

***MENINGES***  
***, VENTRICLES &***  
**CSF**

# OBJECTIVES

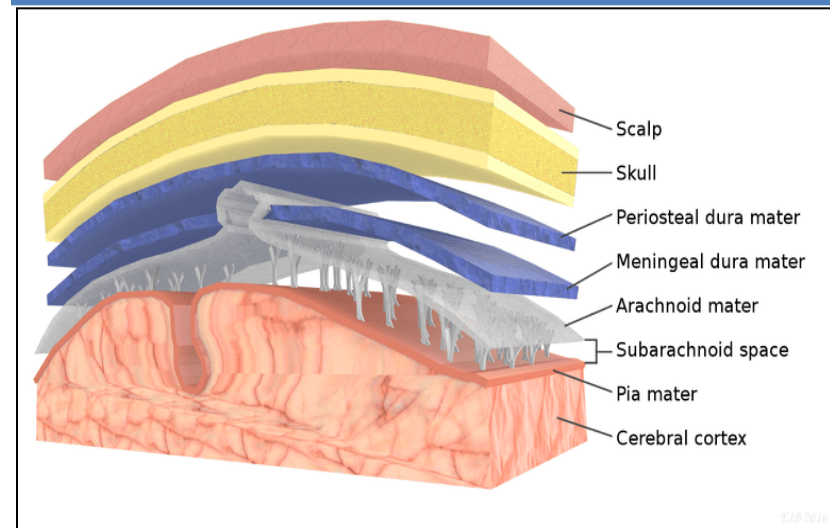
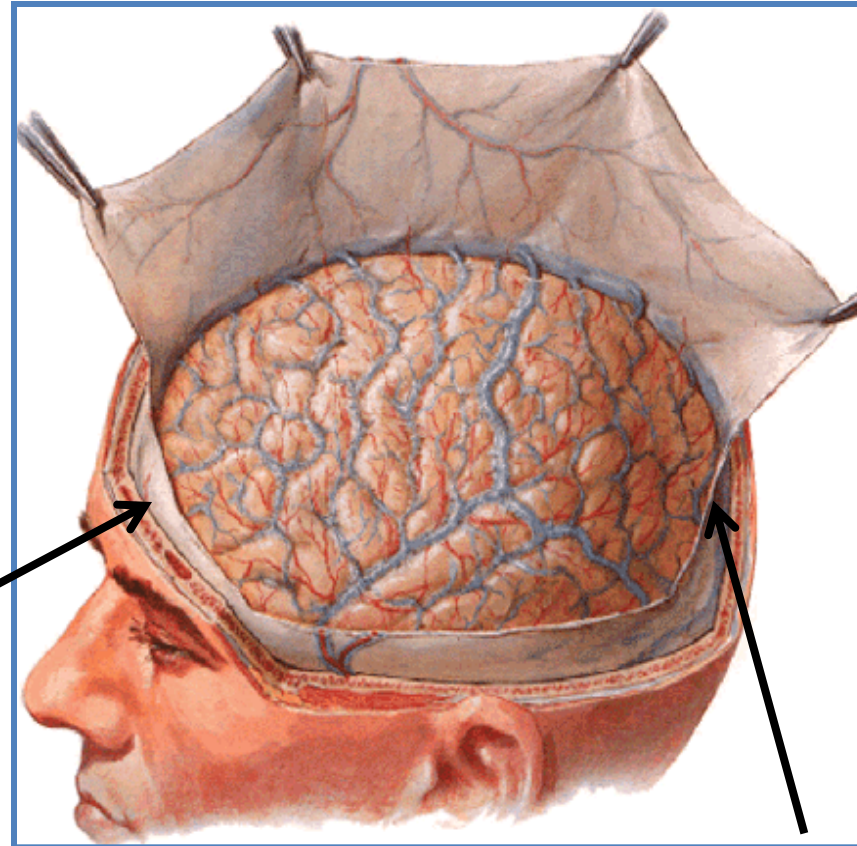
- *By the end of the lecture the student should be able to:*
- Describe the **cerebral meninges** & list the main dural folds.
- Describe the **spinal meninges** & locate the level of the termination of each of them.
- Describe the importance of the **subarachnoid space**.
- List the **Ventricular system of the CNS** and locate the site of each of them.
- Describe the **formation, circulation, drainage, and functions of the CSF**.
- Know some clinical point about the **CSF**

# MENINGES

- The **brain and spinal cord** are invested by three concentric membranes ;
- The outermost layer is the **dura matter.**
- The middle layer is the **arachnoid matter.**
- The innermost layer is the **pia matter.**

# DURA MATER

- The **cranial dura** is a two layered tough, fibrous thick membrane that surrounds the brain.
- It is **formed of** two layers; **periosteal** and **meningeal**.
- The **periosteal layer** is attached to the skull.
- The **meningeal layer** is folded forming the **dural folds** : **false cerebri**, and **tentorium cerebelli**.
- **Sensory innervation of the dura** is mostly from : meningeal branches of the **trigeminal** and **vagus nerves** & **C1 to C3**(upper cervical Ns.).



# DURA MATER Folds

□ Two large reflections of dura extend into the cranial cavity :

