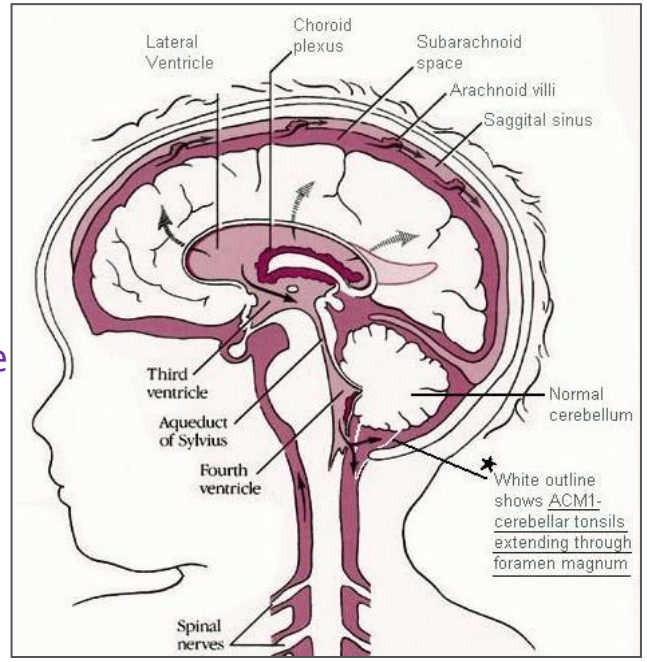
[lecture 6]

BODY FLUIDS: Cerebrospinal Fluid

- CSF is formed in the choroid plexus.
- It is essential for the physical protection of the
- The physical & chemical analysis of CSF is esse

for diagnosis of certain diseases.



Red = Import-ant

Blue = explain

Green = addition notes

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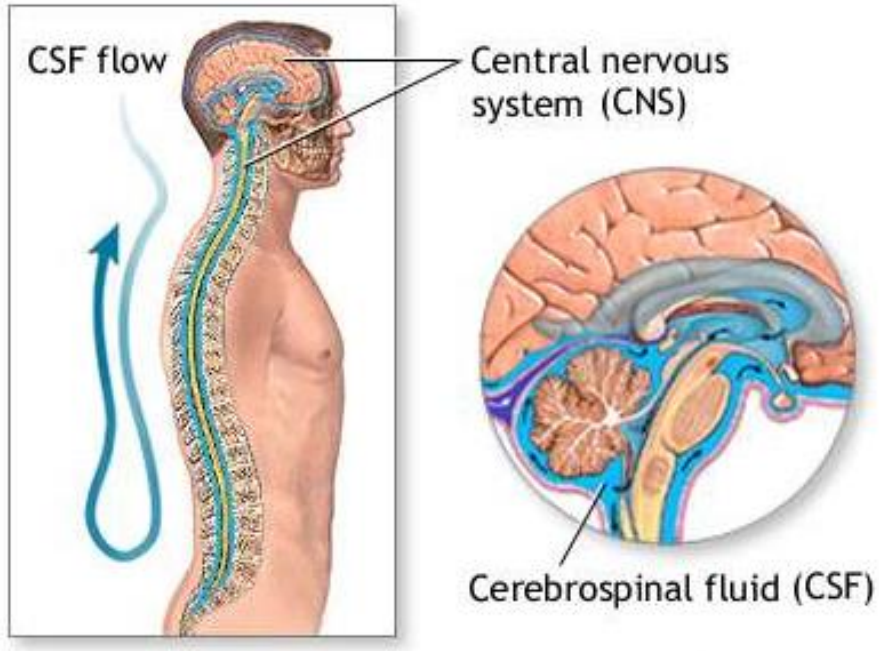
CSF definition:

The liquid surrounding the brain and spinal cord.
It **flows in subarachnoid area** (the space between the arachnoid & Pia matter)



Functions:

Physical support & protection
Provides a controlled chemical environment → **nutrient supply** & **waste removal**
Intra- & extracerebral transport: Neuroendocrine function

CSF Formation & Circulation

CSF is formed at the choroid plexuses & by the cells lining the ventricles.
Normal blood brain barrier is important for the normal chemistry results of CSF

Rate of formation: 500 ml/day

Mechanism of formation:

Selective ultrafiltration of plasma , Active secretion by epithelial membranes

Mechanism of excretion (absorption):

Excretion volume = production volume → **constant CSF volume**

Absorption occurs at the arachnoid villi protruding through the Dura to the **venous sinuses** of the brain→ **bloodstream**

