

# Cerebrospinal fluid

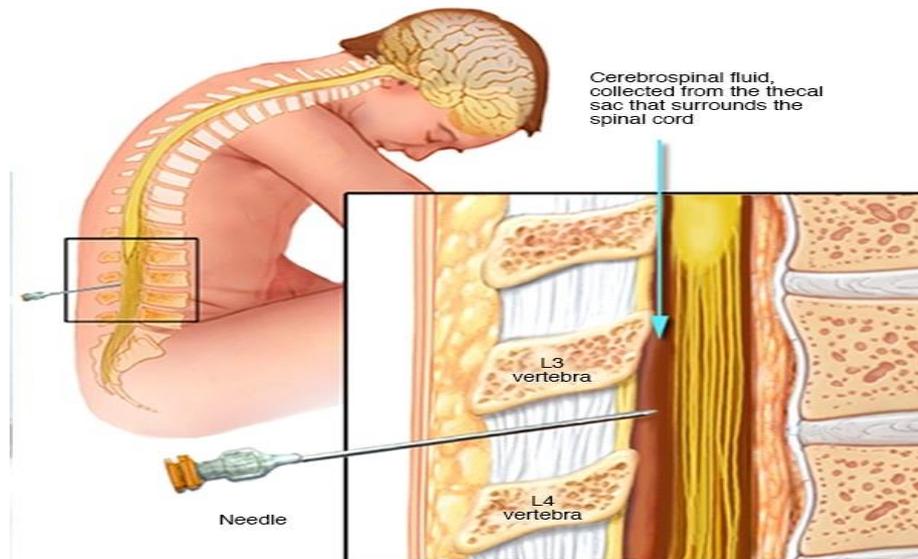
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By

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# CSF

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- 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

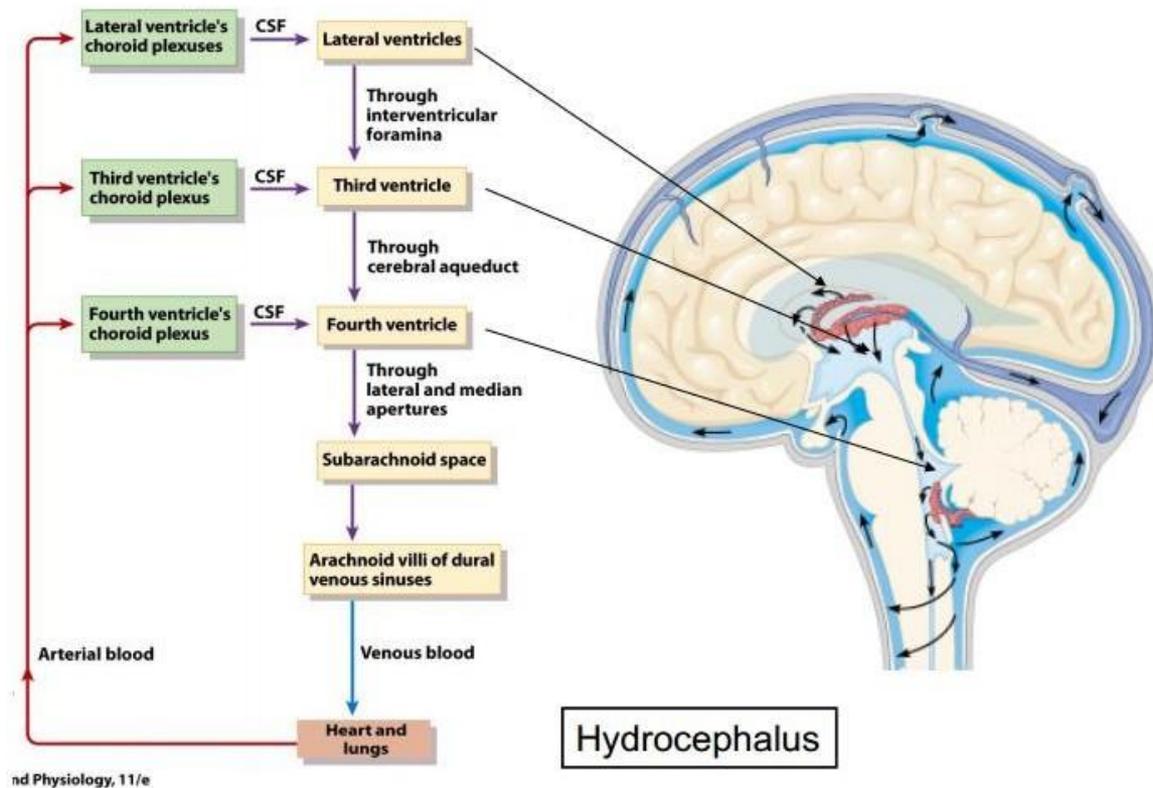
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- **Formations**
- Basically CSF is a secretion product of ultra filtration of blood
- Its composition is the result of material exchange between blood and adjacent brain tissue
- Circulates through the foramen of Monro from the two lateral ventricles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

