



# **Neuroanatomy**

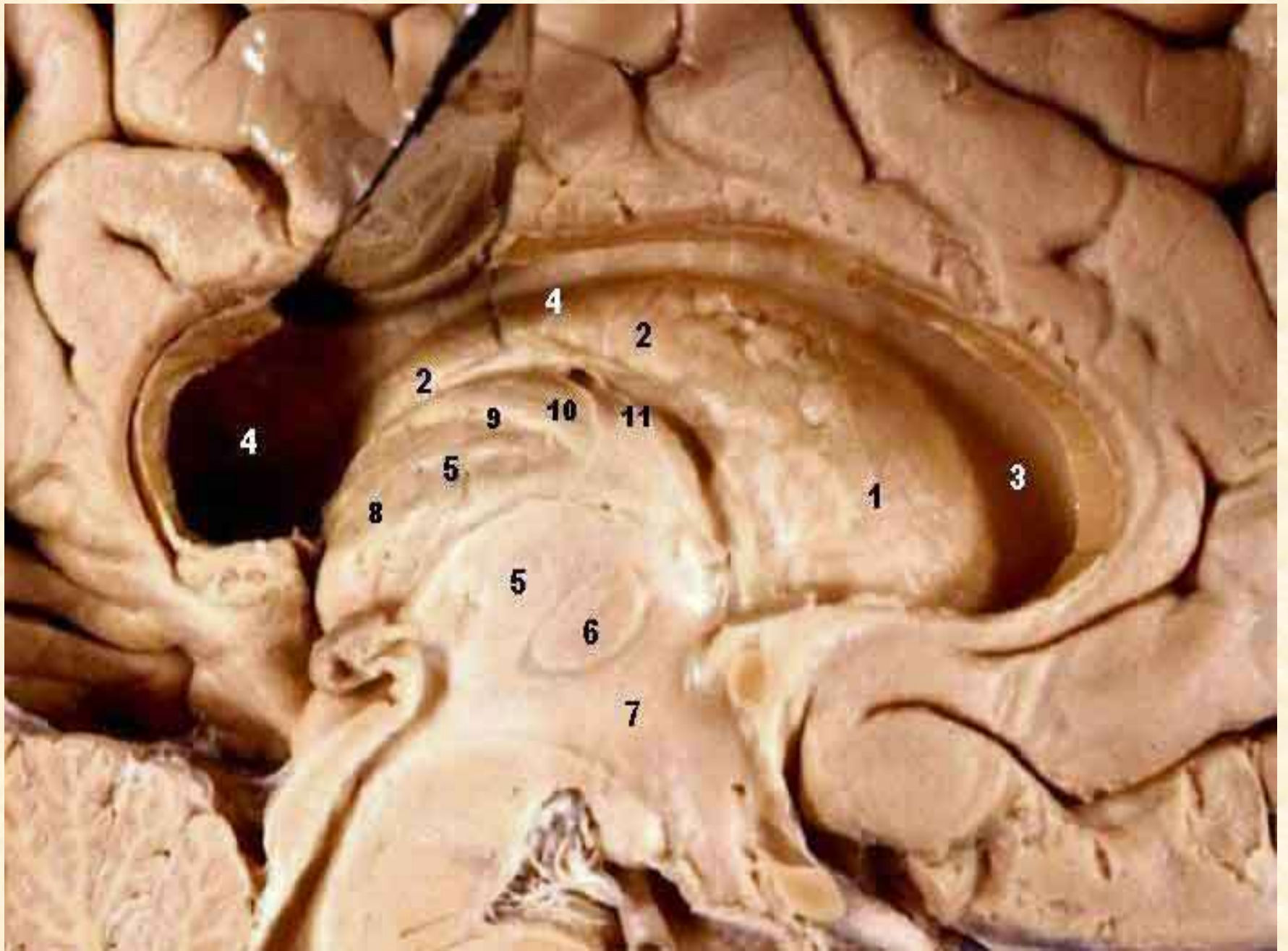
**Dr. Maha ELBeltagy**

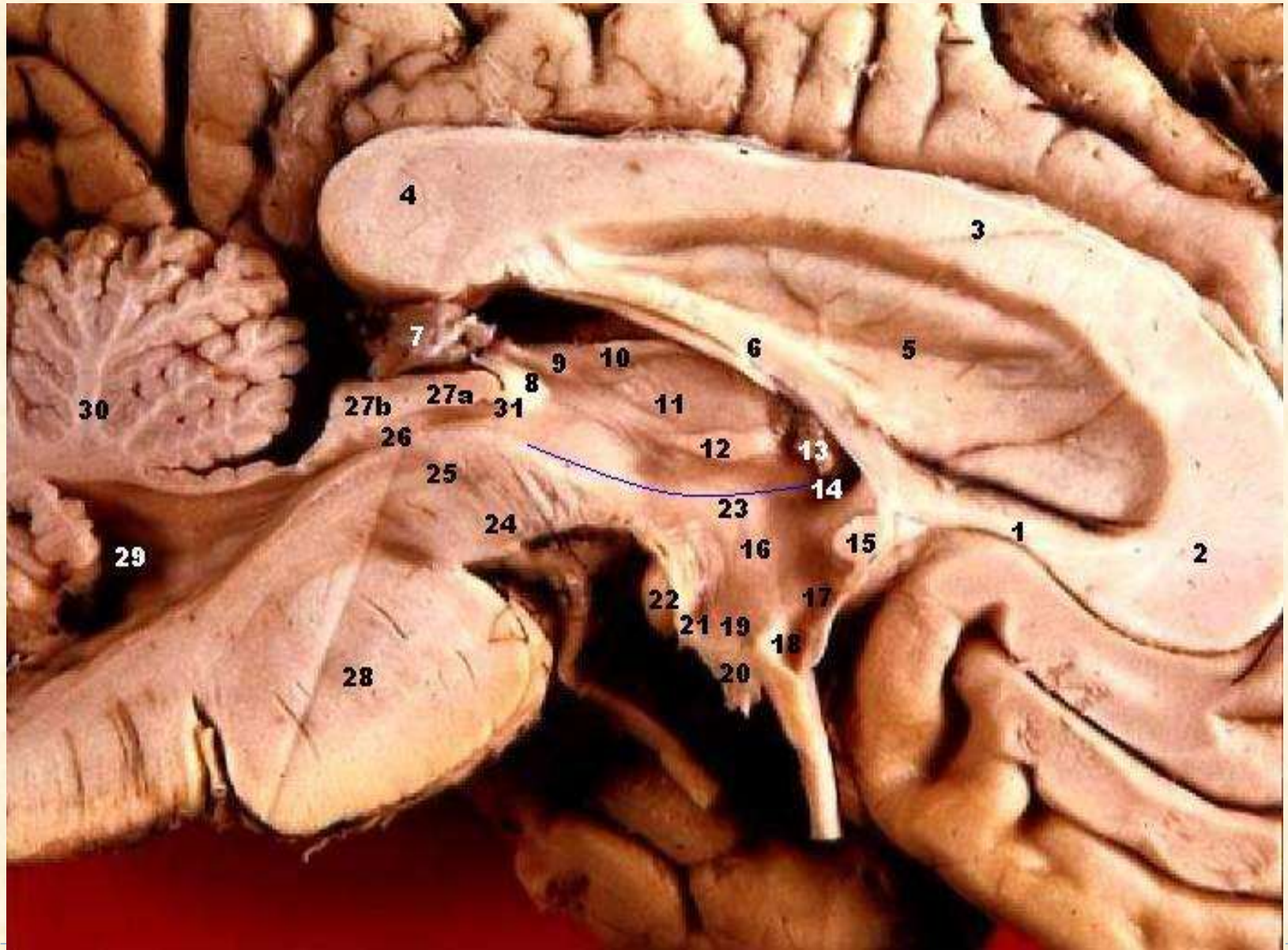
**Assistant Professor of Anatomy**

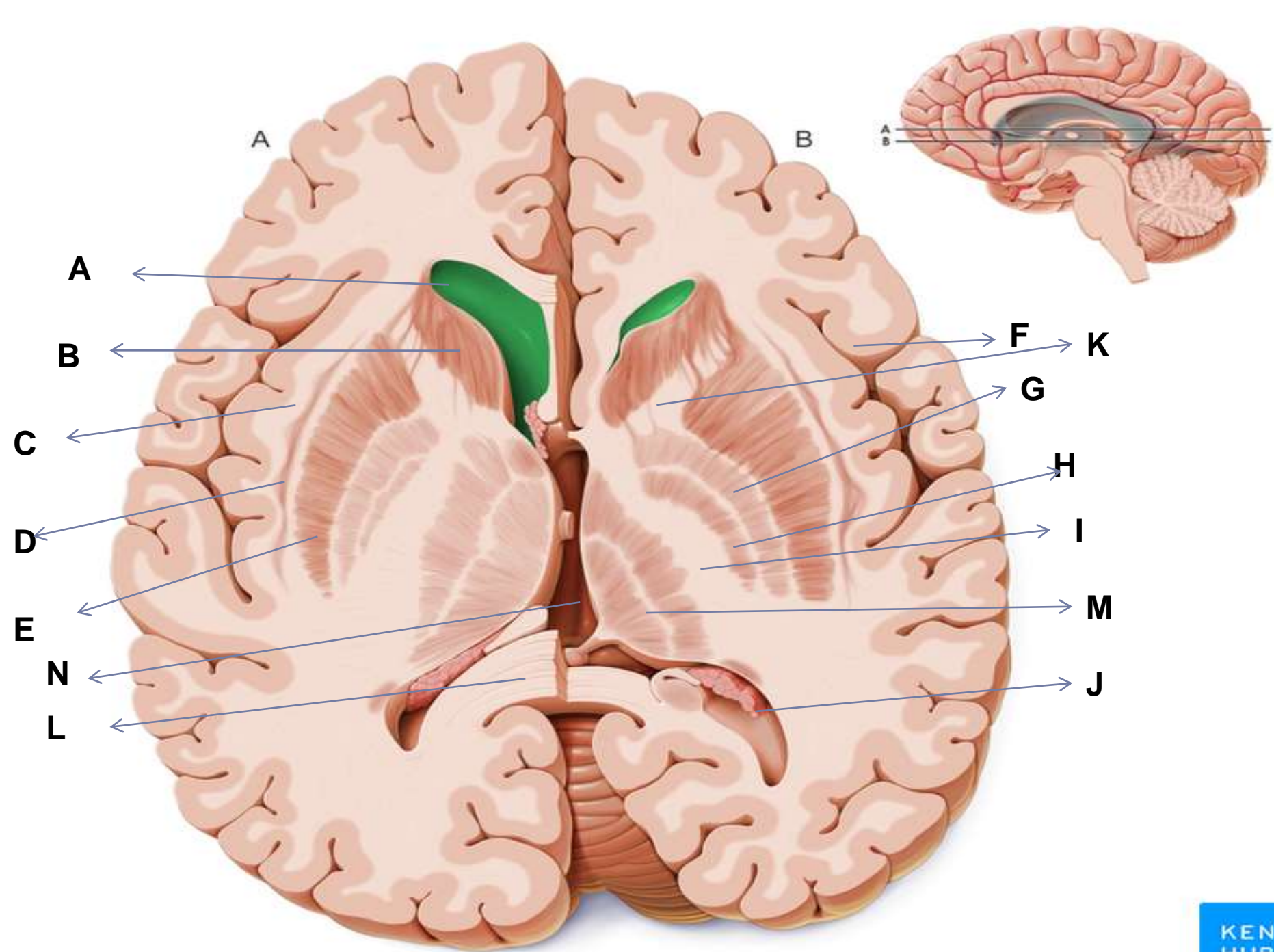
**Faculty of Medicine**

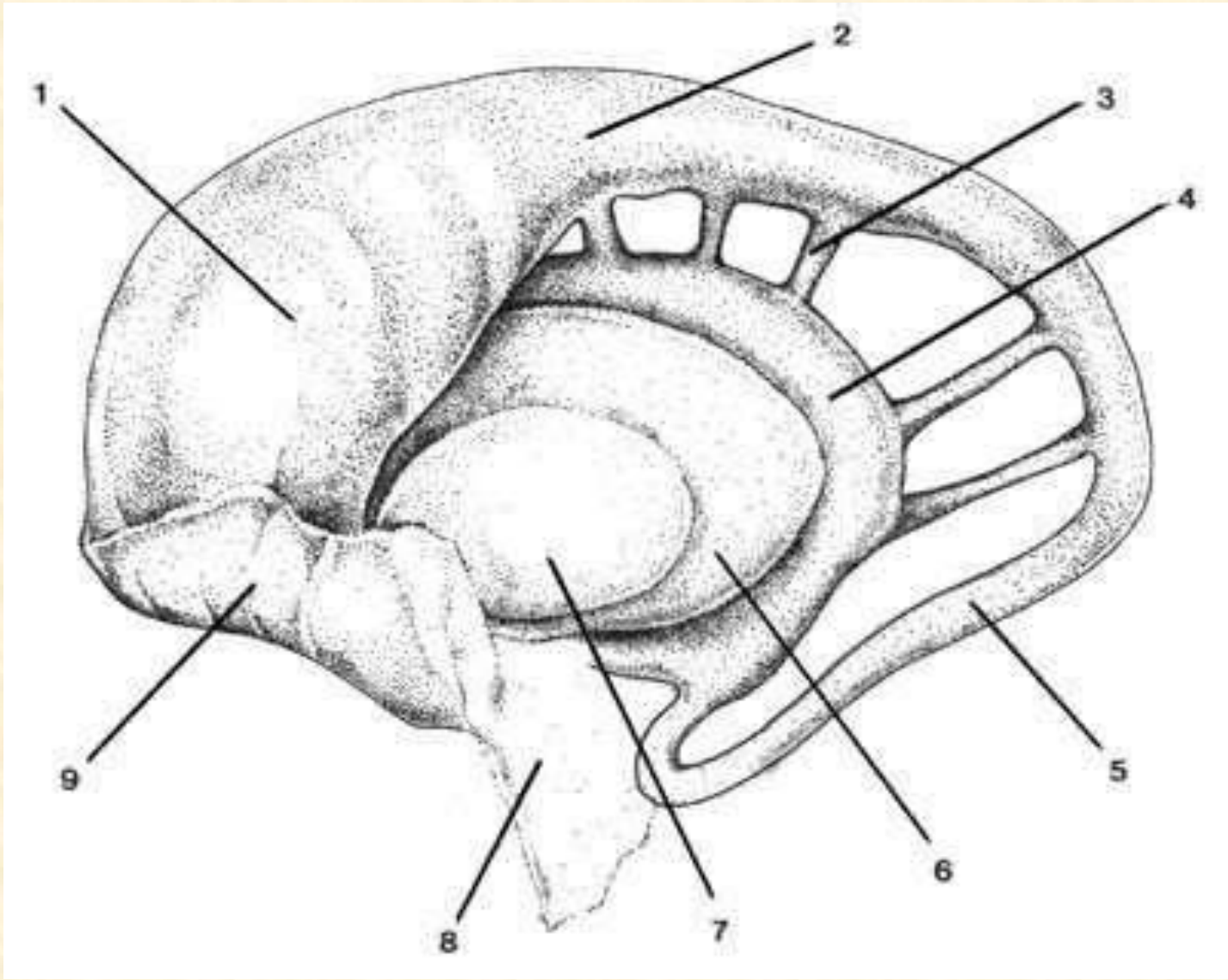
**The University of Jordan**

**2018**

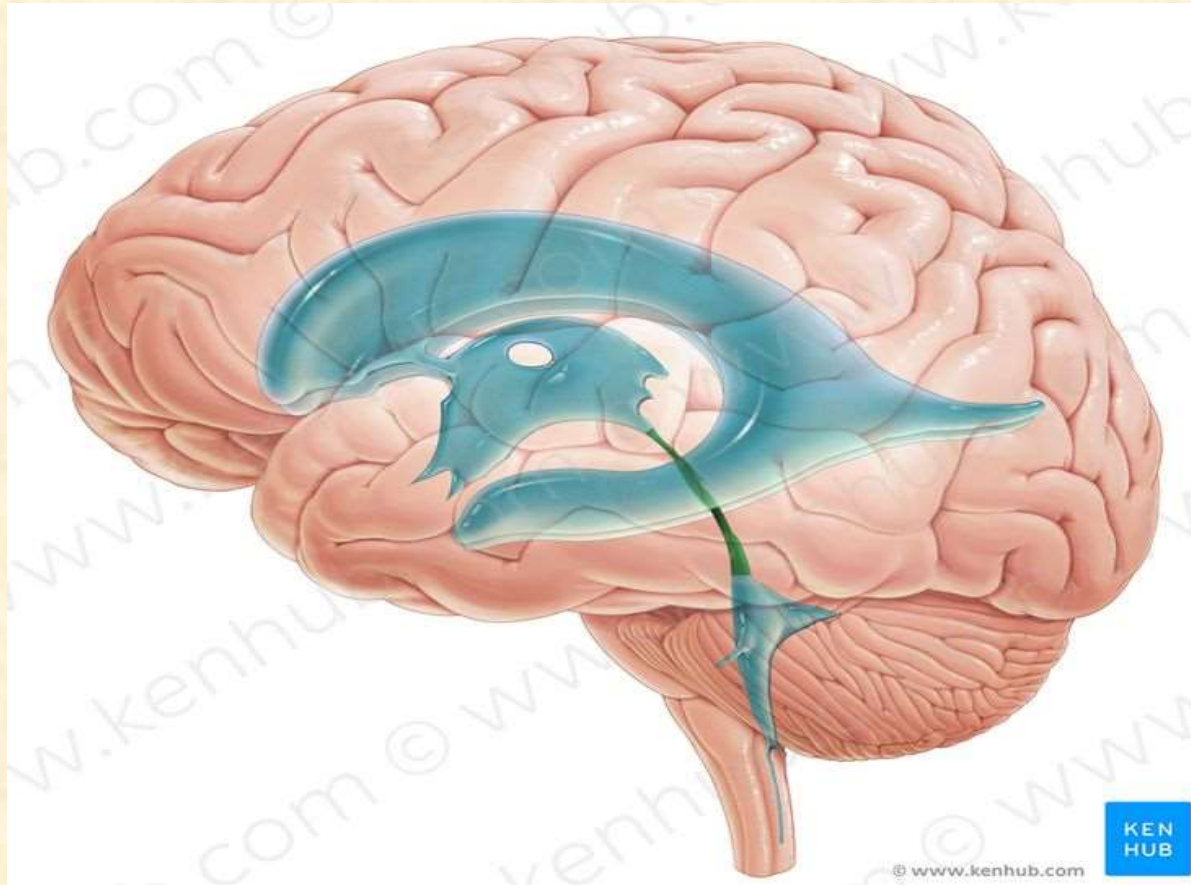








# Ventricular System, The Cerebrospinal Fluid, and the Blood Brain Barrier



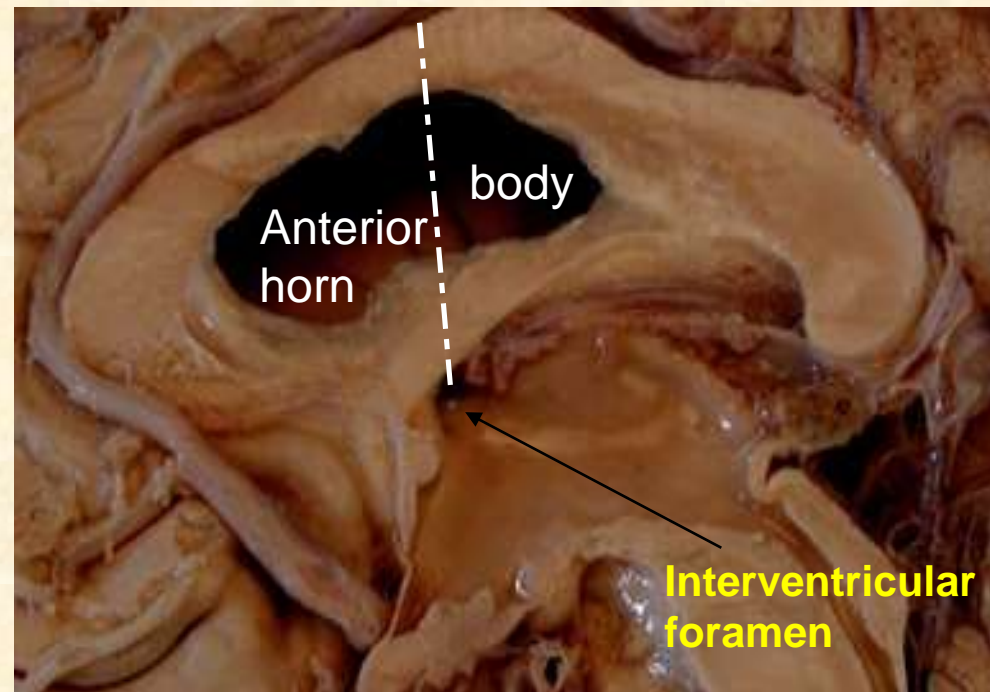
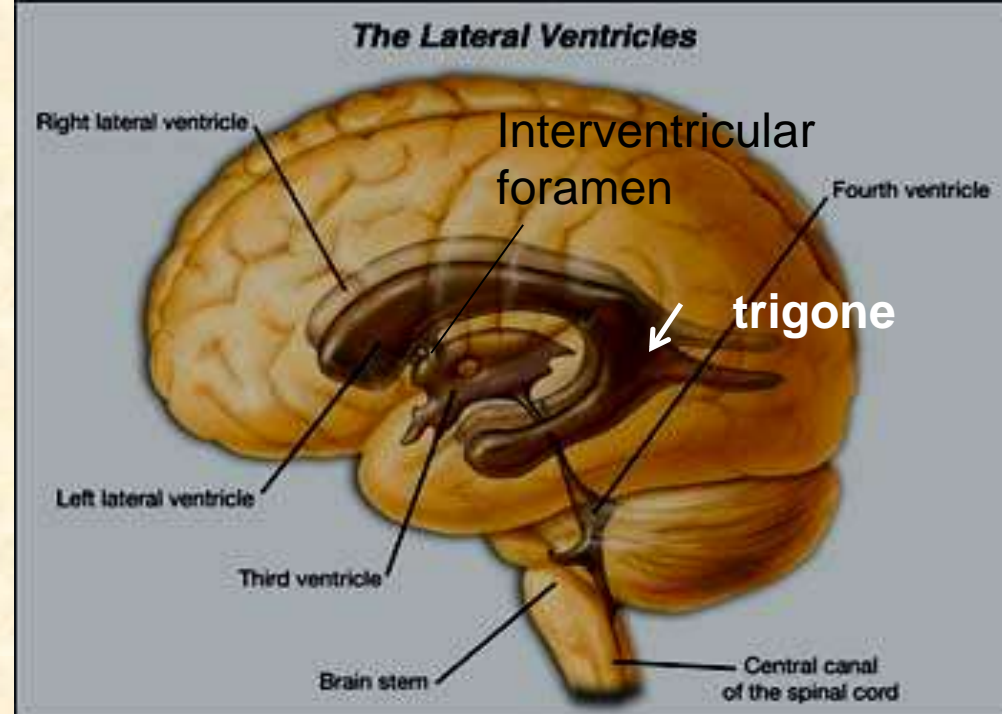
# The lateral ventricle

It is Y-shaped cavity in the cerebral hemisphere with the following parts:

- 1) **A central part (body):** Extends from the interventricular foramen to the splenium of corpus callosum.
- 2) **3 horns:**
  - **Anterior horn:** Lies in the **frontal** lobe in front of the interventricular foramen.
  - **Posterior horn :** Lies in the **occipital** lobe.
  - **Inferior horn :** Lies in the **temporal** lobe.

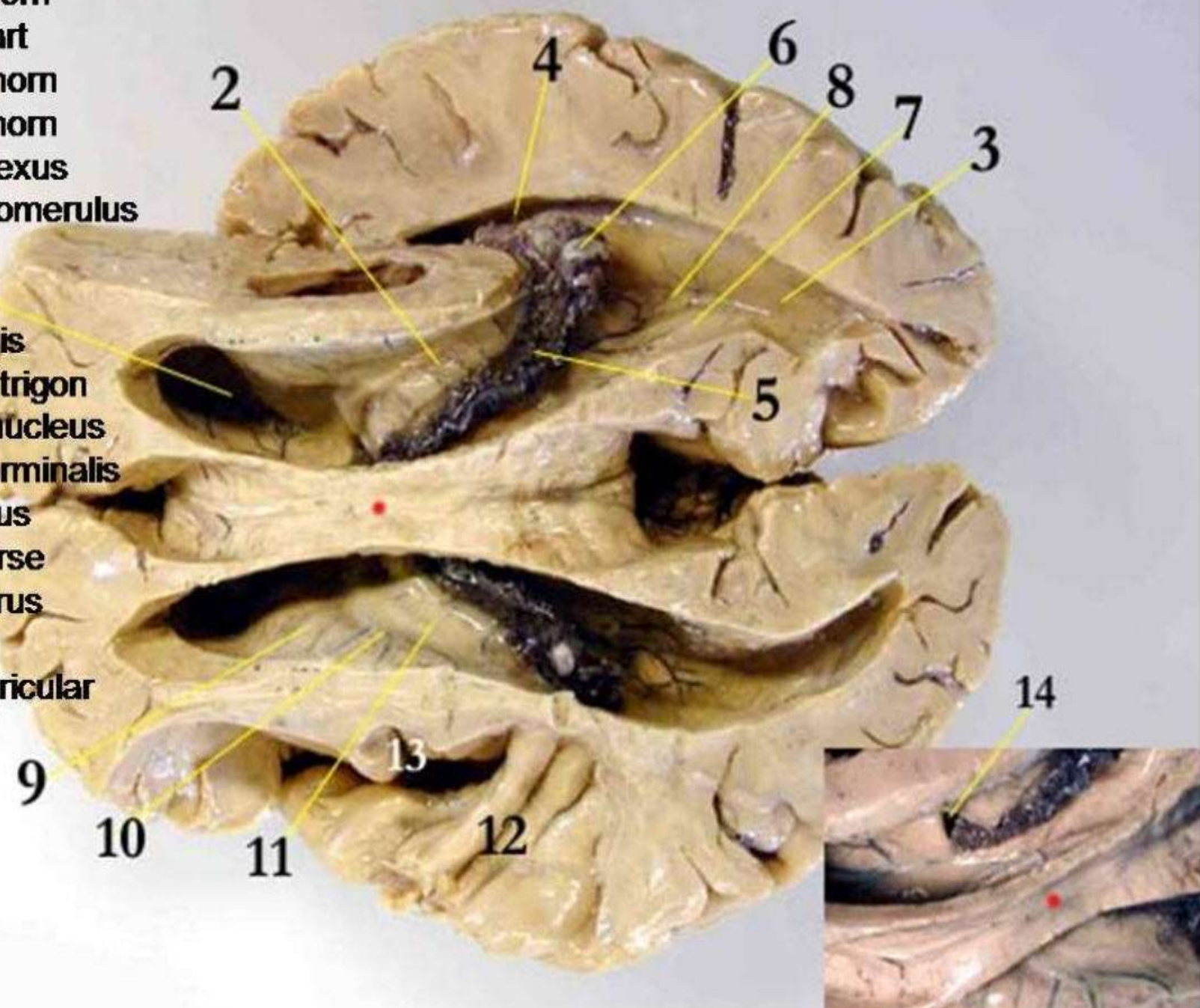
