



神經解剖學
NEUROANATOMY

VENTRICLE & CSF

 盧家鋒 助理教授

臺北醫學大學醫學系 解剖學暨細胞生物學科

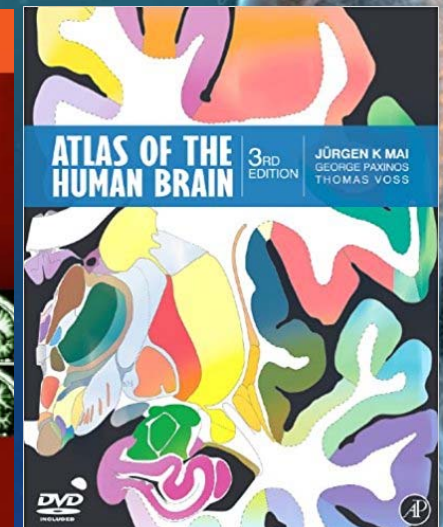
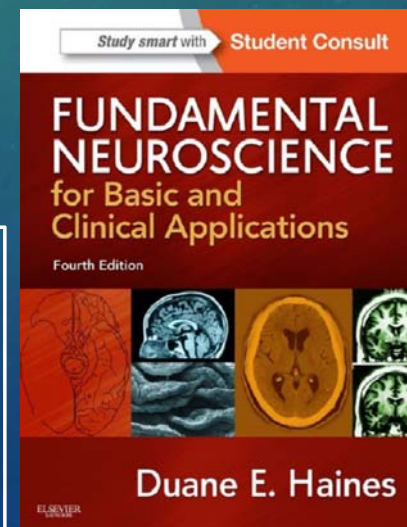
臺北醫學大學醫學院 轉譯影像研究中心

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OUTLINE

- Ventricle and Choroid Plexus
- Hydrocephalus and Related Conditions

- **Fundamental Neuroscience (4th edition)**
 - Chapter 6: The Ventricles, Choroid Plexus, and Cerebrospinal Fluid
- **Atlas of the Human Brain (3rd edition)**

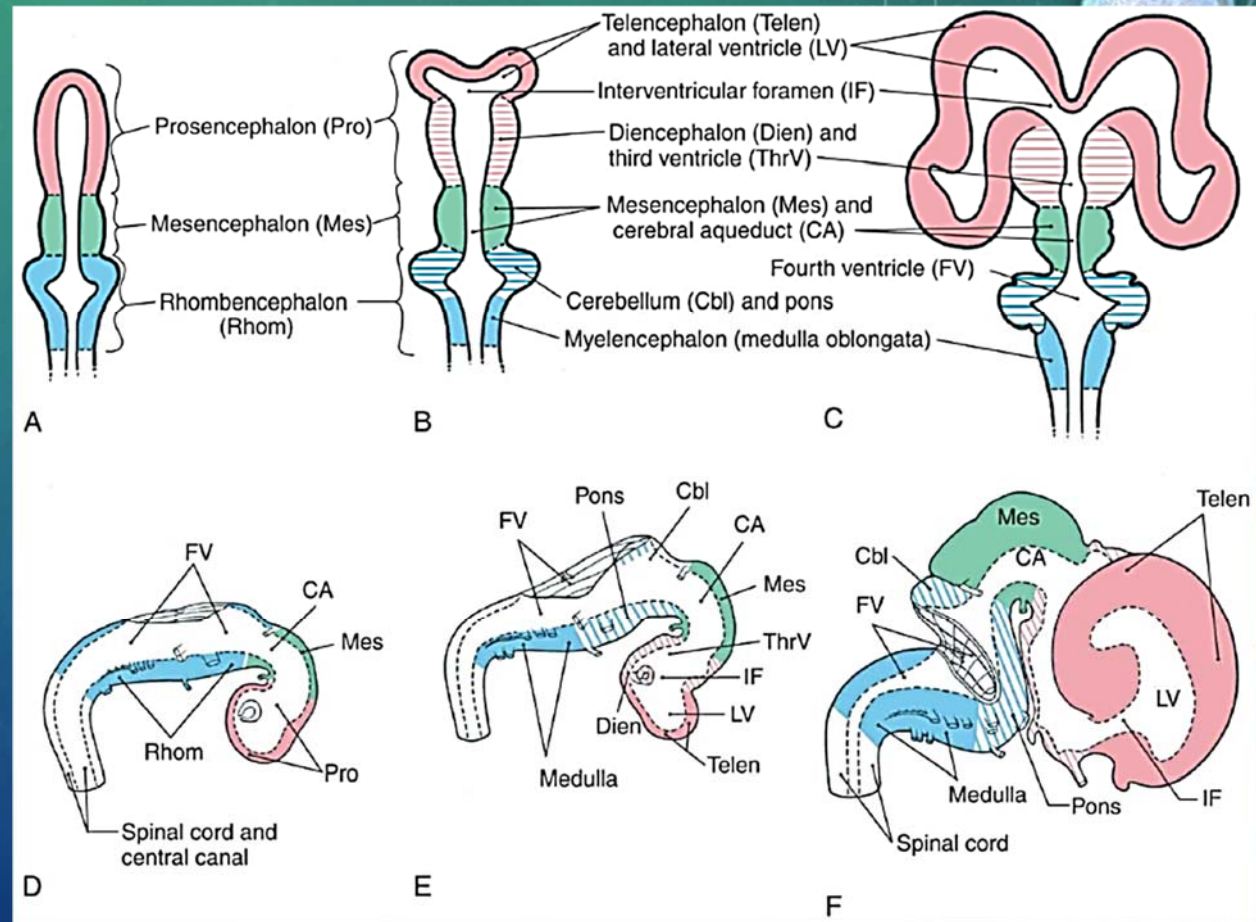


VENTRICLE AND CHOROID PLEXUS



DEVELOPMENT OF VENTRICLE

- By about the third week of development, the nervous system consists of a tube closed at both ends and somewhat hook shaped rostrally.
- The cavity of this tube, the **neural canal**, eventually gives rise to the **ventricles** of the adult brain and the **central canal** of the spinal cord.



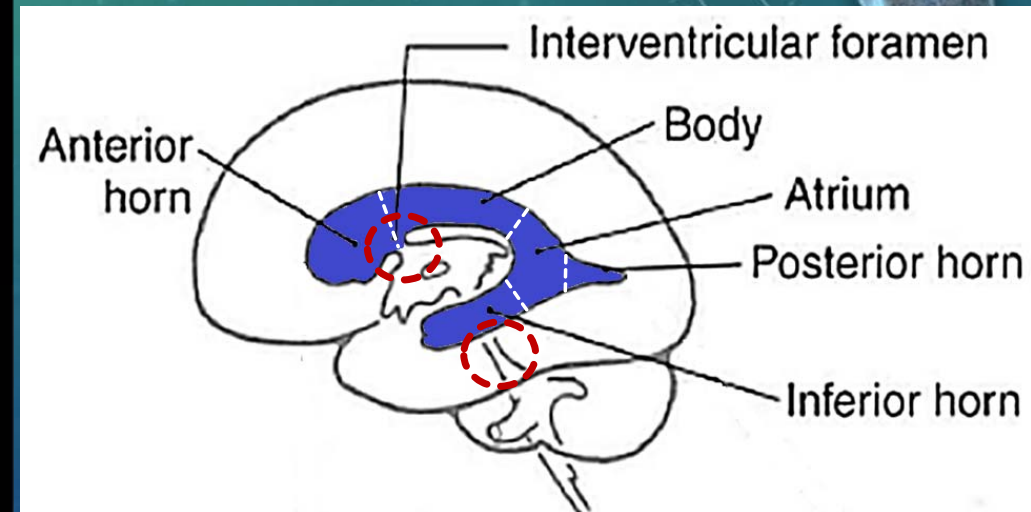
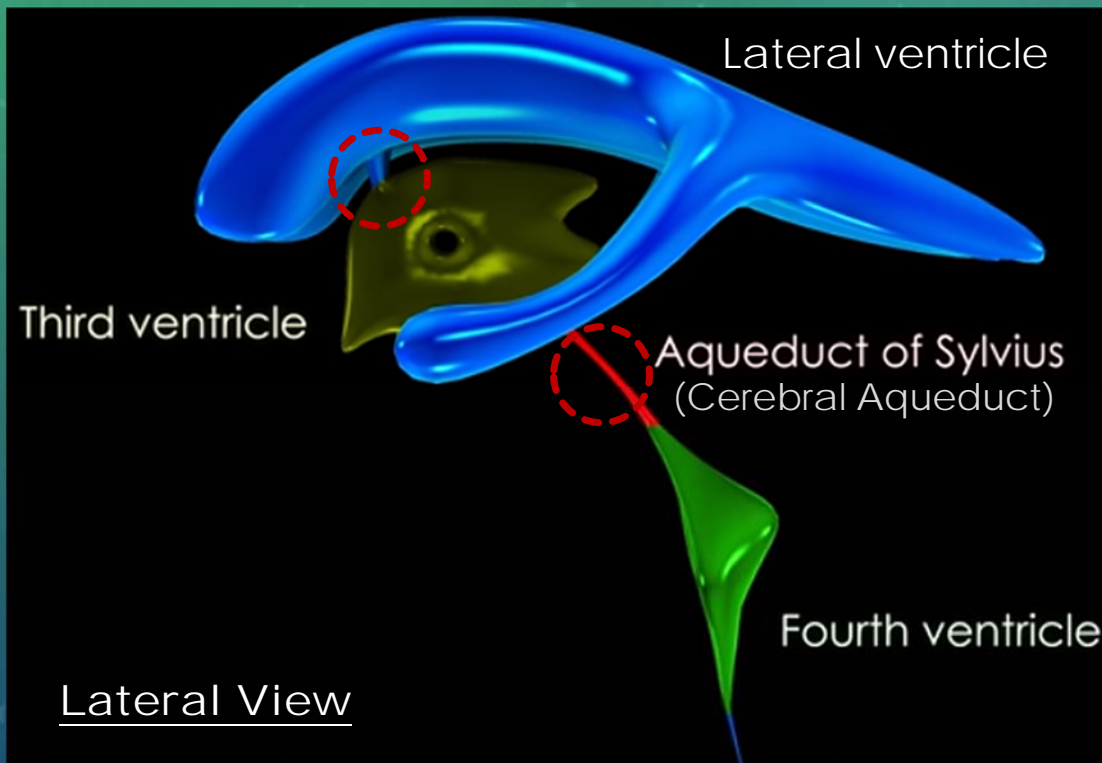
OVERVIEW

