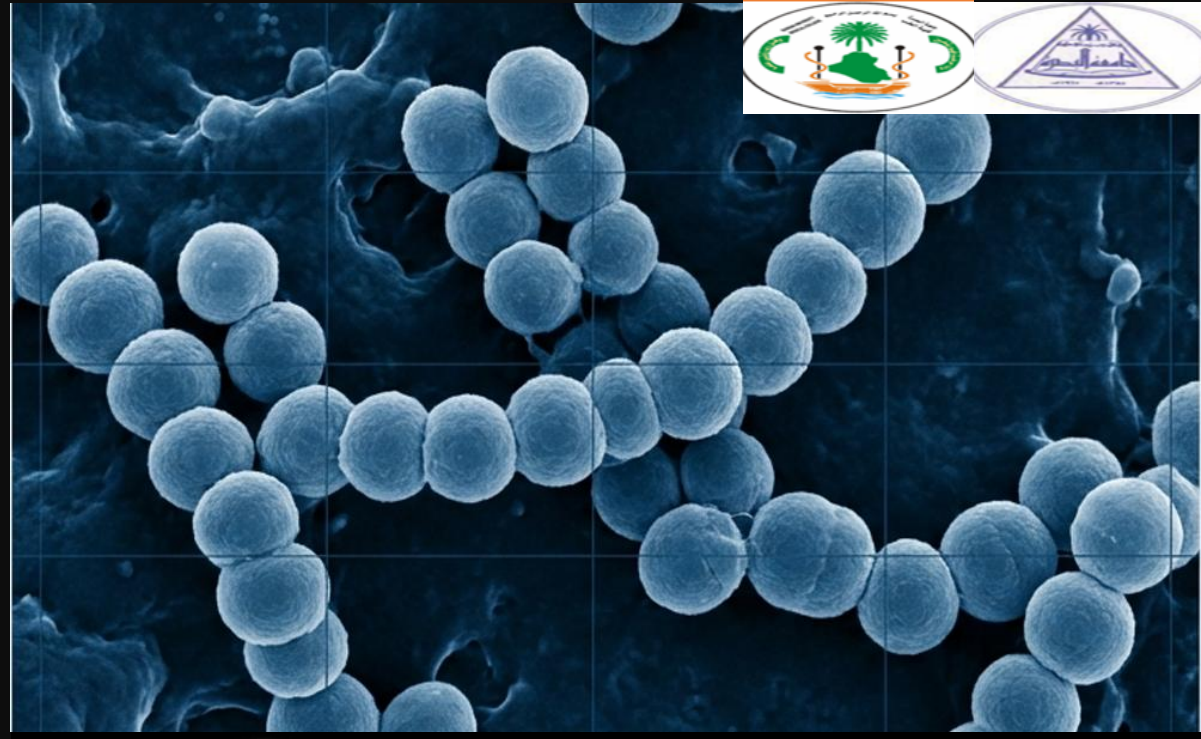
Gram positive cocci

Streptococci

- Prof. Dr. Lamyaa Kadhim
- Medical Bacteriology



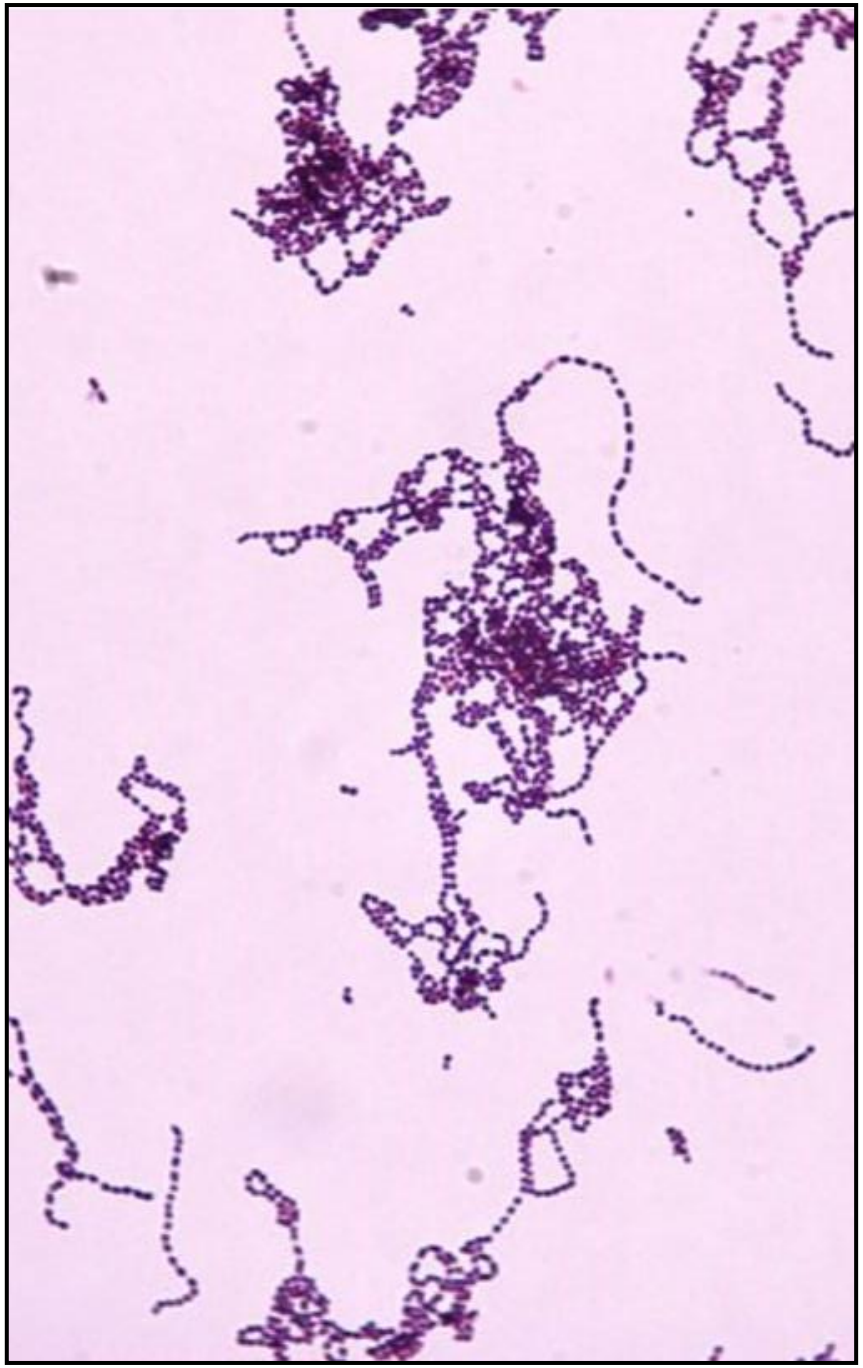
❖Intended learning outcomes:

- **By the end of this lecture the student will be able to:**

1. **Understand the types of Streptococci and their virulence factors .**

2. **Know the diseases caused by Streptococci sp.**

1. **Have a knowledge on the difference between pyogenic infections and toxin mediated infection**



