CEREBROSPINAL FLUID

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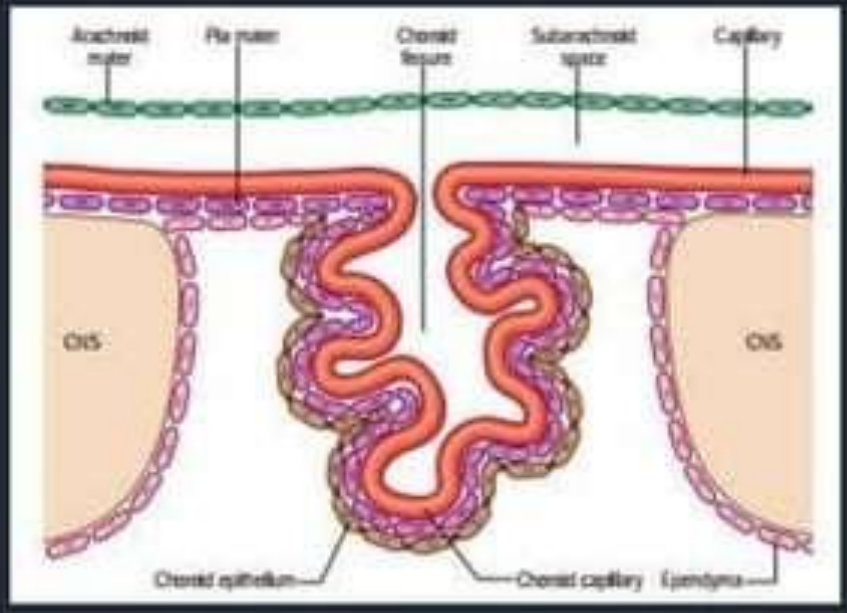
the CEREBRO SPINAL FLUID

- CSF is a clear, colorless liquid
- it is not simply ultrafiltrate of blood but is actively secreted by the choroid plexuxes
- the **choroid plexus** epithelial cells have the characteristics of transport and secretory cells
- their **apical surfaces** have microvilli and their basal surfaces exhibit interdigitations and folding



sources

- **tight junctions** at the apical ends of the choroid epithelium are permeable to small molecules
- the **fenestrated capillaries** lie beneath the epithelial cells
- hence the **sources of CSF** are
  - choroid plexus
  - ependymal lining of the ventricles
  - extracellular fluid from the brain parenchyma
- the contribution of each is unclear
- main bulk is produced in **lateral ventricles**
- **anterior choroid artery**, branch of ICA and **posterior choroid arteries**, branches of PCA

characteristics

- produced at rate of **0.35 to 0.37 ml per minute**, (600-700 ml/day)
- entire reservoir, in an adult - **90 to 150 ml**
- of which 75ml is intracranial ; **25 ml in the ventricles**
- **in newborn - 40 to 60 ml**
- this amount is completely replaced several times **(4 times approx)**
- **formation rate** depends on
  - osmotic pressure
  - hydrostatic pressure of blood
  - variations in venous pressure
- *independent of CSF pressure*
- **Carbonic anhydrase** - involved in production of CSF

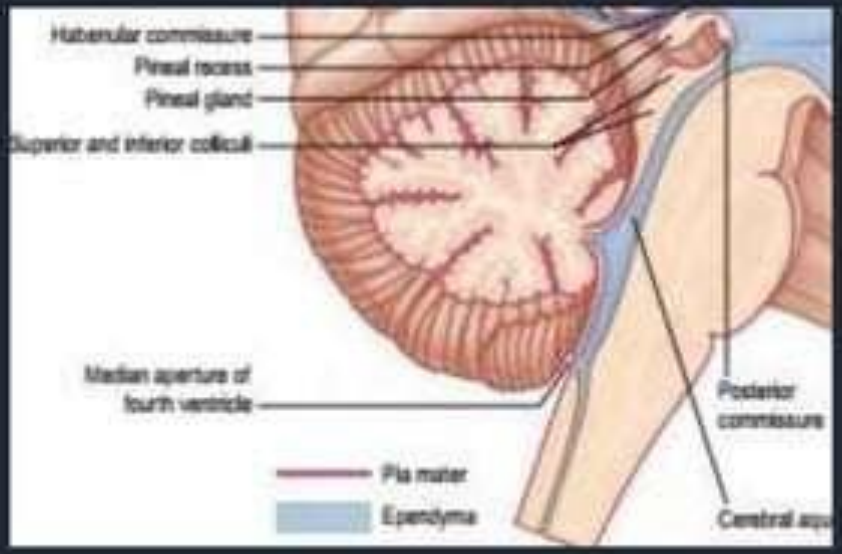
- it contains small amount of protein, little more than half amount glucose than plasma, few cells and various ions

