Cerebrospinal fluid

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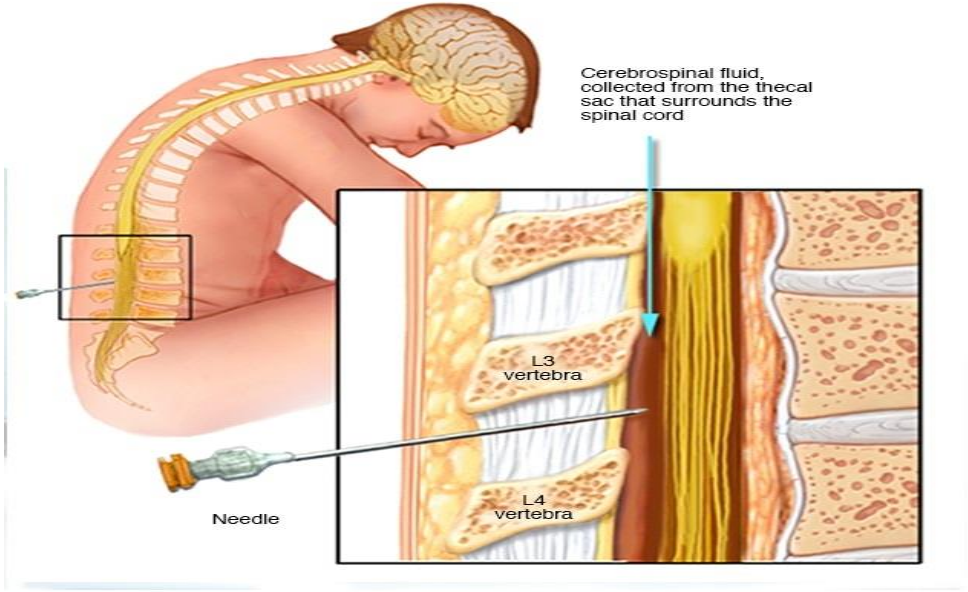


CSF

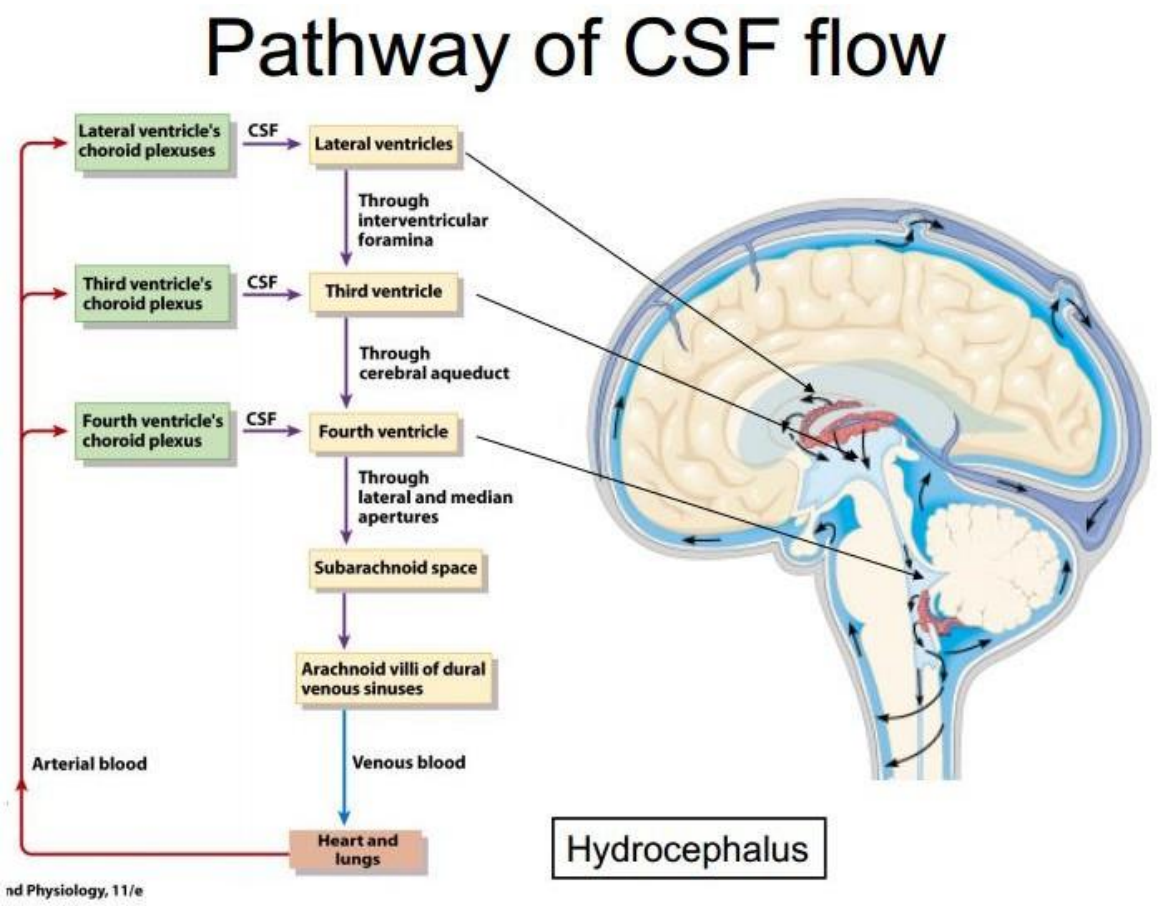
- CSF is a colorless, clear liquid that fills the ventricles (cavities) of the brain and the spinal cord.
- Acts as lubricant and a mechanical barrier against shock
- About 100 – 150 ml in adults
- 10 – 60 ml in infants - children
- It is mainly 99% water
- It has low amounts of protein and lipids compared to blood