INTRODUCTION

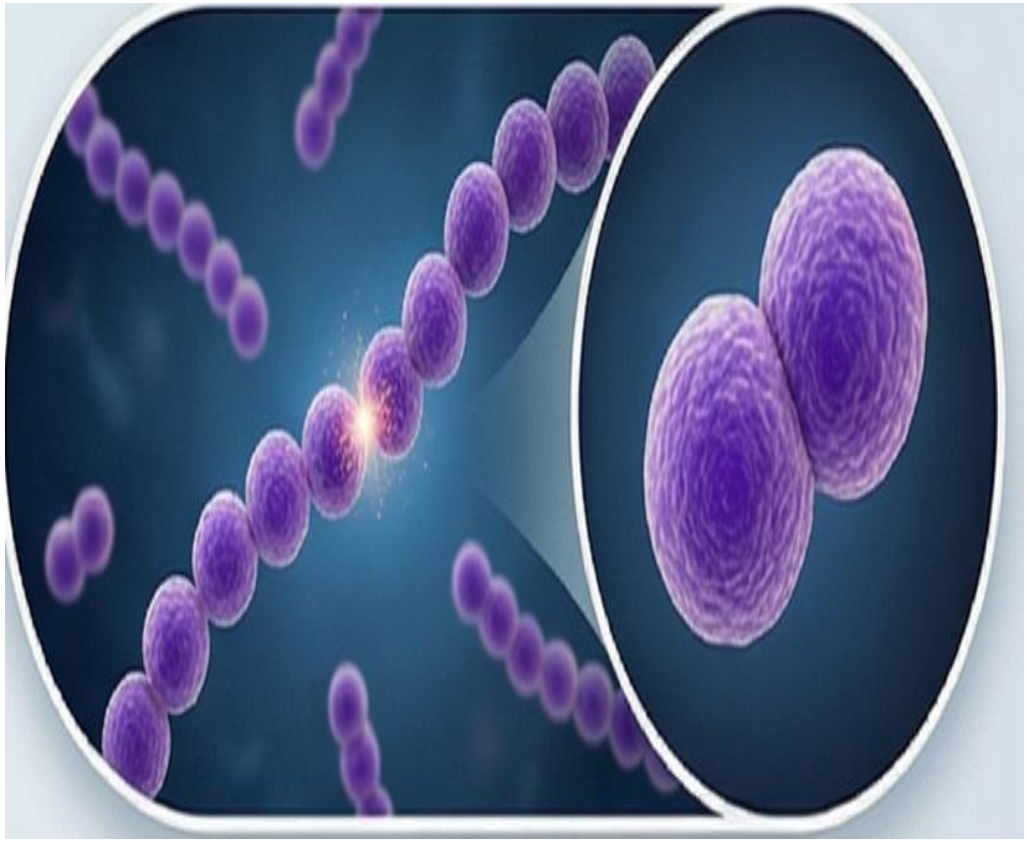
- **Family: Streptococcaceae**
- **Genus : *Streptococcus***

The term *Strepto meaning twisted chain* .

Habitat

- **They are widely distributed in nature, some are commen commensals in the throat and intestine, while others significant human disease.**

General Characteristics of Streptococci

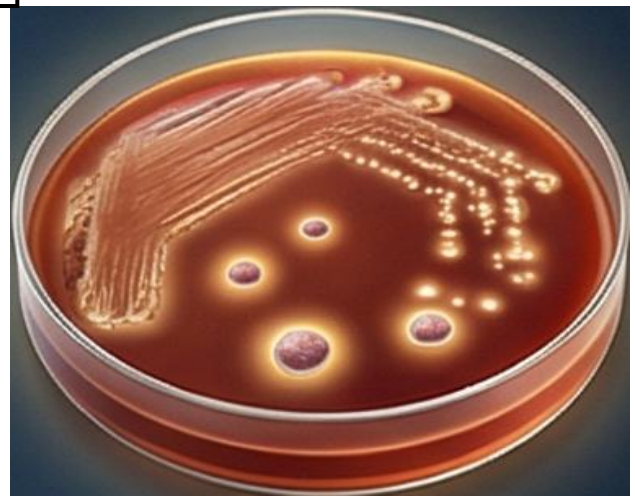


- **Classification**: Gram- positive cocci
- **Arrangement**: Chains or pairs
- **Size**: 0.5-1.0 μm in diameter
- **Features**: Non-motile, non-sporing, some strains are capsulated

In the lab Streptococci require:

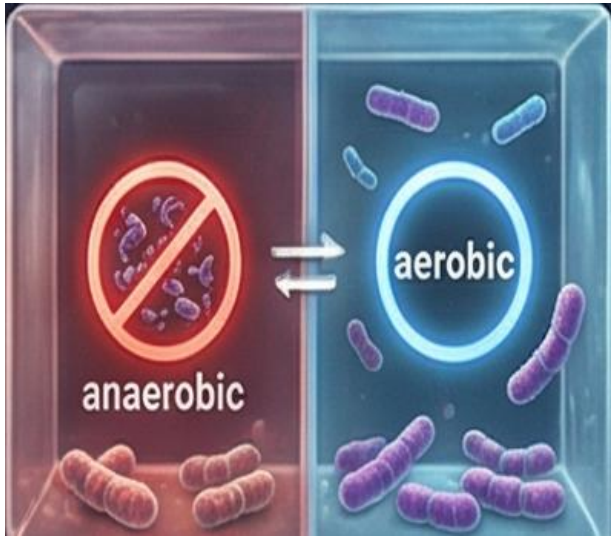
Enriched media

Needs growth medium supplemented with special nutrients to be cultivated in a lab like blood agar for optimal growth.



Facultative anaerobes

Can survive in environments with or without oxygen



Biochemical Markers

Streptococci are catalase negative, they do not produce the enzymes catalase.

Q/ Which organism would be positive for catalase test?

A-Streptococcus

B-Staphylococcus

C-It depends on how they were cultured

D-Both , because all gram positive are catalase positive

STREPTOCOCCI CLASSIFICATION SCHEMES

COMPLICATED CLASSIFICATION

More than 100 species within the genus *Streptococcus*. Three different overlapping schemes are used.

1. SEROLOGIC PROPERTIES

Lancefield Groupings
(originally A to W)

2. HEMOLYTIC PATTERNS

Complete (beta [β]) hemolysis

Incomplete (alpha [α]) hemolysis

No (gamma [γ]) hemolysis

3. BIOCHEMICAL PROPERTIES

(physiologic) properties

1. SEROLOGIC PROPERTIES

β-Haemolytic Streptococci are further classified into Lancefield groups (A to H and K to V) based on the presence of specific carbohydrate C-polysaccharides in their cell walls.

Lancefield grouping
Based on cell wall antigens

Groupable

S. pyogenes (Group A lancefield)
S. agalactiae (Group B lancefield)
S. equi (Group C lancefield)
S. bovis & Enterococcus (Group D lancefield)
S. porcinus (Group E, P, U, V lancefield)

Non-groupable

- *S. pneumoniae*
- viridans streptococci
- *S. mutans*

Modern Method

Latex Agglutination Test

This technique is performed using commercial test kits for the rapid detection of clinically important streptococcal groups.

2. HEMOLYTIC PATTERNS

The type of hemolytic reaction displayed on blood agar is used to classify the streptococci

Beta-hemolytic Streptococci : Is associated with complete lysis of red cells surrounding the colony.

Alpha-hemolytic Streptococci : Is a partial or "green" hemolysis associated with reduction of red cell hemoglobin.

Gamma-hemolytic (Non-hemolytic)

Refers to absence of any hemolytic activity.

IMPORTANT HUMAN PATHOGENS

- *Streptococcus pyogenes* (group A streptococcus/ GAS)
- *Streptococcus agalactiae* (GBS)
- *Streptococcus pneumoniae*
- *Streptococcus viridans*
- Group D streptococcus (enterococci)

(now called *Enterococcus faecalis* is placed in a separate genus *Enterococcus*

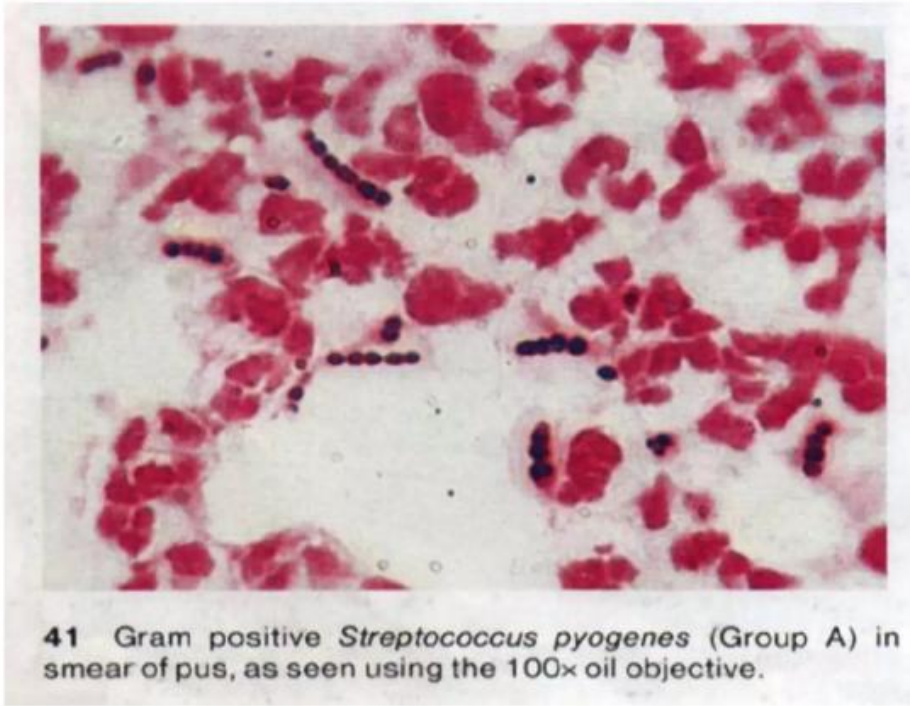
Because it differ in rRNA
And cause Urinary tract infections (Unlike streptococci)

