- It is the outer layer and is tough and fibrous.
- The name dura mater is derived from Latin "tough mother".
- It is formed of two layers around the brain:
  1. The outer **endosteal layer** which is adherent to the skull
  2. The inner **meningeal layer** which forms 4 dural folds.
- The two layers lie close together but separate to include a **venous sinus**.



Skull

Dura mater

Arachnoid  
mater

Pia mater

Brain  
tissue



# *Dura Mater*

---

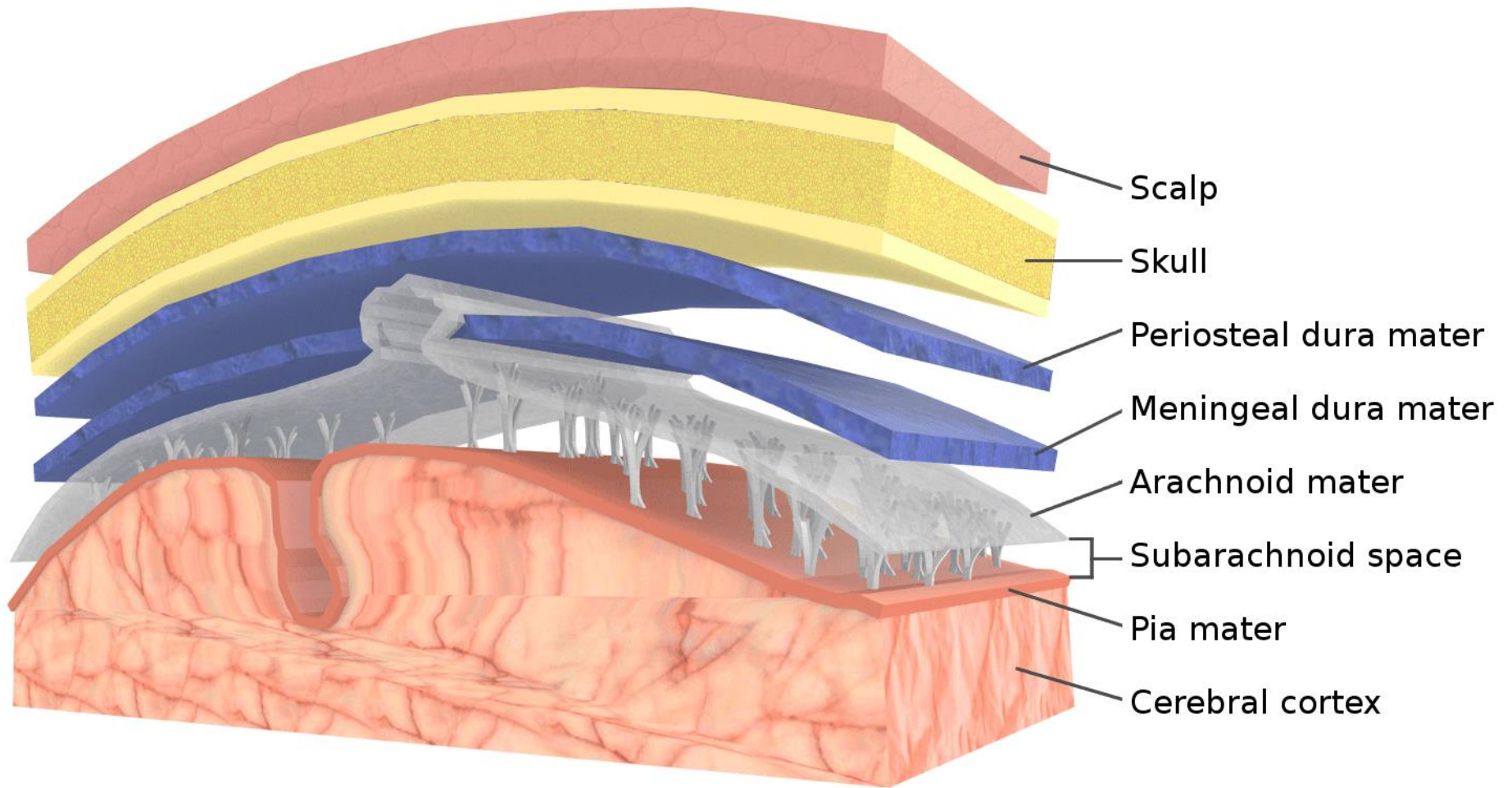
## *Outer Endosteal layer*

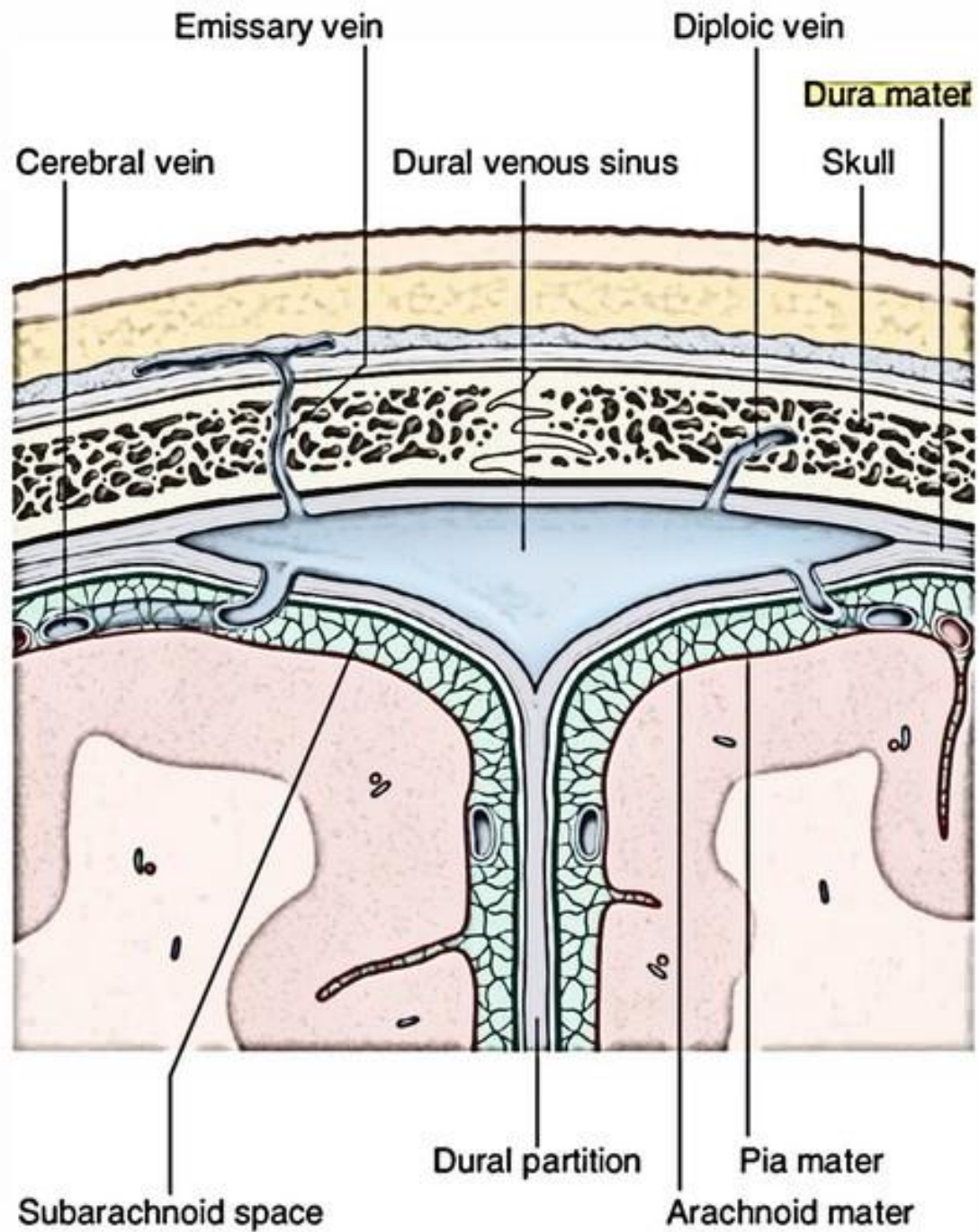
1. Periosteum present on the inner surface of the skull bones
2. *Not* continuous with dura mater of spinal cord

## *Inner Meningeal layer*

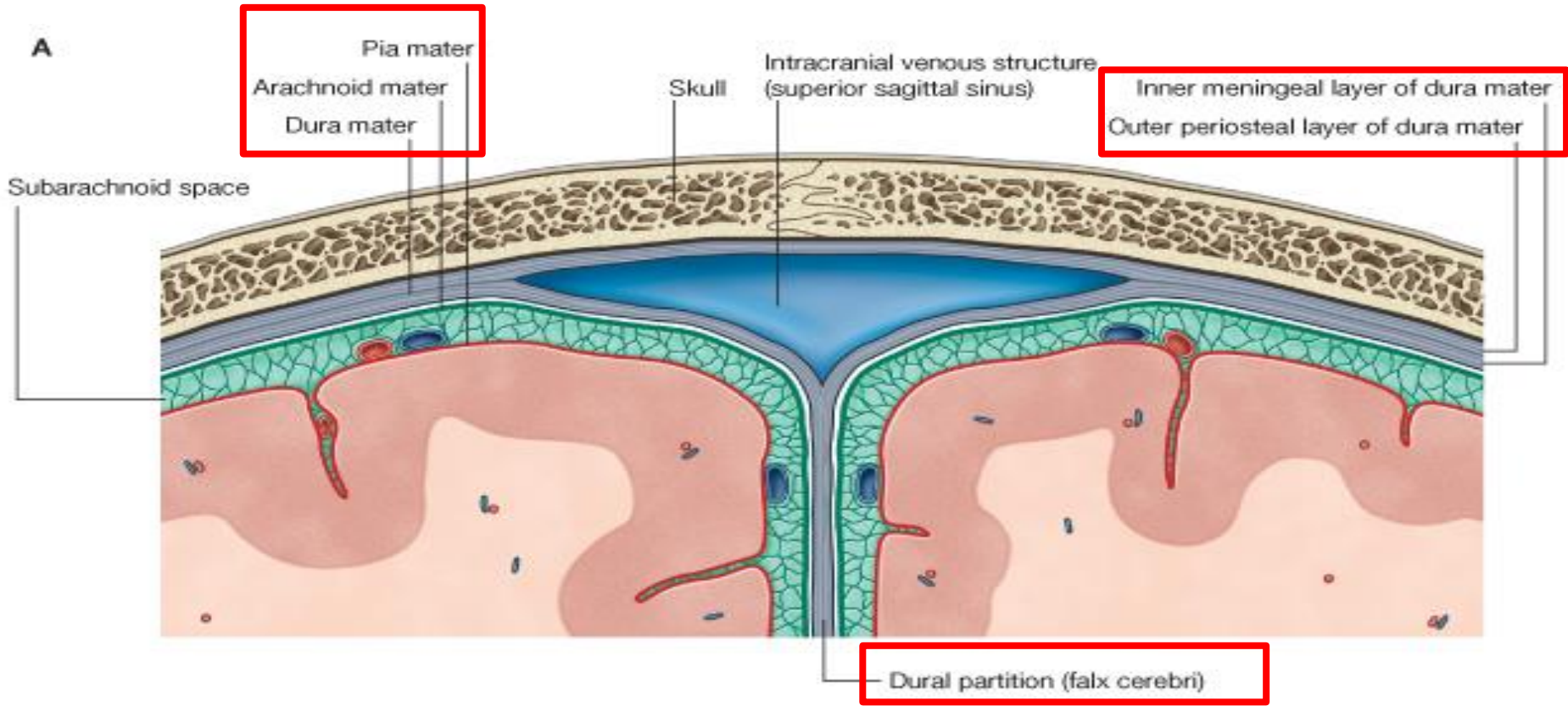
1. Dura mater proper
2. Continuous with dura mater of spinal cord
3. Sends four septa which divide the cranial cavity into freely communicating spaces that lodge the subdivisions of brain.



