



Neuroanatomy

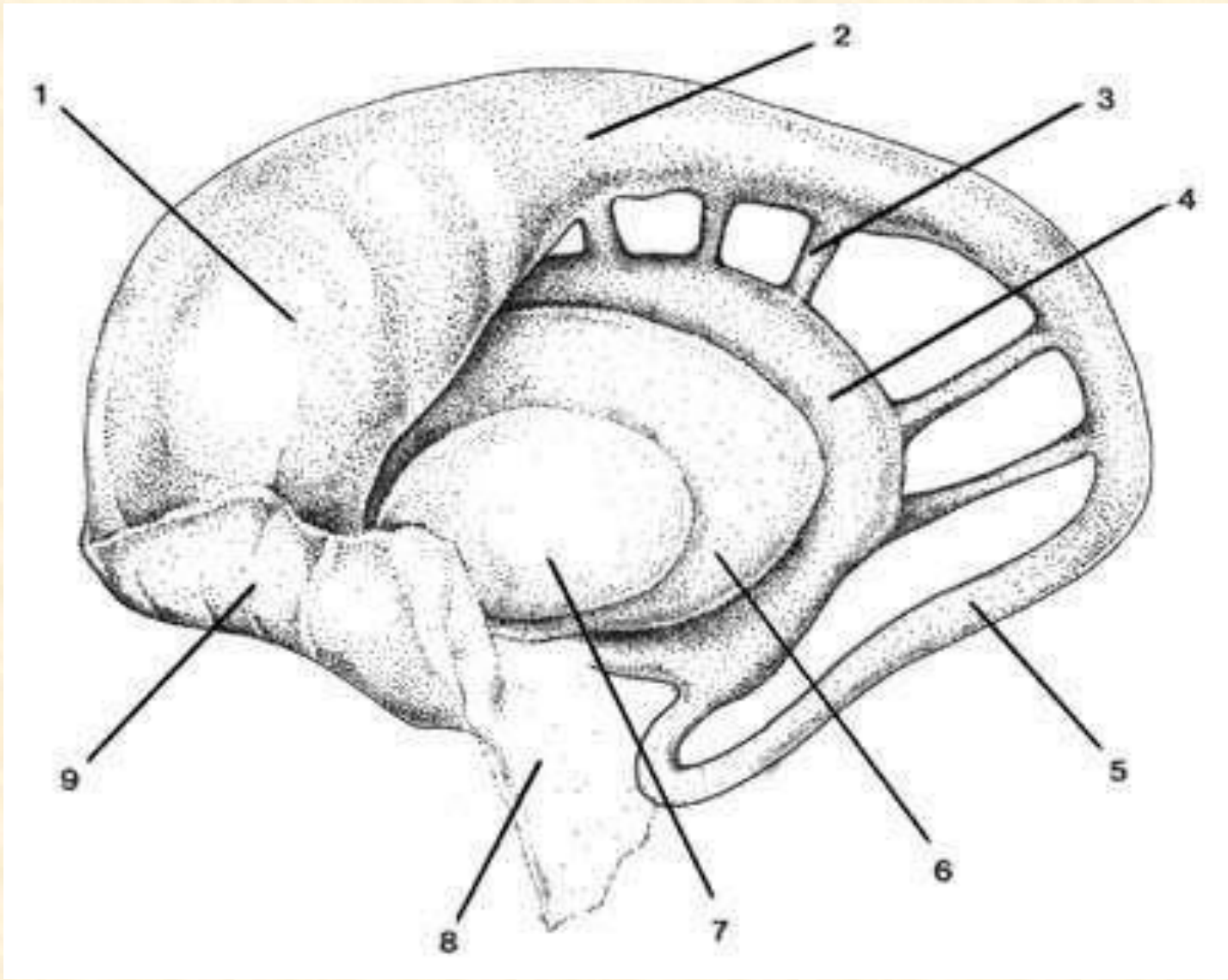
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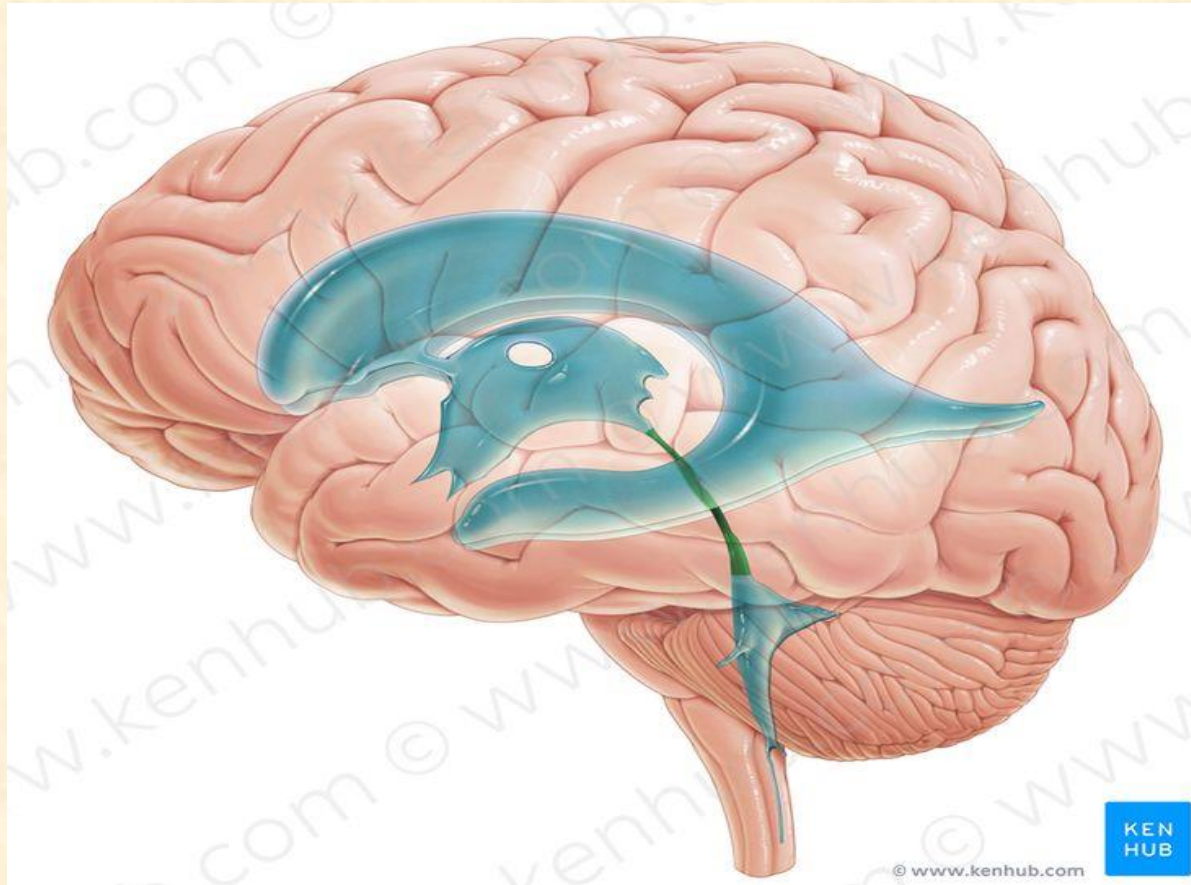
Faculty of Medicine

The University of Jordan

2018



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

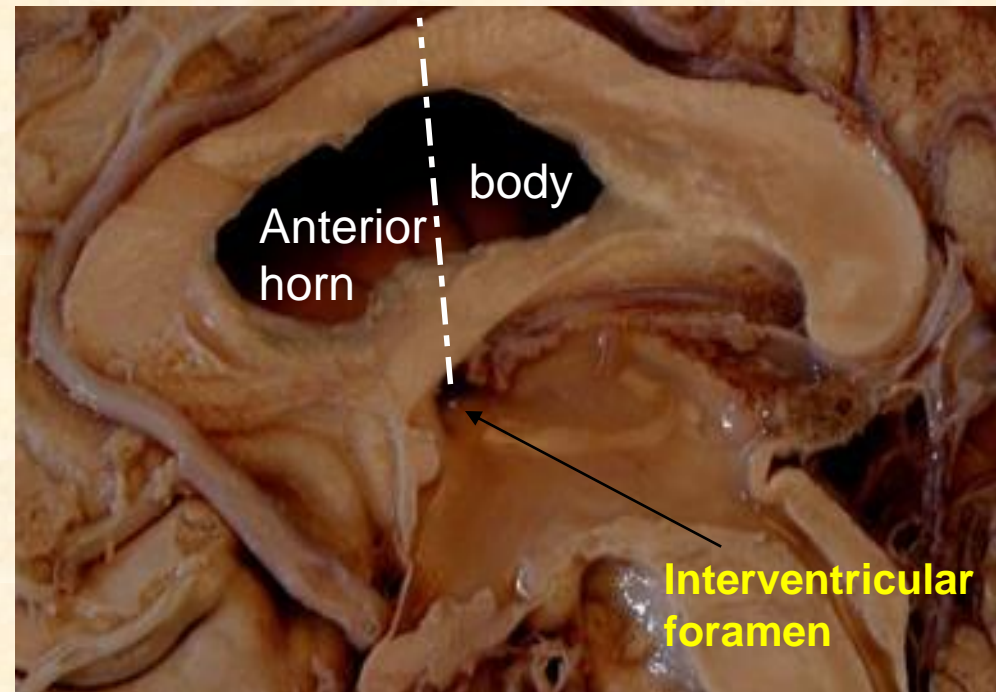
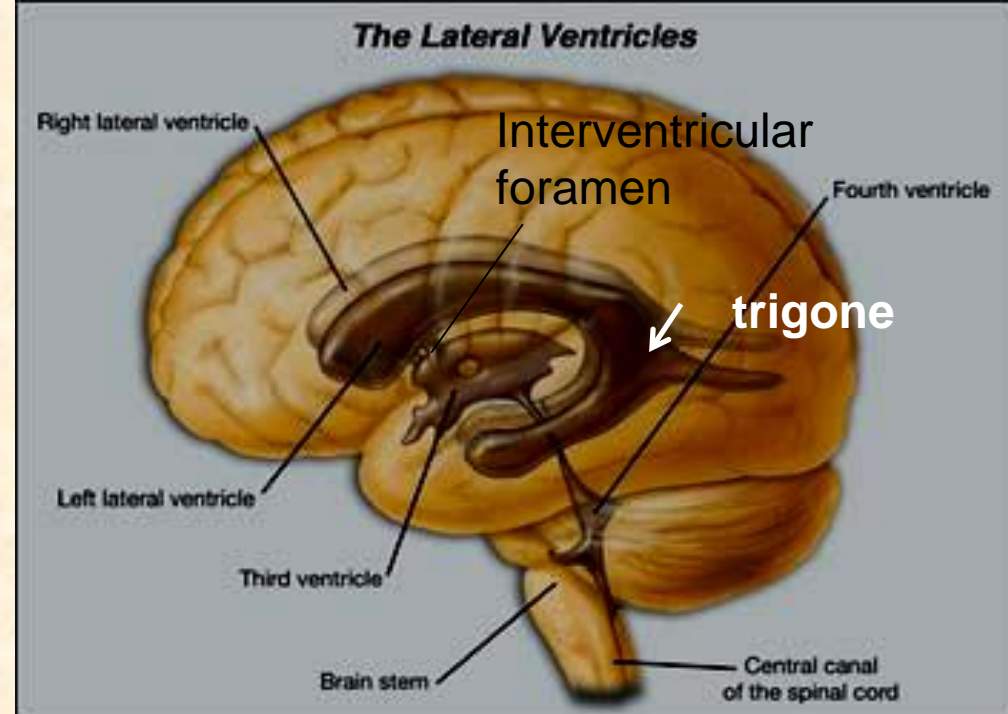


The lateral ventricle

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

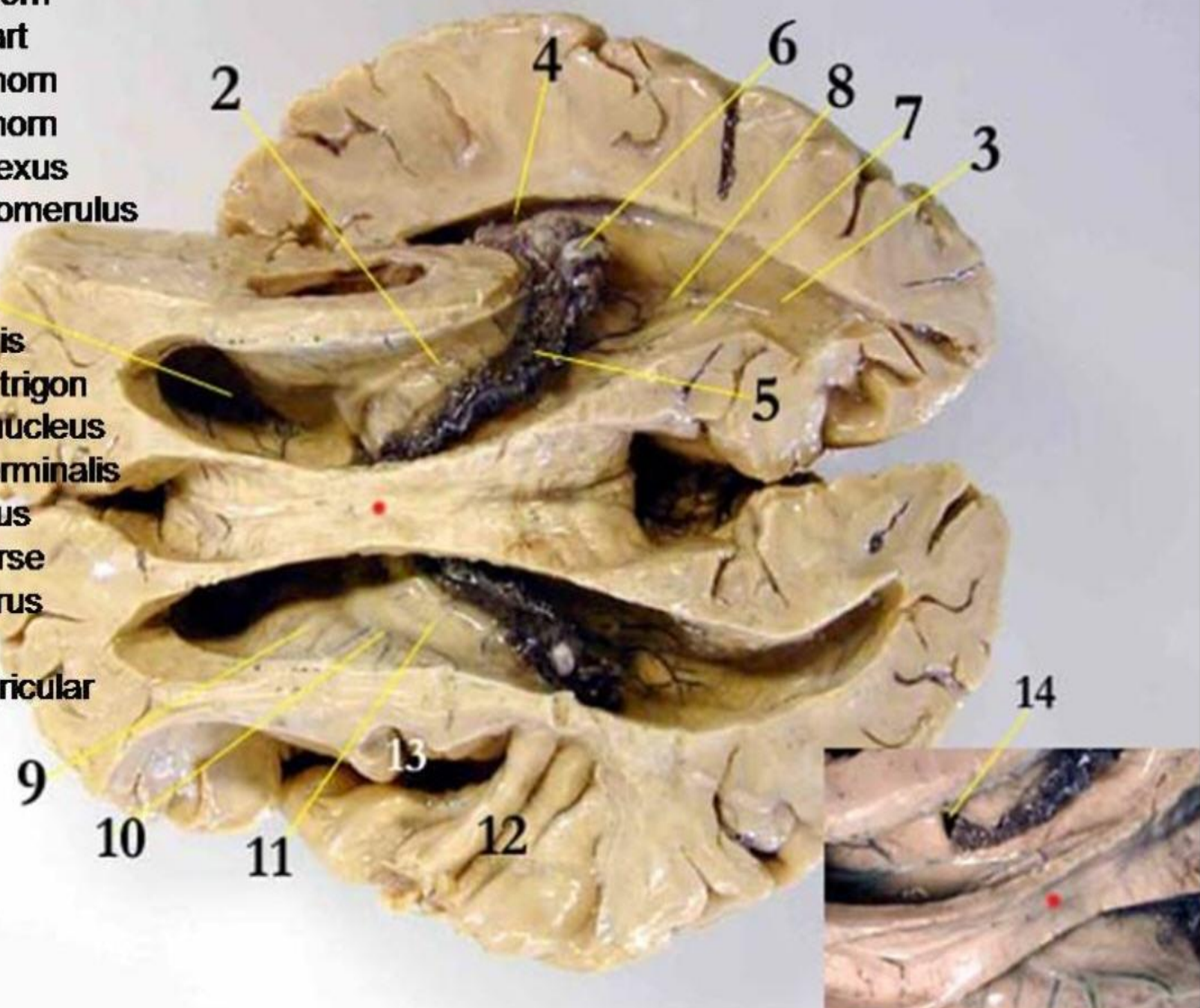
- 1) **A central part (body):** Extends from the interventricular foramen to the splenium of corpus callosum.
 - 2) **3 horns:**
 - **Anterior horn:** Lies in the **frontal** lobe in front of the interventricular foramen.
 - **Posterior horn :** Lies in the **occipital** lobe.
 - **Inferior horn :**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

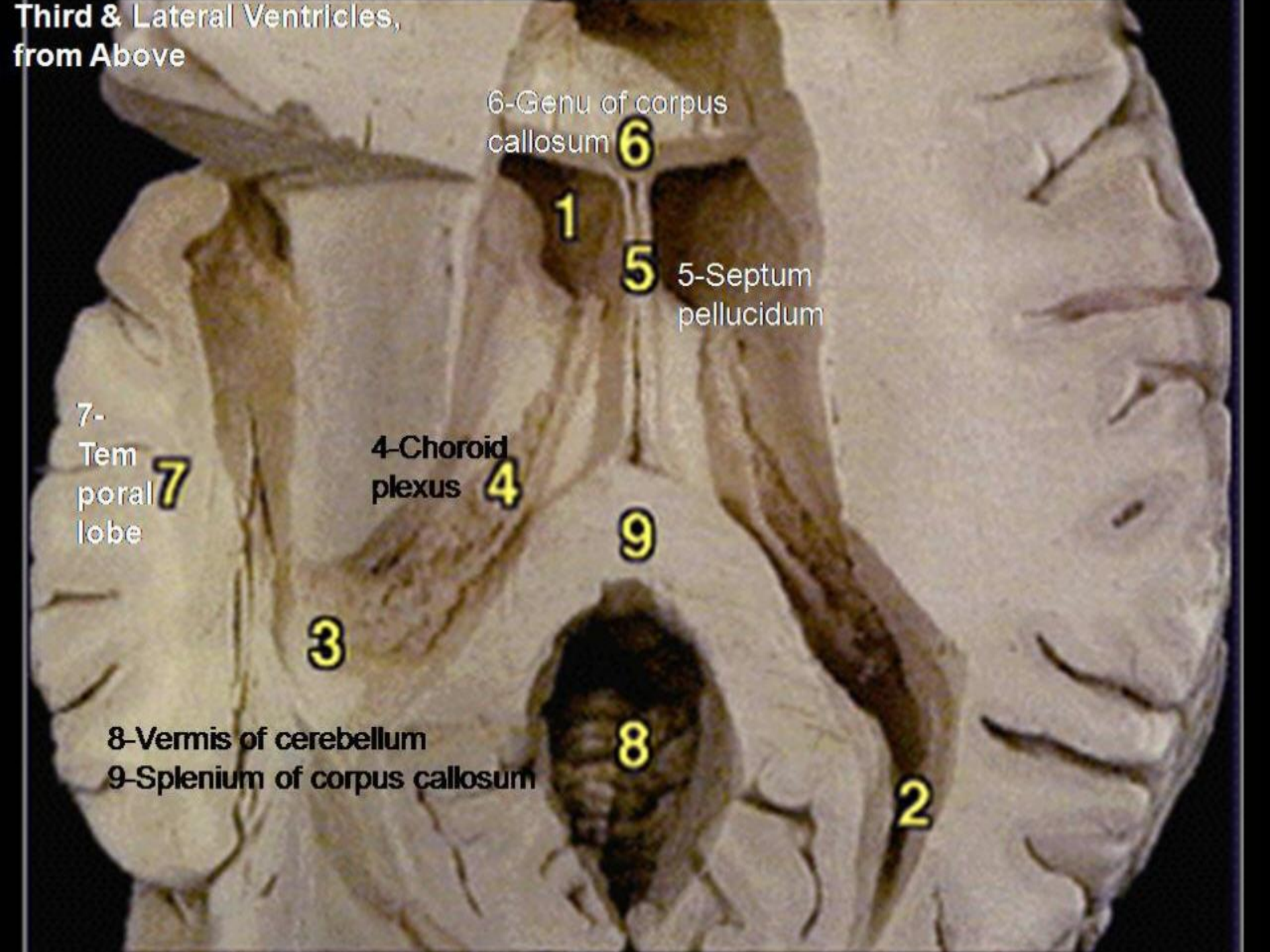
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3