TABLE 59.1 Normal Characteristics and Composition of the CSF

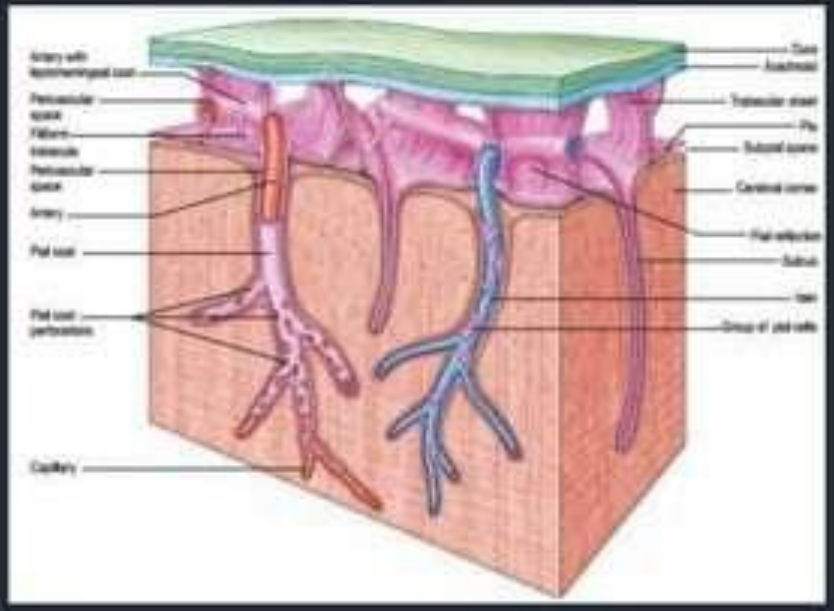
Appearance	Clear and colorless
Cells	<5 lymphocytes or mononuclear cells
Total protein	15–50 mg/dL
IgG	<8.4 mg/dL
Gamma globulin	8%–13% of total protein
Oligoclonal bands	0–1 band
Myelin basic protein	0–4 ng/mL
CSF IgG index	0–0.77
CSF IgG synthesis rate	0–8 mg/24 h
Glucose	45–80 mg/dL, 60%–80% of blood sugar

