Biochemistry of biological fluids (BIOCH 472)

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Class 7:

Cerebrospinal Fluid (CSF)

Objectives for this lecture

- State the major functions of cerebrospinal fluid (CSF).
- State the normal CSF values.
- Briefly explain the methods used

Cerebrospinal Fluid (CSF)

CSF Function:

- Supply nutrients to the nervous tissue.
- Remove metabolic wastes.
- Mechanical barrier to cushion the brain and spinal cord against trauma.

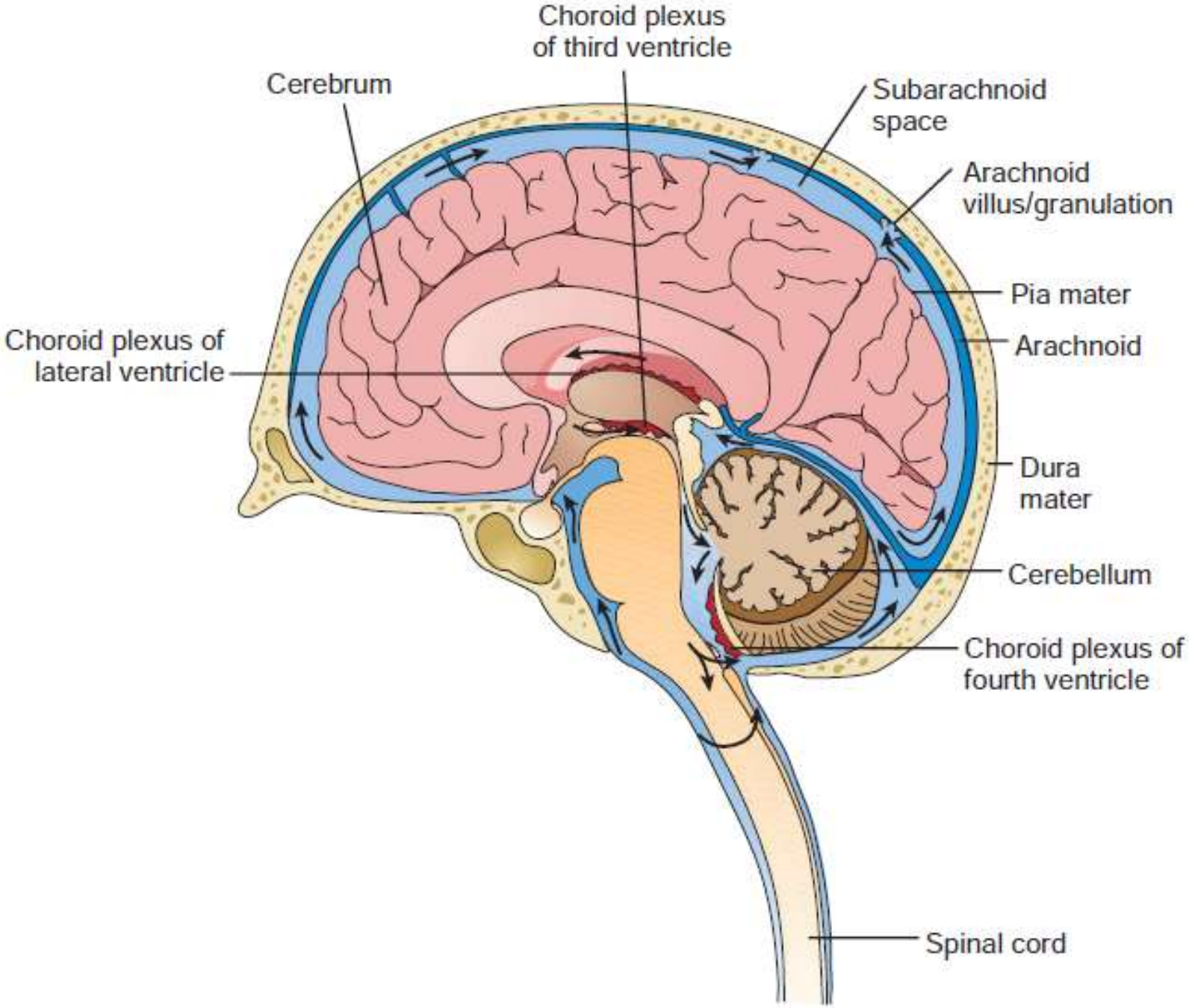
CSF sturcture

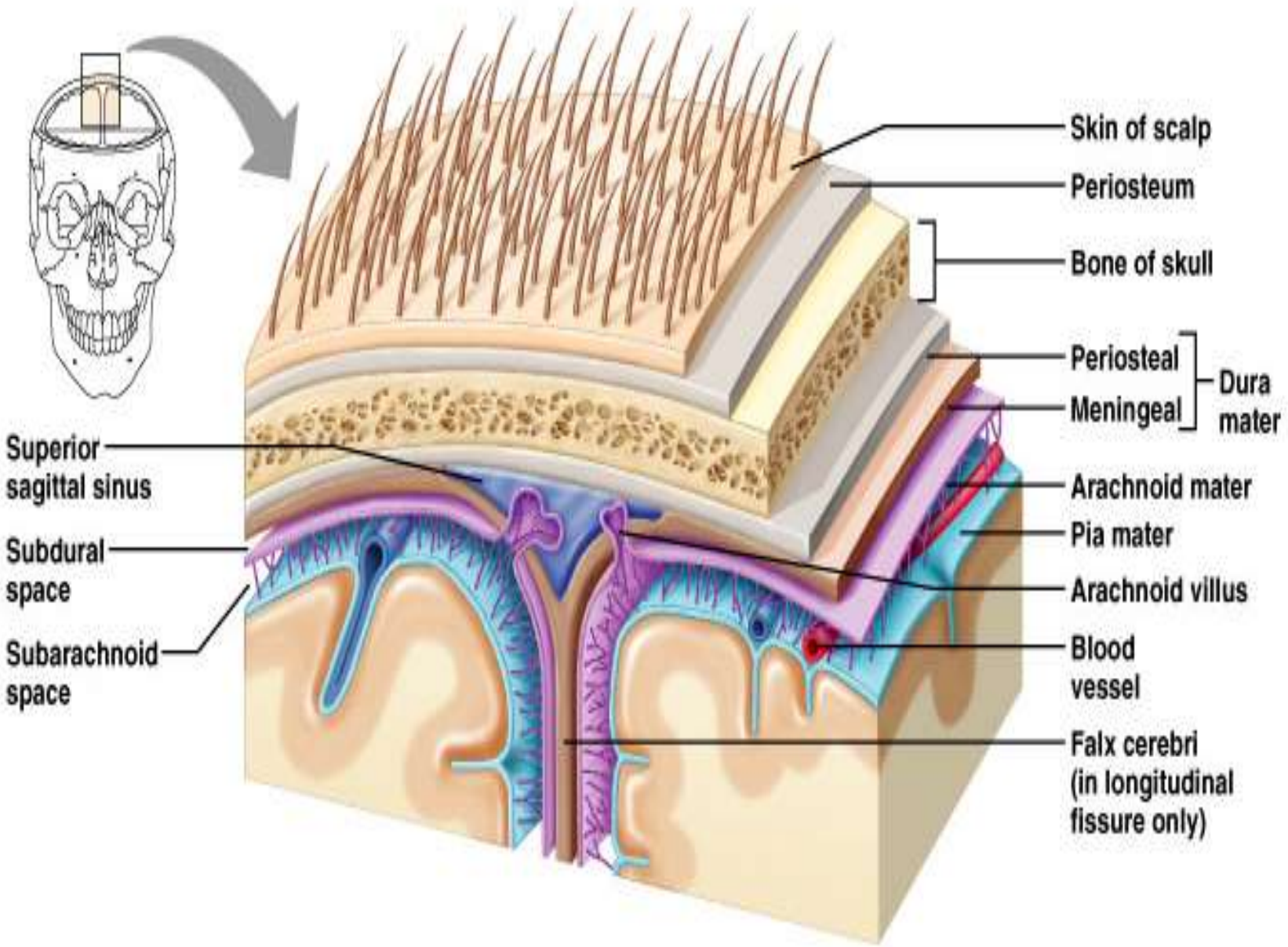
- Brain and spinal cord are lined by the ***meninges,*** which consists of three layers:

1. Dura mater… outer, lines skull & vertebral canal.

2. Arachnoid… inner, filamentous membrane.

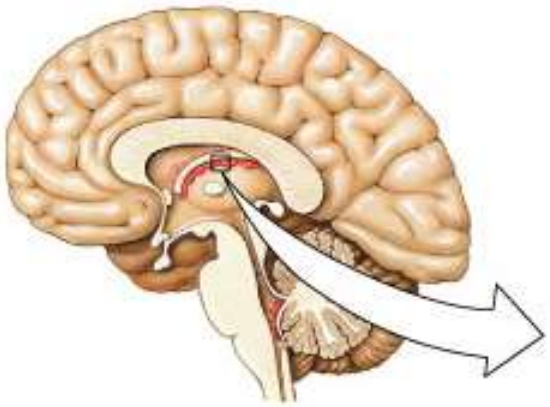
3. pia mater…. thin membrane lining the surfaces of the brain and spinal cord.

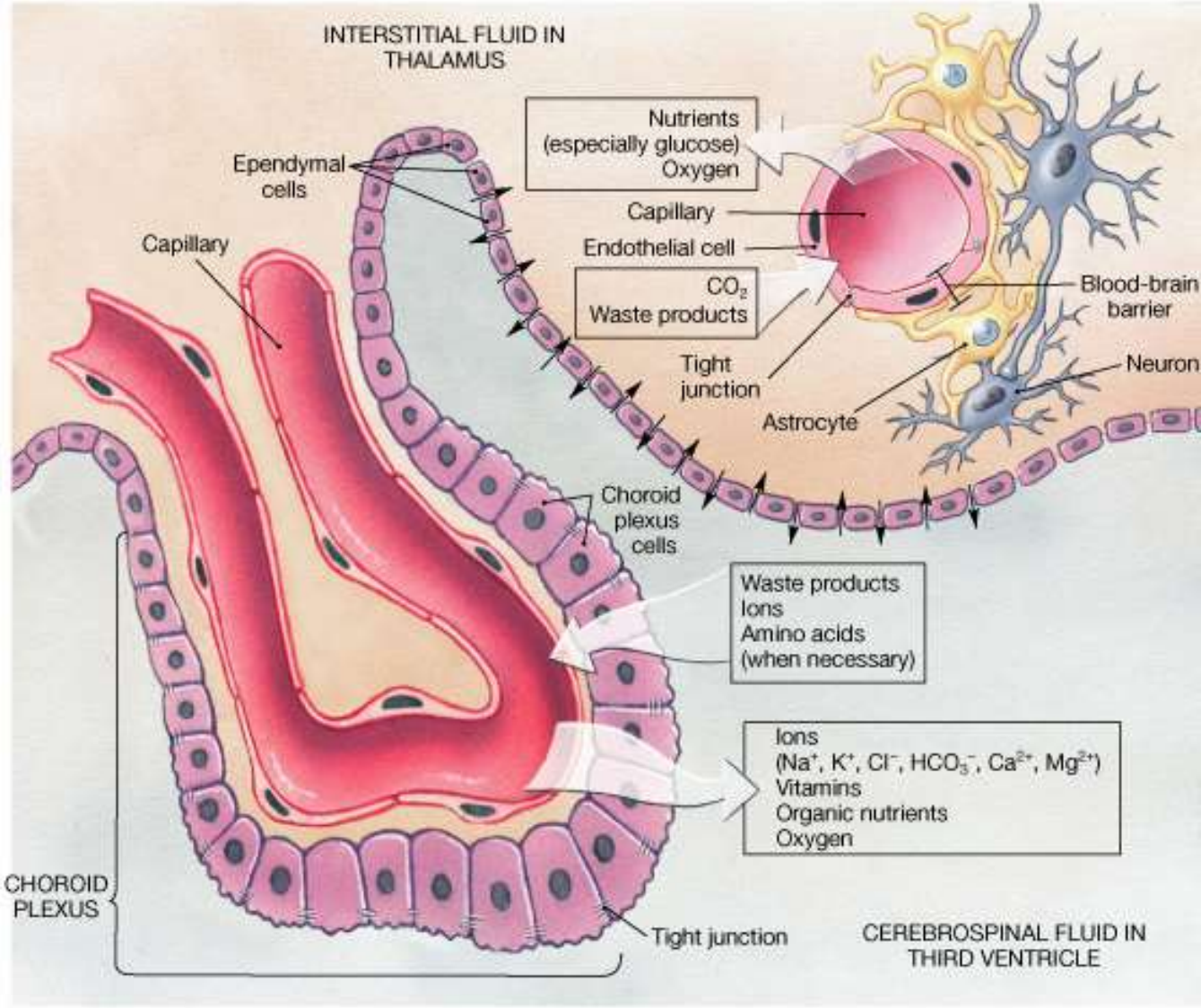

Choroid plexus
of third ventricle
Cerebrum
Subarachnoid
space
Arachnoid
villus/granulation
Pia mater
Choroid plexus of
lateral ventricle
Arachnoid
Dura
mater
Cerebellum
Choroid plexus of
fourth ventricle
Spinal cord


Skin of scalp
Periosteum
Bone of skull