CSF

- Formations
- Basically CSF is a secretion product of ultra filtration of blood
- Its composition is the result of material exchange between blood and adjacent brain tissue
- Circulates through the foramen of Monro from the two lateral ventricles to the third ventricle.
- Some of the CSF travels down the central canal of the spinal cord.

CSF

- Circulation



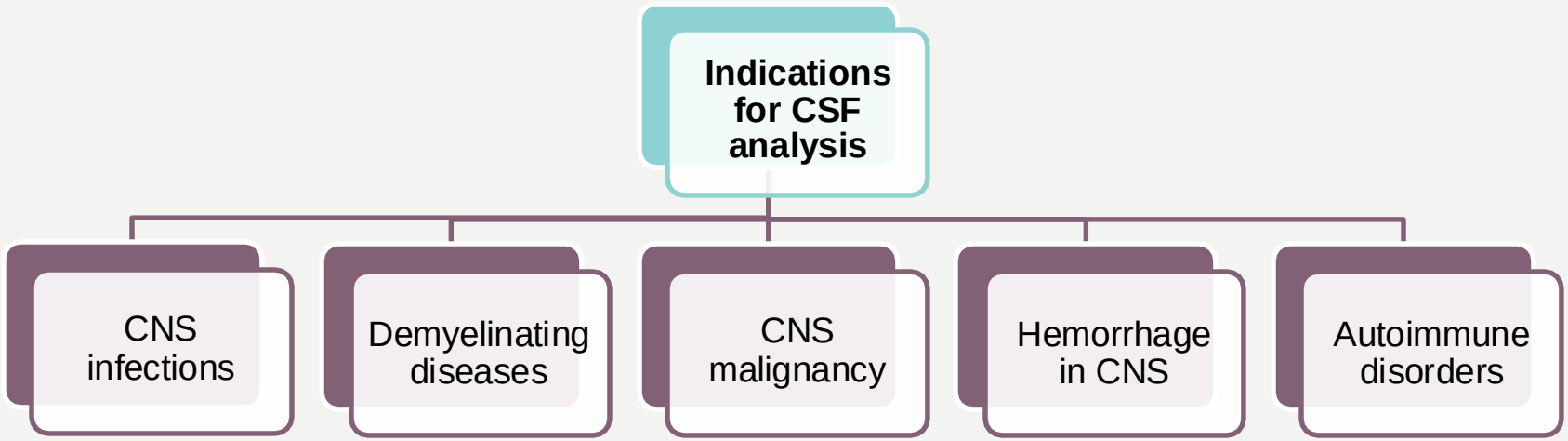
CSF

- Functions
- The central nervous system (CNS) : Brain and spinal cord are floating by the cerebrospinal fluid medium.
- This provides CNS with support and protection against rapid movements and trauma by acting as **cushion**
- CSF provides nutrition for both neuron and glial cells
- CSF functions as lymphatic system by providing medium for removing waste products of metabolism of CNS cells