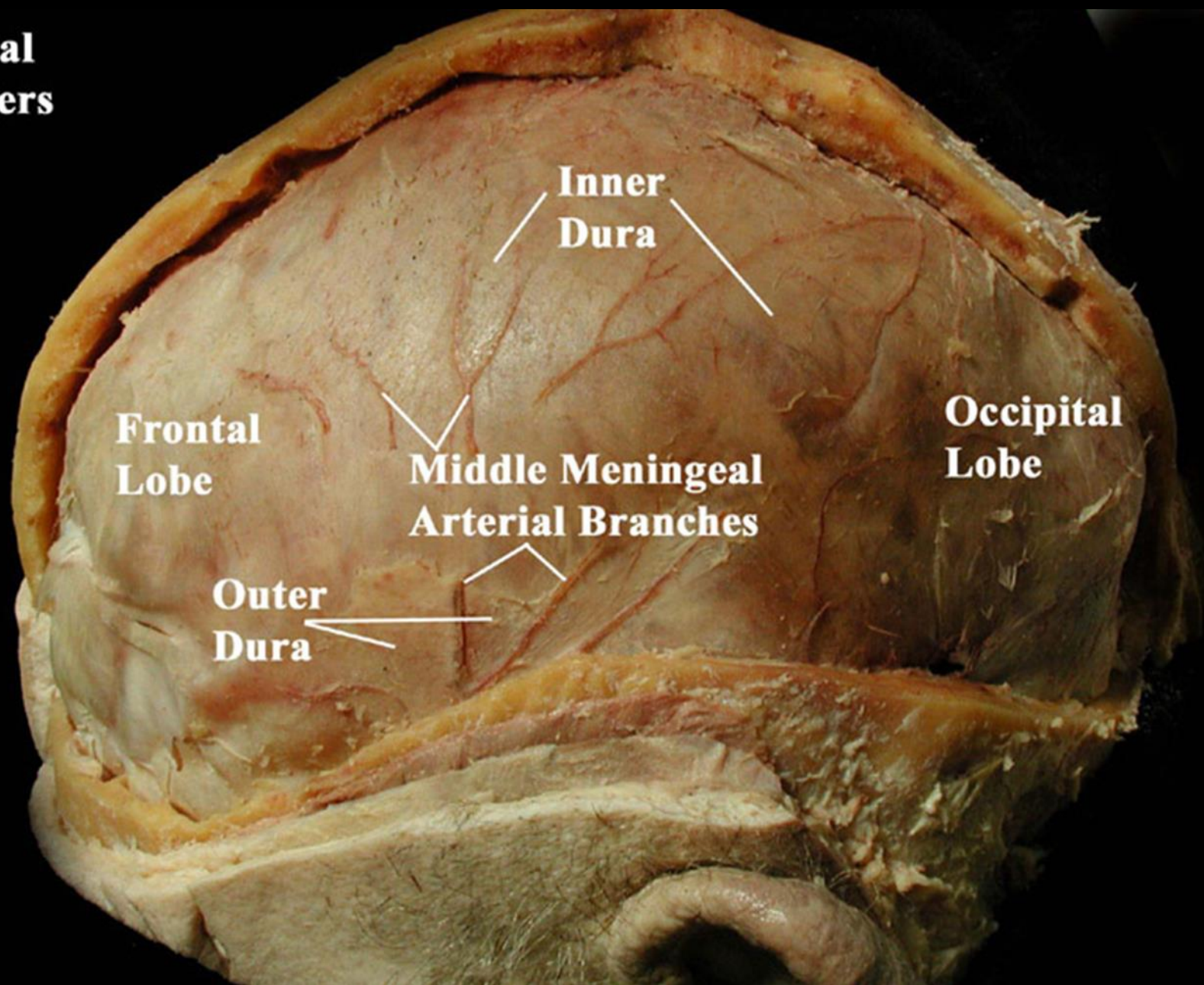




A



# Dural Layers



**Meningeal  
Layers**

**Bone**

**Dura**

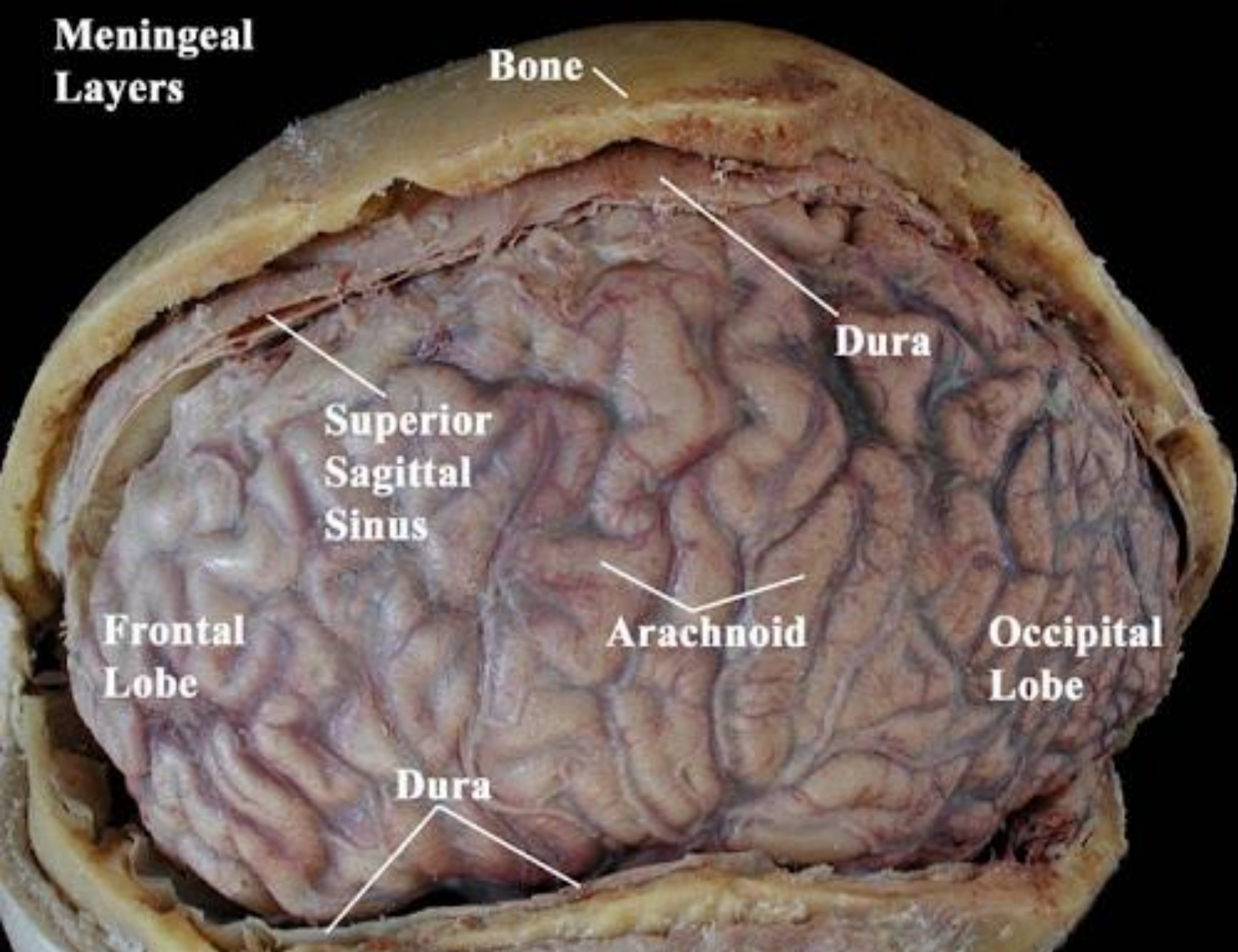
**Superior  
Sagittal  
Sinus**

**Frontal  
Lobe**

**Arachnoid**

**Occipital  
Lobe**

**Dura**

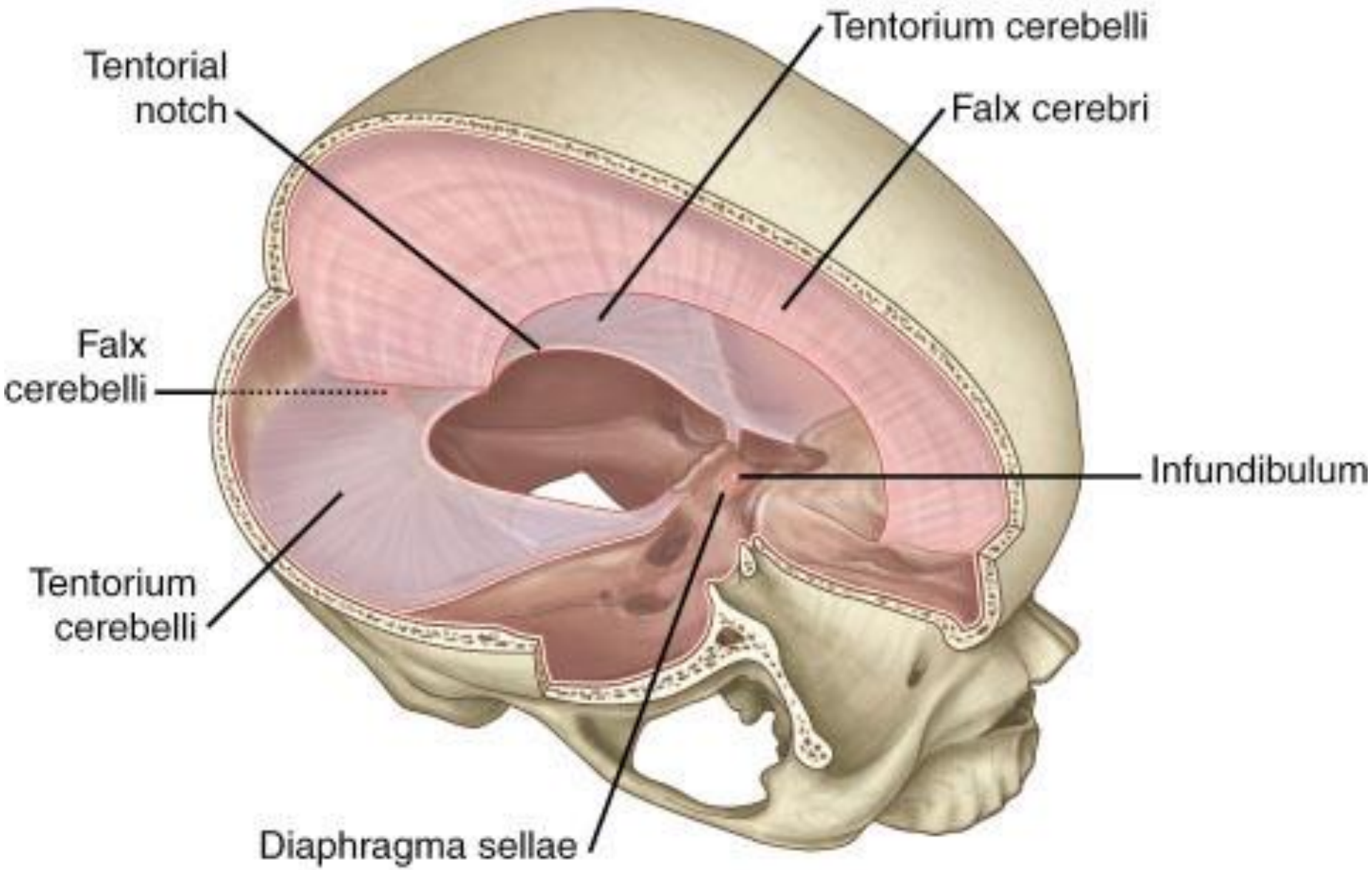




# *Dural Folds*

---

- Are formed by the meningeal (inner) layer of the dura mater *reduplicates* to form partition-like processes, between different parts of the brain.
- These folds are:
  - 1- Falx cerebri
  - 2- Tentorium cerebelli
  - 3 - Falx cerebelli
  - 4- Diaphragma sellae
- Function: They help to stabilize the brain within the cranial cavity during movements of head.



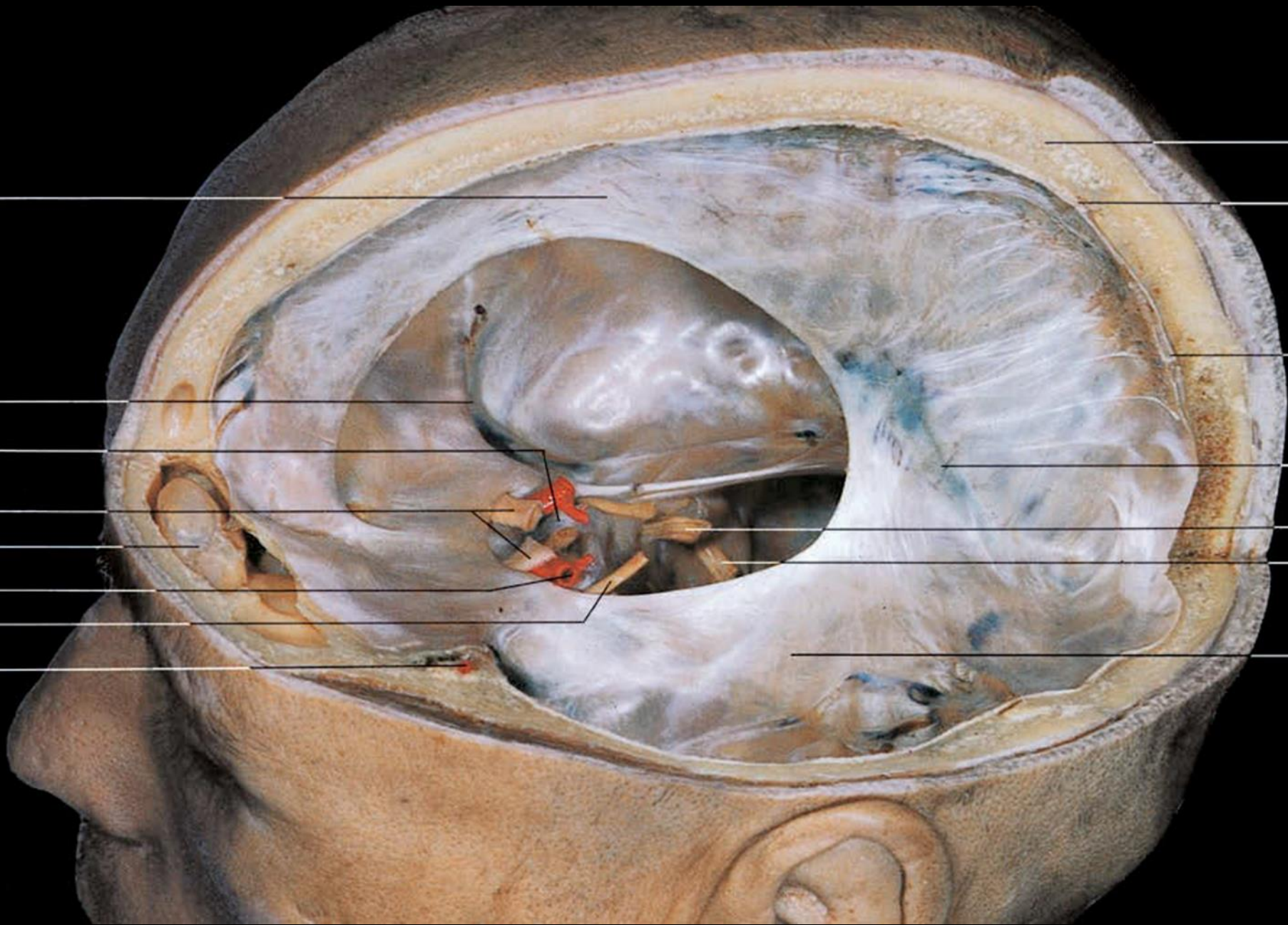


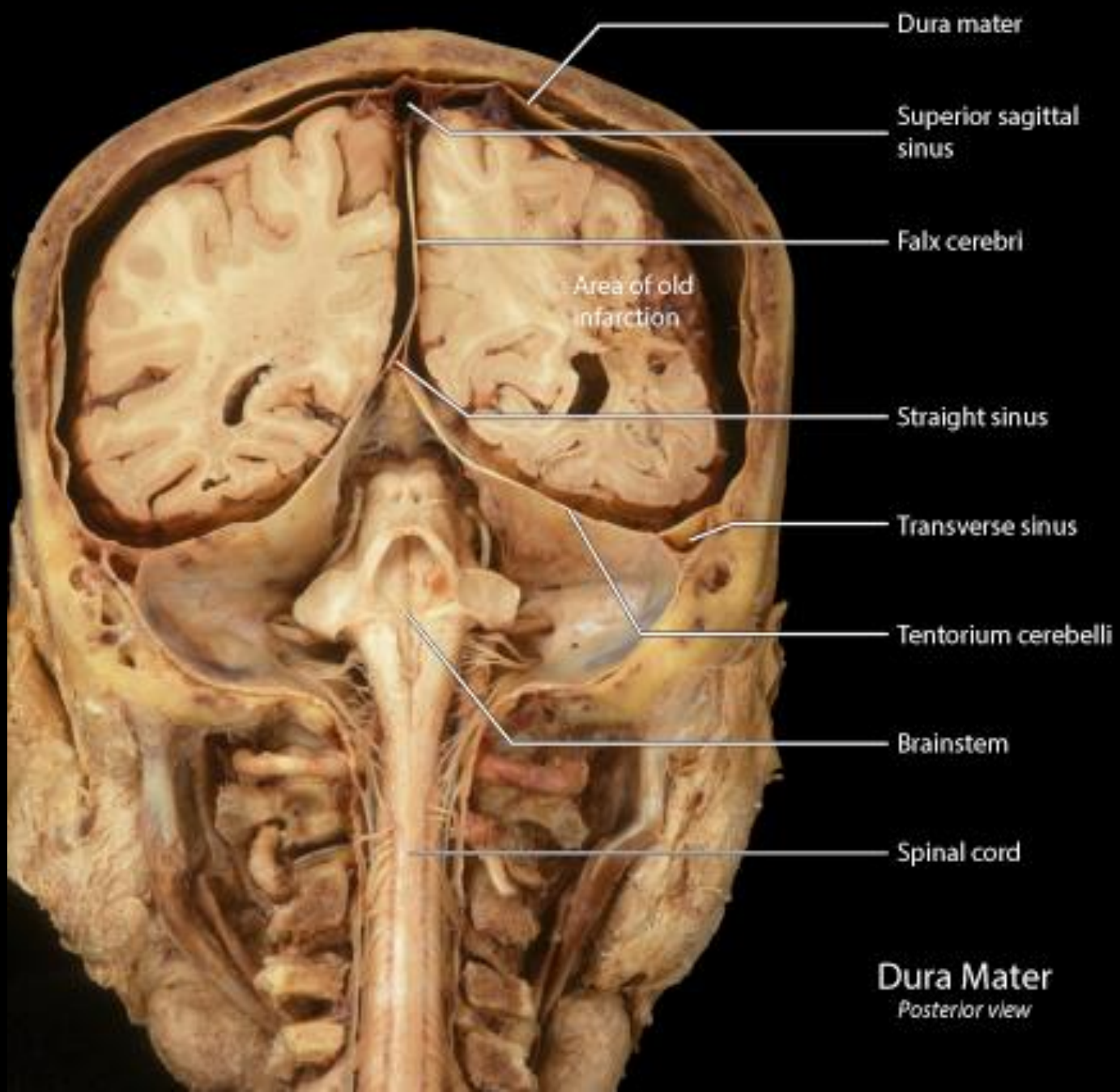
# *The Falx Cerebri*

---

- It is a sickle-shaped fold of dura mater that lies in the midline between the two cerebral hemispheres.
- Its narrow end in front is attached to the internal frontal crest and the crista galli.
- Its broad posterior part blends in the midline with the upper surface of the tentorium cerebelli.







Dura mater

Superior sagittal sinus

Falx cerebri

Area of old infarction

Straight sinus

Transverse sinus

Tentorium cerebelli

Brainstem

Spinal cord

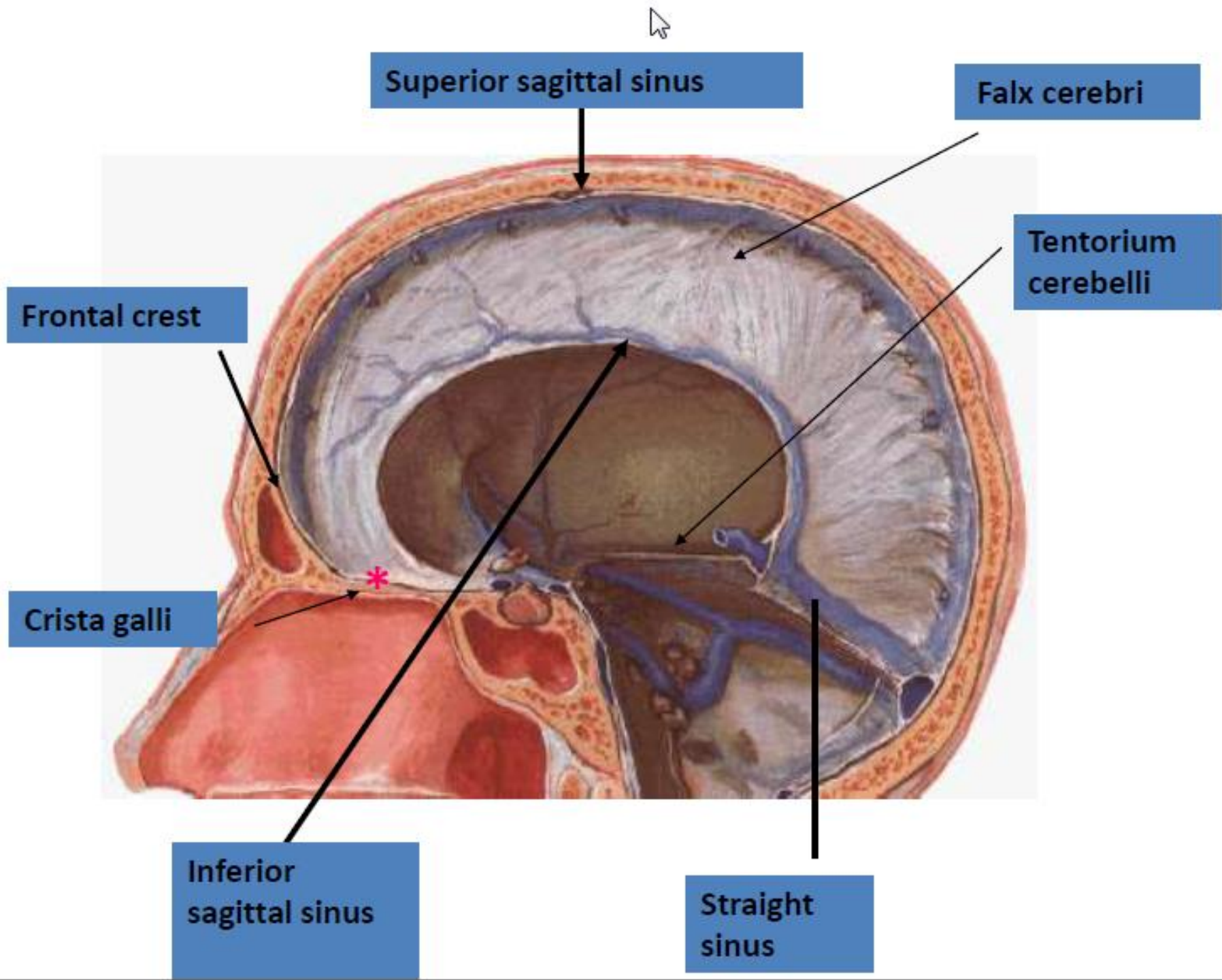
**Dura Mater**  
*Posterior view*

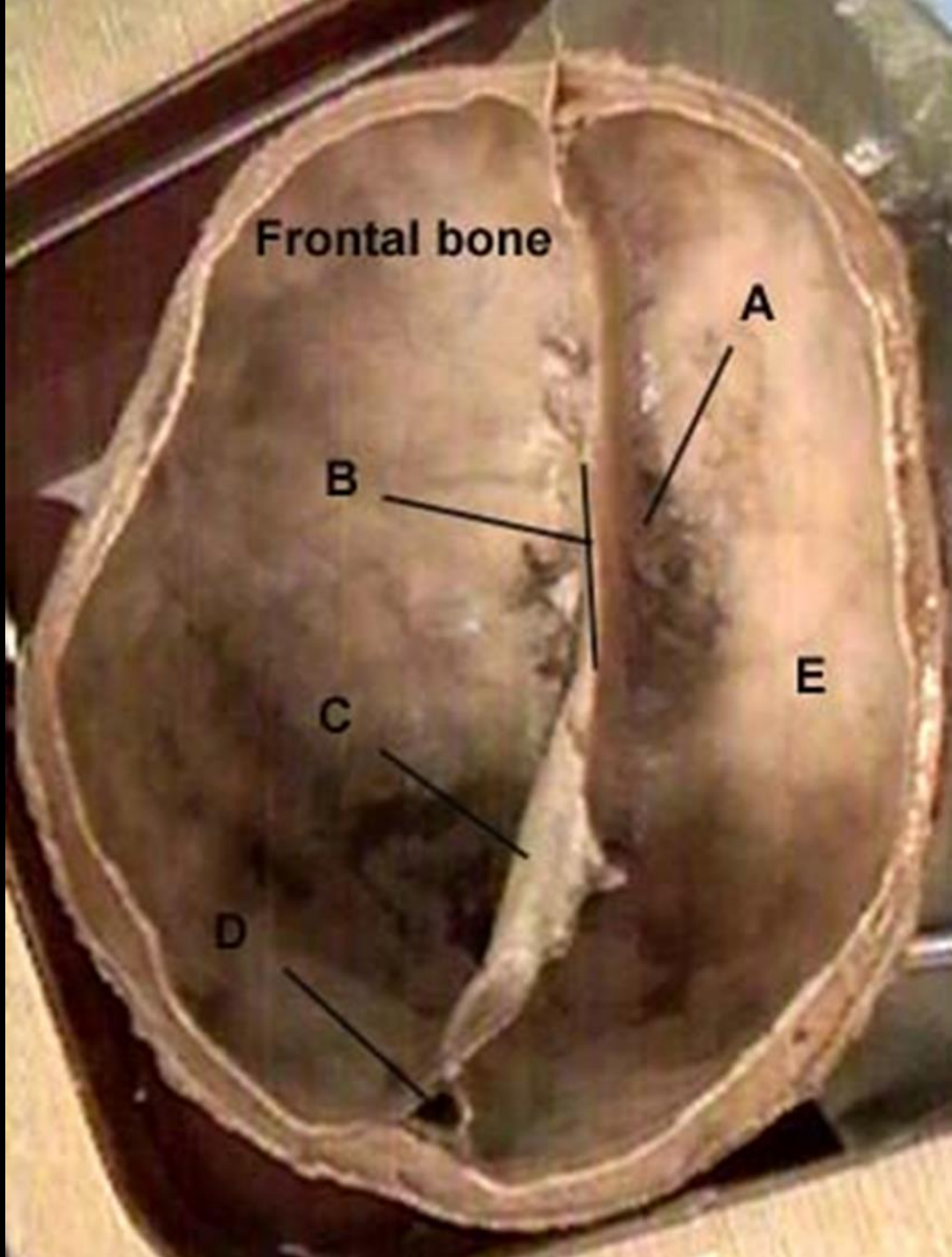


# *The Falx Cerebri*

---

- The superior sagittal sinus runs in its upper fixed margin,
- The inferior sagittal sinus runs in its lower concave free margin,
- The straight sinus runs along its attachment to the tentorium cerebelli.





