Ventricular System and Cerebrospinal Fluid

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Ventricular System and Cerebrospinal Fluid

Objectives

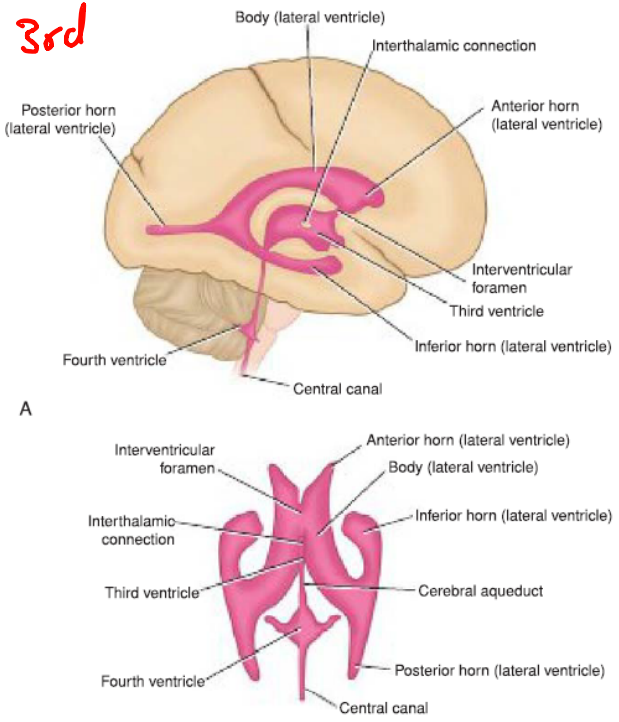
- CSF location, function, production & absorption

