



# **MICROBIOLOGY OF ACUTE PYOGENIC MENINGITIS**

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# Objectives

1. Define and know important facts about acute pyogenic meningitis.
2. Know the epidemiology of acute pyogenic meningitis.
3. Know the etiologic agents according to the age and common serotypes of the main causative pathogens
4. Know the clinical presentation of acute meningitis

# Objectives-cont. ,

5- Identify the microbiology of common causative agents including the morphology, pathogenesis ,identification and complications.

6-Know the approaches to the clinical diagnosis of acute meningitis case with emphasis on lab diagnosis and comparison between normal and abnormal CSF analysis.


7-Know the management of acute meningitis case with emphasis on rapid diagnosis and



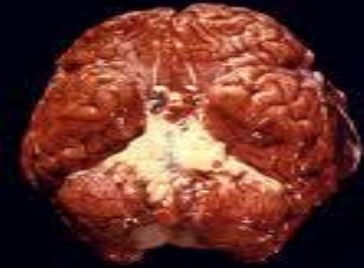
# Objectives-cont.,

selection of empirical antimicrobial therapy for the common pathogens.

8-Know the prevention using vaccination and prophylaxis against common pathogens.

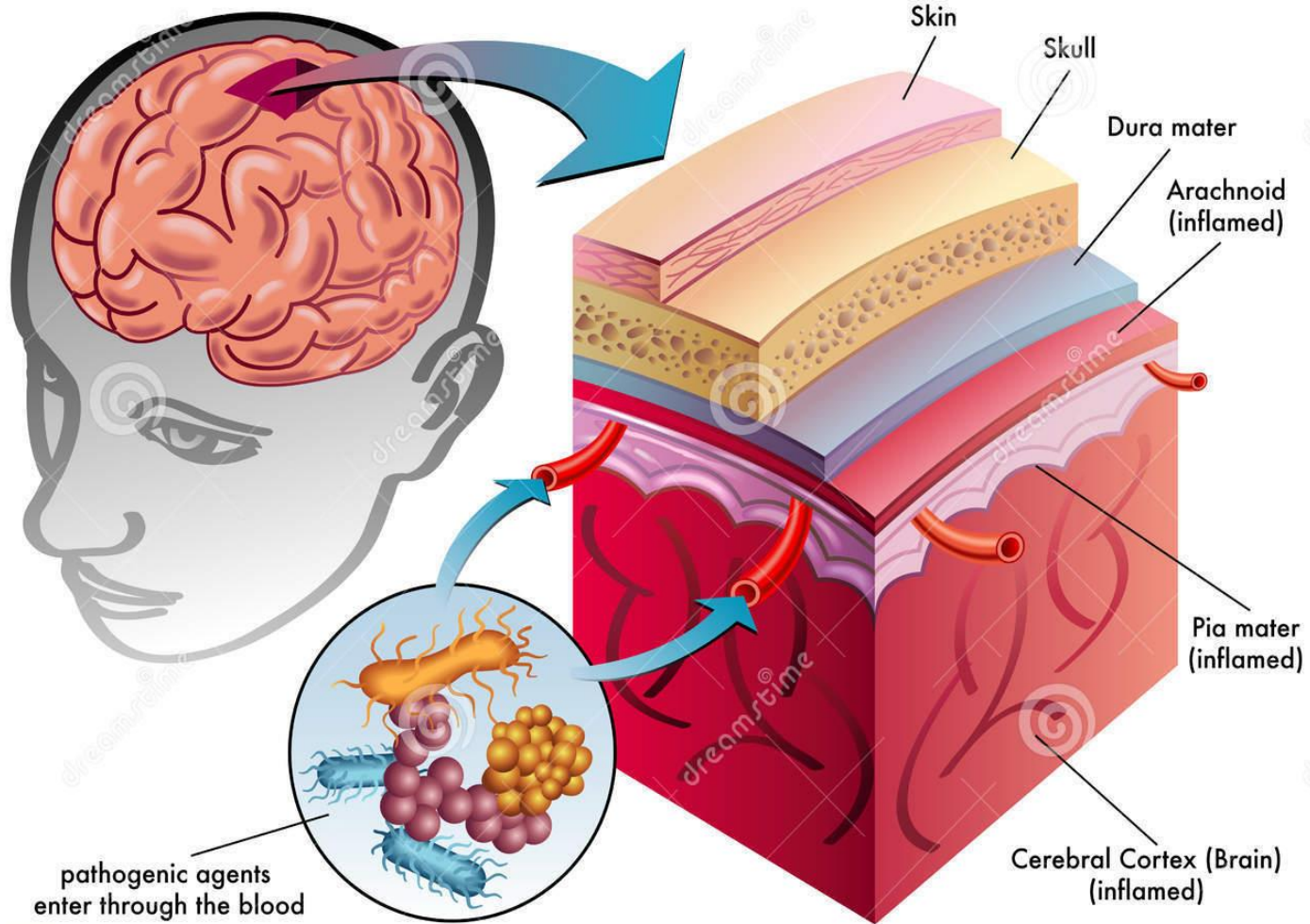


# Definition



- Pyogenic meningitis is an inflammation of the meninges affecting Pia , Arachnoid and subarachnoid space.