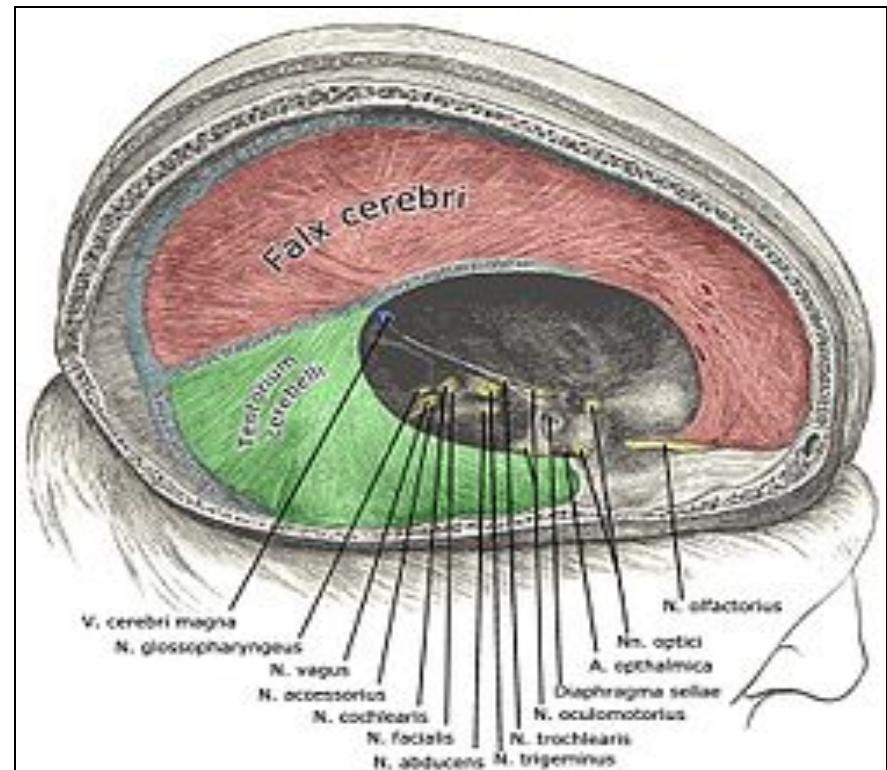
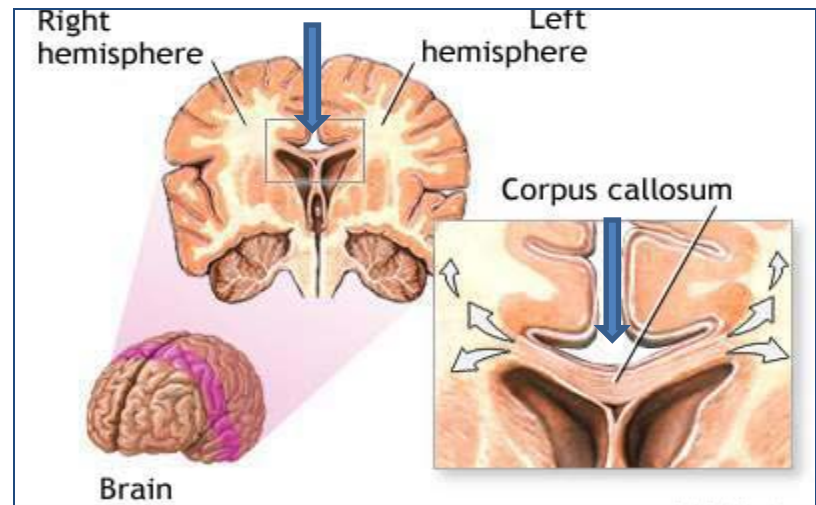
## 1. The falx cerebri,

In the midline,

■ It is a vertical sickle-shaped sheet of dura, extends from the cranial roof into the great longitudinal fissure between the two cerebral hemispheres.

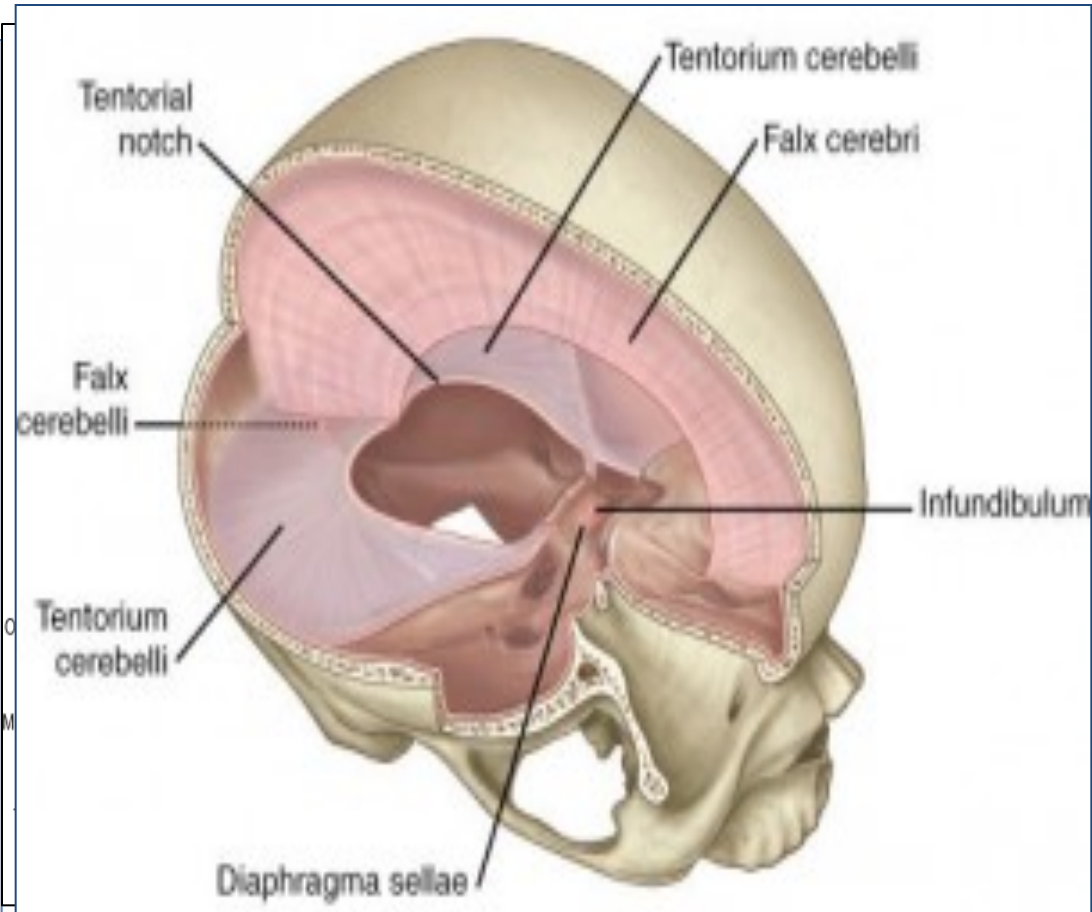
■ It has an attached border adherent to the skull.

■ And a free border lies above the corpus callosum.



# DURA MATER Folds

2. A horizontal shelf of dura, **The tentorium cerebelli**,
- It lies between the posterior part of the cerebral hemispheres and the cerebellum.
  - It has a free border that encircles the midbrain.
  - In the middle line it is continous above with the falx cerebri.



Dural nerve supply:

Branches of trigeminal, vagus, and first three cervical nerves and branches from the sympathetic system.

