Ventricles of Brain and CSF Circulation

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• The ventricles are four fluid-filled cavities located within the brain; these are the two lateral ventricles, the third ventricle, and the fourth ventricle.

• The ventricles are lined throughout with ependyma and are filled with cerebrospinal fluid.
Figure 17.1: Ventricular system of the brain seen from the lateral side
• Lateral Ventricles:
• There are two large lateral ventricles, and one is present in each cerebral hemisphere.
• The ventricle is a roughly C-shaped cavity and may be divided into a body, which occupies the parietal lobe and from which anterior, posterior, and inferior horns.
Figure 17.2: Parts of the lateral ventricle
• **Third Ventricle:**

• The third ventricle is found between the two thalami.

• It communicates anteriorly with the lateral ventricles through the interventricular foramina and posteriorly with the fourth ventricle through the cerebral aqueduct.
Ventricles of the Brain

- Lateral ventricles
- Anterior horn
- Interventricular Foramen – connects LV and 3rd V
- Third ventricle
- Cerebral aqueduct – connects 3rd and 4th V
- Fourth ventricle
- Central canal of spinal cord

(a) Anterior view
(b) Left lateral view
Cerebral Aqueduct

- The cerebral aqueduct a narrow channel connects the third ventricle with the fourth ventricle.
Fourth Ventricle

• The fourth ventricle is a tent-shaped cavity filled with cerebrospinal fluid. It is situated anterior to the cerebellum and posterior to the pons and the superior half of the medulla oblongata.
CEREBROSPINAL FLUID

• The cerebrospinal fluid is found in the ventricles of the brain and in the subarachnoid space around the brain and spinal cord.
• It has a volume of about 150 mL.
• It is a clear, colorless fluid and possesses, in solution, inorganic salts similar to those in the blood plasma.
• The glucose content is about half that of blood, and there is only a trace of protein.
• Only a few cells are present, and these are lymphocytes.
• **Functions:**
• The cerebrospinal fluid, which bathes the external and internal surfaces of the brain and spinal cord,
• serves as a cushion between the central nervous system and the surrounding bones,
• thus protecting it against mechanical trauma.
• **Formation:**

• The cerebrospinal fluid is formed mainly in the choroid plexuses of the lateral, third, and fourth ventricles.
Choroid Plexuses

• The choroid plexuses are highly vascular structures that are responsible for the formation of CSF.
Choroid plexus
The central nervous system requires a very stable environment in order to function normally.

This stability is provided by isolating the nervous system from the blood by the existence of the so-called blood-brain barrier and the blood–cerebrospinal fluid barrier.
Blood-Brain Barrier

• The permeability of the blood-brain barrier is inversely related to the size of the molecules and directly related to their lipid solubility.

• Gases and water pass readily through the barrier, whereas glucose and electrolytes pass more slowly.

• The barrier is almost impermeable to plasma proteins and other large organic molecules.
Capillary (general)

- Cell forming capillary wall
- Substance in blood
- Pore passage
- Lipid-soluble substances

Capillary (brain)

- Astrocyte
- Substance in blood
- Pore passage
- Lipid-soluble substances
- Tight junction (no pores)
- Carrier-mediated transport
Blood–Cerebrospinal Fluid Barrier

• There is free passage of water, gases, and lipid-soluble substances from the blood to the cerebrospinal fluid.

• Macromolecules such as proteins and most hexoses other than glucose are unable to enter the cerebrospinal fluid.

• It has been suggested that a barrier similar to the blood-brain barrier exists in the choroid plexuses.
Cerebrospinal Fluid (CSF) – Choroid plexus

- Ependymal cells
- Capillary
- Connective tissue of pia mater
- Cavity of ventricle
- Wastes and unnecessary solutes absorbed
- CSF forms as a filtrate containing glucose, oxygen, vitamins, and ions (Na⁺, Cl⁻, Mg²⁺, etc.)
Blood CSF barrier
• Functional Significance of the Blood–Brain and Blood–Cerebrospinal Fluid Barriers:

• In normal conditions, the blood-brain and blood–cerebrospinal fluid barriers are two important semipermeable barriers that protect the brain and spinal cord from potentially harmful substances while permitting gases and nutriments to enter the nervous tissue.
Clinical Notes

• **Hydrocephalus:**
  • Hydrocephalus is an abnormal increase in the volume of the cerebrospinal fluid within the skull.
  • If the hydrocephalus is accompanied by a raised cerebrospinal fluid pressure, then it is due to one of the following:
    • (1) an abnormal increase in the formation of the fluid,
    • (2) a blockage of the circulation of the fluid or
    • (3) a diminished absorption of the fluid.
Blood-Brain Barrier in the Fetus and Newborn

• In the fetus, newborn child, or premature infant, where these barriers are not fully developed, toxic substances such as bilirubin can readily enter the central nervous system and produce yellowing of the brain and kernicterus.

• This is not possible in the adult.
Jaundice

Yellowing of eyes

Yellowing of skin

Excess bilirubin in blood

Kernicterus

Bilirubin moves from bloodstream into brain tissue
Drugs and the Blood-Brain Barrier

• In Parkinson disease, there is a deficiency of the neurotransmitter dopamine in the corpus striatum.

• Dopamine cannot be used in the treatment, as it will not cross the blood-brain barrier.

• L-Dopa readily crosses the barrier and has been used with great success.