Streptococcus pyogenes

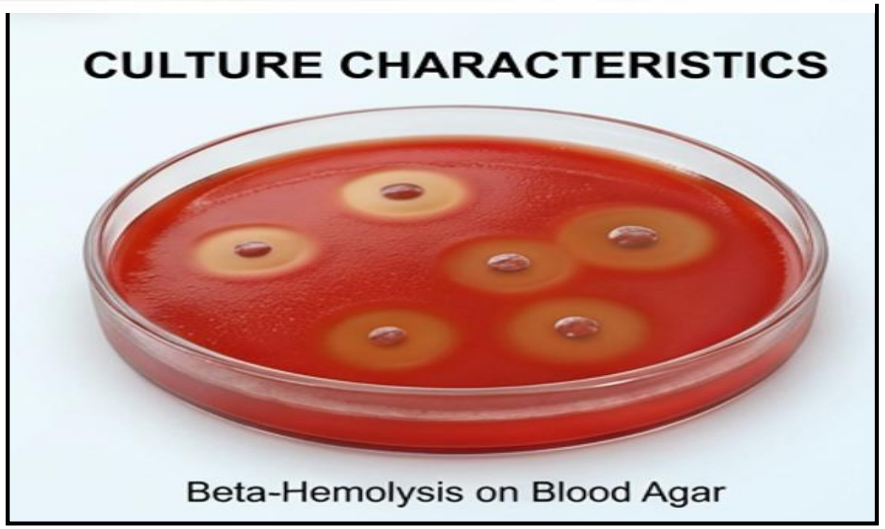
-It is also known as the **Group A streptococci (GAS).**

-Facultative anaerobe

- 5-10% optimal
- Catalase negative
- Human pathogen
- Is **Beta-hemolytic**

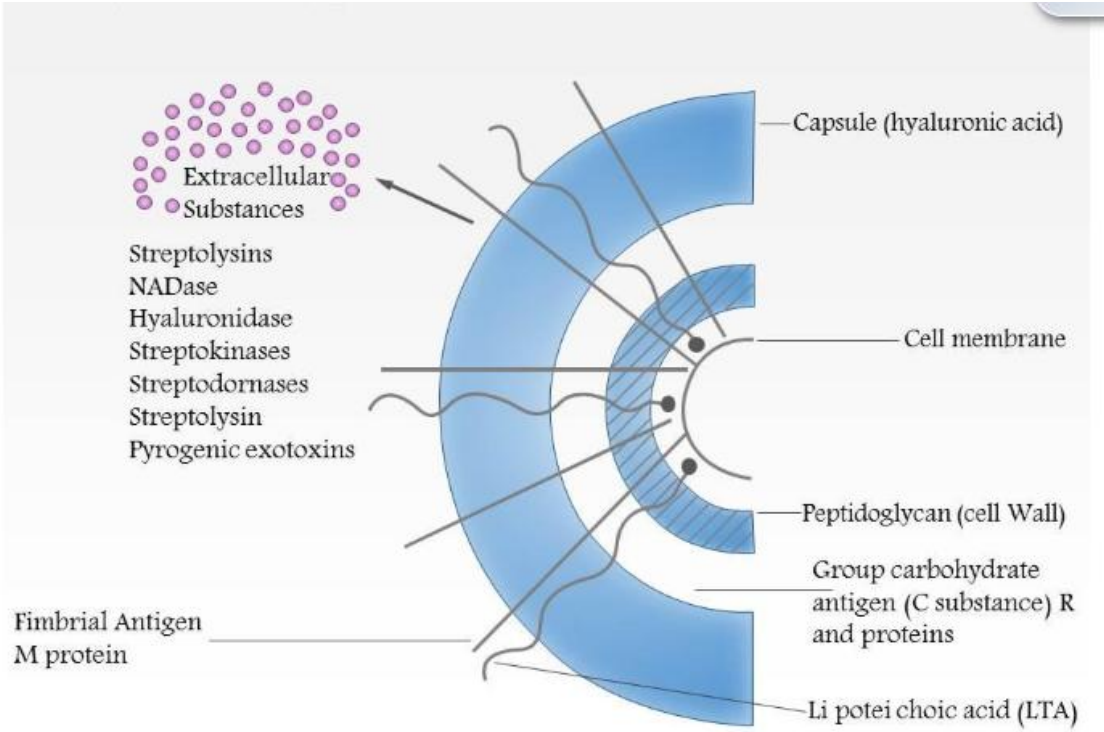


41 Gram positive *Streptococcus pyogenes* (Group A) in smear of pus, as seen using the 100× oil objective.



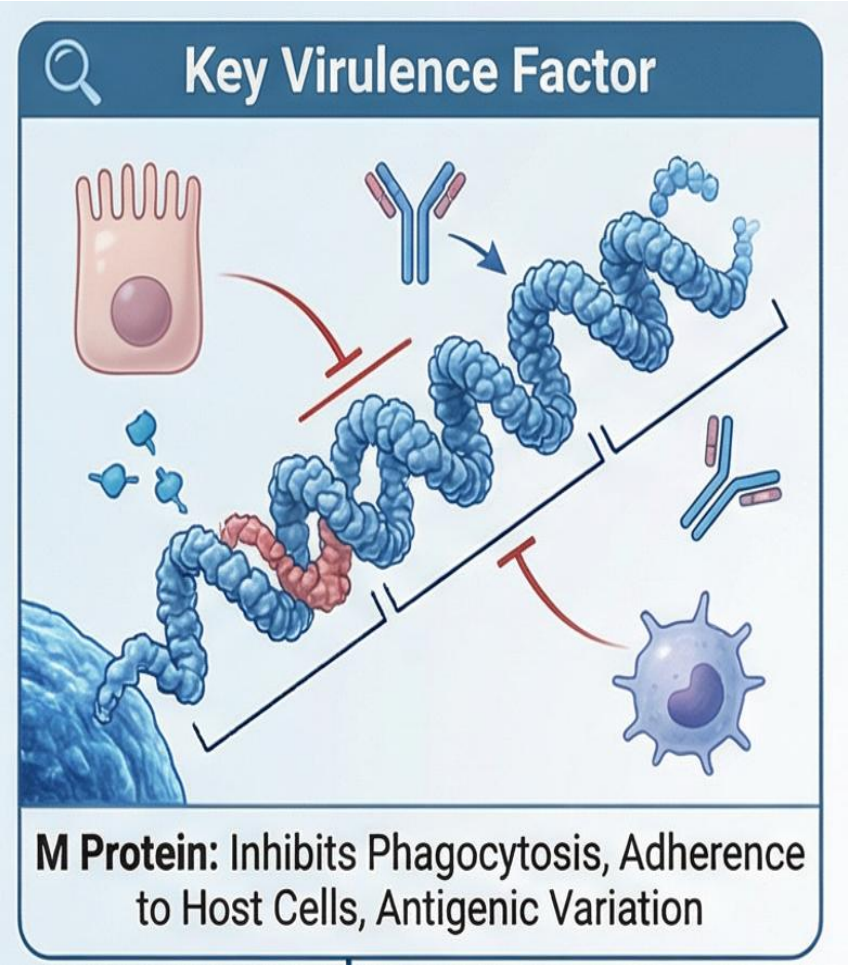
Pathogenesis and virulence factors

Streptococcus pyogenes produces human infection by its capability to invade and spread into tissue and by production of certain enzymes and toxins.