- A serious infection , associated with marked inflammatory exudation.
- Acute in onset.
- Usually caused by bacterial infections.
- May be preceded by URTI.
- Can be **fatal** if untreated.

# Bacterial Meningitis



pathogenic agents enter through the blood



# Common Etiologic Agents

Three main bacterial pathogens :

*Neisseria meningitidis*

*Sterptococcus pneumoniae*

*Hemophilus influenzae*



# Causes according to the age

## Newborns

Group *B Streptococcus*, *E.coli* (and other gram negative bacilli ),  
*Listeria monocytogenes*,

## Infants / Children

*S.pneumoniae*, *N.meningitidis*,  
*H.influenzae*

## Adults

*S.pneumoniae*, *N.meningitidis*

## Special circumstances

*S.aureus*, *S.epidermidis*,  
*S.pneumoniae*, anaerobes,  
*P.aeruginosa*



# Epidemiology of Meningitis

- A worldwide disease, there are 1.2 million cases annually & **135,000 deaths**.
- Bacterial meningitis is one of the top ten infections which cause death worldwide.
- Half of the survivals suffer neurological damage, and /or permanent side effects.

# Signs/Symptoms of Acute Meningitis

## Most Common

fever  
Headache  
Stiff neck  
Nausea & vomiting  
Sensitivity to light ,Confusion