Frontal bone

A

B

E

C

D

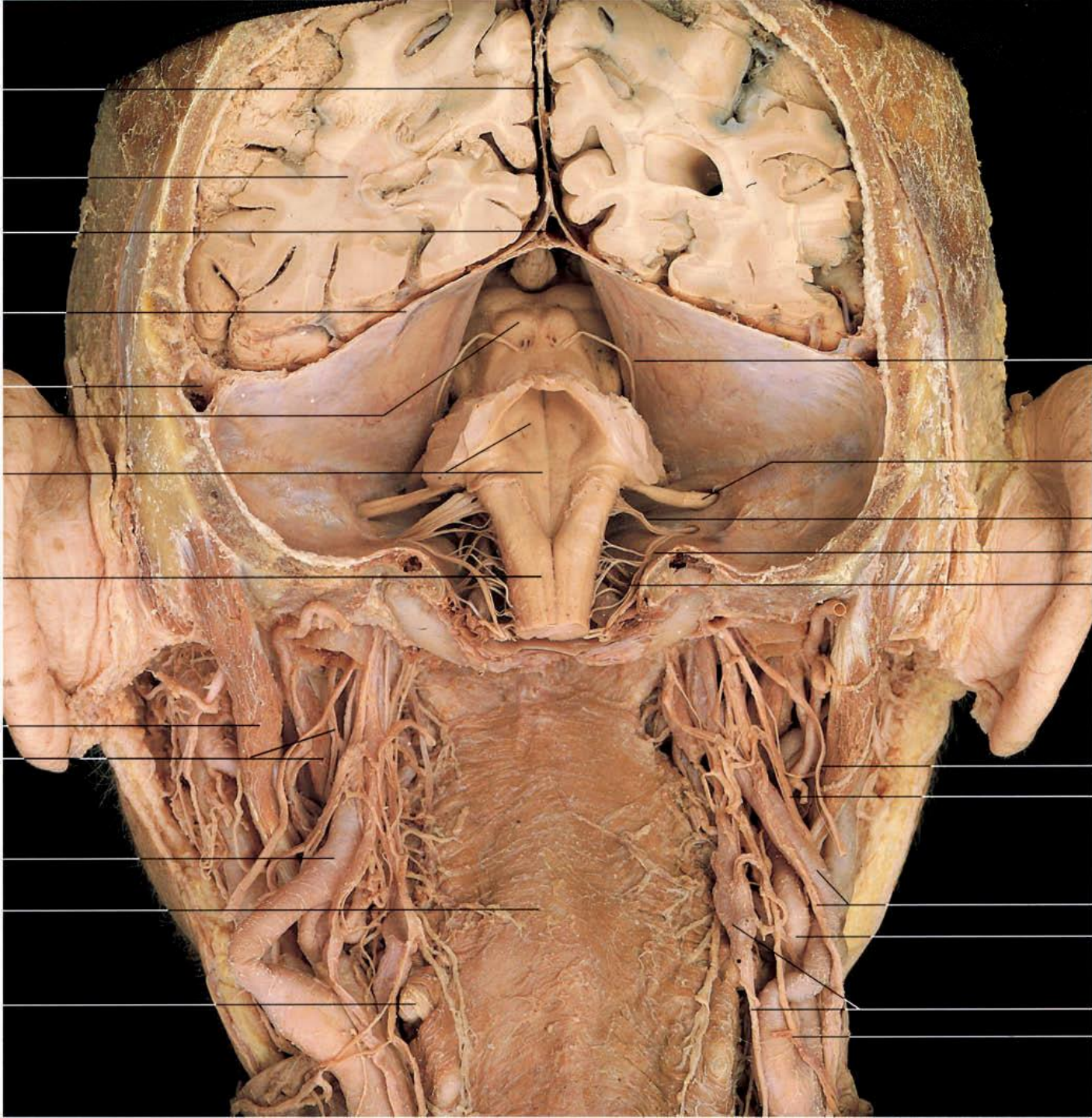


# *The Tentorium Cerebelli*

---

- The tentorium cerebelli is a crescent shaped fold of dura mater that roofs over the posterior cranial fossa.
- It covers the upper surface of the cerebellum and supports the occipital lobes of the cerebral hemispheres.

1  
2  
3  
4  
5  
6  
7  
8  
9  
24  
10  
11  
12



13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23

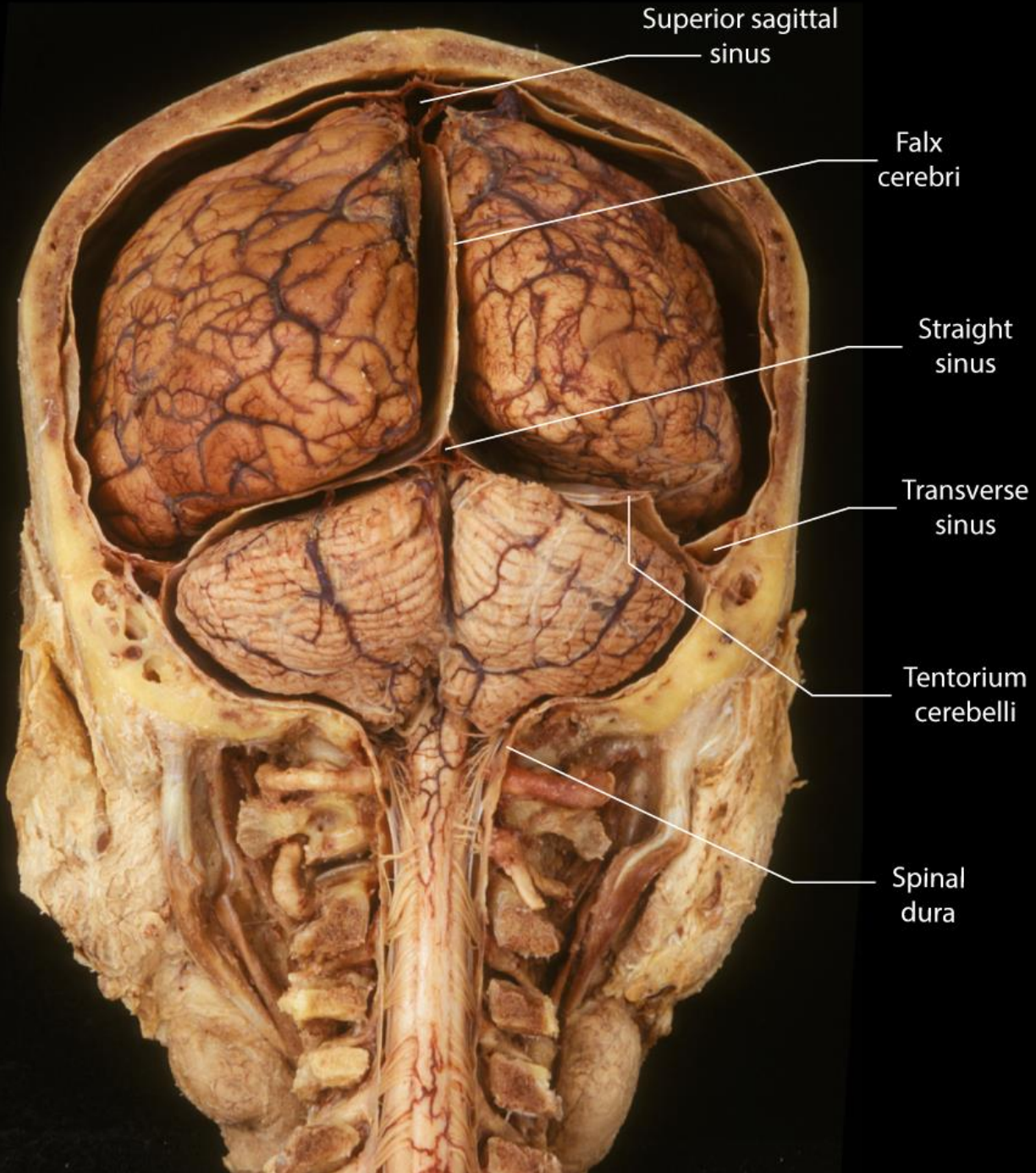


# *The Falx Cerebelli*

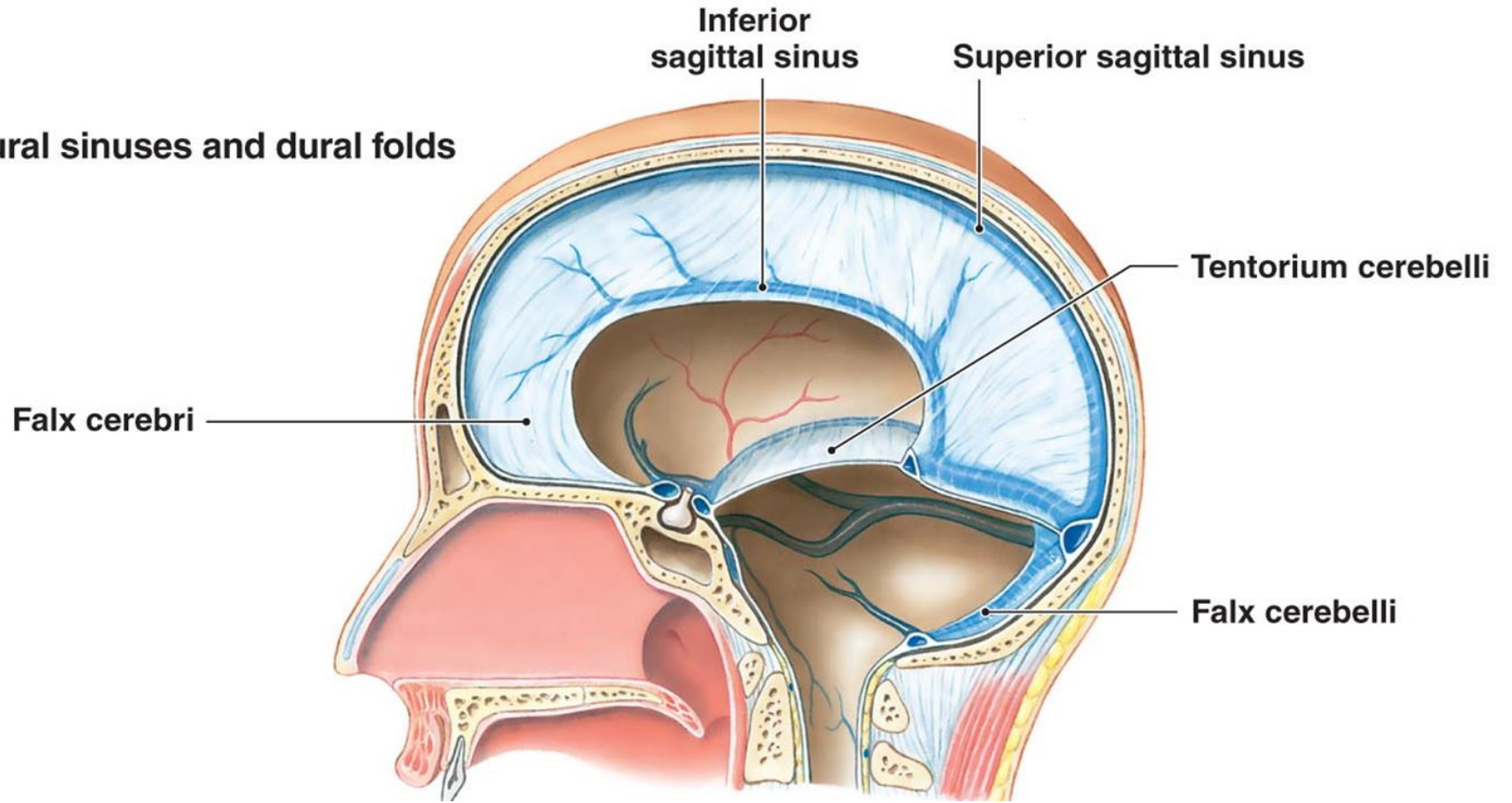
---

- The falx cerebelli is a small, sickle-shaped fold of dura mater that is *attached to the internal occipital crest and projects forward between the two cerebellar hemispheres.*
- Its posterior fixed margin contains the **occipital sinus.**





**The dural sinuses and dural folds**

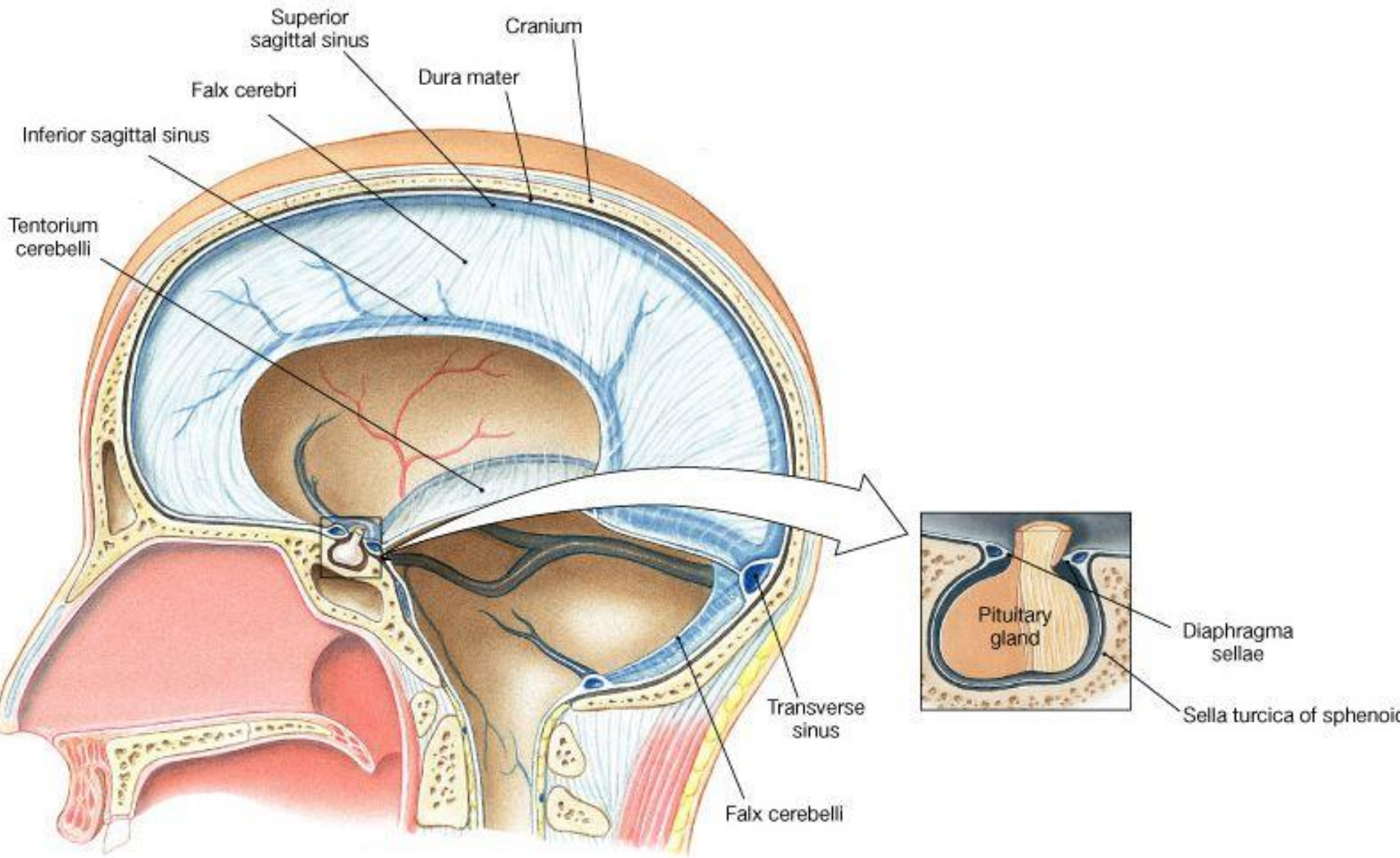




# *The Diaphragma Sellae*

---

- 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.



(b) Midsagittal view



# *Arachnoid Mater*

---

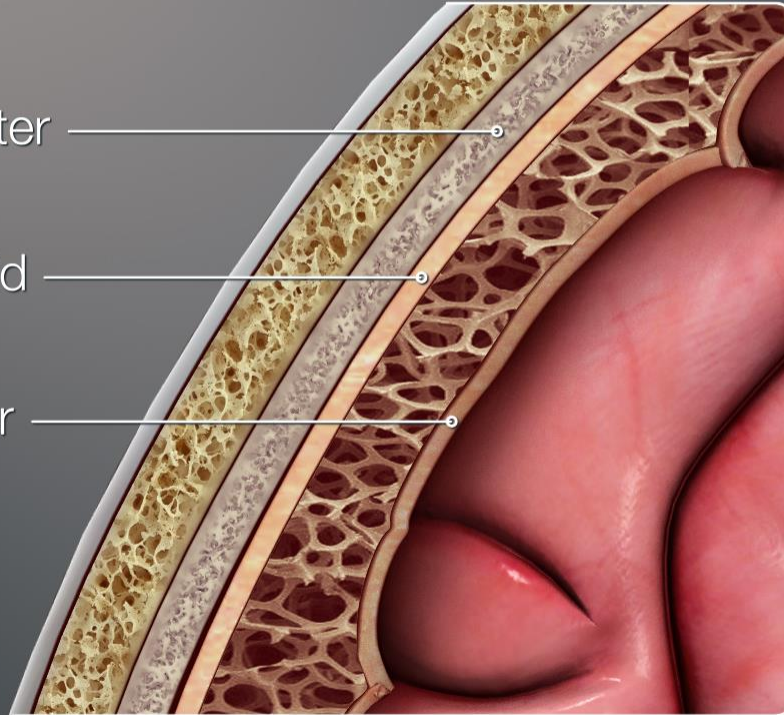
- It is a delicate membrane that lies between dura and pia.
- Cover the brain without dipping into sulci.
  - Separated from dura mater by a potential space, the *subdural space* (filled by thin film of fluid).
  - Separated from pia mater by the *subarachnoid space* (filled with CSF).