It is connected to the **3<sup>rd</sup> ventricle** by **interventricular foramen (of Monro)**.

**Trigone (atrium):** the part of the body at the junction of inferior and posterior horns  
Contains the glomus (choroid plexus tuft)  
calcified in adult (x-ray&CT).



- 1- anterior horn
- 2- central part
- 3- posterior horn
- 4- temporal horn
- 5- choroid plexus
- 6- choroid glomerulus

- 7- Calcar avis
- 8- Collateral trigon
- 9- Caudate nucleus
- 10- sulcus terminalis
- 11- Thalamus
- 12- Transverse temporal gyrus
- 13- Insula
- 14- Interventricular foramen





# Third & Lateral Ventricles, from Above

6-Genu of corpus callosum **6**

**1**

**5**

5-Septum pellucidum

7-  
Tem  
poral  
lobe **7**

4-Choroid  
plexus **4**

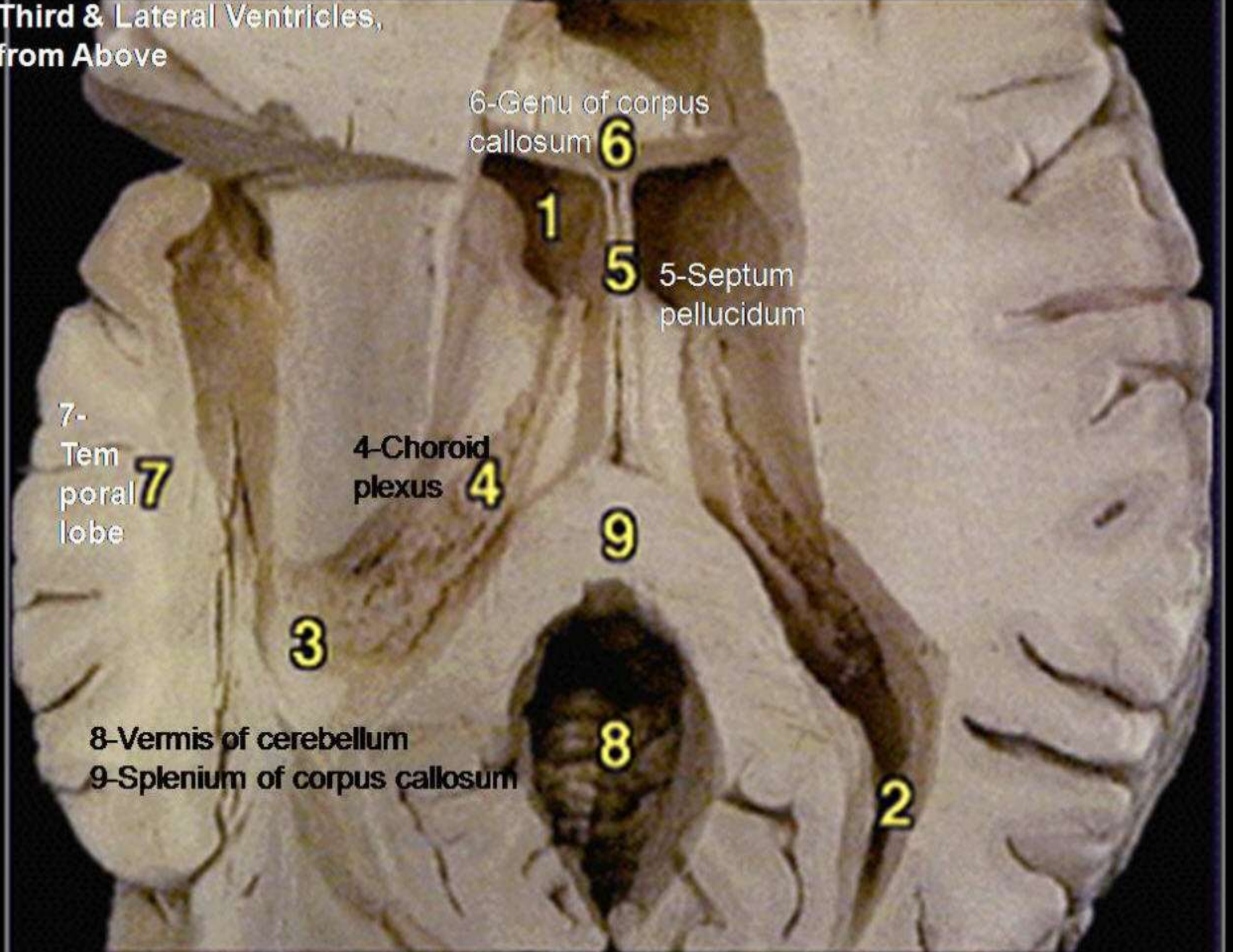
**9**

**3**

8-Vermis of cerebellum  
9-Splenium of corpus callosum

**8**

**2**



# Relations of Body of the lateral ventricle

**Roof** : body of the Corpus callosum

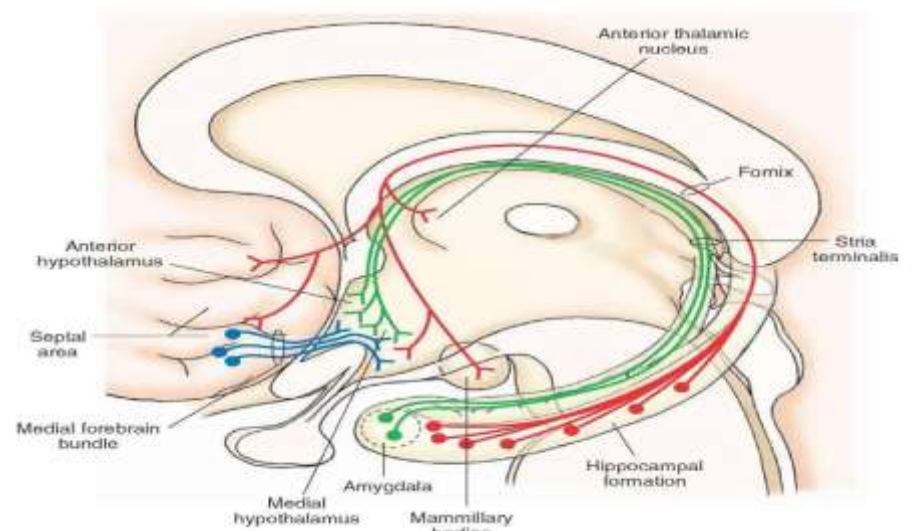
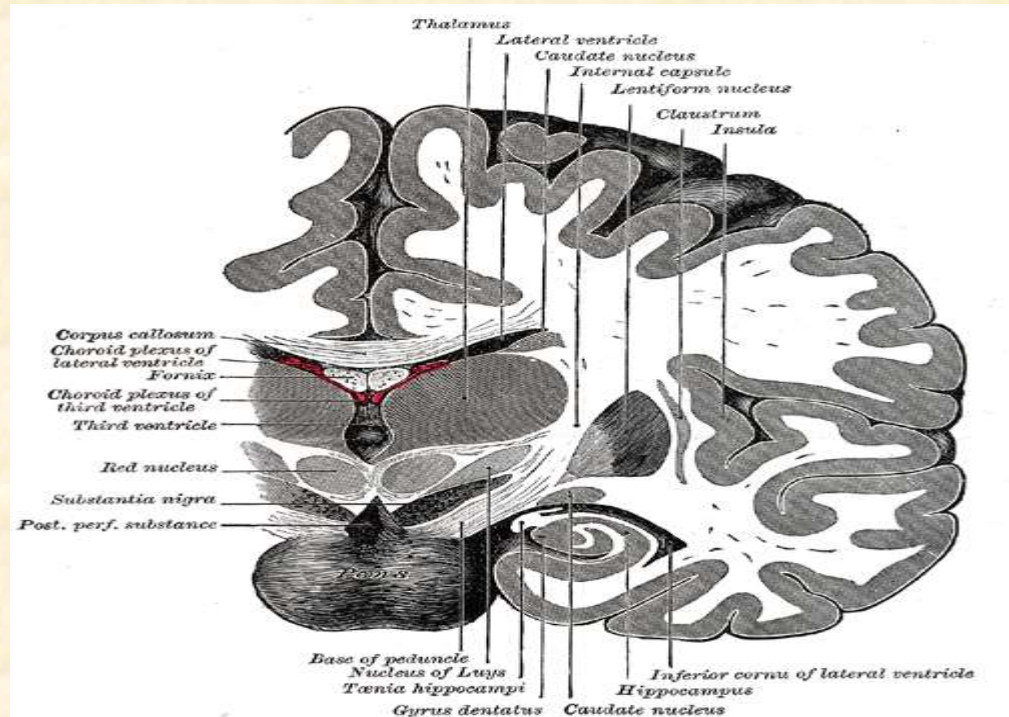
**Floor**: body of Caudate Nucleus and body of the thalamus.