## Advanced Cases

bruises under skin , rapidly spread

## In infants

Inactivity  
Irritability  
Vomiting  
Poor feeding

## Advanced Disease:

Brain damage  
Coma  
Death

# CHILDREN & ADULTS



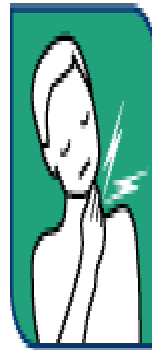
Fever – cold hands & feet



Vomiting



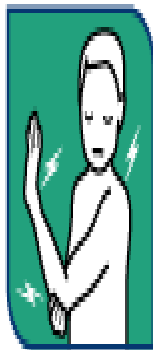
Headache



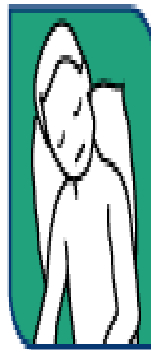
Stiff neck



Dislike of bright lights



Joint/muscle pain



Drowsy, difficult to wake

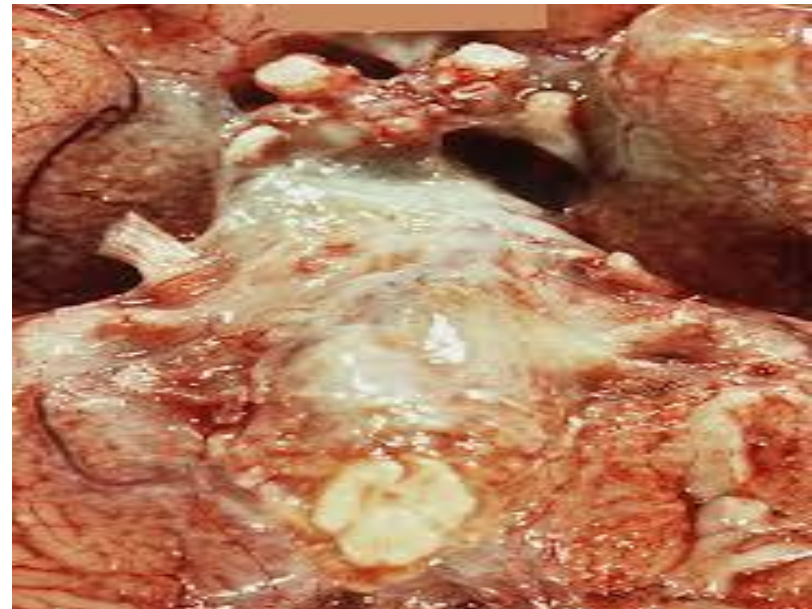


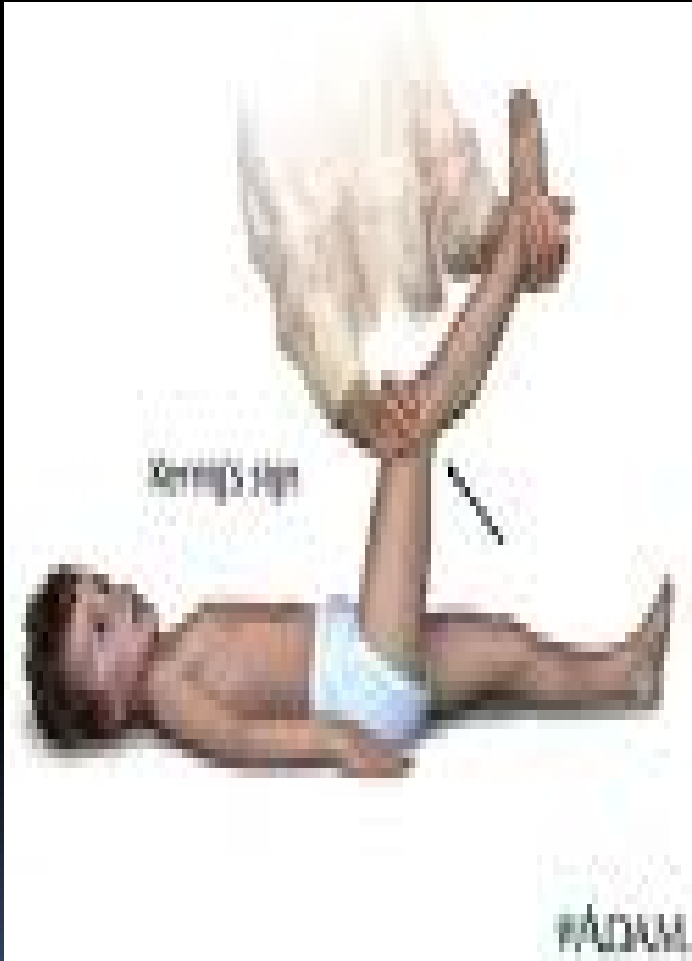
Confusion

قد تكون الصورة محمية بموجب حقوق النشر. إرساں تعبیات



Photo: VietNamNet





# *N. meningitidis*

- A Gram negative diplococci present in the nasopharynx of 10 % of people.

Transmitted by inhalation of aerosolized droplets & close contact.

Common in children < 6 years

**Risk factor:** susceptible individuals.

Serotypes: **B, C, Y, W135** cause isolated, sporadic small epidemics in close population.

Serotype **A** has an epidemic potential in sub-Saharan Africa (meningitis belt).

# Pathogenesis- *N.meningitidis*

Colonization of nasopharynx ( or birth canal)