# Meninges

Dura Mater

Arachnoid

Pia Mater



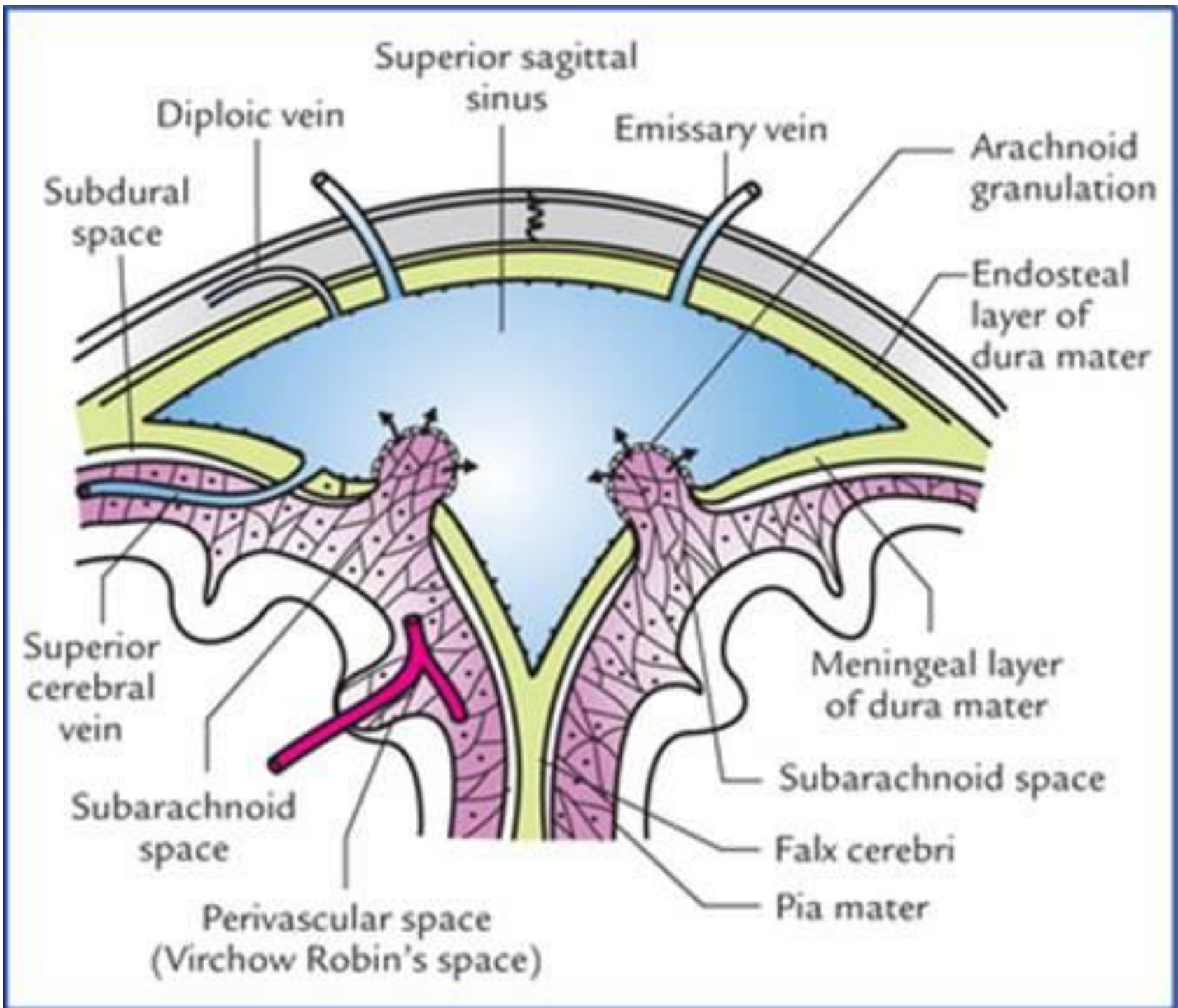


# *Arachnoid Mater*

---

**Arachnoid villi** are small, fingerlike process of arachnoid tissue, projecting into cranial venous sinuses. They are structures filled with cerebrospinal fluid (CSF) that extend into the venous sinuses through openings in the dura mater and allow the drainage of CSF from subarachnoid space into venous system.

In advancing age size increases, forms pedunculated tufts, called **arachnoid granulations**, which produces depression in bone.



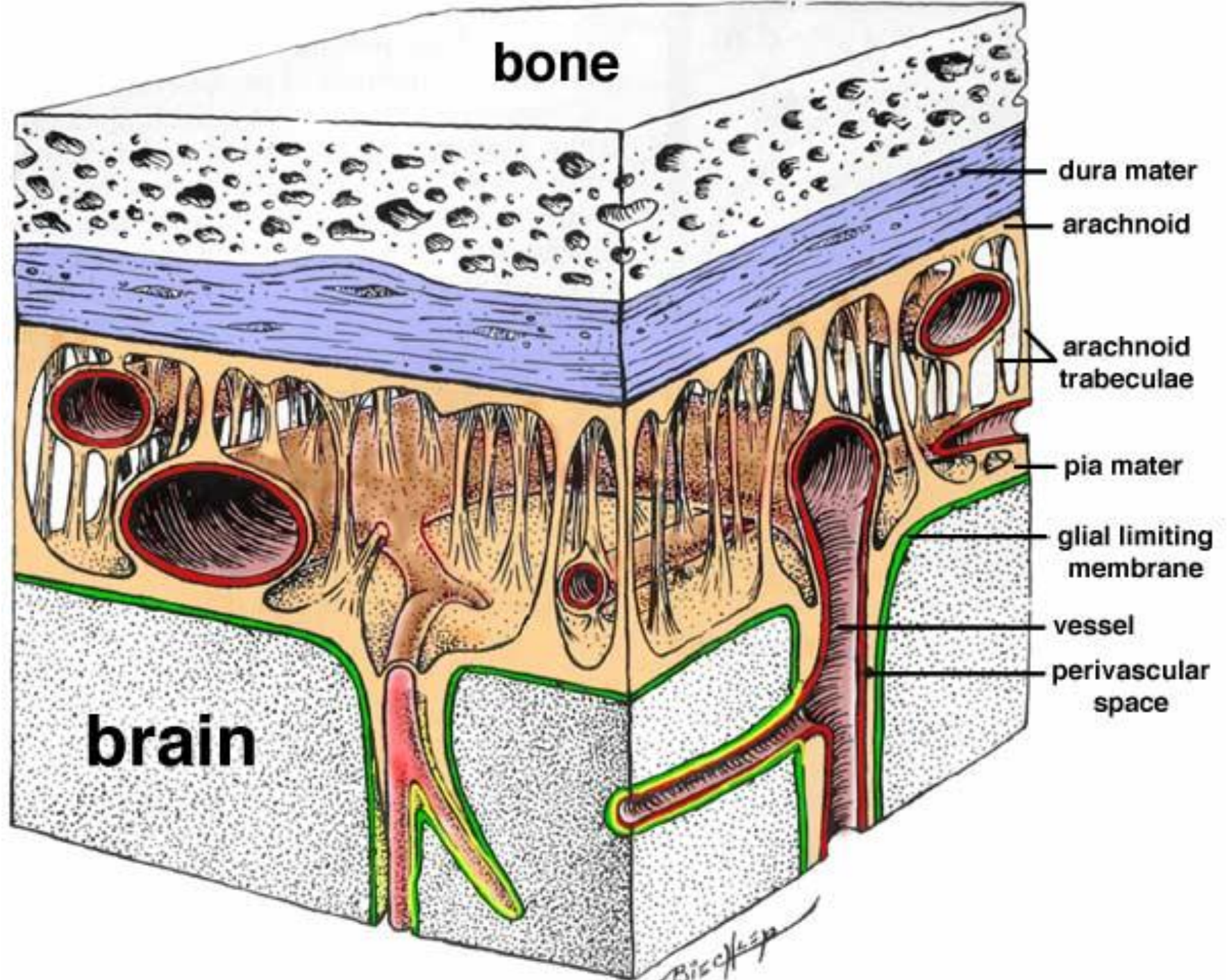




# *Subarachnoid Space*

---

- Space between arachnoid and pia mater.
- Occupied by spongy tissue consisting of network of Arachnoid trabeculae (delicate connective tissue filaments that extend from the arachnoid mater and blend into the pia mater).
- Contains **CSF**, and **Large vessels** of brain.



**bone**

dura mater

arachnoid

arachnoid  
trabeculae

pia mater

glial limiting  
membrane

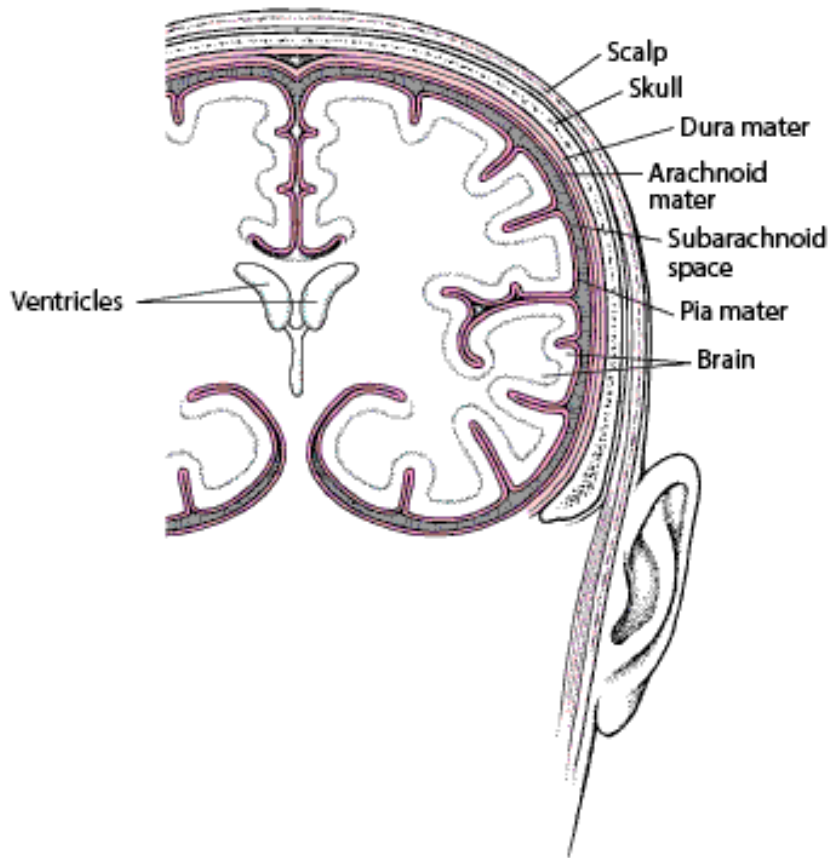
vessel

perivascular  
space

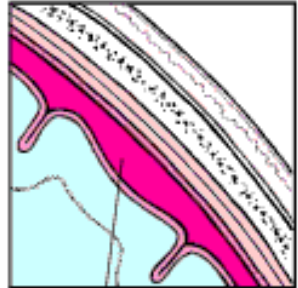
**brain**

*Bicycle*

**Cross Section of the Brain**

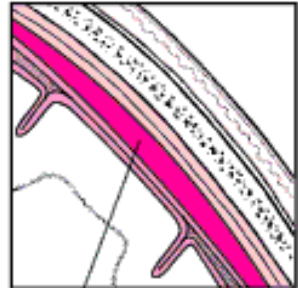


**Subarachnoid Hemorrhage**



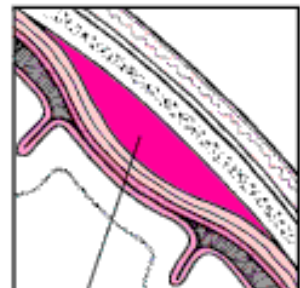
Bleeding in the subarachnoid space

**Subdural Hematoma**



Bleeding between the arachnoid mater and the dura mater

**Epidural Hematoma**



Bleeding between the dura mater and the skull

**Intraventricular Hemorrhage**



Bleeding into the normal fluid-filled spaces (ventricles) of the brain

**Intracerebral Hemorrhage**



Bleeding inside the brain

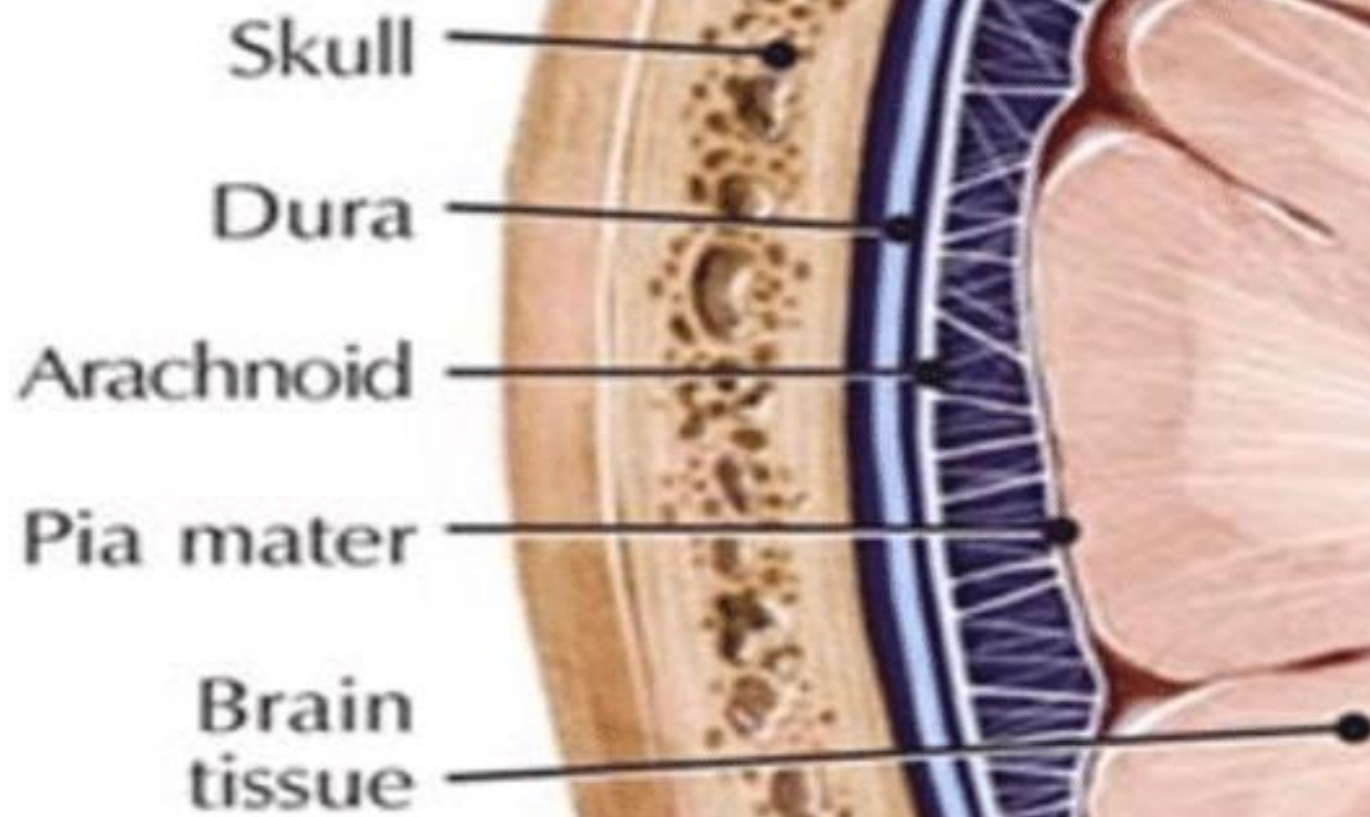


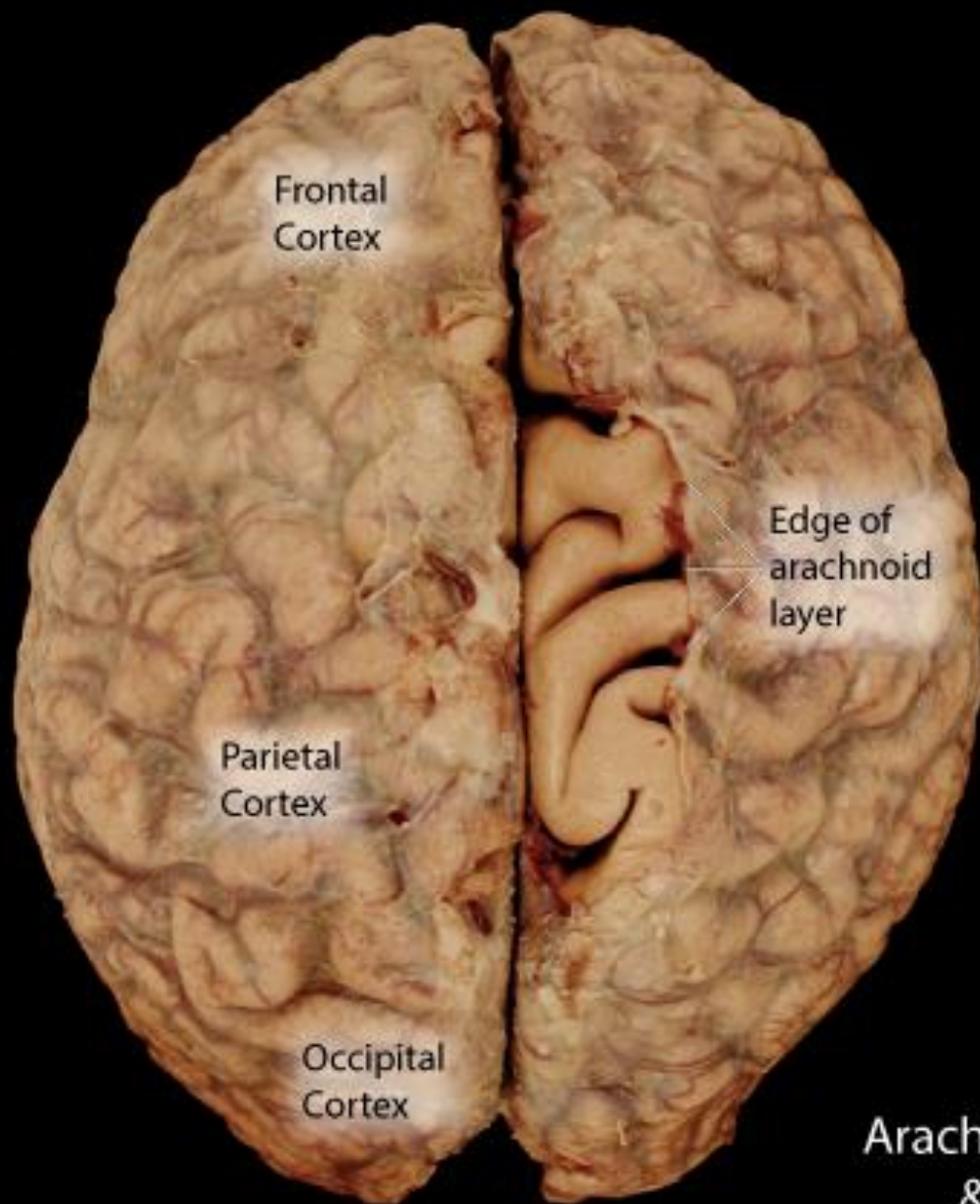
# *Pia Mater*

---

- It is a delicate vascular membrane that is **adherent to the surface of brain.**
- It covers gyri **and dips into its sulci.**
- It extends out over the cranial nerves & fuses with their epineurium (Provides sheaths for cranial nerves).
- The cerebral arteries entering the substance of the brain, carry a sheath of pia mater with them.