Stria terminalis between thalamus and caudate. (connects between amygdala and ventral nucleus of the hypothalamus)

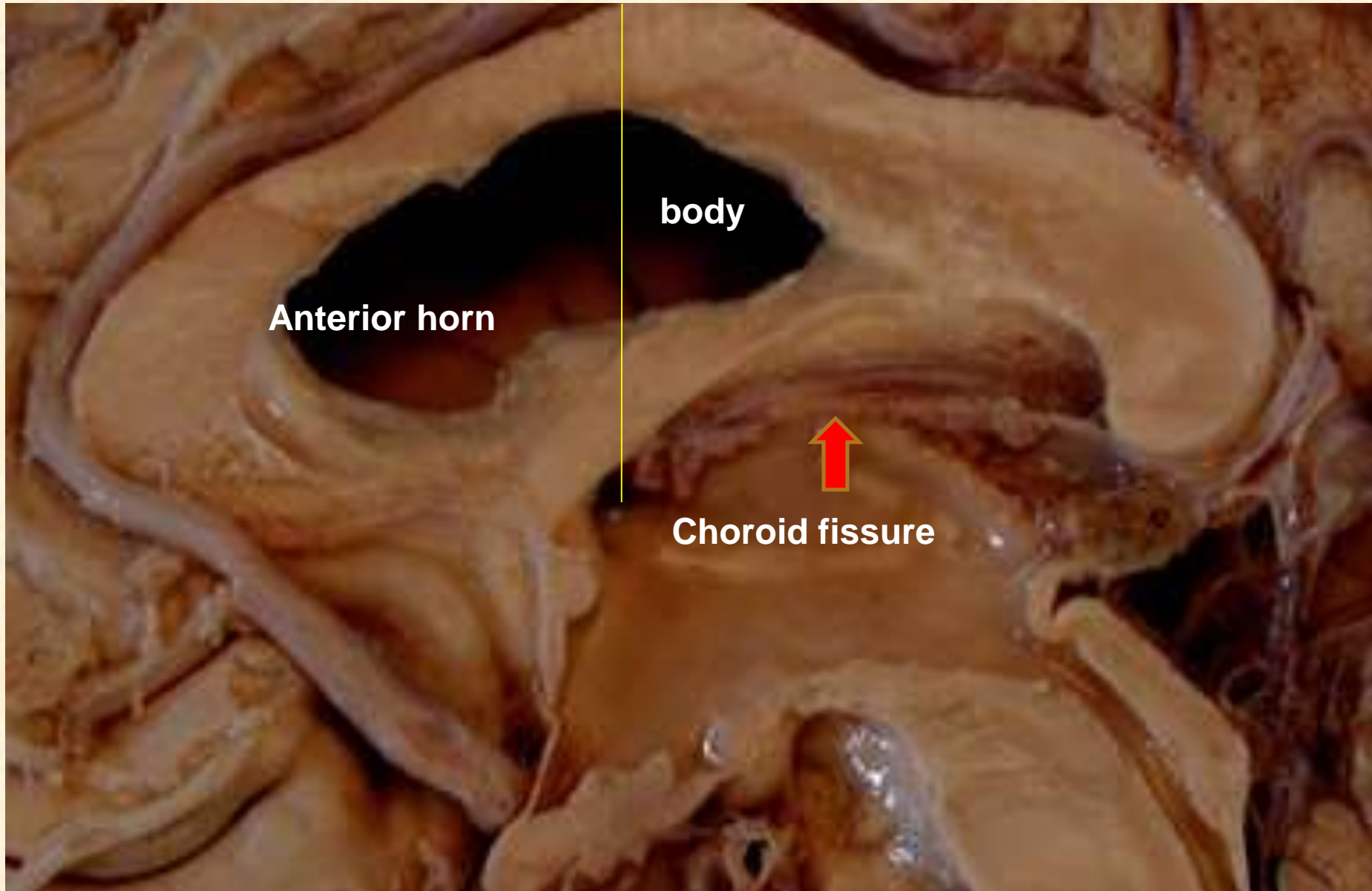
**Medial wall**:

Septum Pellucidum

Body of the fornix (choroid fissure between fornix and thalamus (choroid plexus))



## Relations of lateral ventricle



# Relations of Anterior horn of the lateral ventricle

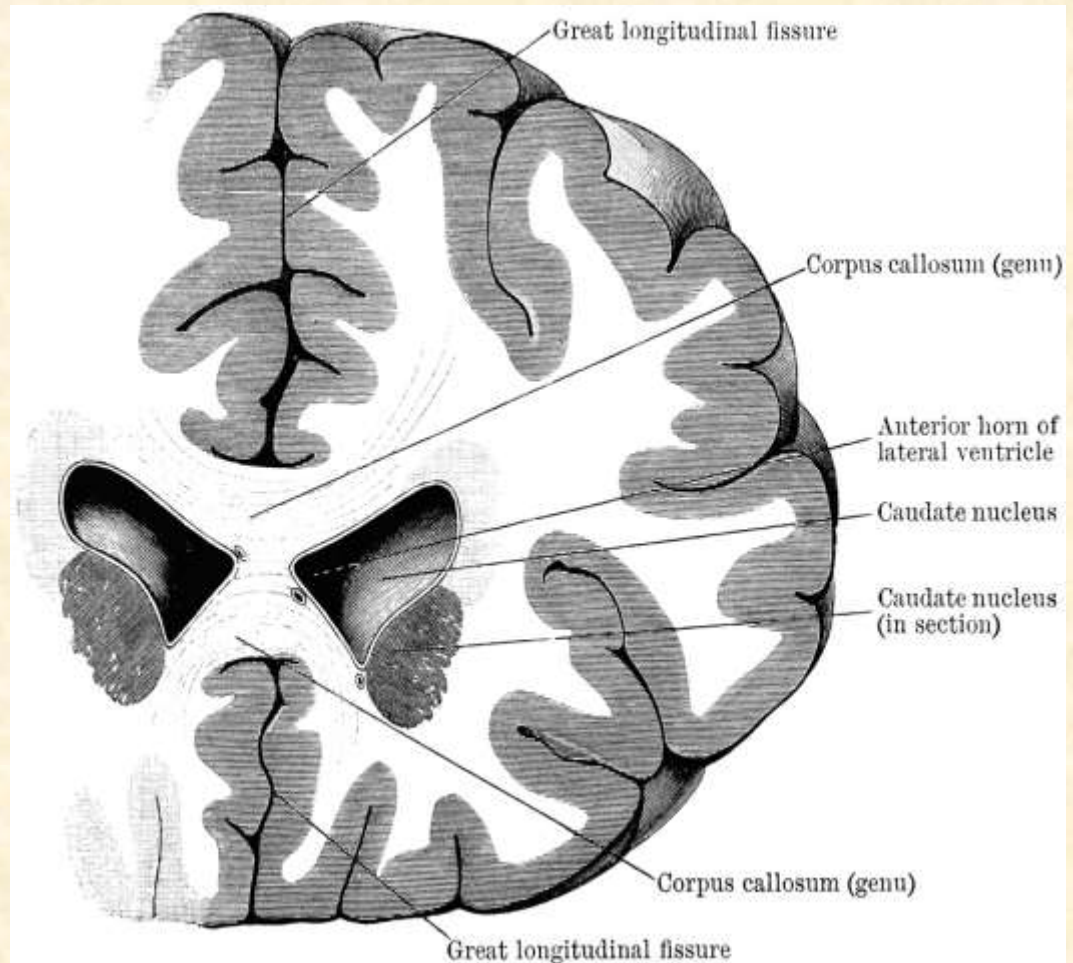
**Roof** : genu of the Corpus callosum

**Floor**: Head of Caudate Nucleus

**Medial wall**: Rostrum of corpus callosum

Septum Pellucidum

Anterior column of the fornix



# Relations of Posterior horn of the lateral ventricle

## •Roof and lateral wall

Tapetum of the corpus callosum  
Optic radiation lying against the tapetum in the lateral wall.

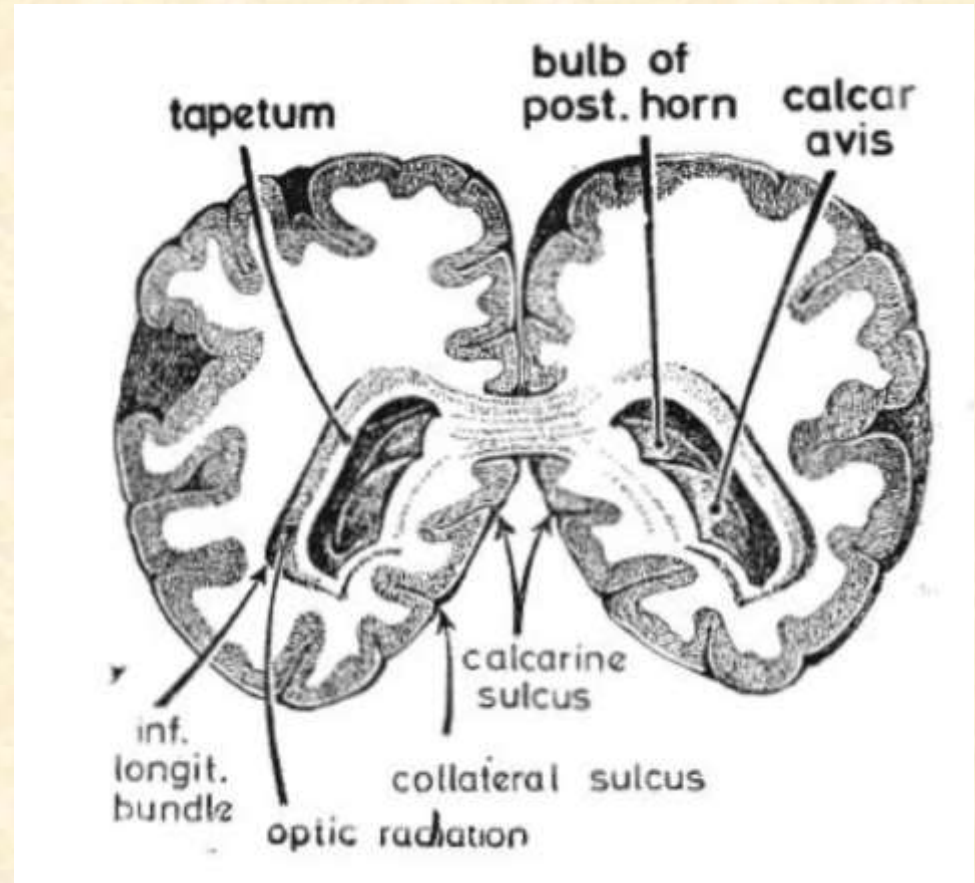
## •Medial wall --- two convexities:

Upper (bulb of the posterior horn)

- Splenium of the corpus callosum (bulb)

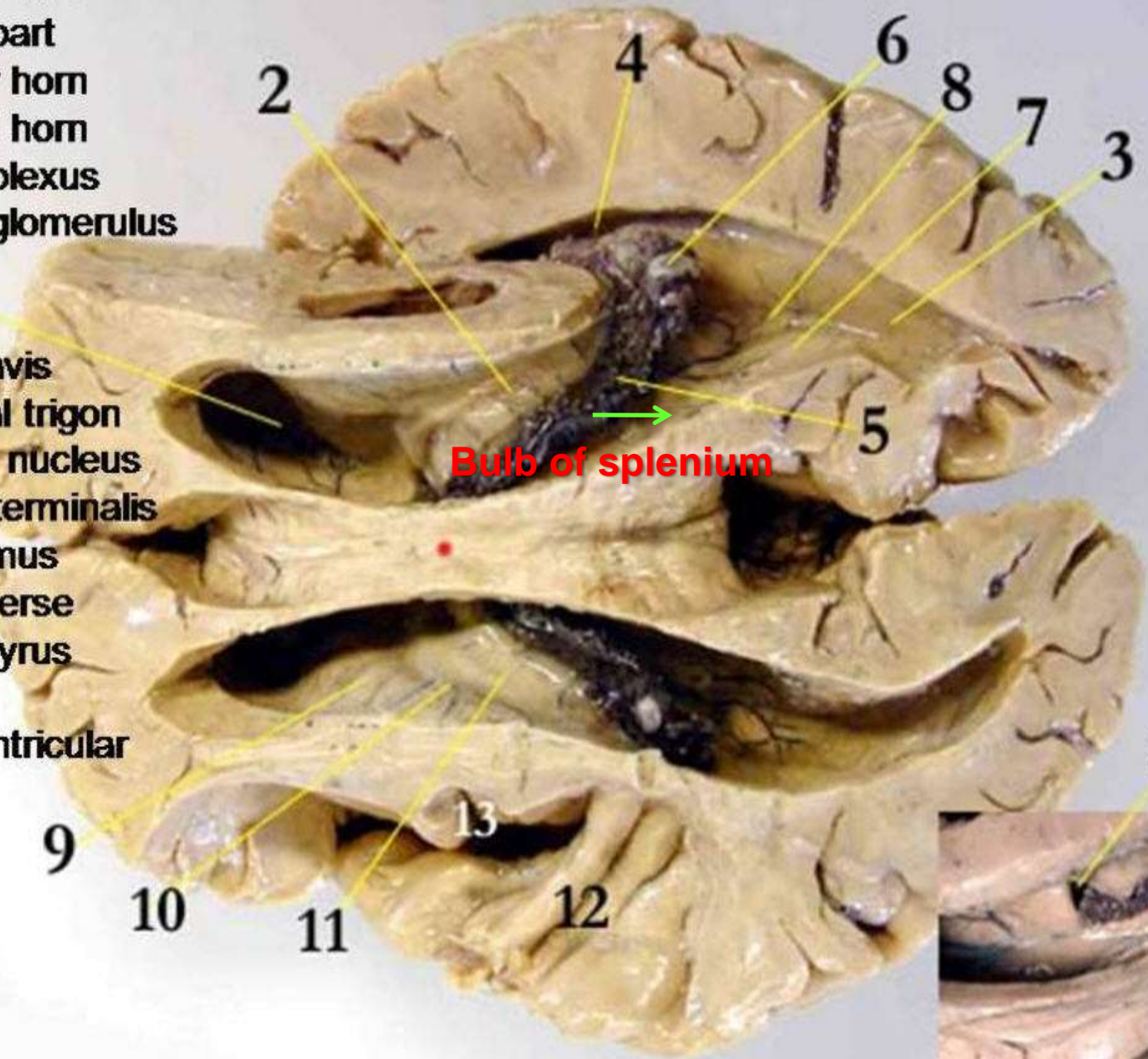
Lower (Calcar avis)

- Calcarine sulcus.
- If Calcar avis is well developed, it obliterates the posterior horn.