Periosteal
Meningeal
Dura mater
Superior sagittal sinus
Arachnoid mater
Pia mater
Subdural space
Arachnoid villus
Subarachnoid space
Blood vessel
Falx cerebri (in longitudinal fissure only)

(a)

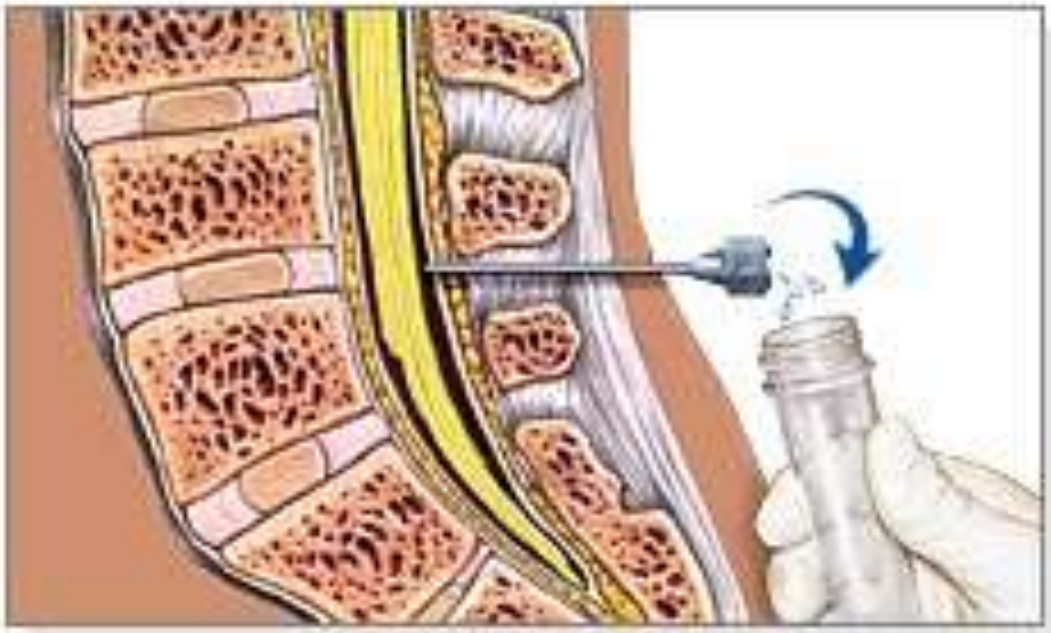
- CSF is produced in the ***choroid plexuses*****,** from plasma by selective filtration.
- Endothelial cells in the choroid plexses act as *blood-brain barrier (BBB)*.
- Adults produced 20 mL of fluid every hour.
- Average volume in adults is 90 to 150 mL and 10 to 60 mL in neonates.