The dura is sensitive to stretching (sense of headache)

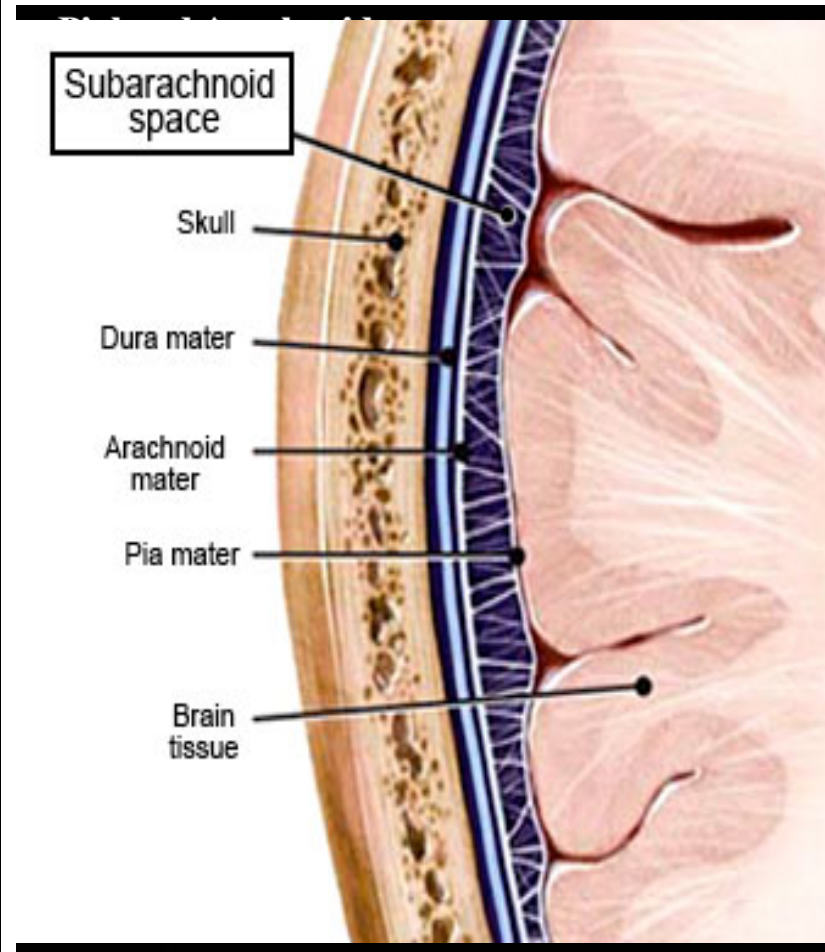
Arterial supply:

Branches from internal carotid, maxillary, ascending pharyngeal, occipital, and vertebral arteries.

Clinically the most important is the middle meningeal artery, which is commonly injured in head injuries.

# Arachnoid Mater & Pia Mater

- **The arachnoid mater** is a soft, translucent membrane loosely envelops the brain.
- The arachnoid mater is separated from the dura by a narrow **subdural space**.
- **The pia mater** is the innermost, thin, delicate & highly vascular membrane that is closely adherent to the gyri and fitted into the sulci.
- Between the pia and arachnoid mater lies the **subarachnoid space** which contains; fibrous trabeculae, main blood vessels and CSF.

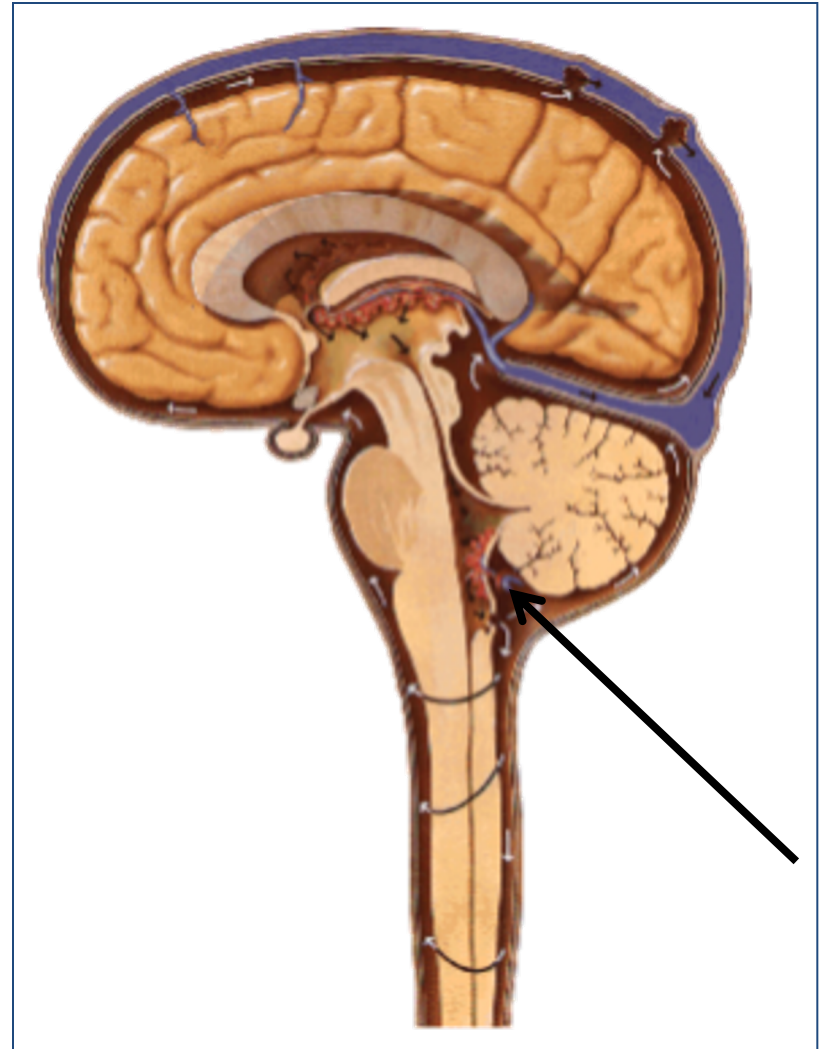




# Subarachnoid Space

▪ It is **varied in depth** forming; **subarachnoid cisterns** ;