- 1- anterior horn
- 2- central part
- 3- posterior horn
- 4- temporal horn
- 5- choroid plexus
- 6- choroid glomerulus

- 7- Calcar avis
- 8- Collateral trigon
- 9- Caudate nucleus
- 10- sulcus terminalis
- 11- Thalamus
- 12- Transverse temporal gyrus
- 13- Insula
- 14- Interventricular foramen



**Bulb of splenium**



# Relations of Inferior horn of the lateral ventricle

## •Roof

tail of the caudate nucleus,  
amygdaloid body

## •Lateral wall

Tapetum of corpus callosum  
and optic radiation

## •Floor

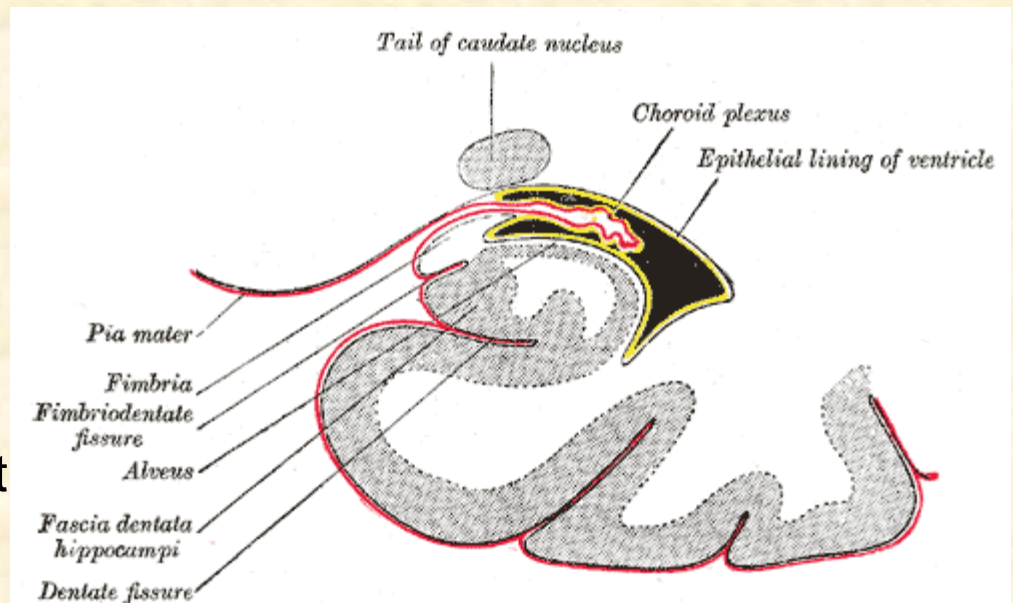
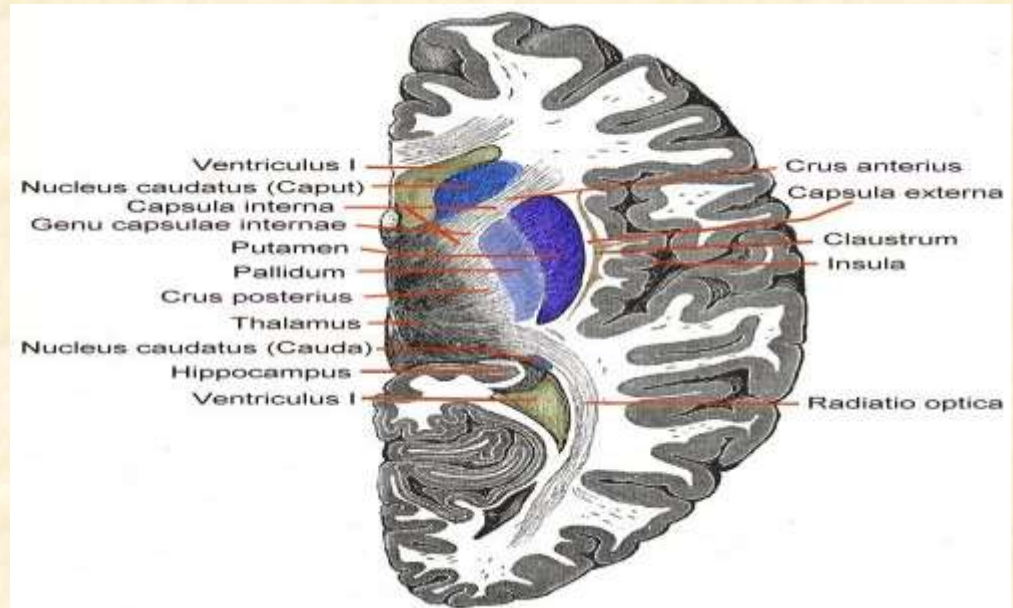
medially

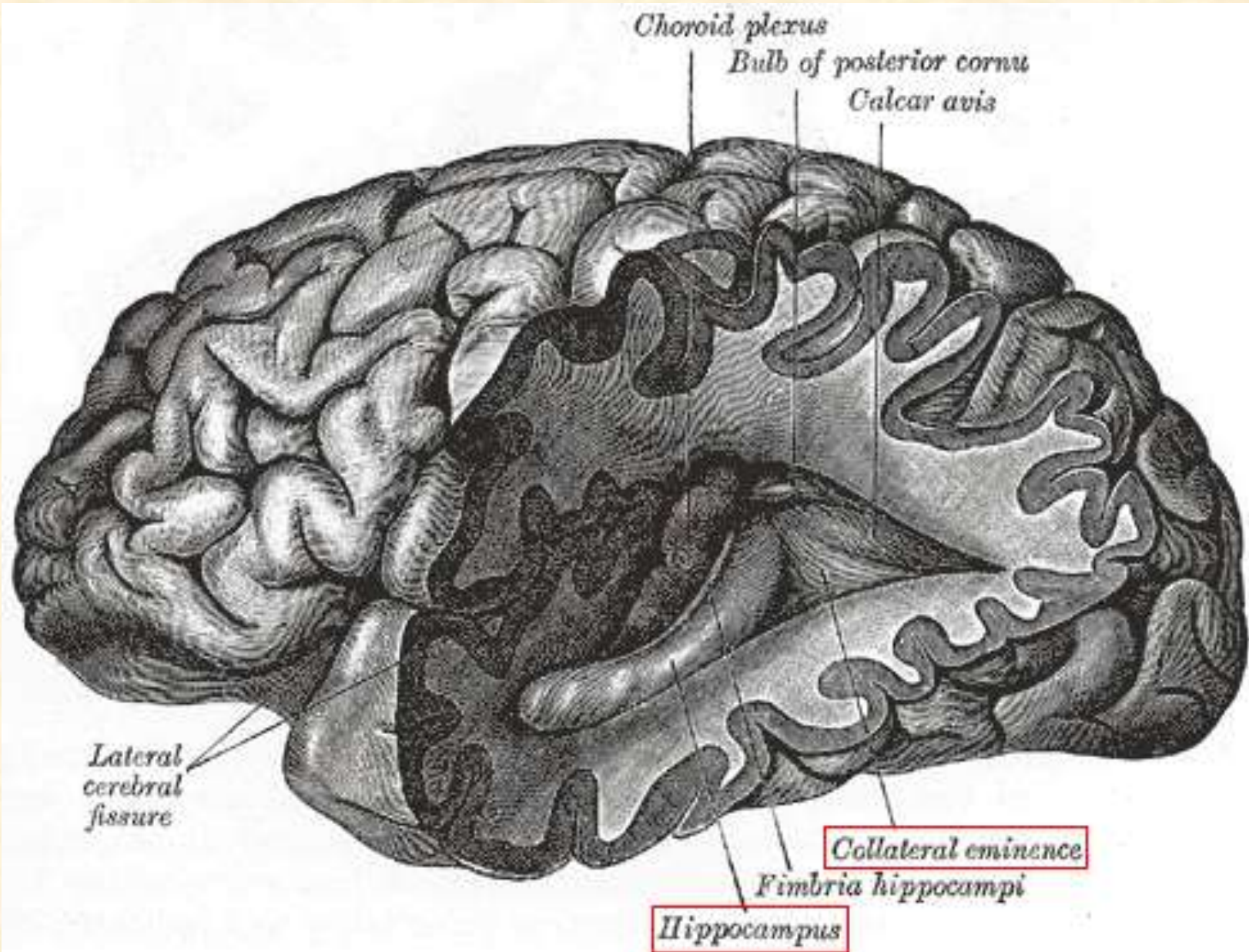
■ hippocampus

laterally

■ collateral eminence  
(by collateral fissure)

Lower part of choroid  
plexus enter this horn  
from the temporal part  
of the choroid fissure







Ventricle

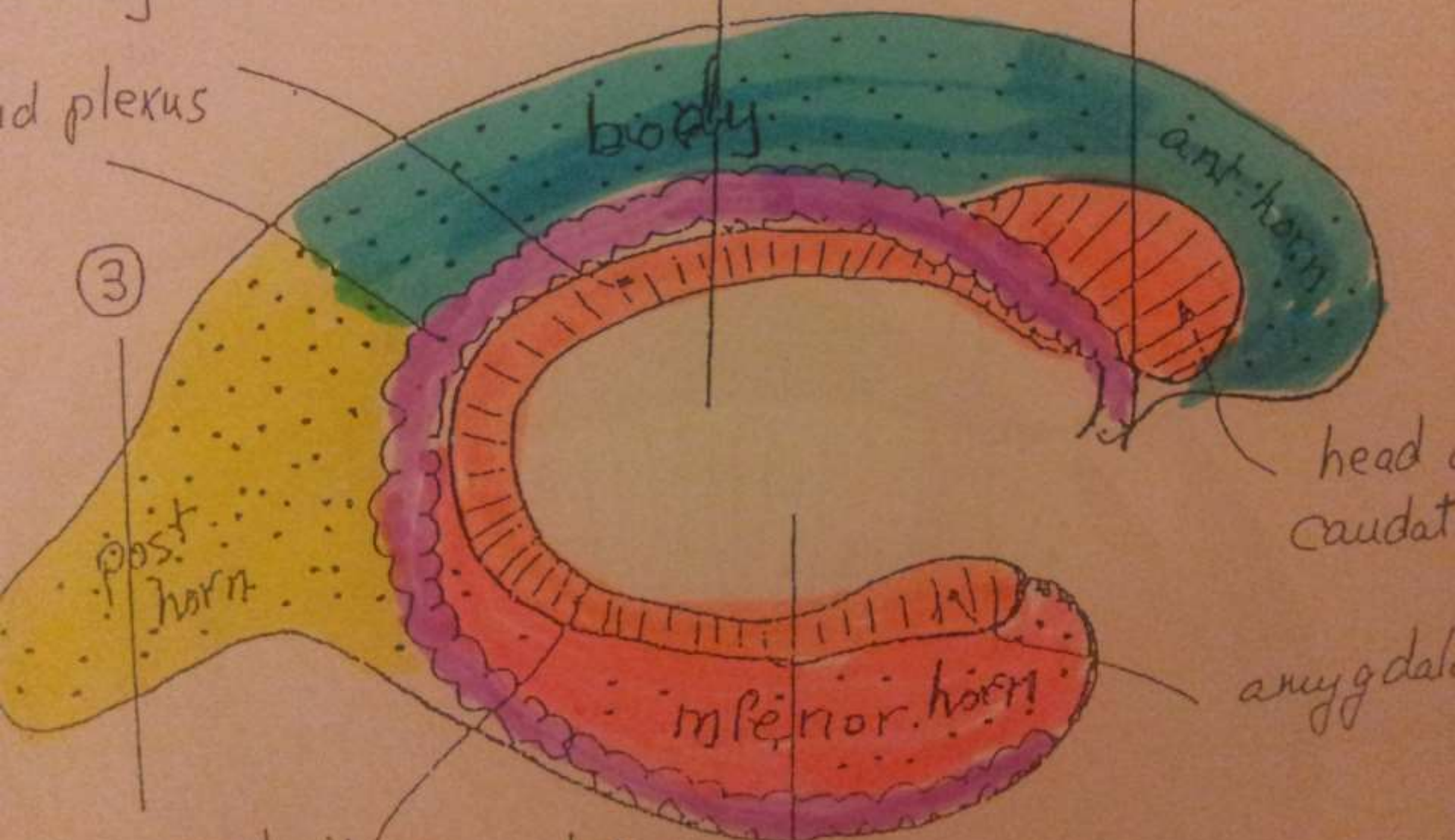
body of caudate n.

plexus

3

2

1



post horn

body

ant. horn

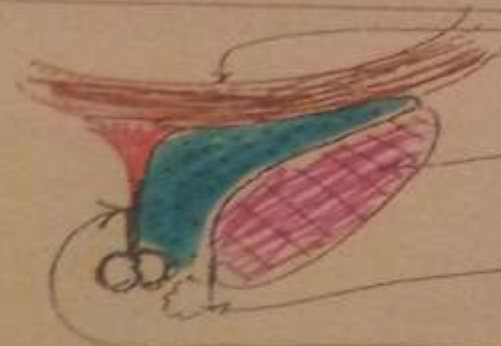
inferior horn

head of caudate

amygdala

tail of caudate n.

- 1) **Ant. horn** Boundaries
- Sup: genu of corpus C.
  - med: Septum pellucidum and Fornix.
  - Lat: head of caudate and choroid plexus



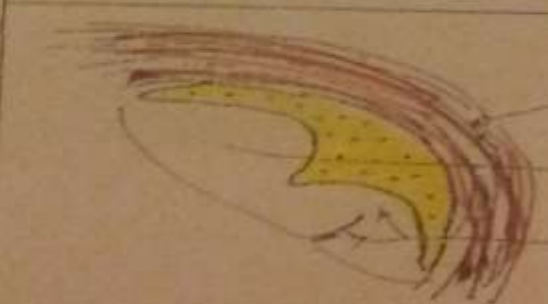
genu of c. c.  
head of caudate  
choroid plexus  
septum pellucidum  
attached to Fo

- 2) **Body** Boundaries
- sup: body of corpus c.
  - med: Fornix
  - floor: - body of caudate  
- Thalamus



body of c. c.  
body of caudate  
Thalamus  
Choroid plexus  
fornix

- 3) **Posterior horn** Boundaries
- Sup & lateral: tapetum
  - medial: bulb and calcar avis



tapetum  
Bulb (formed by splenium)  
Calcar avis (Fornix)  
Calcarine sulcus

- 4) **Inferior horn** Boundaries
- Sup: tail of caudate n. and amygdaloid body
  - medial: choroid fissure and plexus
  - Lateral: tapetum



tapetum (extension of corpus callosum)  
amygdaloid body  
hippocampal gyrus  
choroid plexus in choroid fissure

# Choroid plexus of Lateral Ventricle

Choroid plexus projects into the ventricles on its **medial aspect**.

Composed of **pia matter** covered with ependymal lining of the ventricle.

Choroid plexus is made of **tela choroidea** (two layers of pia matter).

Lies between **fornix** superiorly and **thalamus** inferiorly.

Situated in **the inferior horn** of the lateral ventricle.