CSF

- Functions
- CSF plays role in maintaining the micoenvironment like ionic concentration
- Might serve as transport system of biological active substances like co-factors, hormones, neurotransmitters and several metabolites
- As CSF and extracellular space of brain are in continuity, analysis of CSF provides information about the normal and pathological state of CNS function

CSF examination

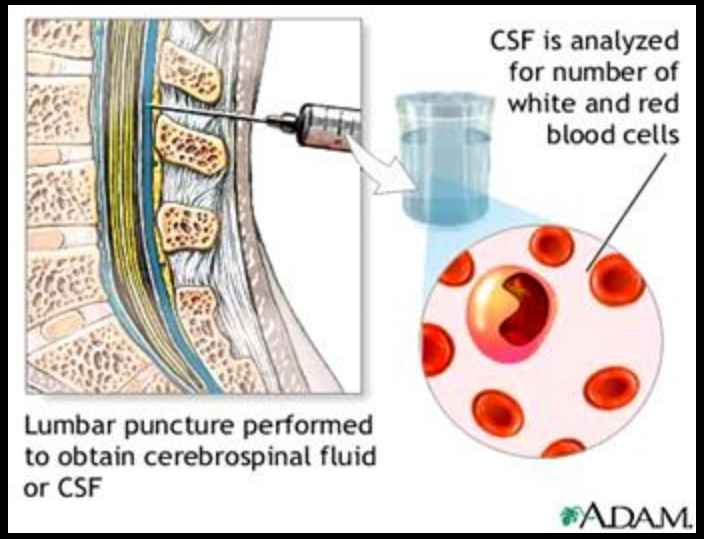


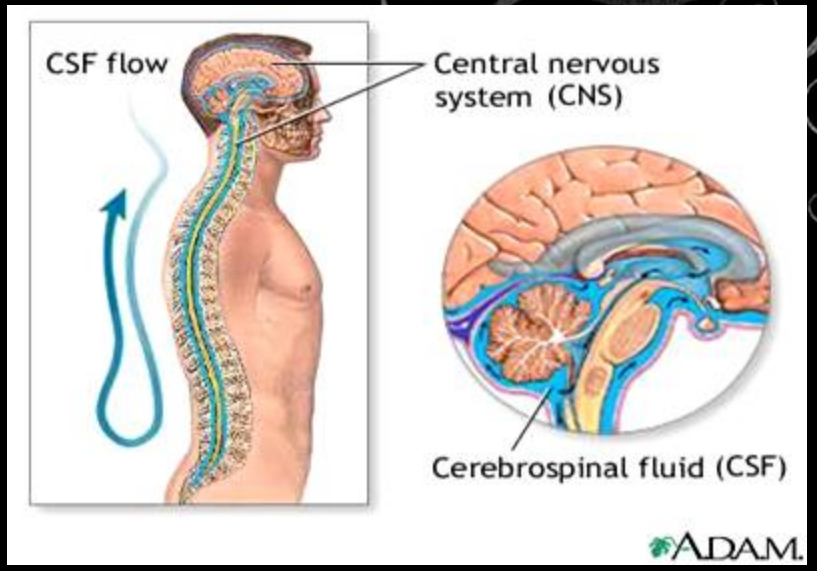
The following examinations performed for CNS samples:

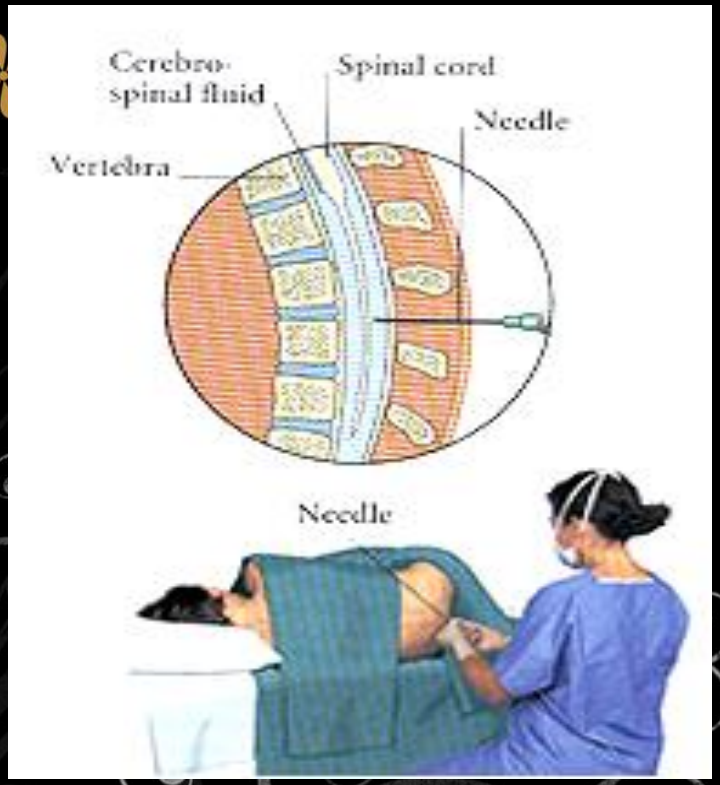
- Physical examination
- Chemical examination
- Microscopic examination
- Microbiological test

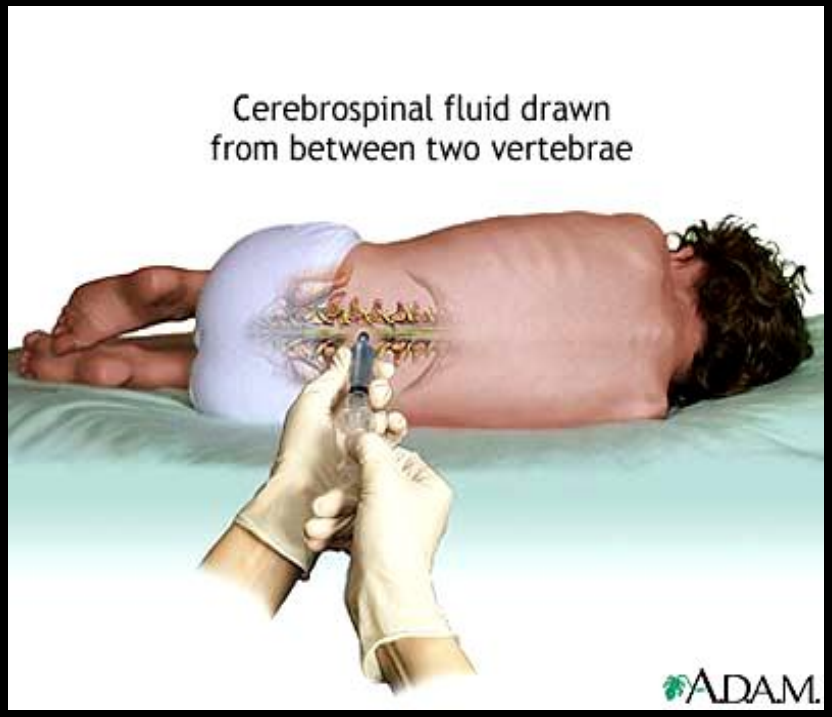
CSF

- Sample collection
- Lumbar puncture or spinal tap is the most common procedure of collecting CSF(Between L3, 4).
- Patient positioned on side with knees and chin tucking towards abdomen
- Occasionally can be done in sitting position bending forward
- Sterile conditions has to practiced throughout the procedure
- 10-20 ml can be collected as required


CSF is analyzed for number of white and red blood cells
Lumbar puncture performed to obtain cerebrospinal fluid or CSF
A.D.A.M.