Subarachnoid space

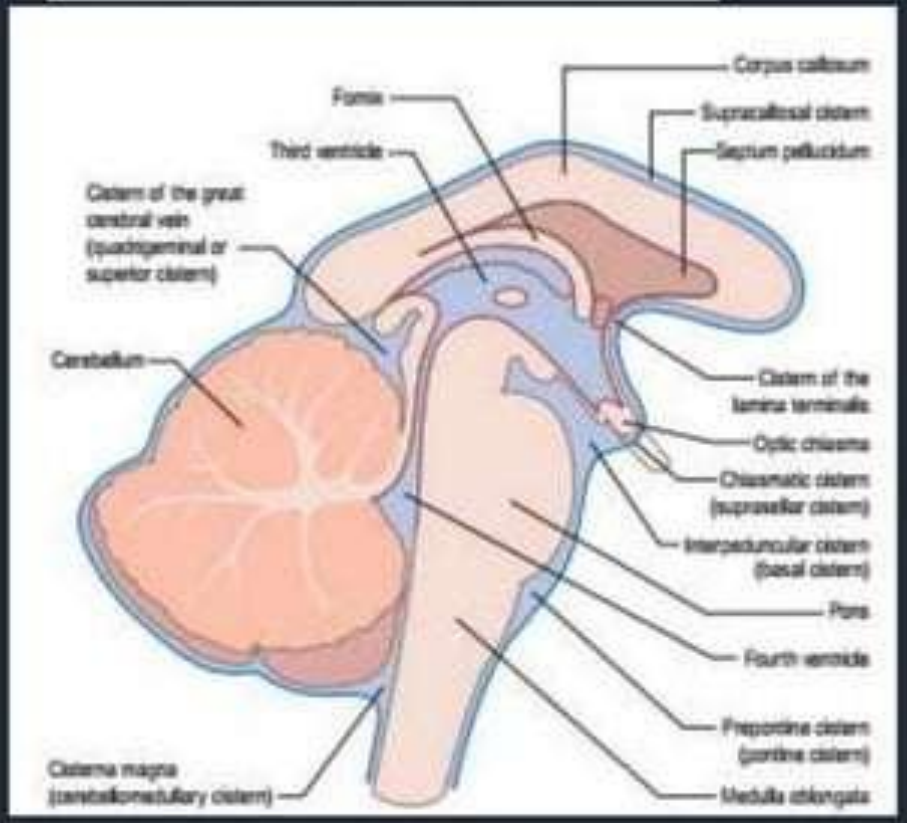
- it is continuous with the lumen of fourth ventricle via the median aperture (**foramen of Magendie**) and the paired lateral apertures (**foramina of Luschka**)
- the **space contains**
  - CSF
  - larger arteries
  - veins - that traverse the surface of the brain
  - intracranial / intravertebral portions of cranial / spinal nerves



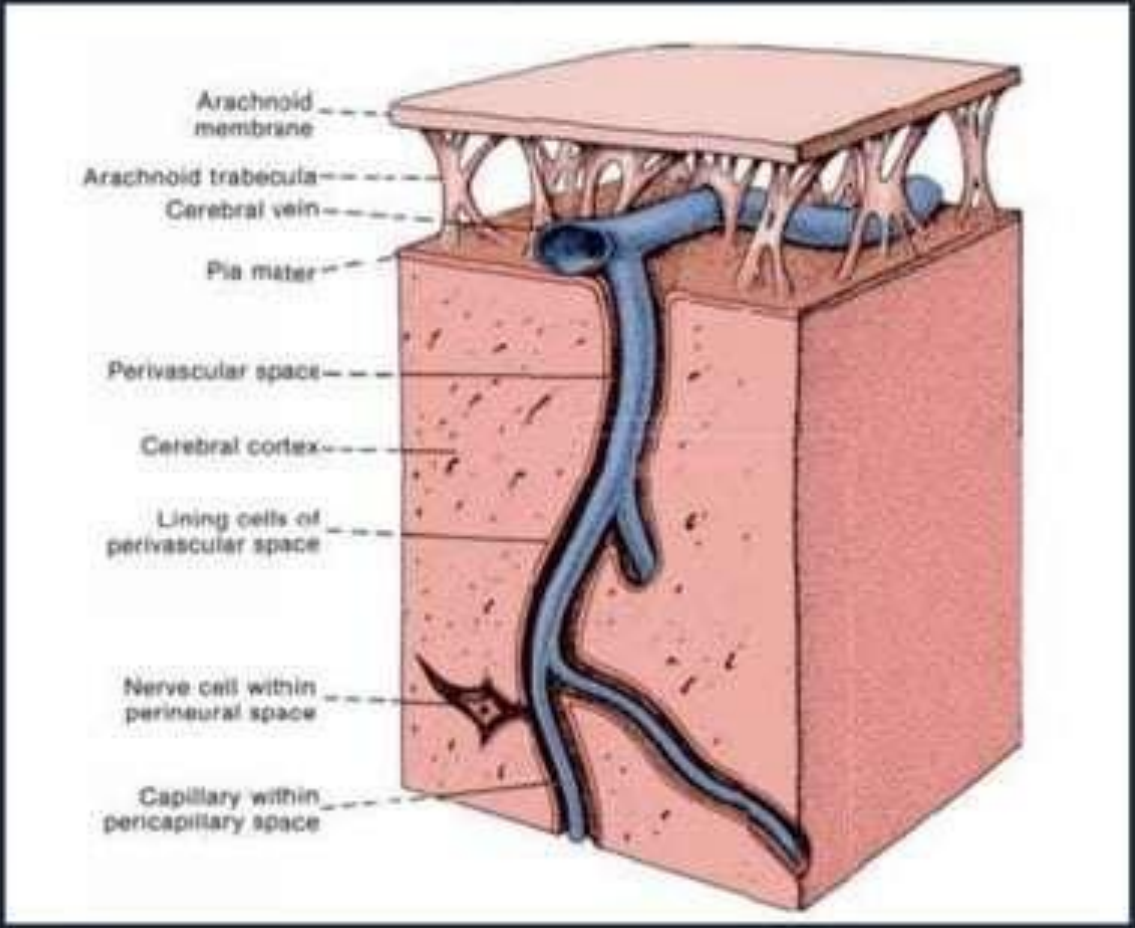
- **trabecular** - in the form of sheets or fine filiform structures, containing a core of collagen, cross the subarachnoid space from the deep layers of the arachnoid mater to the pia mater
- they are **attached to larger vessels** within the space and may form compartments, particularly in the perivascular regions, possibly facilitating the directional flow of CSF