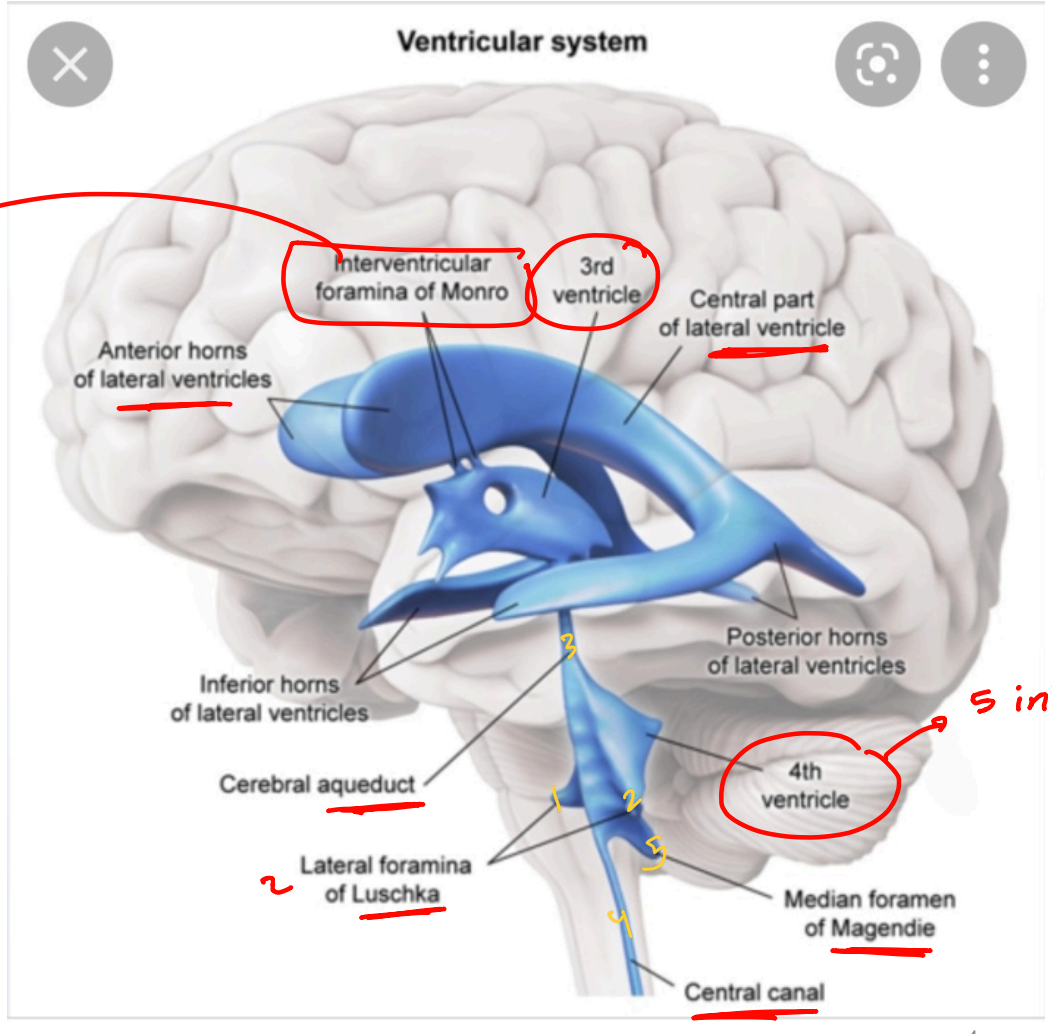
- Blood-brain barrier

- Blood-cerebrospinal fluid barrier

Ventricular System

- 2 lateral ventricles
  - ➢ Interventricular foramina (of Monro)
- 3d ventricle
  - ➢ Cerebral aqueduct (aqueduct of Sylvius)
- 4th ventricle
  - ➢ Central canal of the spinal cord
  - ➢ 3 foramina in its roof, with the subarachnoid space (2 Luschka, 1 Magendie)





Connection between 2 thalmi

5 inlet

obstruction → hydrocephalus

Lateral ventricles → has 3 horn

- Body
- Anterior (frontal) horn
- Posterior (occipital) horn
- Inferior (temporal) horn
- Trigone (Atrium)

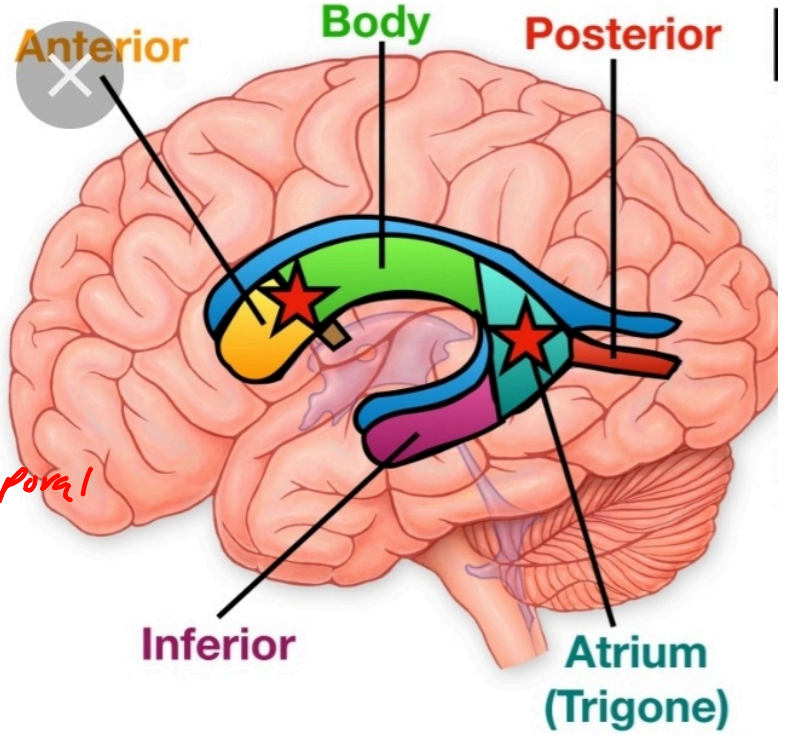
صنابيط shunt او غالبة hydrocephelus

connect Body with occipital, temporal

common site of meningioma

choroid plexus papiloma

Ventricles ما بتيجي على Cortex كتير بتيجي على أكتر (لكن لو صار هنا بكون أكثر حكم trigone يعني Lt)



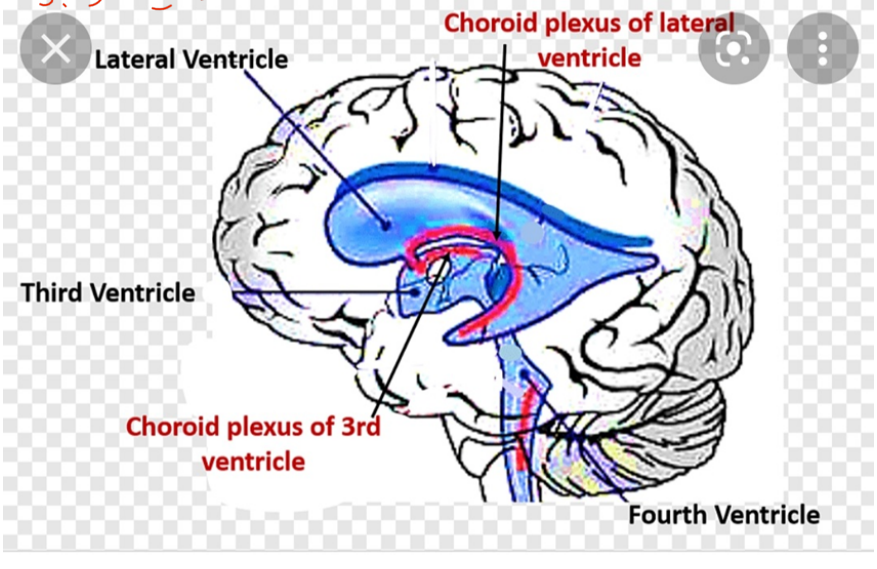
3d & 4th ventricles

- 3d ventricle: a slitlike cleft between the two thalami
  - ➢ Choroid plexus is suspended from the roof