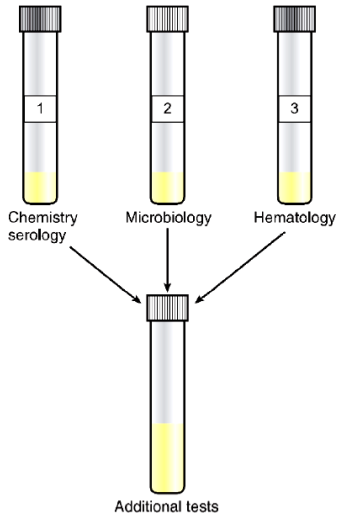

CSF flow
Central nervous system (CNS)
Cerebrospinal fluid (CSF)
A.D.A.M.


Cerebro-spinal fluid
Spinal cord
Needle
Vertebra
Needle


Cerebrospinal fluid drawn from between two vertebrae
A.D.A.M.

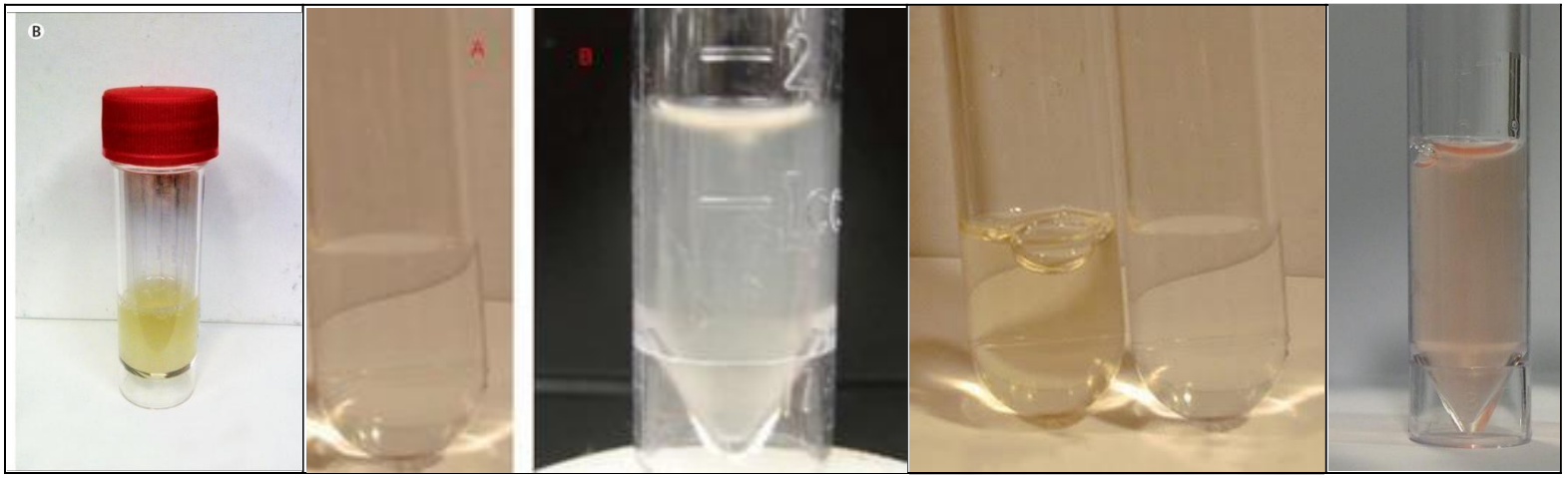
CSF

- Sample collection
- Sample must be collected under sterile conditions
- Proper labeling should be done before collecting
- Immediate examination is required
- Usually collected in 3 tubes
  - Chemical analysis
  - Microbiology
  - Cell count



CSF analysis

Physical examination	Color :
Appearance	Normal CSF is colorless clear liquid. Looks almost similar to water (crystal clear) Cloudy or turbid, milky appearance indicate abnormal conditions like presence of RBC, microorganisms etc……
Specific gravity	1.006 – 1.008