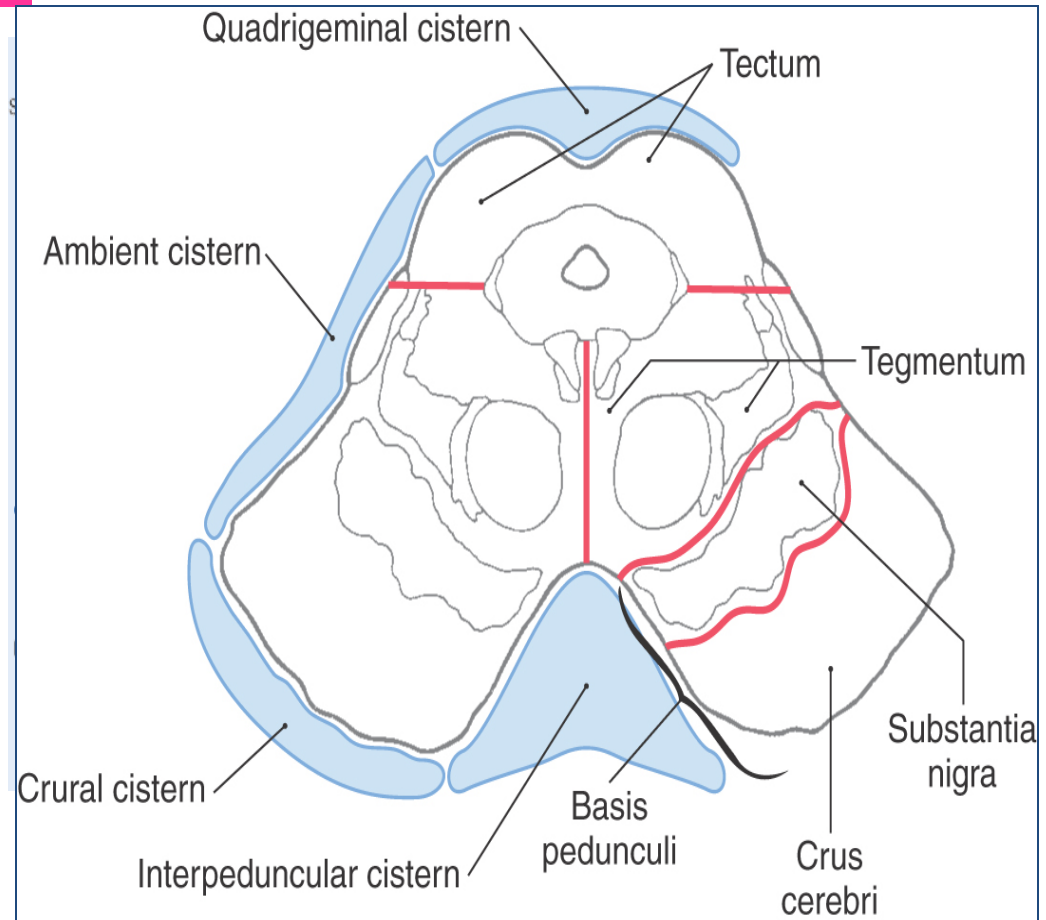
1. The **cisterna magna**, or **cerebellomedullary cistern** which lies between the inferior surface of the cerebellum and the back of the medulla.
  - At this cistern **CSF flows out of the 4<sup>th</sup> ventricle via** the 2 lateral aperatures and median aperature.



# Subarachnoid Space

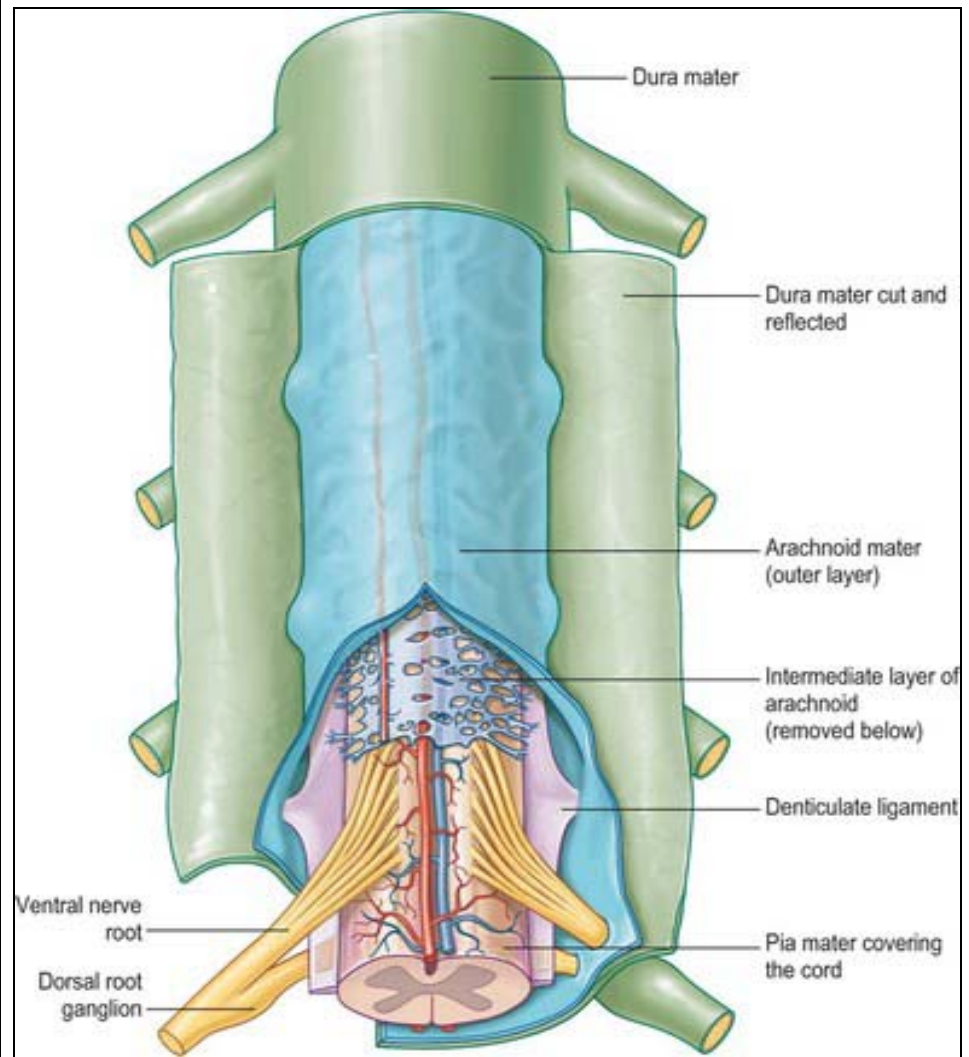
2. The **interpeduncular cistern**, which is located at the base of the brain, where the arachnoid spans between the two cerebral peduncles of midbrain.

- This cistern contains the optic chiasma & **circulus arteriosus of Wills**.



# Spinal meninges

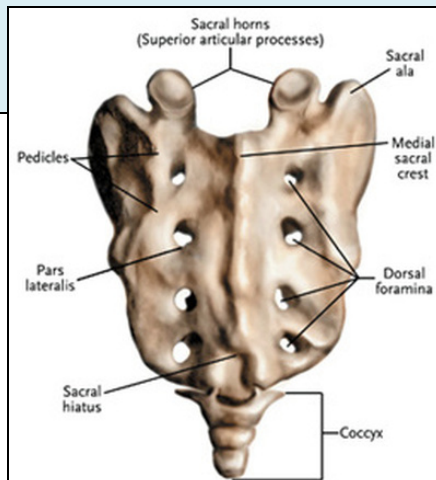
- ❑ The spinal cord, is invested by **three meningeal coverings: pia mater, arachnoid mater and dura mater.**
- ❑ The **dura matter; The outer covering; is** a thick, tough fibrous membrane.
  - It envelopes the cord **loosely.**
  - It is separated from arachnoid matter by the **subdural space**, and from the **bony wall of the vertebral canal** by the **epidural space.**
- ❑ The **arachnoid matter** is a translucent membrane lies between the pia and dura,
  - **Between arachnoid and pia** lies the **subarachnoid space** contains CSF.
- ❑ The **pia matter; The innermost covering,** is a delicate fibrous membrane **closely envelops the cord and nerve roots.**
  - It is attached through the arachnoid to the dura by the **denticulate ligament.**