- 4th ventricle: a tent-shaped cavity
  - ➢ Situated anterior to the cerebellum and posterior to the pons and the superior half of the medulla
  - ➢ Floor: a rhomboid-shaped
  - ➢ Roof: Superior medullary velum & Inferior medullary velum
  - ➢ Choroid plexus is suspended from the inferior half of the roof (PICA)

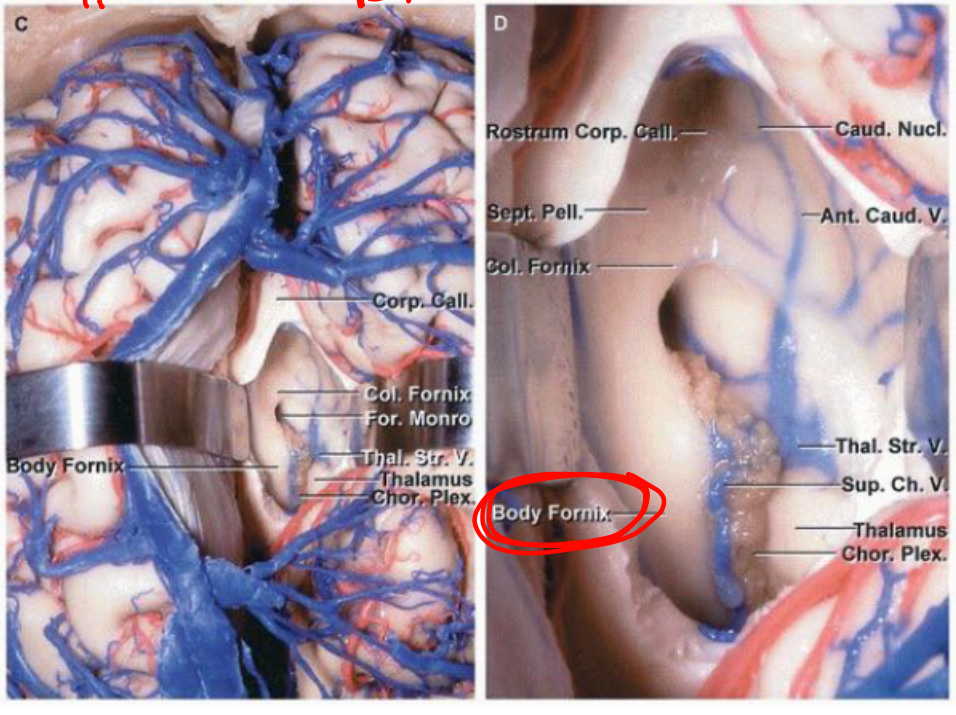
Choroid plexus of the ventricular system

- In lateral ventricles:
  - ➢ Body: medial & inferior
  - ➢ Inferior horn: medial & superior
- In 3d ventricle:
  - ➢ roof
- In 4th ventricle:
  - ➢ the inferior half of the roof



Rt lateral Ventricle

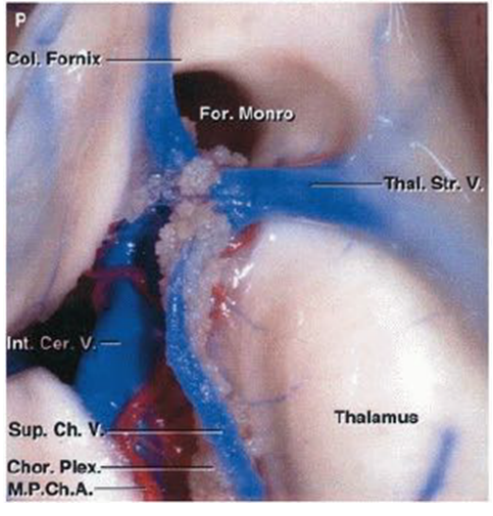
(via transcallosal approach)



Transchoroidal approach to 3d Ventricle

- Transchoroidal approach directed through the body portion of the choroidal fissure using an opening through the corpus callosum

- The choroidal fissure has been opened by incising along the tenia fornicis, not tenia thalami



Subarachnoid space

- Between the arachnoid & pia mater, around the brain and spinal cord
- Filled with CSF
- Contains the large blood vessels of the brain
- Basal subarachnoid cisterns
- In Spine: it ends at S2-S3

in skull base

subarachnoid space يتسع في

csf منطقة مختزنة

منتفخة

→ the spinal cord end in L1 - L2

Cerebrospinal Fluid

له تركيبة ثابتة

Table 16-1 Cerebrospinal Fluid Physical Characteristics and Composition

Appearance	Clear and colorless
Volume Brain & spine	c. 150 mL
Rate of production	0.5 mL/min
Pressure (spinal tap with patient in lateral recumbent position)	60–150 mm of water
Composition	
Protein	15–45 mg/100 mL
Glucose	50–85 mg/100 mL
Chloride	720–750 mg/100 mL
Number of cells	0–3 lymphocytes/mm^3

[CSF] clear color less normally.