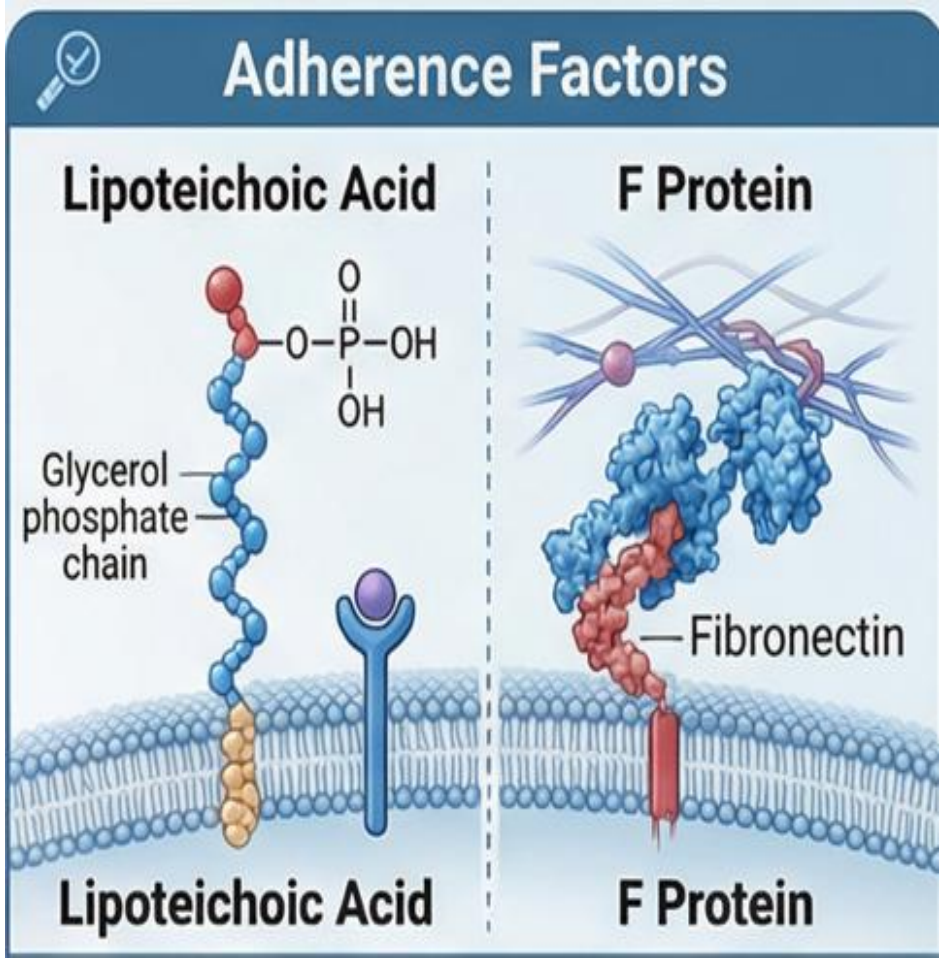
Virulence Factors of *Streptococcus pyogenes*

1- M protein: Is the most important virulence of *streptococcus pyogenes* and has antiphagocytic activity.
Antibodies to M protein are protective.
The M protein plays an important role in the pathogenesis of rheumatic fever,
Antibodies to these components react with cardiac muscle tissue.
Some M types are rheumatogenic, while other types are nephritogenic.



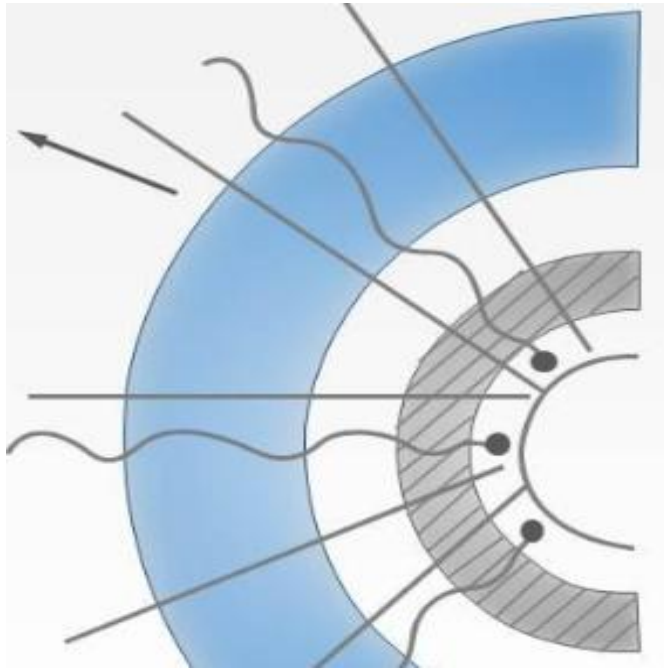
2- Lipoteichoic acid: a surface component that mediates adherence of the organism to mucosal surfaces.

3- F protein (fibronectin-binding protein) a surface structure that interacts with host cell fibronectin and mediates adherence and entrance of the bacteria into the host cel



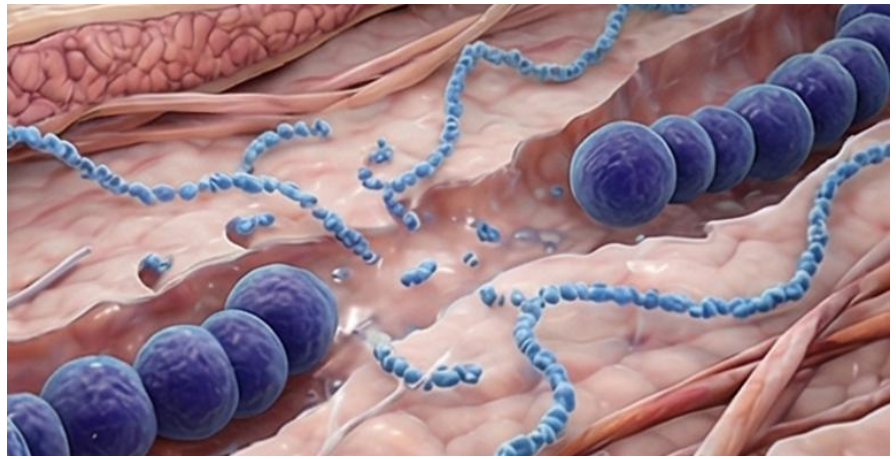
Immune Evasion

Hyaluronic Acid Capsule:
Mimics Host Connective Tissue, Resists Phagocytosis and Immune Recognition



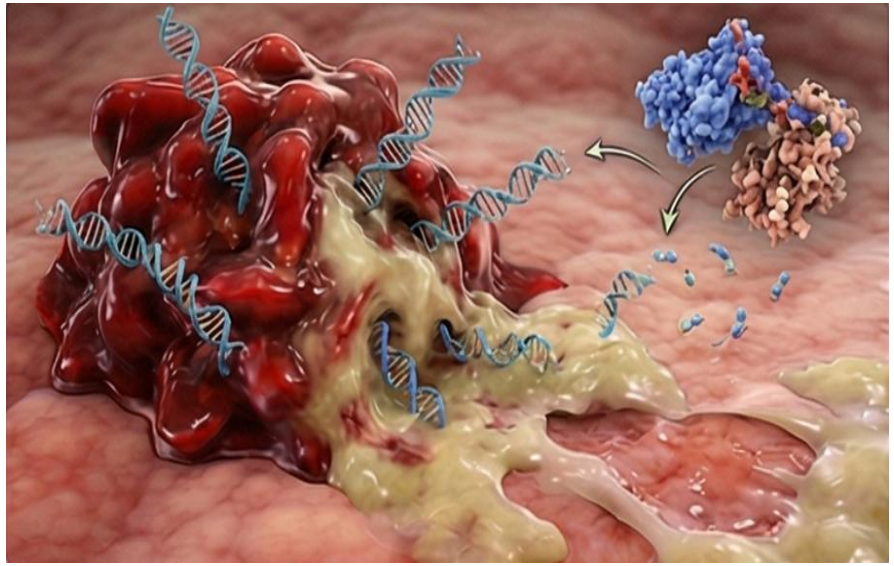
Hyaluronidase

This enzyme destroys hyaluronic acid in the host connective tissue, which helps in the spread of skin infections like cellulitis.



