



LECTURE: Microbiology of Acute Pyogenic Meningitis

[Editing File](#)

- Important
- Doctor's notes
- Extra explanation
- Only F or only M

"لا حول ولا قوة إلا بالله العلي العظيم" وتقال هذه الجملة إذا
داهم الإنسان أمر عظيم لا يستطيعه ، أو يصعب عليه القيام به .

OBJECTIVES:

Upon completion of the lecture , students should be able to:

- Define and know important facts about acute pyogenic meningitis.
 - Know the epidemiology of acute pyogenic meningitis.
 - Know the etiologic agents according to the age and common serotypes of the main causative pathogens
 - Know the clinical presentation of acute meningitis
 - Identify the microbiology of common causative agents including the morphology, pathogenesis ,identification and complications.
 - Know the approaches to the clinical diagnosis of acute meningitis case with emphasis on lab diagnosis and comparison between normal and abnormal CSF analysis.
 - Know the management of acute meningitis case with emphasis on rapid diagnosis and selection of empirical antimicrobial therapy for the common pathogens.
 - Know the prevention using vaccination and prophylaxis against common pathogens.
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• **Definition:**

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

• **Common Etiologic Agents:**

Three main capsulated bacterial species:

1. **Neisseria meningitidis**
2. **Streptococcus pneumoniae** (most serious)
3. **Hemophilus influenzae** (mild & only in children)

• **Causes According to the Age**

Age Group	Common Causative Agents
Newborns 0-1 month	Group B Streptococcus, E.coli (and other gram negative bacilli) , Listeria monocytogenes,
Infants / Children (1 month – adulthood)	Strep.pneumoniae, N.meningitidis, H.influenzae Young people, Elderly, Pregnant lady
Adults	Strep.pneumoniae, N.meningitidis
Special circumstances Trauma	Staph.aureus (sugery) ,Staph.epidermidis (shunt) , Step.pneumoniae (base of skull fracture) , anaerobes, P.aeruginosa



- **Meningitis- Epidemiology :**

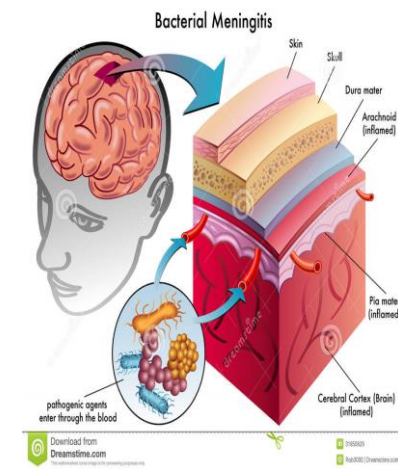
- There are 1.2 million cases annually worldwide.
- 135,000 deaths.
- Bacterial meningitis is 1 of the top 10 infections causes death worldwide.
- Half of the survivals suffer neurological damage, and /or permanent side effects.

- **Signs/Symptoms of Acute Meningitis**

Most Common	In infants they don't show with neck stiffness like adult, they come with unspecific symptoms like:	Advanced Cases	Advanced disease
<ul style="list-style-type: none"> • fever • Headache severe • Stiff neck • Nausea & vomiting • Sensitivity to light • Confusion 	<ul style="list-style-type: none"> • Inactivity • Irritability • Vomiting • Poor feeding 	<ul style="list-style-type: none"> • bruises under skin & spread rapidly 	<ul style="list-style-type: none"> • Brain damage • Coma • Death