75cc on head
75cc on back
20 ml/hr
500 ml/d

→ if there is obstruction in csf pathways lead to cell death → ↑ ICP
خلال سنوات

[hydrocephalus] in adult may need to urgent surgery—

adult die on one day
child → suture بعد ايام متفرقة

ارتفاع بعض infection زيادة ... ارتفاع بعض

zero غالبا

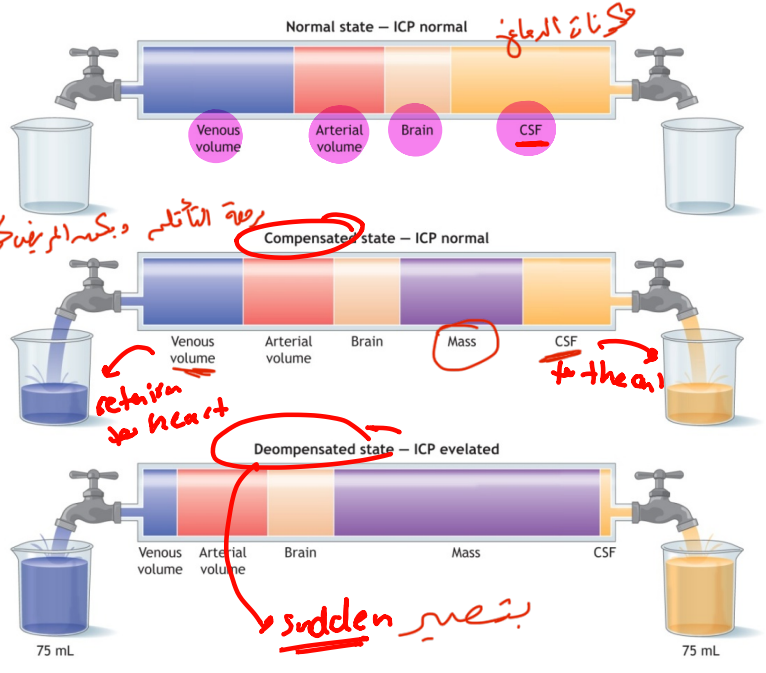
in bacteria → neutrophils / viral → lymphocyte عكس عكس

CSF function

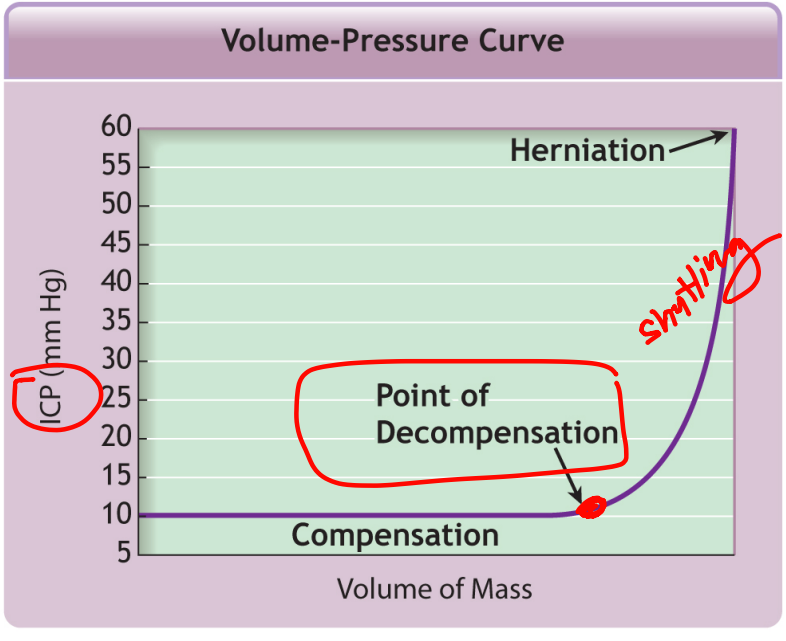
Table 16-2 Cerebrospinal Fluid Functions

1. Cushions and protects the central nervous system from trauma
2. Provides mechanical buoyancy and support for the brain
3. Serves as a reservoir and assists in the regulation of the contents of the skull
4. Nourishes the central nervous system
5. Removes metabolites from the central nervous system
6. Serves as a pathway for pineal secretions to reach the pituitary gland