Projects into the **choroid fissure**

**Formed by posterior choroid branch of PCA (body) and anterior choroid branch of ICA (inferior horn)**

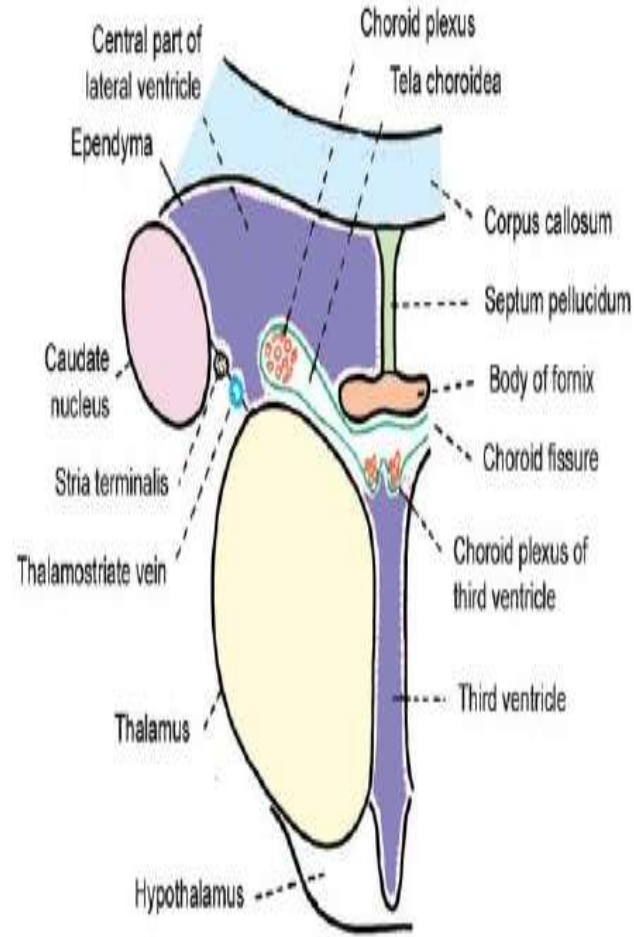
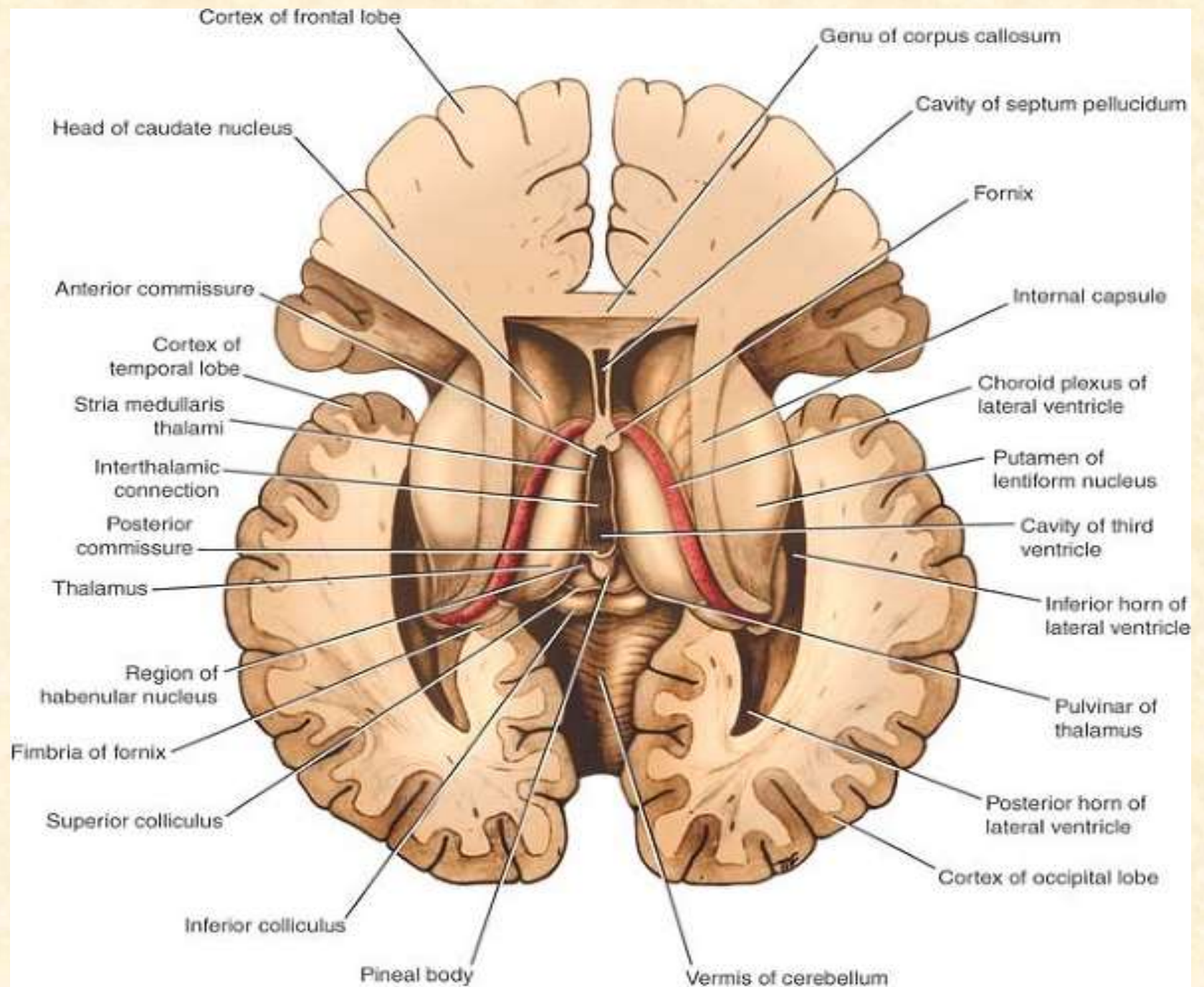
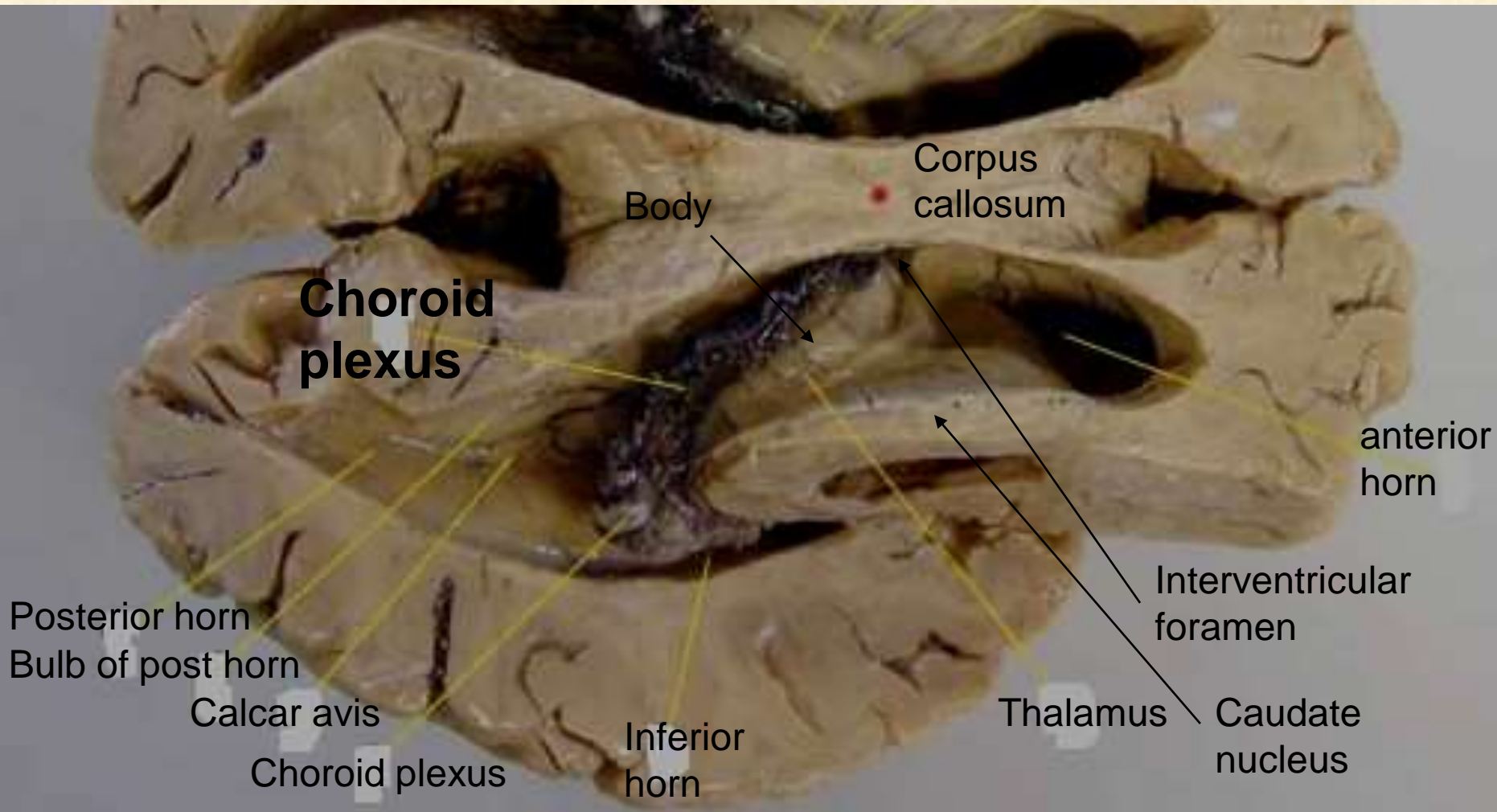


Fig. 20.2.  
Boundaries of the central part of the lateral ventricle and of the third ventricle. Note the relationship of the tela choroidea and the choroid plexuses to these ventricles.



# The lateral ventricle



Superior view

BP: -2.9  
ST: 5.0

10

A

TR: 10000.0  
TE: 140.0  
FA: 90.0

R

L



Lossy 1:8  
Zoom: 1.6

T2 FLAIR AXIALS

### Key to MRI:

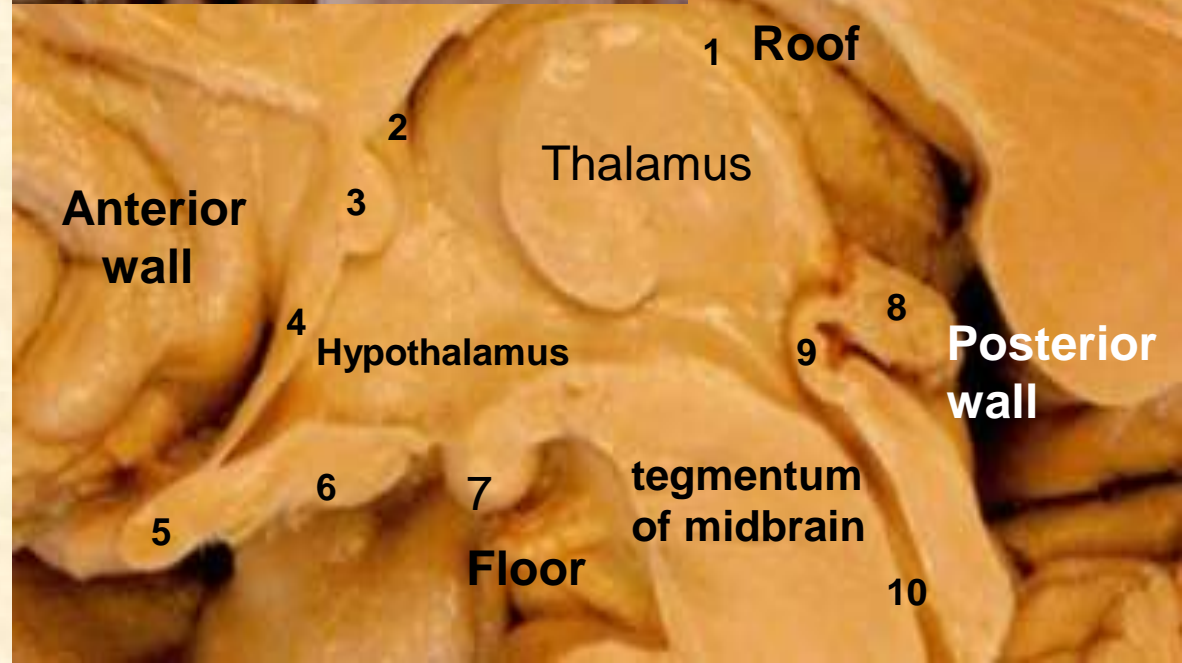
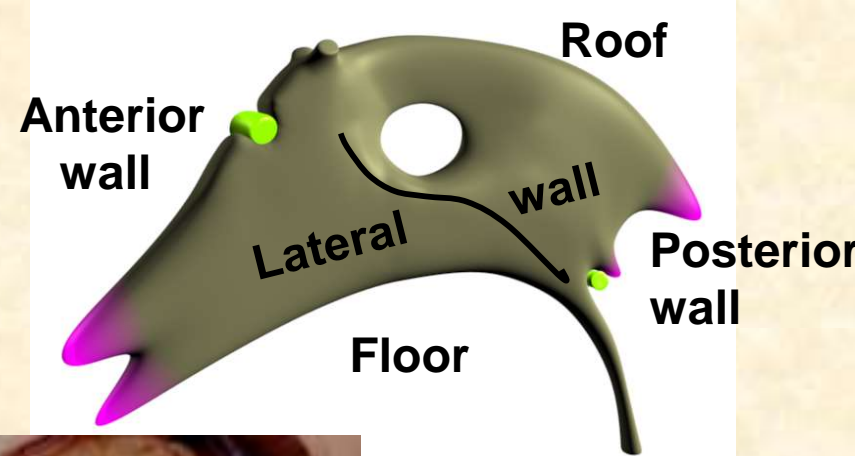
1. anterior horn of lateral ventricle
2. posterior horn of lateral ventricle
3. septum pellucidum
4. head of caudate nucleus
5. internal capsule
6. lentiform nucleus
7. thalamus
8. 3<sup>rd</sup> ventricle
9. longitudinal fissure
10. corpus callosum
11. superior sagittal sinus

# The third ventricle

It is a narrow slit like cleft between the 2 halves of the diencephalon.

## Boundaries:

- **Roof:** Thin layer of ependyma stretched between lateral walls containing choroid plexus (1).
- More superiorly, fornix, septum pellucidum and corpus callosum
- **Anterior wall:** Columns of fornix (2), anterior commissure (3), Lamina terminalis (4) &
- **Floor:** Hypothalamus [ optic chiasma (5), tuber cinereum (6) Mammillary body (7)] & tegmentum of midbrain.
- **Posterior wall:** Pineal body (8), posterior commissure (9) & aqueduct of Sylvius (10).
- **Lateral wall:** Thalamus & hypothalamus.

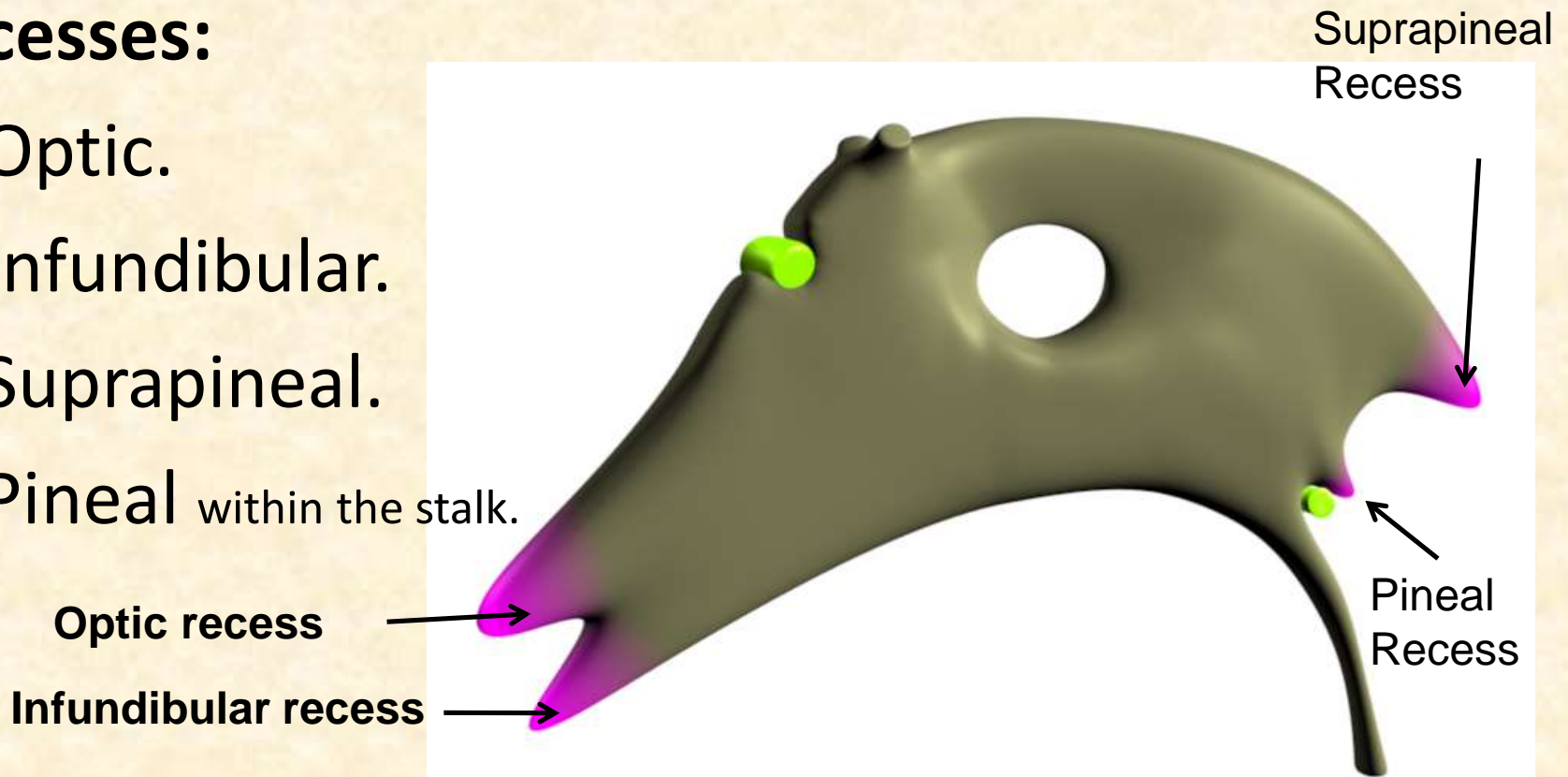


## Connections:

It is connected with the lateral ventricle through interventricular foramen & with the 4<sup>th</sup> ventricle through cerebral aqueduct.

## Recesses:

- 1) Optic.
- 2) Infundibular.
- 3) Suprapineal.
- 4) Pineal within the stalk.





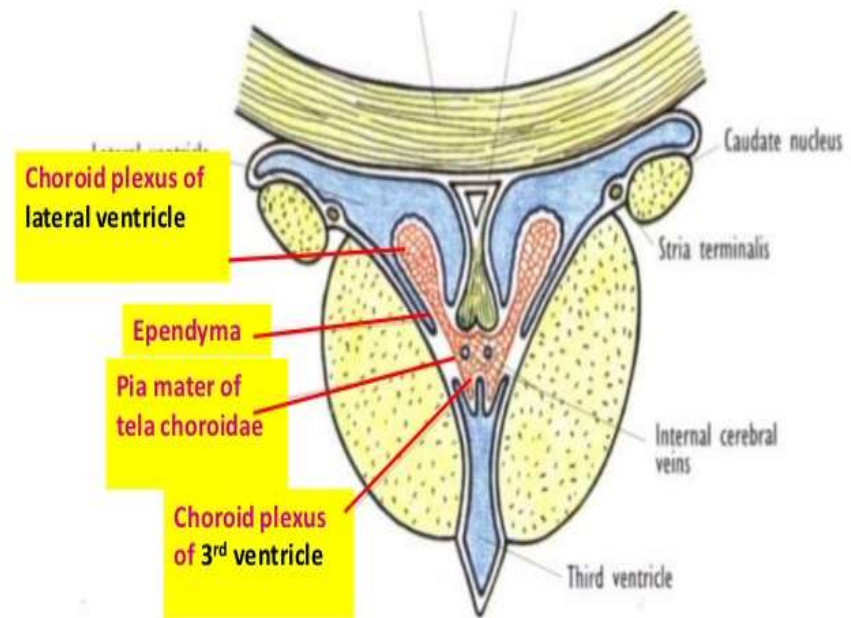
## Choroid plexus of Third Ventricle

Formed of tela choroidea above **the roof** of the ventricle.

Vascular tela choroidea projects downward on each side of the midline, invaginating the **ependymal roof of the ventricle**.

Blood supply of choroid plexus of third ventricle is derived from **choroidal branch of posterior cerebral artery**

Venous drainage (**Internal cerebral veins- Great cerebral vein+Inferior sagittal sinus/ Straight sinus**)



Coronal section of the interventricular foramen showing the choroid plexus of 3<sup>rd</sup> & lateral ventricles

# The fourth ventricle

It is a diamond shaped cavity of the hindbrain.