8-Vermis of cerebellum
9-Splenium of corpus callosum

8

2



Relations of Body of the lateral ventricle

Roof : body of the Corpus callosum

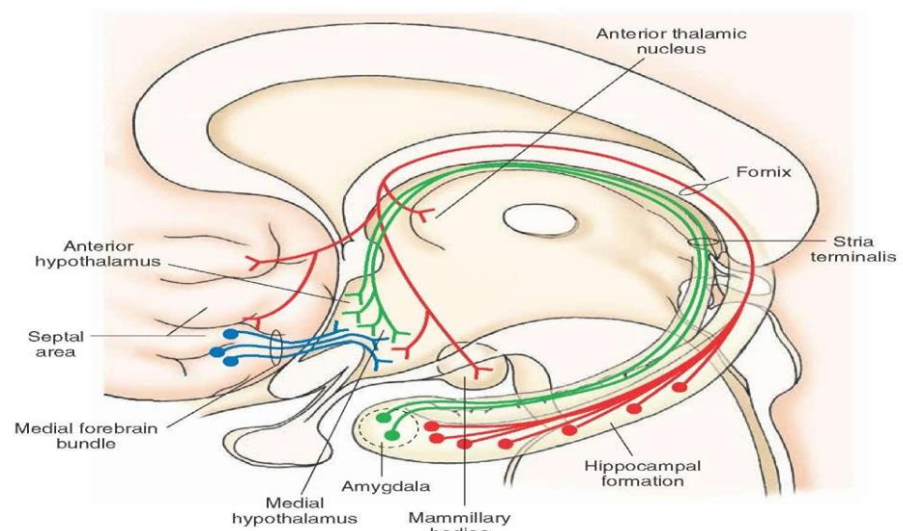
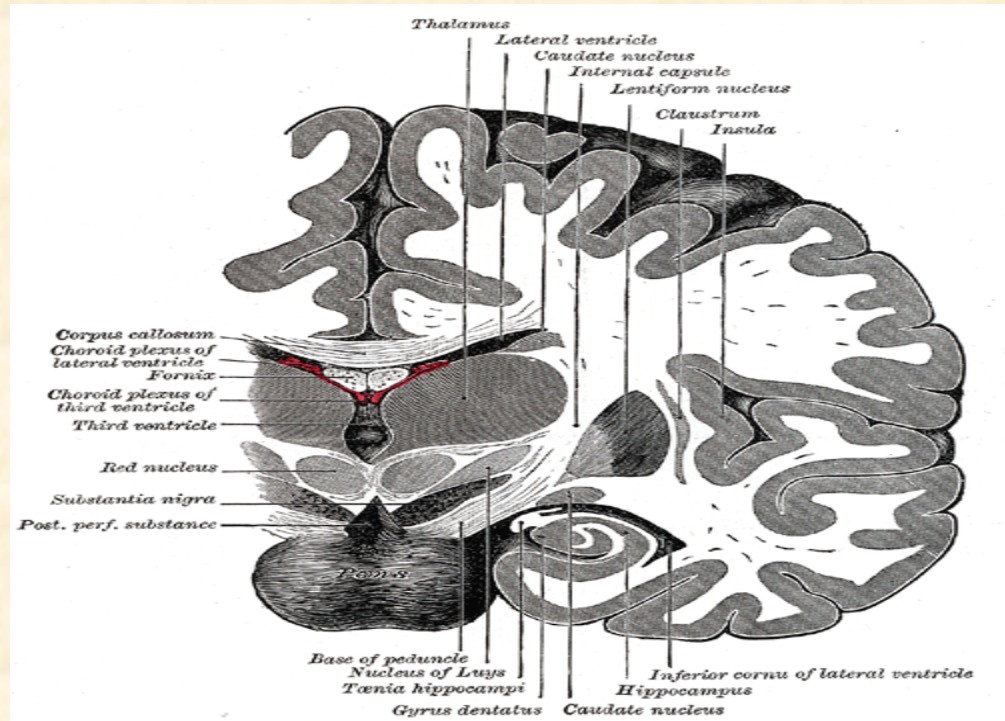
Floor: body of Caudate Nucleus and body of the thalamus.

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

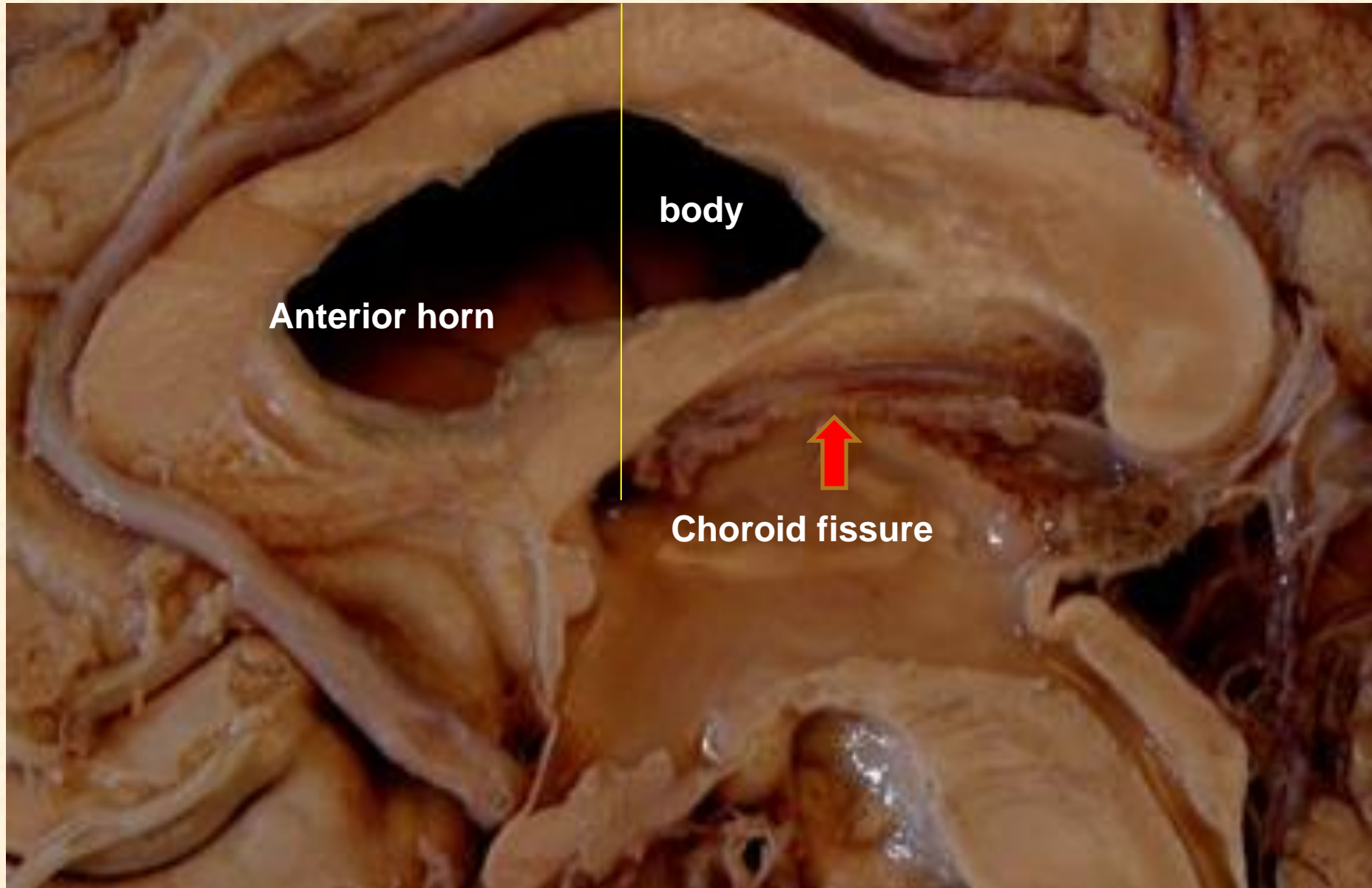
Medial wall:

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

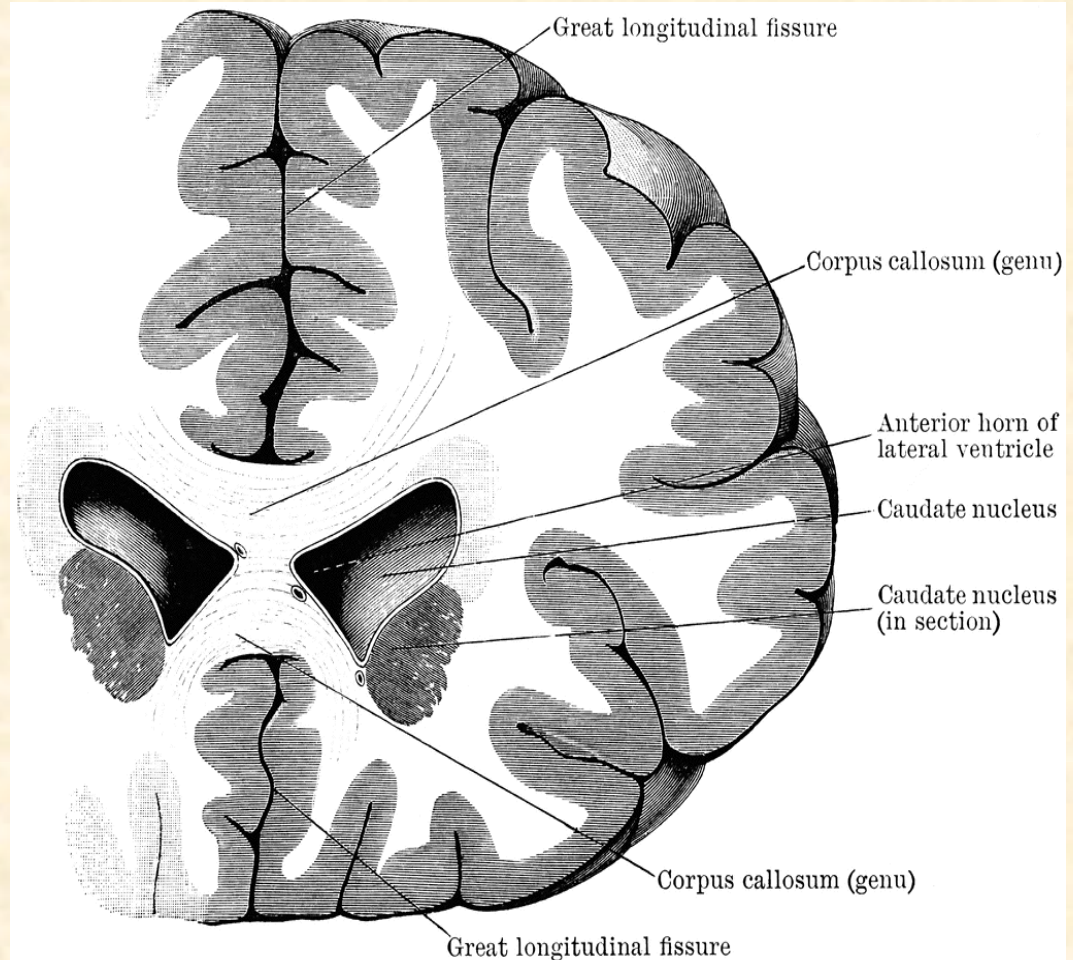
Roof : genu of the Corpus callosum

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.

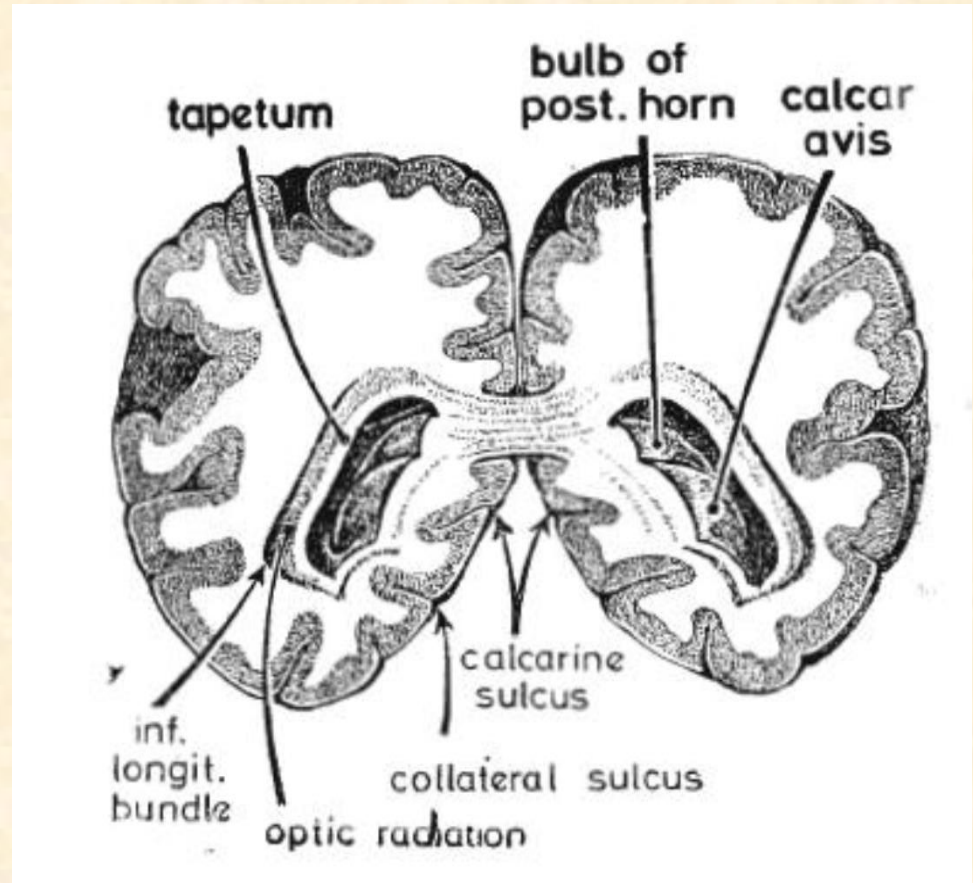
•Medial wall --- two convexities:

Upper (bulb of the posterior horn)

- Splenium of the corpus callosum (bulb)

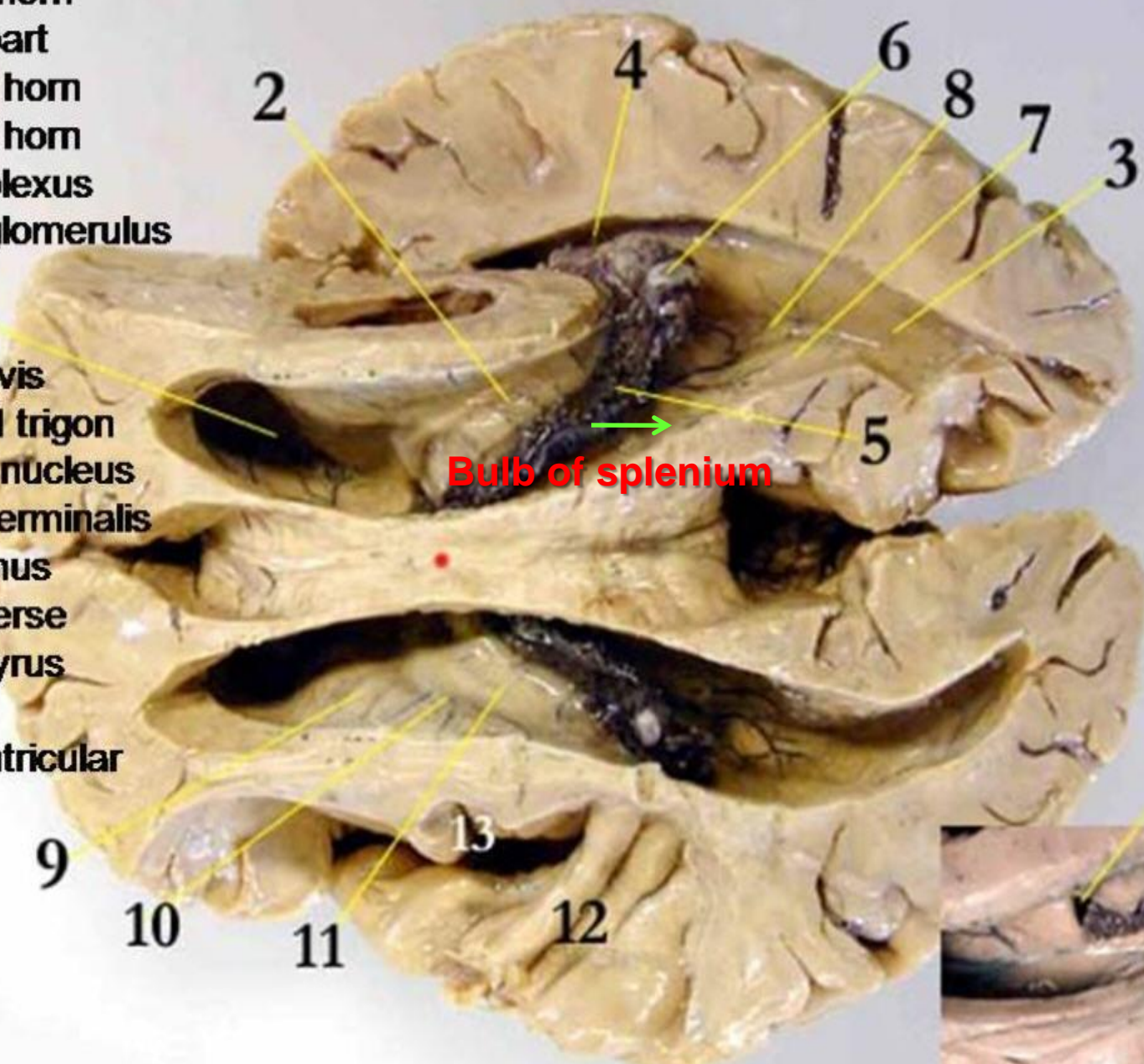
Lower (Calcar avis)