DNase(Ribonuclease)

Removes clotted blood or fibrinous / purulent accumulations by digesting DNA within them



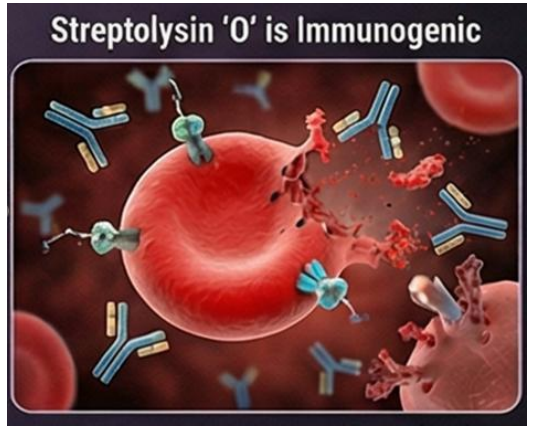
Streptolysins (hemolysins)

These are toxins that lyse red blood cells. There are two distinct types:

Streptolysin O

Oxygen-labile toxin

It triggers an immune response, leading to the development of antibodies (ASC) during Strp. pyogenes infections.



Streptolysin S

Oxygen-stable toxin

It does not trigger an antibody response but is responsible for the visible hemolysis (destruction of red blood cells) observed on blood agar plates in the lab.

Streptolysin S

Pyrogenic Exotoxins of Streptococci

SECTION 1

Pyrogenic Exotoxin A (Erythrogenic Toxin)

Pyrogenic Exotoxin A

Scarlet Fever

Damages blood capillary membranes

SECTION 2

Pyrogenic Exotoxin B (Protease)

Pyrogenic Exotoxin B

Necrotizing Fasciitis

Destroys bodily tissues rapidly

SECTION 3

Pyrogenic Exotoxin C

Pyrogenic Exotoxin C

Streptococcal Toxic Shock Syndrome

Contributes to STSS development

Secretes Pyrogenic Exotoxin B

Secretes Pyrogenic Exotoxin A

Secretes Pyrogenic Exotoxin C

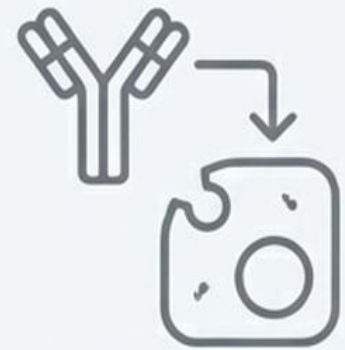
The Three Mechanisms of *S. pyogenes* Pathogenesis

Mechanism 1: Pyogenic Inflammation

- **Action:** Bacteria induce a local, pus-forming inflammatory response at the site of infection.

Mechanism 2: Exotoxin Production

- **Action:** Toxins are released into the bloodstream, causing widespread systemic symptoms.



Mechanism 3: Immunologic Reaction

- **Action:** Antibodies produced against bacterial components cross-react with normal human tissues, causing post-infectious disease.

Clinical Manifestations of *Streptococcus pyogenes*

Portal of Entry detect the Disease

The specific location where *S. pyogenes* enters the body determines the primary clinical infection that will manifest.

Streptococcal Sore Throat

S. *pyogenes* is the most common bacteriol cause of sore throat. Visually, this presents as inflammation and exudates on the tonsils.

Erysipelas & Cellulitis

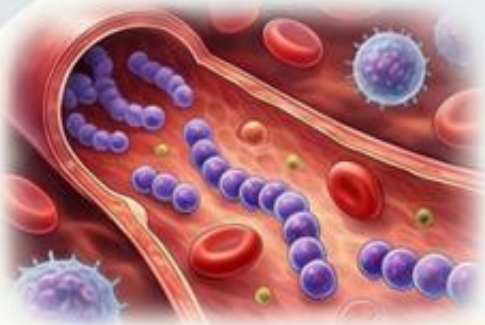
These are infections of the skin and underlying soft tissues, causing aress of redness, swelling, warmth, and pain.

Streptococcal Pyoderma (Impetigo)

Necrotizing Fasciitis (Flesh-Eating Disease)

A severe, rapidly progressing infection that destroys soft tissue, including muscle and fat, requiring immediate surgical intervention.

