Unit VIII – Problem 6 – Physiology: Cerebrospinal Fluid (CSF)

- **Functions of cerebrospinal fluid (CSF): memorize 3 functions for the exam**
  - Reducing the weight of brain from 1500g (in dry air) to 50g only! thus protecting brain from injuries.
  - Removing waste products of cellular metabolism from the nervous system.
  - Providing nutrients for both neurons and glial cells.
  - Maintaining the constancy of the ionic composition.
  - Acting as a transport system (for hormones and chemical substances).
  - Serving as a lymphatic system.
- **Production of CSF:**
  - **60% is produced from choroid plexuses** (which are mainly present in lateral and 4th ventricles). Choroid plexuses are clusters of interwoven capillaries covered by a layer of ependymal cells. They allow the exit of sodium and chloride to cavity of ventricles → this is going to generate a difference in osmotic pressure → therefore, water will follow Na and Cl to cavity of ventricles.
  - **40% is produced by the ependymal lining of ventricle walls.**
    Notes:
    - ✓ Total daily production of CSF: 400-500 ml/day.
    - ✓ CSF pressure: 130-150 mmH_2O
- **Absorption of CSF:**
  - **This is occurring through arachenoid villi which possess a one-way valve:**
    - ✓ When CSF pressure is increased (more than pressure of venous blood) → these valves will open allowing CSF to enter the venous blood in superior sagittal sinus. If CSF pressure is low (lower than pressure of venous blood) → venous blood will not be allowed to enter the subarachenoid space.
- **Circulation of CSF: read neuroanatomy note.**
- **Hydrocephalus:**
  - **Definition**: increased volume in cerebral ventricles.
  - **Causes**:
    - ✓ Oversecretion (increased production).
    - ✓ Obstruction of flow.
    - ✓ Impaired reabsorption.
  - **Types:**
    - ✓ Non-communicating: occurring when there is obstruction of CSF flow in ventricles especially in narrow places such as cerebral aqueduct.
    - ✓ Communicating: occurring when there is impaired CSF absorption in arachenoid granulations or obstruction of CSF in subarachenoid space.
    - ✓ Normal pressure: it is a form of communicating hydrocephalus in which CSF is not absorbed. The ventricles will be dilated and there will be thinning of the brain (death of brain cells) → resulting in the triad of:
      - ❖ Dementia.
      - ❖ Apraxic gait.
      - ❖ Urinary incontinence.

      Note: this condition is treated by peritoneal or jugular shunt.
    - ✓ Hydrocephalus ex vacuo: when there is brain damage → the damaged area will be occupied by CSF which will lead to compression and act as if there is a tumor.
- **Hydrocephalus in babies:**
  - **Non-communicating (due to obstruction of CSF flow)**: ventricular volume will be increased and the skull is going to enlarge very little because the fluid is expanding to eat brain tissue → this results in retardation.
  - **Communicating**: in which the skull is tremendously enlarged.

- **Lumbar puncture (L3-L4 in adults… L4-L5 in children):**
  - **Uses:**
    - ✓ Anesthesia (epidural block).
    - ✓ Administration of antibiotics (intrathecal).
    - ✓ CSF sampling. Normally:
      - ❖ Color: clear.
      - ❖ Cells: no neutrophils - < 5 lymphocytes/ml^3
      - ❖ Glucose: 66% of plasma glucose level.
      - ❖ Proteins: 0.4 g/l
    - ✓ Diagnostic and therapeutic issues (myelography).
  - **CSF pressure may rise due to:**
    - ✓ Brain tumor: causing decreased reabsoprtion of CSF.
    - ✓ Hemorrhage of infection: RBCs or WBCs in large amounts may block arachenoid villi channels.
    - ✓ Congenital: little number of arachenoid villi or abnormal absorptive properties.
- **Blood-brain barrier:**
  - **What is forming the blood brain barrier (memorize 2-3 for the exam):**
    - ✓ Pinocytotic vesicles.
    - ✓ Mitochondria.
    - ✓ Inter-endothelial tight junctions.
    - ✓ Basal lamina.
    - ✓ Astrocyte foot.
    - ✓ Pericytes.
- **Blood-CSF barrier:**
  - **Definition**: blood vessels in contact with CSF in choroid plexus.
  - **It is allowing the passage of substances more than blood-brain barrier (Why?)** → because these substances are needed for the production of CSF.
- **Area postrema in medulla is responsible for vomiting reflex** → this area is sensitive to toxic substances present in the blood → so it must have access to the blood to detect them and initiate vomiting (protective mechanism) → so this area lacks blood-brain barrier. other areas include: pineal gland and hypothalamus.