- 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

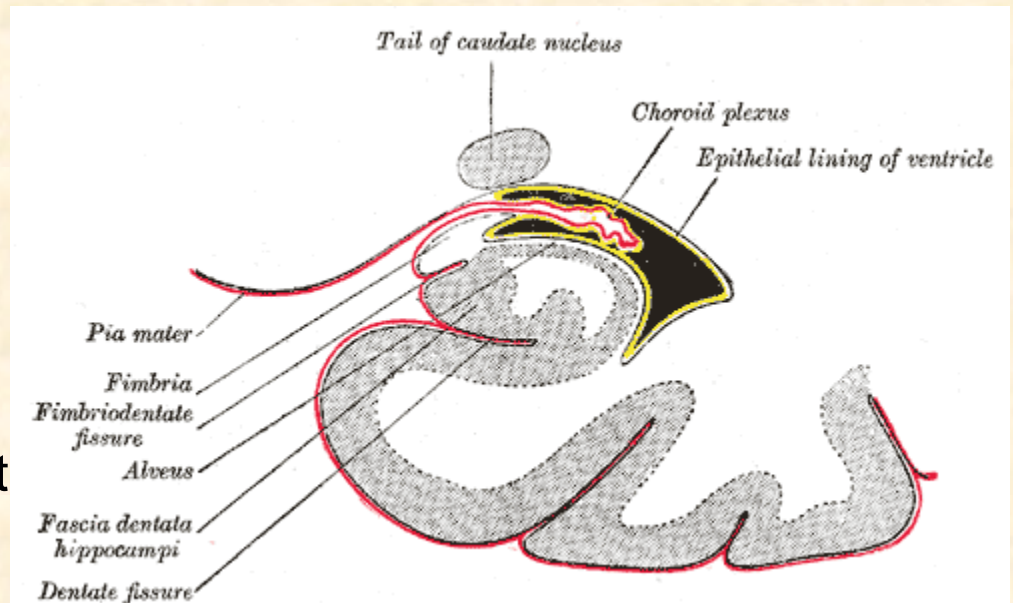
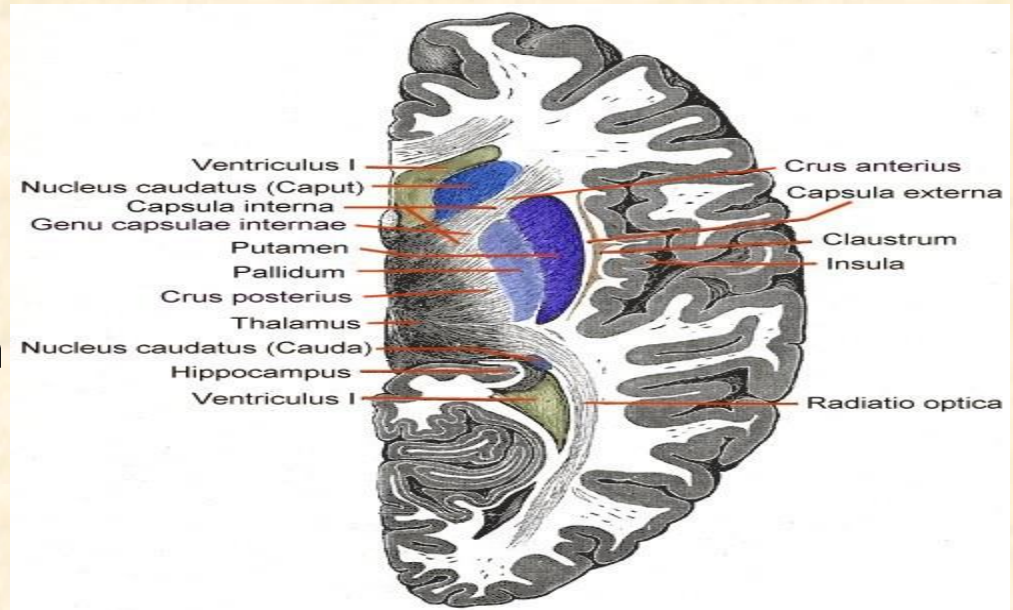
medially

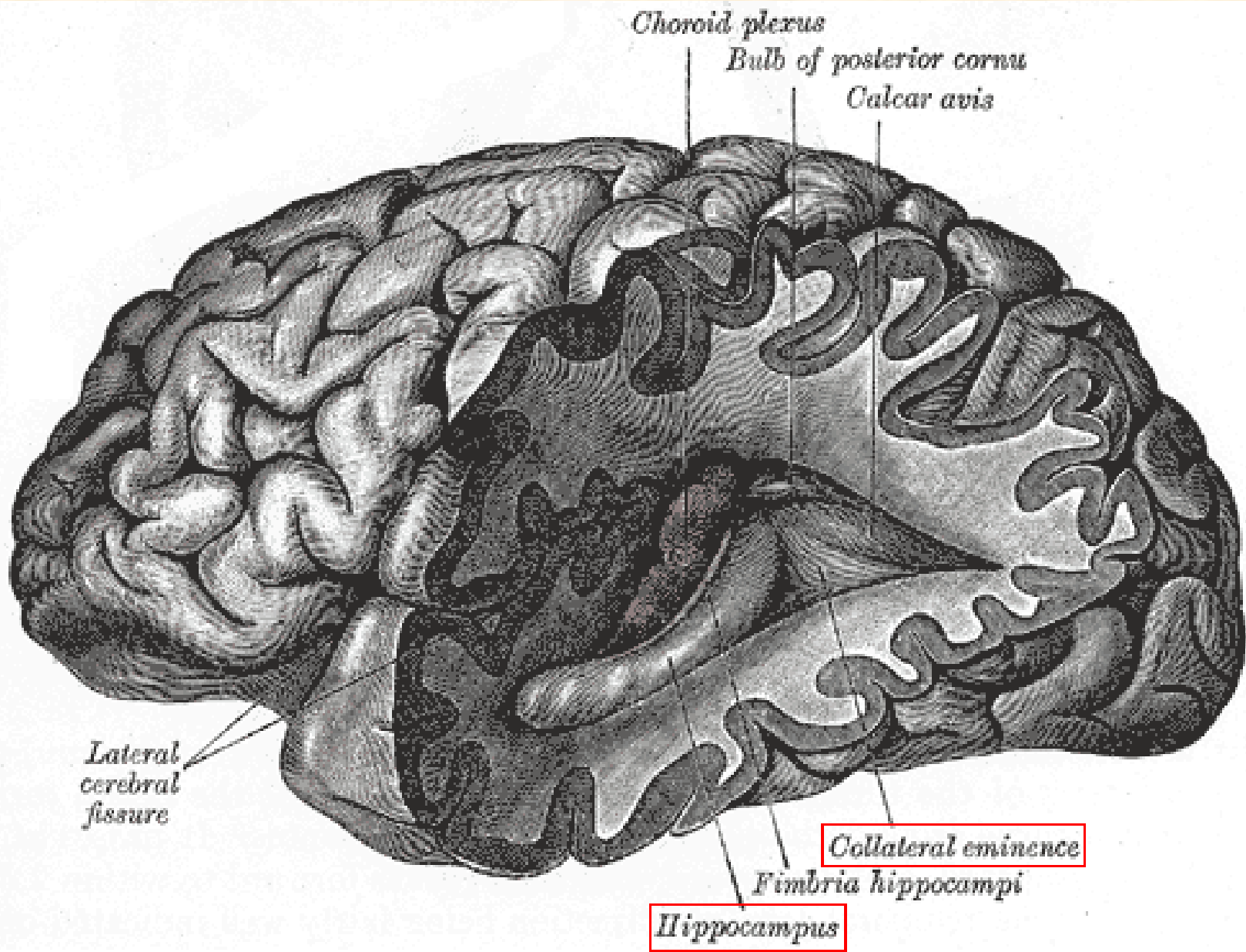
■ hippocampus

laterally

■ collateral eminence
(by collateral fissure)

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





Choroid plexus

Bulb of posterior cornu

Calcar avis

Lateral cerebral fissure

Collateral eminence

Fimbria hippocampi

Hippocampus

Ventricle

body of caudate n.

mid plexus

body

ant. horn

head of caudate

amygdala

inferior horn

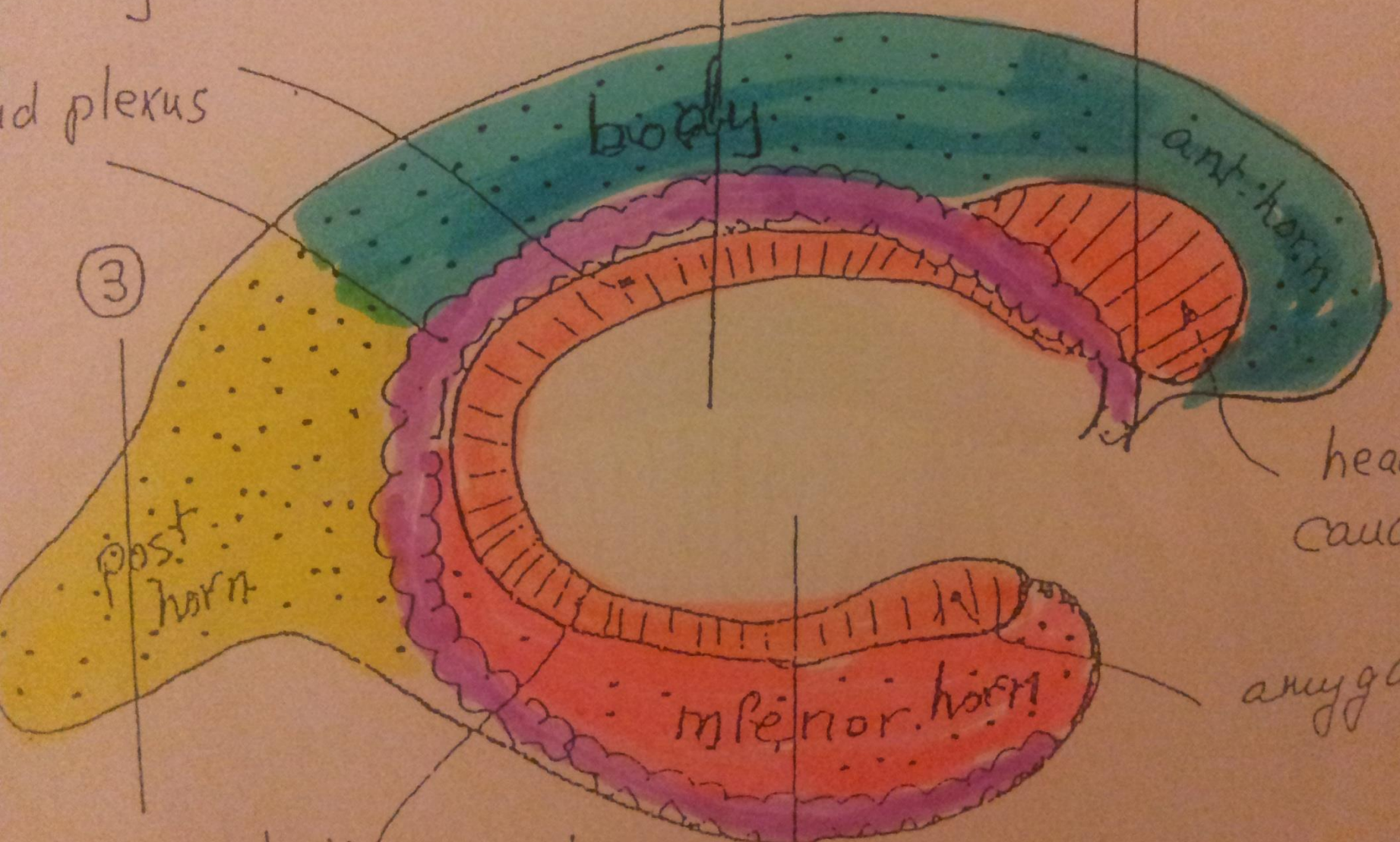
tail of caudate n.

2

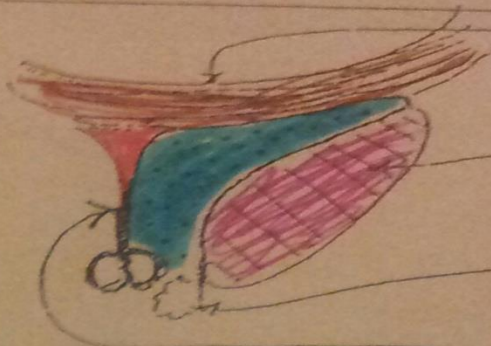
1

3

post horn



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



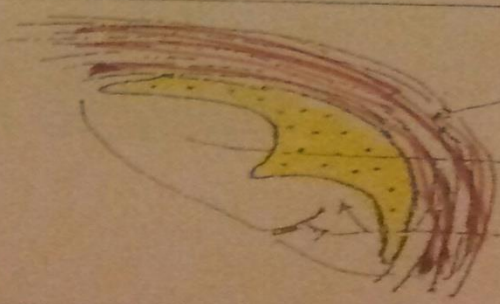
genu of c.c.
 head of caudate
 choroid plexus
 septum pellucidum
 attached to fornix

- 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 (forming 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)

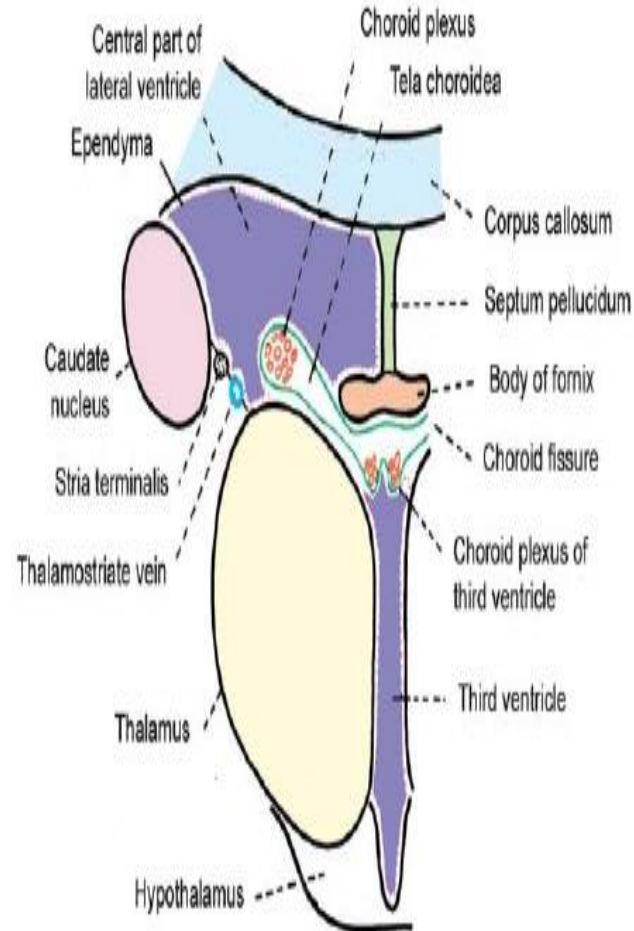
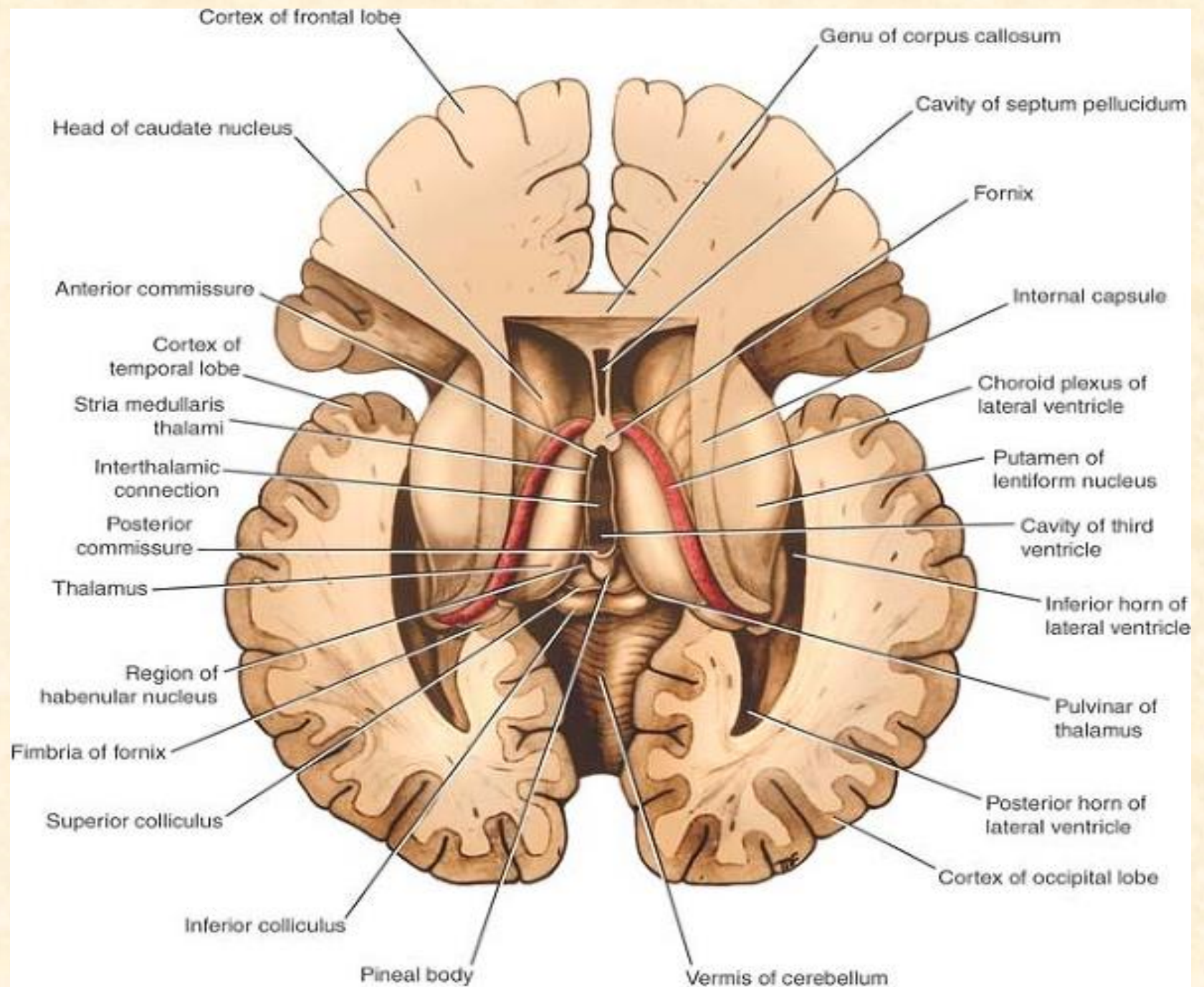
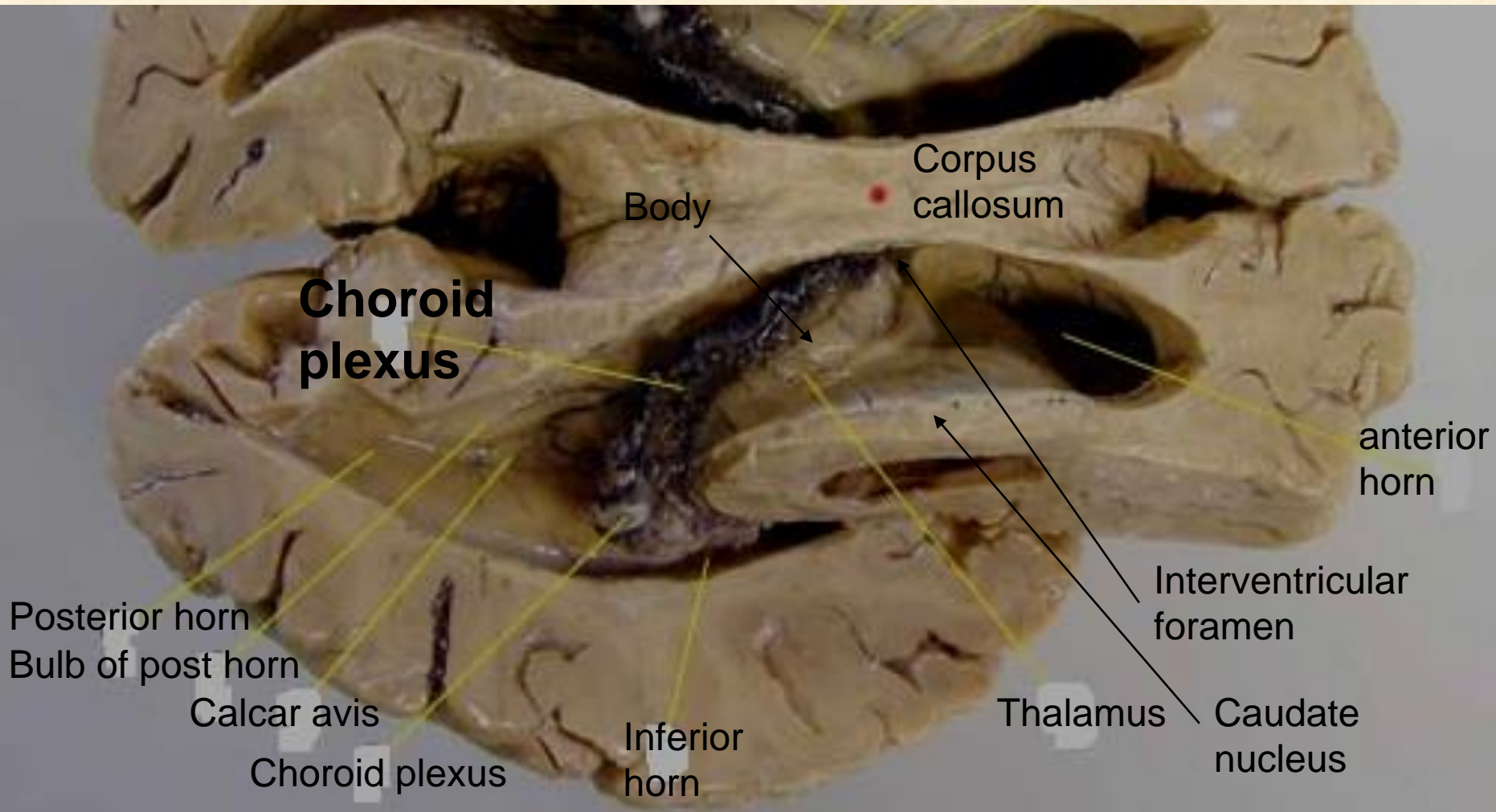