# CSF

- Circulation

## Pathway of CSF flow



# CSF

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- **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

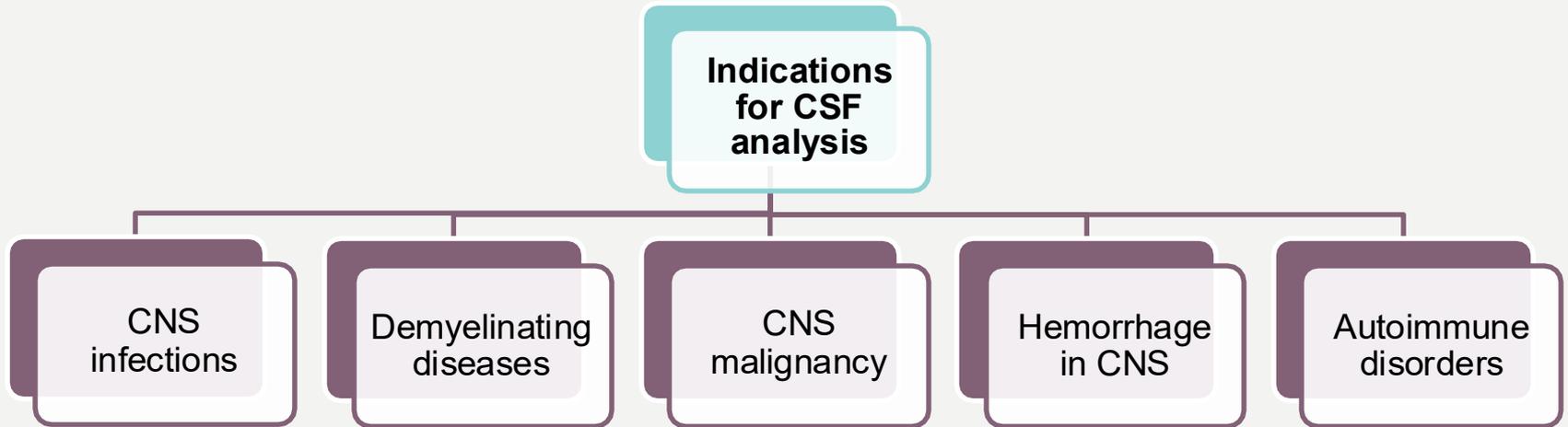
# CSF

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- **Functions**
- CSF plays role in maintaining the microenvironment 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

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The following examinations performed for CNS samples:

Physical examination

Chemical examination

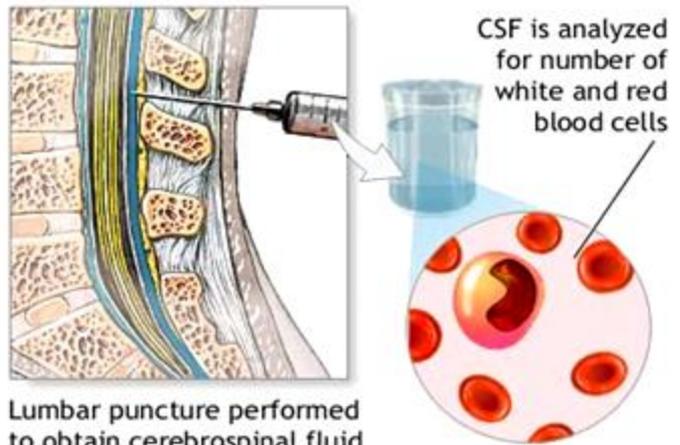
Microscopic examination

Microbiological test

# CSF

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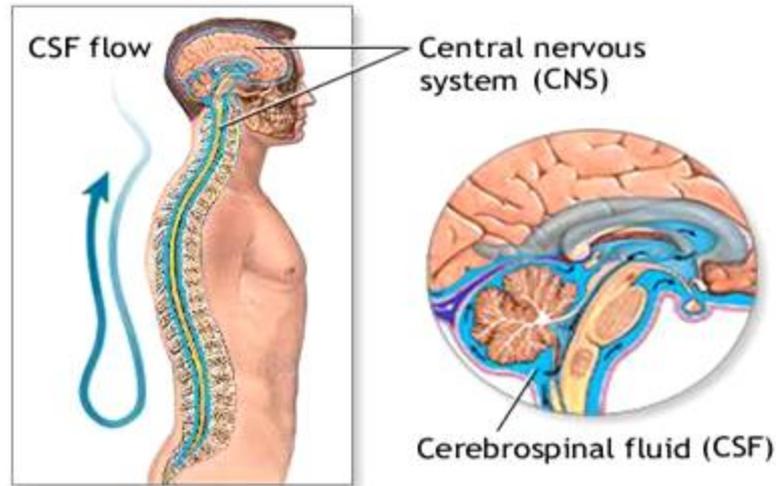
- **Sample collection**
- Lumbar puncture or spinal tap is the most common procedure of collecting CSF (Between L3, 4).
- Patient positioned on side with knees and chin tucking towards abdomen
- Occasionally can be done in sitting position bending forward
- Sterile conditions has to practiced throughout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

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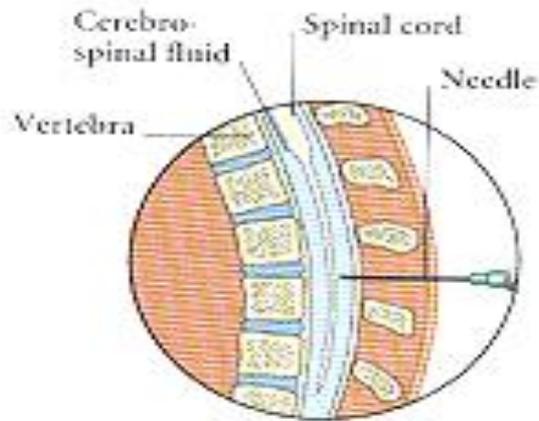


CSF flow

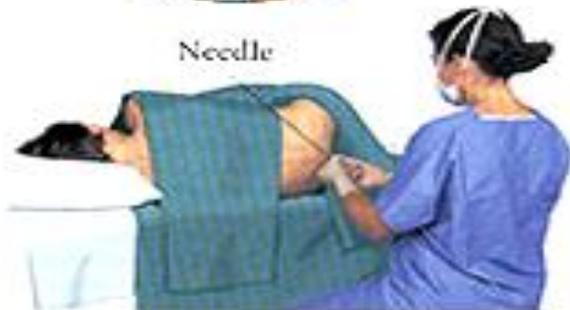
Central nervous system (CNS)

Cerebrospinal fluid (CSF)