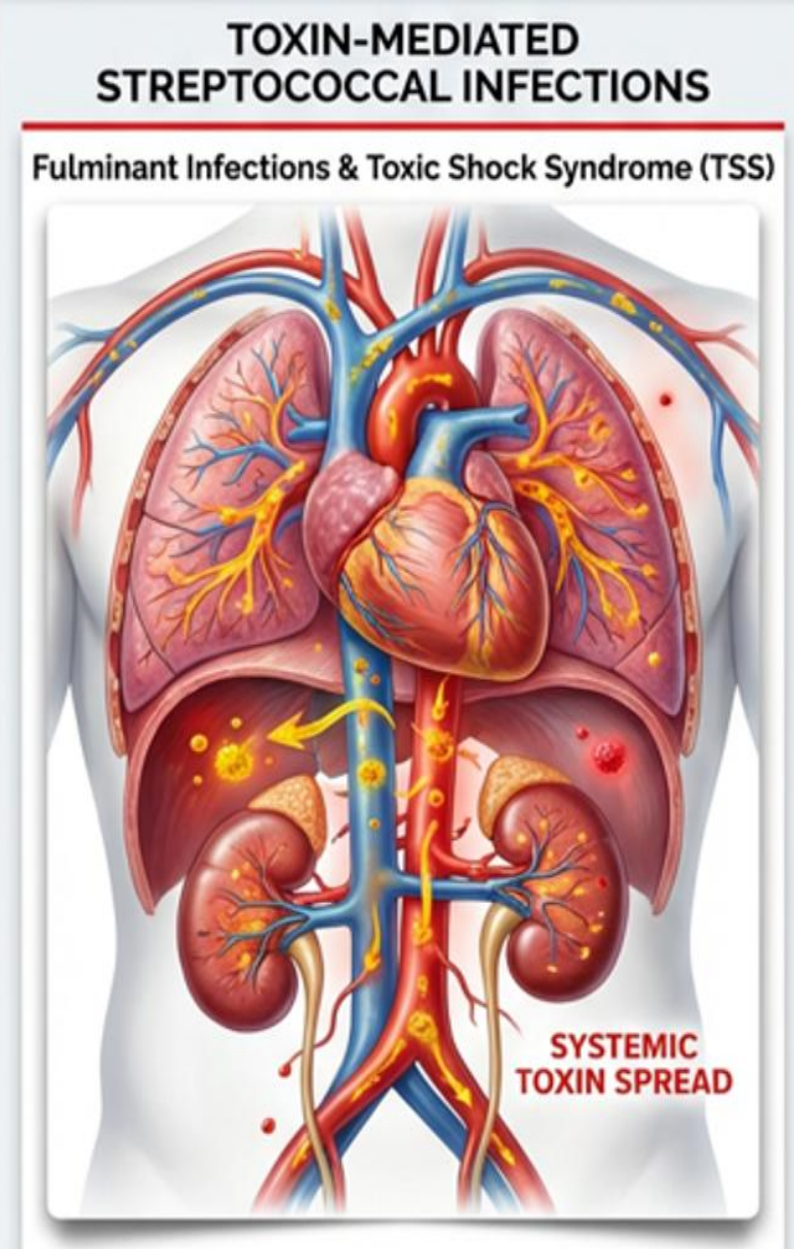
Systemic & Post-Partum Infections



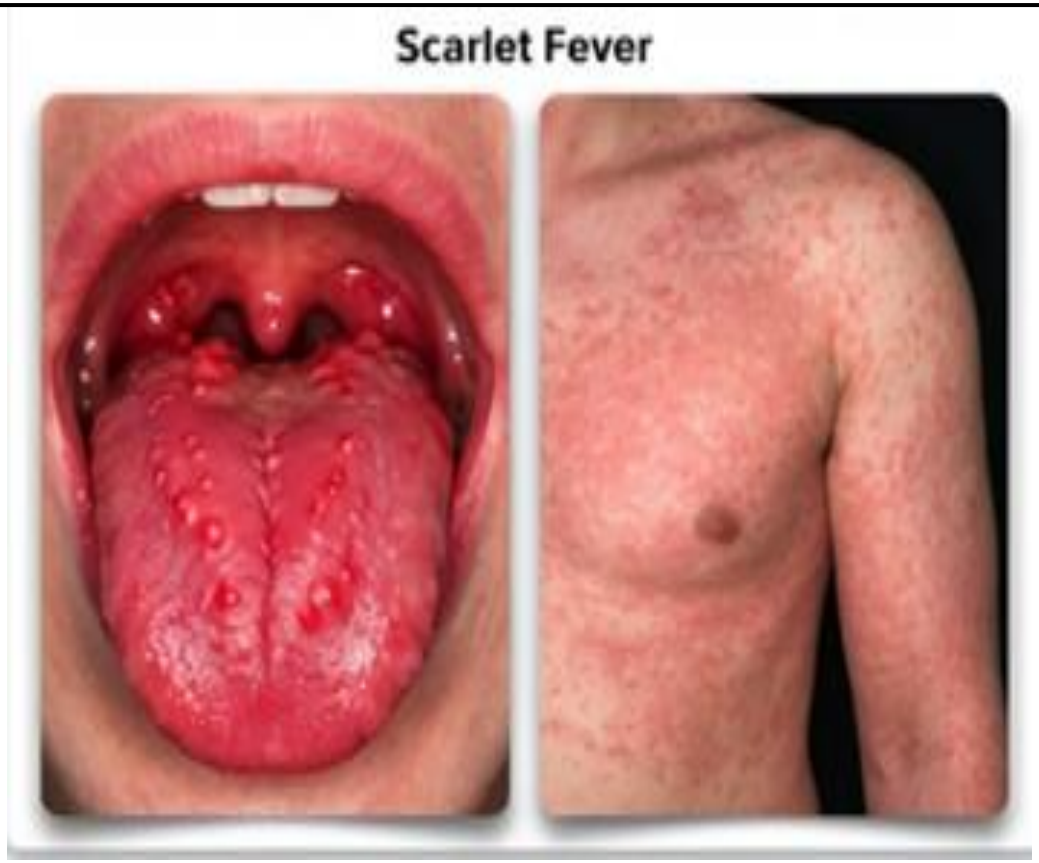
The bacteria can cause life-threatening systemic conditions like Sepsis (bloodstream infection) and Puerperal Fever (a uterine infection after childbirth).

- **Toxin- mediated streptococcal infections:**

Streptococcal toxic shock syndrome: Following minor trauma, characterized by fever, bacteremia, rapidly progressive shock, and multi-organ failure.**(blood culture are often positive)**



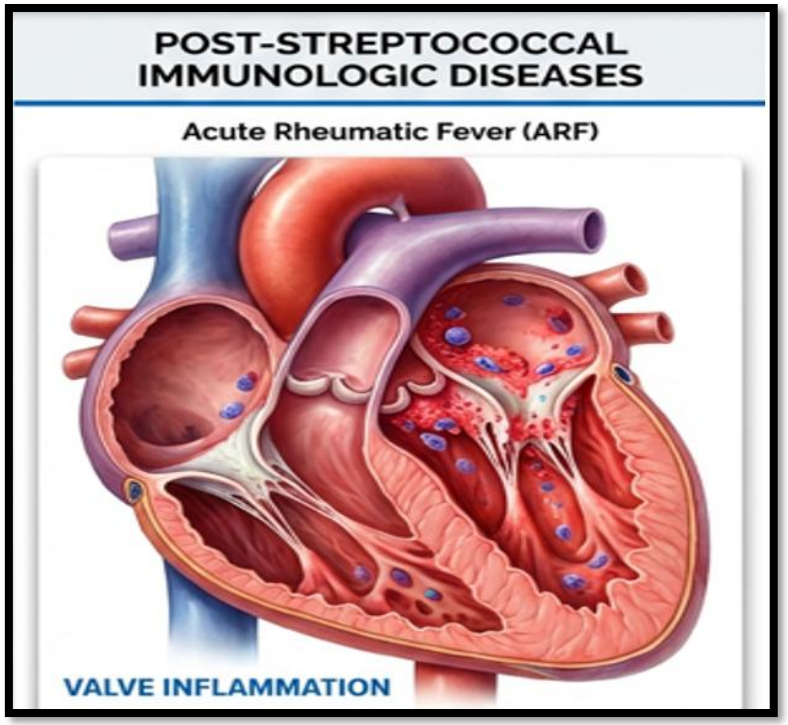
- **Scarlet fever:** it can develop in people who have strep throat. It's characterized by a bright red rash usually on trunk and extremities, fever and sore throat.



- **Post-streptococcal diseases:**

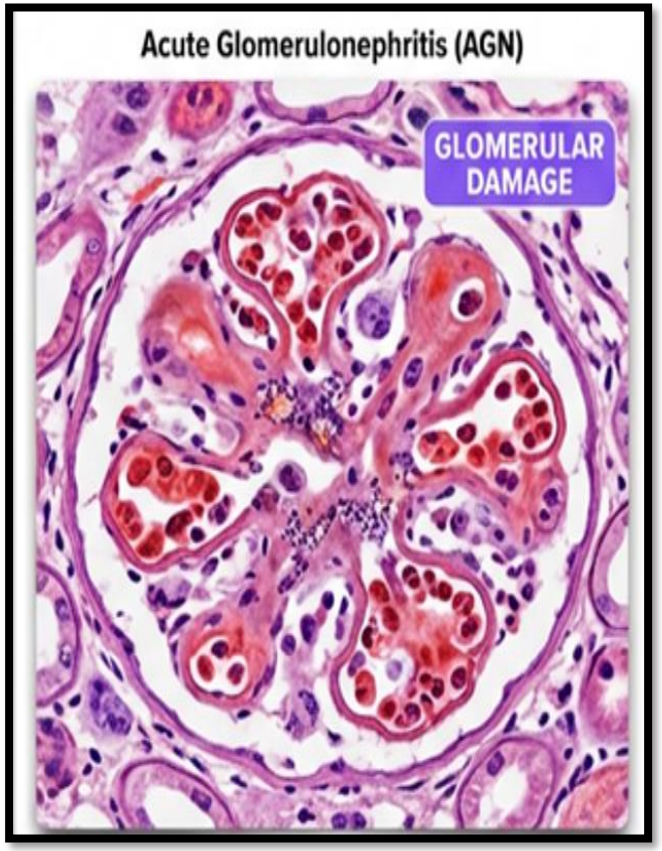
- Rheumatic fever:

* Is more common following *st. pyogenes* respiratory infection (Due to an immunologic reaction between cross-reacting antibodies to certain streptococcal M proteins and antigens of joint, heart, and brain tissues).



Acute glomerulonephritis:

Is more commonly following *st. pyogenes* skin infection (initiated by deposition of Ag-Ab complexes on the glomerular membrane).



Group B Streptococcus (*S. agalactiae*)

Prevalence & Transmission

5-25%

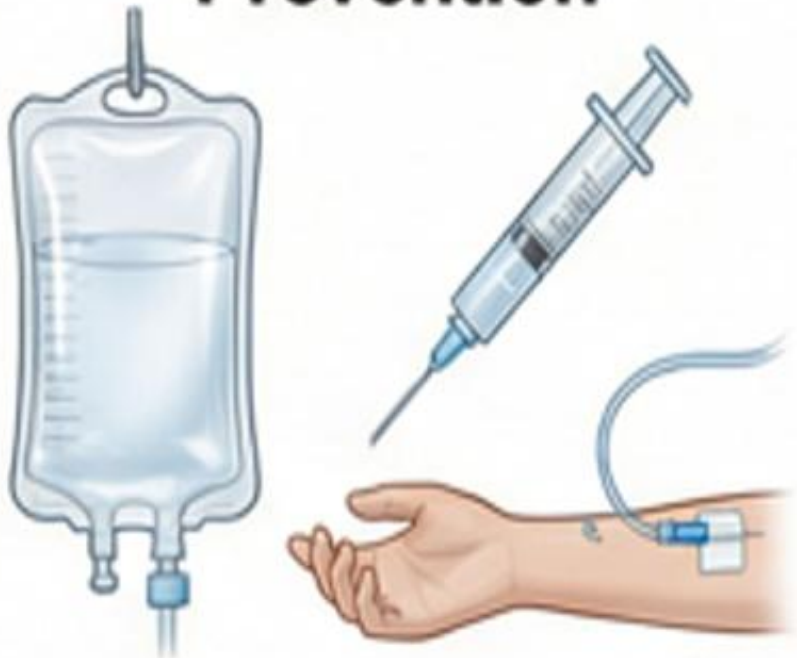
of women carry GBS as normal vaginal flora