Fig. 20.2. Boundaries of the central part of the lateral ventricle and of the third ventricle. Note the relationship of the tela choroidea and the choroid plexuses to these ventricles.



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

BP: -2.9
ST: 5.0

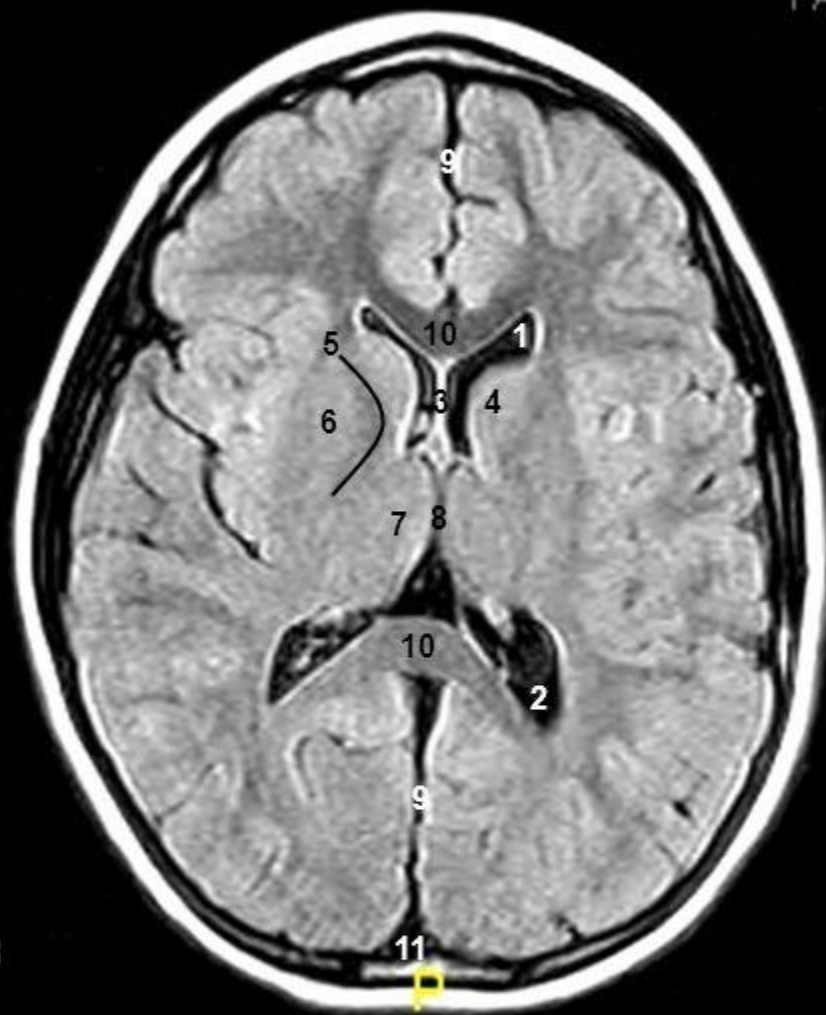
10

A

TR: 10000.0
TE: 140.0
FA: 90.0

R

L

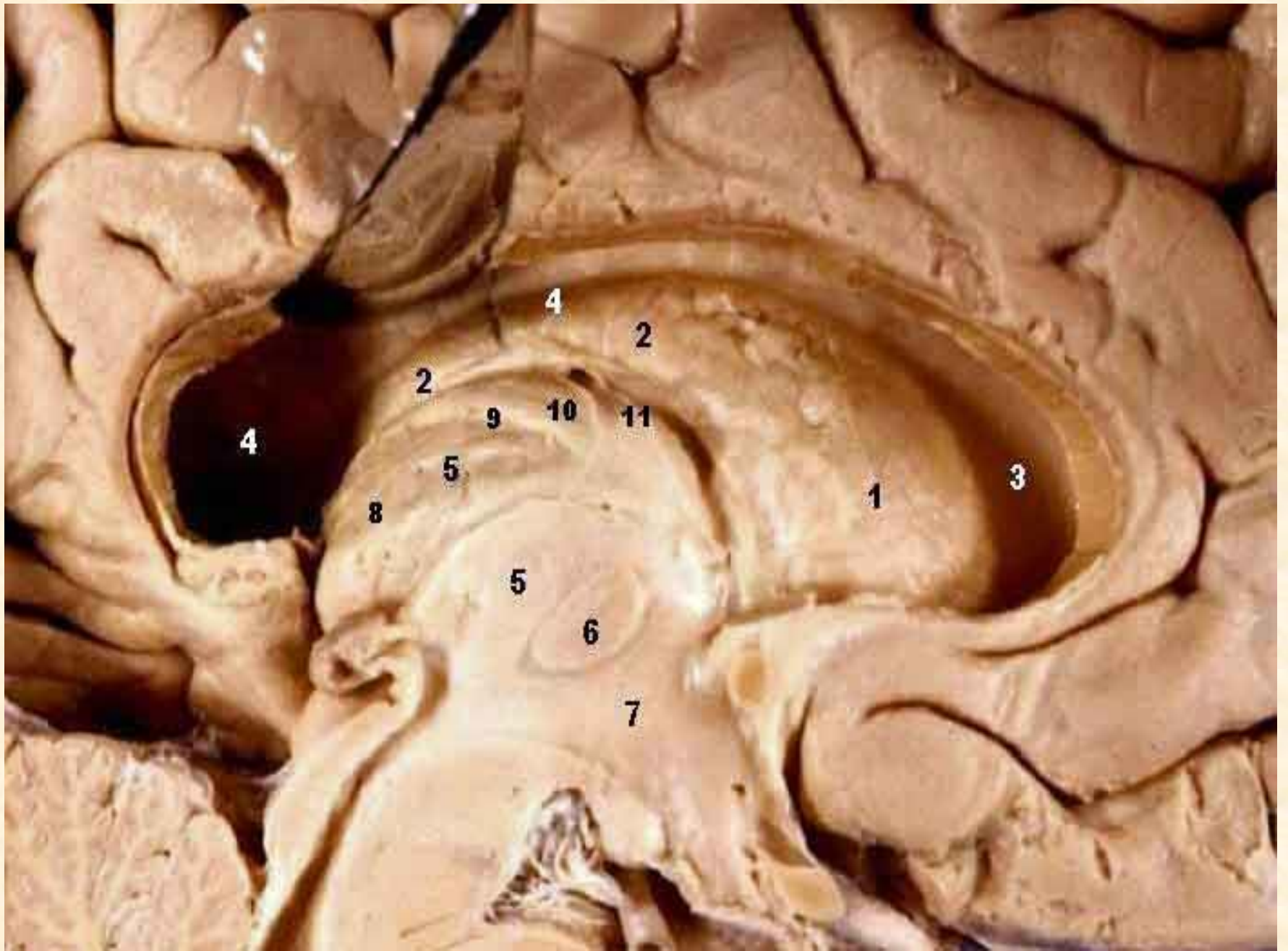


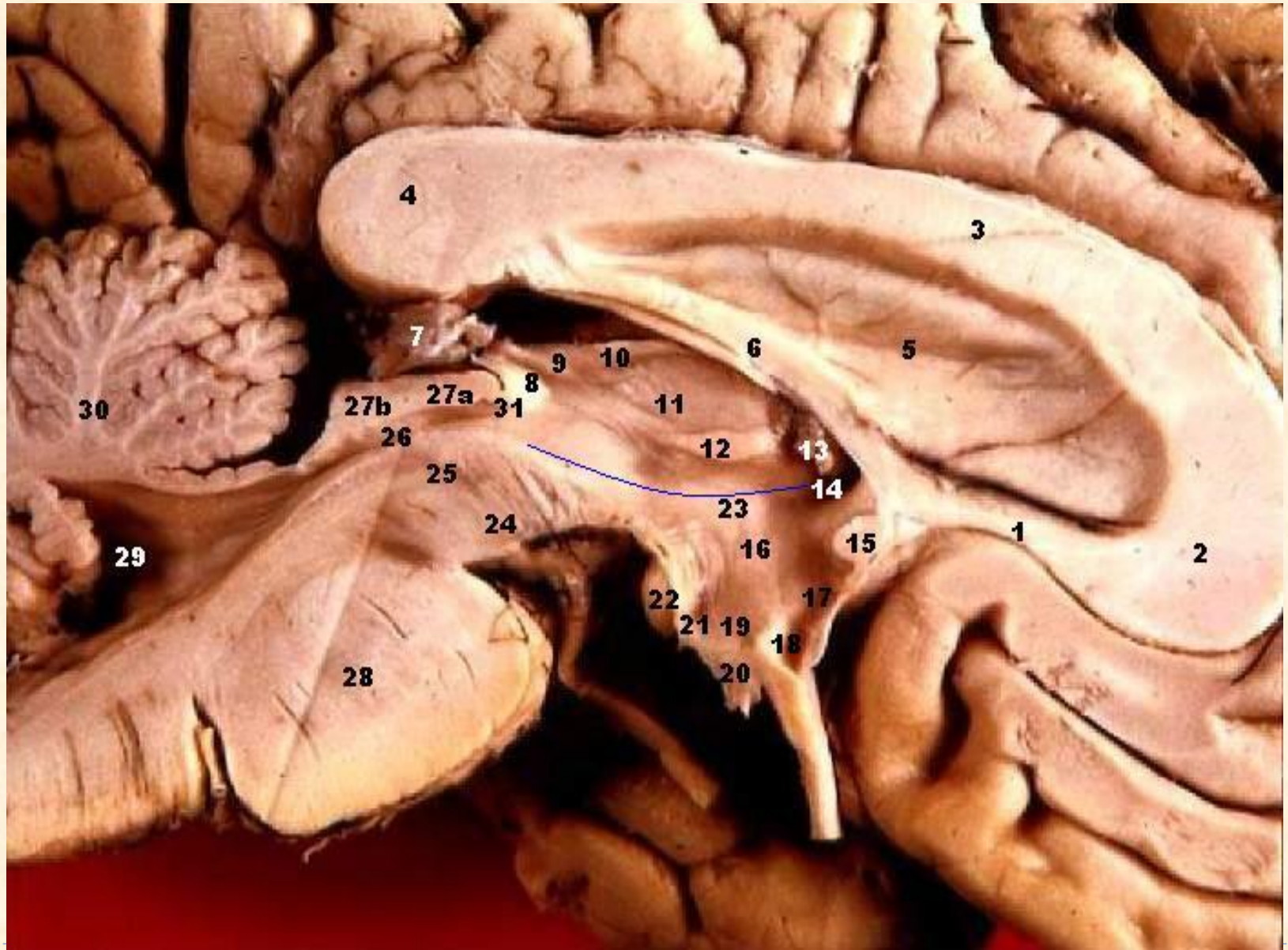
Lossy 1:8
Zoom: 1.6

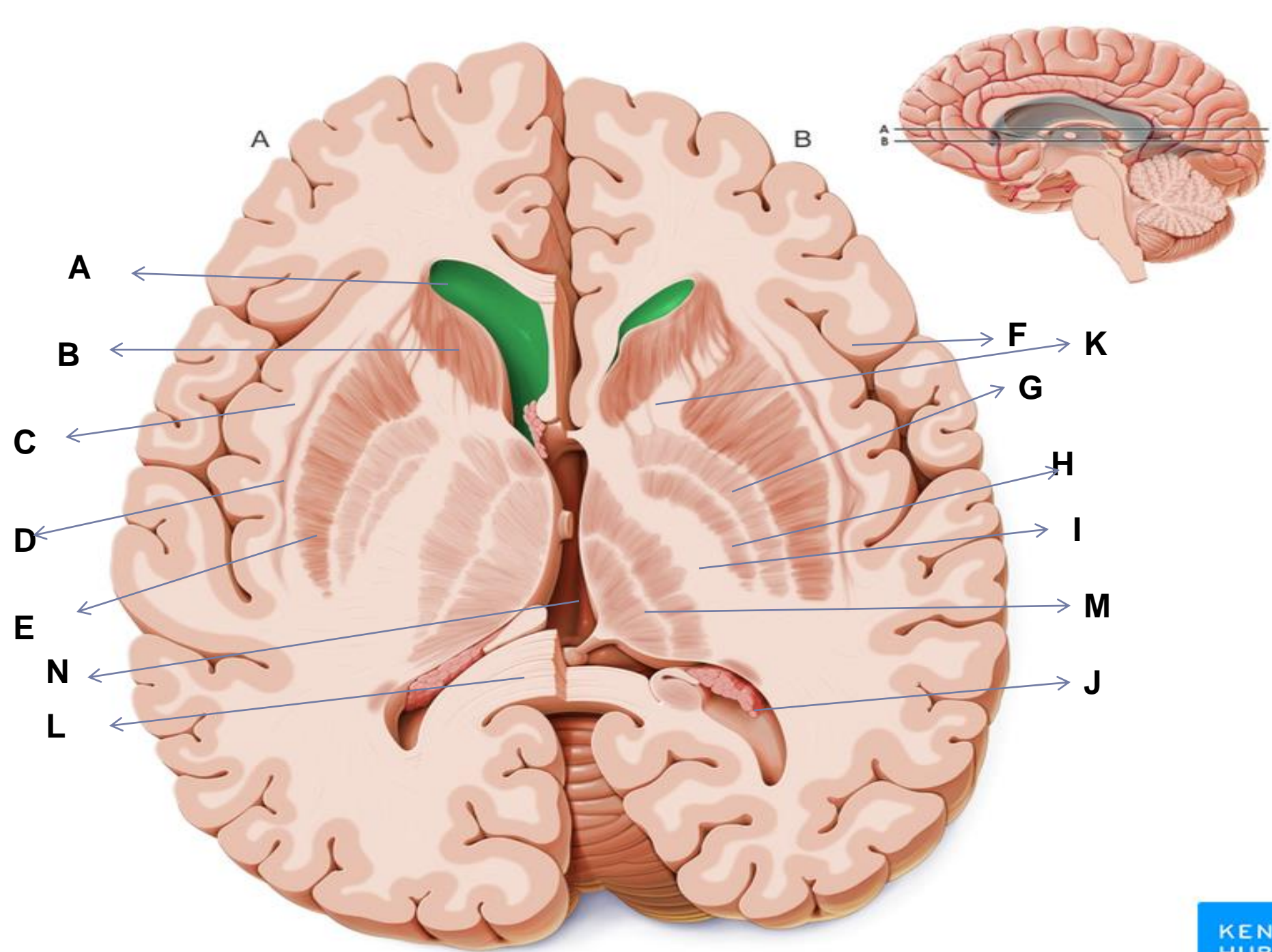
T2 FLAIR AXIALS

Key to MRI:

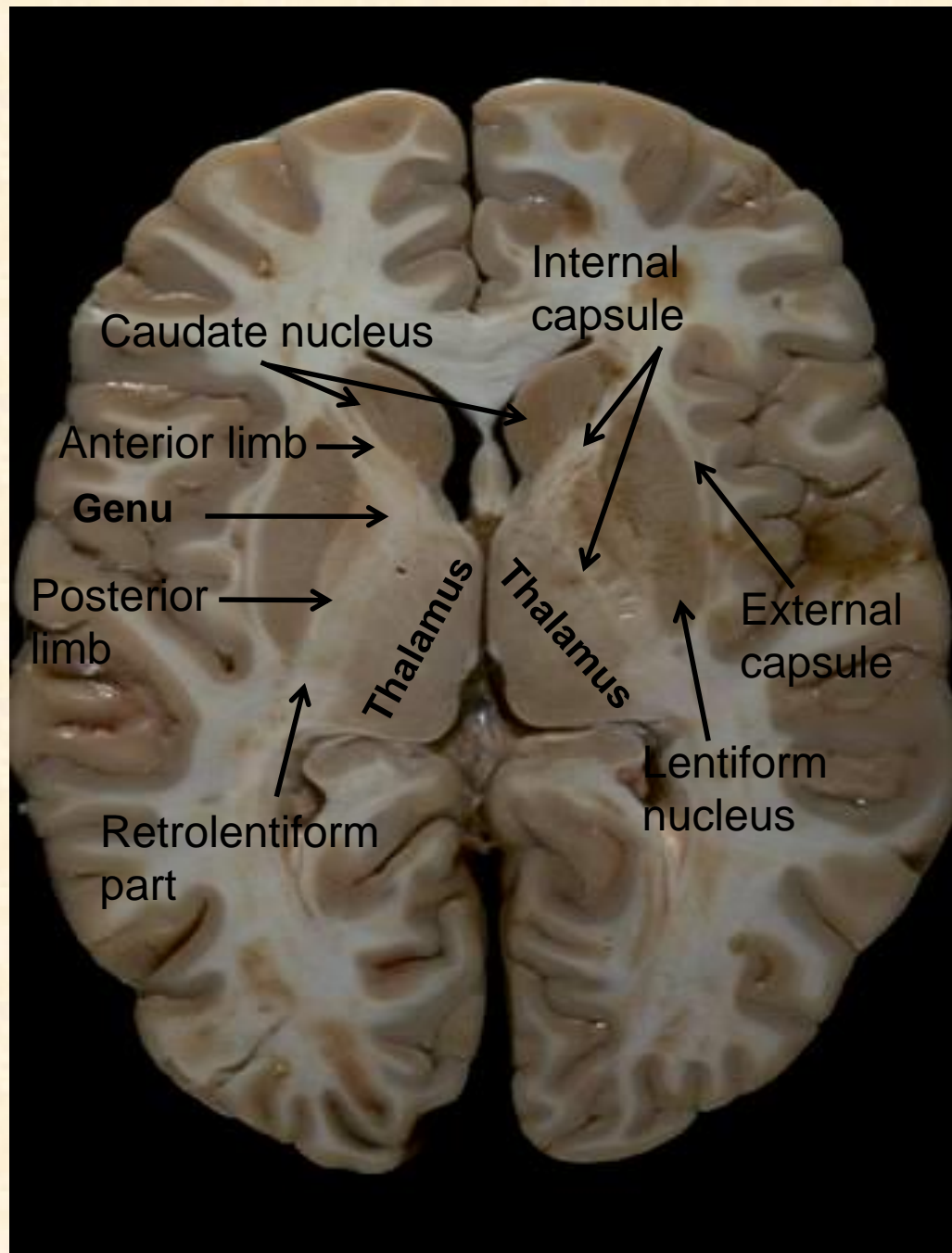
1. anterior horn of lateral ventricle
2. posterior horn of lateral ventricle
3. septum pellucidum
4. head of caudate nucleus
5. internal capsule
6. lentiform nucleus
7. thalamus
8. 3rd ventricle
9. longitudinal fissure
10. corpus callosum
11. superior sagittal sinus









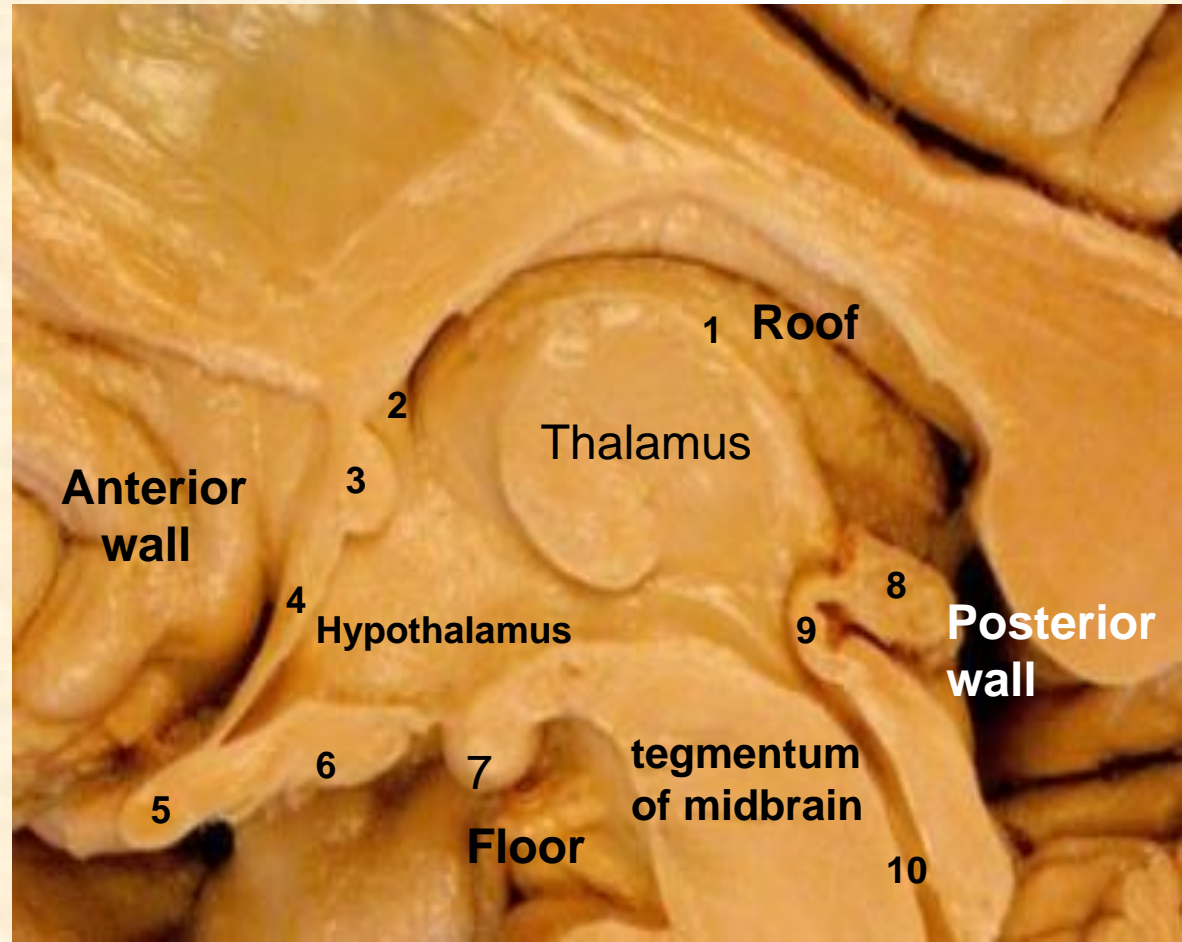
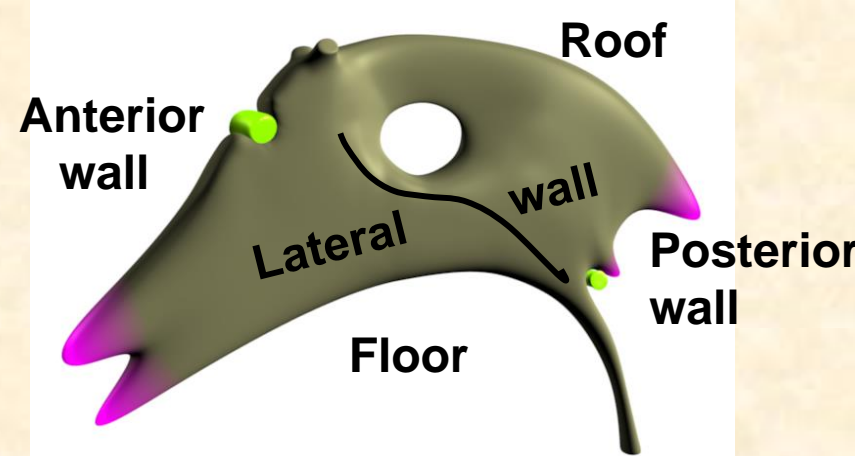


The third ventricle

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.

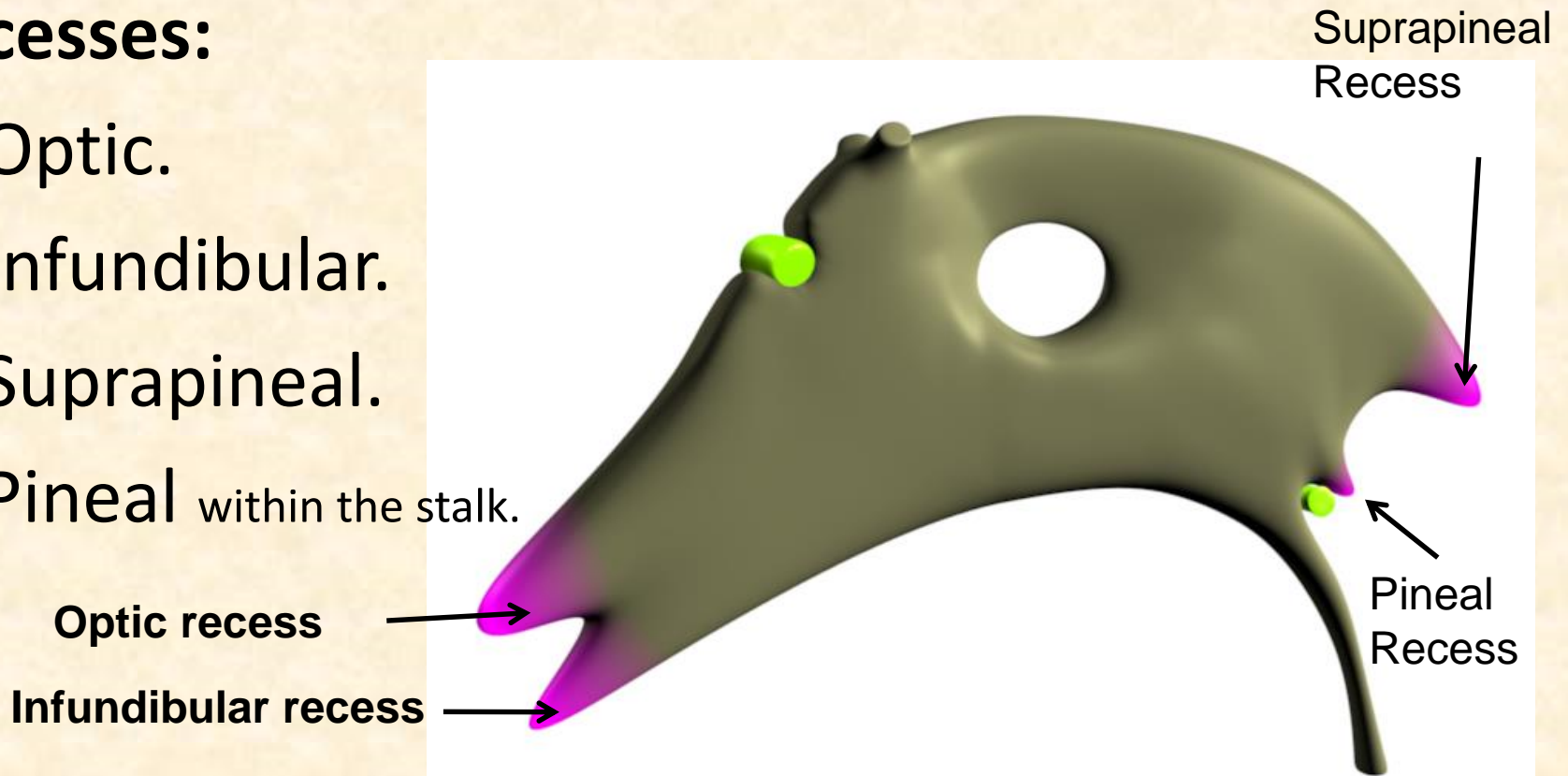


Connections:

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

Recesses:

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

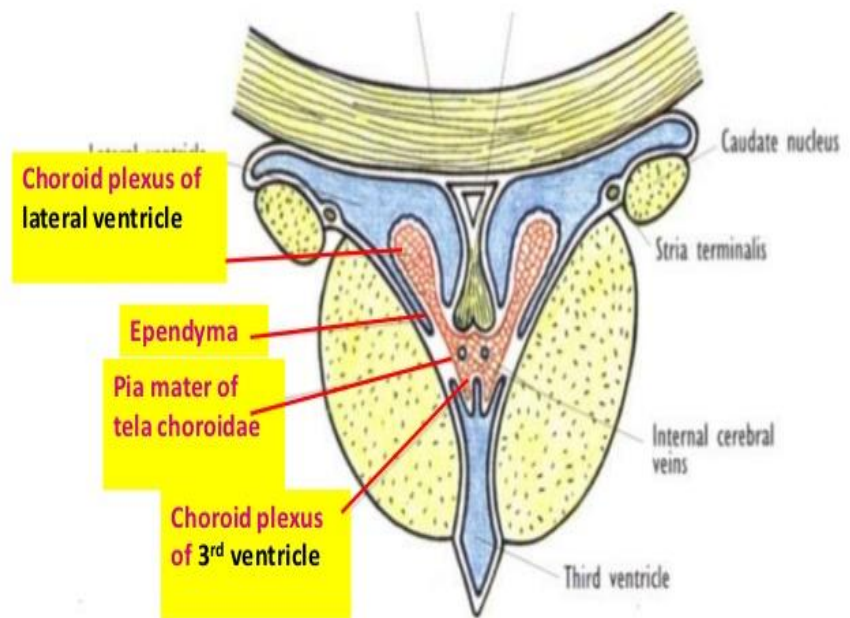


Choroid plexus of Third Ventricle

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**



Coronal section of the interventricular foramen showing the choroid plexus of 3rd & lateral ventricles

The fourth ventricle

It is a diamond shaped cavity of the hindbrain.

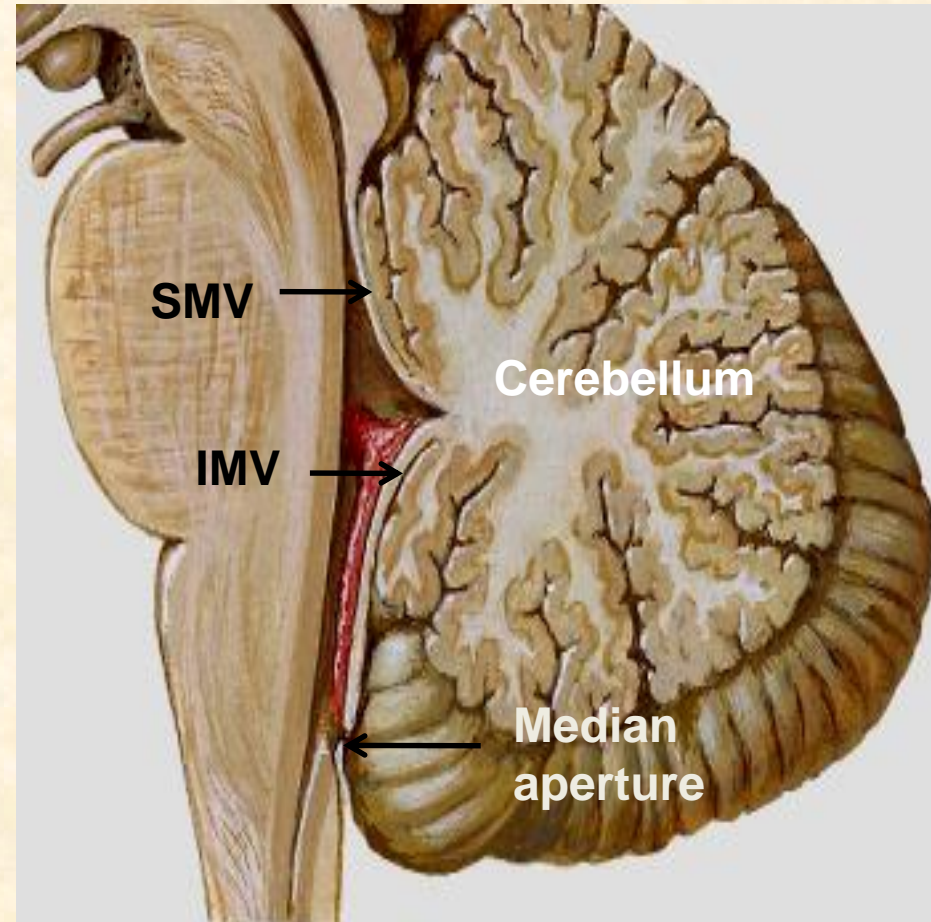
It lies behind the pons & open medulla & in front of the cerebellum.

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).