Two circulation compartments:

- Ventricles
- Subarachnoid space

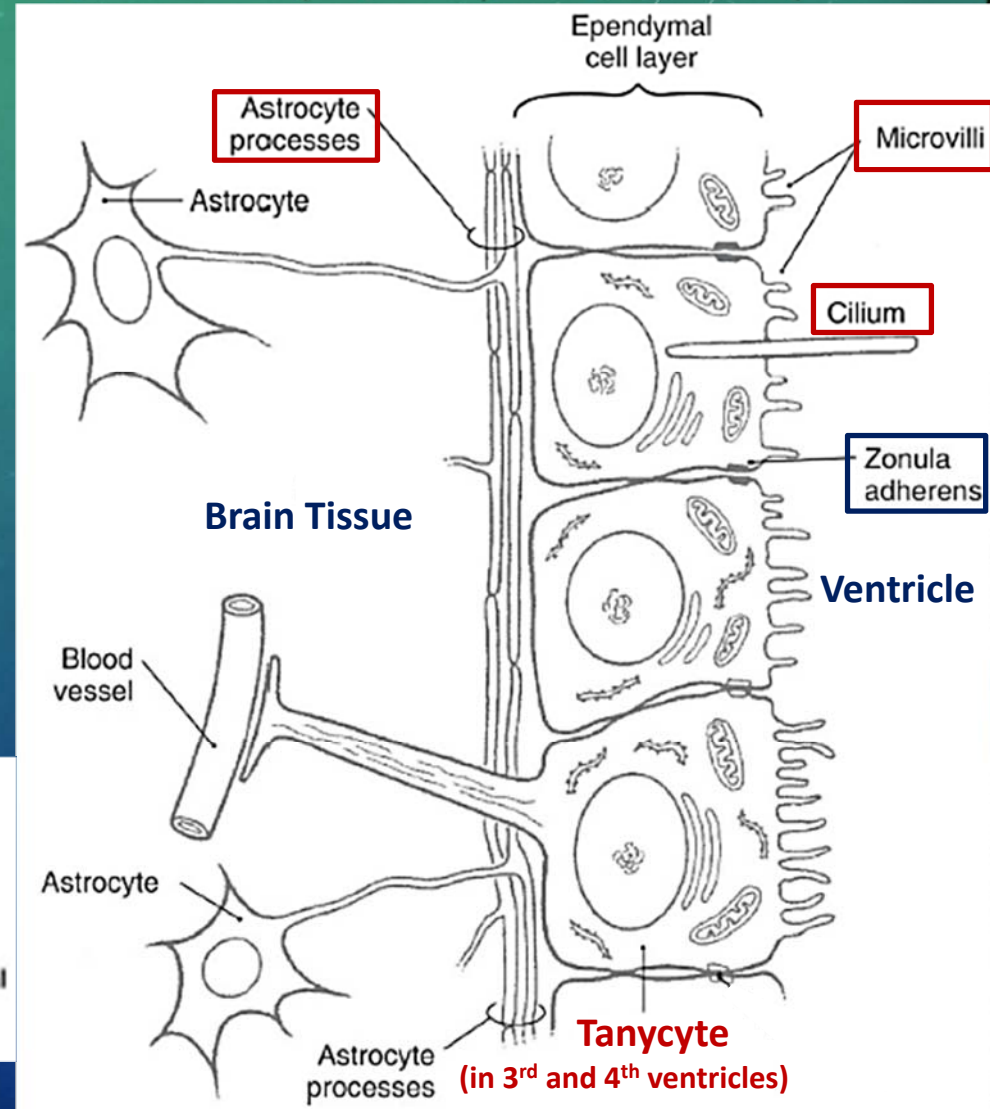
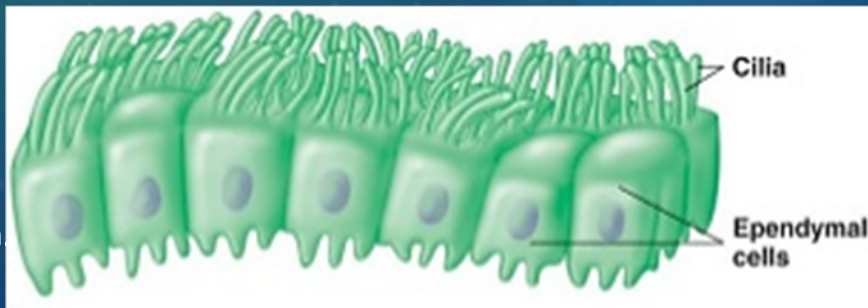


