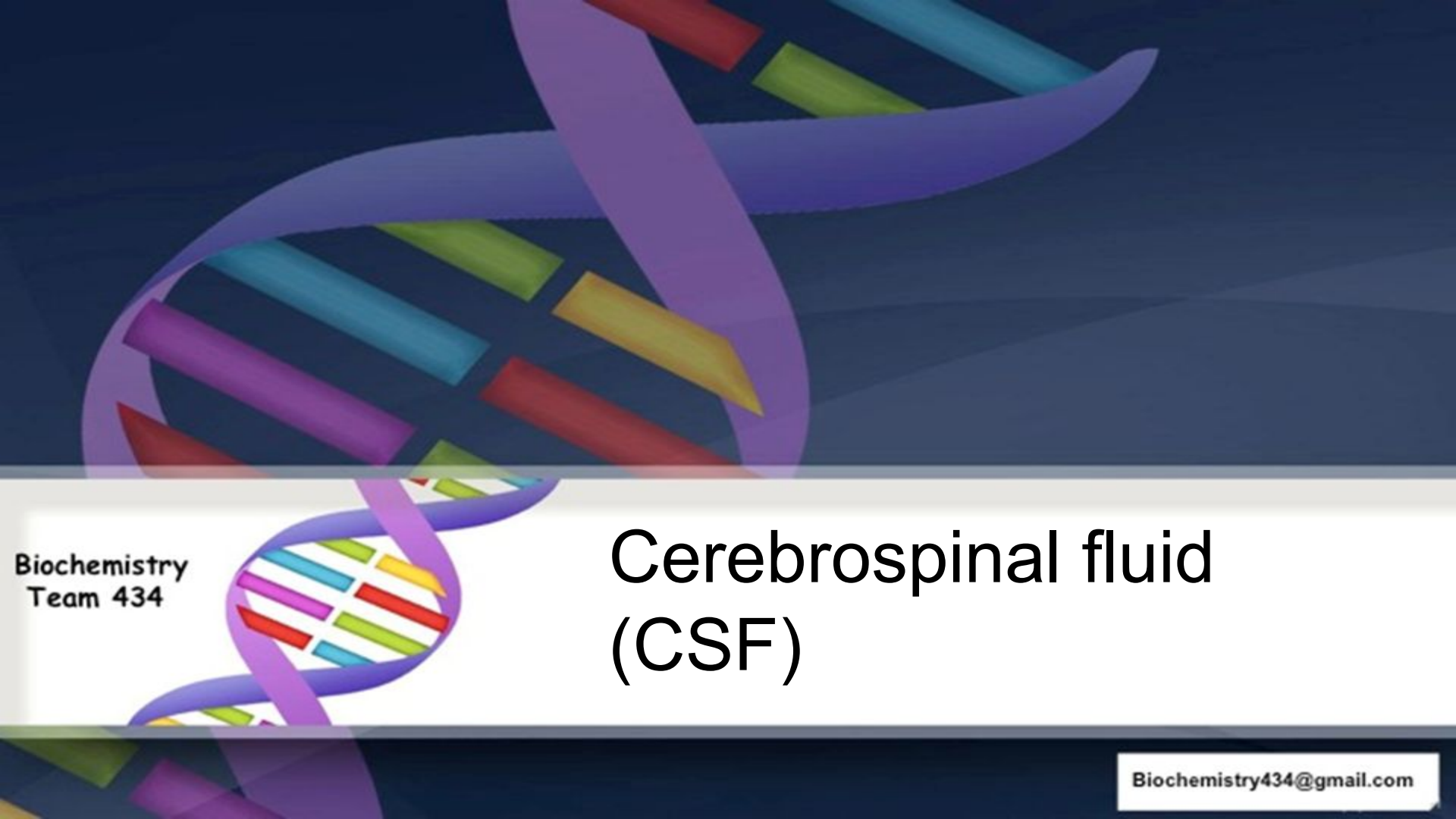


Biochemistry
Team 434

Cerebrospinal fluid (CSF)

Biochemistry434@gmail.com

Cerebrospinal fluid (CSF):