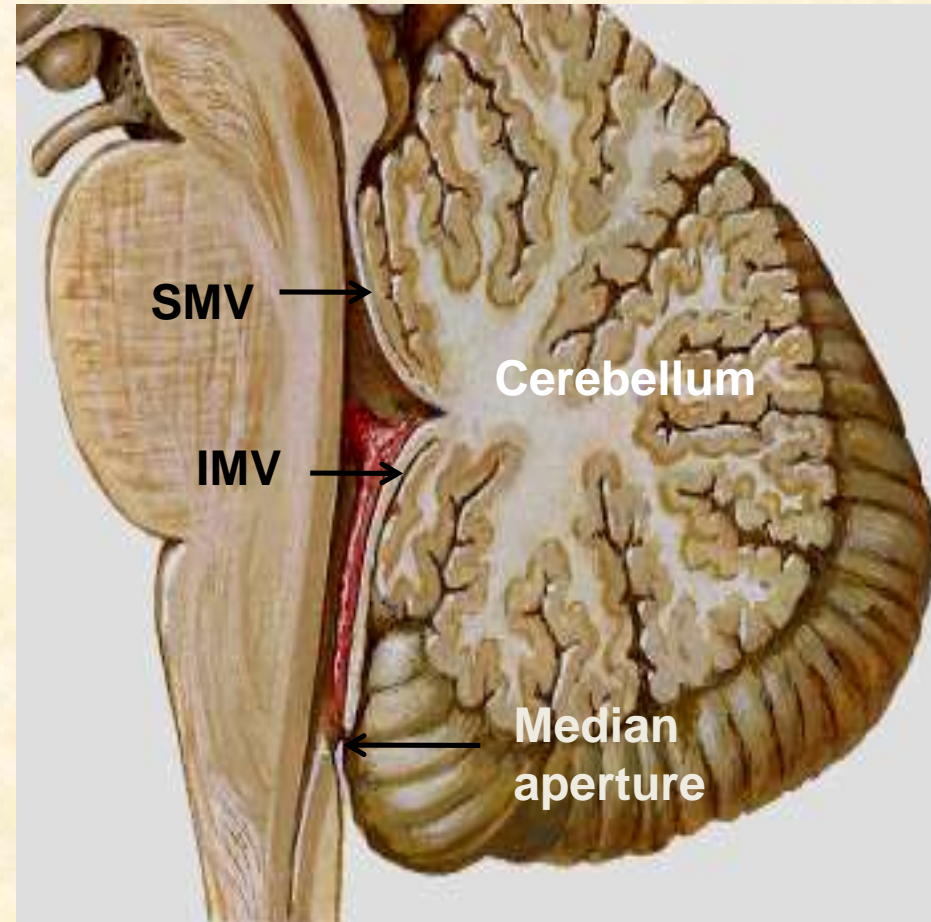
It lies behind the pons & open medulla & in front of the cerebellum.

Its **superior angle** is continuous with the cerebral aqueduct of midbrain & its **inferior angle** is continuous with the central canal of closed medulla (at the obex).

It has **2 lateral recesses** which curve around the inferior cerebellar peduncle & open by lateral apertures in the subarachnoid space at the flocculus .

**The roof:** Is tent shaped & is formed of

- The superior cerebellar peduncles (SCPs).
- the superior medullary velum (SMV) stretching between the 2 SCPs.
- The inferior medullary velum (IMV) which has a median aperture (of Magendie) connecting the 4<sup>th</sup> ventricle to the subarachnoid space.



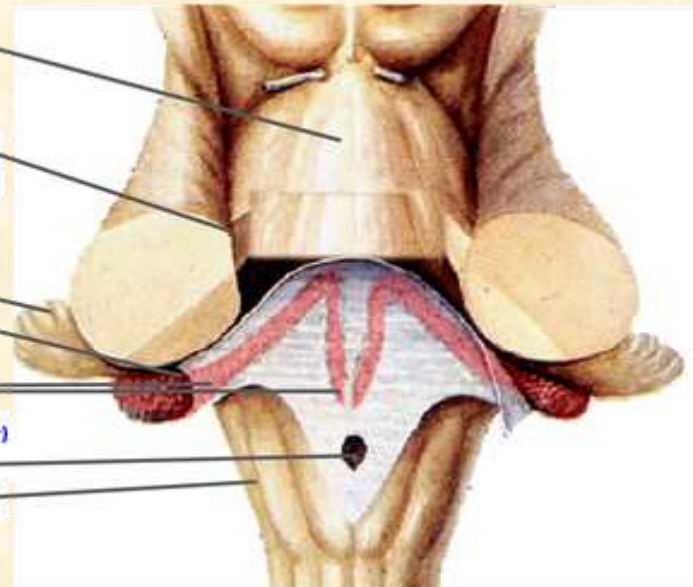
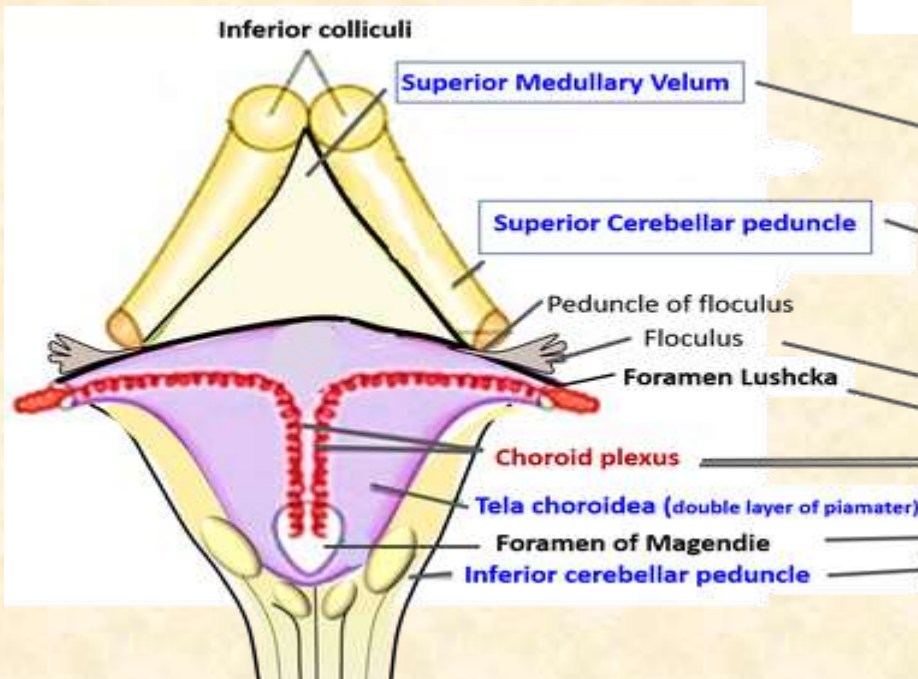
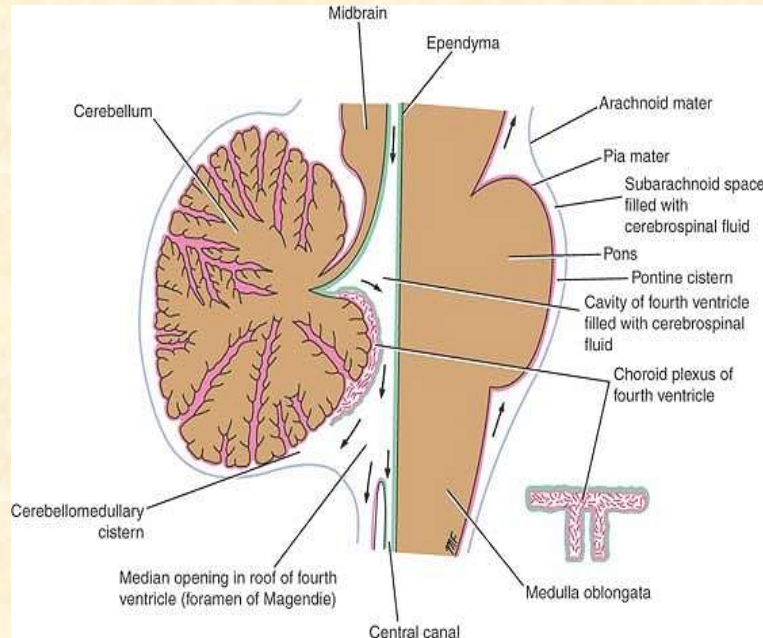
# Choroid plexus of Fourth Ventricle

T shape.

Formed of highly vascular tela choroidea.

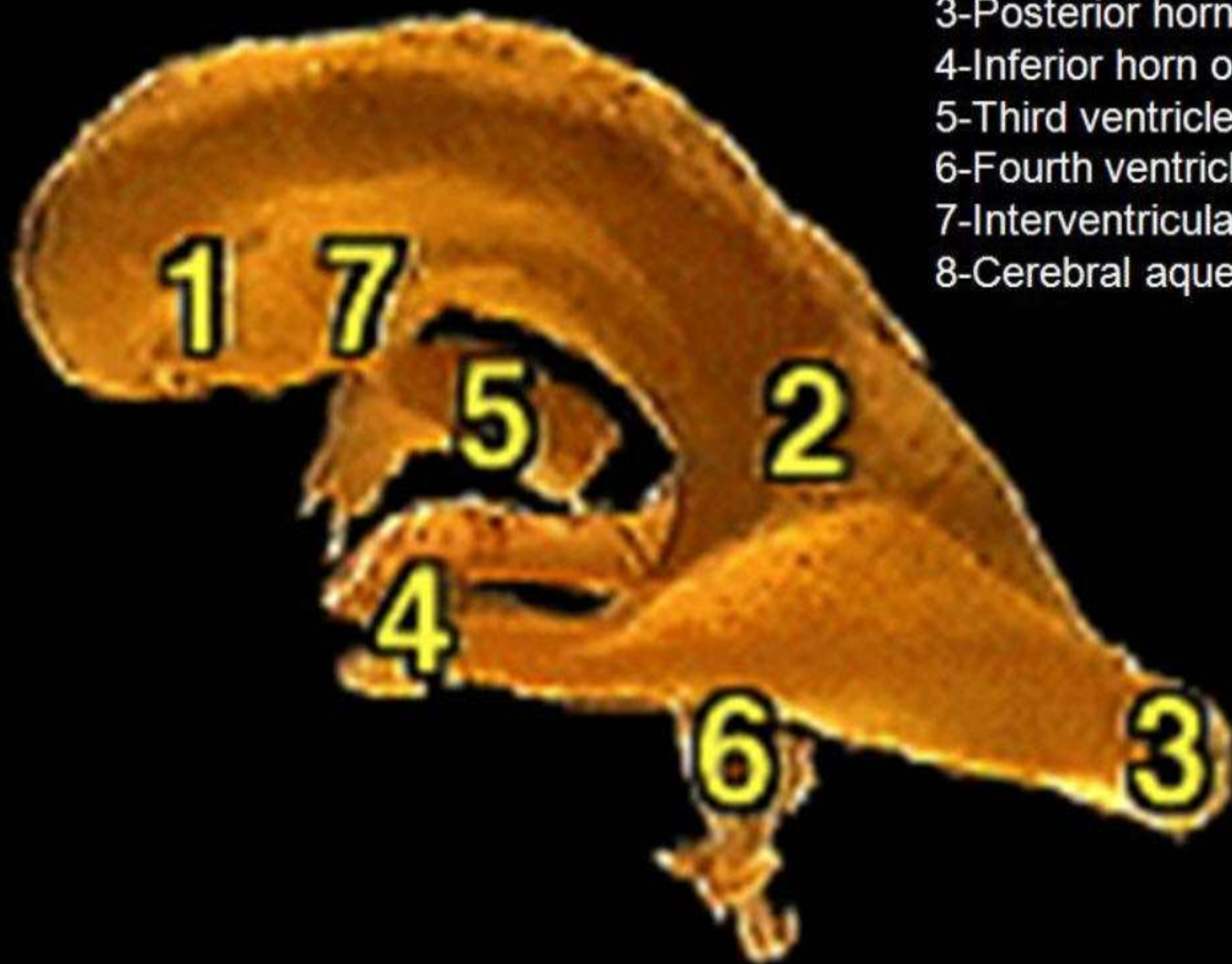
Suspended from the inferior half of the roof.

Blood supply: Posterior inferior cerebellar arteries (vertebral arteries)





- 1-Anterior horn of lateral ventricle
- 2-Body of lateral ventricle
- 3-Posterior horn of lateral ventricle
- 4-Inferior horn of lateral ventricle
- 5-Third ventricle
- 6-Fourth ventricle
- 7-Interventricular foramen
- 8-Cerebral aqueduct



# Subarachnoid cisterns

## 1- Cerebello-medullary cisterna (Cisterna magna)

Between cerebellum and roof of 4<sup>th</sup> ventricle  
Receives foramen of magendie

## 2- Pontine (ponto-medullary) cisterna

In front of pons and medulla  
Contain basilar and vertebral arteries  
Receives foramens of luchka  
Transversed by roots of lower 8 cranial nerves

## 3- Interpeduncular cistern

Lies over interpeduncular fossa  
Contains circle of willis  
Transversed by roots of 3<sup>rd</sup> and 4<sup>th</sup> cranial nerves