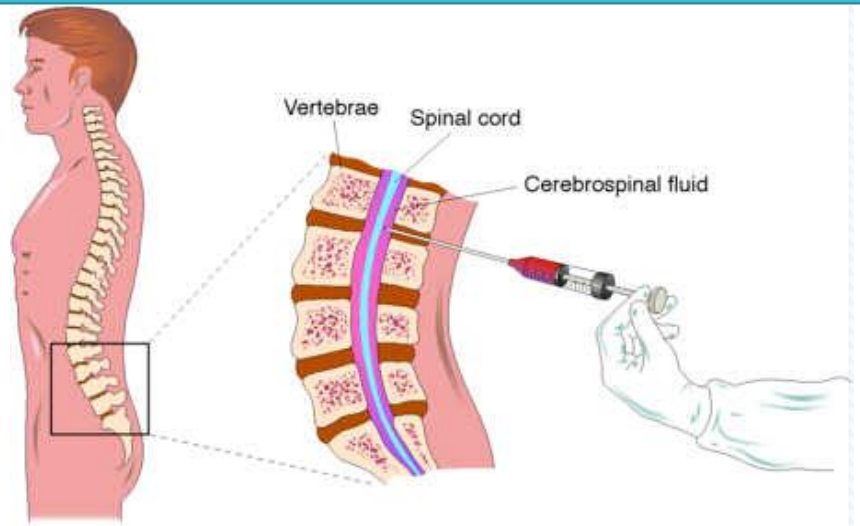
CSF Specimen Collection :

- Obtained by lumbar puncture (At the interspace L3-4, or lower)
- Using aseptic technique
- CSF is separated into 3 aliquots:
  - for chemistry & serology
  - for microbioloy
  - for cell count
- Immediate analysis
- It's a precious sample: Preserve any remaining sample

Contraindications for performing lumbar puncture:

1. Bleeding diathesis
2. Increased intracranial pressure
3. Infection at site of needle insertion

Method of CSF Sampling



Traumatic tap (damage to blood vessel during specimen collection) → blood in CSF

Indications for laboratory investigation of CSF:

1. CNS *infection*
2. *Demyelinating* diseases
3. CNS *Malignancy*
4. *Hemorrhage* in CNS

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Examination of CSF:

1- Physical examination

Normal CSF is:

- Colorless.
- Clear.
- Free of clots.
- Free of blood.

If CSF is cloudy (turbid) perform microscopic examination:

- Is usually due to leucocytes. (cells)
- May be due to micro-organisms. (organisms)

Blood & Hemoglobin pigments in CSF:

Traumatic tap

- bright red color, (fresh).
- RBCS in decreasing number as the fluid is sampled.

Subarachnoid hemorrhage (SAH)

- **Xanthochromia**, (the color (hemoglobin breakdown pigments) = RBCs lysis & metabolism previously occurred (at least 2 hr. earlier).

Xanthochromia = yellowish appearance of CFS

When would Xanthochromia indicate hemorrhage?

If you exclude:

- Prior traumatic tap.
- Hyperbilirubinemia (bilirubin > 20 mg/dL).

2- Biochemical analysis of CSF

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Examination of CSF:

1- Physical examination

2- Biochemical analysis of CSF

- **Tests of interest:**
  - **Glucose**
  - **Protein**
    - Total
    - Specific:
      - Albumin
      - Immunoglobulin
      - Others (e.g. myelin basic protein; MBP)
  - **Lactate**
  - **Glutamine** *(replaced by measuring plasma [ammonia])*

The most reliable diagnostically & accessible analytically

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GLUCOSE in CSF

- Glucose enters CSF via facilitative transporter (**GLUT**)
- CSF [glucose] is ~ 2/3 that of plasma (**50 - 80 mg/dl**)
- ***plasma sample*** must be obtained ~ 2-4 hr before CSF sample
  - **In hypoglycemia:** [CSF glucose] may be very low
  - **In hyperglycemia:** [CSF glucose] is raised.
- **Measure CSF [Glucose]:**
  - **immediately**
  - or preserve the specimen with and ***antiglycolytic*** e.g. fluoride ion

Abnormal GLUCOSE in CSF

- **↓CSF [glucose] *(hypoglycorrhachia)*:**
  1. **Disorder in carrier-mediated transport**
     - e.g. TB meningitis, sarcoidosis
  2. **Active metabolism of glucose by cells or organisms:**
     - e.g. acute purulent, amebic, & fungal meningitis
  3. **Increased metabolism by the CNS**
     - e.g. by CNS neoplasm
- In ***viral meningitis*** CSF [glucose] is usually normal

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PROTEIN in CSF

- Proteins, mostly albumin are found in the CSF (0.15-0.45 g/L)
- Source of CSF proteins:
  - 80% from plasma by ultrafiltration
  - 20% from intrathecal synthesis

Abnormal PROTEIN in CSF

- ↑ **CSF [total protein]:**
  - **Must be compared to the serum [protein]**
  - Useful nonspecific indicator of pathological states:
    - **Lysis of contaminant blood (traumatic tap)**
    - ↑ **premeability of the epithelial membrane due to:**
      - Bacterial or fungal infection
      - Cerebral hemorrhage
    - ↑ **production by CNS tissue in:**
      - Multiple sclerosis (MS)
      - Subacute Sclerosing Panencephalitis (SSPE)
    - **Obstruction e.g. in:**
      - Tumors
      - Abscess

CON. PROTEIN in CSF

CSF Albumin

- Albumin is produced solely in the liver
- Its presence in CSF must occur through BBB

Because of its low molecular weight

CSF Immunoglobulin

- **CSF IgG can arise:**
  from **plasma cells** within CSF & from the **blood** through BBB

- **↑CSF [IgG] without concomitant ↑ in CSF [Alb] suggests local production of IgG:**
  - multiple sclerosis (MS)
  - subacute sclerosing panencephalitis (SSPE)

What to do if ↑ CSF [protein] was detected?