# The Meninges





Frontal  
Cortex

Parietal  
Cortex

Occipital  
Cortex

Edge of  
arachnoid  
layer

Arachnoid  
&  
Pial Layers



---

# Brain Ventricles

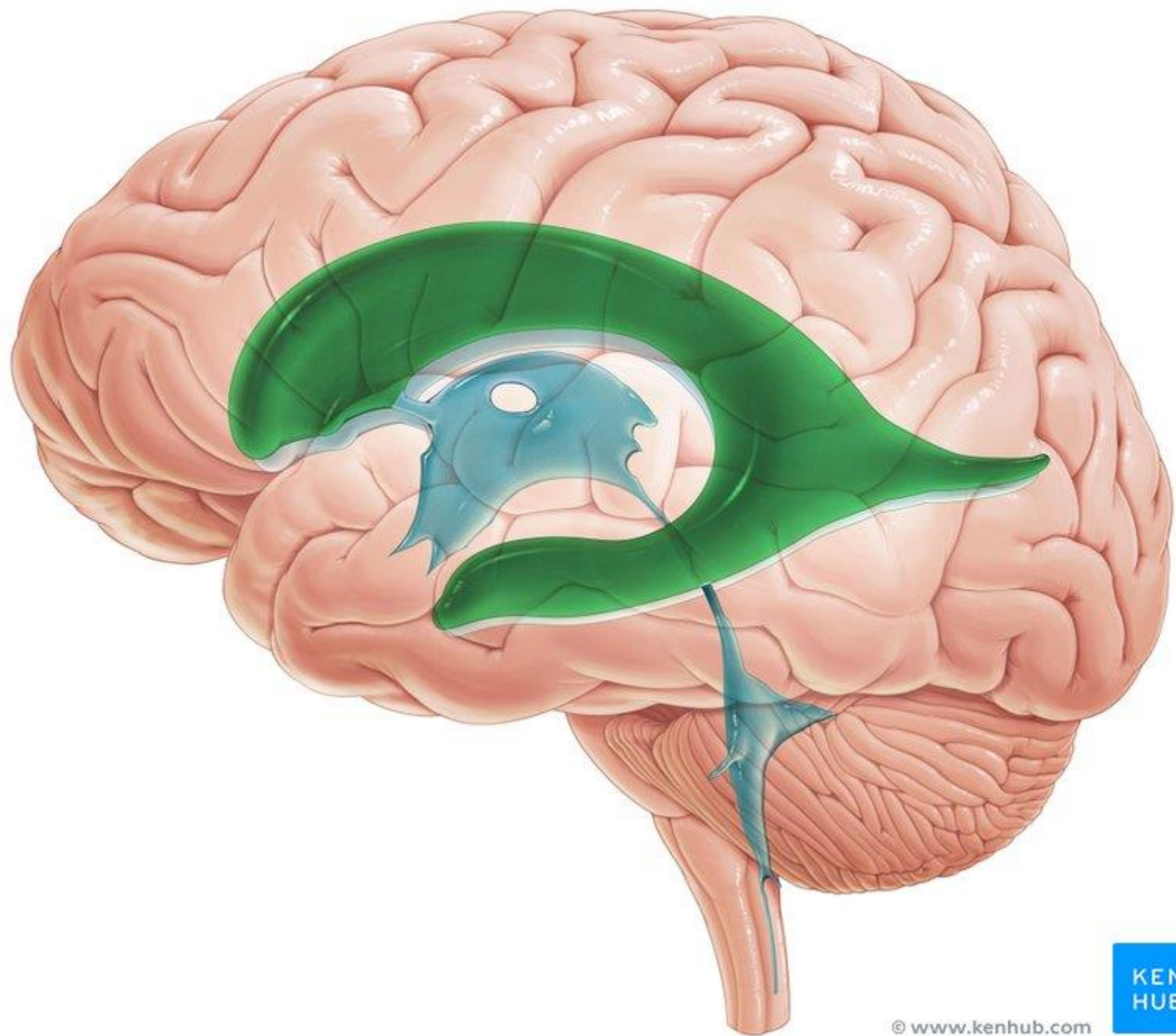


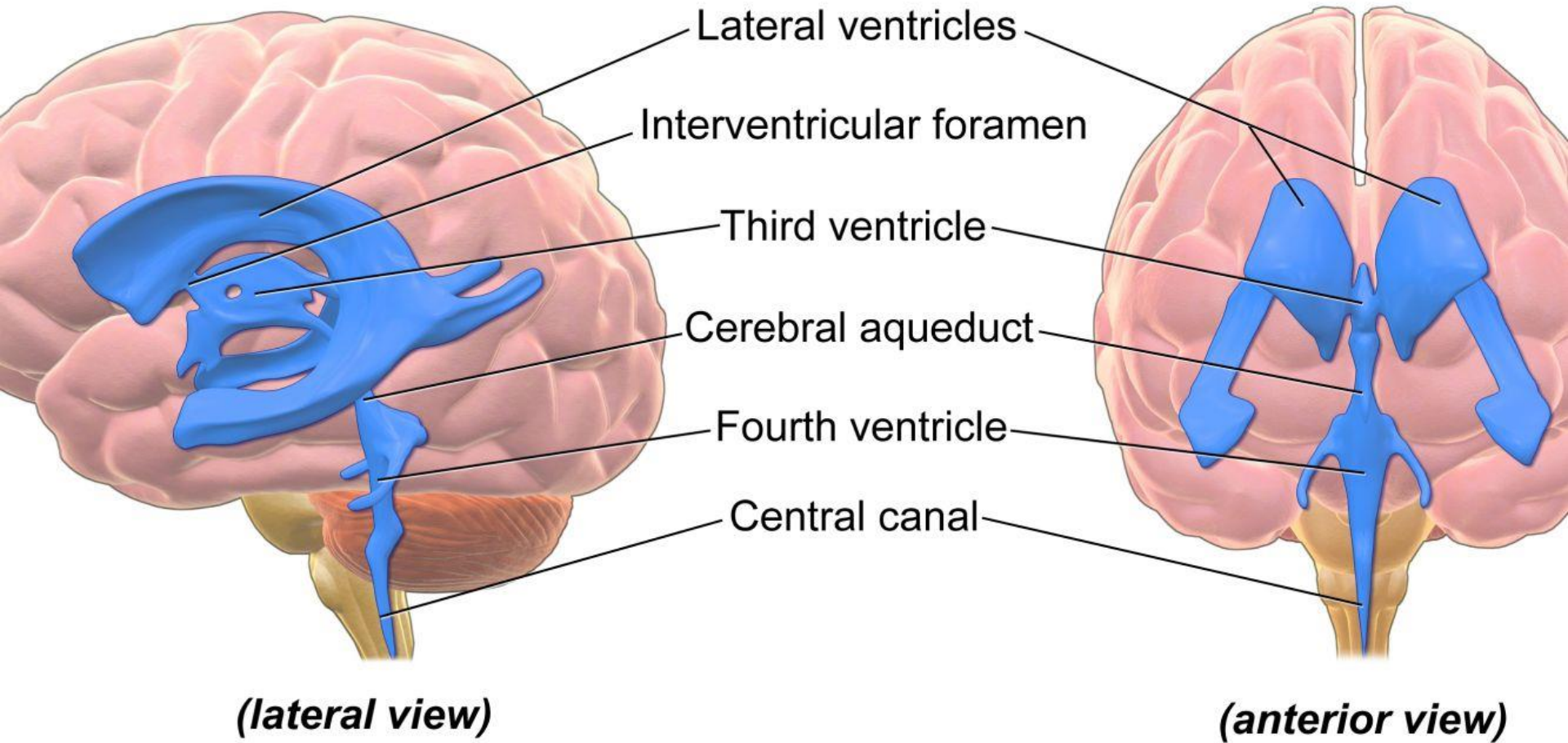
# *Ventricular System*

---

- The ventricular system is a set of communicating cavities within the brain.
- It is composed of *two lateral ventricles* and *two midline ventricles (third and fourth ventricles)*.
- They are lined by *ependymal cells*, which form a structure called the choroid plexus.
- These structures are responsible for the production, transport and removal of *cerebrospinal fluid (CSF)*.







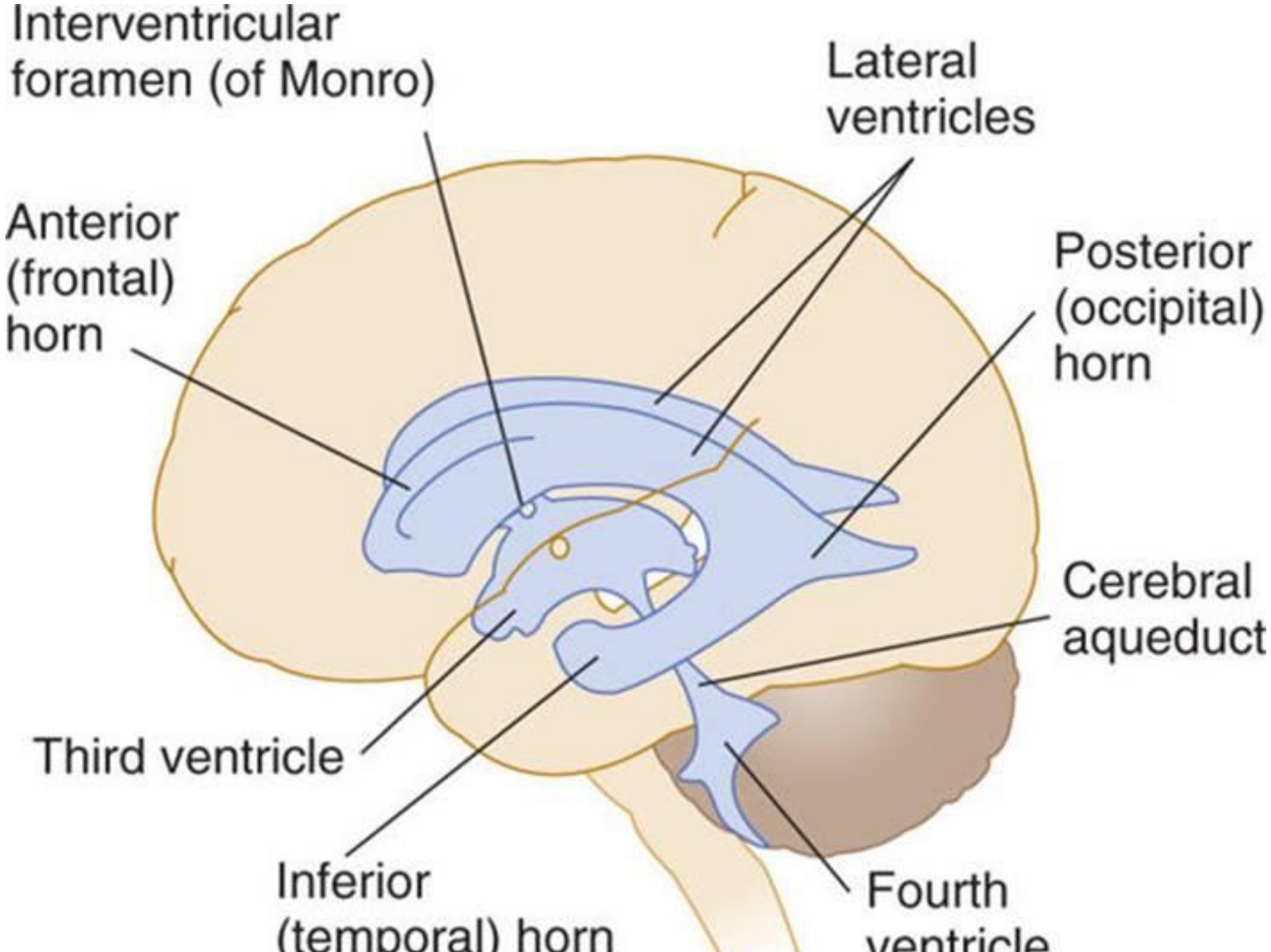


# *Ventricular System Communication*

---

**They are connected by**

- 1. The foramen of monro (lateral → third).**
- 2. Cerebral aqueduct ( third → fourth).**
- 3. The foramen of magendie and Luschka (fourth → subarachnoid space)**



Interventricular foramen (of Monro)

Lateral ventricles

Anterior (frontal) horn

Posterior (occipital) horn

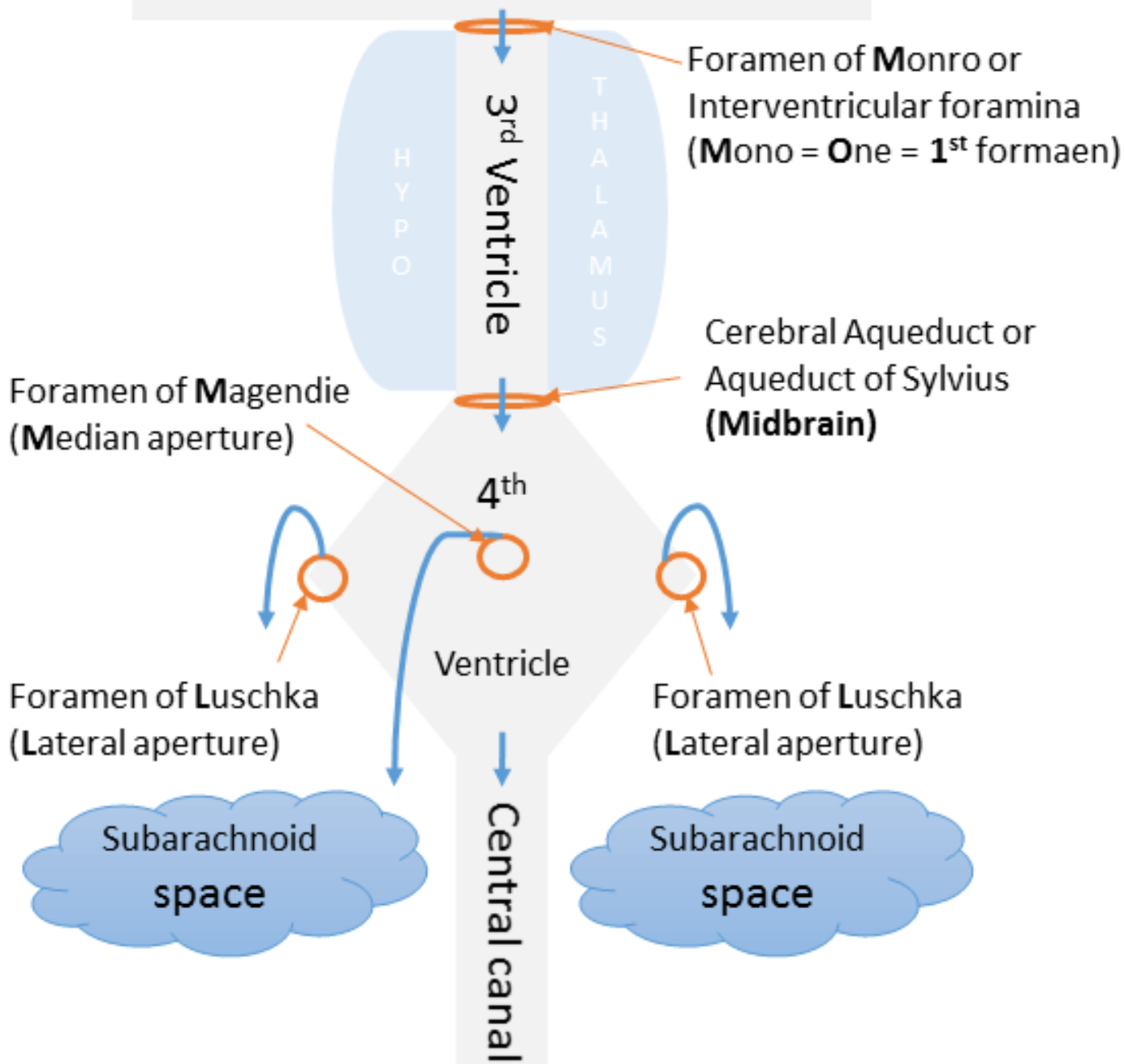
Cerebral aqueduct

Third ventricle

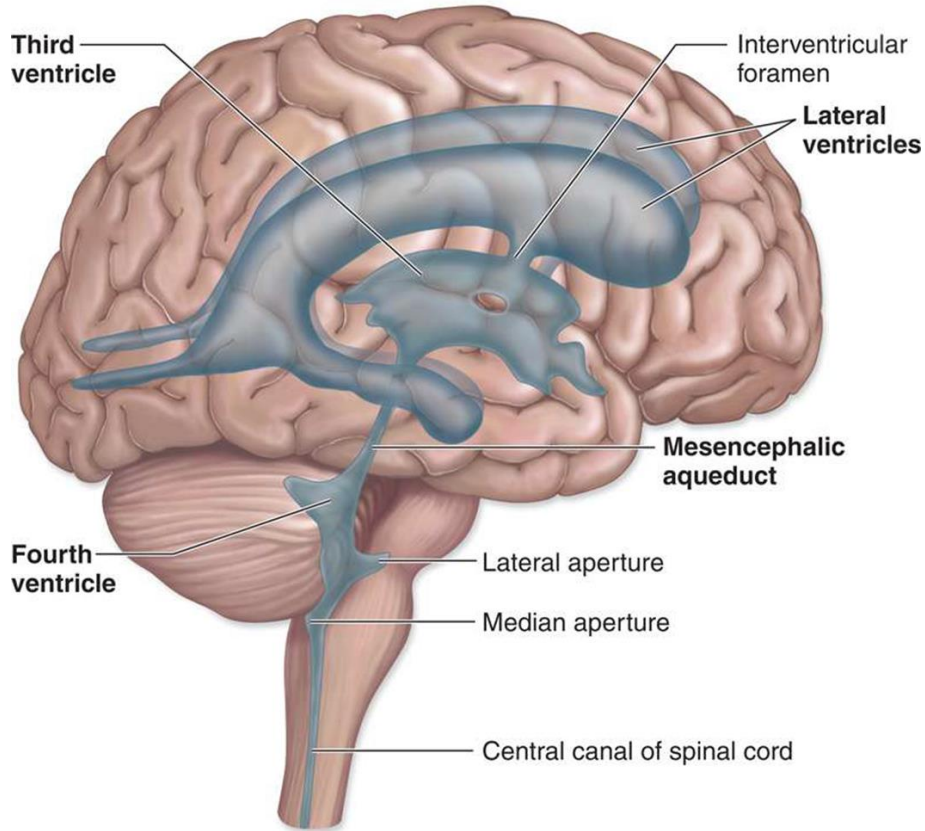
Inferior (temporal) horn

Fourth ventricle

# Lateral Ventricles



Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.  
*Posterior*                      *Anterior*