## 4- Cistern of lateral fissure

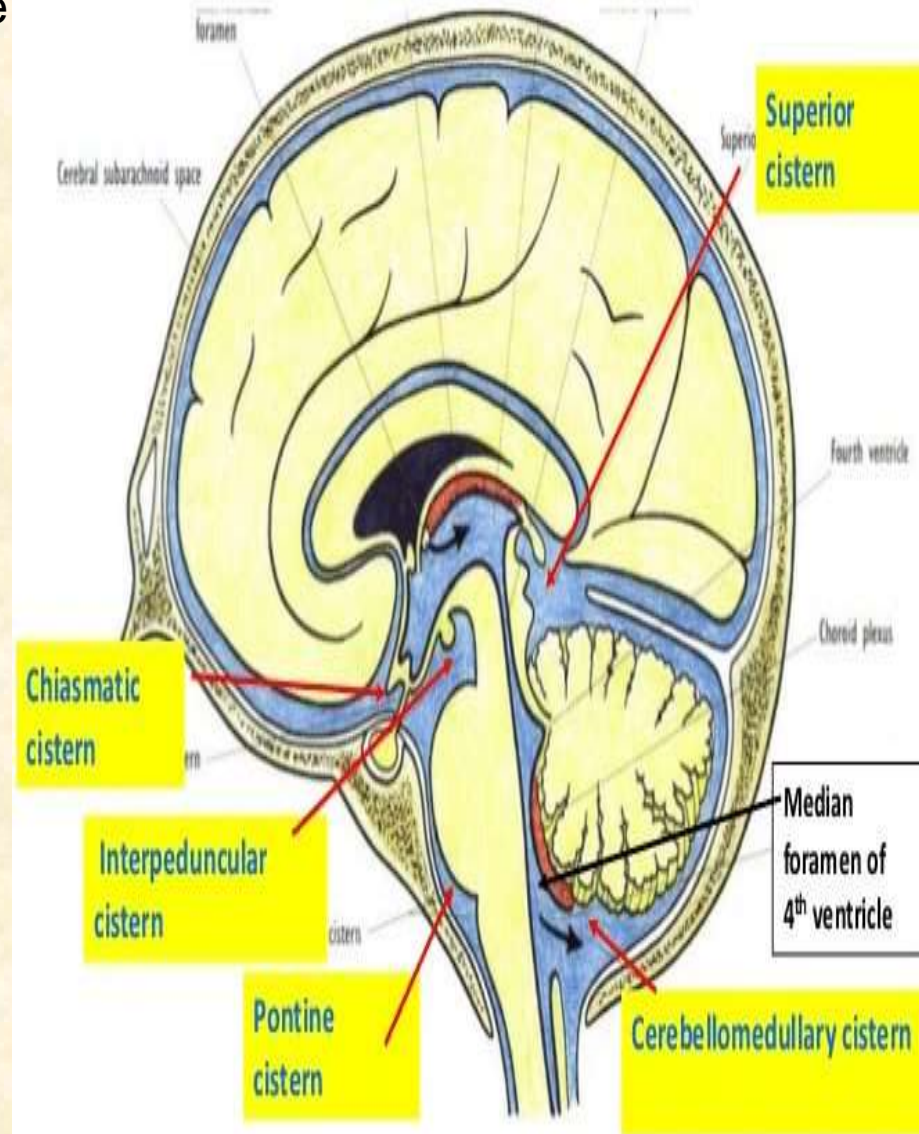
Contains the middle cerebral vessels

## 5- Callosal cistern

Lies above corpus callosum  
Contains anterior cerebral vesseles

## 6- Chiasmatic cistern

Lies around optic chiasma



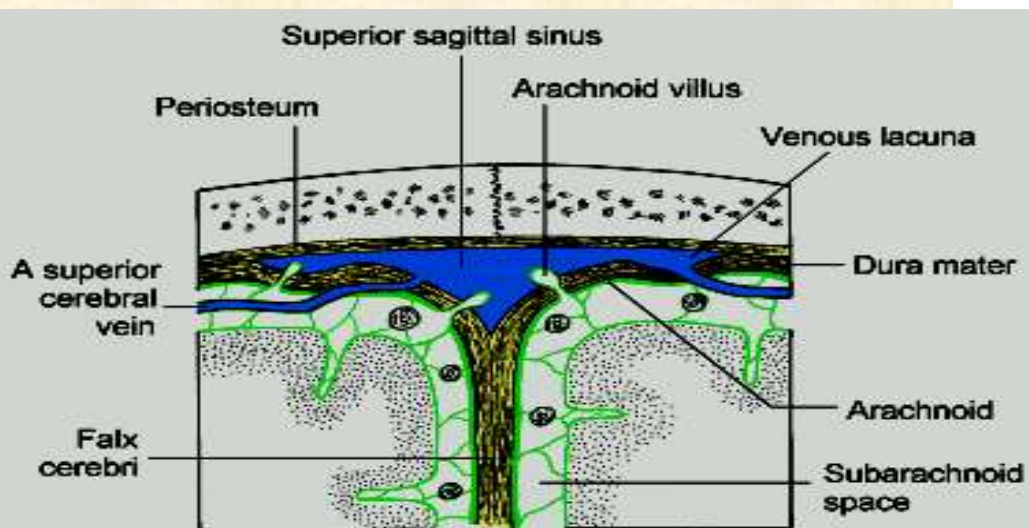
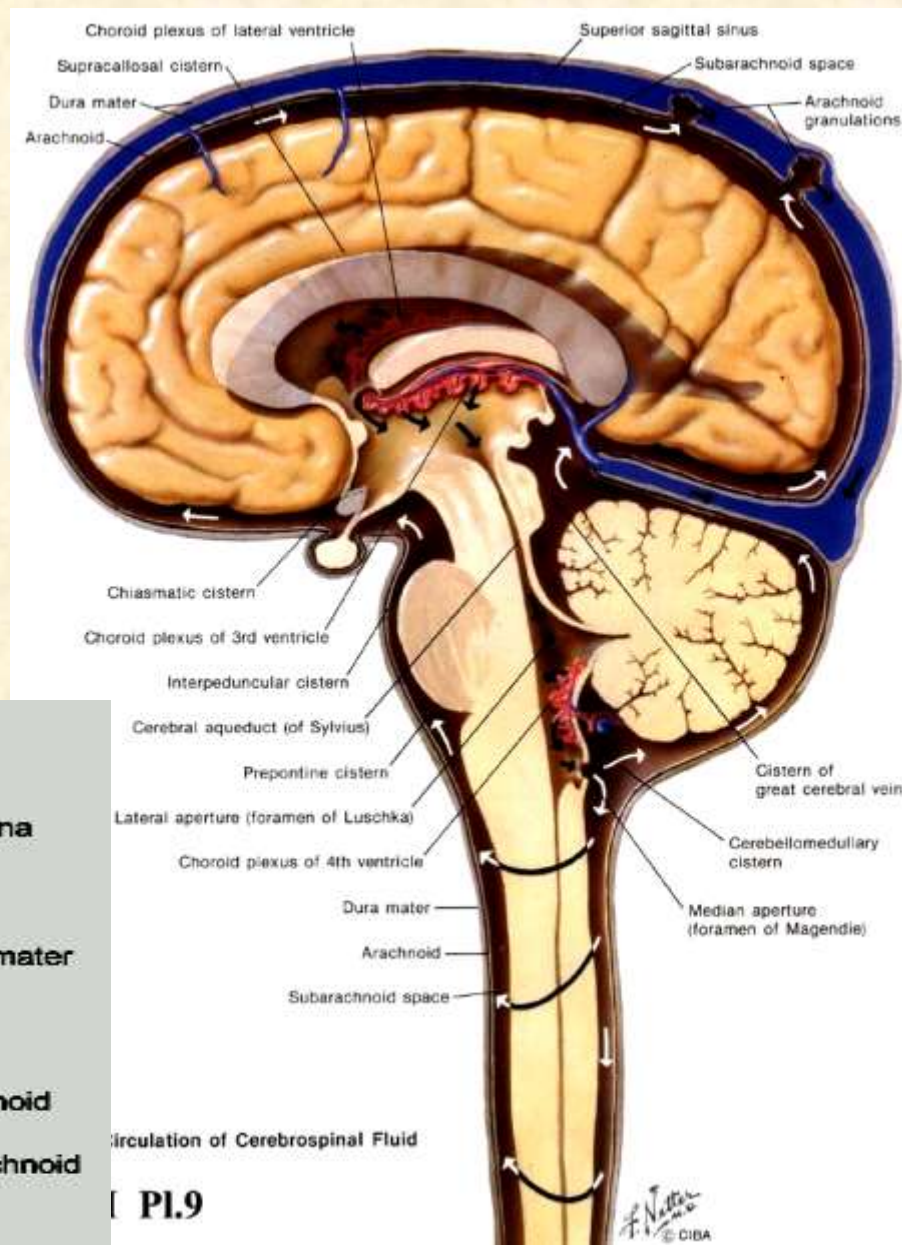
# The Cerebrospinal Fluid (CSF)

It is the fluid filling the ventricles & central canals of the CNS and subarachnoid spaces around brain and spinal cord.

**Production of CSF:** It is secreted by the **choroid plexuses** in the medial wall of the lateral ventricles & the roof of the 3<sup>rd</sup> & 4<sup>th</sup> ventricles

**Circulation of CSF:** It circulates in the ventricles & central canals of the CNS. It leaves the lateral ventricle through interventricular foramen to the 3<sup>rd</sup> ventricle then to the 4<sup>th</sup> ventricle through cerebral aqueduct of midbrain & leaves the 4<sup>th</sup> ventricle through its 3 apertures to the subarachnoid space forming a water cushion to protect the brain & spinal cord.

**Absorption of CSF:** It is absorbed by arachnoid villi & granulations to be excreted into the dural venous sinuses.



Circulation of Cerebrospinal Fluid

## Not an exam material

### Properties

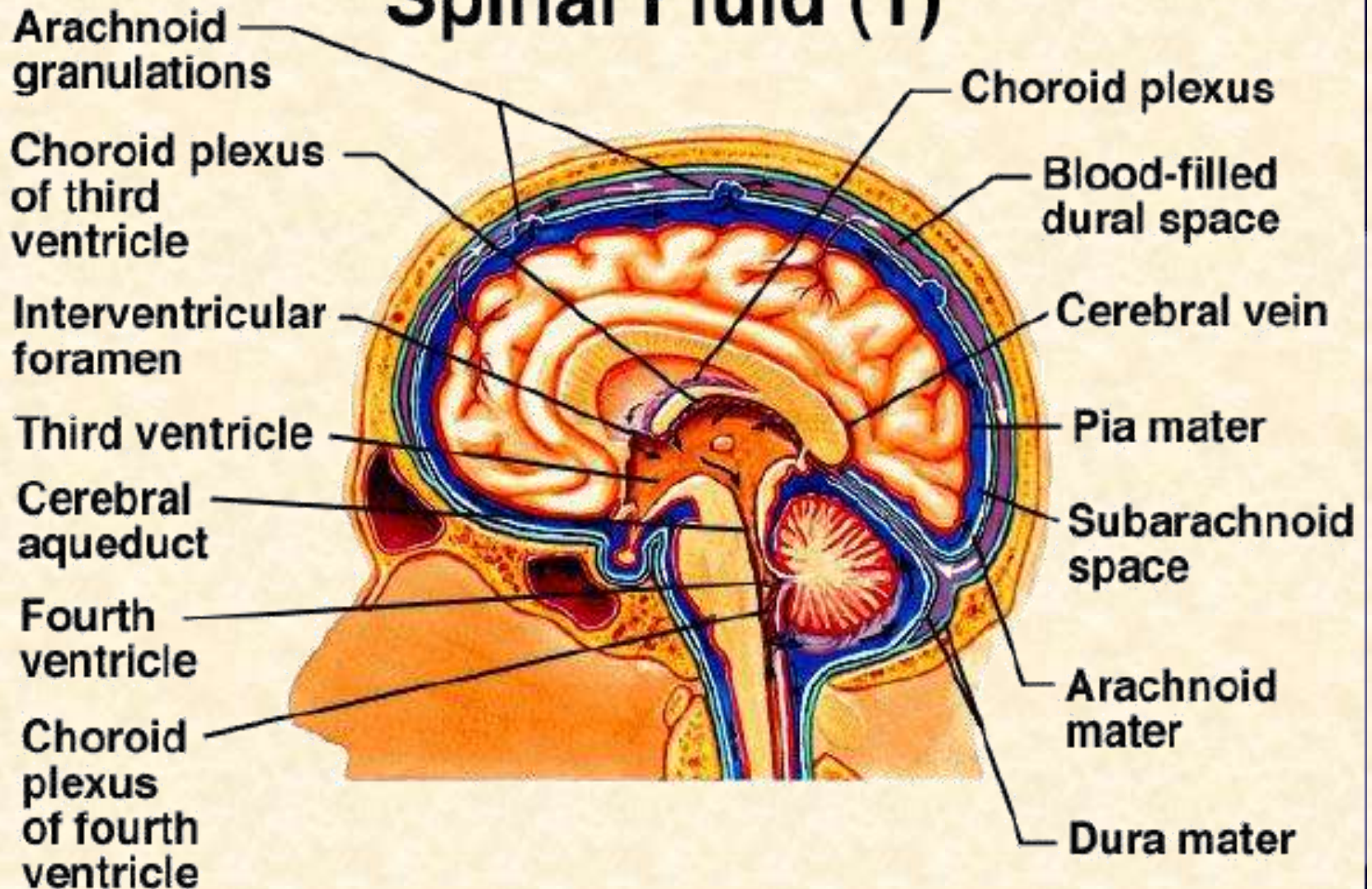
- Clear, colorless, transparent fluid
- Normal Volume is 150ml (varies between 100 – 200 ml)
- Rate of formation : 0.3ml /min (550ml/day)
- Specific gravity : 1005
- Reaction : alkaline

### Functions

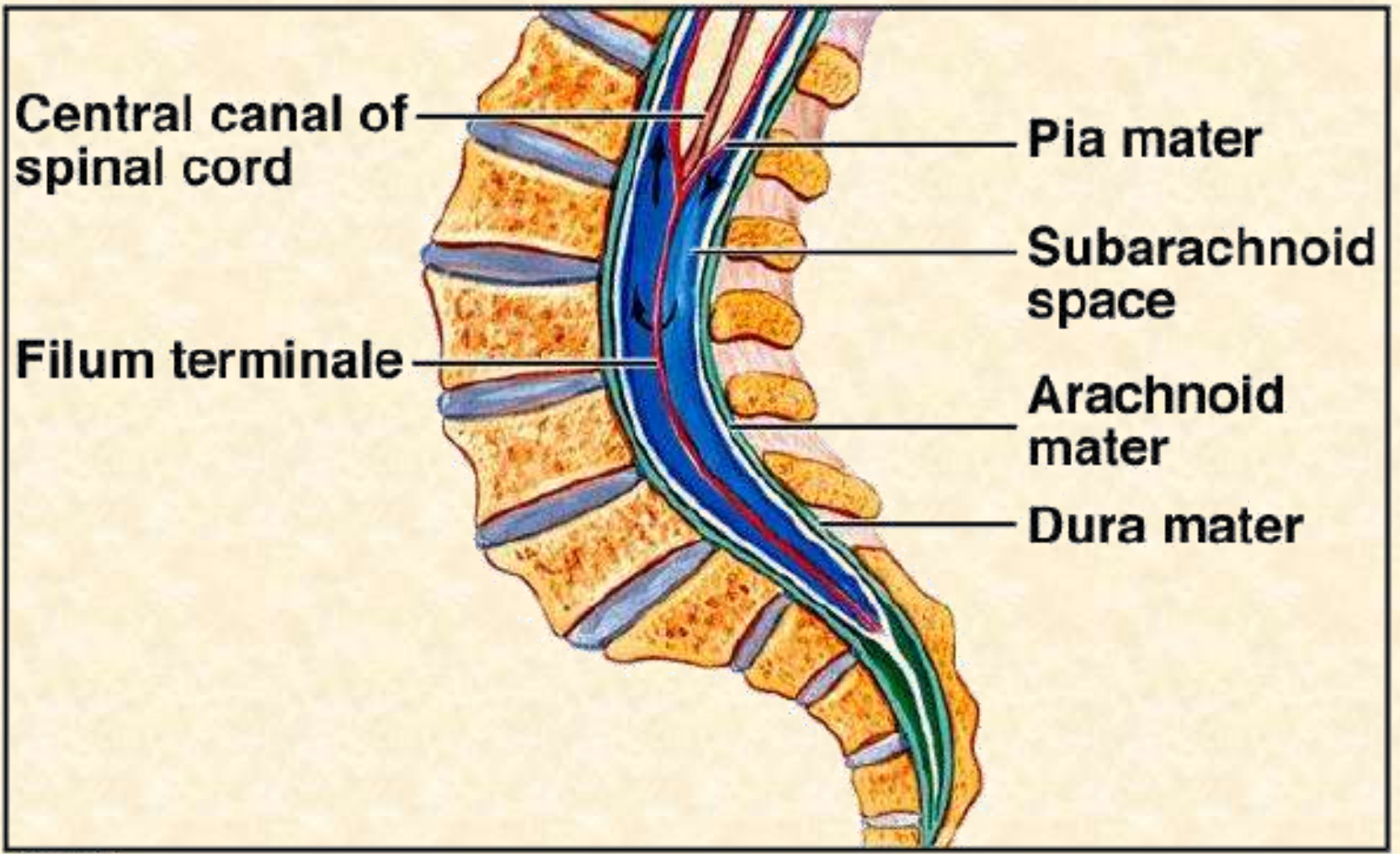
- Supports the weight of the brain
- Distributes the force of blows on the head
- Mechanical shock absorber
- Maintains the intracranial pressure
- Nutrient
- Removal of wastes



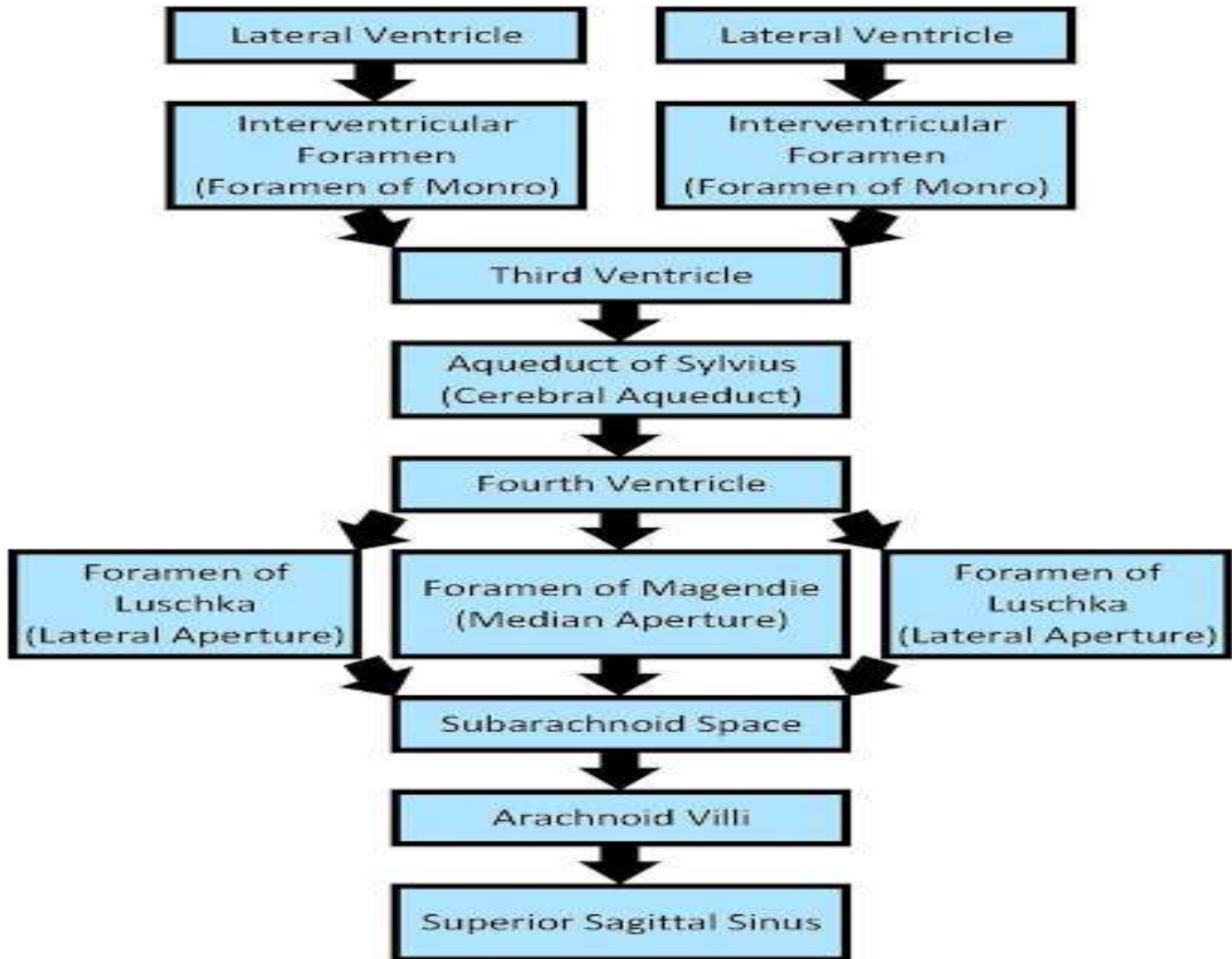
# Ventricles and Cerebro Spinal Fluid (1)



## Ventricles and Cerebrospinal Fluid (2)



## Circulation of Cerebrospinal Fluid (CSF)



# Lumbar Puncture

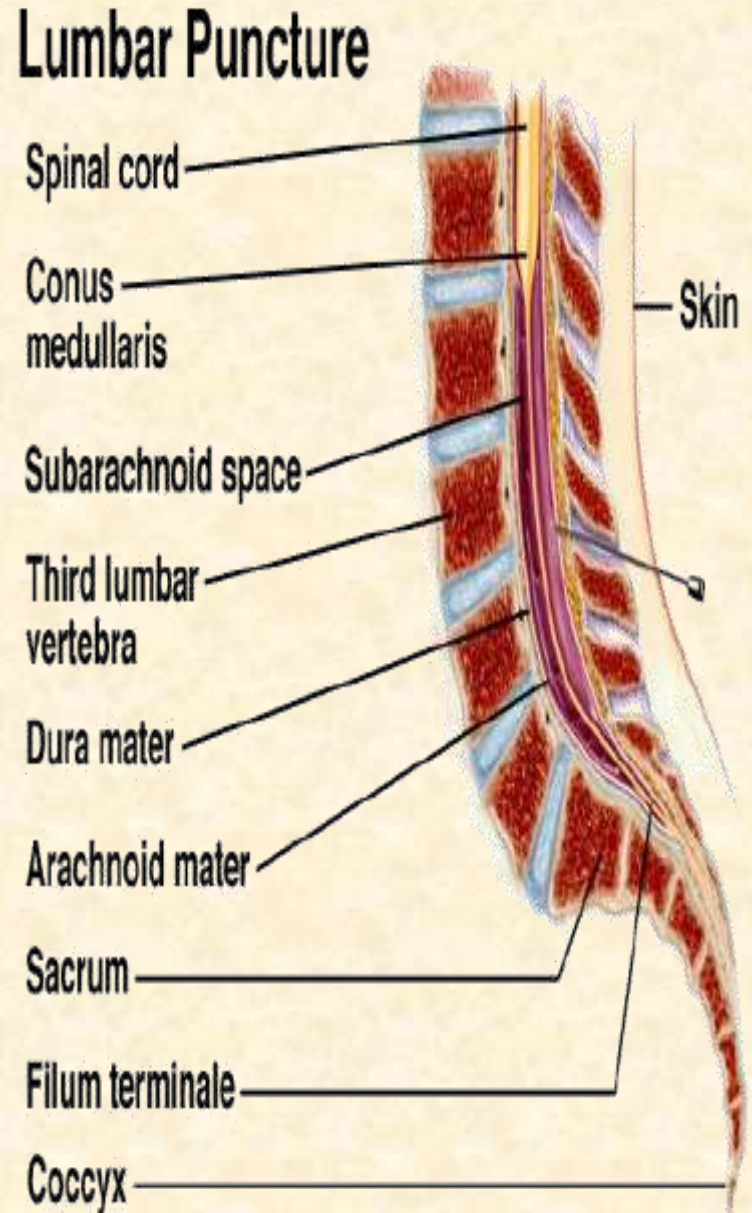
Procedure by which CSF is taken out from the subarchnoid space.