Monro-Kellie Doctrine



Volume-Pressure Curve



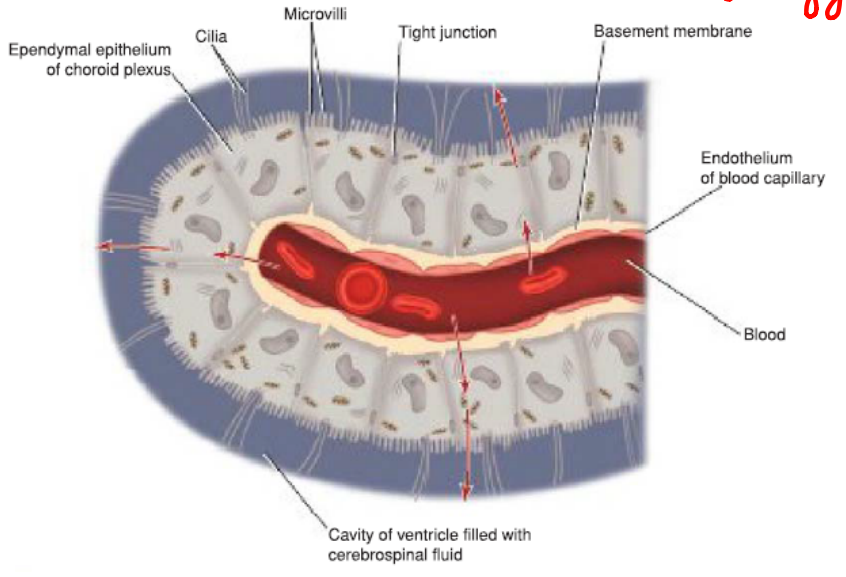
CSF formation

inside the Ventricular System

- Mainly in the choroid plexuses → main producer of CSF → active secretion need transport and energy.
  - ➢ Active secretion
  - ➢ Not pressure regulated

  طريقة سلبية بدون طاقة

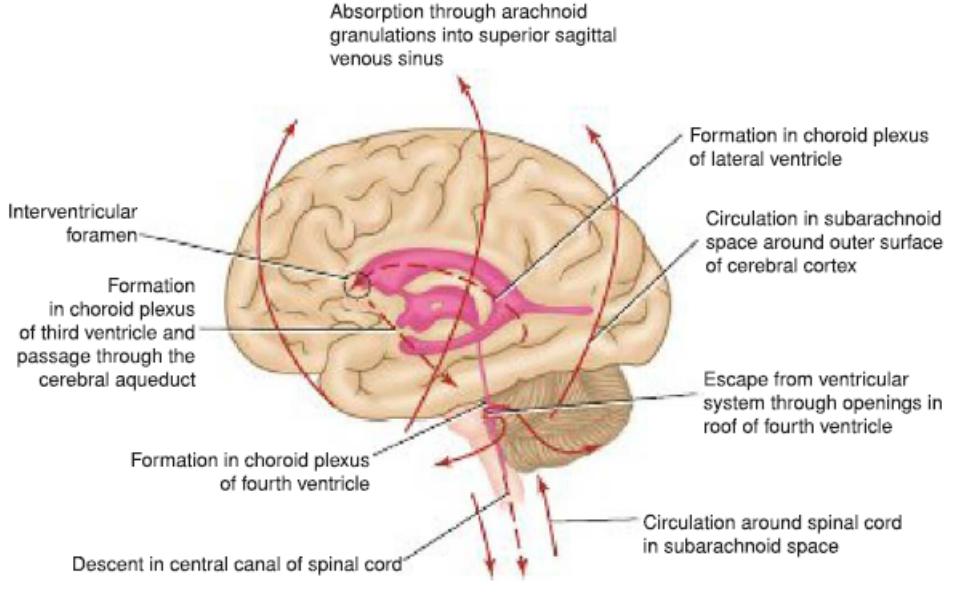
- Ependymal cells
- Brain



* production from blood to CSF

Lateral V. → 3rd V. → 4th V. → Sub arachnoid space in brain (absorbtion is occure)