- Perform electrophoretic separation
- If multiple banding of the IgG band is detected (oligoclonal bands):
  - MS
  - SSPE
  - Inflammatory diseases

OTHER CHEMICAL COMPONENTS OF CSF

- **CSF [Calcium], [Potassium] & [Phosphates] are lower than their levels in the blood**

- **CSF [Chloride] & [Magnesium] are higher than their levels in the blood**
  - **Abnormal CSF [Chloride]**
    - marked ↓↓ in acute bacterial meningitis
    - slight ↓ in viral meningitis & brain tumors

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NORMAL COMPOSITION OF CSF

Appearance	Clear ,Colorless
Lymphocytes	<5/mm^3
Polymorphs	Nil
pH	7.4
Total Volume	100 - 150 ml
Daily Secretion	450 - 500 ml
Specific Gravity	1.006 - 1.007
Protein	**0.15 – 0.45 g/L**
Glucose	**50 - 80 mg/dL** **(2.8-4.2 mmol/L)** **(>50% plasma level)**
Chloride	115 - 130 mmol /L
Calcium	1.0 - 1.40 mmol/L
Phosphorus	0.4 - 0.7 mmol/L
Magnesium	1.2 - 1.5 mmol/L
Potassium	2.6 - 3.0 mmol/L

Not for exam
just for your reference

ABNORMAL FINDINGS OF CSF IN SOME PATHOLOGICAL CONDITIONS

Parameter	Condition		
The numbers are not important	**Bacterial Meningitis (pyogenic)**	**Tuberculous Meningitis**	**Viral Meningitis**
Appearance	Often turbid	Often fibrin web	Usually clear
Predominant cell	Polymorphs	Mononuclear	Mononuclear
Cell count/mm³	90-1000+	10-1000	50-1000
Bacteria	In smear & culture	Often none in smear	None seen or cultured
Protein (0.15-0.45 g/L)	>1.5 (↑ ↑)	1-5 (↑ ↑)	<1 (Normal)
Glucose (2.8-4.2 mmol/L)	<1/2 plasma (↓ ↓)	<1/2 plasma (↓ ↓)	>1/2 plasma (Normal or slightly ↓)
Chlorides (115 - 130 mmol/L)	↓ ↓	↓ ↓	Normal or ↓

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OTORRHEA & RHINORRHEA

Finally =))

- **Otorrhea**: leakage of CSF from the ear
- **Rhinorrhea**: leakage of CSF into the nose

- **How to identify it as CSF?**
  - Measure β-transferrin (a protein unique to the CSF)

QUESTIONS

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1) The appearance of CSF in Bacterial Meningitis is ?

a) Turbid
b) Fibrin web
c) Clear
d) None of the above

2) Xanthochromia indicates which of the following ?

a) subacute sclerosing panencephalitis (SSPE)
b) sarcoidosis
c) Subarachnoid hemorrhage
d) hyperglycemia

3) In Bacterial Meningitis Glucose CSF level shows :

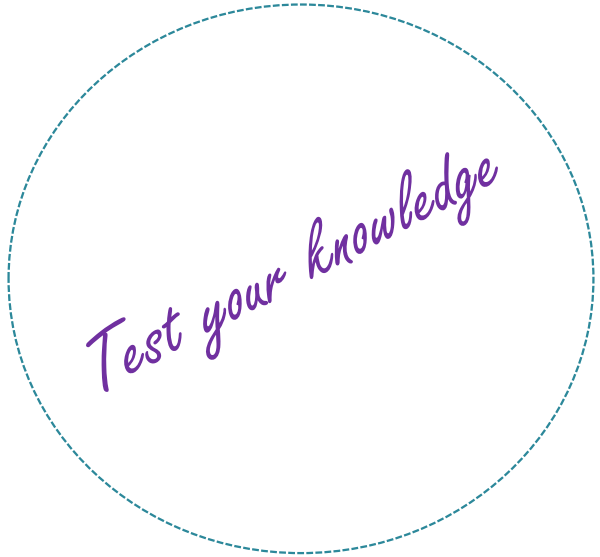
a) decrease
b) increase
c) normal

4) When would Xanthochromia indicate hemorrhage :

a) If you exclude Hyperbilirubinemia
b) bright red color hemoglobin pigments
c) RBCS in decreasing number
d) none of the above

5) In Bacterial Meningitis Protein CSF level shows :

a) increase
b) slight decrease
c) normal



Answers

1 a
2 c
3 a
4 a
5 a

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If you find any mistake, please contact us:)

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