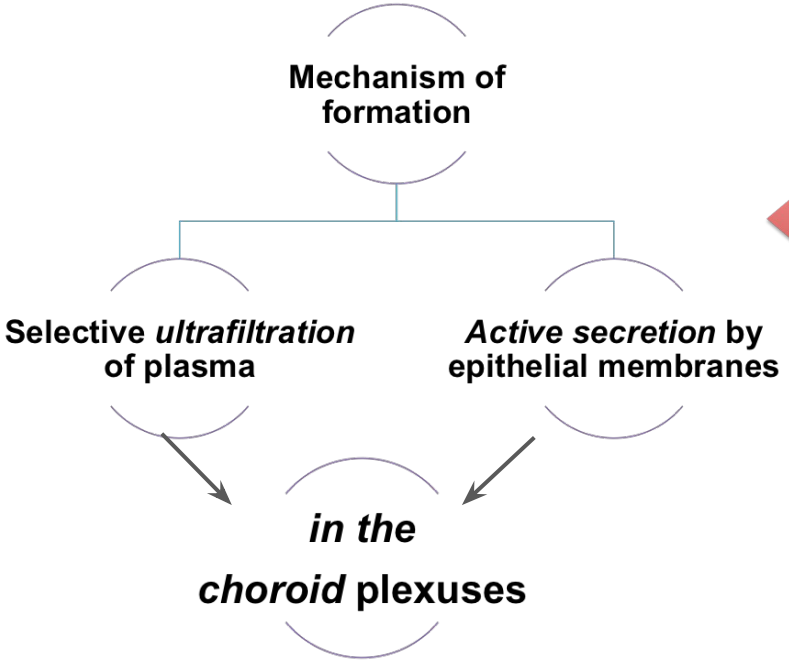
The liquid surrounding the brain and spinal cord

Main Functions:

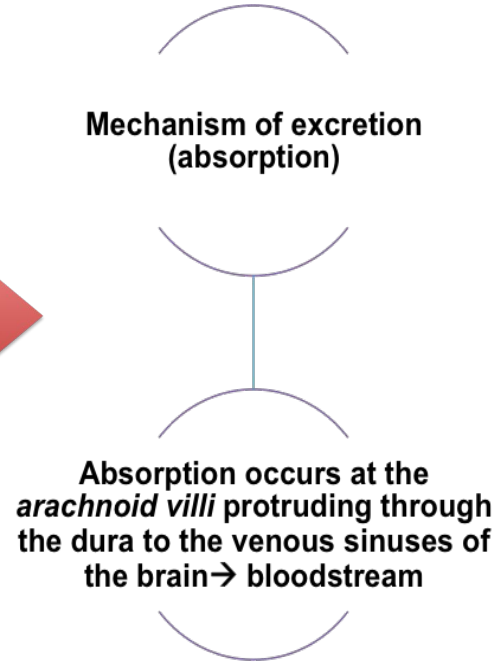
1-Physical support & protection

2-Provides a controlled chemical environment that supply nutrient & removal wastes.

CSF Formation & excretion



Excretion volume = production volume

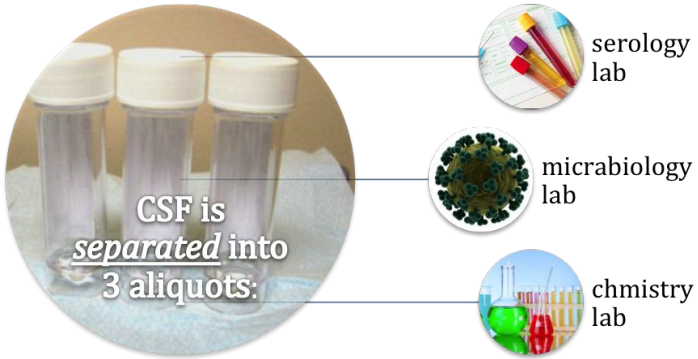


Rate of formation:
500 ml/day

It flows in subarachnoid area (the space between the arachnoid & pia matter)

CSF Specimen Collection:

Obtained by ***lumbar puncture***
(At the interspace L3-4, or lower)
using ***aseptic*** technique.