CSF analysis

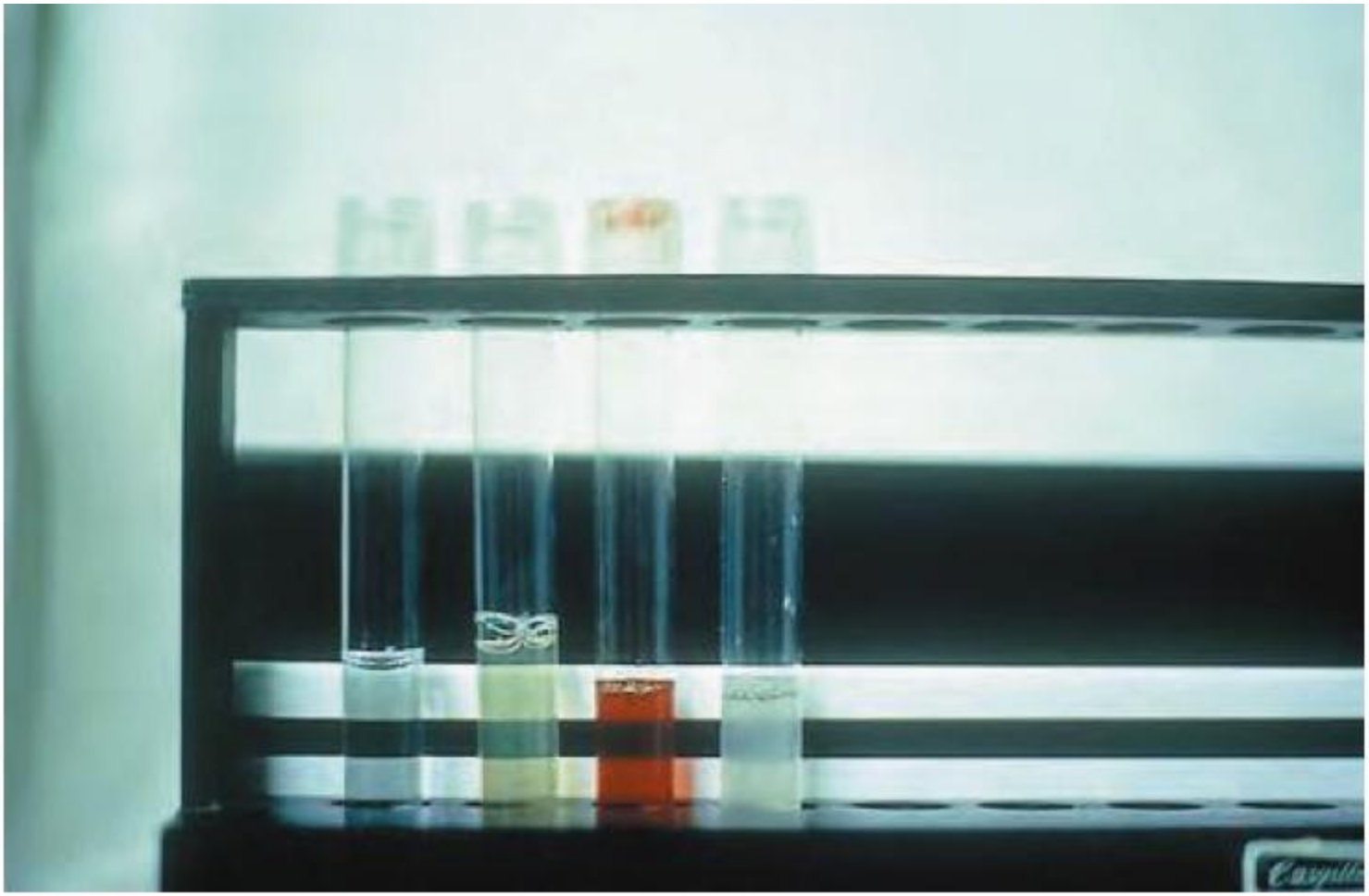


Figure 9–4 Tubes of CSF. Appearance left to right is normal, xanthochromic, hemolyzed, and cloudy.