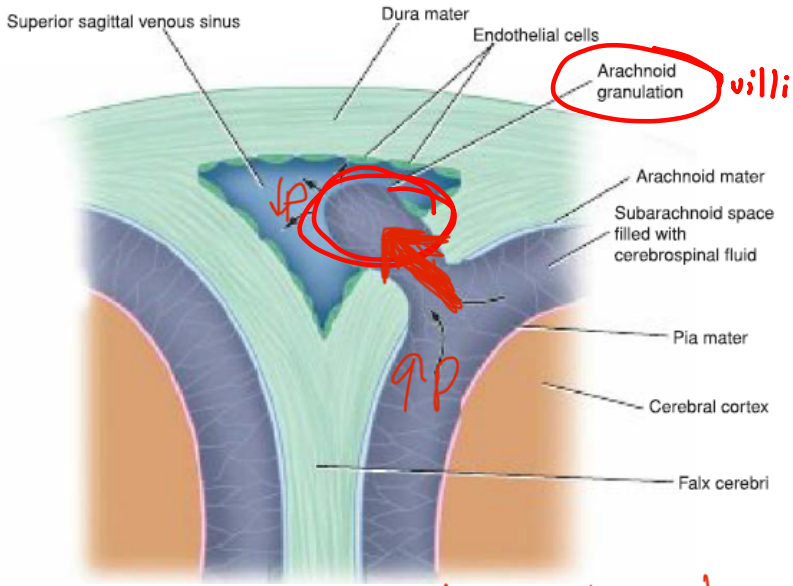
CSF circulation



CSF absorption

Caronal Section in the midline

- Arachnoid villi (granulations) esp. in superior sag. Sinus
- Occurs when CSF pressure exceeds the venous pressure in the sinus
- One way valve
- CSF absorption controls CSF pressure



→ depend on the pressure...

Non Communicating hydrocephalus

obstruction at arachnoid villi
b/c infection or truma
meningitis
Subarachnoid hemorrhage

Blood-Brain & Blood-CSF Barriers

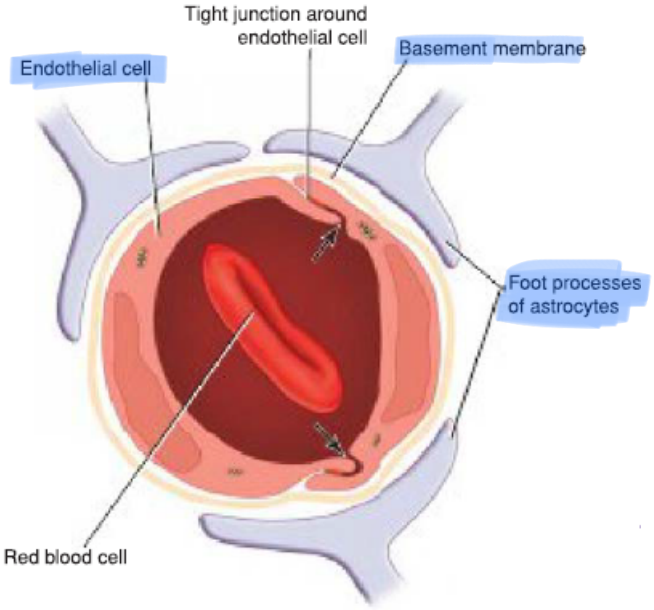
- The CNS requires a very stable environment In order to function normally
- This is provided by isolating the nervous system from the blood by these barriers
- They protect brain and spinal cord from potentially harmful substances while permitting gases and nutriments to enter the nervous tissue

blood + brain } blood + CSF

Blood-Brain Barrier (BBB)

Structure

- Endothelial cells
  - ➢ Tight junctions (Lipid)
- Basement membrane
- The foot processes of the astrocytes



In newborn: BBB is more permeable (Bilirubin → kernicterus)

Blood-Brain Barrier (BBB)

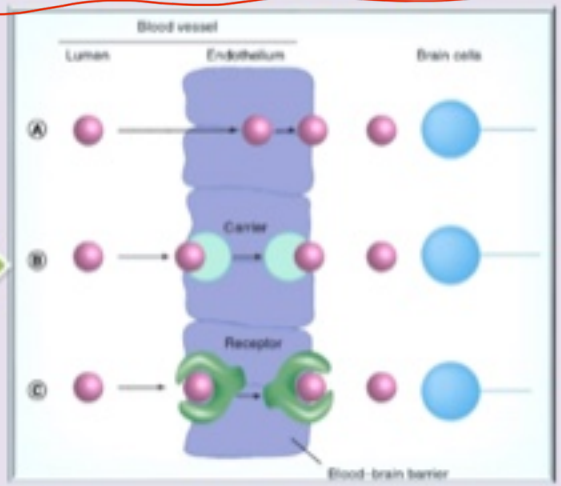
- BBB permeability is inversely related to the size of the molecules and directly related to their lipid solubility.
- BBB is absent in:
  - pineal gland
  - posterior lobe of the pituitary
  - tuber cinereum
  - the wall of the optic recess
  - area postrema (sample the chemical content of the plasma directly)
- BBB is disrupted in brain traumatic, inflammatory or toxic inj., as well as in malignant brain tumors

→ influence choice and dose of antibiotics.

Blood-Brain Barrier (BBB)

Drugs crosses Blood brain barrier

Different ways



E.g.