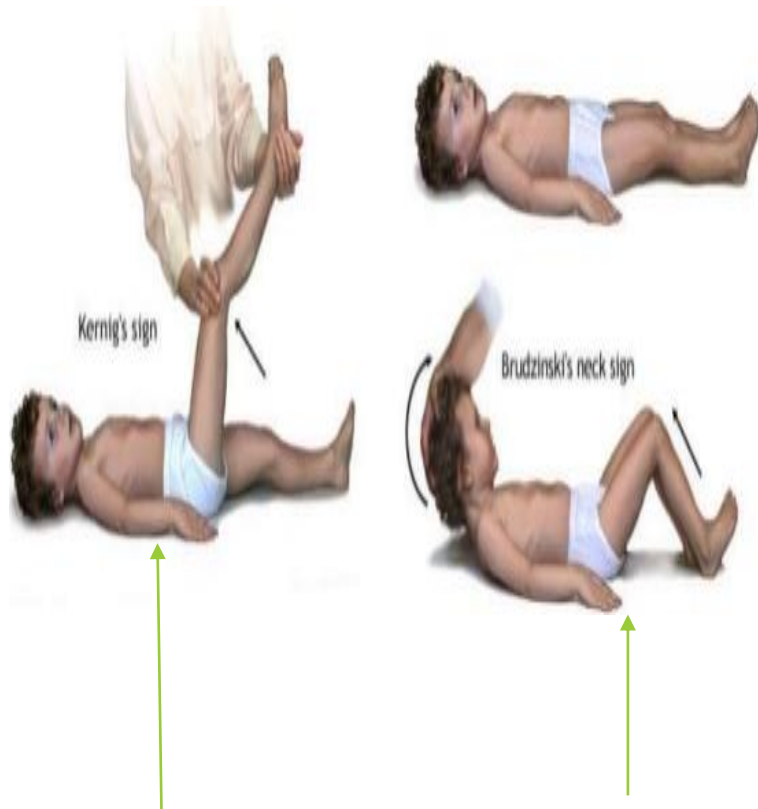


Photo: VietNamNet



*Very important, it will come in the exam as a case

*Q: a boy 2 months old, he has hyperthermiaetc , In this case the first thing we have to do is? Lumbar puncture.



Kernig's sign is positive when the thigh is flexed at the hip and knee at 90 degree angles, and subsequent extension in the knee is painful (leading to resistance)

(Brudzinski's neck sign) is the appearance of involuntary lifting of the legs when lifting a patient's head off the examining couch, with the patient lying supine



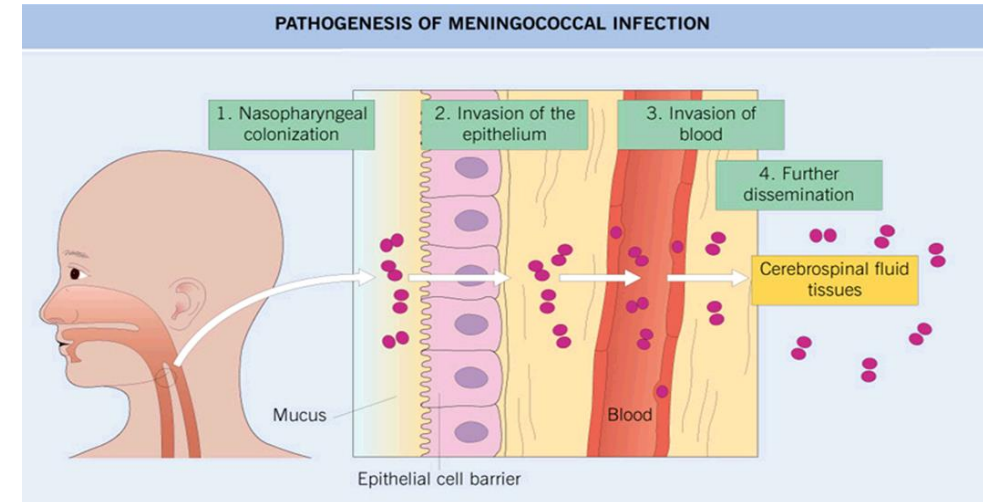
Another of the physically demonstrable symptoms of meningitis is Kernig's sign. Severe stiffness of the hamstrings causes an inability to straighten the leg when the hip is flexed to 90 degrees.

One of the physically demonstrable symptoms of meningitis is Brudzinski's sign. Severe neck stiffness causes a patient's hips and knees to flex when the neck is flexed.