Contraindications for performing lumbar puncture:

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

Indications for laboratory investigation of CSF:

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

Examination of CSF

	Normal	abnormal	disease	couses
1- Physical examination	**Clear**	**cloudy (turbid)**		- it **is usually due to leucocytes** - **may be due to micro-organisms**
	Colorless			
	Free of clots			
	Free of blood	**Blood & Hemoglobin pigments in CSF**	1-***Traumatic tap***	- bright red color - RBCs in decreasing number as the fluid is sampled
			2-***Subarachnoid hemorrhage (SAH)***	- **Xanthochromia:** (hemoglobin breakdown pigments) = RBCs lysis & metabolism previously occurred (at least 2 hr earlier)

	Normal	abnormal	disease	causes
2- Biochemical analysis of CSF	**1-Glucose :** - Glc enters CSF via facilitative transporter (***GLUT***) - CSF [glucose] is ~ 2/3 that of plasma ***50 - 80 mg/dl*** - A ***plasma sample*** must be obtained ~ 2-4 hr before CSF sample	In hypoglycemia: [CSF glucose] may be very low	***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 hyperglycemia: [CSF glucose] is raised.		-Not clinically informative -Provides only confirmation of hyperglycemia

In ***viral meningitis*** CSF [glucose] is usually normal

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 (Mostly albumin because it is made in the liver)

20% from intrathecal synthesis

Abnormal PROTEIN in CSF

↑ CSF [total protein]: Must be compared to the serum [protein]

Useful nonspecific indicator of pathological states (tells you there is a disease ,but doesn't tell you the disease itself)

Lysis of contaminant blood (traumatic tap) (traumatic tap will increase protein ,because it is a blood :))

↑ permeability of the epithelial membrane due to:

1 :Bacterial or fungal infection

2 :Cerebral hemorrhage

↑ production by CNS tissue in:

1:Multiple sclerosis (MS)

2:Subacute Sclerosing Panencephalitis (SSPE)

Obstruction e.g. in: 1:Tumors ,2:Abscess

CON. PROTEIN in CSF:

= here we have only high level of IgG WITHOUT alb = so the problem is not in the BBB , If the problem is in the BBB = HIGH level of IgG AND alb ,because

CSF Albumin

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

(Because it is low molecular weight)

CSF Immunoglobulin

- CSF IgG can arise:

from plasma cells within CSF & from the blood through BBB

- ↑IgG and normal Alb suggests local production of IgG #:

o multiple sclerosis (MS)
o subacute sclerosing panencephalitis (SSPE)

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

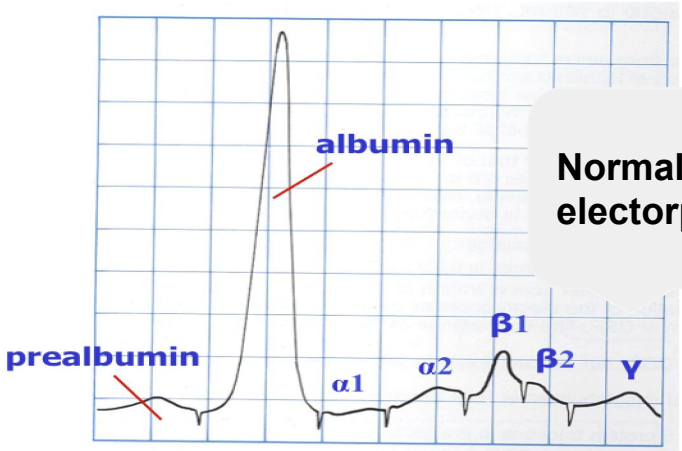
- Perform electrophoretic separation
- If multiple banding of the IgG (Y-globulin) band is detected (oligoclonal bands):

o MS
o SSPE
o Inflammatory diseases

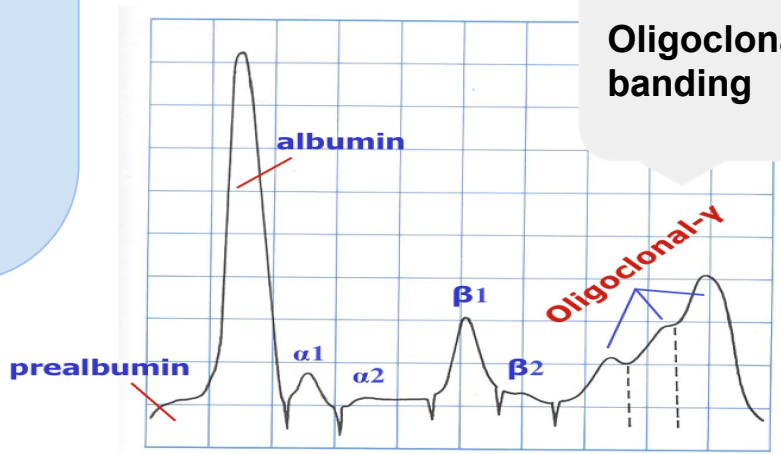
OTHER CHEMICAL COMPONENTS OF CSF

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

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



Normal electorphoresis.