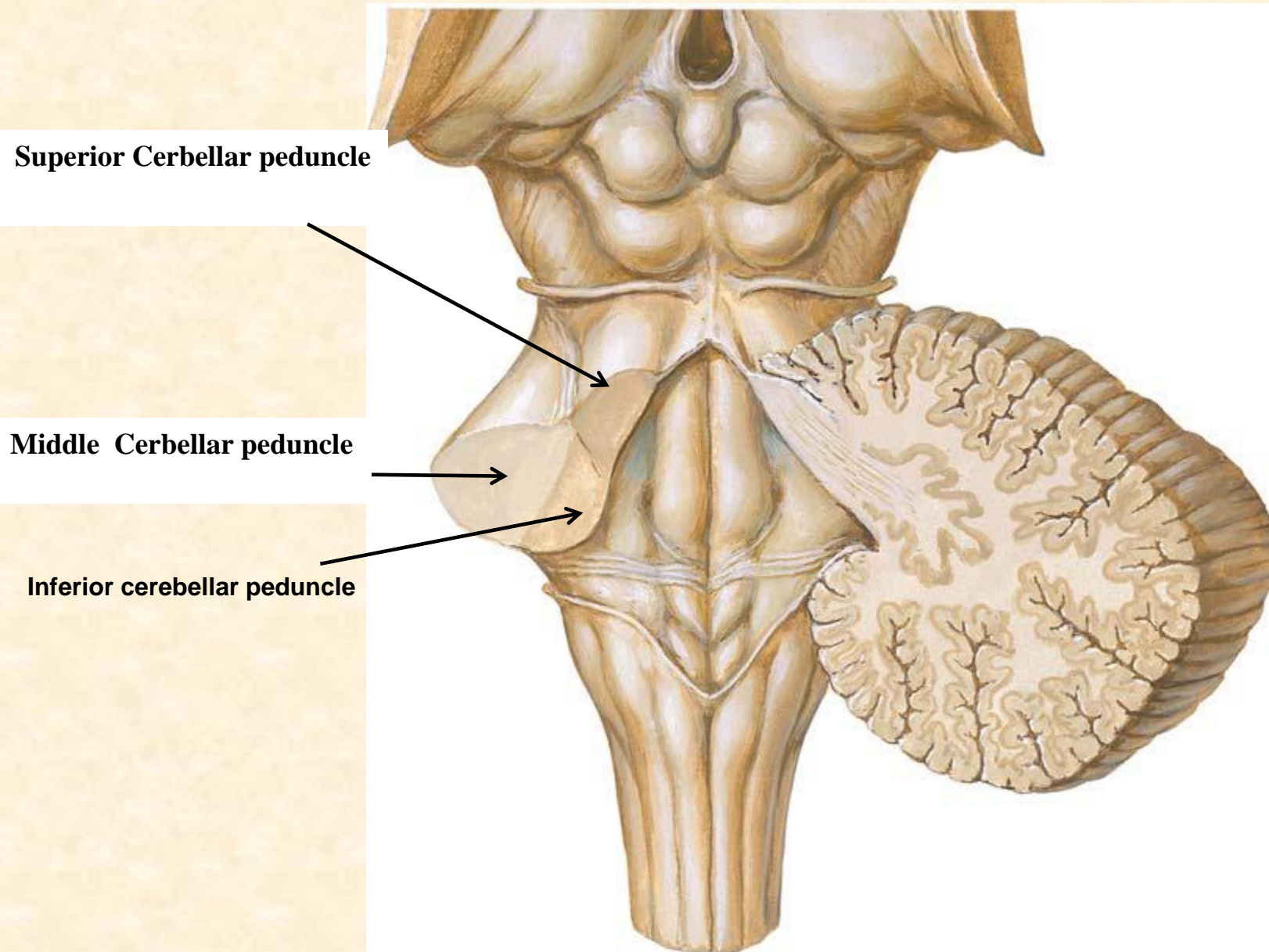
It has **2 lateral recesses** which curve around the inferior cerebellar peduncle & open by lateral apertures in the subarachnoid space at the flocculus .

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 4th ventricle to the subarachnoid space.



Floor of the 4th ventricle



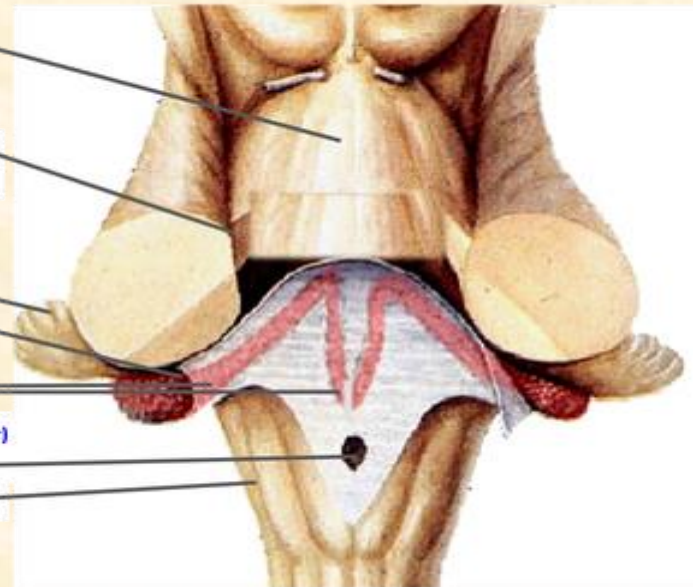
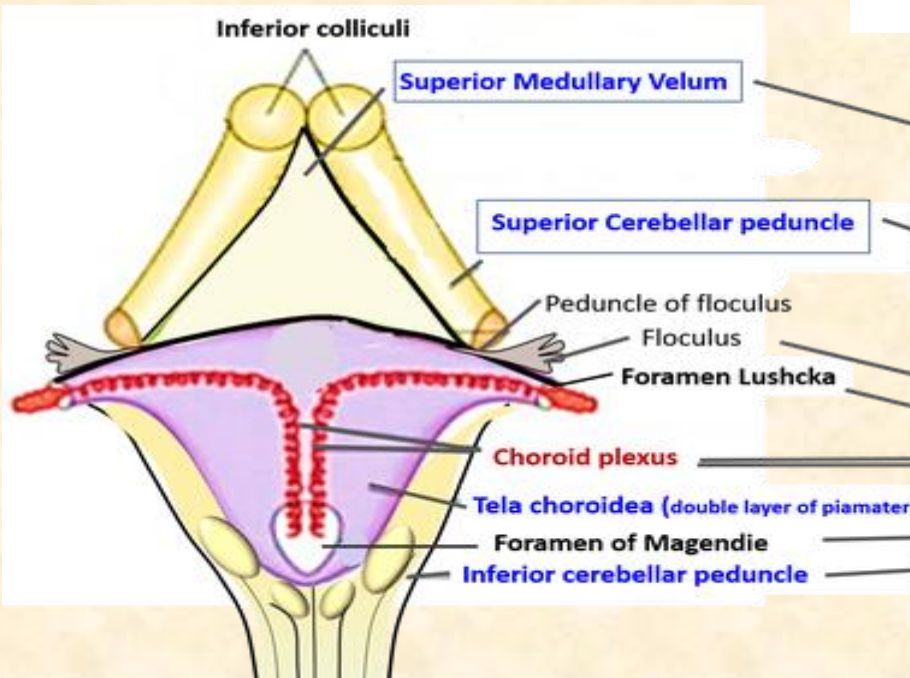
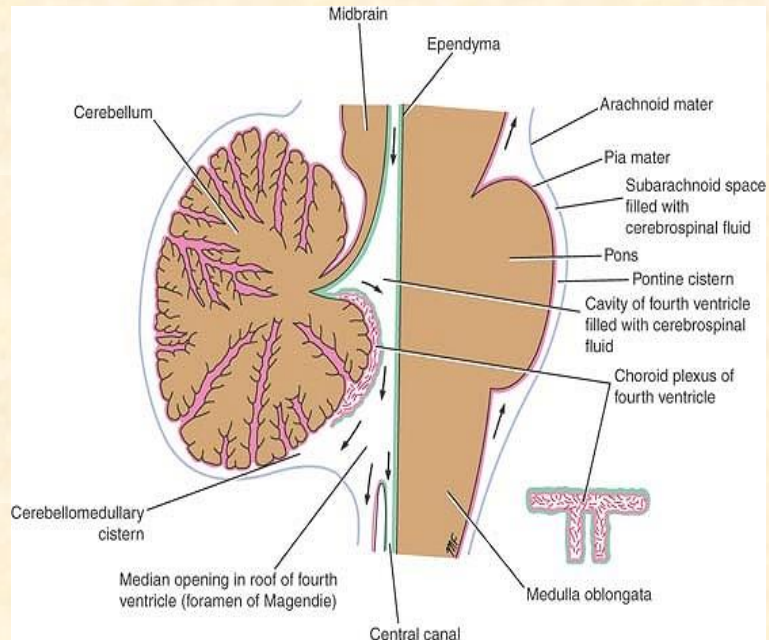
Choroid plexus of Fourth Ventricle

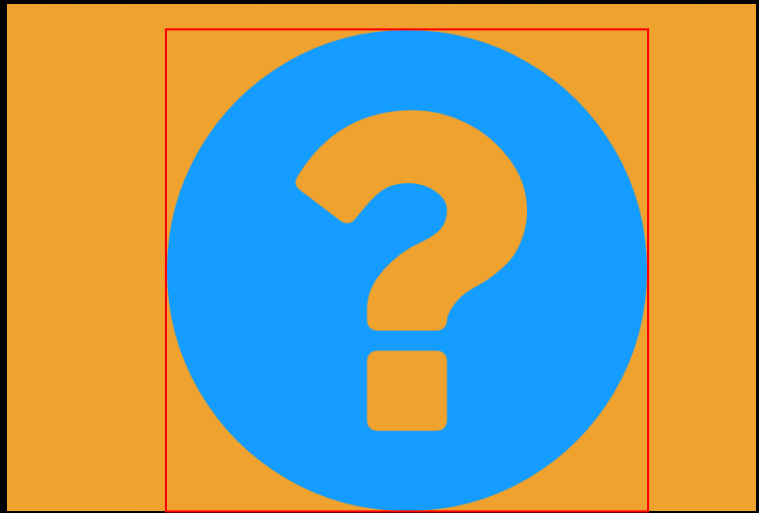
T shape.

Formed of highly vascular tela choroidea.

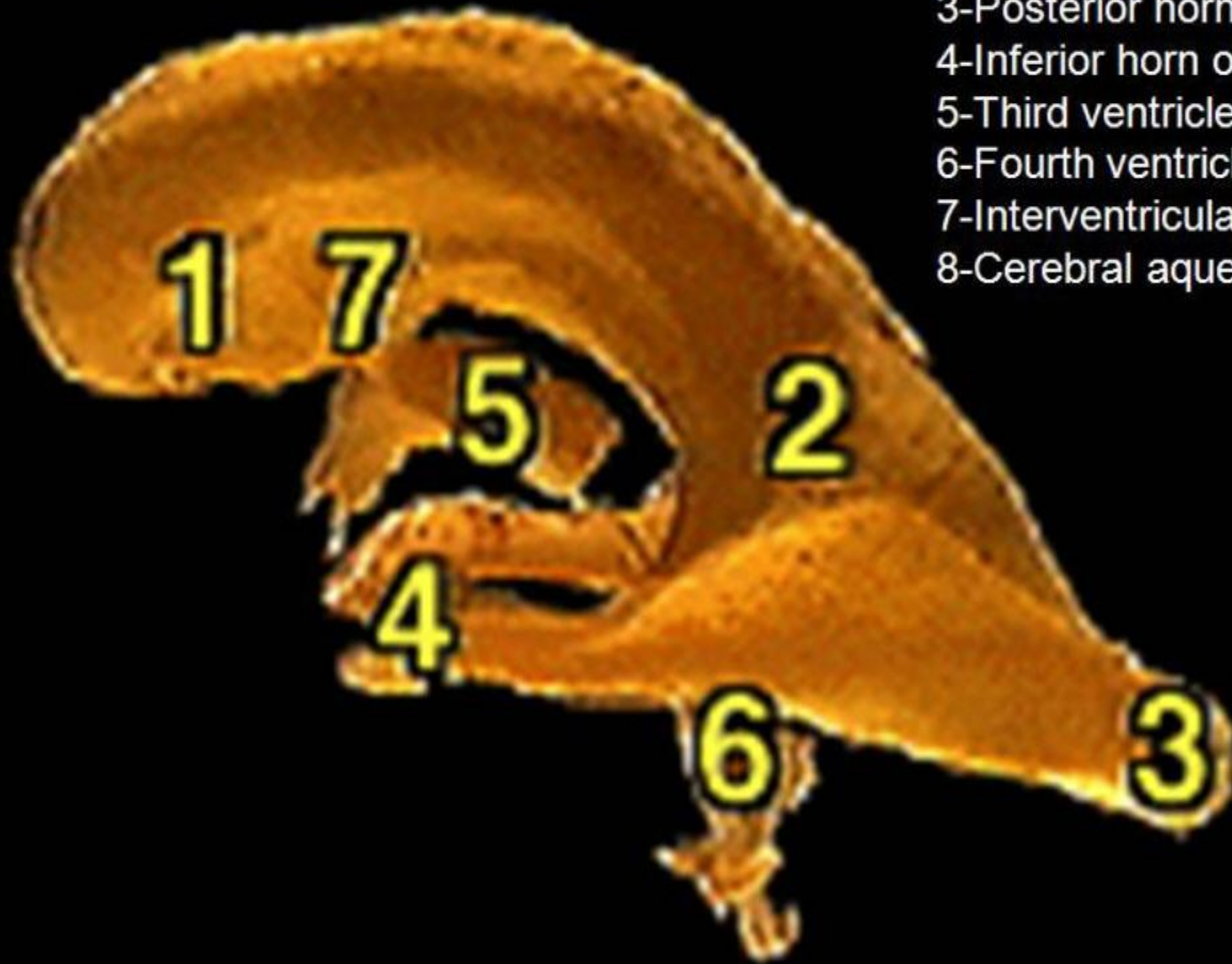
Suspended from the inferior half of the roof.

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 4th 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 3rd and 4th cranial nerves