VENTRICLES



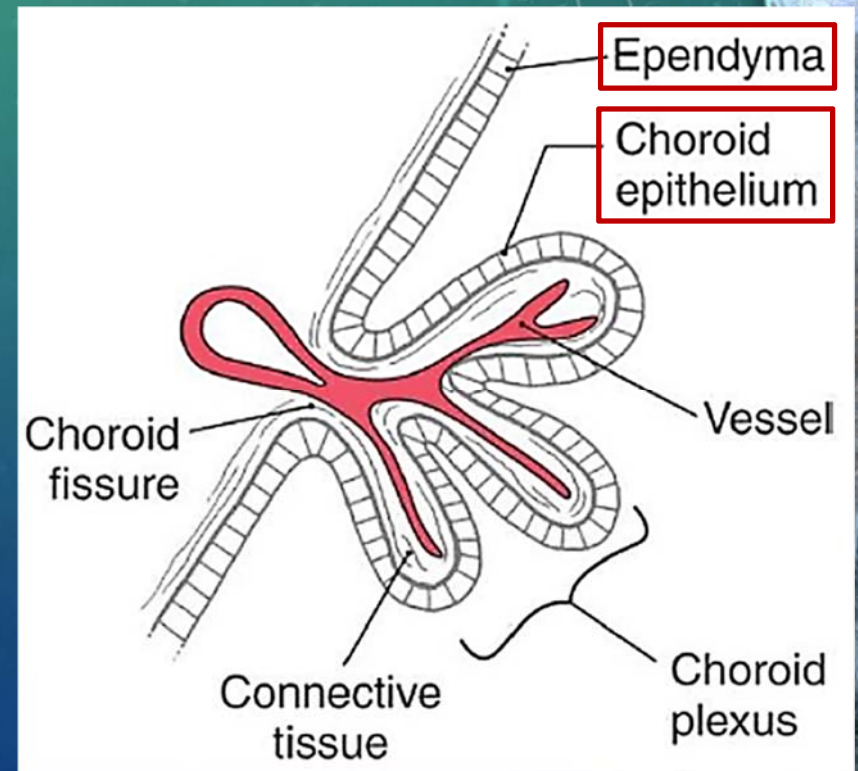
Ependyma

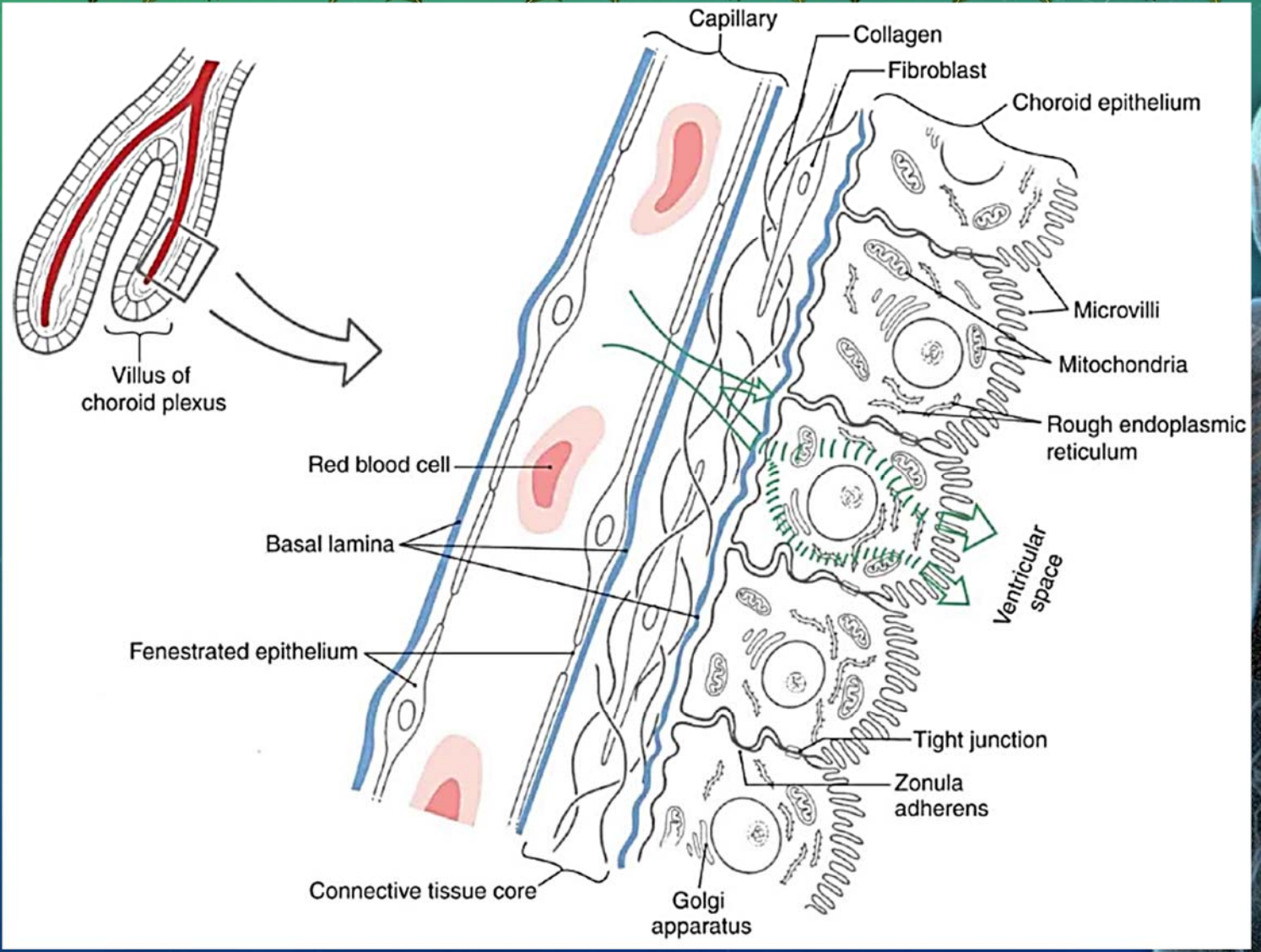
- The ventricles of the brain and the central canal of the spinal cord are lined by a simple cuboidal epithelium, the **ependyma**.
- Ependymal cells contain **abundant mitochondria** and are metabolically active.
- **Cilia** help move cerebrospinal fluid thru the cavities of the brain.



CHOROID PLEXUS

- Choroid epithelium (modified ependymal cells)
- Each is attached to its neighbor by continuous **tight junctions** that seal off the subjacent extracellular space from the ventricular space to form the **blood-CSF barrier**.
- They are specialized to control the flow of ions and metabolites into the CSF.
 - Diffusion and active transport from the arterial blood supplies.

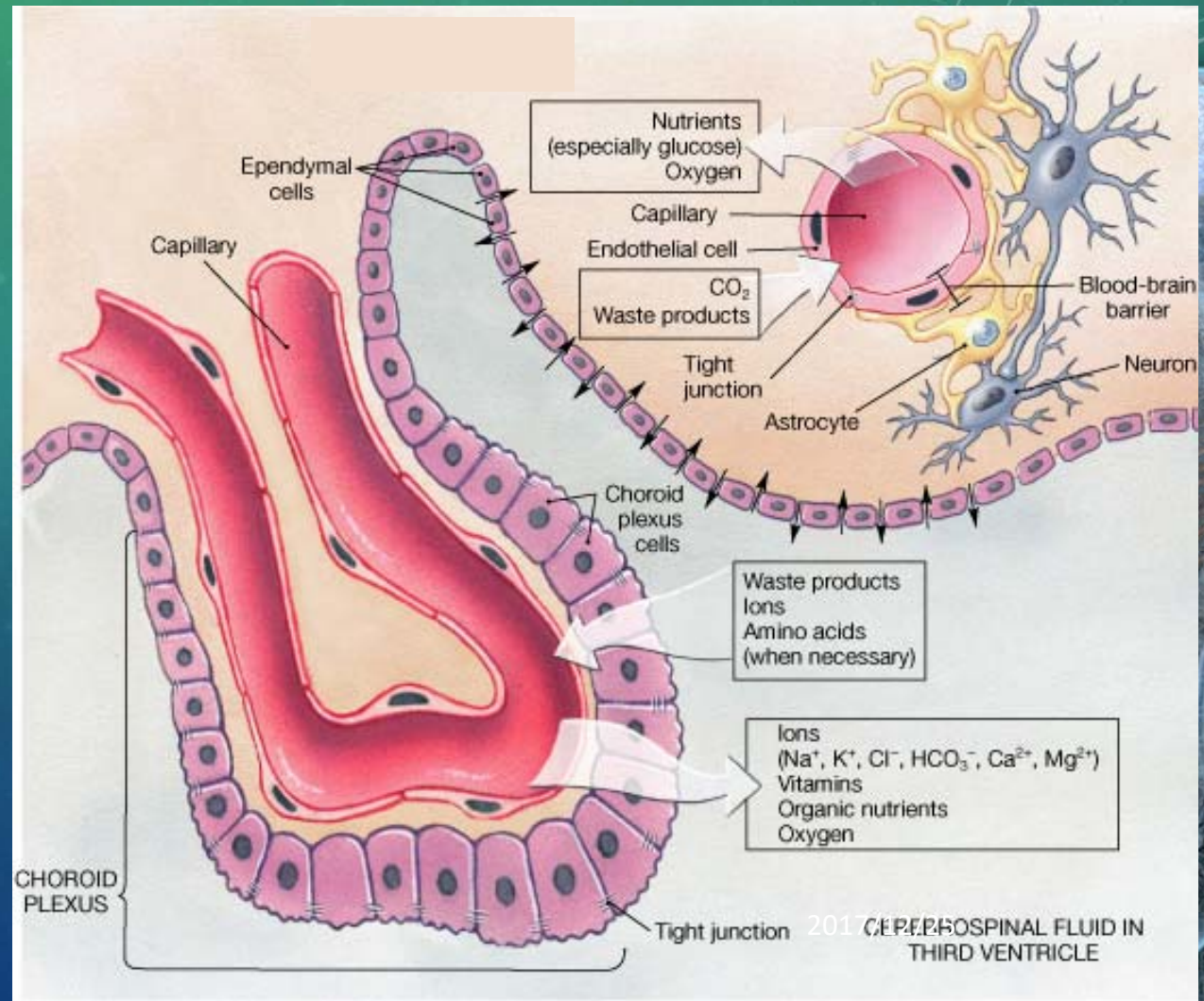




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CHOROID PLEXUS



<http://jonlieffmd.com/blog/the-very-intelligent-choroid-plexus-epithelial-cell>

CONSTITUENTS OF CSF

- Normal CSF is clear and colorless and contains very little protein, little immunoglobulin, and only one to five cells (leukocytes) per milliliter.

	CSF	PLASMA
Chloride	125.0 mEq/L	100.0 mEq/L
Magnesium	2.3 mEq/L	1.9 mEq/L
Sodium	143.0 mEq/L	138.0 mEq/L
Creatinine	1.1 mg/dL	1.2 mg/dL
Potassium	2.9 mEq/L	4.5 mEq/L
Calcium	2.4 mEq/L	5.0 mEq/L
Glucose	50.0 mg/dL	80.0 mg/dL
Proteins	34.0 mg/dL	6500.0 mg/dL
Albumin	155.0 mg/L	35,000.0 mg/L
Uric acid	0.7 mg/dL	4.0 mg/dL

*These are general averages that approximate the center of a range.





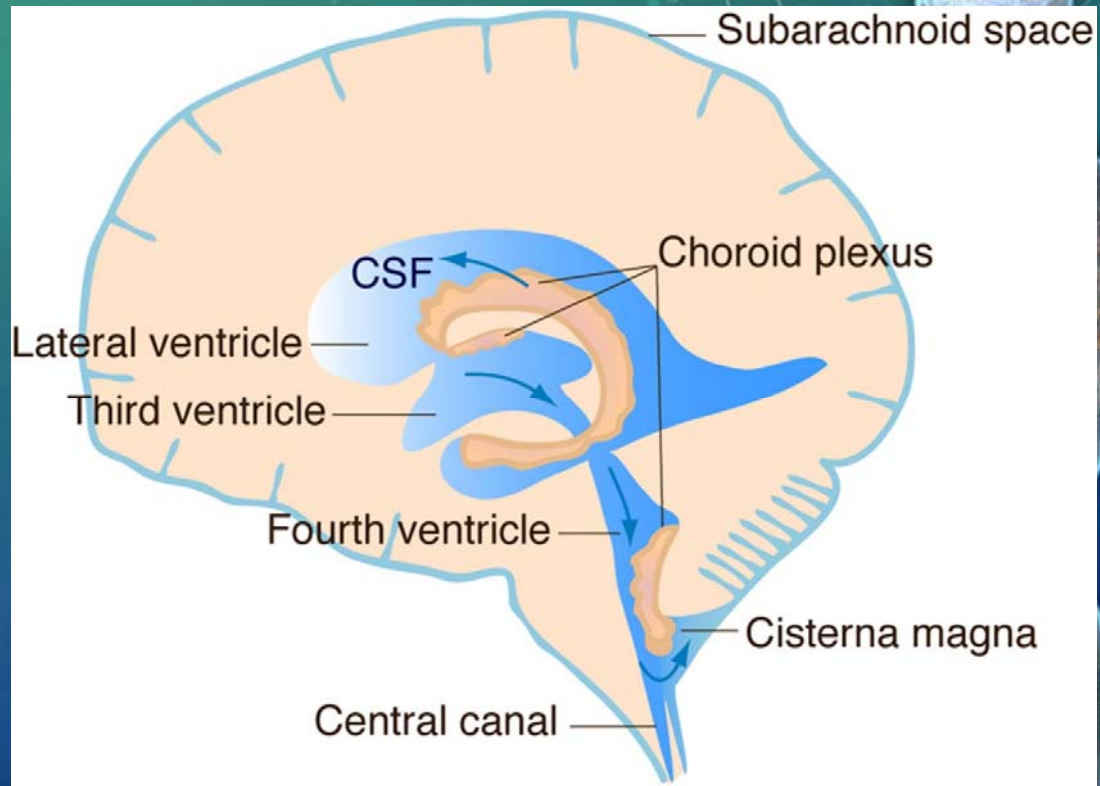
BLOOD SUPPLY TO THE CHOROID PLEXUS

- **Anterior choroidal artery** (a branch of the internal carotid) and **lateral posterior choroidal artery** (a branch of P2)
 - choroid plexus in the inferior horn, atrium of the lateral ventricle, and body of the lateral ventricle.
- **Medial posterior choroidal artery** (also a branch of P2)
 - choroid plexus of the third ventricle.
- **Posterior inferior cerebellar arteries**
 - choroid plexus located inside the fourth ventricle.