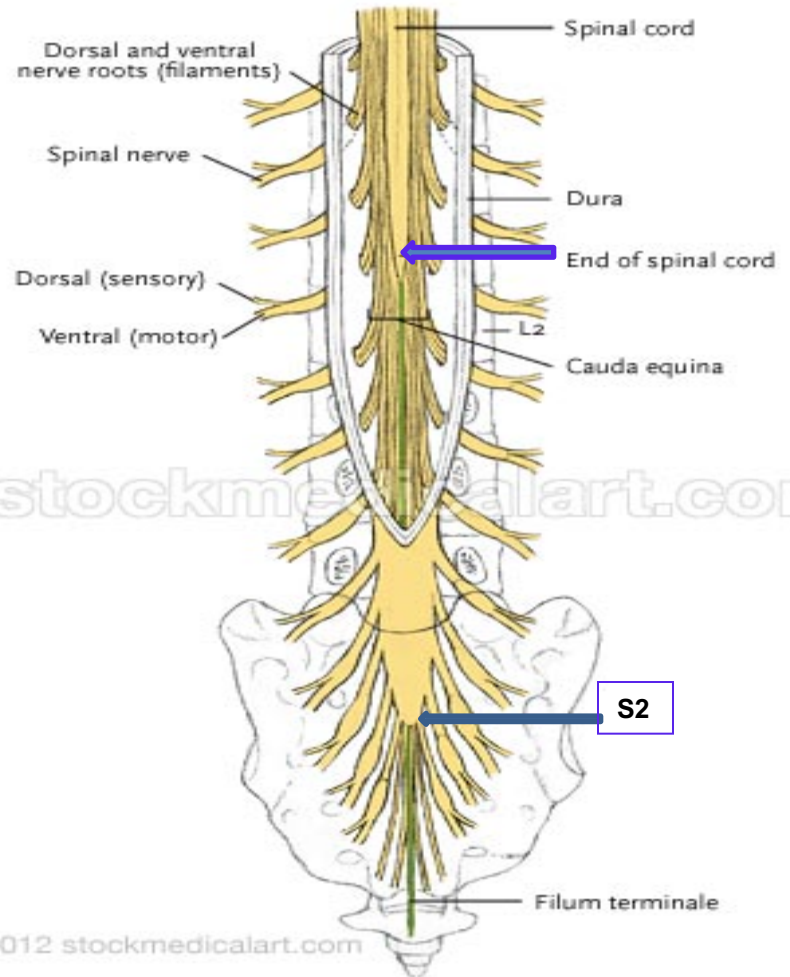
❑ The **spinal cord** terminates at level **L1-L2**, while

❑ The **dura and arachnoid** and, **subarachnoid space**, continue caudally to **S2**.

❑ The **pia** extends downwards forming the **filum terminale** which pierces the **arachnoid** and **dural sacs** and passes through the **sacral hiatus** to be attached to the **back** of the **coccyx**.

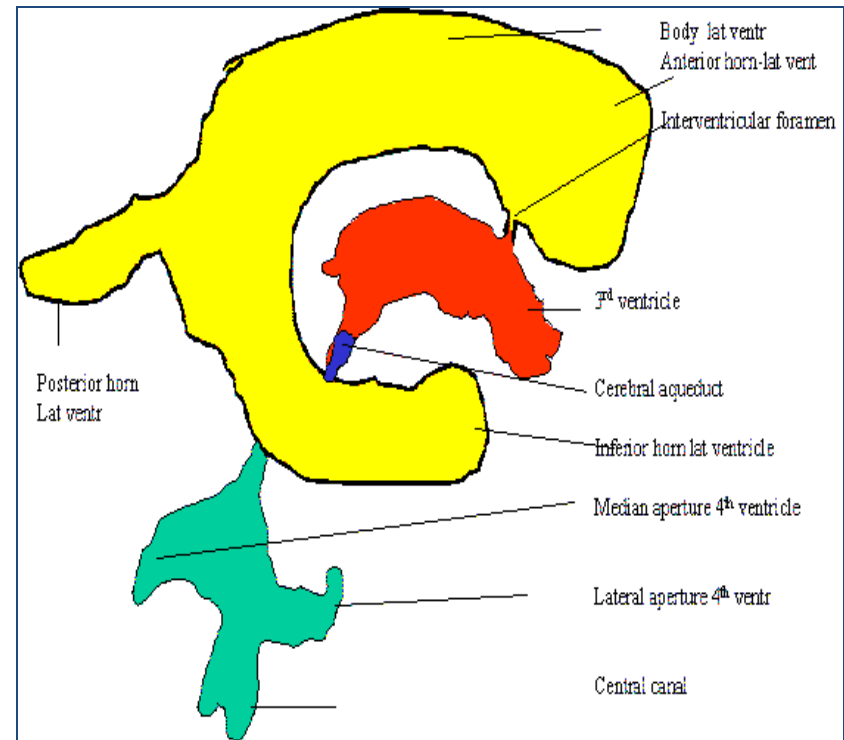


# Spinal meninges



# VENTRICULAR SYSTEM

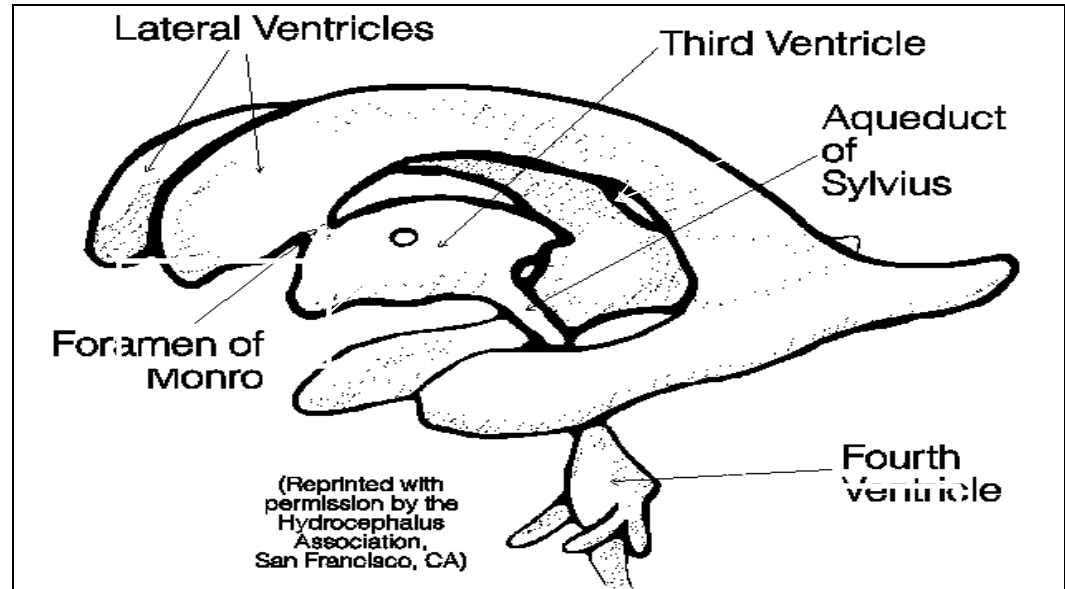
- ❑ **Interconnecting channels** within the CNS.
- ❑ In the spinal cord; represented by the **central canal**.
- ❑ Within the brain; a system of **ventricles** is found.
- ❑ The **central canal** of the spinal cord is **continuous upwards** to the **fourth ventricle**.
- ❑ On each side of the **fourth ventricle** laterally, **lateral recess** extend to open into lateral aperture (**foramen of Luschka**), central defect in its roof (**foramen of Magendie**)