Third ventricle

Interventricular foramen

Lateral ventricles

Mesencephalic aqueduct

Fourth ventricle

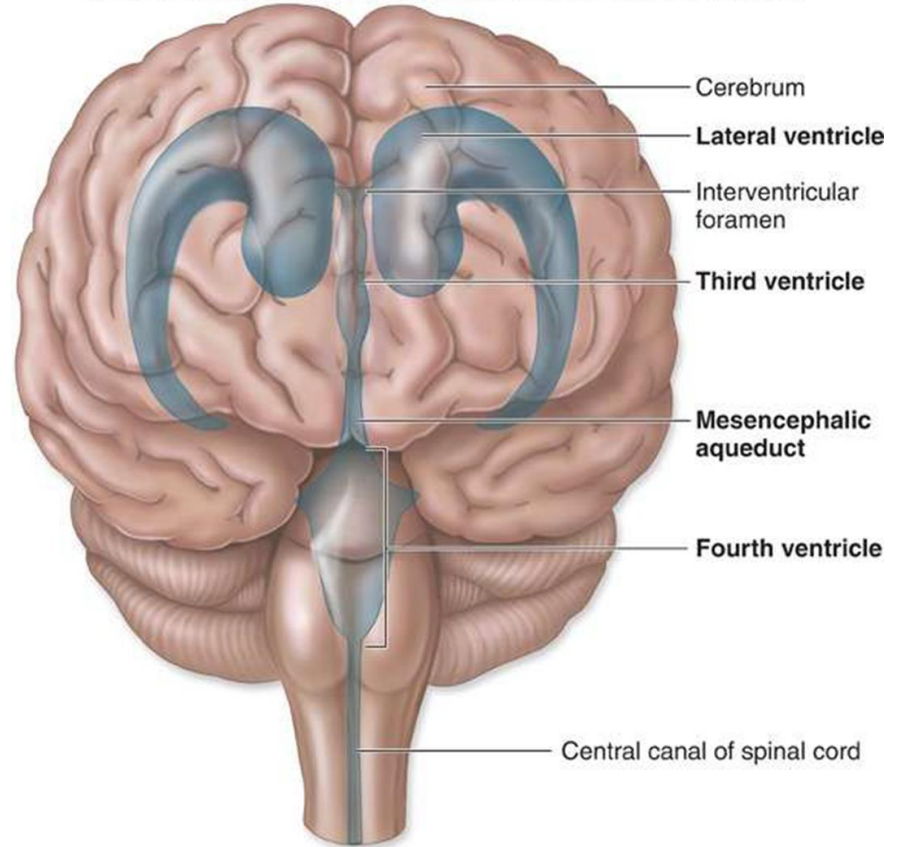
Lateral aperture

Median aperture

Central canal of spinal cord

(a) Lateral view

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.



Cerebrum

Lateral ventricle

Interventricular foramen

Third ventricle

Mesencephalic aqueduct

Fourth ventricle

Central canal of spinal cord

(b) Anterior view



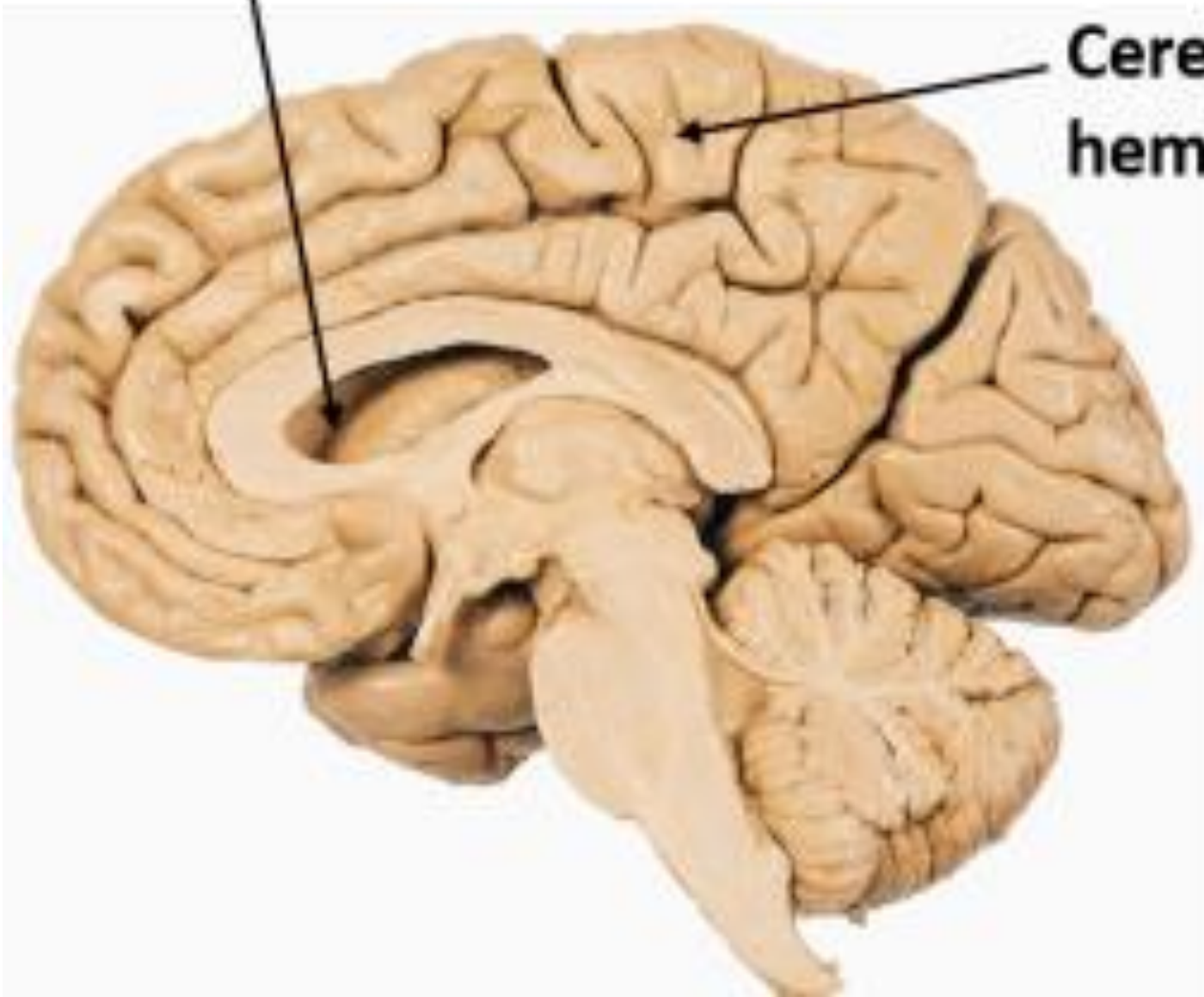
# *Lateral Ventricles*

---

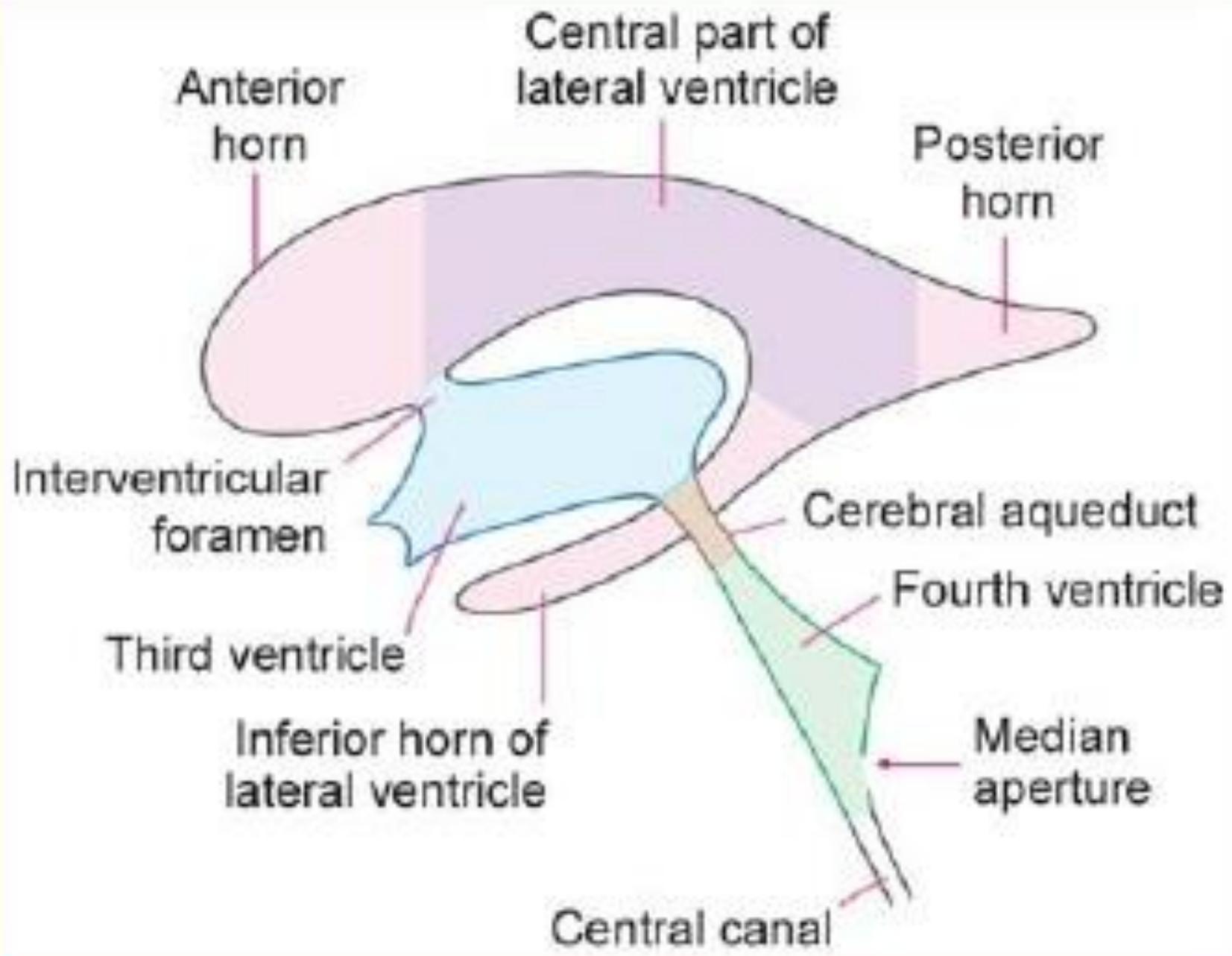
- The lateral ventricles are two C-shaped cavities located within the cerebral hemispheres.
- It has 3 horns and central part:
  - 1. Anterior Horn:** in the frontal lobe.
  - 2. Posterior horn:** in the occipital lobe
  - 3. Inferior horn:** in temporal lobe.
  - 4. Central part or body:** in the parietal lobe.
- The lateral ventricles are separated by the **septum pellucidum** and do not communicate directly.

**Lateral ventricle**

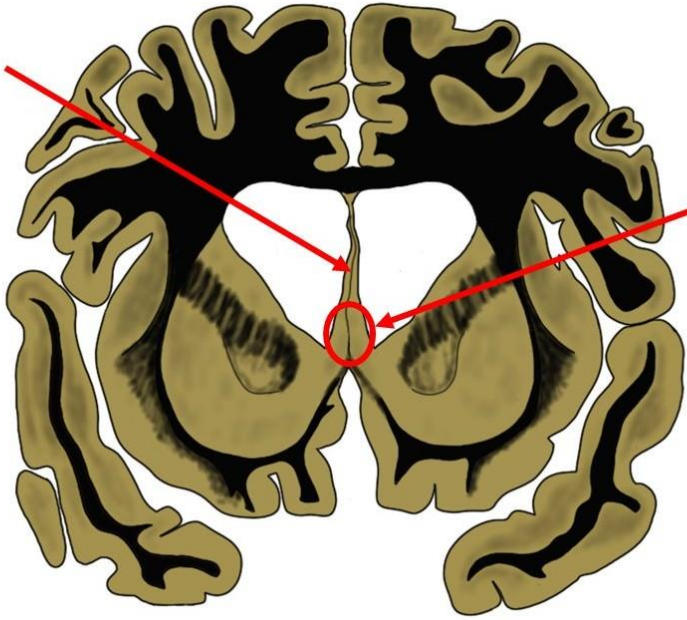
**Cerebral hemisphere**



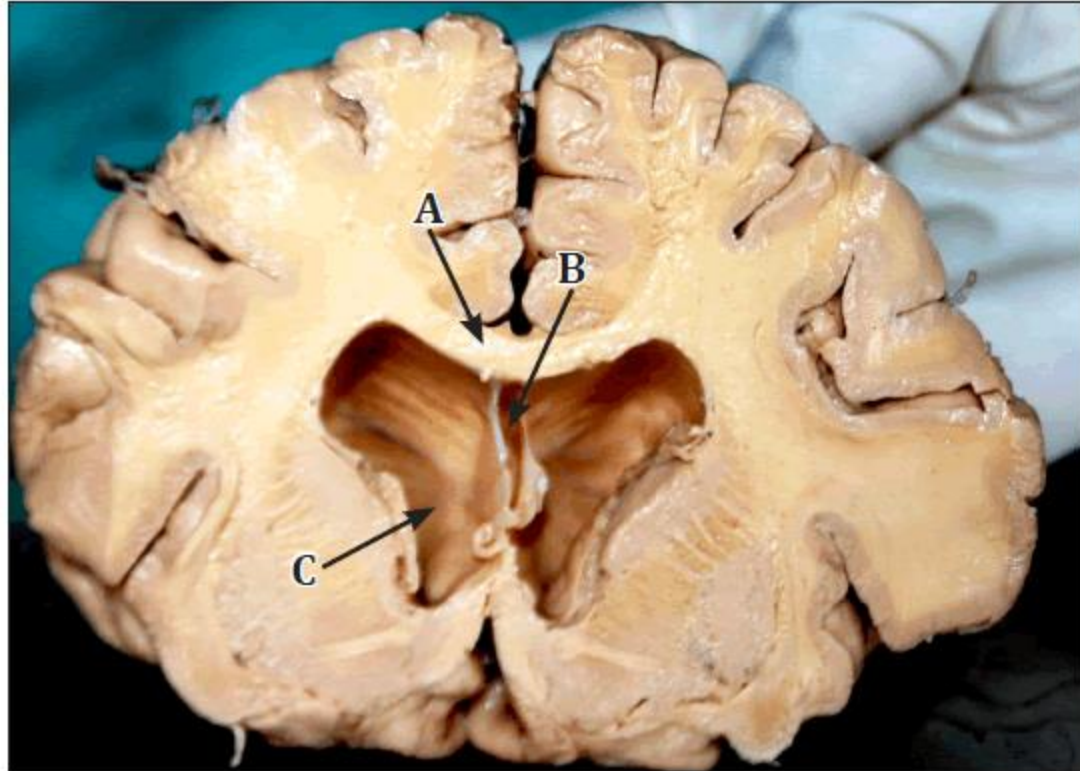




SEPTUM  
PELLUCIDUM



SEPTAL  
NUCLEI





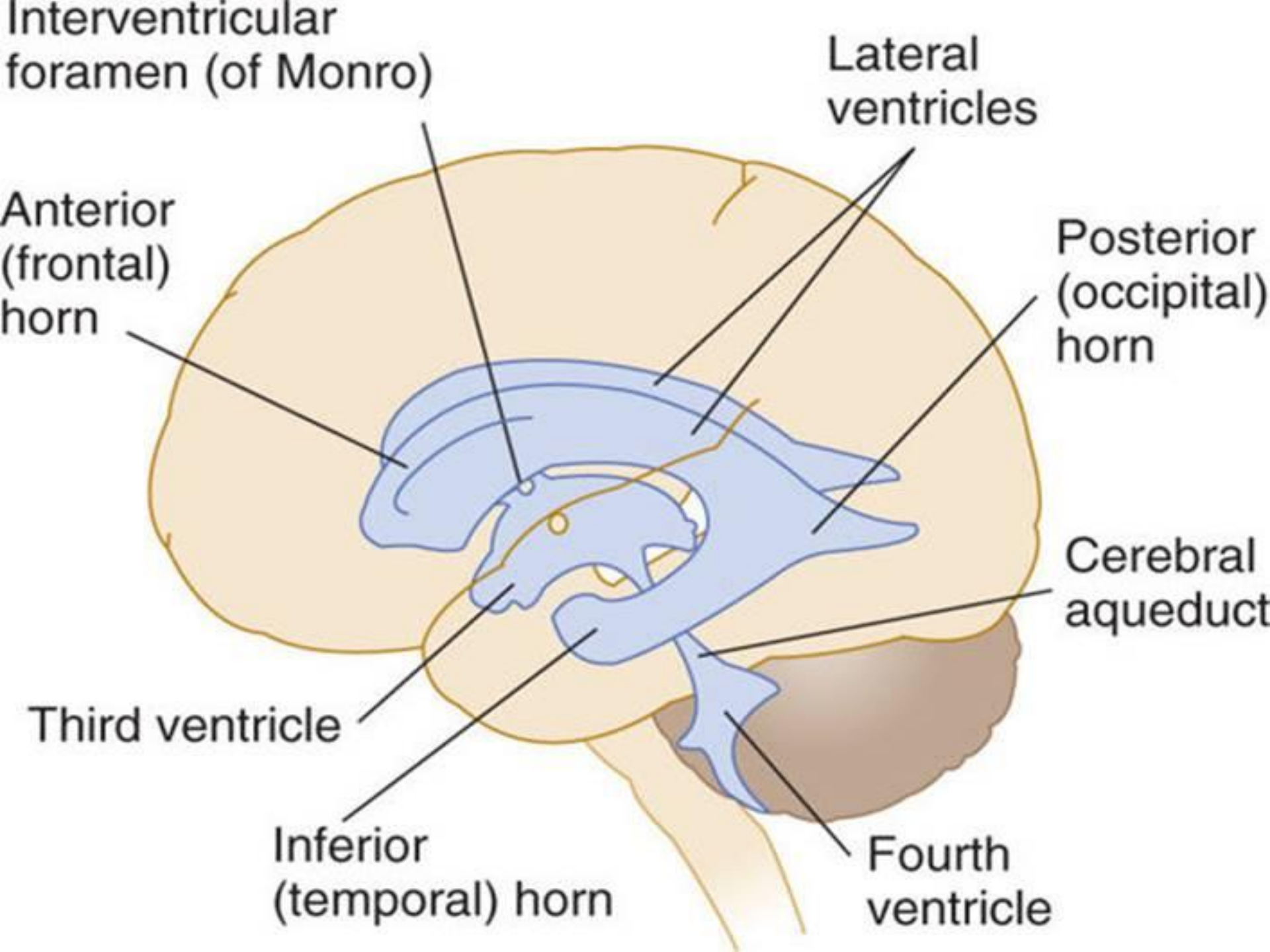
# *Third Ventricle*

---

- The third ventricle is a narrow cavity or a slit like cleft between the 2 thalami.