CHOROID PLEXUS

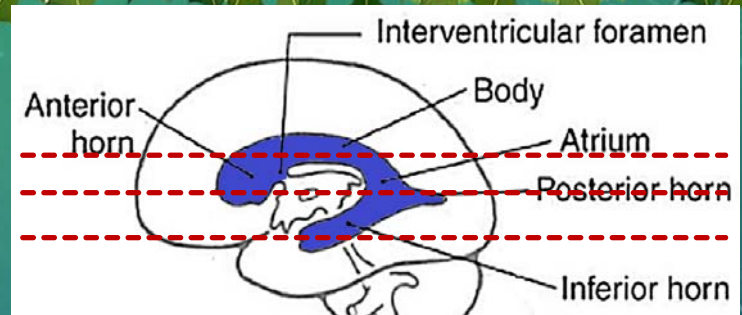
Locations:

- extends from the inferior horn of the lateral ventricle into the atrium along the floor of the body of the **lateral ventricle**.
- continues through the **interventricular foramen**, and attaches to the roof of the **third ventricle**.
- Attaches the caudal roof of the **fourth ventricle** and extends laterally into the lateral apertures.



LATERAL VENTRICLES - MRI

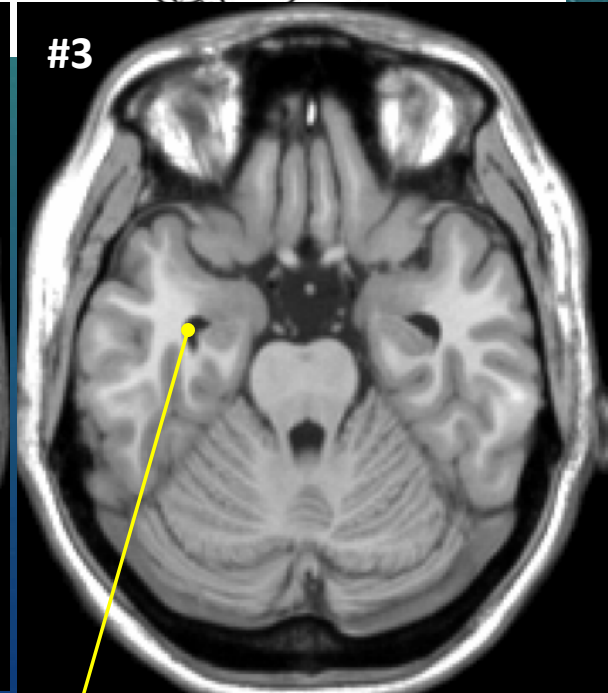
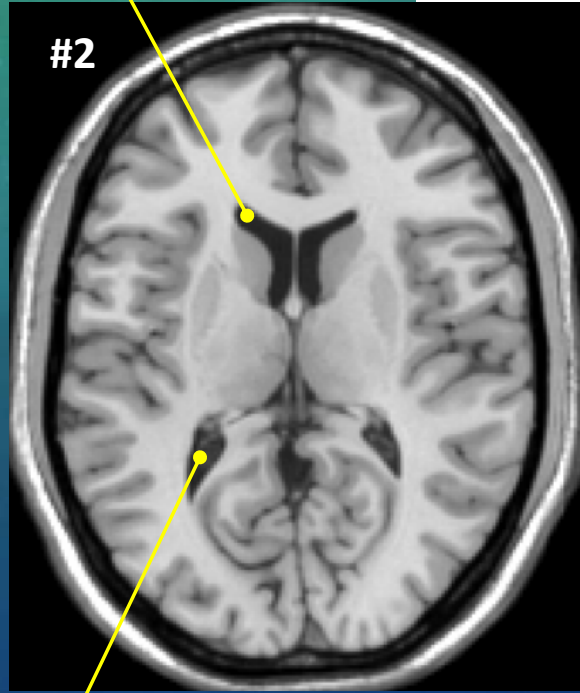
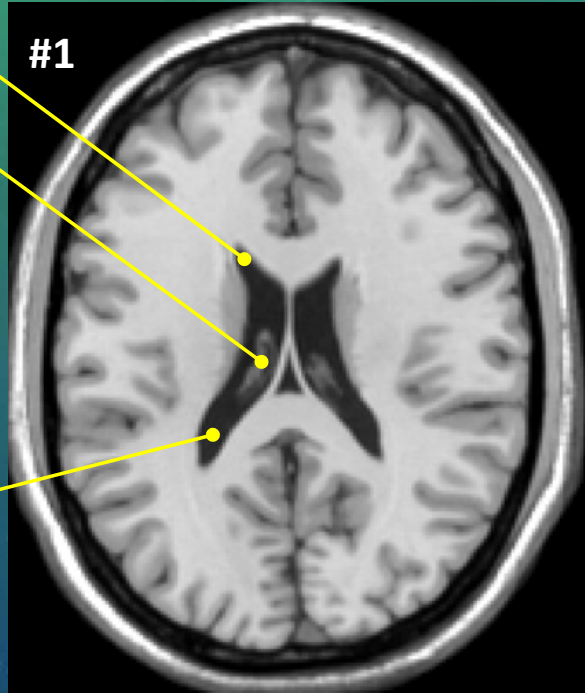
#1
#2
#3