CSF analysis

Physical examination	Color :
Appearance	**Xanthochromic CSF** •Xanthochromia is a term used to indicate pink/orange/yellow CSF which may be caused by the following conditions •Oxyhemoglobin from lysed **RBC** present before spinal tap or traumatic spinal tap •Bilirubin from lysed RBC or direct bilirubin with normal blood-brain barrier or in immature infants • High protein levels because of traumatic tap • Contamination from disinfectants used • Carotinoids in CSF due to hypercarotenemia •Melanin in CSF because of meningeal melanosarcoma

CSF analysis

Physical examination	Color :
Appearance	**Bloody appearance** • Highly bloody CSF indicate hemorrhage • It can also be due to puncture of blood vessel during spinal tap • It can be differentiated by…. •Uneven distribution of blood : traumatic tap shows more blood in first sample • traumatic tap often shows clear supernatant after brief centrifugation • Traumatic tap shows clot formation • Care should be taken while reporting •A recent hemorrhage would have the same properties as blood vessel damage

CSF analysis

Chemical examination	
pH	Normal CSF is alkaline in nature as plasma
Spontaneous clotting	•Occurs when there is an excess of fibrinogen in the specimen. • This usually associated with high protein concentration •Classically this is associated with tuberculous menengitis or tumors in CNS

CSF analysis

Chemical examination	• CSF is formed by filtration of plasma •Same chemicals can be found in CSF as plasma •How ever because of selective filtration process and the chemical composition is adjusted by the blood brain barrier, normal values of CSF chemicals are not the same as plasma values •Abnormal values can be attributed to alterations in the permeability of blood-brain barrier or increased metabolism by neuronal cells in response to pathological condition
Lactate	Measurement of lactate may be useful as part of investigation of inborn errors of metabolisms like • Disorders of gluconeogenesis • Disorders of pyruvate dehydrogenase complex • Disorders of Krebs cycle and ETC • Also in children with neurological diseases

CSF analysis

Chemical examination	
Proteins	Most frequently done test is protein determination. Normal CSF has very low amount. • Normal CSF protein is less than 1% of plasma •Usually 15 – 45 mg / dl Elevated protein can be found in • Froin's syndrome – complete spinal block) • Cerebral tumors • Meningitis •In all diseases there is **decreased clearance** of normal protein, and degeneration of neural tissue. • Increased local synthesis of Immunoglobulins •Increased capillary permeability due to blood brain barrier damage

CSF analysis

Chemical examination	
IgG – albumin index	The IgG-albumin index can be used to distinguish diseases affecting **permeability (meningitis, cerebral infarctions, tumors of the brain)** from diseases resulting in **increased immunoglobulin (usually IgG) synthesis** (multiple sclerosis) and some inflammatory diseases (idiopathic polyneuropathies). A normal range for this index has been proposed to be 0.34-0.58. In diseases associated with increased IgG production, the ratio is elevated, whereas in diseases affecting CSF permeability, the ratio is deceased because of increased CSF albumin concentration. Some disorders can affect both CSF IgG concentration and blood permeability.

CSF analysis

Chemical examination	
Glucose	Glucose enters CSF by active transport across blood brain barrier. CSF glucose is little lower than that of Plasma and is usually 60-70% of plasma Relative comparison has to be done with blood glucose
	Low CSF glucose can be of considerable diagnostics value in determining the causative agents in meningitis • An increased WBCs with large percentage of neutrophils indicate bacterial meningitis •WBCs count and later percentage of T cells indicate tubercular meningitis
	•Low glucose values can be associated with diseases of glucose transport, utilization of glucose by brain cells, bacteria and leukocytes

CSF analysis

Table 9–6 Major Laboratory Results for Differential Diagnosis of Meningitis

Bacterial	Viral	Tubercular	Fungal
Elevated WBC count	Elevated WBC count	Elevated WBC count	Elevated WBC count
Neutrophils present	Lymphocytes present	Lymphocytes and monocytes present	Lymphocytes and monocytes present
Marked protein elevation	Moderate protein elevation	Moderate to marked protein elevation	Moderate to marked protein elevation
Markedly decreased glucose level	Normal glucose level	Decreased glucose level	Normal to decreased glucose level
Lactate level >35 mg/dL	Normal lactate level	Lactate level >25 mg/dL	Lactate level >25 mg/dL
		Pellicle formation	Positive India ink with *Cryptococcus neoformans*
Positive Gram stain and bacterial antigen tests			Positive immunologic test for *C. neoformans*