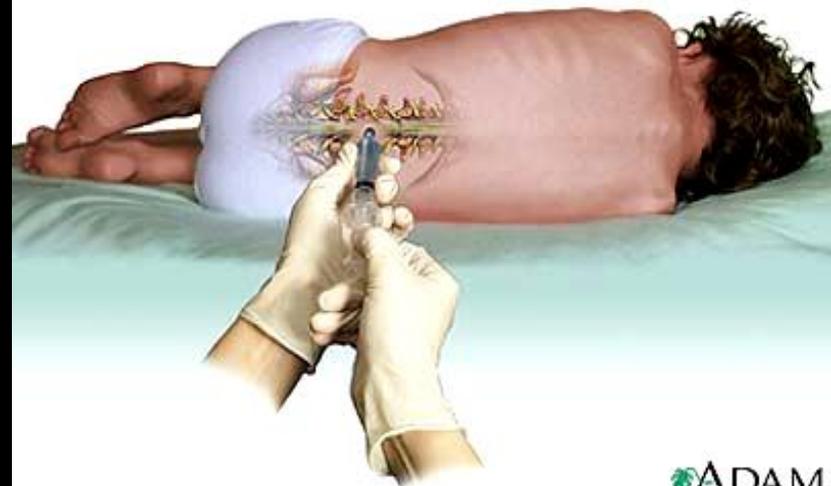
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Needle



Cerebrospinal fluid drawn from between two vertebrae

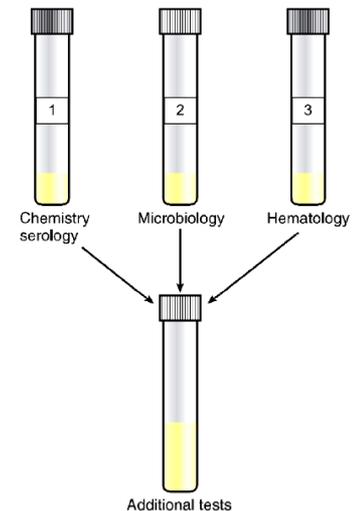


ADAM.

# CSF

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- **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