- ***Communications:***

1. Anteriorly with lateral ventricles through **interventricular foramina** (of monro)
2. Posteriorly with fourth ventricle through **cerebral aqueduct** (***of sylvius***)

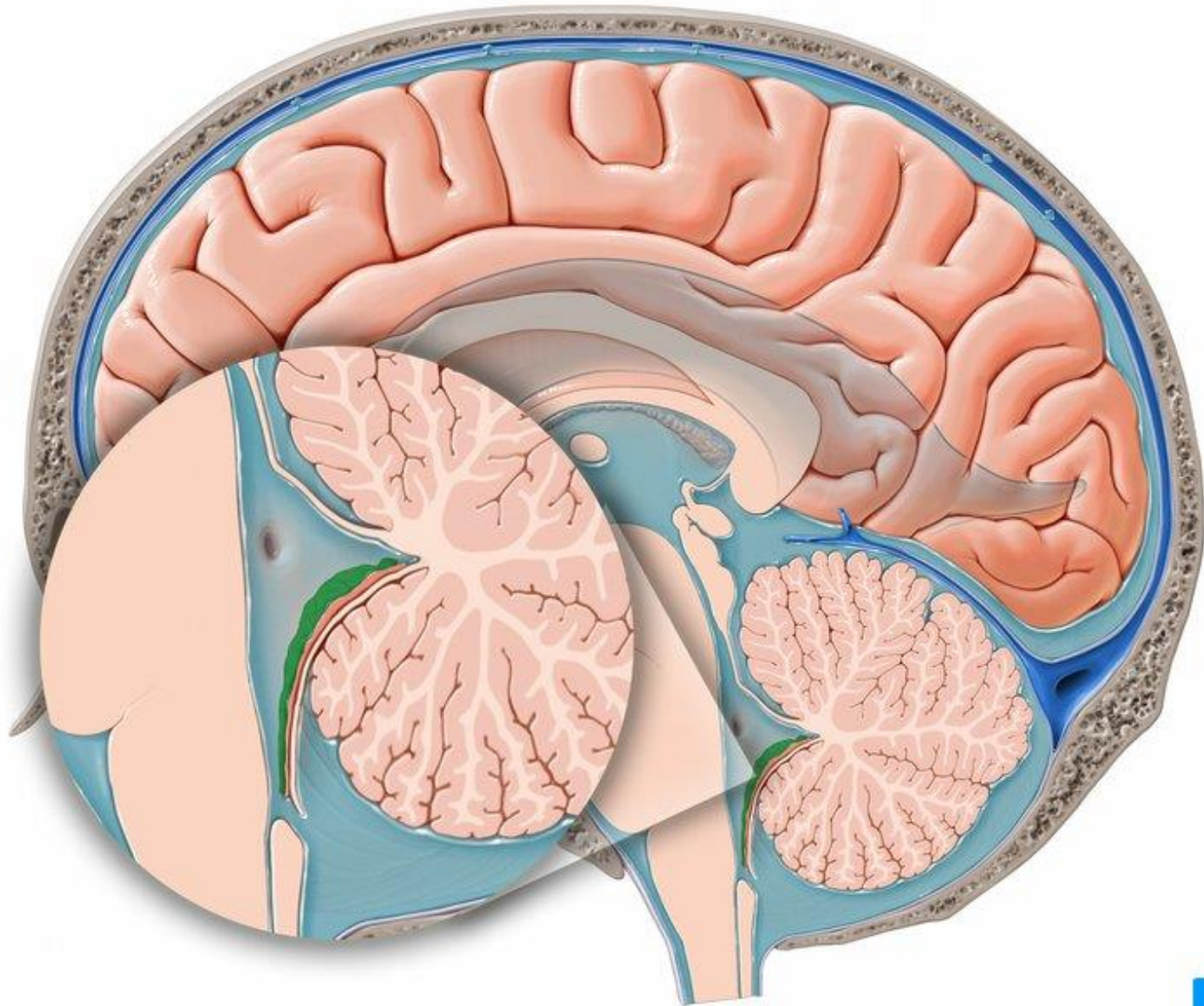


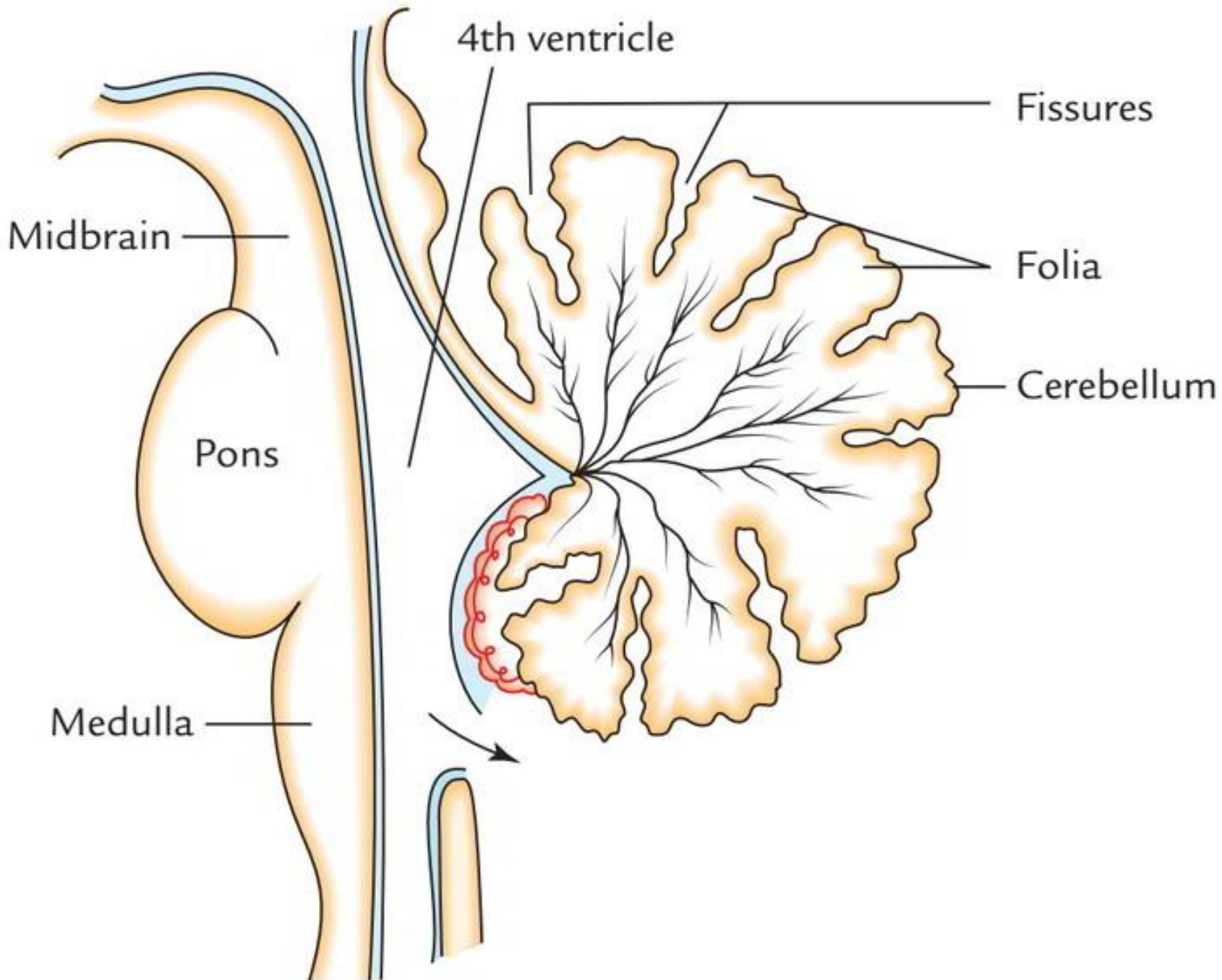


# *Fourth Ventricle*

---

- Is a diamond shaped cavity.
- It is a wide and flattened space *located just anterior to the cerebellum and posterior to the upper half of the medulla oblongata and the pons*





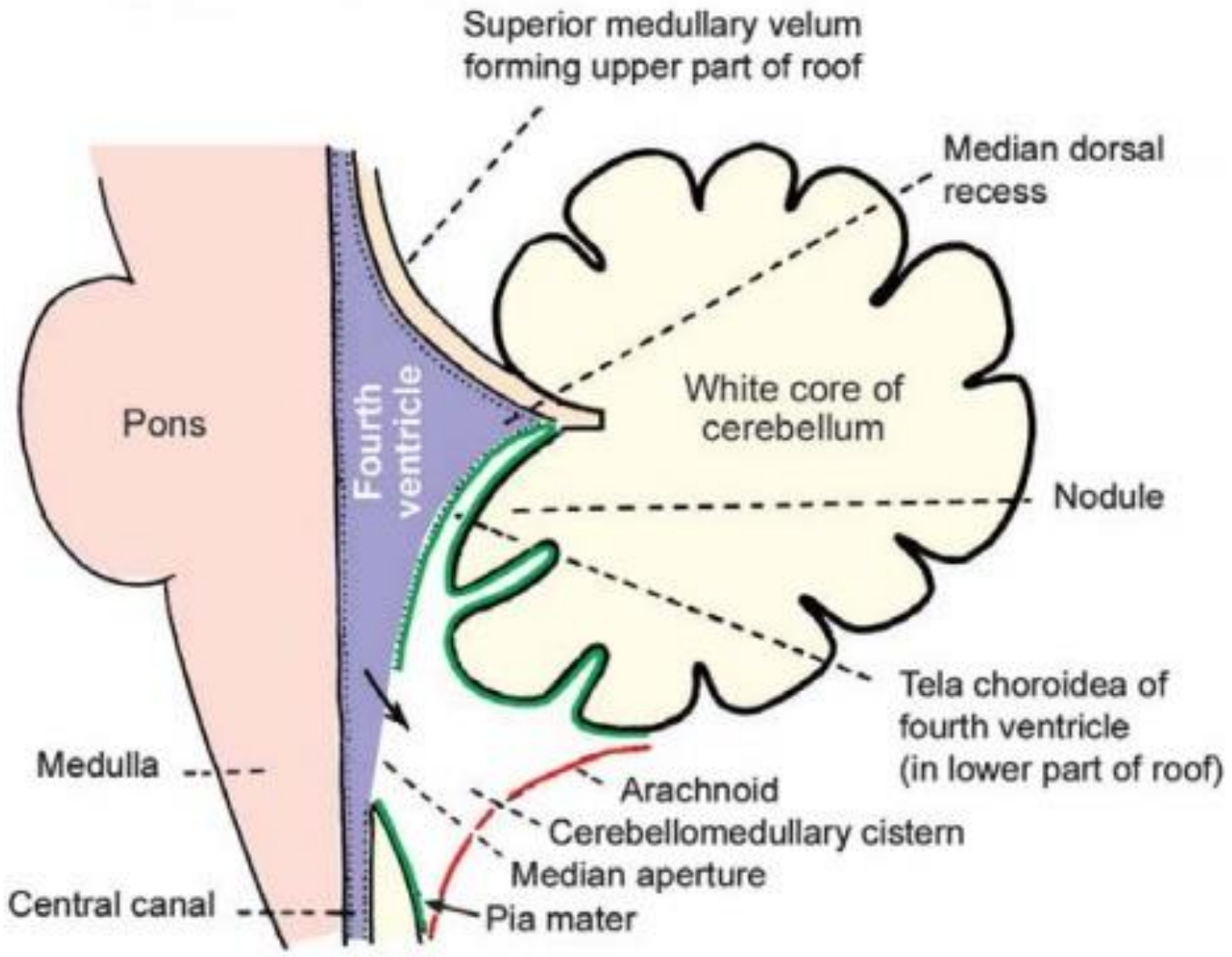


Fig. 20.8. Mid-sagittal section through the fourth ventricle and related structures. Note how the tela choroidea is formed.





---

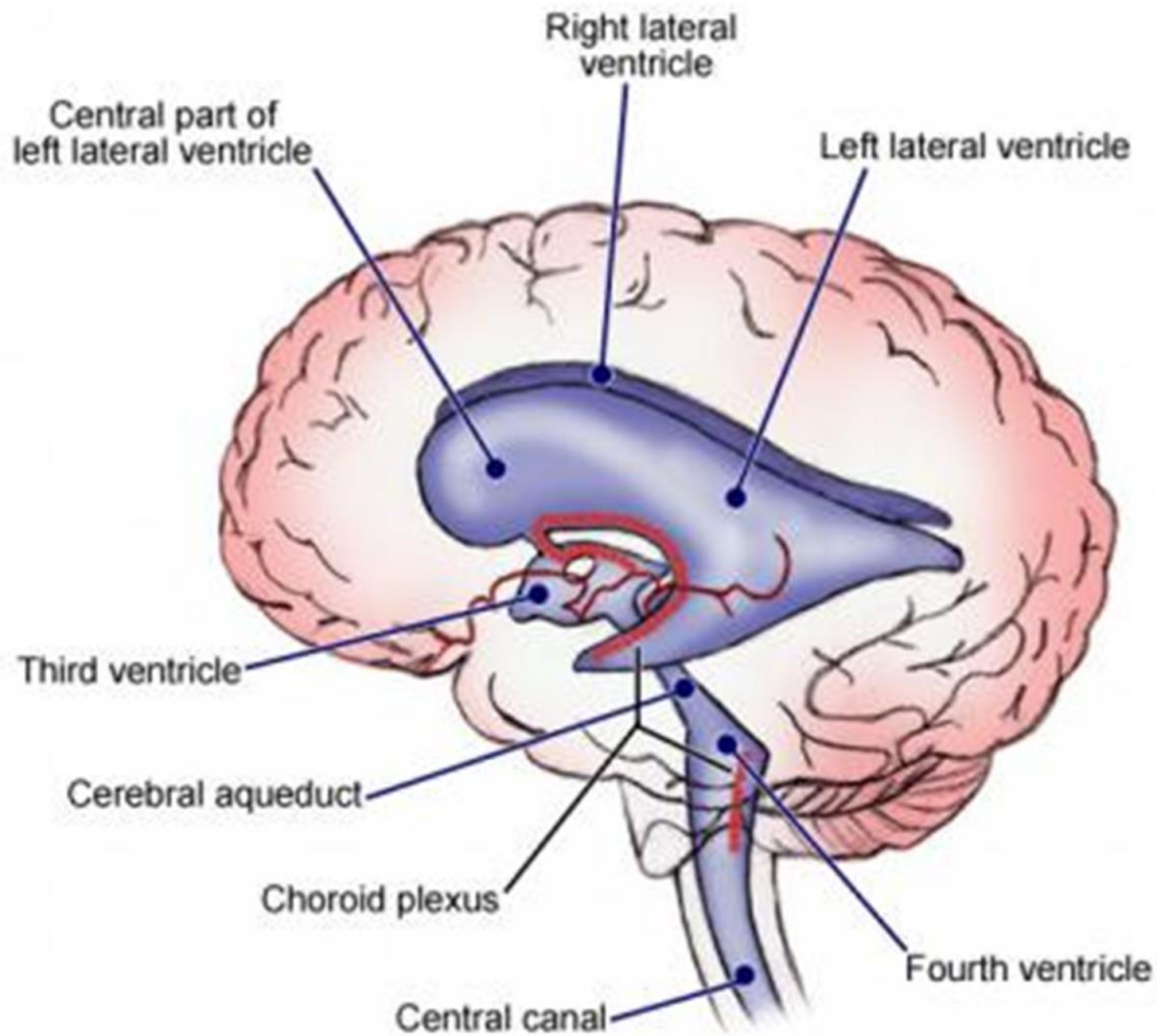
# **CEREBROSPINAL FLUID**

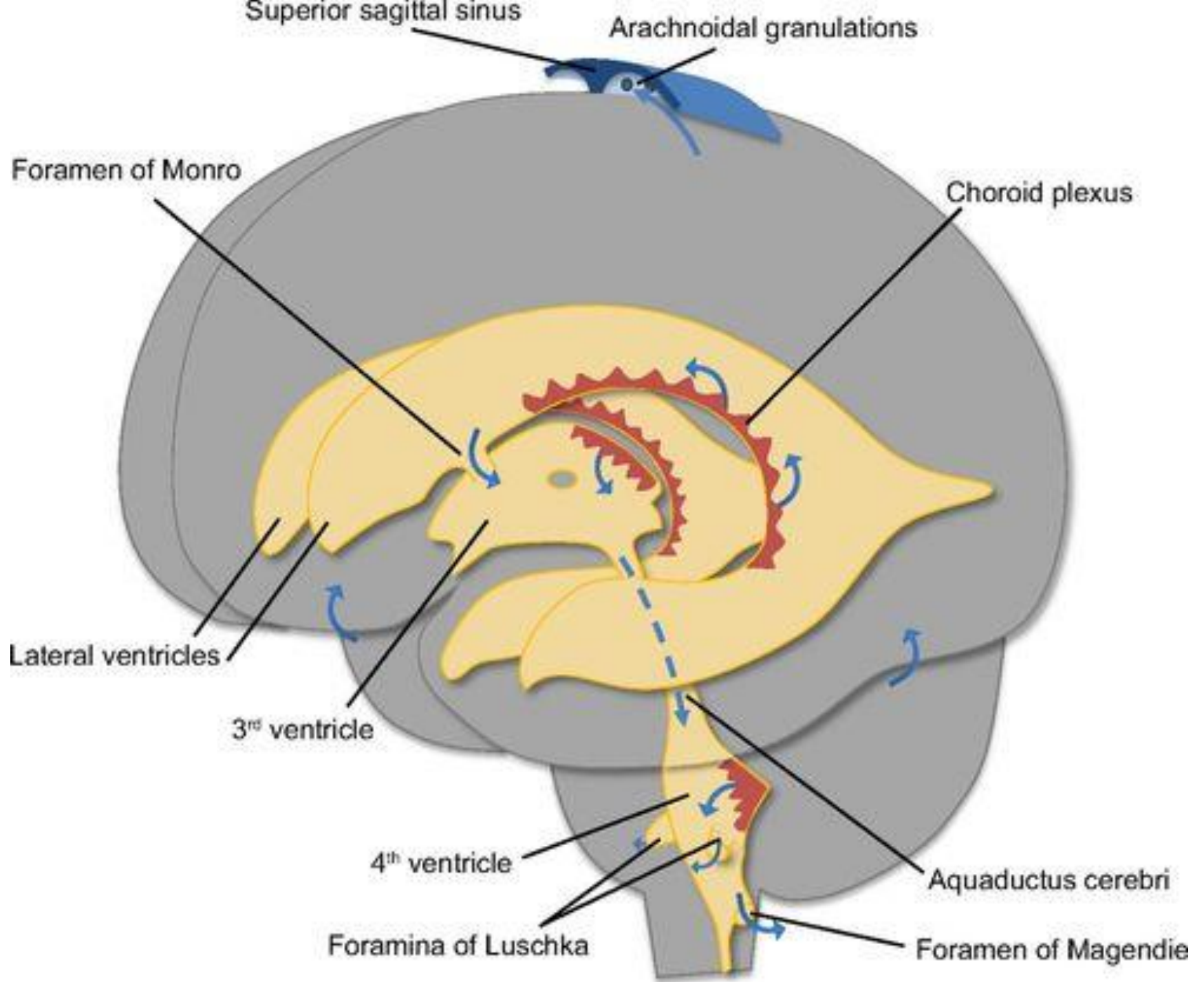


# *Choroid Plexus*

---

- Folds of pia mater enclosing tufts of capillaries form the **tela chorioidea**.
- The tela chorioidea fuse with ependyma to form the **choroid plexus** *on the roof of 3rd and 4th ventricle and the floor of lateral ventricles*.
- Choroid plexus produces **cerebrospinal fluid** (CSF).