Anterior horn of lateral ventricle

Choroid plexus

Atrium of lateral ventricle



Posterior horn of lateral ventricle

Inferior horn of lateral ventricle

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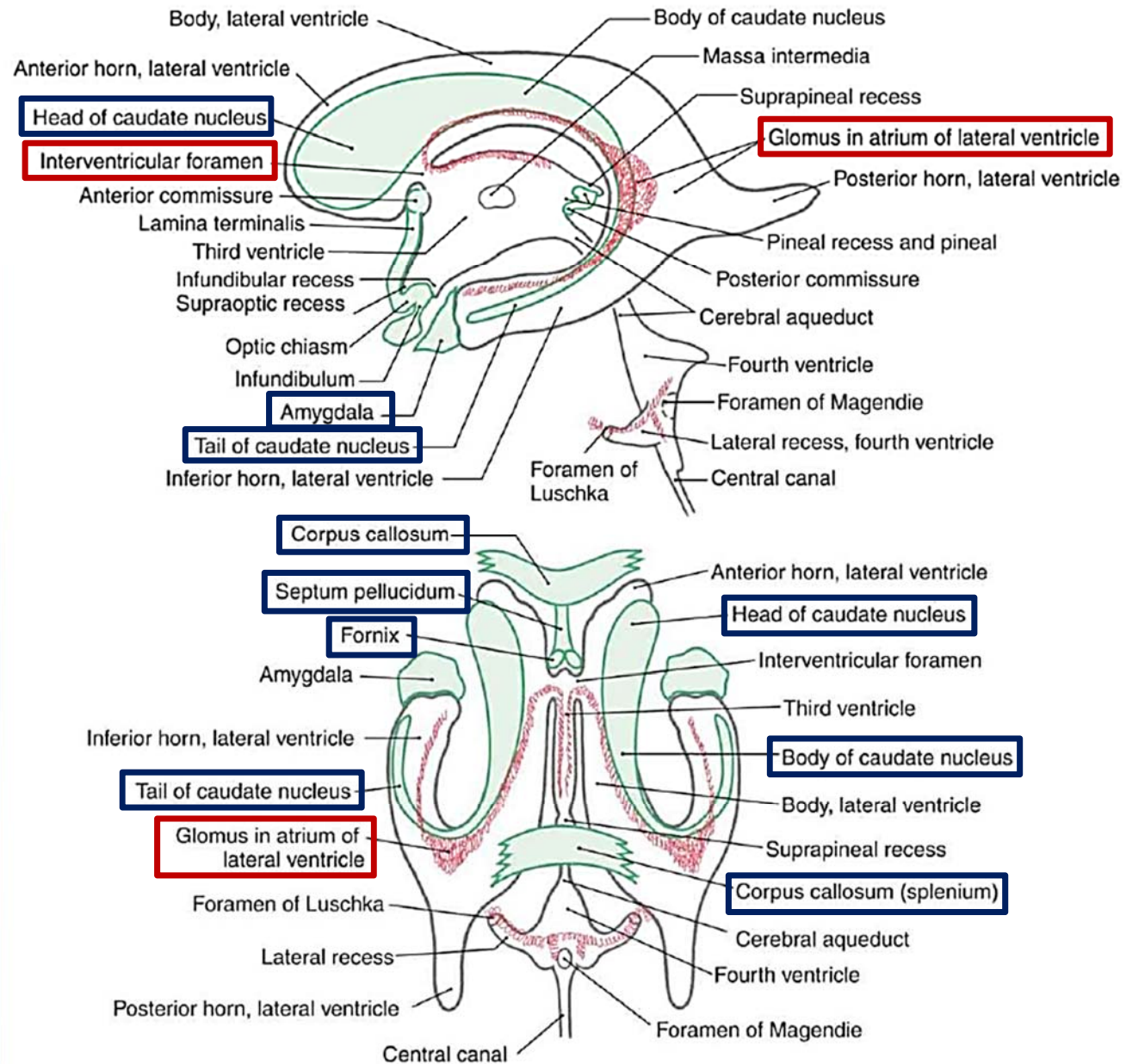
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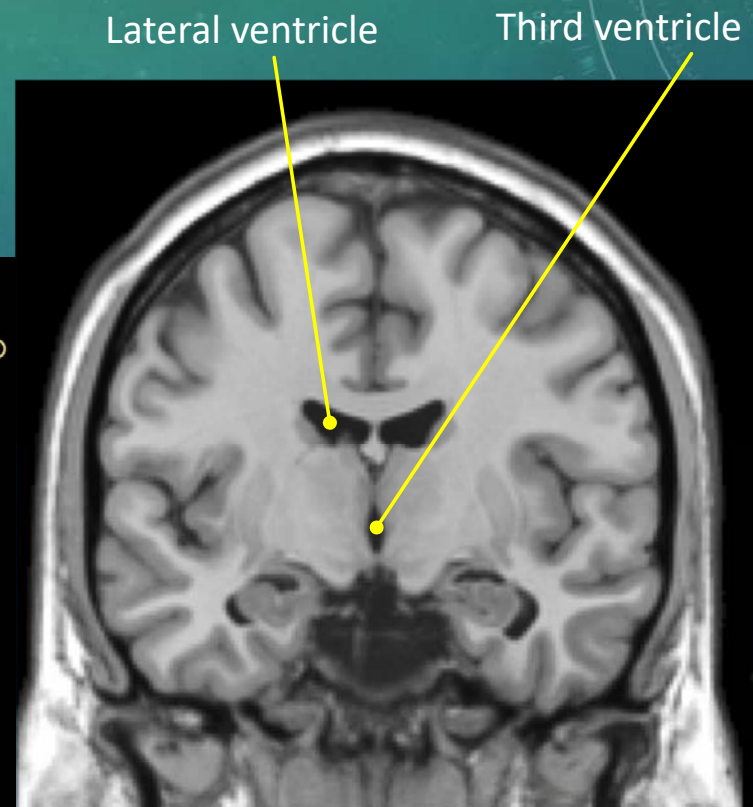
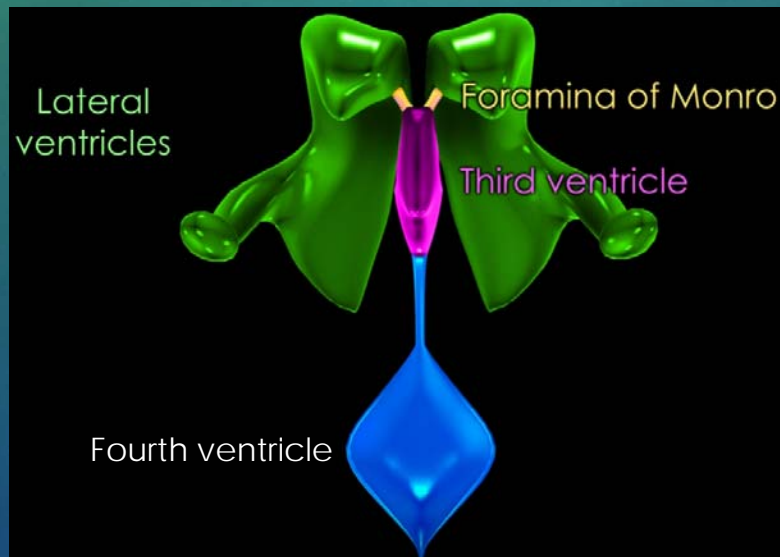
LATERAL VENTRICLES

- An especially large clump of choroid plexus, the **glomus (or glomus choroideum)**, is found in the atrium of lateral ventricles.



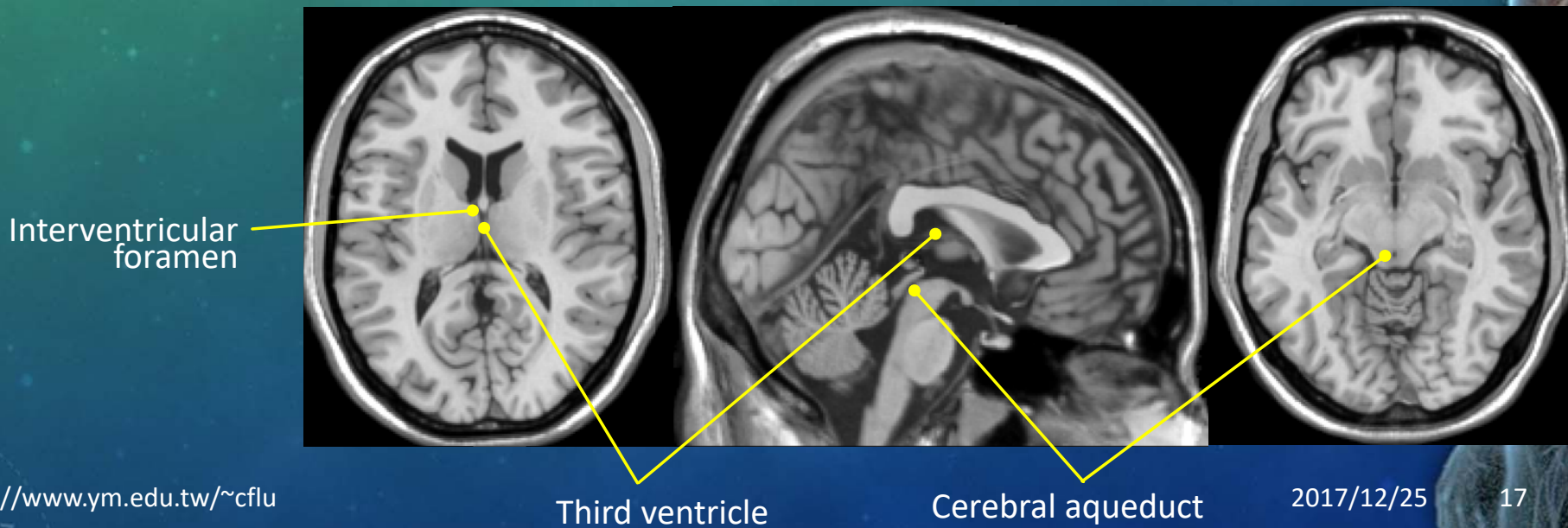
INTERVENTRICULAR FORAMEN

- There are two **interventricular foramina**, one opening from each lateral ventricle into the single midline third ventricle.