CSF is drawn by introducing a needle between the 3<sup>rd</sup> and 4<sup>th</sup> lumbar vertebrae.

(because the spinal cord terminates at lower border of L1 & subarachnoid space is wider ).

## Purpose of Lumbar puncture:

- For diagnostic purposes
- Spinal anesthesia
- To measure CSF pressure



# Hydrocephalus

accumulation  
of cerebrospinal fluid (CSF)  
within the brain.

## Not an exam material

headaches, double vision,  
poor balance, urinary  
incontinence, personality  
changes, or mental  
impairment.

In babies there may be a  
rapid increase in head size.

Other symptoms may  
include vomiting,  
sleepiness, seizures, and  
downward pointing of the  
eyes (sunset eyes).



# Types of hydrocephalus

**Not an exam material**

## **Communicating (non obstructive)**

impaired cerebrospinal fluid reabsorption in absence of any CSF-flow obstruction between the ventricles and subarachnoid space.

functional impairment of the arachnoid granulations

**Causes** : subarachnoid/intraventricular hemorrhage, meningitis and congenital absence of arachnoid villi.

## **Non-communicating (obstructive)**

caused by a CSF-flow obstruction.

### Foramen of Monro

aqueduct of Sylvius dilation of both lateral ventricles and third ventricle.

Fourth ventricle (e.g., Chiari malformation).

foramina of Luschka and foramen of Magendie may be obstructed due to congenital malformation (Dandy-Walker malformation): cystic dilatation of 4<sup>th</sup> ventricle.

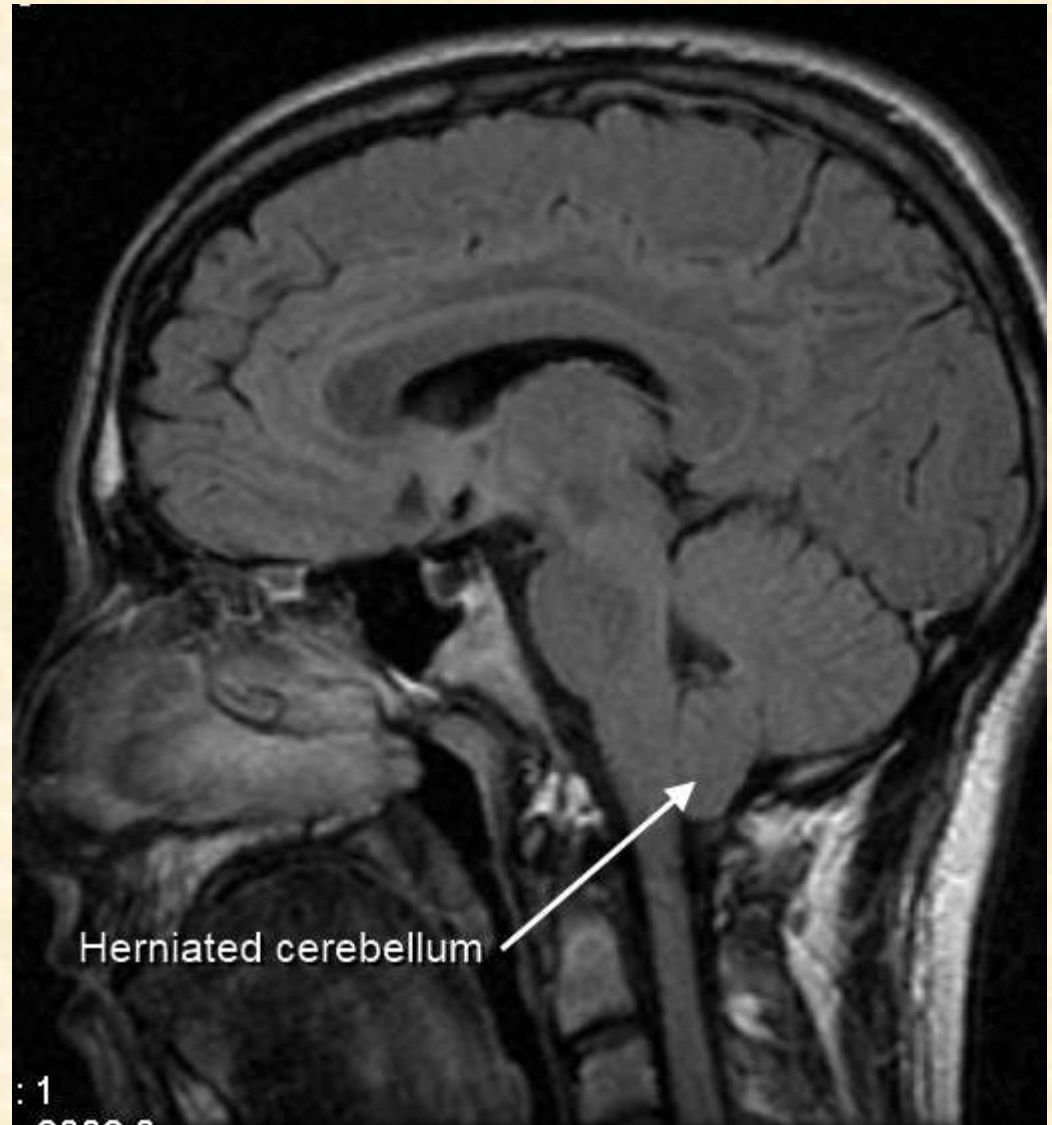
## Not an exam material

### Chiari malformation

**Chiari malformations (CMs)** are structural defects in the cerebellum. They consist of a downward displacement of the cerebellar tonsils through the foramen magnum causing non-communicating hydrocephalus as a result of obstruction of cerebrospinal fluid (CSF) outflow

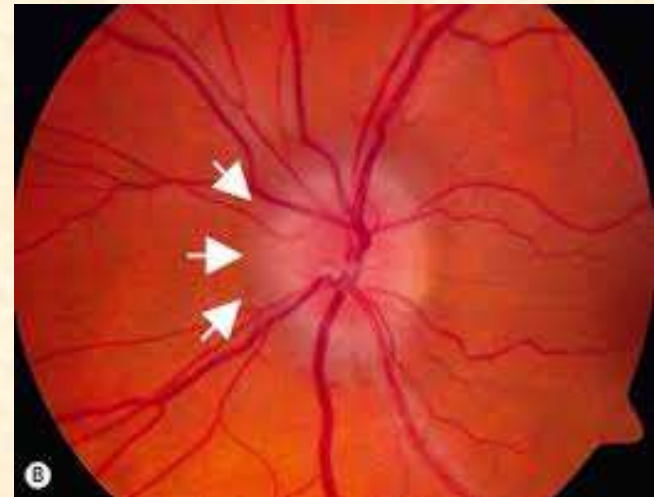
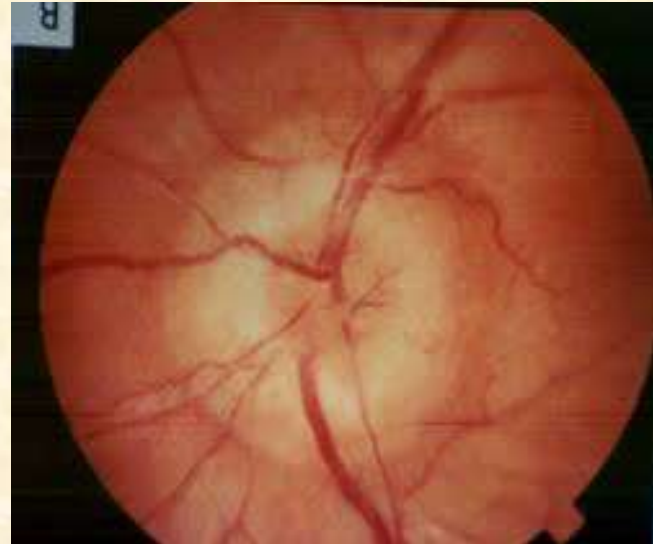
#### **Signs&symptoms:**

Headache, tinnitus, dysphagia  
May be paralysis.



# Papilledma

- Optic nerves are surrounded by pia mater, arachnoid mater and dura mater.
- Subarachnoid space is extending around optic nerve to the back of eyeball.
- Rise in CSF pressure compress retinal vein.
- Congestion of the retinal vein and bulging of the optic disc.
- Optic atrophy and blindness.



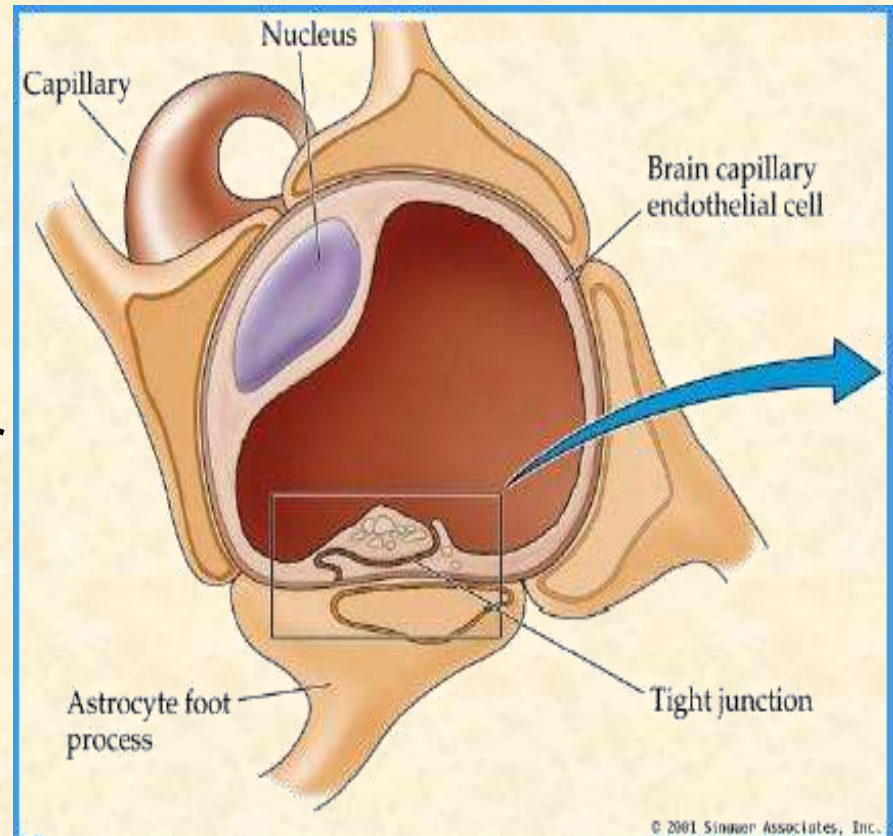


# The blood brain barrier

barrier present between the brain and the blood

## Structure

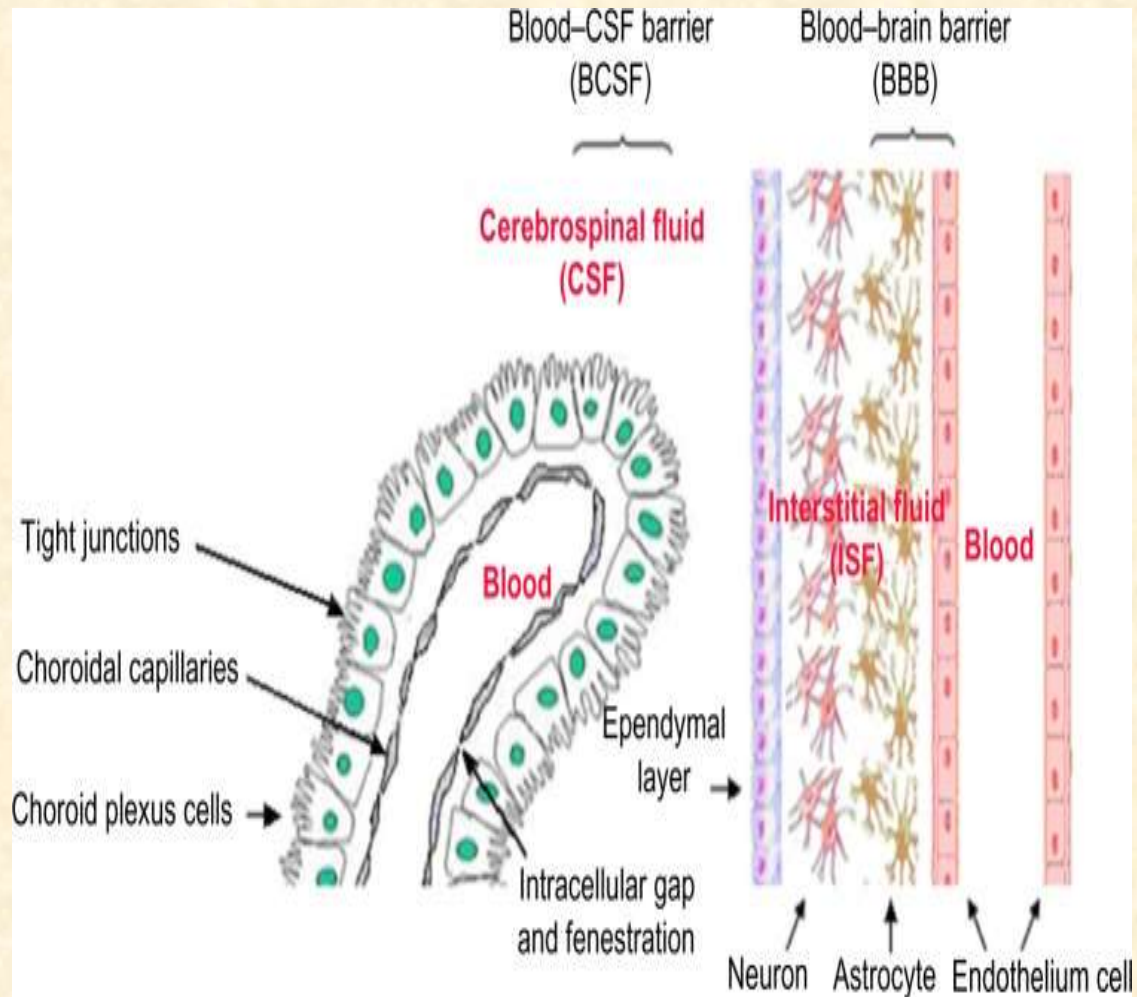
- The capillaries of the brain consist of **endothelial lining** which have **tight junctions** which close the pores in the blood vessels
- Astrocytes** completely cover the capillaries and make it less porous
- The blood vessels have a **thick basement membrane**.
- Exists in all parts of the brain except hypothalamus, pineal gland and area postrema



The Blood-Brain Barrier

# The blood CSF barrier

Blood CSF barrier: barrier between the blood and CSF exists at the choroid plexus whose function is similar to blood brain barrier. Doesn't allow the entry of substances into the CSF from the blood



## Not an exam material

### Queckenstedt sign

The normal CSF pressure on lying on side is 60-150 mm water. In case of obstruction, normal variation of pressure due to pulse or respiration is absent.

Compression of Jugular veins in the neck raises cerebral venous pressure and inhibits CSF absorption producing rise in CSF pressure. Failure of this phenomenon is referred as **positive queckenstedt sign**.

### Kernicterus

In fetus, newborn or premature the blood brain barrier is not fully developed.

Toxic bilirubin enters CNS and produce yellowing of the brain.

### Drugs and BBB

Easily pass (Chloramphenicol and tetracyclins, lipid soluble anaesthesia) + **L-dopa (treatment of parkinsonism)**

Don't pass (water soluble norepinephrine, and Dopamine)

**THANK YOU**