INTERSTITIAL FLUID IN THALAMUS
Nutrients (especially glucose) Oxygen
Ependymal cells
Capillary
Capillary
Endothelial cell
CO_2 Waste products
Blood-brain barrier
Tight junction
Neuron
Astrocyte
Choroid plexus cells
Waste products Ions Amino acids (when necessary)
Ions (Na^+, K^+, Cl^-, HCO_3^-, Ca^{2+}, Mg^{2+}) Vitamins Organic nutrients Oxygen
CHOROID PLEXUS
Tight junction
CEREBROSPINAL FLUID IN THIRD VENTRICLE

CSF Collection & Handling

- collected by lumbar puncture between the third, fourth, or fifth lumbar vertebrae.
- Collected volume of CSF depend on:
  - Volume available in the patient (adult vs. neonate)
  - Opening pressure of the CSF



Spinal fluid is collected for testing

CSF Collection & Handling

- Specimens are collected in three sterile tubes, which they are labeled *as they withdrawn*:

Tube 1: chemical and serologic tests. (froz.)

Tube 2: microbiology. (RT)

Tube 3: cell count (least contain cells introduced by the *sample tap procedure*). (Rdf)

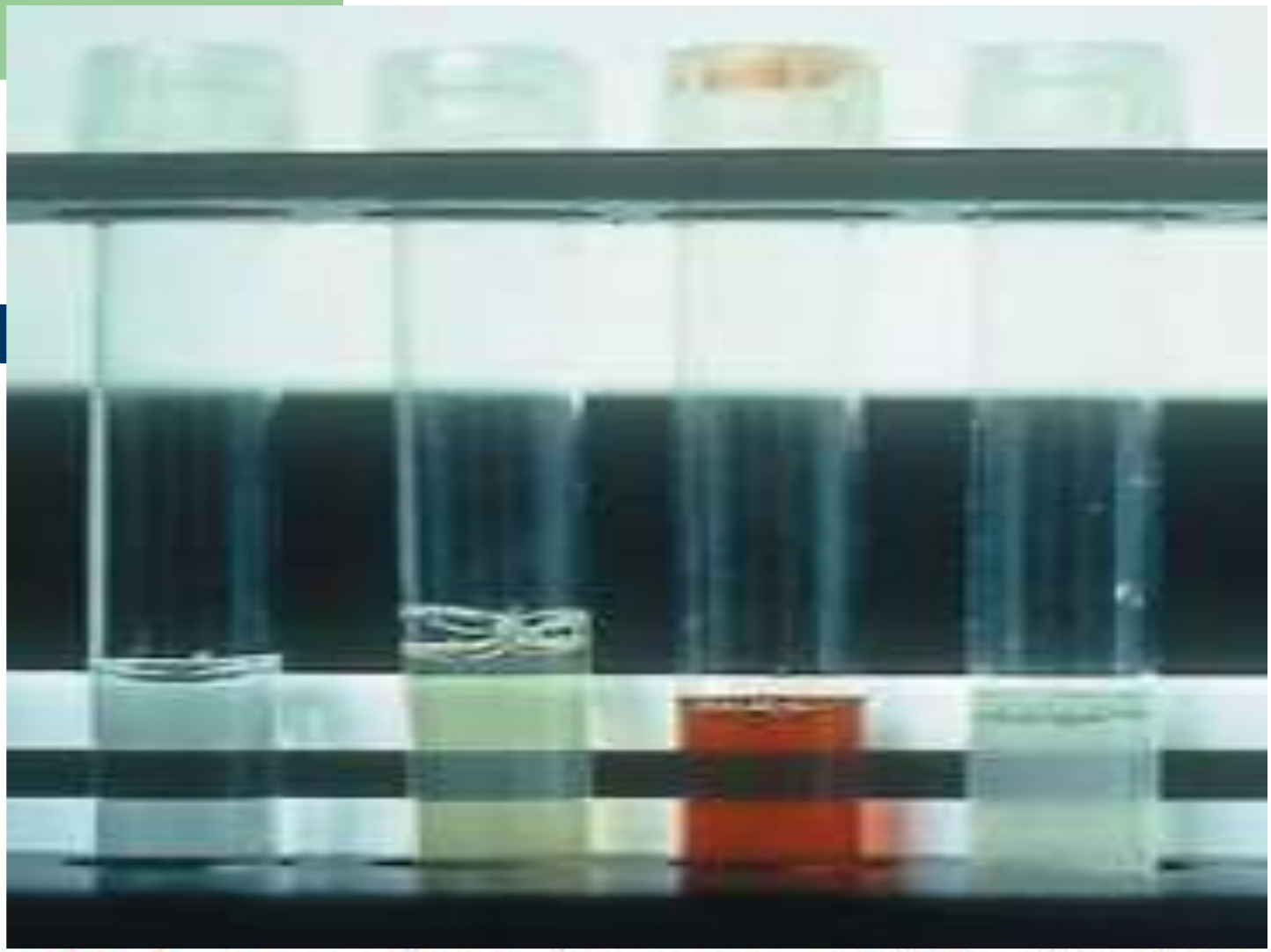


Figure 10–3 Tubes of CSF. Appearance left to right is normal, xanthochromic, hemolyzed, and cloudy.

CSF Appearance

- *crystal clear*
  - ✓ Normal specimen.
- *cloudy or turbid, milky*
  - ✓ high protein or lipid concentration.
  - ✓ WBCs in infection (Meningitis).
  - ✓ Production of IgG within the CNS.
  - ✓ Diseases in which damage to BBB.

CSF Appearance

- *Xanthochromic*
  - ✓ pink, orange, or yellow.
  - ✓ RBC degradation.
  - ✓ elevated serum bilirubin.
  - ✓ pigment carotene.
- *Hemolyzed / bloody*
  - ✓ RBCs from hemorrhage.
  - ✓ RBCs from traumatic tap.

Cell Count for CSF

- Performed immediately, because *WBCs* and *RBCs* begin to lyse within 1 hour.
- *macrophages* containing ingested RBCs indicative of intracranial hemorrhage.