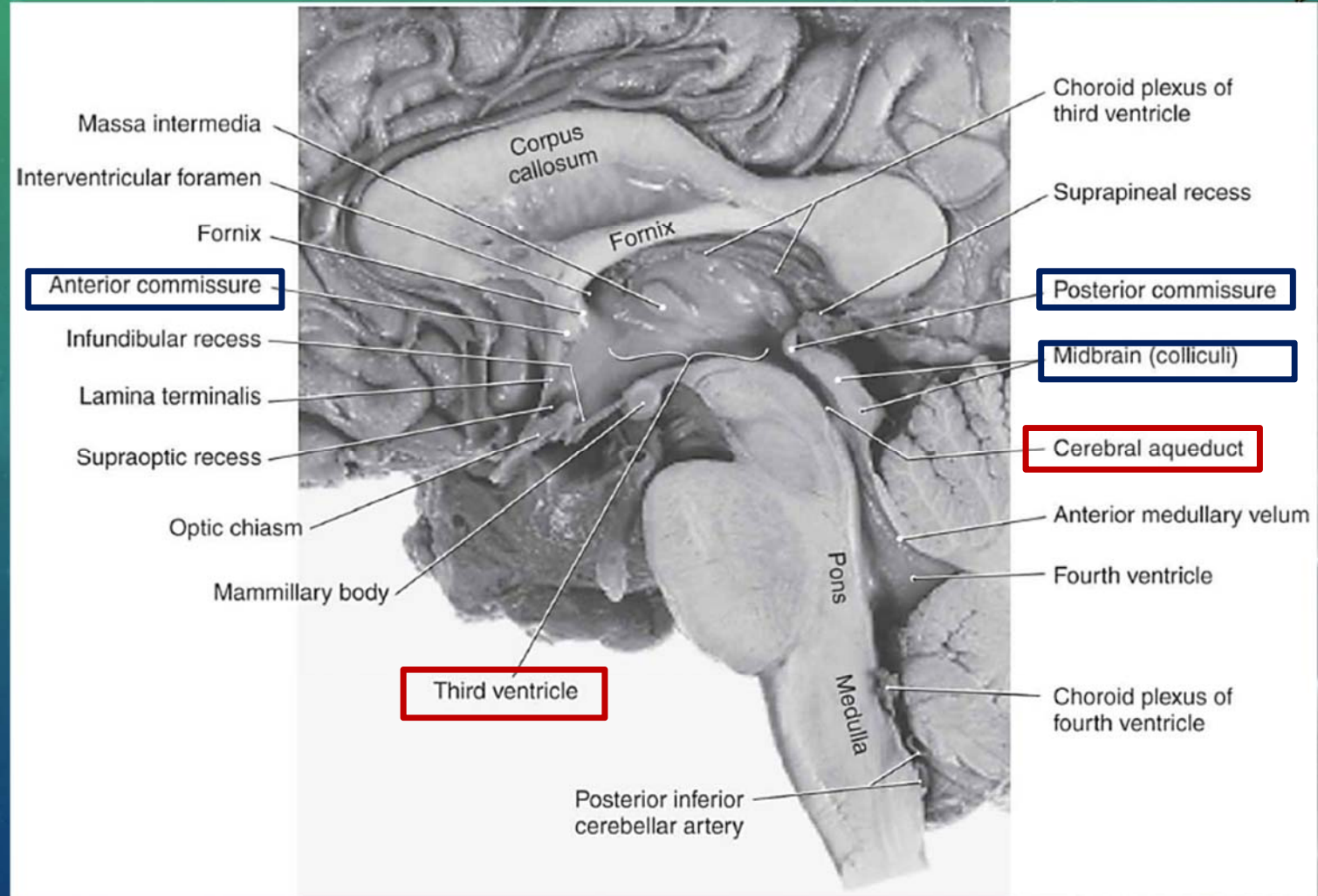


THIRD VENTRICLE

- The cavity of the diencephalon, is a narrow, vertically oriented midline space that communicates rostrally with the lateral ventricles and caudally with the cerebral aqueduct (Aqueduct of Sylvius, 1.5 mm in diameter).



THIRD VENTRICLE

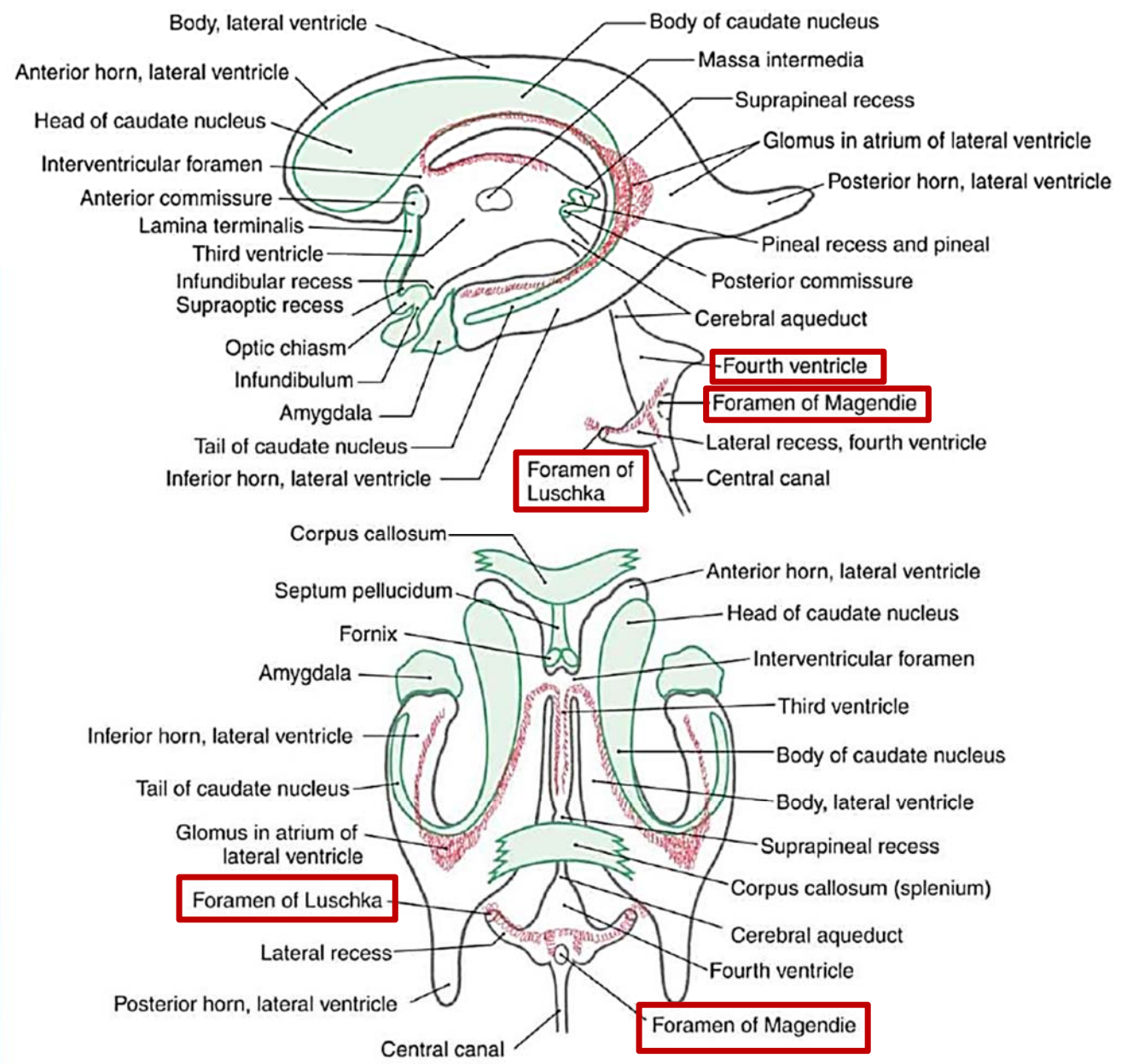


FOURTH VENTRICLE

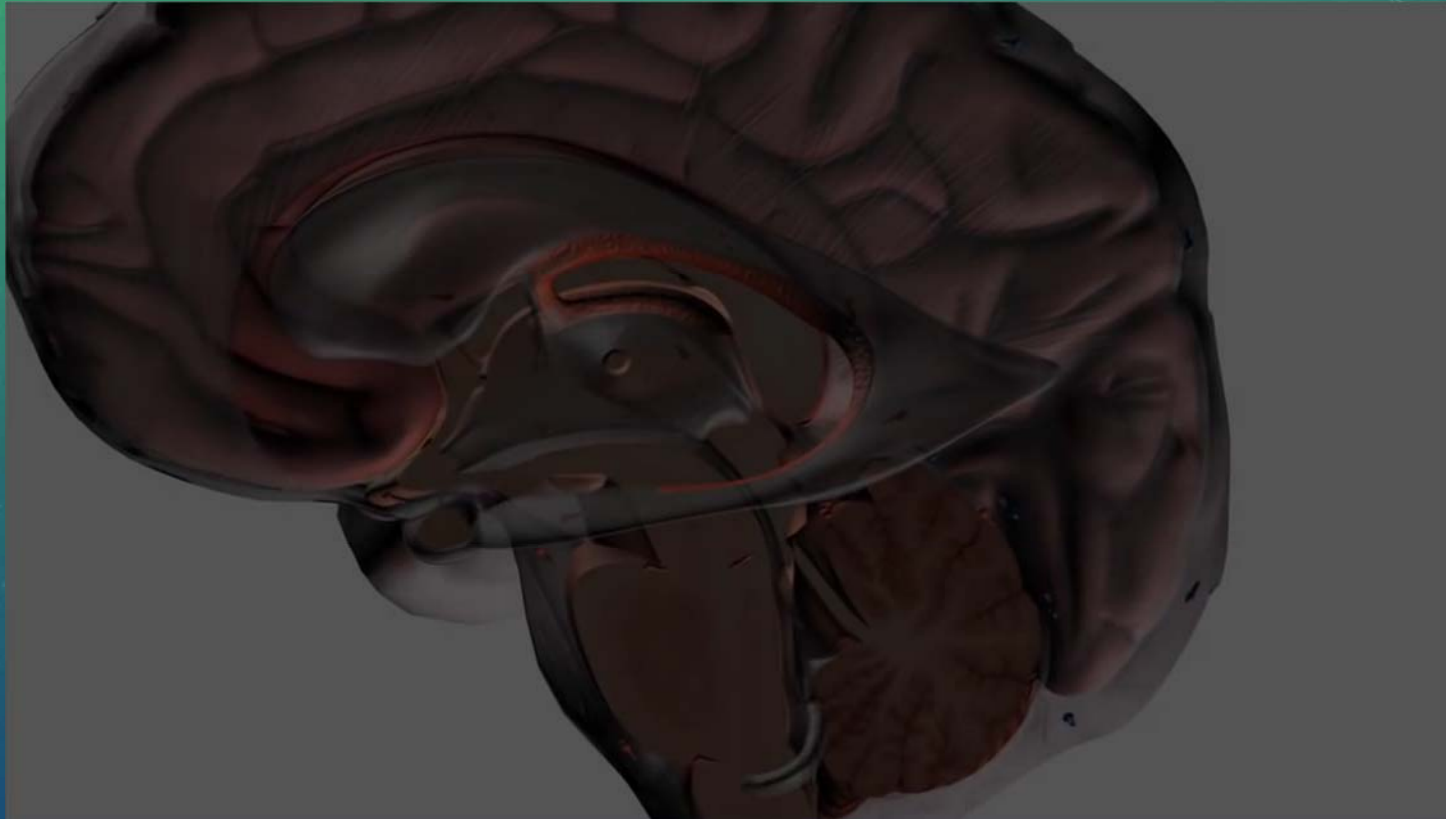
The only openings between the ventricles of the brain and the subarachnoid space surrounding the brain are...