# ***What is Cerebrospinal Fluid (CSF) ?***

---

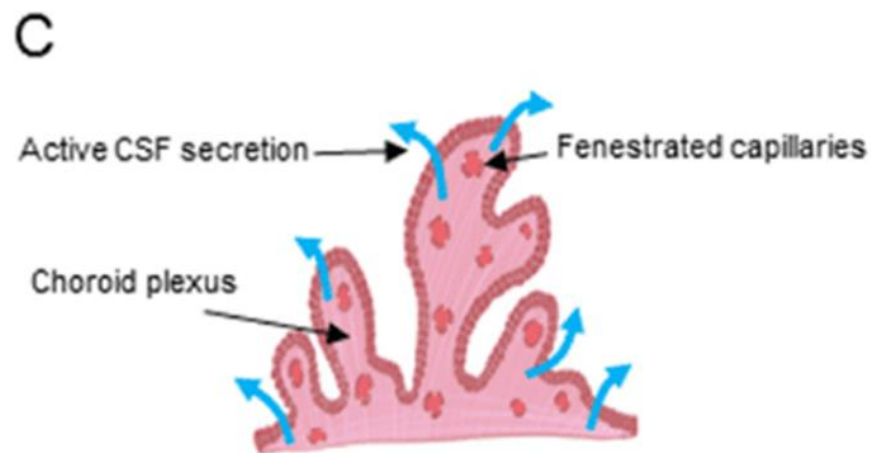
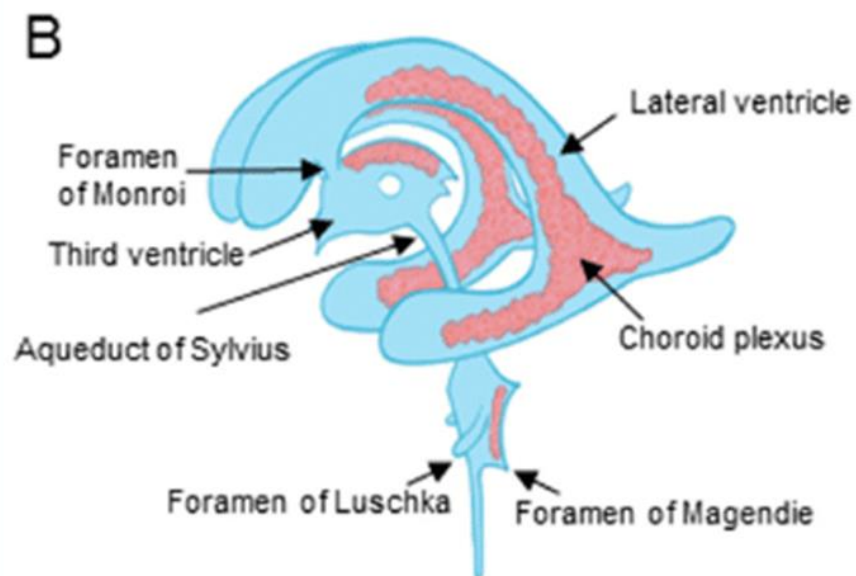
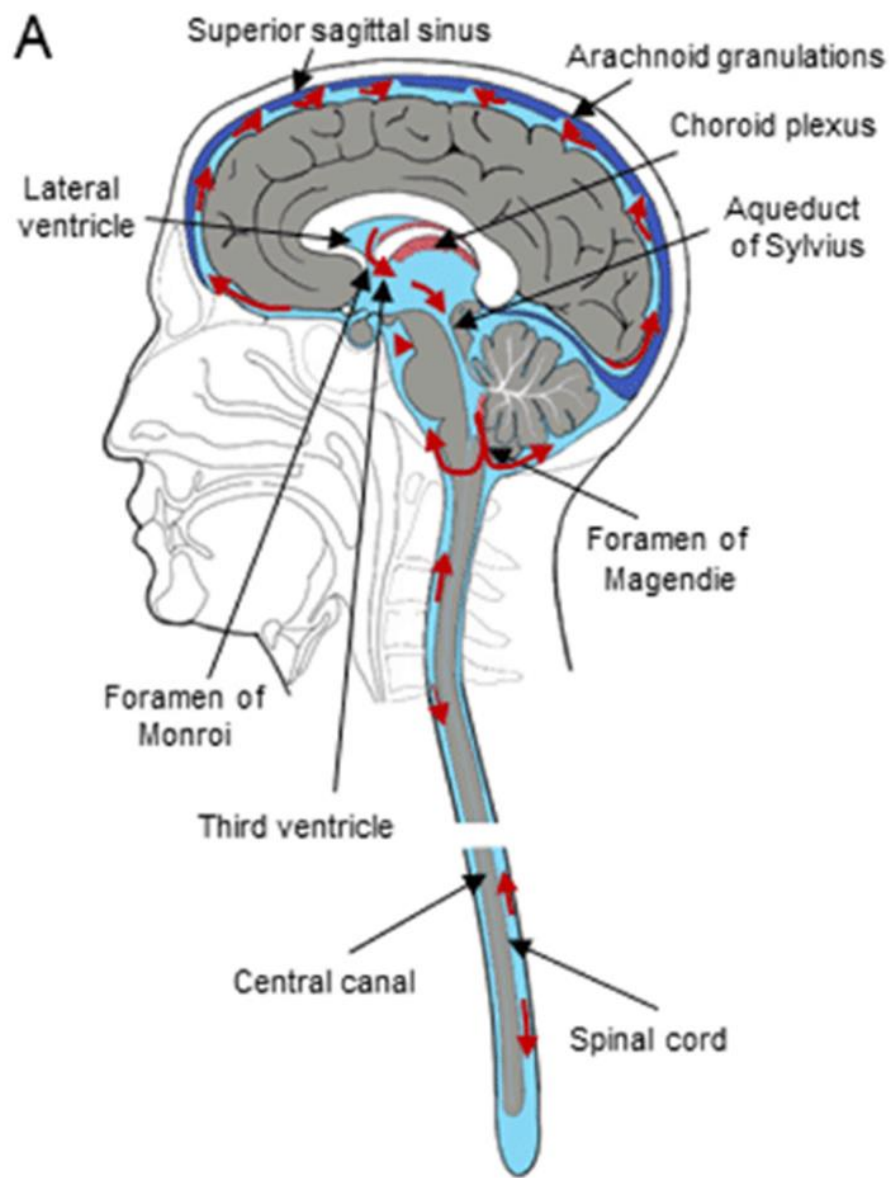
- Clear, colorless fluid (filtrate of plasma).
- Produced by the choroid plexus
- Found in the: Ventricles of the brain, Subarachnoid space (between Arachnoid + Pia mater) around the brain & spinal cord



# *Cerebrospinal Fluid (CSF)*

---

- The CSF is formed in the lateral ventricles escapes by the *foramen of monro* into the third ventricle
- From the third ventricle by the *cerebral aqueduct* into the fourth ventricle.
- 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*.



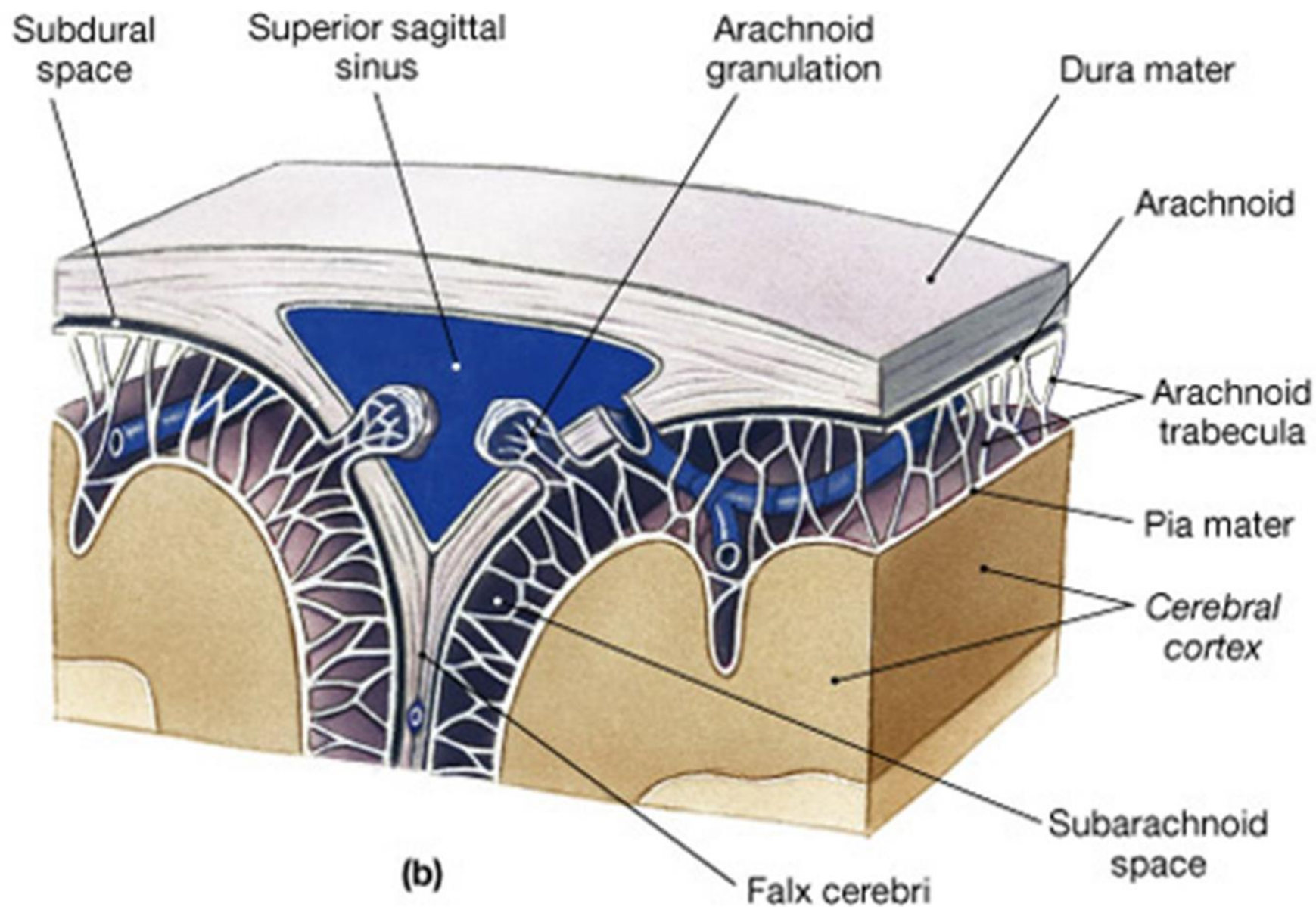


# *Absorption of the CSF*

---

- Main sites - *arachnoid villi* (project into dural venous sinuses, especially, superior sagittal sinus)
- *Arachnoid villi* tend to be grouped together & form elevations known as *arachnoid granulations*.







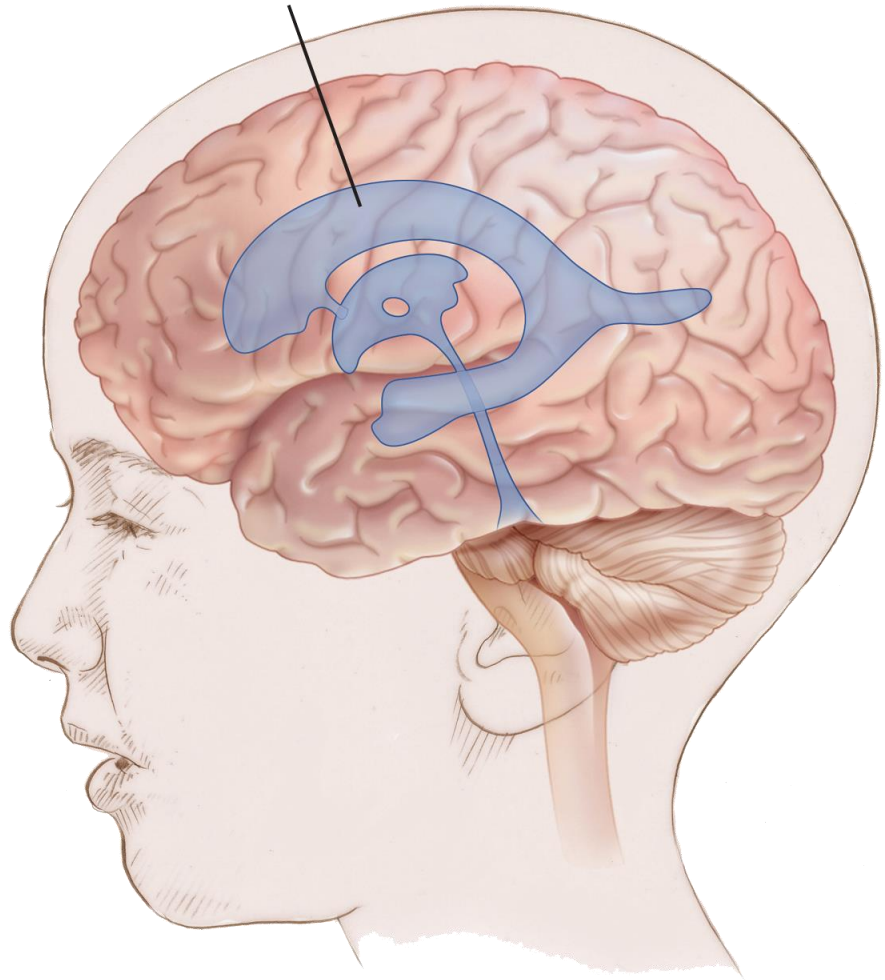
# *Clinical Application*

---

## *Hydrocephalus*

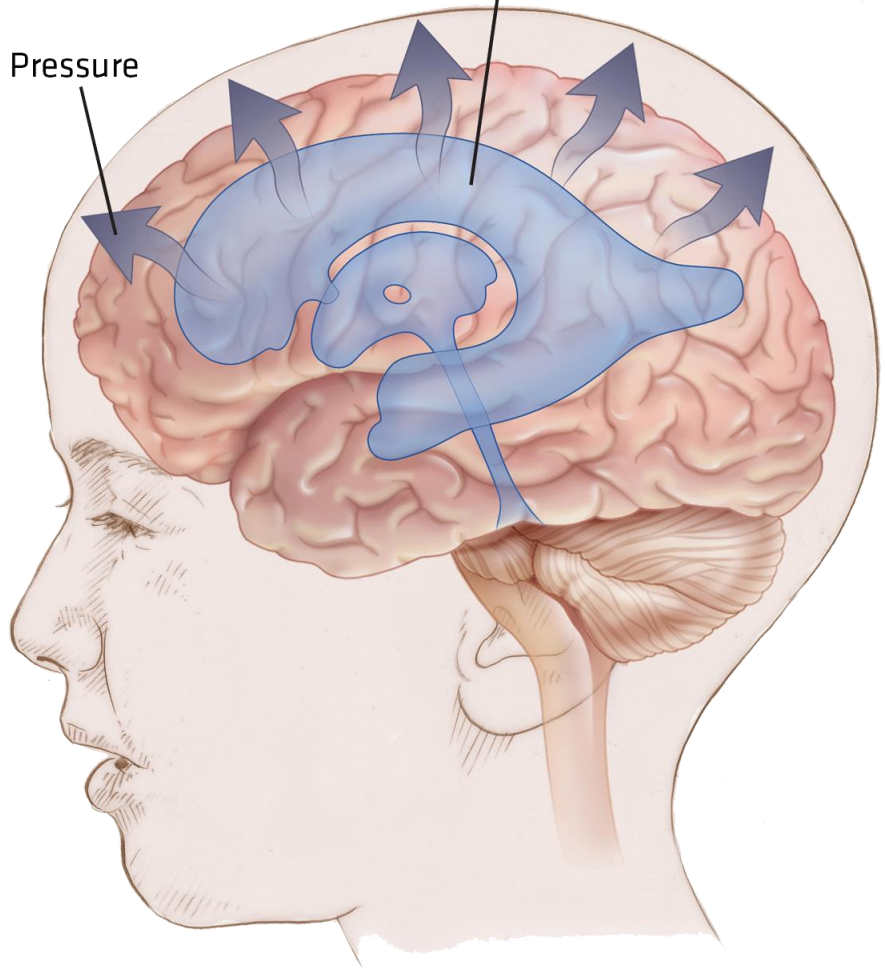
- The term hydrocephalus is derived from the Greek words "hydro" meaning water and "cephalus" meaning head.
- It is excessive accumulation of fluid in the brain.

Normal ventricle

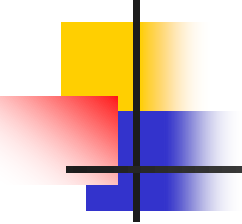


Enlarged ventricle

Pressure

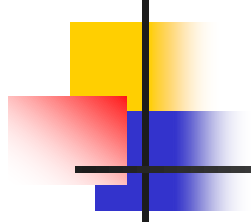




- 
- 
- For further inquiries **PLZ** feel free to contact at any time through email

[gamaltaha@med.asu.edu.eg](mailto:gamaltaha@med.asu.edu.eg)

[gamal.abdelhady@yu.edu.jo](mailto:gamal.abdelhady@yu.edu.jo)



---

*Thank You*