- **arachnoid and pia mater** are in close apposition over the convexities of the brain whereas concavities are spanned by arachnoid.
- this produces subarachnoid space of greatly variable depth that is location dependent. the more expansive spaces form **subarachnoid cisterns**



- the blood vessels that penetrate the brain go through the subarachnoid space and become invested with two layers of arachnoid; these arachnoid coats, which accompany the vessels for varying distances in the brain, are known as perivascular **Virchow - Robin spaces**



extension of the space

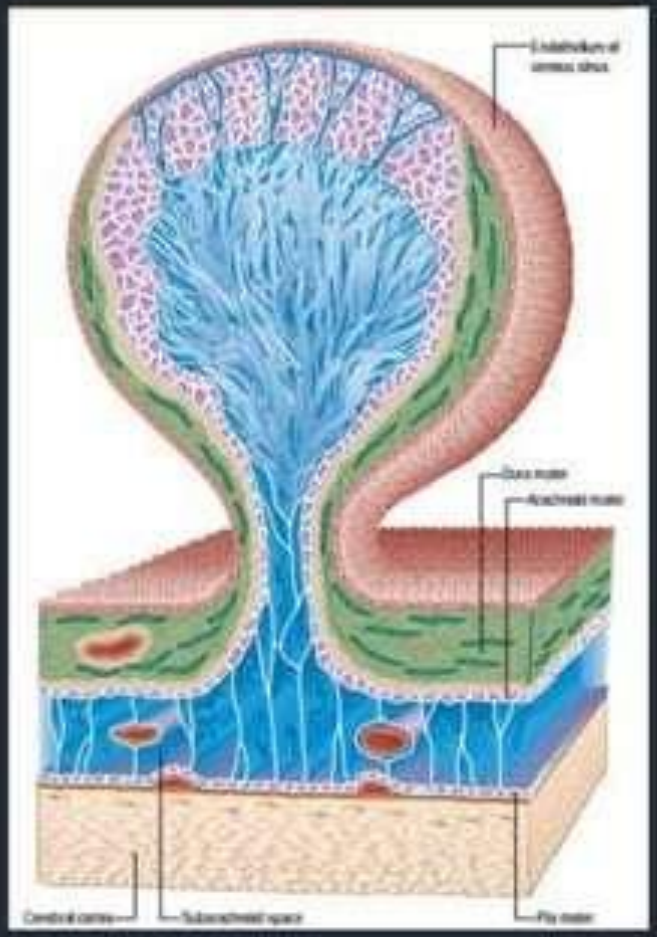
- the **CSF flows** into the **perivascular spaces** and is carried for certain distance into the **substance of the brain and spinal cord**
- the CSF space also extends outward for varying distance in **periradicular and perineural spaces along exiting cranial and spinal nerves**
- the subarachnoid space extends from the termination of the spinal cord to **about the second sacral verebra**
- the terminal sac contains cauda equina and is the preferred site for LP.