Oligoclonal banding

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 important , just for your knowledge

ABNORMAL FINDINGS OF CSF IN SOME PATHOLOGICAL CONDITIONS

	Bacterial Meningitis (pyogenic)	Tuberculous Meningitis	Viral Meningitis
Appearance	Often turbid	Often fibrin web	Usually clear
Predominant cell	Polymorphs	Mononuclear (lymphocytes)	Mononuclear (lymphocytes)
Cell count/mm^3	90-1000+	10-1000	50-1000
Bacteria/virus	+ve smear & culture	Often none in smear	-ve smear or culture
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 ↓

OTORRHEA & RHINORRHEA

Otorrhea: leakage of CSF from the ear

Rhinorrhea: leakage of CSF into the nose

summary

-CSF is a liquid surrounding the brain and spinal cord & It flows in the subarachnoid area It Provides a controlled chemical environment by nutrient supply & waste removal.

-CSF is formed at the choroid plexuses & by the cells lining all the ventricles and Excretion volume = production volume to maintain constant CSF volume.

-Rate of formation is 500 ml/day & The Absorption occurs at the arachnoid villi.

-Normal blood brain barrier is important for the normal chemistry results of CSF.

-CSF is Obtained by lumbar puncture (At the interspace L3-4, or lower), The sample needs Immediate analysis & It's a precious sample.

-you should avoid lumbar puncture in cases of risk of bleeding, high ICP and if there is an infection at the site of needle insertion.

-Indications for lumbar puncture is CNS INFECTIONS, Demyelinating ,MALIGNANCY and Hemorrhage

-Normal CSF is Colorless, clear, clots free and blood free, cloudy (turbid) CSF IS usually due to leucocytes &/OR micro-organisms

- Traumatic tap (damage to blood vessel during specimen collection) SHOULD BE differentiated from Subarachnoid hemorrhage (SAH) where you can find Xanthochromia.

-for accurate analysis of glucose & proteins in CSF A plasma sample must be obtained before CSF sample.

-increase glucose in CSF Provides only confirmation of hyperglycemia while decrees its level indicate some diseases.

-increased CSF total protein is could be due to increase permeability of BBB or production of proteins or Obstruction.

-CSF IgG is coming from plasma cells in CSF or through BBB but Albumin is produced by the liver so its present must occur through BB

- INCREASE [IgG] and normal [Alb] of CSF suggests local production of IgG e.g. MS.

- The conc.. of some Chemical Components of CSF is different from blood, some are higher e.g. Chloride and some are lower e.g. potassium

MCQs & SAQs

MCQs:

1-in the Biochemical analysis of CSF we are interested in which of the following?

A-potassium B-dopamine C-glucose

2-during a lumbar puncture the doctor has noticed that the specimen was red in the beginning then it changes latter, which on of the following could explain this?

A-the patient has Subarachnoid hemorrhage *(SAH) B-he has injured a blood vessel during the needle insertion "Traumatic tap" C-this is normal*

3-what should you do with the remnant of a CSF specimen ?

A-preserve it with fluoride ion B-get rid of it C-preserve it with anticoagulant

4-which of the following is characteristic of normal CSF?

A- Colorless B-blood free C-both

SAQs:

1-name three Contraindications for performing lumbar puncture?

A.Bleeding diathesis

B.Increased intracranial pressure

C.Infection at site of needle insertion

2-name three Indications for laboratory investigation of CSF?

A.CNS infection

B.Demyelinating diseases

C.CNS Malignancy

answers:
1)C
2)B
3)A
4)C

Biochemistry
Team 434

Done by:
Abdulrahman Alyahya
Abdulrahman Almizal
Mohammad Alotaibi
Mohammad Almashouq

Biochemistry434@gmail.com