4- Cistern of lateral fissure

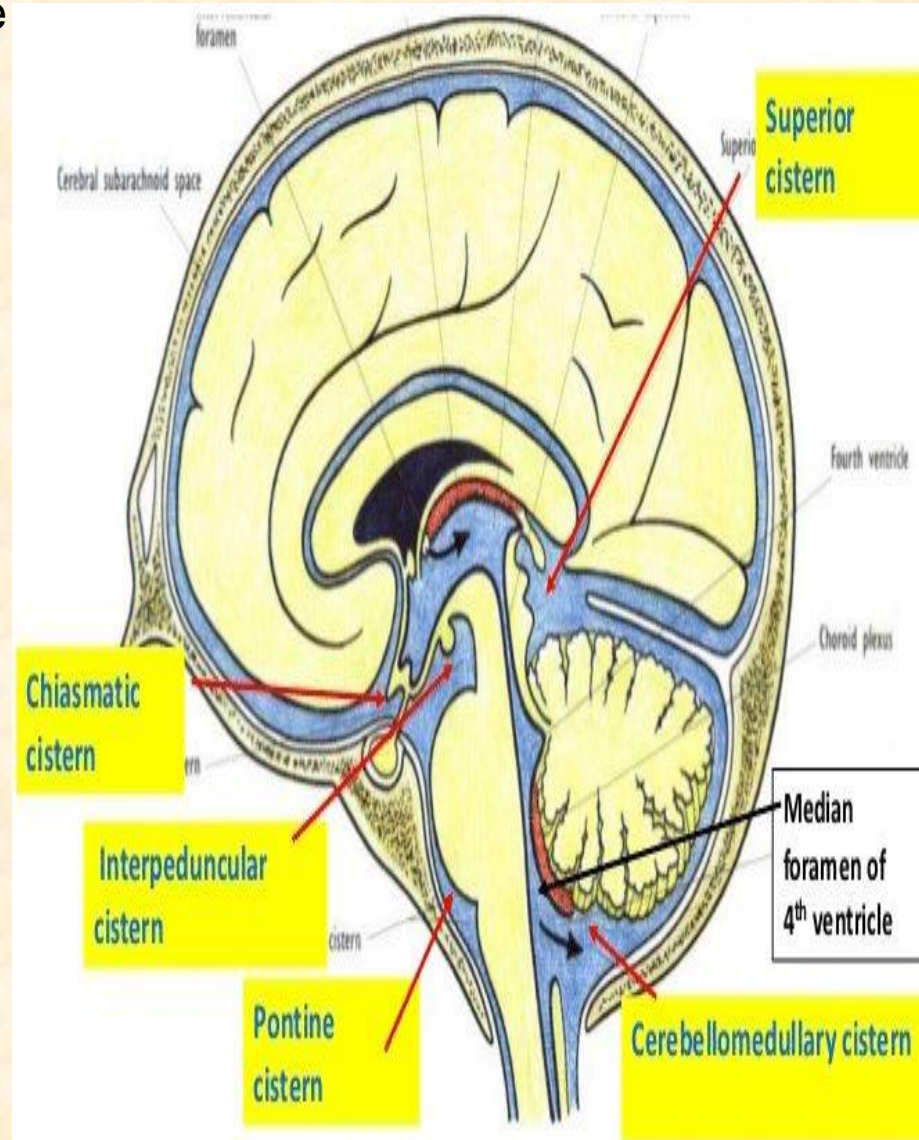
Contains the middle cerebral vessels

5- Callosal cistern

Lies above corpus callosum
Contains anterior cerebral vesseles

6- Chiasmatic cistern

Lies around optic chiasma



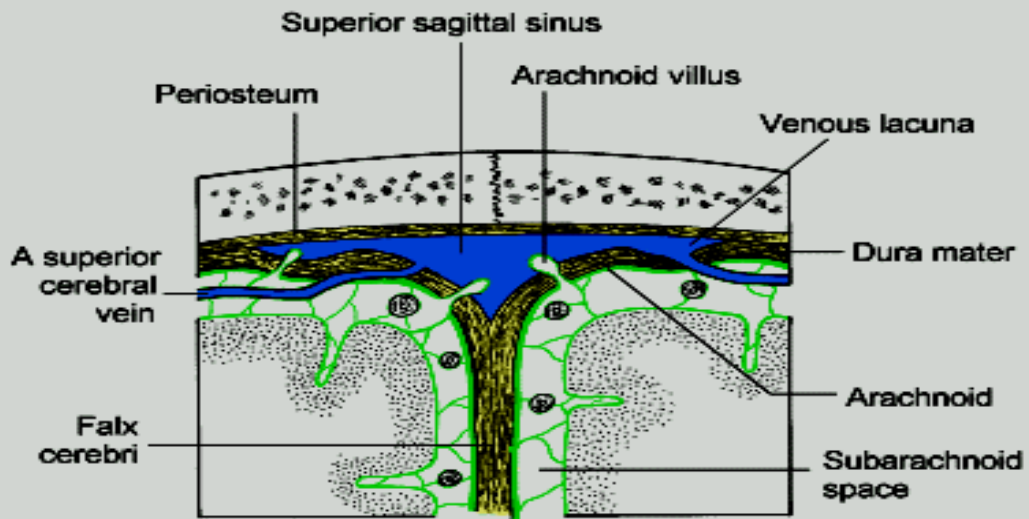
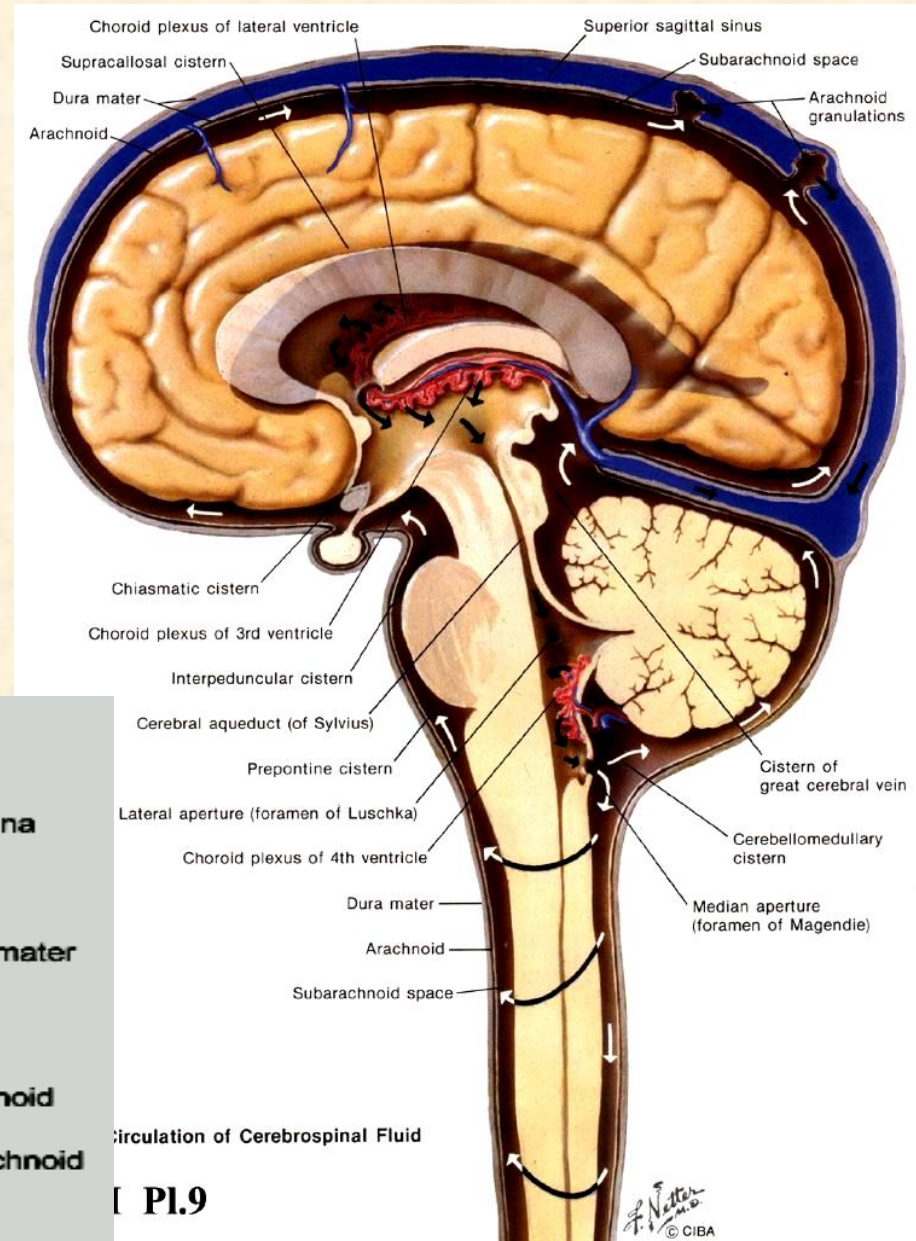
The Cerebrospinal Fluid (CSF)

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 3rd & 4th ventricles

Circulation of CSF: It circulates in the ventricles & central canals of the CNS. It leaves the lateral ventricle through interventricular foramen to the 3rd ventricle then to the 4th ventricle through cerebral aqueduct of midbrain & leaves the 4th 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

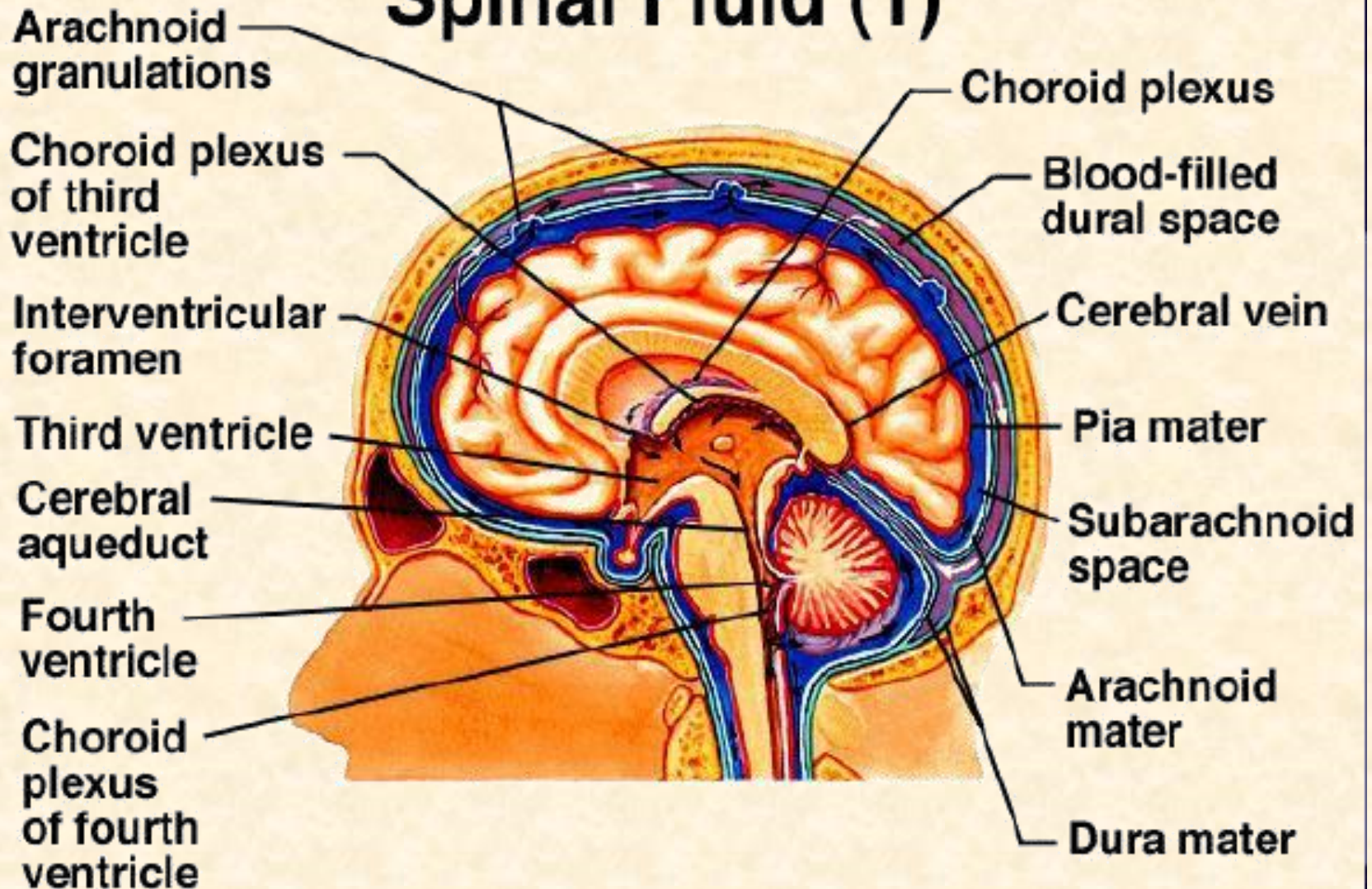
Properties

- 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

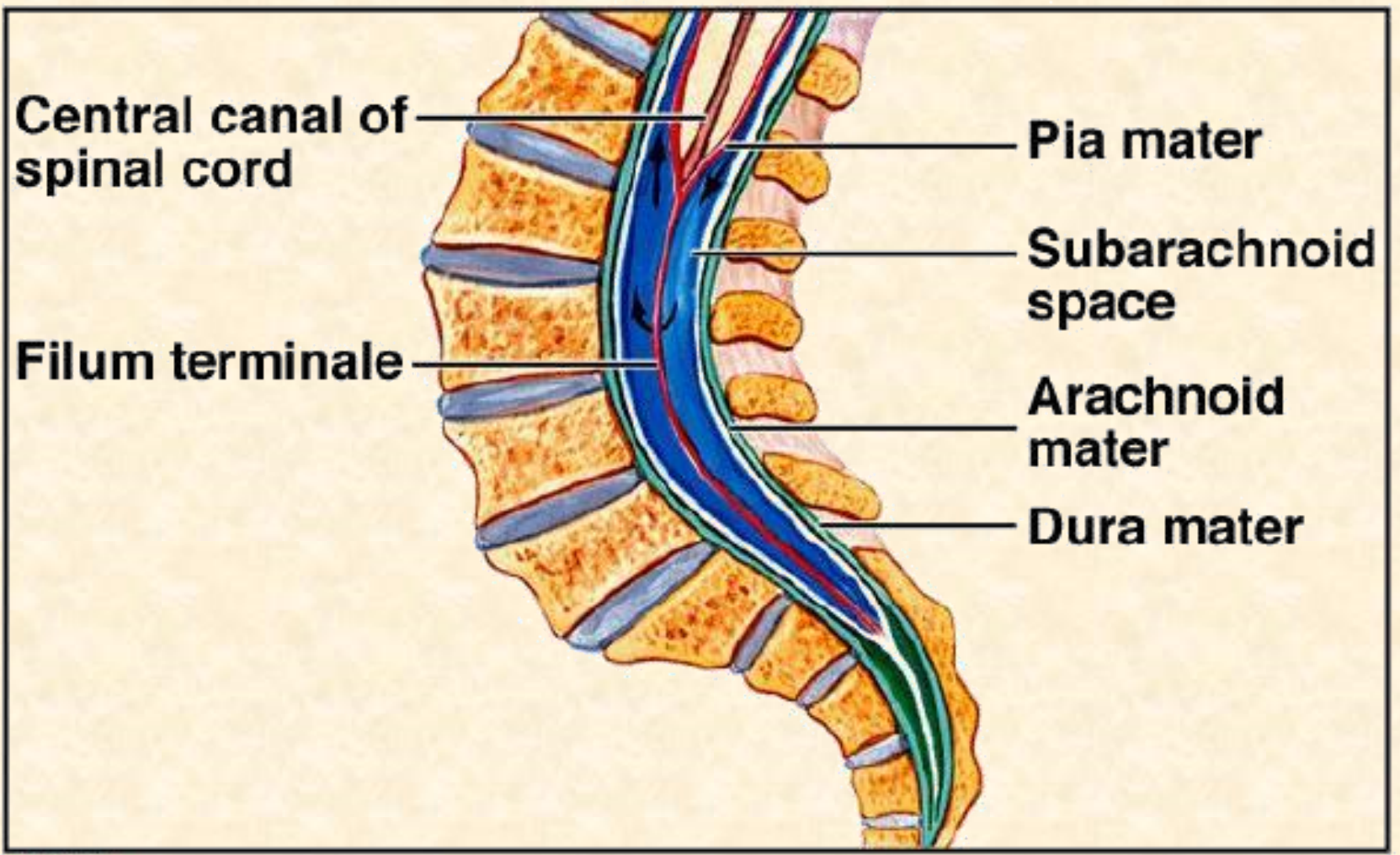
Functions

- 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

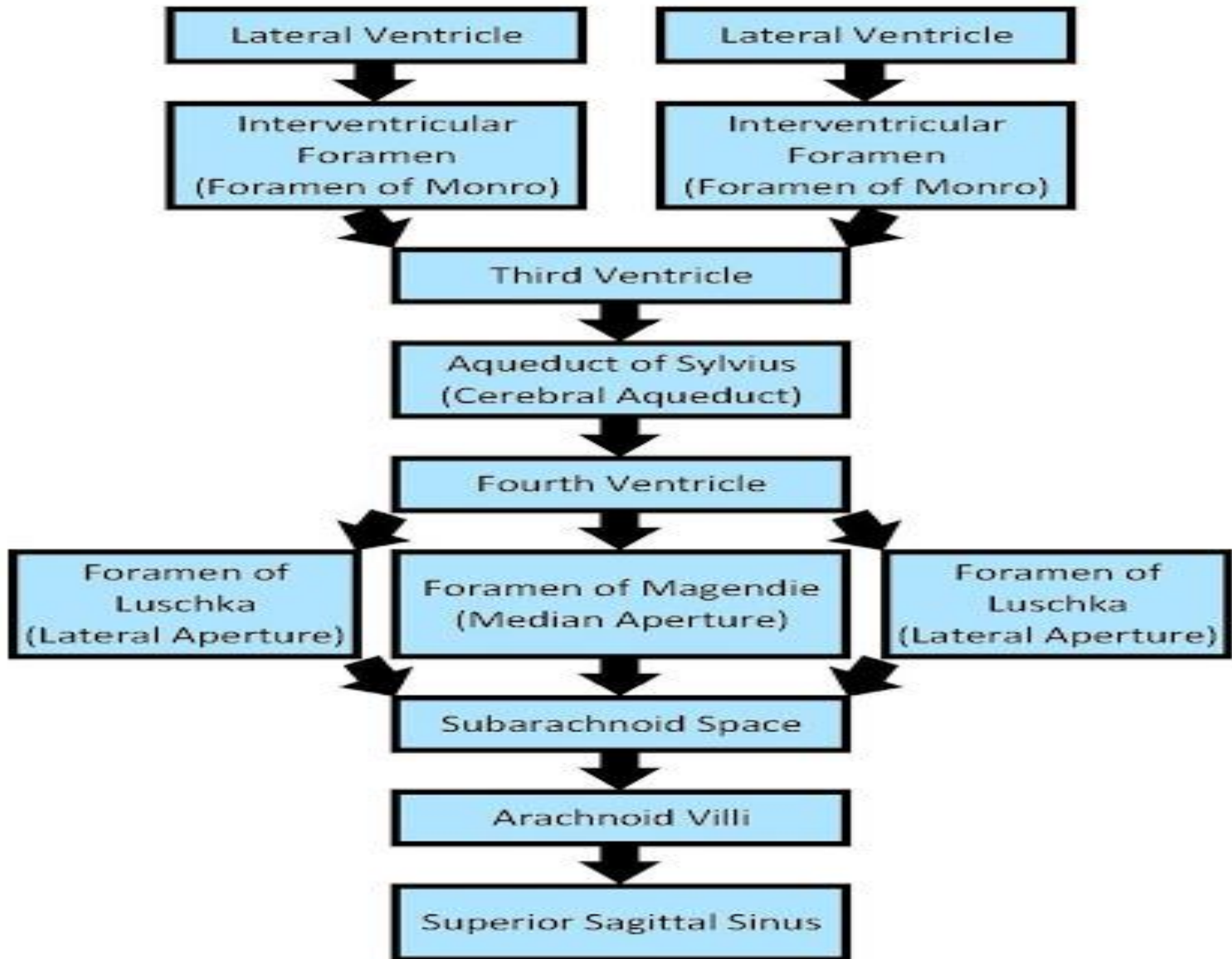
Ventricles and Cerebro Spinal Fluid (1)



Ventricles and Cerebrospinal Fluid (2)



Circulation of Cerebrospinal Fluid (CSF)



Lumbar Puncture

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

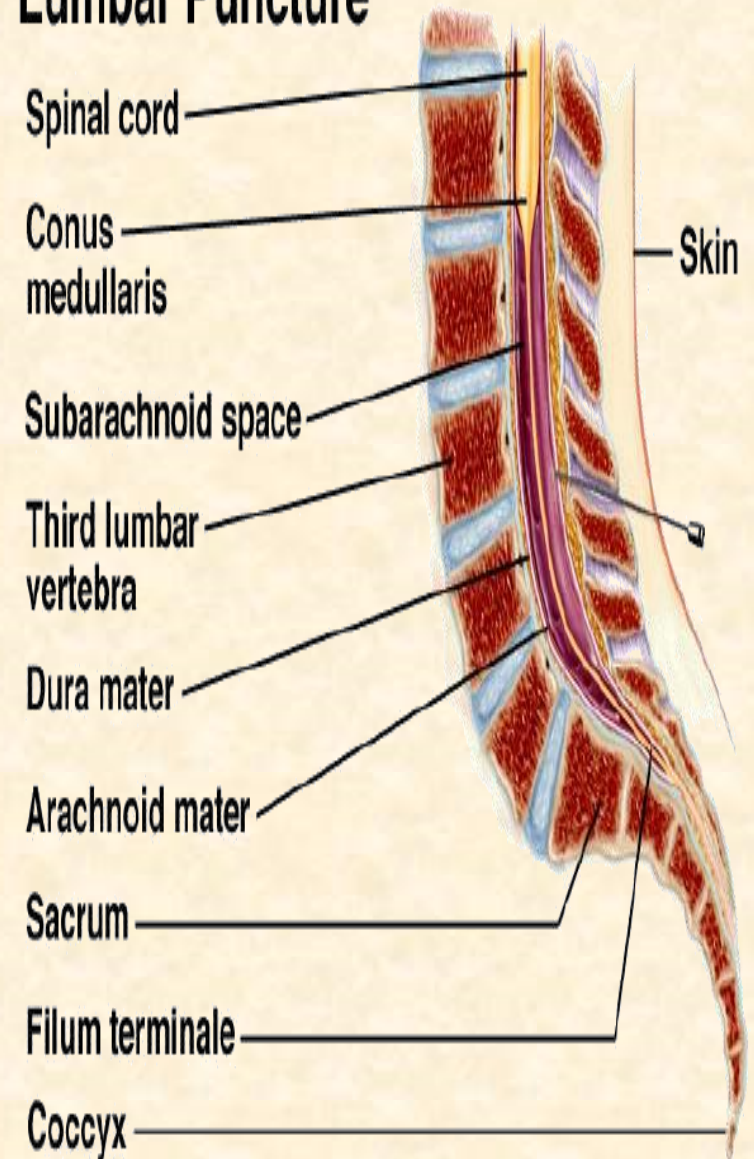
CSF is drawn by introducing a needle between the 3rd and 4th lumbar vertebrae.

(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

Lumbar Puncture



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.