CSF circulation

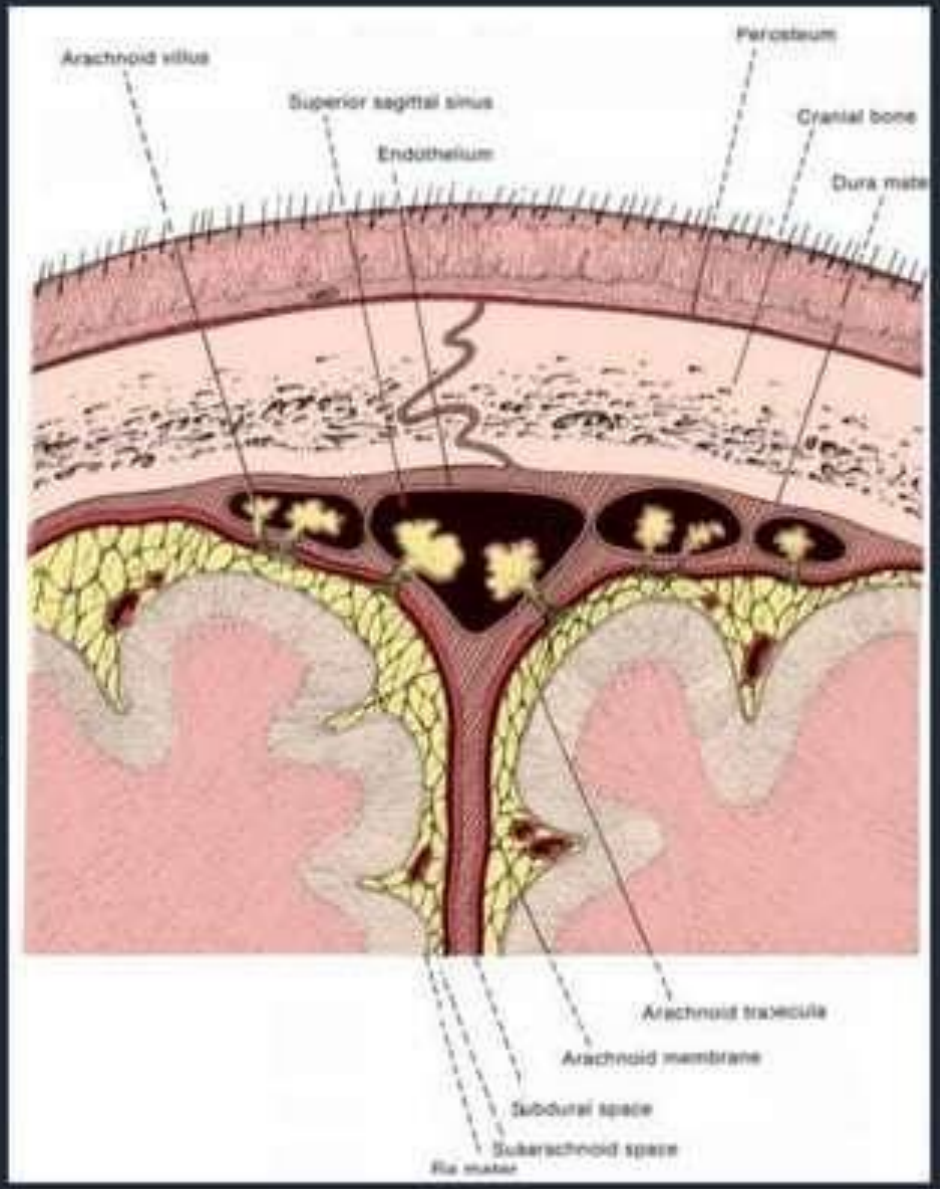
- The CSF percolates from the **lateral ventricles**, through the **foramen of Monro**, into the **third ventricle**, and then down the **cerebral aqueduct** into the **fourth ventricle**.
- From the fourth, a small amount enters the **central canal** of the spinal cord while the majority is discharged through the **foramina of Luschka and Magendie** into the **subarachnoid cisterns** surrounding the brainstem and cerebellum.
- There is **continuous circulation** between these basal cisterns and the spinal subarachnoid space all the way to the lumbosacral region.
- Eventually, CSF migrates into the subarachnoid space over the convexities of the hemispheres alongside the superior sagittal sinus.
- Harvey Cushing referred to the flow of CSF as the "**third circulation.**"

Arachnoid villi and granulations

- **Arachnoid villi and granulations** (Pacchionian bodies) are focal pouches of arachnoid mater and subarachnoid space that protrude through the walls of the dural venous sinuses, very often close to points where veins enter the sinuses.
- They are found in the **superior sagittal**, **transverse**, **superior petrosal** and **straight sinuses** in decreasing frequency and are most prominent along the margins of the great longitudinal fissure, commonly in the **lateral lacunae** of the superior sagittal sinus.