Birth Canal → Newborn

Risk factors:

- Delayed delivery
- Premature birth

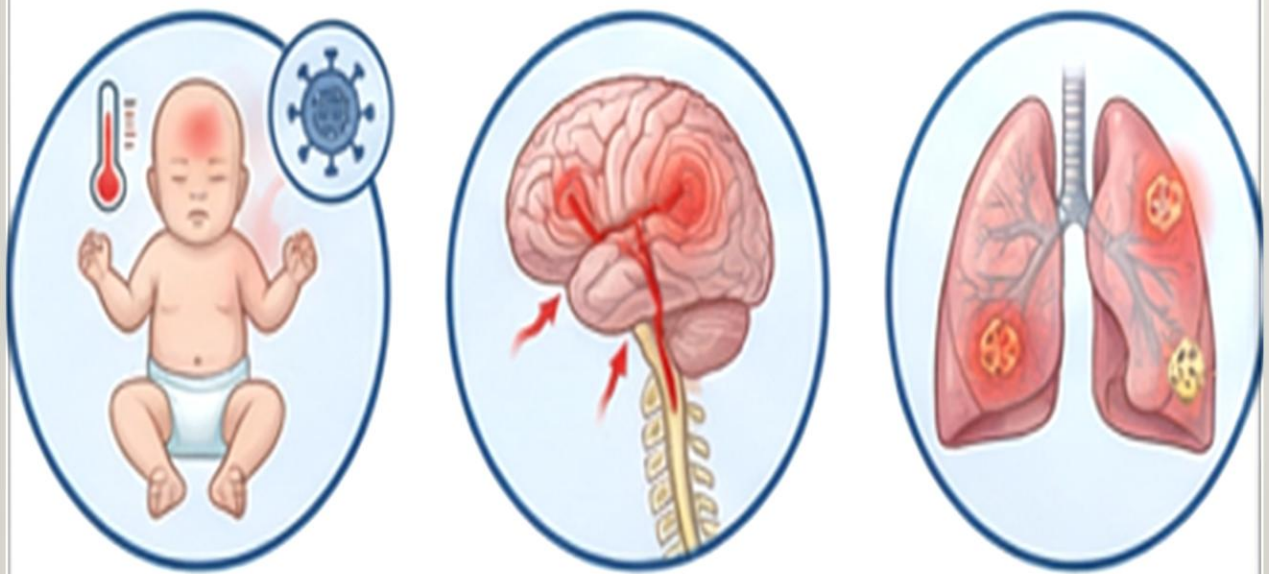
Prevention



Intravenous Penicillin during labor for colonized mothers

CLINICAL IMPACT

Neonatal Complications



Sepsis | Meningitis | Pneumonia

Adult Complications

Pneumonia

Endocarditis

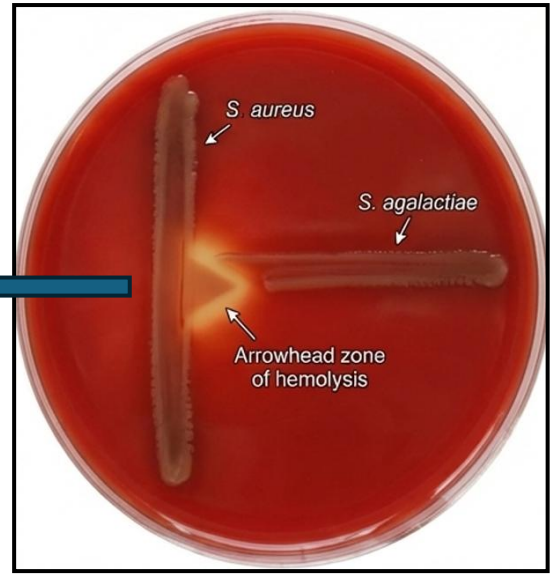
Osteomyelitis

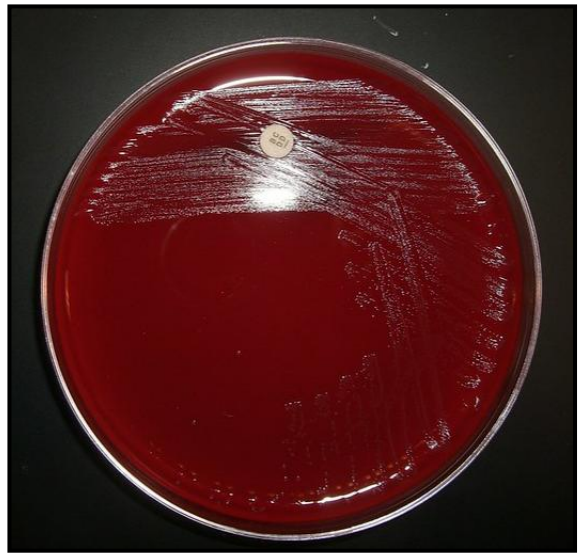
Postpartum endometritis

Laboratory identification of *S. agalactiae*

The CAMP Test

Positive result:
Arrowhead
hemolysis appears where the two bacterial growths are closest





Bacitracin Resistant

Streptococcus pneumoniae (Pneumococcus)

GENERAL FEATURES

Gram stain : Gram positive , lancet-shaped diplococci, encapsulated .

Culture: Small, round ,alpha-hemolytic colonies.

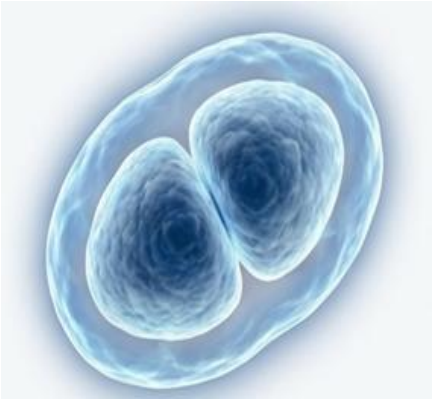
Key test: -Optochin sensitive .
-Quellung reaction
-Bile solubility

Virulence & immunity

-primary virulence factor:

Polysaccharide capsule prevents phagocytosis. More than 80 antigenic types exist.

Immunity: Depends on anti-capsular antibodies

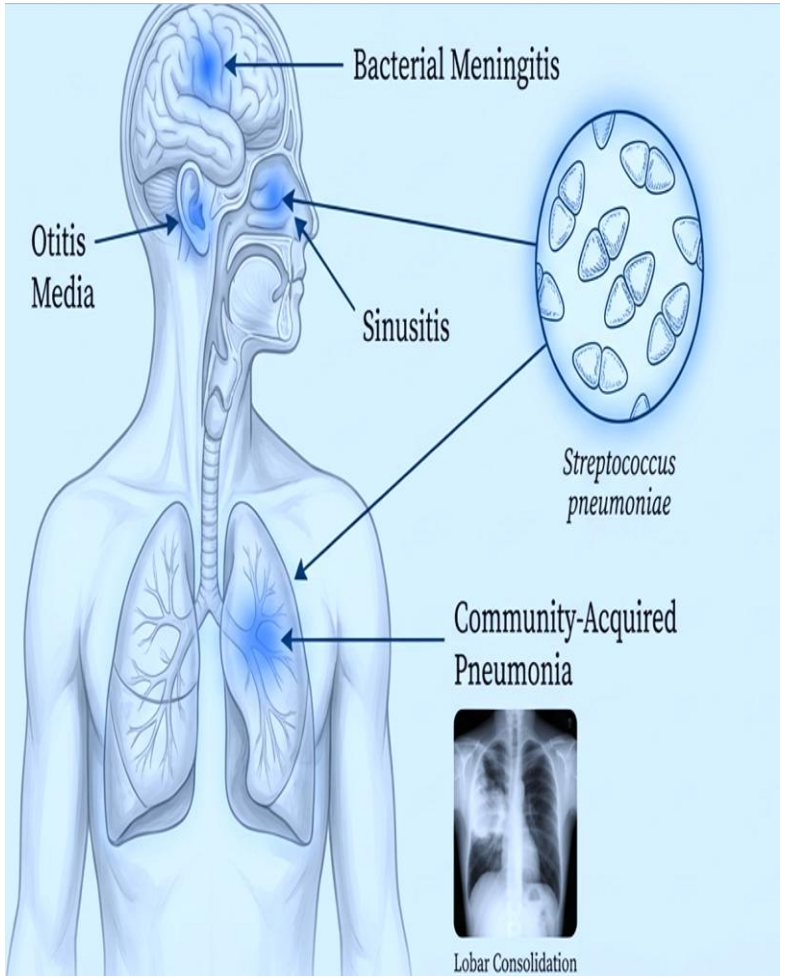


Clinical significance

-**Primary cause of pneumonia** (60-70% of bacterial cases), sinusitis , otitis media, meningitis.