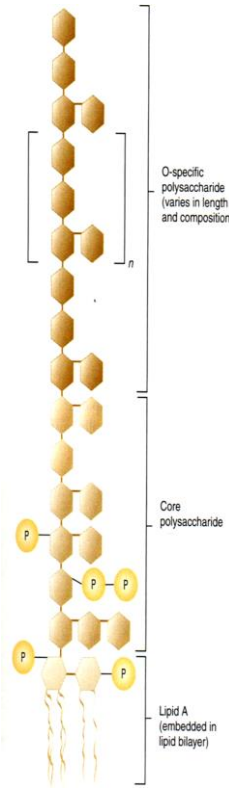


- Pathogenesis :

1. Microorganisms colonize the nasopharynx or the birth canal
 2. Septicemia
 3. Organisms cross the BBB
 4. Cause widespread endothelial damage
 5. Activation of coagulation
 6. Thrombosis and platelets aggregation
 7. Bleeding : Skin rash and adrenal hemorrhage
- Purpuric (inside the skin)



Neisseria Meningitidis	
General info.	Gram negative Diplococci – Present as normal flora of nasopharynx in 10% of people
Transmission	By inhalation of aerosol droplets and close contact
Prevalence	Common in children below 6 years
Risk Factors	Susceptible individuals (with no antibodies) <i>Not vaccinated or they have a problem in their immune system.</i>
Serotypes *	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • Carriers stimulate antibody production • In some individuals , the bacterial pili attach to the nasopharyngeal microvilli → invasion → bacteremia → endotoxin Lipopolysaccharide (LPS) produced → meninges. • In case of carriers it stimulates antibody production • its capsule resists phagocytosis
Prognosis	<ul style="list-style-type: none"> • 11-20 % of recovered patients suffer permanent hearing loss, mental retardation. • 10-14% of cases are fatal



- Tests used to identify it:**
- 1- chocolate agar (the best to diagnose bacteremia)
 - 2- gram negative diplococci
 - 3- sugar fermentation: glucose and maltose fermentive

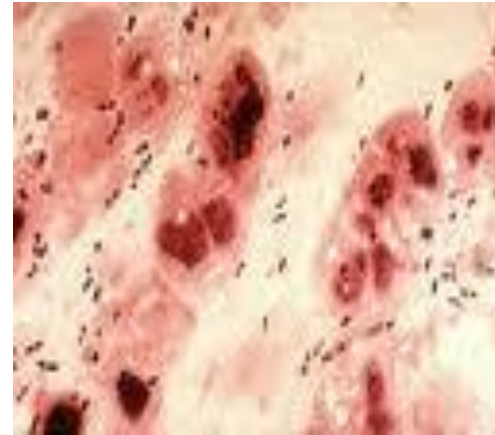
*Very important you should know it, and it should be named as “serogroup” + (based on the difference of polysaccharide)

Streptococcus pneumoniae Worse than N.meningitidis

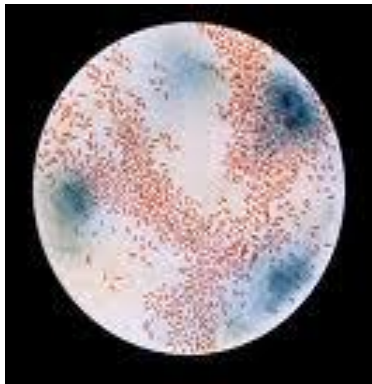
General info.	Gram positive Diplococci
Risk Factors	<ul style="list-style-type: none">• May develop after trauma to the skull• None vaccinated patients (infection rate decreased due to vaccination)
Pathogenesis	<ul style="list-style-type: none">• May follow a Pneumococcal pneumonia, or any other site infected with the organism.• Pneumolysin toxin decreases inflammatory immune response and leads to severe infection.• Capsule is polysaccharide polymer.
Prognosis	<ul style="list-style-type: none">• High mortality rate more than 30% with treatment (due to invasive disease)• Recovered patients develop learning disabilities.