Septicemia  blood brain barrier

Wide spread endothelia damage

Activation of coagulation

Thrombosis and platelets aggregation

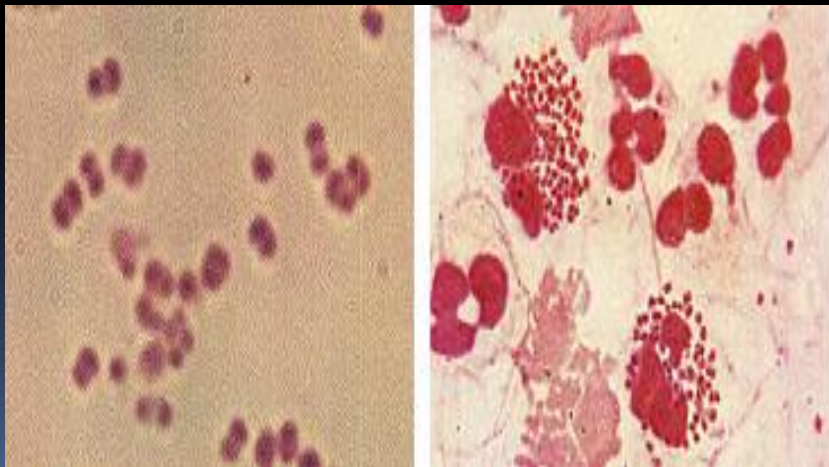
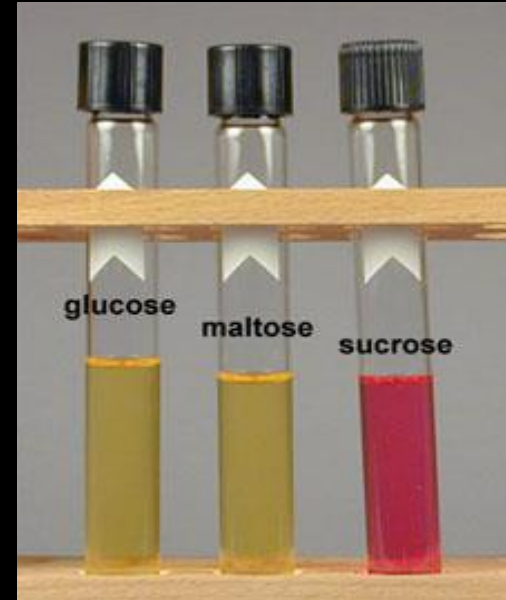
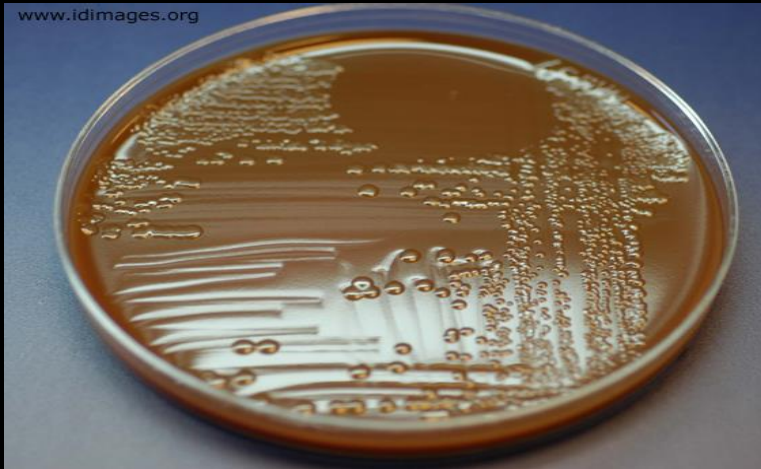
**Bleeding : skin rash, adrenal hemorrhage**



# Pathogenesis- *N.meningitidis*

- In carriers ; it stimulates antibody production
- Pili attach to microvilli of nasopharynx , invasion ,then bacteremia, endotoxin (LPS) produced which spreads to the meninges.
- Capsule resists phagocytosis.
- 11-20 % of recovered patients suffer permanent hearing loss, mental retardation.
- 10-14 % of cases are fatal.

# *N. meningitidis*





# *S. pneumoniae*

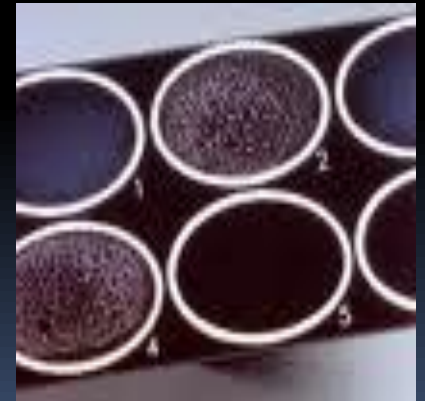
- A Gram positive diplococcus ,meningitis may follow pneumococcal pneumonia ,or other site infection with the bacteria.
- May develop after trauma to the skull.
- **High mortality rate >30% due to invasive disease.**
- Capsule is polysaccharide polymer

**Pneumolysin** decreases inflammatory immune response and leads to severe infection.

# *S. pneumoniae* , cont. ,

- Infection rate decreases due to vaccination .
- Recovered cases develop sustained learning disabilities .

## *S. pneumoniae*



# *H. influenzae*

- A small Gram negative coccobacilli
- Has polysaccharide capsule , other species has no capsule.
- Need blood for optimal growth, **Hematin** (factor **X**) and **NAD** ( factor **V**)
- Many serotypes **a-f** , *H. influenzae* **type b** has a capsule made of a polymer of PRP (*Polyribosyl Ribitol Phosphate* ) cause acute life threatening invasive infections .