- bacterial meningitis, viral, fungal, tubercular, and parasitic meningitis (*Neutrophils, Lymphocytes and Monocytes*).
- Increased *eosinophils* is seen in introduction of foreign material, including medications.

Chemistry Tests for CSF

- *Protein: (albumin, globulin, transferrin, IgG)*
    1. Normal concentration is 15 to 45 mg/dL.
    2. Elevated in patients with meningitis, hemorrhage, and multiple sclerosis.
- *Glucose: (test immediate due to glycolysis)*
    1. Normal value is 60% to 70% of the plasma concentration.
    2. Decreased in bacterial, tubercular, and fungal meningitis.

Chemistry Tests for CSF

- *Lactate: (occur normally on oxygen deprivation)*

1. >35 mg/dL in bacterial meningitis.
2. >25 mg/dL in tubercular.
3. Lower levels in viral meningitis and fungal meningitis.

- *Glutamine: (remove toxic ammonia from CNS)*

1. Normal concentration is 8 to 18 mg/dL.
2. >35 mg/dL are associated with disturbance of consciousness (coma).

Microbiology Tests for CSF

- Identification of the causative agent in meningitis.
- CSF culture is a confirmatory rather than a diagnostic procedure.
- Microorganism is recovered from the fluid by growing it on culture medium:
  - 24 hours in cases of bacterial meningitis
  - 6 weeks for tubercular meningitis.
- Diagnostic methods: Gram stain, acid-fast stain, India ink preparation, latex agglutination tests.

Serologic Tests for CSF

- Detect the presence of neurosyphilis.
- *Serologic Tests:*
  - ✓ Venereal Disease Research Laboratories **(VDRL)**
  - ✓ Fluorescent treponemal antibody-absorption **(FTA-ABS)**

Bacterial meningitis

- Appearance : Cloudy
- WBC count : >100 cells/µL
- Glucose level : Low (< 40% of serum glucose)
- Protein level : Elevated (>50 mg/dL)

- https://youtu.be/SDMO4vYkqdg