- Medial aperture
 - Foremen of Magendie
- Lateral apertures
 - Foremen of Luschka

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CIRCULATION OF CEREBROSPINAL FLUID



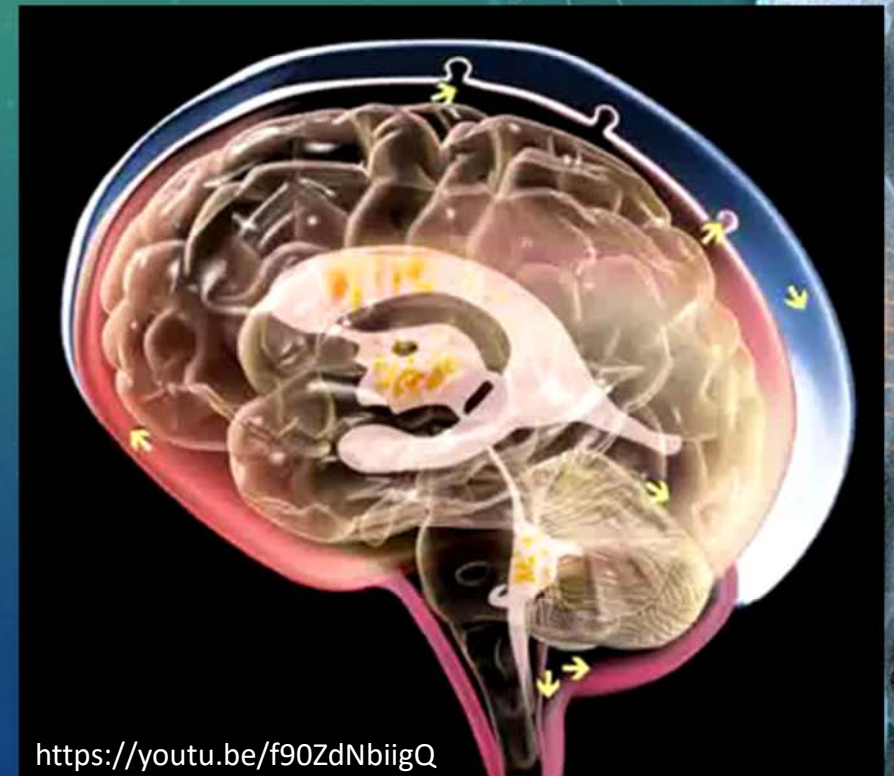
Bristol Neuroscientists, <https://youtu.be/kaOphkMv2pM>

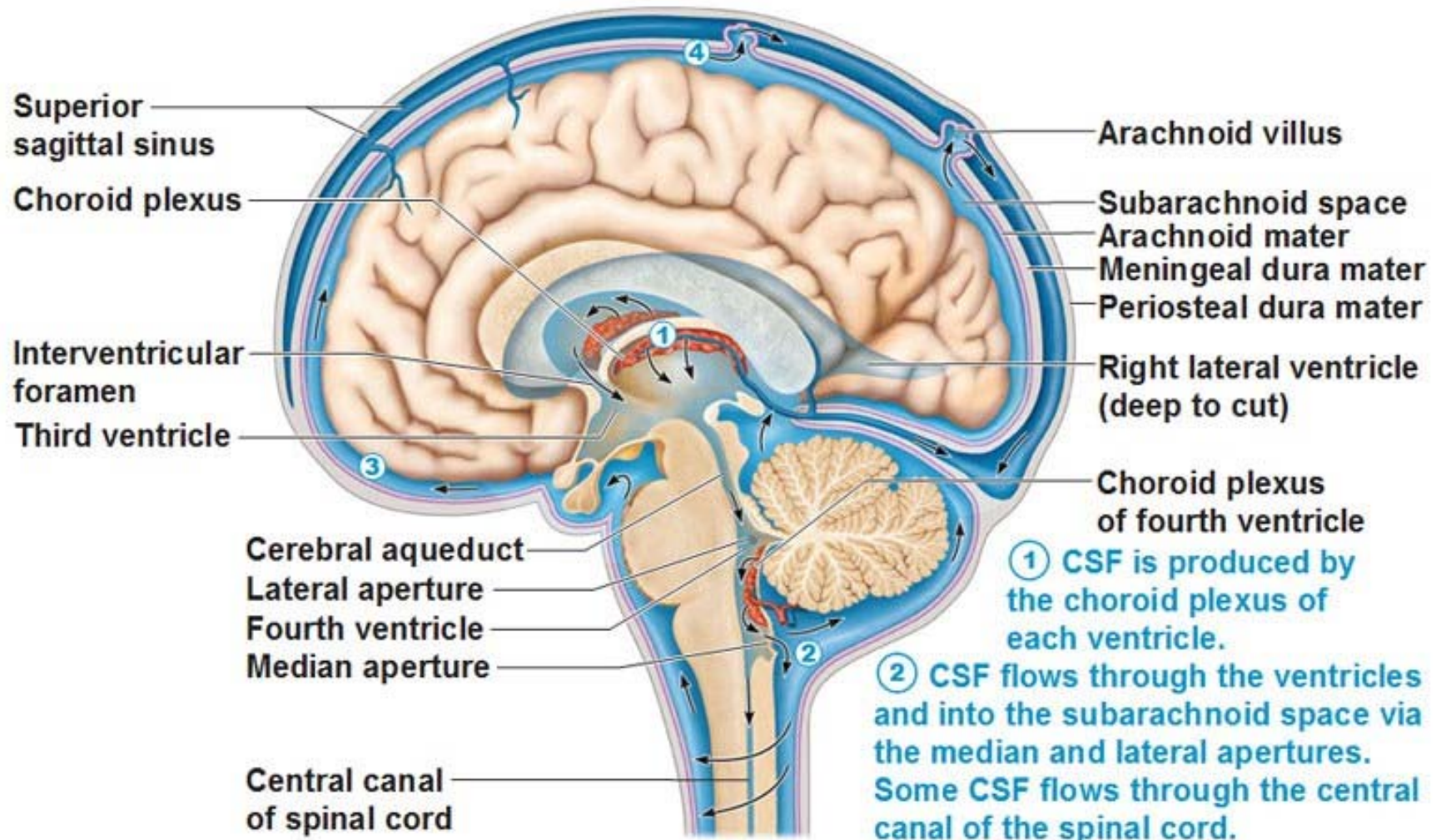
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CIRCULATION OF CEREBROSPINAL FLUID

- Total volume 120-140 mL and circulation of 330-380 mL/day.
- Function of CSF
 - Provide buoyancy to suspend Brain (1400 g in air → 45 g in CSF)
 - Shock absorbance
 - Removal of waste





Superior sagittal sinus
 Choroid plexus
 Interventricular foramen
 Third ventricle

Arachnoid villus
 Subarachnoid space
 Arachnoid mater
 Meningeal dura mater
 Periosteal dura mater
 Right lateral ventricle (deep to cut)
 Choroid plexus of fourth ventricle

Cerebral aqueduct
 Lateral aperture
 Fourth ventricle
 Median aperture
 Central canal of spinal cord

- ① CSF is produced by the choroid plexus of each ventricle.
- ② CSF flows through the ventricles and into the subarachnoid space via the median and lateral apertures. Some CSF flows through the central canal of the spinal cord.
- ③ CSF flows through the subarachnoid space.
- ④ CSF is absorbed into the dural venous sinuses via the arachnoid villi.