# VENTRICULAR SYSTEM

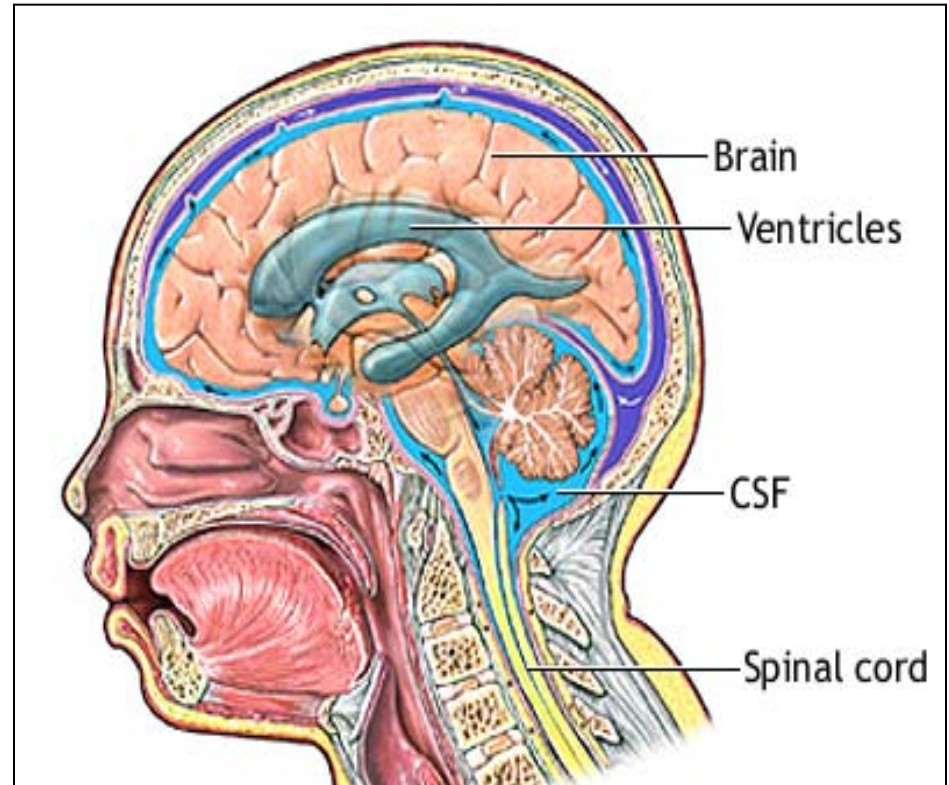
❑ The **forth ventricle** is continuous up with the **cerebral aqueduct**, that opens in the **third ventricle**.

❑ The **third ventricle** is continuous with the **lateral ventricle** through the **interventricular foramen (foramen of Monro)**.



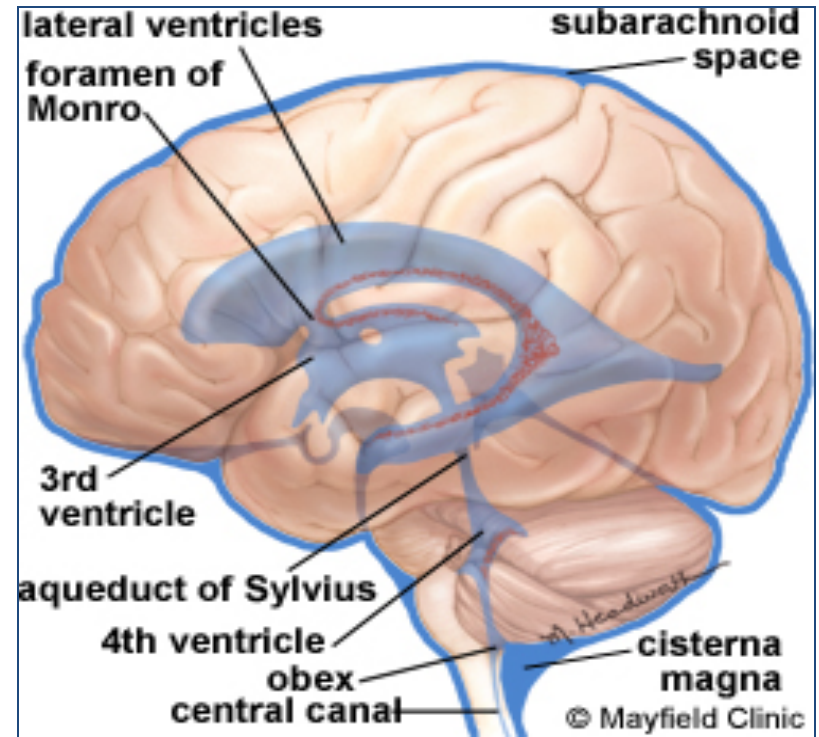
# CEREBROSPINAL FLUID

- ❑ Present in the ventricular system, together with the cranial and spinal **subarachnoid spaces**.
- ❑ It is **colourless clear fluid** containing little protein and few cells.
- ❑ It is about **150 ml**.
- ❑ It acts as a **cushion** for the brain from sudden movements of the head.