Tests used to identify it:

- 1- a hemolytic blood agar
- 2- gram positive diplococci
- 3- optochin sensitivity no growness



General info.	<ul style="list-style-type: none"> • Small gram negative coccobacilli in the nasopharynx normal flora • Has a polysaccharide capsule, other species have no capsule. • Need blood for optimal growth, Hematin (factor X) and NAD (factor V). • Major cause of LRTI. • Occasionally invade deeper tissues and cause bacteremia • Bacteremia → CNS ,bones or other organs. • Infection rate decreases since the routine use of Hib vaccine .(hemophilus influenzae type B)
Serotypes	<ul style="list-style-type: none"> • Has many serotypes (from A to F). • H.Influenzae type b has a capsule ,a polymer of polyribosyl-ribitolphosphate(RPR) ,cause acute life threatening invasive infections
Prognosis	<ul style="list-style-type: none"> • 3-6% mortality rate. • 1/3 of survivals have significant neurological sequelae.



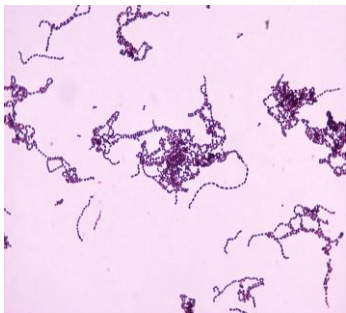
Tests used to identify it:

- 1- gram negative coccobacilli
- 2- satellite test

Group B Streptococcus

General info.	<ul style="list-style-type: none">• Gram positive cocci in chains , Catalase –ve , Resident Bacteria in GIT and vagina (10-30%)
Risk factors	<ul style="list-style-type: none">• premature rupture of membrane• prematurity,• low infant innate immunity
Pathogenesis	<ul style="list-style-type: none">• Gain access to the amniotic fluid during delivery → Colonize the newborn as it passes the birth canal → Cause sepsis and meningitis in the first few days of life or after 4 weeks.

If we discovered Group B in pregnant lady after swabbing the vagina we give the baby prophylaxis because if the baby was born while the mother had Group B streptococcus or UTI this will cause an early (they will comeback to the hospital after 1-2 weeks) or late infection to the baby. Early infection(from the mother) usually have sepsis or pneumonia while the late infection (from the people surrounding the baby) might develop meningitis.



Tests used to identify it:

- 1- b hemolytic blood agar.
- 2- gram positive cocci in chains)

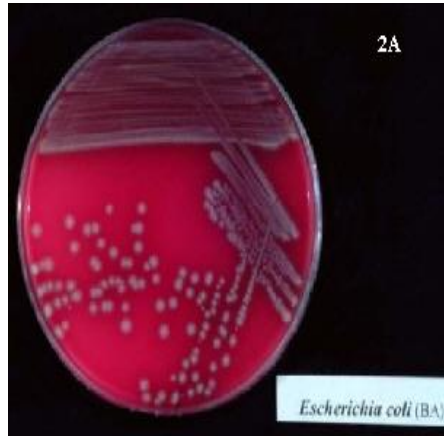
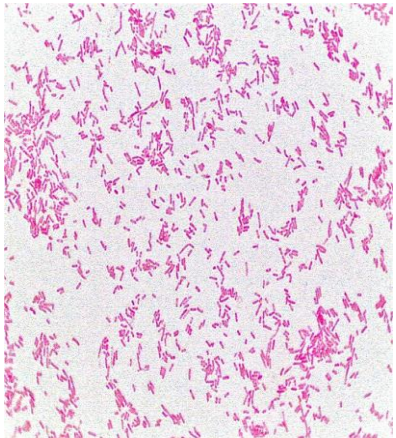
Escherichia Coli

General info.