- they are the site where the **CSF is reabsorbed** into the blood
- the CSF in the granulations are seperated from the venous blood in the dural sinuses by only a **layer of mesothelial arachnoid cells** and a layer of vascular endothelium.



CSF functions

- most important - **mechanical**
- serving as a **water jacket** for the brain and the spinal cord
- helps **support the weight** of the brain and **cushioning effect**
- **lubricant** between the brain and cranium
- acts to **dissipate the force** of a blow to the head
- **space-compensating mechanism** for regulating the contents of the cranium and helps in keeping the ICP relatively constant.
- **homeostasis** - maintain a constant external milieu for the brain - in equilibrium with the ECF of brain

- **medium for the transfer** of substances from within the brain and spinal cord to the blood stream.
- **"sink"** for the ECF of the brain.

Lumbar puncture

- **equipment** - atraumatic, noncutting, pencil - point (Sprotte) needles , help reducing the complications, mainly headache, in comparision to tradional cutting - tip (Quincke) needles
- **information** obtained
  - CSF pressure
  - CSF composition
- **the Opening pressure**
  - vital part of the LP
  - normal upto 180mm of CSF
  - 180-200 are borderline and above 200 are abnormal, unless patient is obese when it can be as high as 250

- **spurious elevations** - caused by poor relaxation
- transmitted **venous pulsations** can cause small fluctuations, respiration causes larger fluctuations
- **it is the most reliable indicator of ICP**
- in *IIH, Pseudotumor cerebri, elevated OP is the only abnormality*
- in children, measuring the CSF pressure is difficult and **counting the number of drops** of CSF over specified time is simple and rapid method

CSF studies

- depend on the clinical circumstances
- **minimum requested** are
  - cell count, differential
  - glucose
  - protein
- normal CSF contain upto **5 lymphocytes, no neurotrophils**
- **normal glucose** is 1/2 to 2/3 of blood glucose
- **normal protein** varies ; intraventricular protein is much lower than LP protein; generally less than 40

- for accurate CSF glucose, *blood samples should be drawn 2 hours prior to LP or the LP is done in fasting state*
- **additional tests**
  - Gm stain, cultures and cytology
  - PCR
  - 14-3-3 protein for prion disease
  - beta amyloid
  - tau
  - heavy and light neurofilaments
  - serology for CEA, AFP,
  - antinuclear antibodies
  - ACE
  - antineuronal antibodies, anti Purkinje antibody
  - lyme's disease
  - tumor markers
- **CSF cisternography**

- **common patterns**
  - normal
  - acute bacterial infection
  - aseptic meningeal pattern
  - albuminocytologic dissociation pattern
- **ACUTE BACTERIAL INFECTION**
  - markedly incresaed cell count, primarily PMNs
  - elevated protein
  - decreased sugar
  - glucose can be as low as less than 10mg/dl or zero

- **ASEPTIC PATTERN**
  - elevated cell count, primarily lymphocytes
  - elevated protein
  - normal sugar (sometimes normal to moderately low)
- aseptic means pattern not of acute bacterial
- produced by
  - viral infections
  - tuberculosis
  - fungal infection
  - neoplastic meningitis
  - partially treated bacterial meningitis
  - parameningeal infections
  - parasitic infection

- **ALBUMINOCYTOLOGIC DISSOCIATION**
  - seen in GBS
  - elevated protein
  - sometimes extremely elevated
  - abscence of increased cell count

- **DYSIMMUNE DISEASE** - multiple sclerosis, demyelinating diseases
  - normal routine studies
  - CSF may contain elevated Ig, caused by synthesis of IG within nervous system
  - it must be compared to albumin level
  - other conditions
    - neurosyphilis, chronic infections, inflammatory conditions

Thank you