Antidepressant: Reboxetine, Viloxazine

Antifungal: Amphotericin B, 5-flucytosine, Voriconazole, Itraconazole, Fluconazole

Antiparasitics: Pyrimethamine, Albendazole, Praziquantel

Antibiotics: Aminoglycosides, Macrolides, B-lactam, Fluoroquinolones, Cephalosporins, Doxycycline, Minocycline, Quinolone

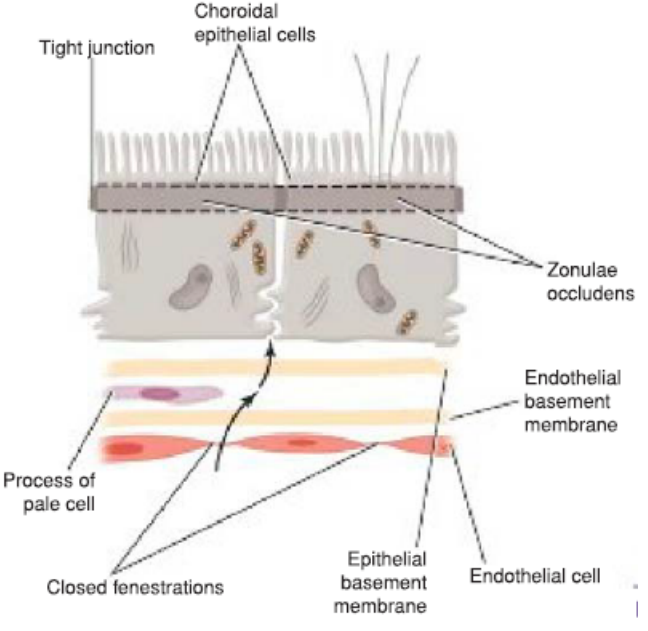
Other: Endorphin, Serotonin, Histamine, Chlorpromazine, Epinephrine

Blood-Cerebrospinal Fluid Barrier

Structure

- Endothelial cells with closed fenestrations
- Basement membrane
- Scattered pale cells
- Basement membrane
- Choroidal epithelial cells
  - Tight junctions

not in vessels but in the cuboidal cell



Cerebrospinal Fluid-Brain Interface

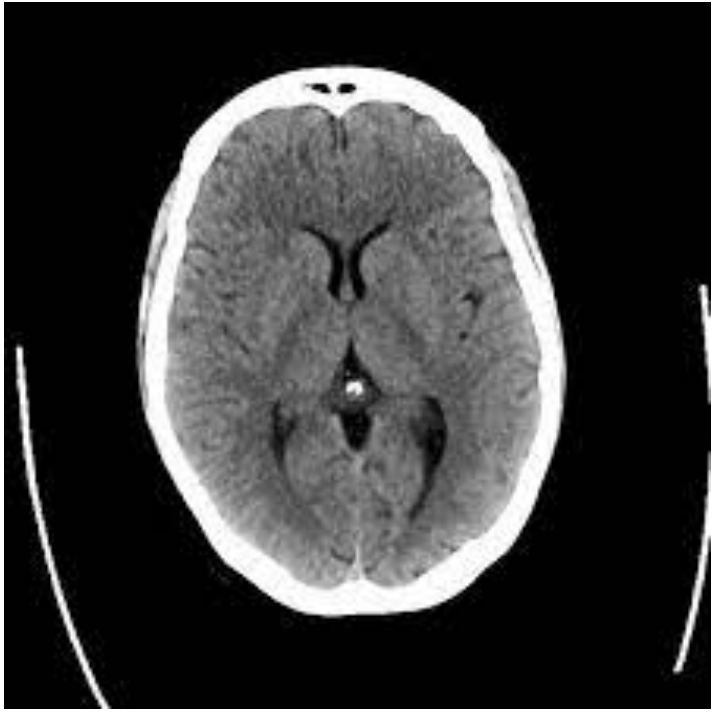
- A comparable physiologic barrier between CSF and the CNS extracellular compartment does not exist!

Clinical Notes

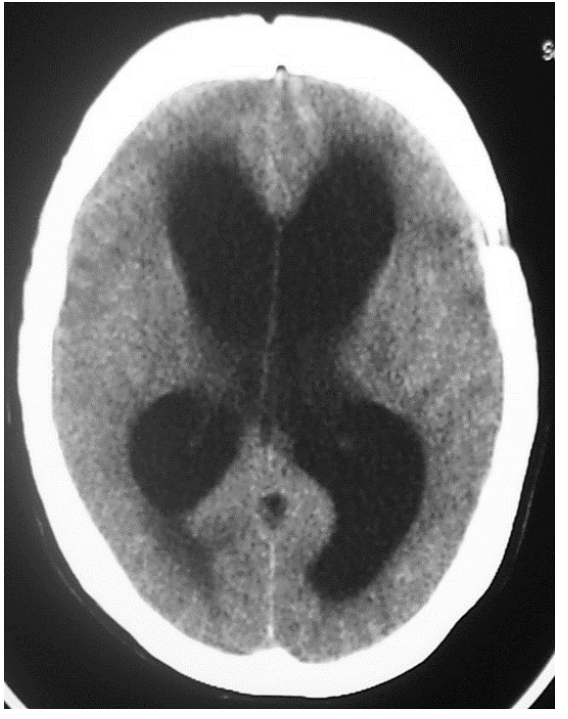
- Papilledema
  - ➢ High ICP → high CSF pressure → Compression of retinal vein BL → optic disc swelling BL "Papilledema" → ON atrophy & blindness if persistent