- **Gram negative bacilli** , Catalase +ve , Oxidase +ve , Lactose Fermenter
- Similar to Group B Streptococcus
- Most common cause of neonatal meningitis

Pathogenesis

- Vaginal Escherichia Coli colonize the infant via a rupture of the amniotic membrane or during birth.
- Failure of preterm maternal IgM to cross the placenta, leading to a special susceptibility of the newborn to infections.
- K1 sialic acid capsule of some strains invade the brain microvascular endothelial cells.



Tests used to identify it:

- 1- b hemolytic blood agar
- 2- gram negative bacilli.
- 3- lactose fermentation

Listeria Monocytogenes

General info.

- **Gram positive rods (diphtheroids like)** , Catalase +ve
- Human intestinal colonization (2-12%) Elderly, pregnant lady, children
- **Causes meningitis in newborns and immunosuppressed patients**

Pathogenesis

- Widespread among animals in nature including those associated with certain foods (**cheese and meat**)
- Spread to fetus following hematogenous spread in the mother, or from the birth canal.
- Has tropism to the CNS.

• Diagnosis of Meningitis

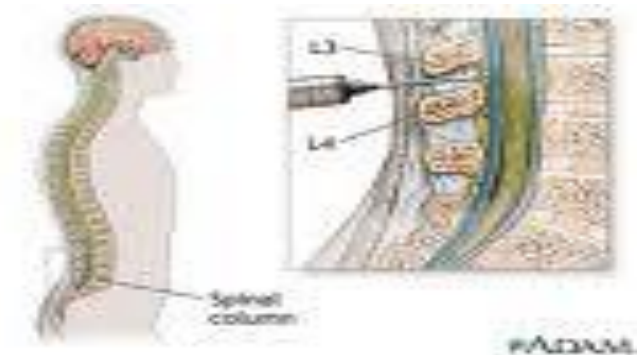
Clinically (**symptoms , signs , history**)

Specimen : CSF acquired through lumbar puncture and blood specimen for culture

CSF :

1. Analysis of cells.
2. protein.
3. glucose .
4. Chloride

Culture and antimicrobial susceptibility testing.



Test	Appearance	Pressure	WBC/ μ L	Protein mg/dL	Glucose mg/dL	Chloride
Normal CSF	Clear	90 – 180 mm	0-8 lymph.	15-45	50-80	115-130 mEq/L
Acute bacterial meningitis	Turbid	Increased	1000 -10000	100 – 500	< 40	Decreased
Viral meningitis	Clear	Normal to moderate increase	5-300, rarely >1000	Normal to mild increased	Normal	Normal
Tubercular meningitis	Slightly opaque cobweb formation	Increased/ decreased, spinal block	100-600 mixed or lymph.	50-300 due to spinal block	Decreased	Decreased
Fungal meningitis	Clear	Increased	40-400 mixed	50-300	Decreased	Decreased
Acute syphilitic	Clear	Increased	About 500 lymph	Increased but <100	Normal	normal

Only in male's slides

Don't memorize the numbers.

CSF Findings
<ul style="list-style-type: none"> Increased protein level due to presence of inflammatory substance, dead organism, protein and WBC. Reduced glucose level (Normally it is 2/3 of serum glucose level). Increased local white cell count (polymorphonuclear leukocytes.)

CSF evaluation			
Only in female's slides			
Condition	WBC	Protein (mg/dL)	Glucose (mg/dL)
Normal	<5, \geq 75% lymphos	20-45	>50 (or 75% serum glucose)
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 Meningoenceph alitis	rarely >1000	Usually 50-200	Generally normal; may be decreased

Abnormal findings of CSF in some pathological conditions				
Only in female's slides				
Parameter	Condition			
	Bacterial Meningitis	Tuberculous Meningitis	Viral Meningitis	Brain Tumor
Protein	↑↑	↑↑	Normal	↑
Glucose	↓↓	↓↓	Normal or slightly ↓	↓
Chlorides	↓↓	↓↓	Normal or ↓	Normal or ↓