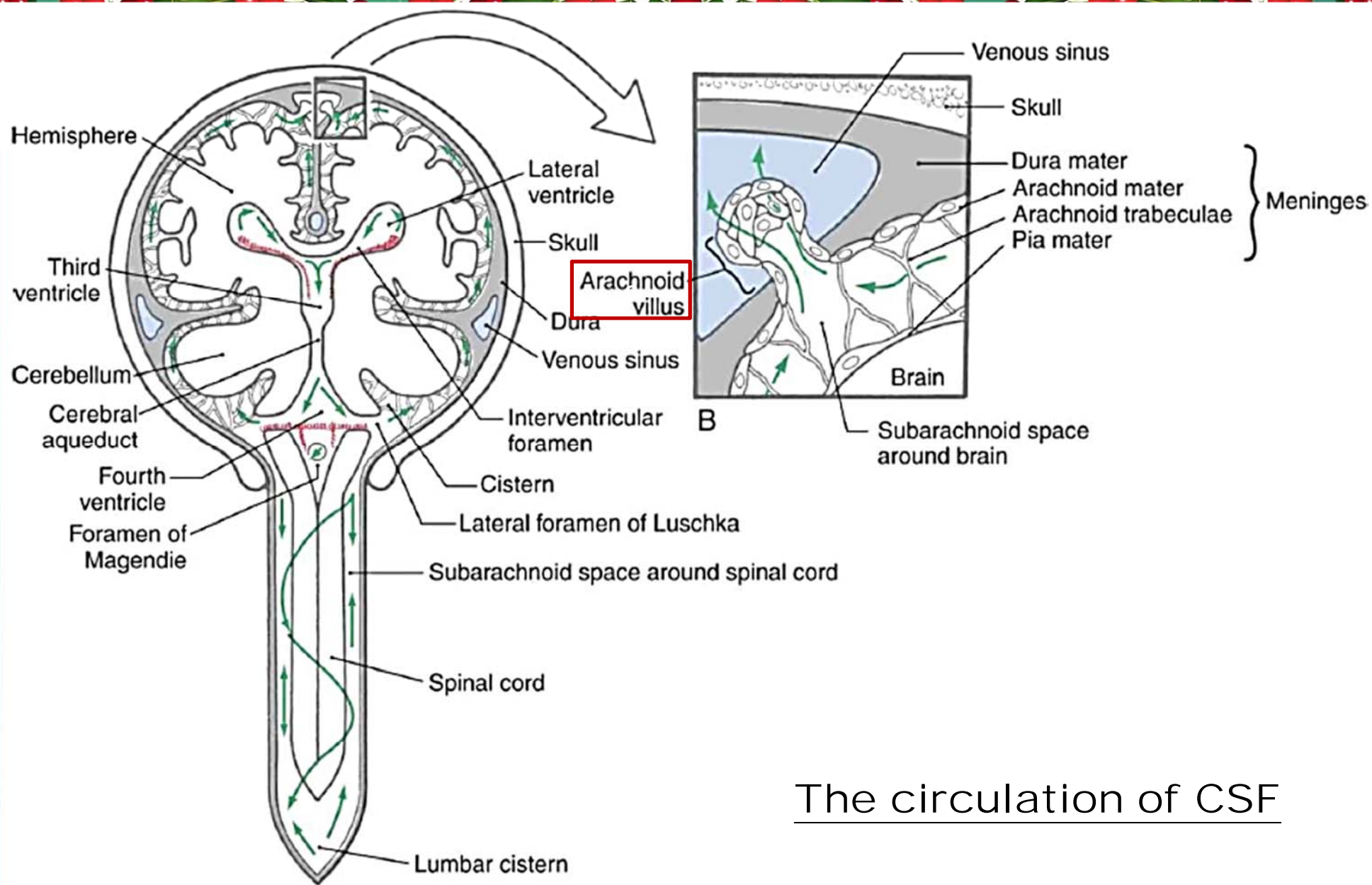
http://

http://beyondachondroplasia.org/blogue/?attachment_id=760



THE MOVEMENT OF CSF

- The **ciliary movement** of intact ependymal cells moves CSF.
- A subtle **pressure gradient** between points of CSF production (choroid plexus) and points of CSF transfer into the venous system (arachnoid villi).
- Pulsations of arteries, the passive movement of CSF through ependyma and brain tissue, and subtle movements of the brain and spinal cord during normal activity also contribute to CSF circulation.



The circulation of CSF

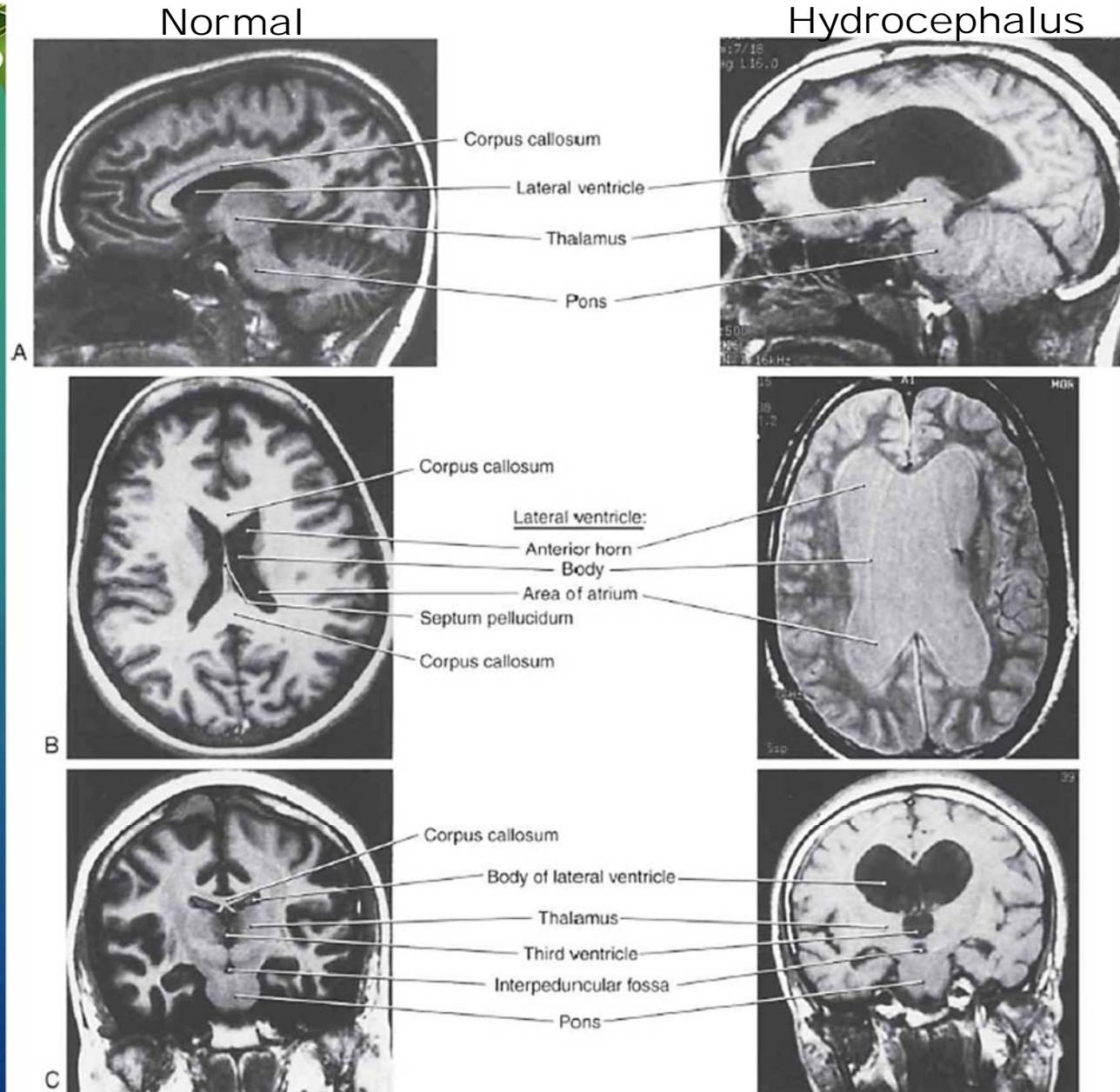
HYDROCEPHALUS AND RELATED CONDITIONS



HYDROCEPHALUS

- Blockage of CSF movement or a failure of the absorption mechanism will result in the accumulation of fluid in the ventricular spaces or around the brain.
- An increase in CSF volume
- Enlargement of the ventricles
- An increase in intracranial pressure

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CAUSES OF HYDRCEPHALUS

- Obstructive hydrocephalus
- Communicating hydrocephalus
- Hydrocephalus ex vacuo
- Normal-pressure hydrocephalus



OBSTRUCTIVE HYDROCEPHALUS

- Obstructive hydrocephalus may result from an obstruction somewhere within the **ventricular system** or within the **subarachnoid space**.
- Common sites of obstruction
 - Interventricular foramen
 - Cerebral aqueduct
 - Caudal portions of the fourth ventricle
 - Apertures of the fourth ventricle
 - Subarachnoid space around the base of the brain
 - Superior sagittal sinus



AQUEDUCTAL STENOSIS

- Possible causes
 - A **tumor** in the immediate vicinity of the midbrain (pineoblastoma or meningioma)
 - Cellular debris seen after **intraventricular hemorrhage**
 - **Bacterial** or **fungal infections**
 - Ependymal proliferation due to **viral infections** of the CNS (especially mumps)
- Sequela
 - **Triventricular hydrocephalus**: Enlargement of the third and both lateral ventricles



COMMUNICATING HYDROCEPHALUS

- Movement of CSF through the subarachnoid space and into the venous system is **partially or totally blocked** → enlargement of all parts of ventricular system.
- Possible causes
 - A congenital absence of the arachnoid villi.
 - Arachnoid villi are partially blocked by red blood cells subsequent to a subarachnoid hemorrhage.
 - An exceedingly high level of protein in the CSF (above 500 mg/dL), as seen in patients with CNS tumors or inflammation.
 - Overproduction of CSF in patients with papilloma of the choroid plexus
 - Impaired venous flow from the brain



HYDROCEPHALUS EX VACUO

- This is actually not a true hydrocephalus but rather a generalized **atrophy of the brain (loss of white matter)** resulting in ventricles that are relatively larger.
- There is **no increase in intracranial pressure**, there are no neurologic deficits other than those that may be related to brain atrophy, and treatment is not indicated.



NORMAL-PRESSURE HYDROCEPHALUS

- Unclear cause of this form of hydrocephalus.
- The name is a misnomer because CSF pressure is elevated episodically.
- Characteristic clinical triad
 - Gait disturbance
 - Urinary incontinence
 - Dementia
- Treatment is a shunting procedure to reduce CSF pressure and volume.

評分方式

- 出席率 10%
- 分段期中考 60%
- 期末分組報告(投影片+錄影檔) 6人一組 30%
 - 針對中樞神經相關疾病做介紹討論，錄製20分鐘，期末考週後一週內交。
 - 內容應包含下述項目：發生率好發族群、臨床症狀、影像表徵、受影響神經系統、致病機轉、臨床治療方式、參考文獻。
 - 每人各負擔一部分投影片錄製，每位同學都要“發聲”，請於投影片正下方標註負責同學姓名學號（不用太大）。
 - 錄影檔可直接繳交EverCam(請至資訊處下載)的錄製檔(附檔名為*.ecm)

THE  END

ALVIN4016@TMU.EDU.TW (TMU EXT. 3273)