# CEREBROSPINAL FLUID

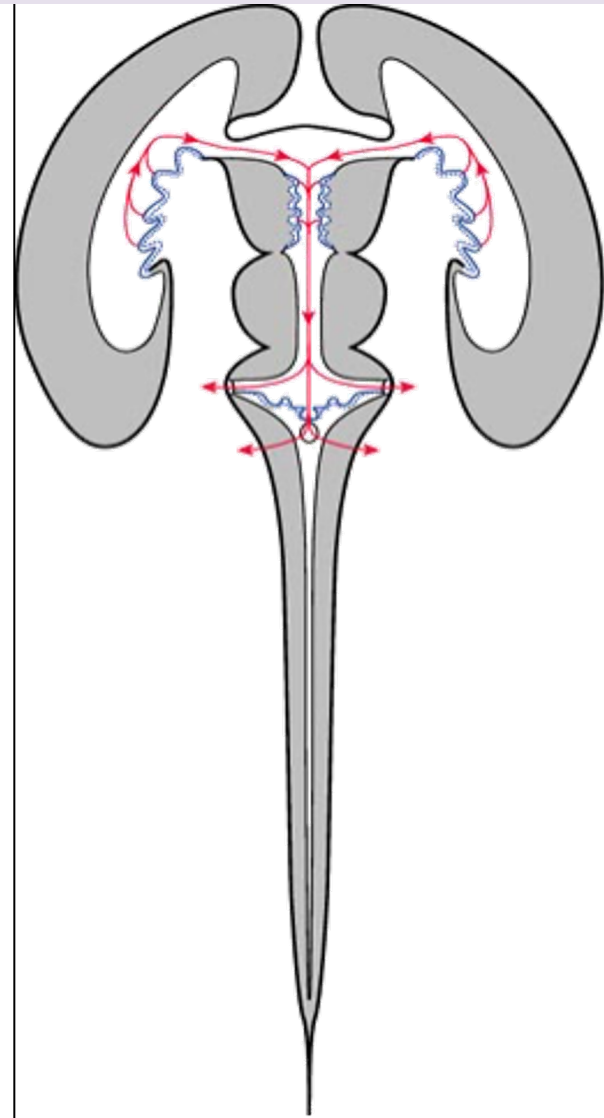
- ❑ It is produced by the **choroid plexus**, which is located in the lateral, third & fourth ventricles.
- ❑ From lateral ventricle it **flows**: through the **interventricular foramen** into the **3<sup>rd</sup> ventricle** and, by way of the **cerebral aqueduct**, into the **4<sup>th</sup> ventricle**.





# CEREBROSPINAL FLUID

□ It leaves the ventricular system through the three **apertures of the 4<sup>th</sup> ventricle** (median foramen of Magindi & 2 lateral foraminae of Leushka), to enters the **subarachnoid space.**

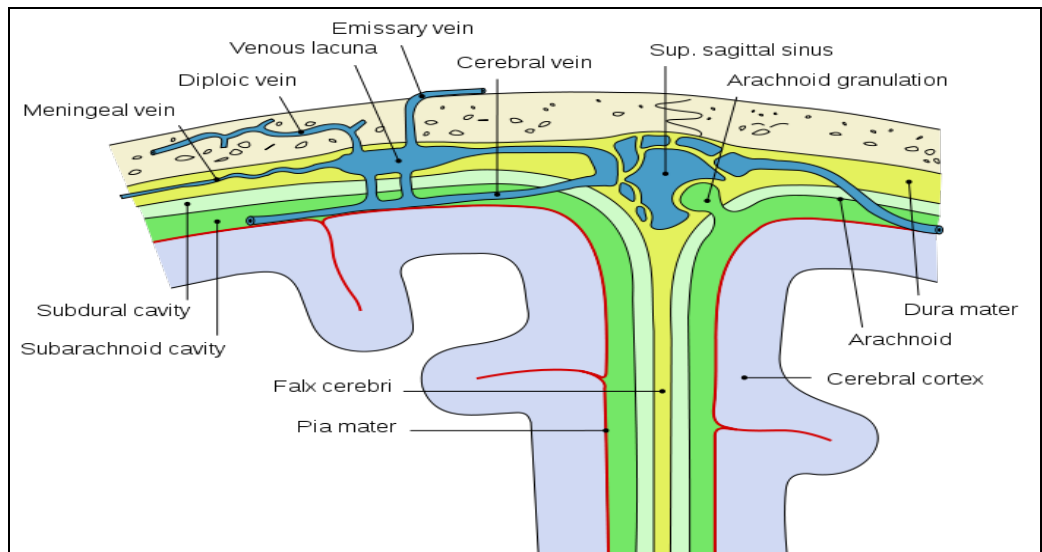
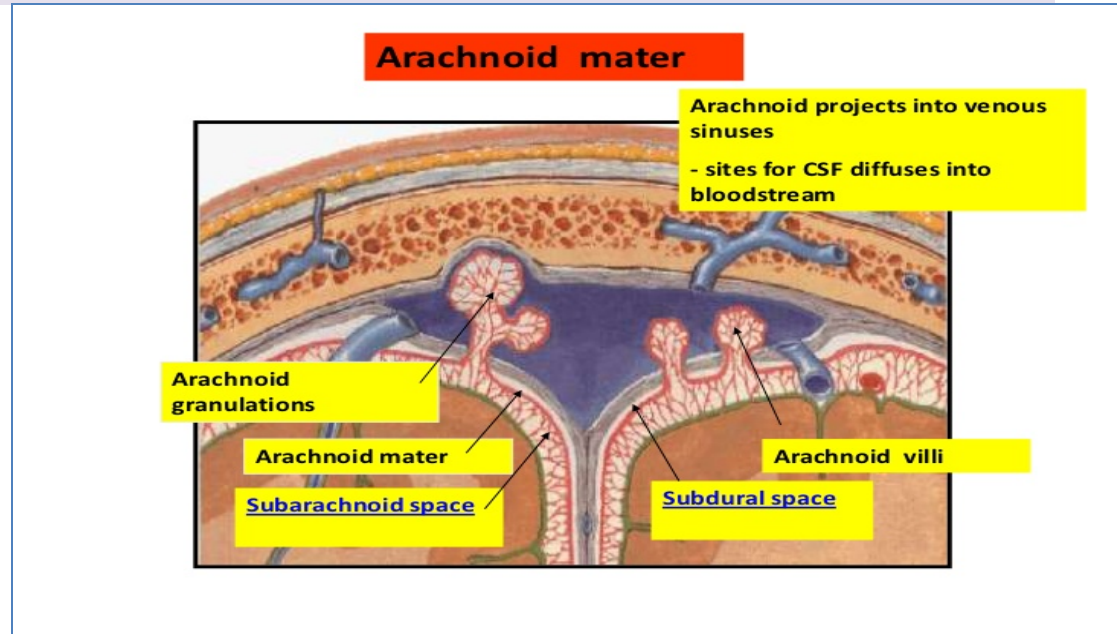


# CEREBROSPINAL FLUID

□ reabsorbed finally  
into the venous system  
along

□ **arachnoid villi** (small  
microscopic herniation of  
arachnoid mater), **and**

□ **arachnoid  
granulation** (Macroscopic  
multilobulated structures) that  
project into the **dural  
venous sinuses**, mainly  
superior sagittal sinus.



# CEREBROSPINAL FLUID

## clinical point

❑ The obstruction of the flow of CSF leads to a rise in fluid pressure causing swelling of the ventricles (**hydrocephalus**).