- CNS parameters

Normal CSF	Pyogenic meningitis
<ul style="list-style-type: none"> Adults WBC = 0-5 /cmm³, PMN= 0 %, glucose= > 60 % of blood, protein =< 30 mg/dl chloride = 115-130 mmol/l 	WBC= 5 - 5000/cmm ³ = 1000-5000/cmm ³ (range 100-10000) PMN= > 60% Glucose = < 45 % of blood Protein= >60 mg/dl Chloride= 110 mmol/l
<ul style="list-style-type: none"> Neonates term : WBC = 0-32 /cmm³, PMN=>60 %, glucose = >60 % of blood, protein= 20-170 mg/dl Preterm: WBC=0-29/cmm³, PMN= <60 %, glucose = >60 % of blood, protein= 60-150 mg/dl 	



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

- Traumatic LP (not important)

- True WBCs in CSF = $\frac{\text{Actual WBC in CSF} - \text{WBC in blood} \times \text{RBC in CSF}}{\text{RBC in blood}}$

- Management

<ul style="list-style-type: none"> Urgent , A MEDICAL EMERGENCY Antibiotics after taking specimens for lab diagnosis Parenteral administration 		
<u>Children & Adults:</u>	Ceftriaxone (or Cefotaxime) + Vancomycin (<i>cover the main 3 pathogens</i>) .	
<u>Neonates :</u>	Ampicillin + Gentamicin or Cefotaxime Modify treatment after lab results (as needed).	
Duration :	10-14 days (or more) according to the medical condition.	
Prevention:	Vaccination	Prophylactic antimicrobial agent for contacts (<i>Hib & N.meningitidis</i>)

SUMMARY:

- Pyogenic meningitis is an inflammation of the meninges affecting Pia, Arachnoid and subarachnoid space.
- In newborns : Group B Streptococcus , Escherichia Coli , Listeria Monocytogenes
- In infants : Streptococcus Pneumoniae , Neisseria Meningitidis , Haemophilus Influenzae
- In adults : Streptococcus Pneumoniae , Neisseria Meningitidis
- *Neisseria Meningitidis* Gram negative diplococci
- Streptococcus Pneumoniae Gram positive diplococci
- Group B Streptococcus Gram positive cocci in chains
- *Haemophilus Influenzae* Small gram negative coccobacilli
- *Escherichia Coli* Gram negative bacilli
- *Listeria Monocytogenes* Gram positive rods
- CSF analysis : high protein , low glucose , increased WBC , Polymorphonuclear cells (Neutrophils).
- URGENT, A MEDICAL EMERGENCY.
- Parenterally: Ceftriaxone (or Cefotaxime) + Vancomycin
- For neonates : Ampicillin + Gentamicin (or Cefotaxime).

QUIZ:

1. A 6-week neonate presented with fever and loss of appetite. LP has revealed the following: presence of cocci gram positive organism in chain. Which one of the following is the most likely causative organism:

- a. Group B Streptococcus
- b. E.coli
- c. Listeria
- d. Streptococcus Pneumoniae .

2. For the previous scenario, what is the most appropriate antibiotic:

- a. Gentamicin + Ampicillin
- b. Gentamicin + Vancomycin
- c. Ceftriaxone + Vancomycin
- d. Amoxicillin + Ceftriaxone

3. A 24-years old presented to the ER with neck stiffness and fever. From the history he performed his pilgrimage “HAJJ” by illegal way. LP confirmed that he had meningitis with the result of gram negative diplococci. Which one of the following is the most likely causative organism. :

- a. H.influenzae
- b. Streptococcus pneumoniae
- c. Nesseria meningitidis
- d. Listeria

4. From the previous scenario. What is the most appropriate antibiotic:

- a. Gentamicin + Ceftriaxone
- b. Gentamicin + Vancomycin
- c. Ceftriaxone + Vancomycin
- d. Amoxicillin + Ceftriaxone

THANK YOU FOR CHECKING OUR WORK, BEST OF LUCK!



Doctors slides



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