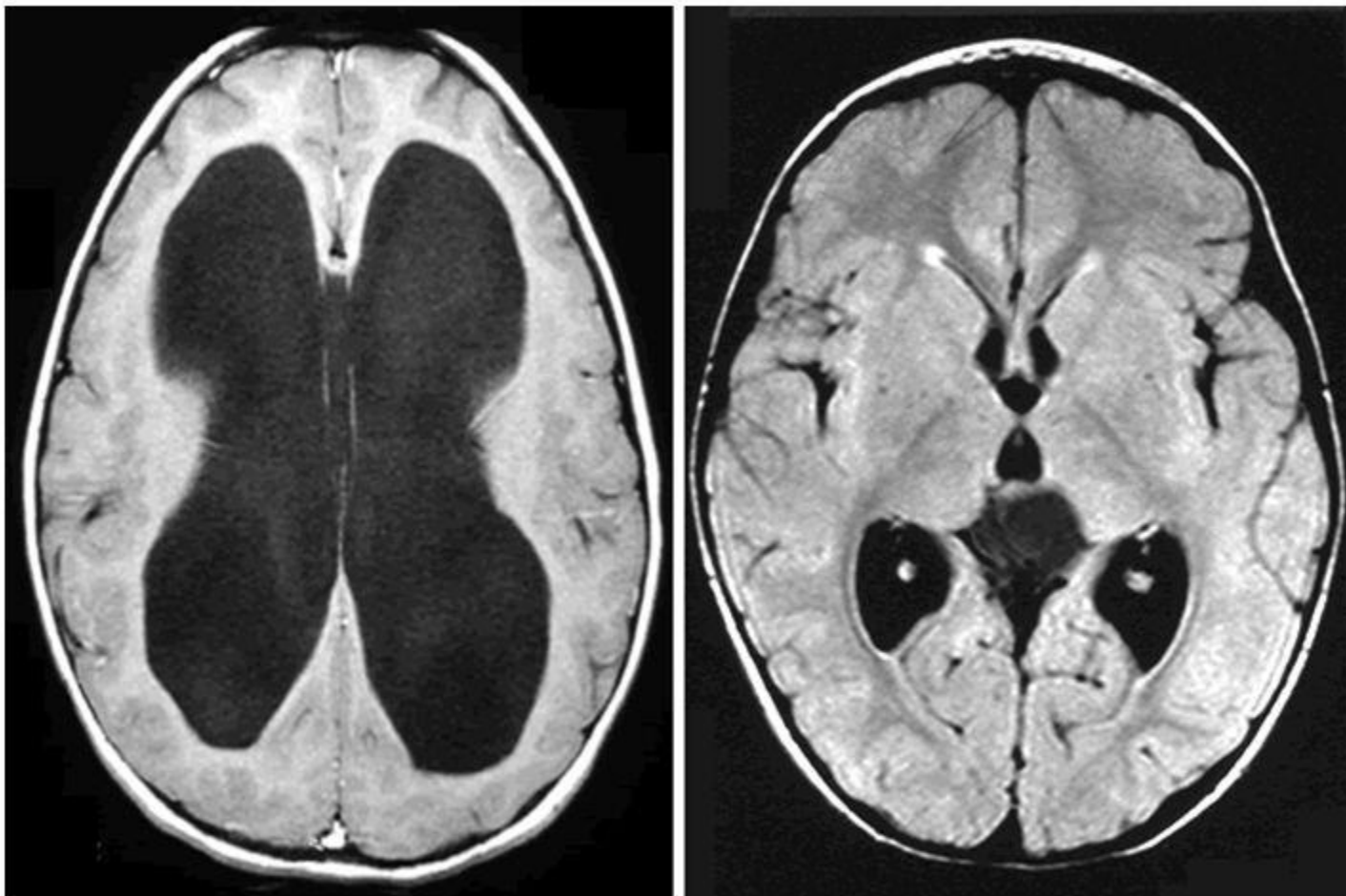
Foramen of Monro

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 4th ventricle.

Hydrocephalus vs Normal – MRI view



An MRI scan of a brain with hydrocephalus (left) and a normal MRI scan (right). The large dark area on the left is the ventricles, made bigger by a build-up of CSF

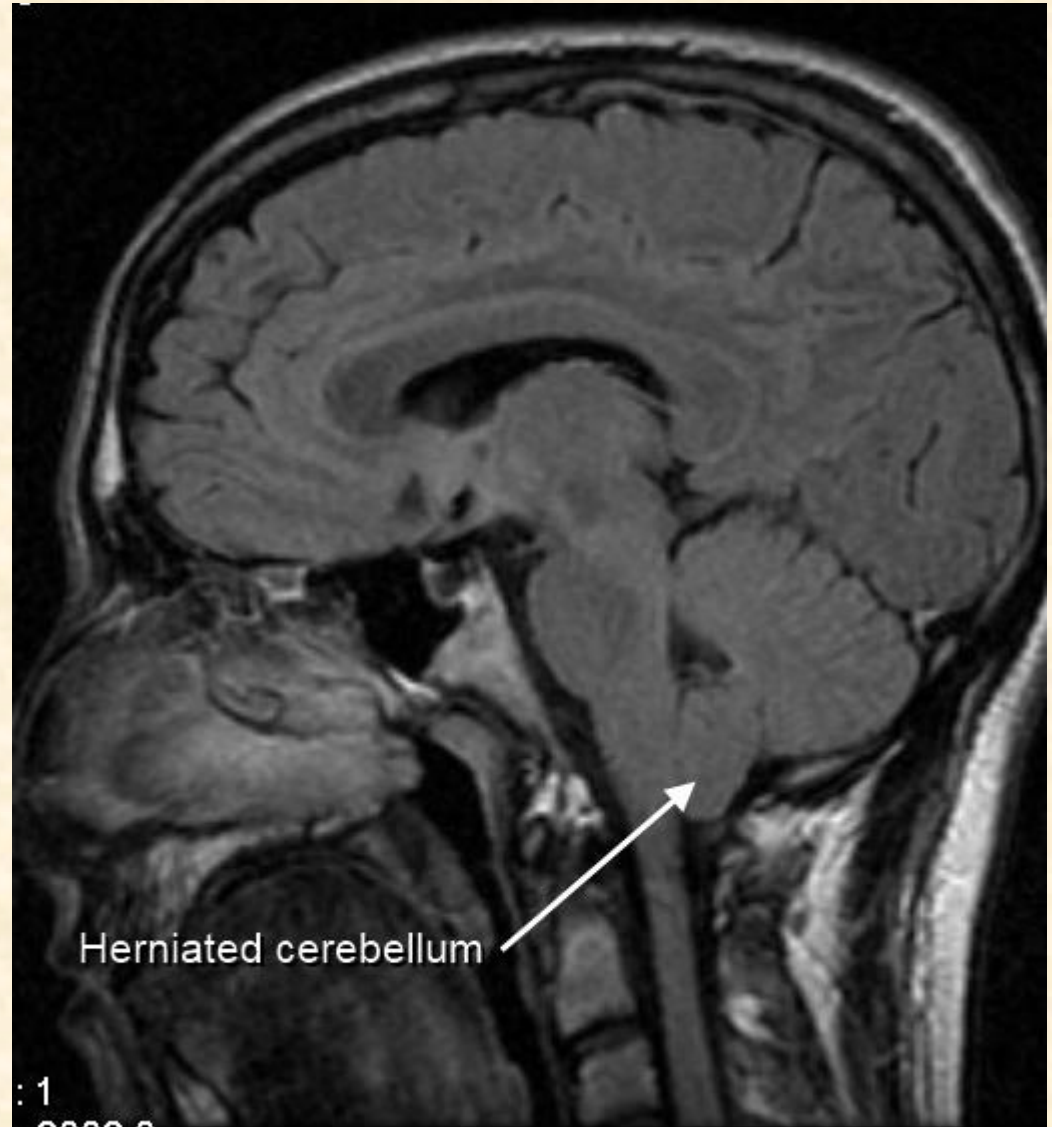
Not an exam material

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

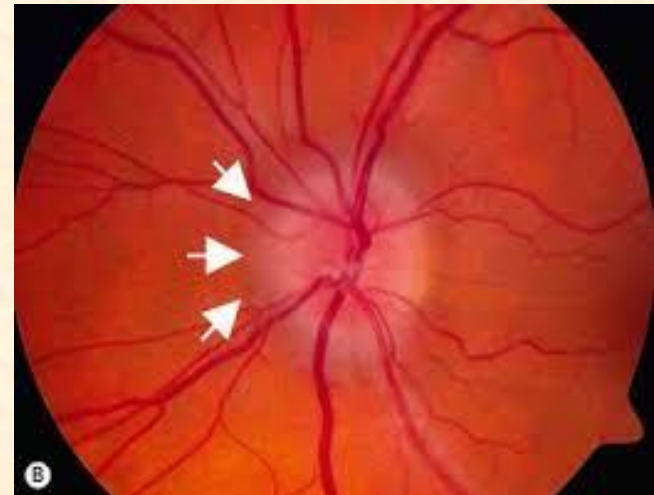
Signs&symptoms:

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.

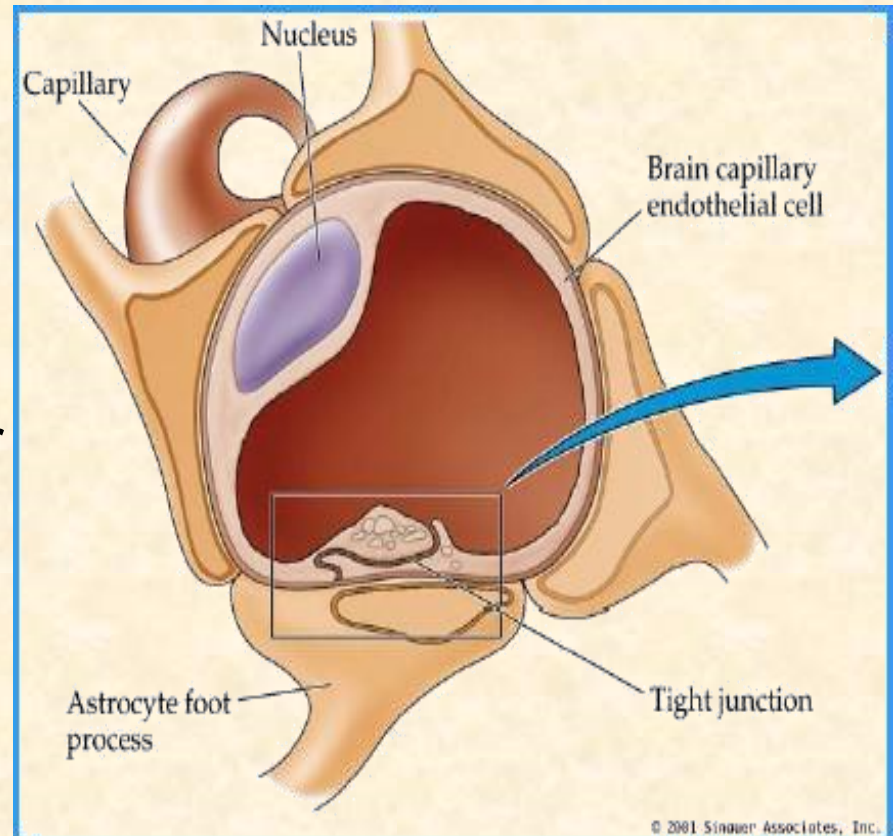


The blood brain barrier

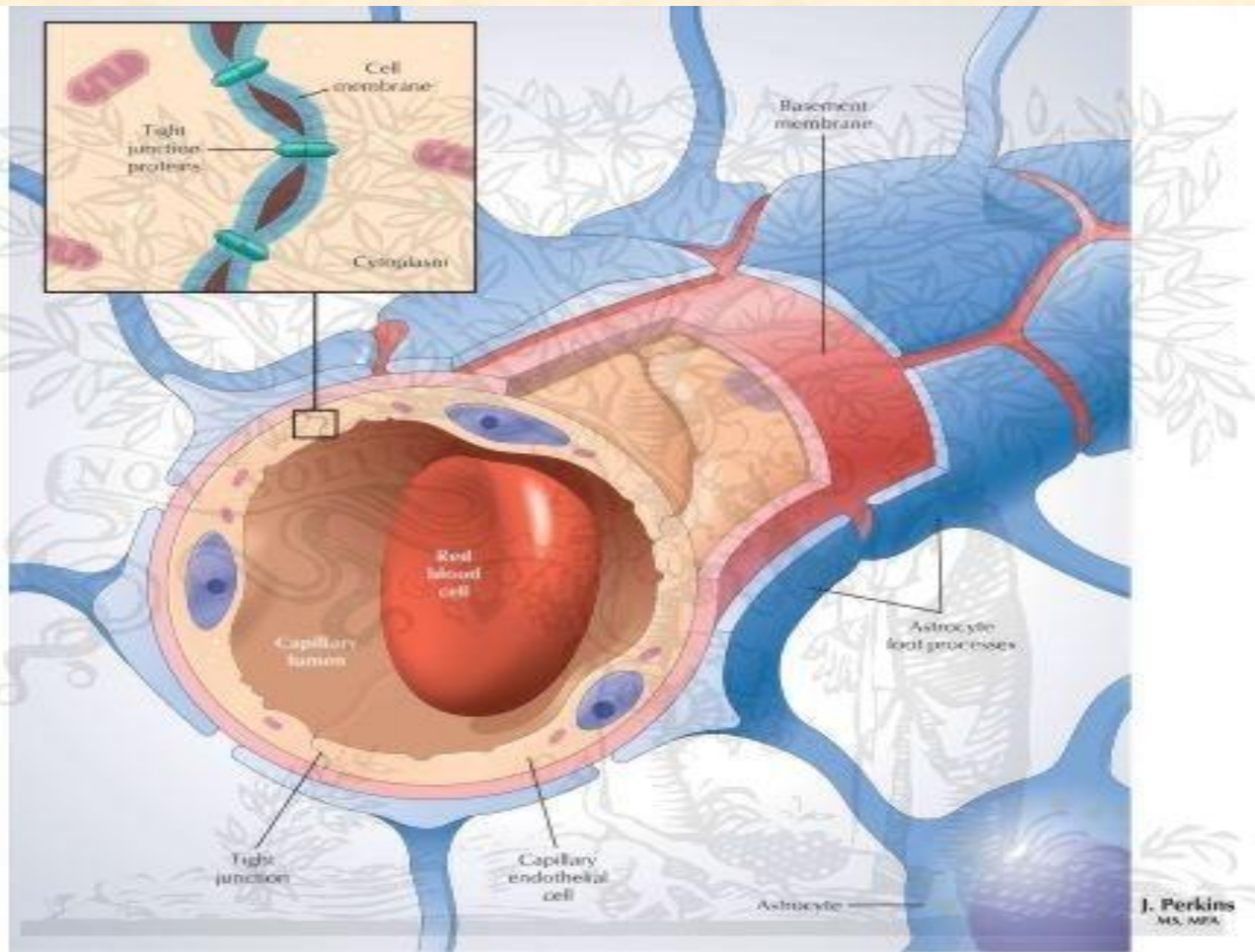
barrier present between the brain and the blood

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



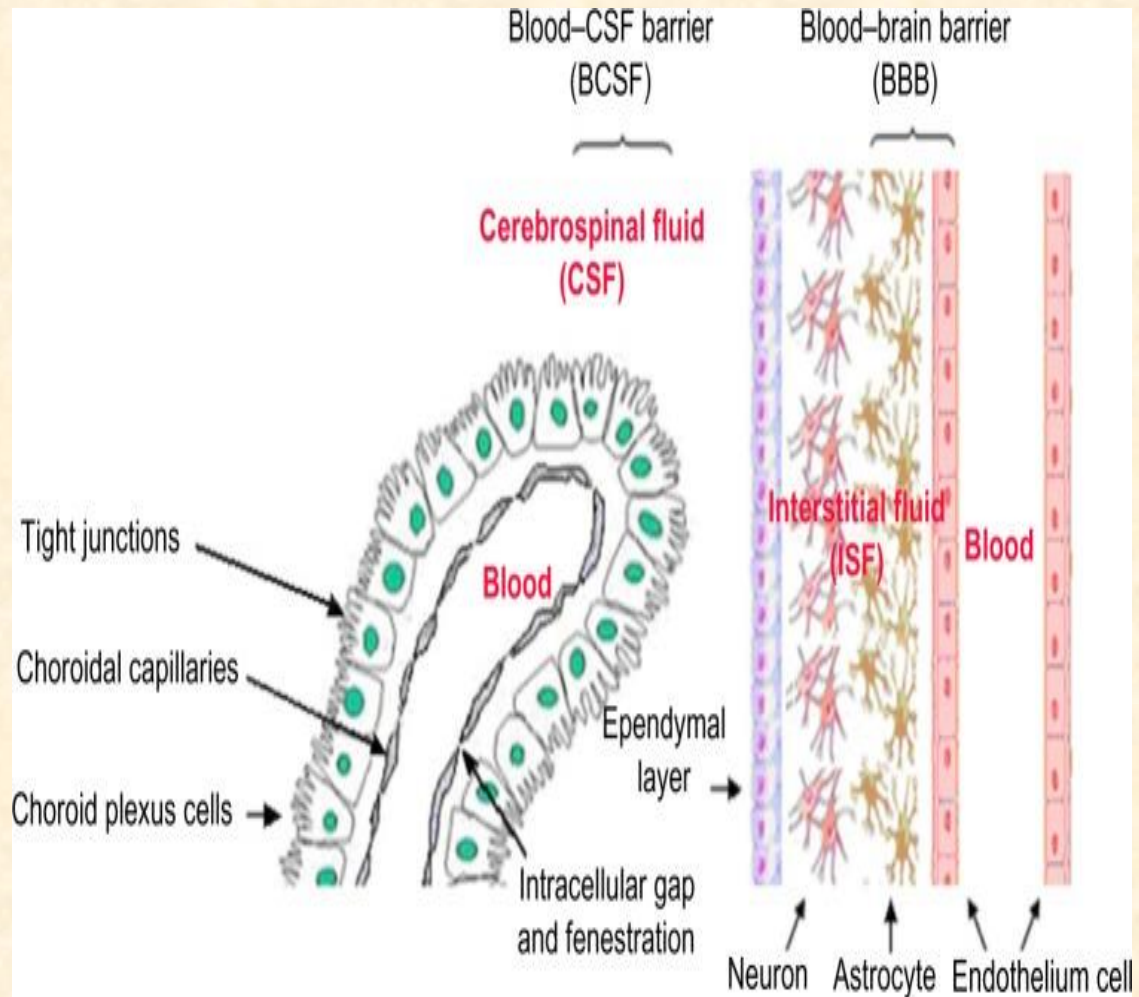
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The blood CSF barrier

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