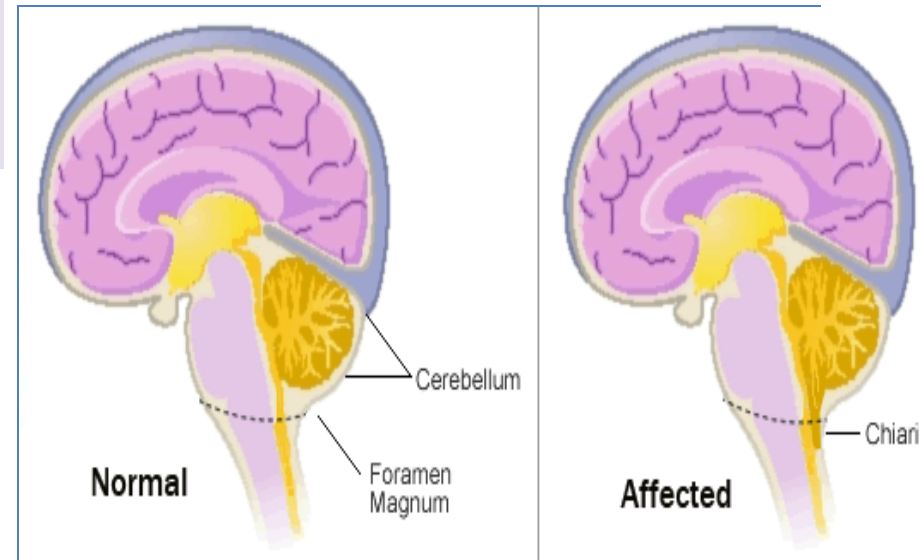
### ❑ Causes :

❑ Congenital : ( **Arnold-Chiari malformation**).

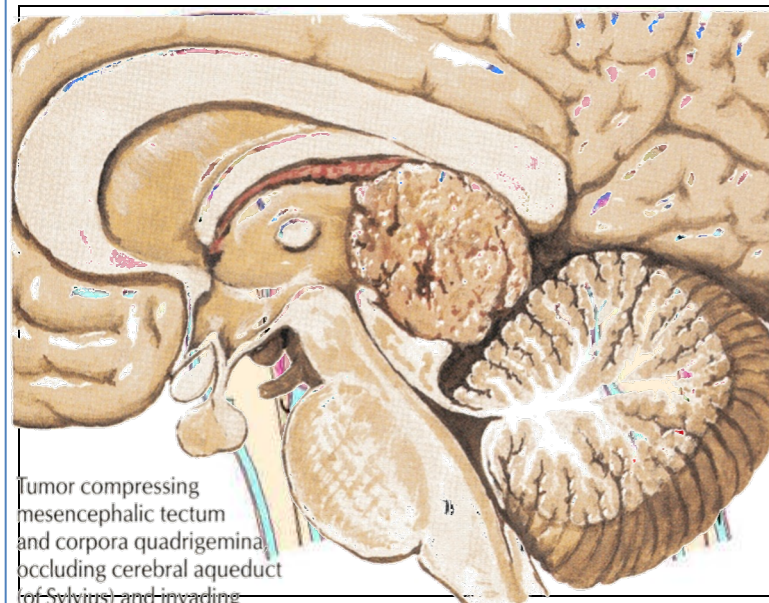
❑ Acquired :

➤ Stenosis of the cerebral aqueduct by **tumor of pineal region**.

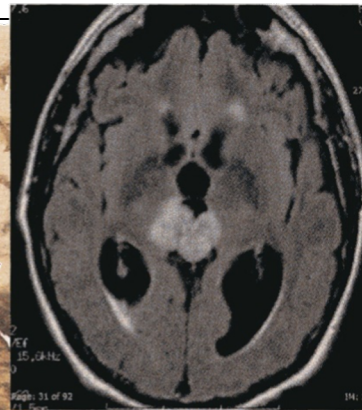
➤ Obstruction of the interventricular foramina secondary to tumors, hemorrhages or infections such as meningitis



### Tumors of Pineal Region



Tumor compressing mesencephalic tectum and corpora quadrigemina, occluding cerebral aqueduct (of Sylvius) and invading 3rd ventricle



MR scan showing tumor of pineal region, with hydrocephalus

# CEREBROSPINAL FLUID

## clinical point

□ **Decompression** of the **dilated ventricles** is achieved by **inserting a shunt** connecting the ventricles to the jugular vein **or** the abdominal peritoneum.

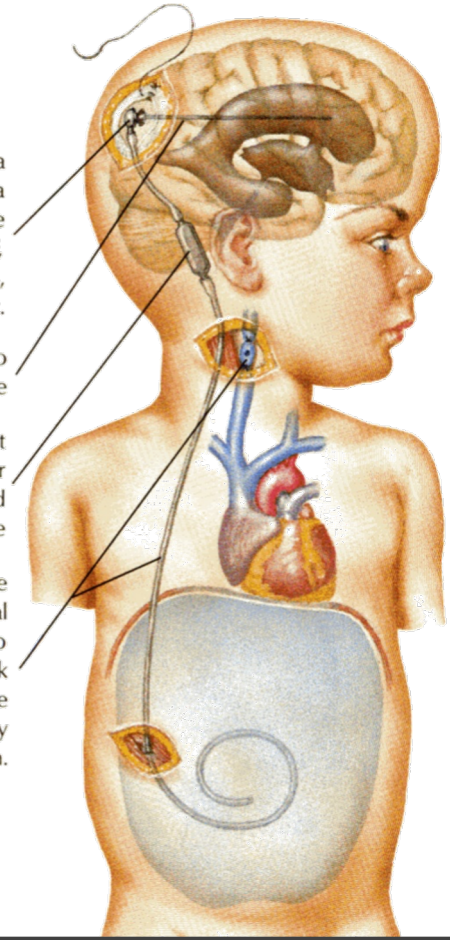
### Shunt procedure for hydrocephalus

Reservoir at end of cannula implanted beneath galea permits transcutaneous needle puncture for withdrawal of CSF, introduction of antibiotics, or dye to test patency of shunt.

Cannula inserted into lateral ventricle

One-way valve to prevent reflux of blood or peritoneal fluid and control CSF pressure

Drainage tube may be introduced into internal jugular v. and thence into right atrium via neck incision, or may be continued subcutaneously to abdomen.



# Summary

- **The brain & spinal cord are covered by 3 layers of meninges** : dura, arachnoid & pia mater.
- **The important dural folds** inside the brain are the **falx cerebri & tentorium cerebelli**.
- **CSF is produced by** the choroid plexuses of the ventricles of the brain : lateral ,3<sup>rd</sup> & 4<sup>th</sup> ventricles.
- **CSF circulates** in the subarachnoid space.
- **CSF is drained into** the dural venous sinuses principally superior sagittal sinus.
- **The subarachnoid space in the spinal cord terminates** at the 2<sup>nd</sup> sacral vertebra.
- Obstruction of the flow of CSF as in **tumors of the brain** leads to hydrocephalus.