- Hydrocephalus
  - ➢ Abnormal increase in CSF formation (rare, like in CPP)
  - ➢ Blockage of CSF circulation (tumor, AS), noncommunicating HCP
  - ➢ ↓ CSF absorption (post meningitis, sinus thrombosis), communicating HCP

Hydrocephalus



normal Brain



active hydrocephalus: symptomatic.

CSF analysis in meningitis

بحسب نوع الـ infection يتغير التركيب لـ csf ..

Tuberculosis	Fungal	Viral	Bacterial	Normal	وجهه اكتبها بسرعة
Variable	Elevated	Normal or slightly elevated	Elevated (Most common)	5-20	Opening pressure cm H_2O
10 - 1000	10 - 1000	25 – 2000	> 1000	< 5	Leukocytes
Lymphocyte predominance	Lymphocyte predominance	Early: Neutrophils Late: Lymphocytes (أكثر)	Neutrophil predominance (not lymphocyte)	0 (and if it present mainly lymphocyte)	Cell differential
Very High	High	Normal or slightly elevated	High	15 – 45	Protein
Low	Low	Normal	Low (bacterial بتستهلك عالـ)	45 - 85	Glucose
+ (AFB)	+ (Fungal)	-	+	-	Cultures

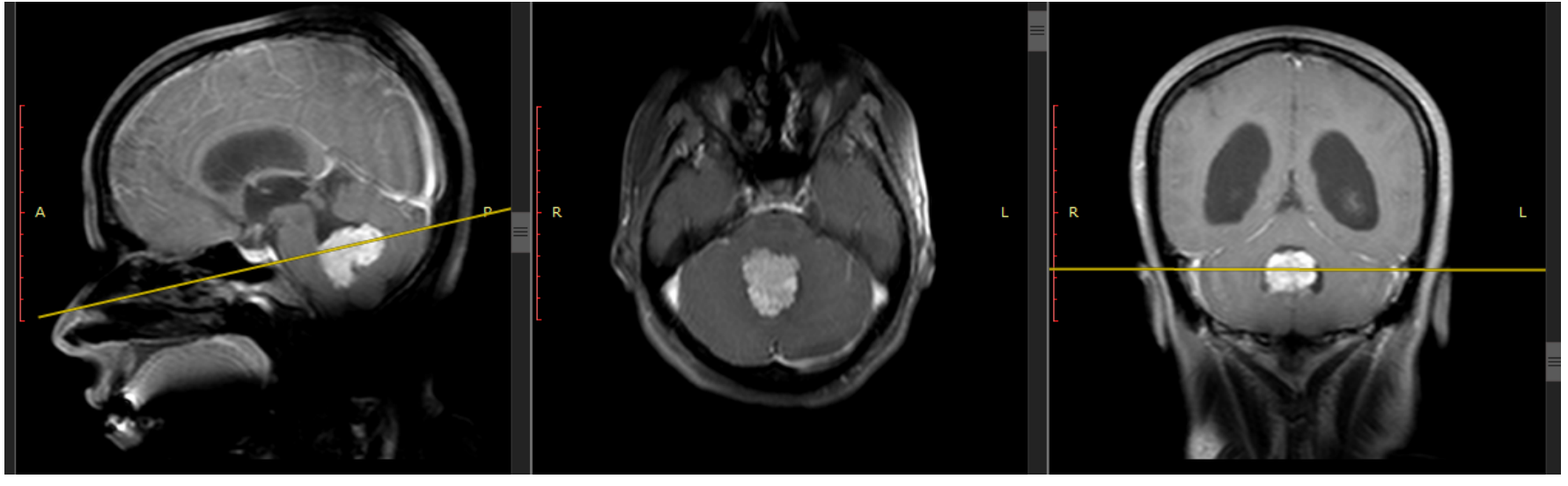
lumbar puncture not for patient with tumor [because there is ↑ P]

4th ventricle tumors

- Medulloblastoma: arises from the vermis (roof) of the 4th V
- Ependymoma: arises from the floor of the 4th V (can invade hypoglossal and vagal nuclei, affecting movements of the tongue and/or swallowing, respiration, heart rate, and blood pressure)

4th ventricle tumor

Choroid plexus papilloma



For you!