# *H. influenzae*, cont.,



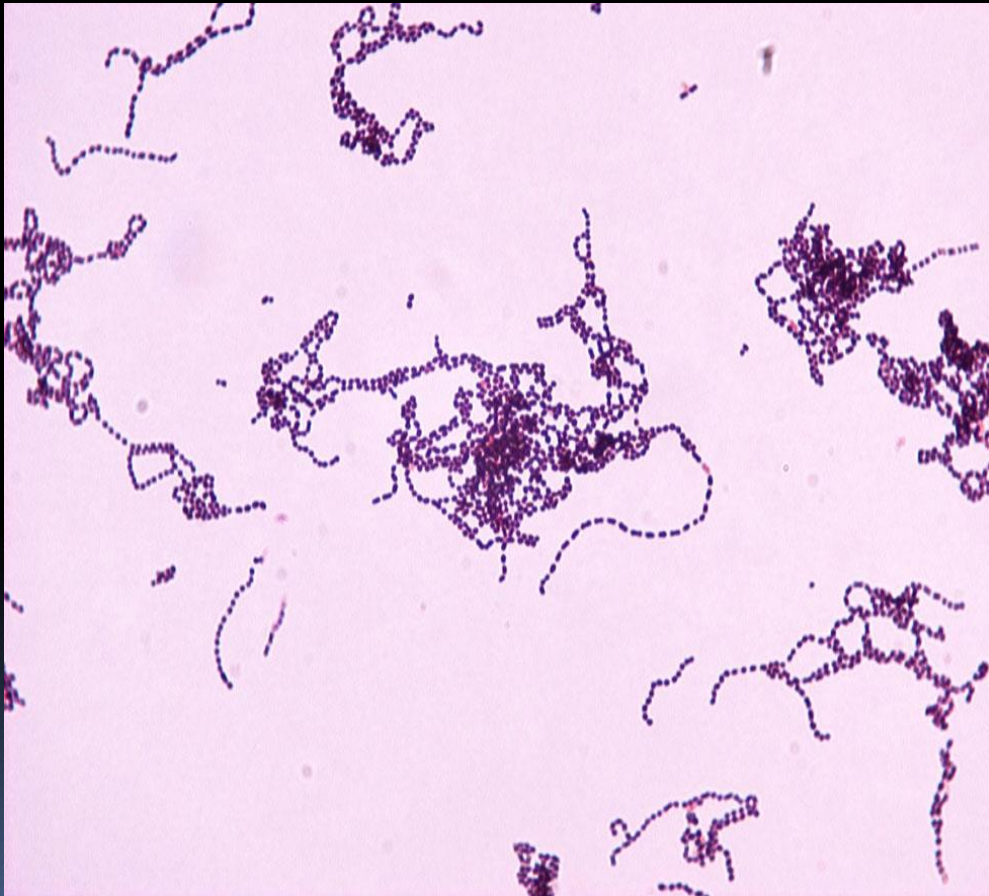
# *H. influenzae* –cont, .

- Found in the nasopharynx normal flora
- Major cause of lower RTI , occasionally invade deeper tissues and cause bacteremia.
- **Bacteremia** : bacteria spread to the CNS ,bones or other organs.
- **3-6% mortality rate**
- 1/3 of survivals have significant neurological sequelae
- Infection rate decreases since the routine use of **Hib** vaccine .

# Group *B Streptococcus* (GBS)

- Gram positive cocci in chains
- Resident bacteria in GIT & vagina ( 10-30%)
- Gain access to amniotic fluid during delivery or colonize newborn as it passes birth canal.
- Risk factors: premature rupture of membrane, prematurity, low infant innate immunity .
- Cause sepsis & meningitis in the first few days of life and after 4 weeks.