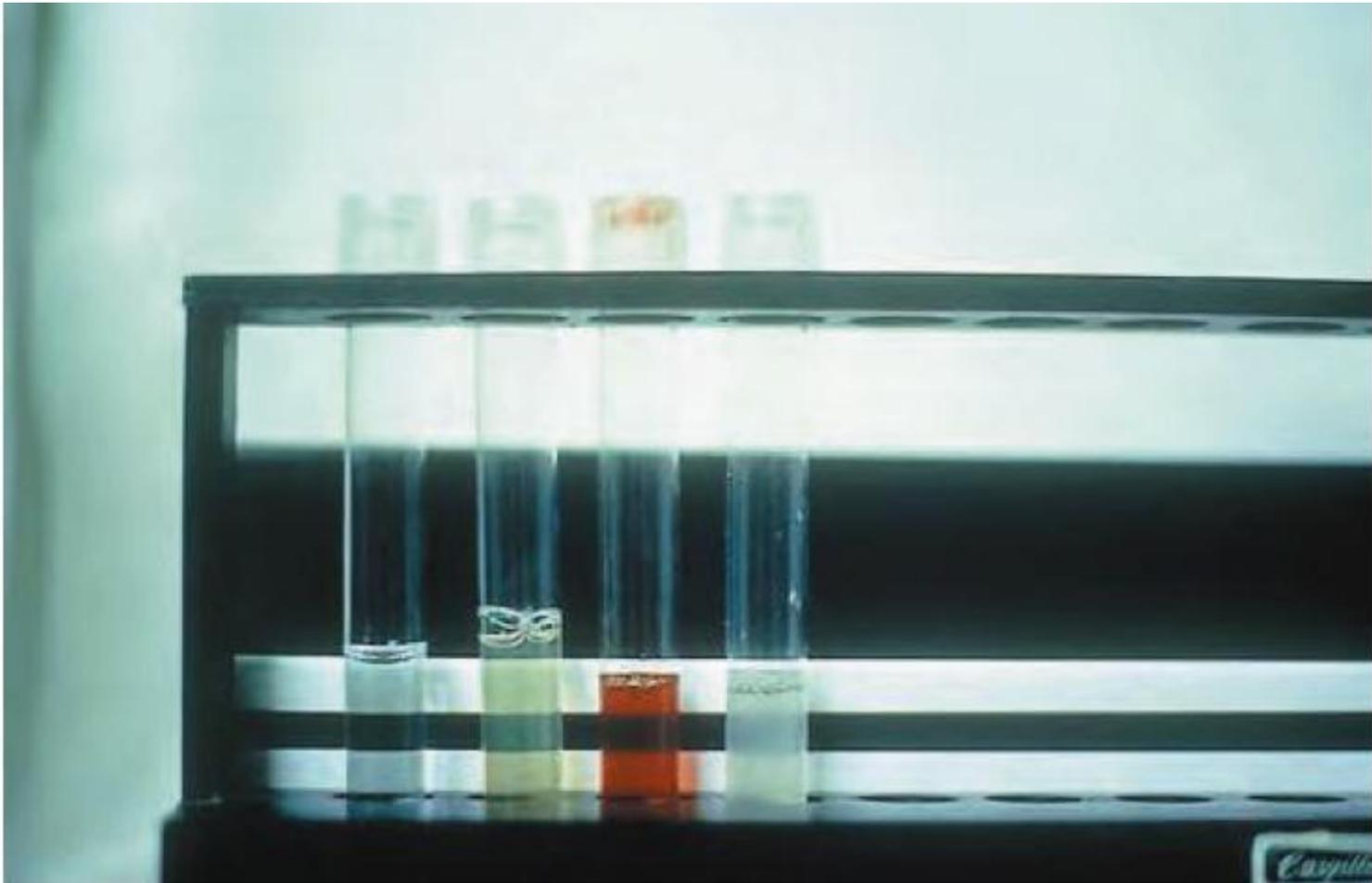


# CSF analysis

Physical examination	Color :
Appearance	<p>Normal CSF is colorless clear liquid. Looks almost similar to water (crystal clear)</p> <p>Cloudy or turbid, milky appearance indicate abnormal conditions like presence of RBC, microorganisms etc.....</p>
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	<p><b>Xanthochromic CSF</b></p> <ul style="list-style-type: none"><li>• Xanthochromia is a term used to indicate pink/orange/<u>yellow</u> CSF which may be caused by the following conditions</li><li>• Oxyhemoglobin from <u>lysed</u> <b>RBC</b> present before spinal tap or <u>traumatic</u> spinal tap</li><li>• Bilirubin from lysed RBC or direct bilirubin with normal blood-brain barrier or in immature infants</li><li>• High <u>protein</u> levels because of traumatic tap</li><li>• Contamination from <u>disinfectants</u> used</li><li>• <u>Carotinoids</u> in CSF due to hypercarotenemia</li><li>• <u>Melanin</u> in CSF because of meningeal melanosaarcoma</li></ul>

# CSF analysis

Physical examination	Color :
Appearance	<p data-bbox="703 348 1147 394"><b>Bloody appearance</b></p> <ul data-bbox="703 405 1702 1079" style="list-style-type: none"><li data-bbox="703 405 1586 451">• Highly bloody CSF indicate <u>hemorrhage</u></li><li data-bbox="703 462 1702 565">• It can also be due to puncture of blood vessel during spinal tap</li><li data-bbox="703 576 1329 622">• It can be differentiated by....</li><li data-bbox="703 634 1634 736">• Uneven distribution of blood : traumatic tap shows more blood in <u>first</u> sample</li><li data-bbox="703 748 1669 851">• traumatic tap often shows <u>clear</u> supernatant after brief centrifugation</li><li data-bbox="703 862 1476 908">• Traumatic tap shows <u>clot</u> formation</li><li data-bbox="703 919 1514 965">• Care should be taken while reporting</li><li data-bbox="703 976 1638 1079">• A recent hemorrhage would have the same properties as blood vessel damage</li></ul>

# CSF analysis

<b>Chemical examination</b>	
pH	Normal CSF is <u>alkaline</u> in nature as plasma
Spontaneous clotting	<ul style="list-style-type: none"><li>• Occurs when there is an excess of <u>fibrinogen</u> in the specimen.</li><li>• This usually associated with <u>high protein</u> concentration</li><li>• Classically this is associated with tuberculous meningitis or tumors in CNS</li></ul>

# CSF analysis

## Chemical examination

- CSF is formed by filtration of plasma
- Same chemicals can be found in CSF as plasma
- However 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 decreased 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 <i>Cryptococcus neoformans</i>
Positive Gram stain and bacterial antigen tests			Positive immunologic test for <i>C. neoformans</i>