# Group B *Streptococcus*

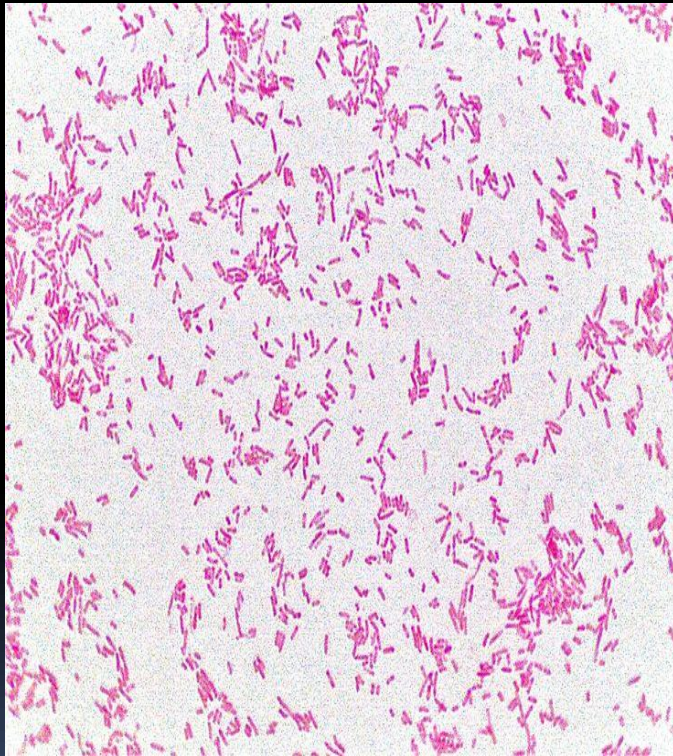


# *E. coli*

- A Gram **negative** bacilli
- Most common cause of neonatal meningitis
- Many features similar to GBS .
- Vaginal *E.coli* colonize infant via rupture of amniotic membrane or during birth.
- Failure of preterm maternal IgM to cross placenta & special susceptibility of newborn.
- K<sub>1</sub> sialic acid capsule of some strains invade brain microvascular endothelial cells.



# *E. coli*



*Escherichia coli* (BA)




Lactose fermenting colonies

Non-lactose fermenting colonies



# *Listeria monocytogenes*

- Gram positive rods ( *diphtheroids like* )
  - Wide spread among animals in nature including those associated with certain foods (cheese and meat).
  - Human intestinal colonization (2-12%)
  - Spread to fetus following hematogenous spread in mother or from birth canal
- 

# *Listeria monocytogenes*

- Has tropism to the CNS.
- Cause meningitis in newborns and immunosuppressed patients.



# Diagnosis of Meningitis

- Clinically: signs & symptoms
- Specimen : **CSF** acquired through lumbar puncture and **blood** specimen .

**CSF** :analysis of cells, protein, glucose , culture and antimicrobial susceptibility testing (CSF and blood).



# CNS parameters

## Normal CSF

### Adults

WBC = 0-5 /cmm<sup>3</sup>,  
PMN = 0 %, glucose = > 60 % of blood,  
protein = < 30 mg/dl, chloride = 115-130  
mmol/l

### Neonates

*term* : WBC = 0-32 /cmm<sup>3</sup>,  
PMN = > 60 %, glucose = > 60 % of blood,  
protein = 20-170 mg/dl

*Preterm*: WBC = 0-29/cmm<sup>3</sup>,  
PMN = < 60 %, glucose = > 60 % of blood,  
protein = 60-150 mg/dl

## Pyogenic meningitis

WBC = 5 - 5000/cmm<sup>3</sup>

PMN = > 60%

Glucose = < 45 % of blood

Protein = > 60 mg/dl

Chloride = 110 mmol/l

# NORMAL & TURBID CSF



Figure 2 – Grossly cloudy cerebrospinal fluid obtained from lumbar puncture is shown.



# CSF evaluation

Condition	WBC	Protein (mg/dL)	Glucose (mg/dL)
Normal	<5, ≥75% lymphos	<b>20–45</b>	<b>&gt;50 (or 75% serum glucose)</b>
Bacterial, acute	100–10,000 or more; usually 300–2,000; Neutros predominate	usually 100–500	Decreased, usually <40 (or <50% serum glucose)
Bacterial, part rx'd	5 – 10,000	usually 100-500	Low to normal
TB	10 – 500	100-3000	<50
Viral or Meningoencephalitis	rarely >1000	Usually 50-200	Generally normal; may be decreased

# Abnormal findings of CSF in some pathological conditions

Parameter	Condition			
	Bacterial Meningitis	Tuberculous Meningitis	Viral Meningitis	Brain Tumor
Protein	↑ ↑	↑ ↑	Normal	↑
Glucose	↓ ↓	↓ ↓	Normal or slightly ↓	↓
Chlorides	↓ ↓	↓ ↓	Normal or ↓	Normal or ↓



# Management



- **A MEDICAL EMERGENCY**
- Antibiotics given after taking specimens for lab diagnosis. Parenteral administration.
- Children & Adults:  
Ceftriaxone (or Cefotaxime) + Vancomycin  
(*cover the main 3 pathogens*) .
- Neonates :  
Ampicillin + Gentamicin or Cefotaxime
- Modify treatment after lab results ( as needed).

# Management

- Duration : 10-14 days ( or more ) according to the medical condition.
- Prevention:
  - . Vaccination ,
  - . Prophylaxis antimicrobial agent for contacts (*Hib & N.meningitidis*)