-**Classic presentation**: sudden onset of fever ,chills sharp pleural pain ,and rusty sputum .

-**Treatment** : drug of choice is Penicillin G.

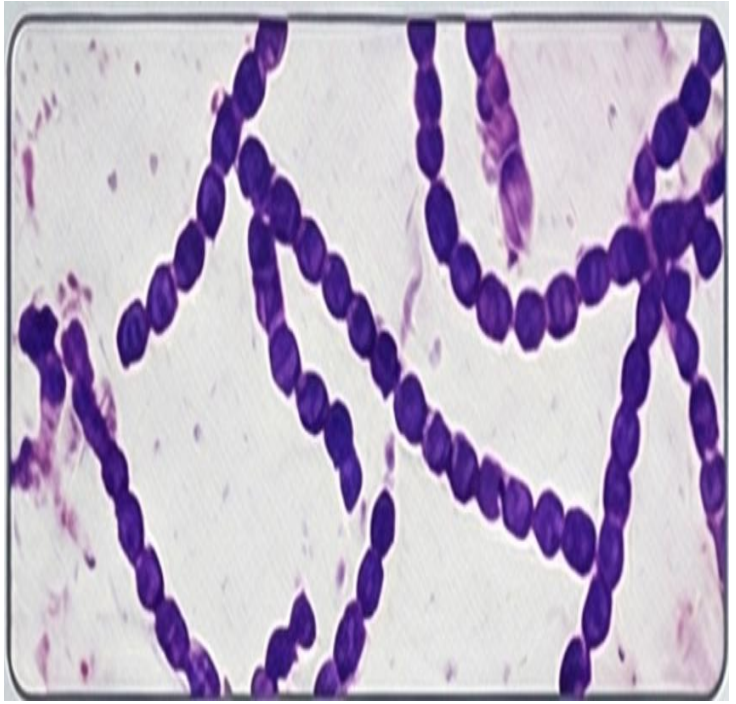


Viridans Streptococci

Gram stain : Gram positive cocci in chains .

Culture: typically alpha-hemolytic but some are non-hemolytic.

Key test: Optochin resistant .



Common Species in the Viridans Group

S. mutans

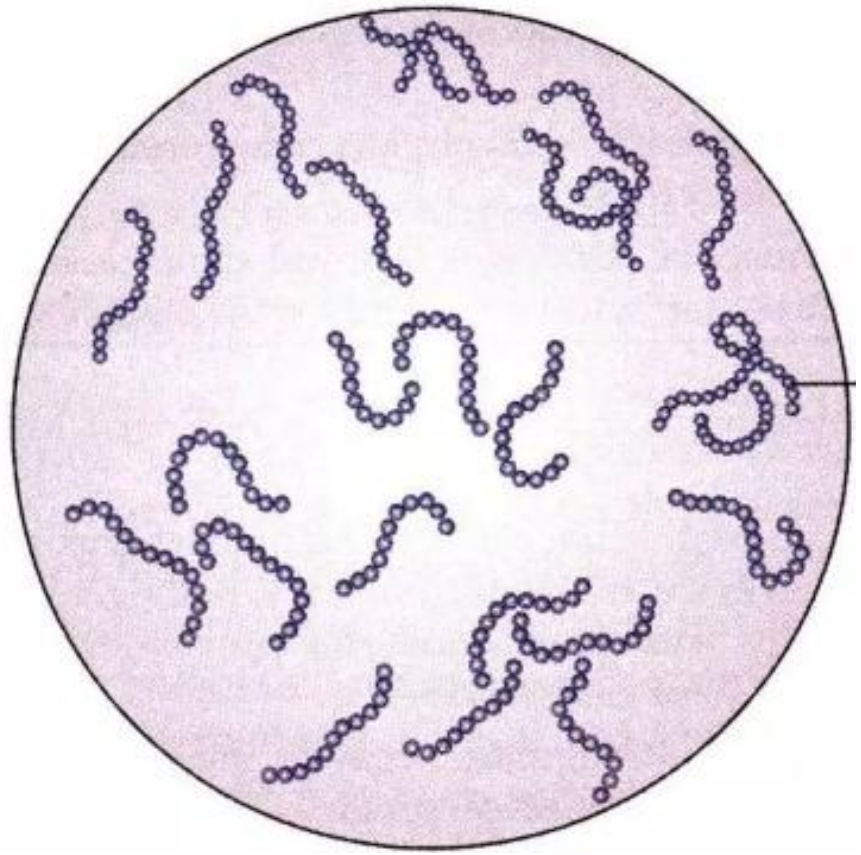
S. salivarius

S. mitis

S. sanguis

S. anginosus

Diverse group including several medically relevant species



Normal Inhabitants of the Human Body

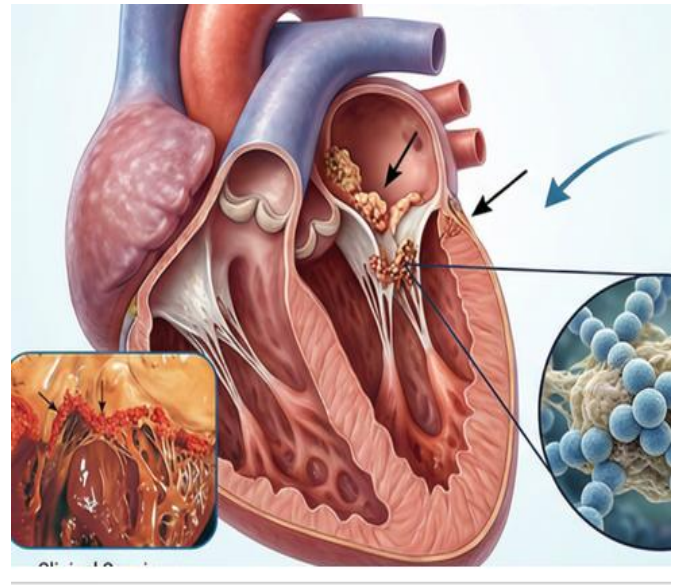
Habitat

- Normal inhabitants of the oral cavity, GIT, and female genital tract.

Clinical Significance

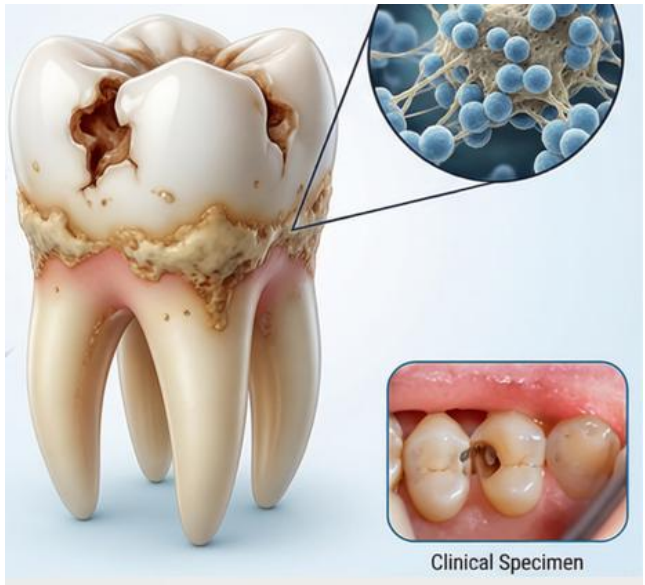
- **Subacute Bacterial Endocarditis (SBE):**

The most serious infection caused by this group, occurring in individuals with damaged or prosthetic heart valves.



- **Dental Plaque & Caries:**

S. mutans synthesizes sticky polysaccharides from sucrose ,contributing to dental caries.



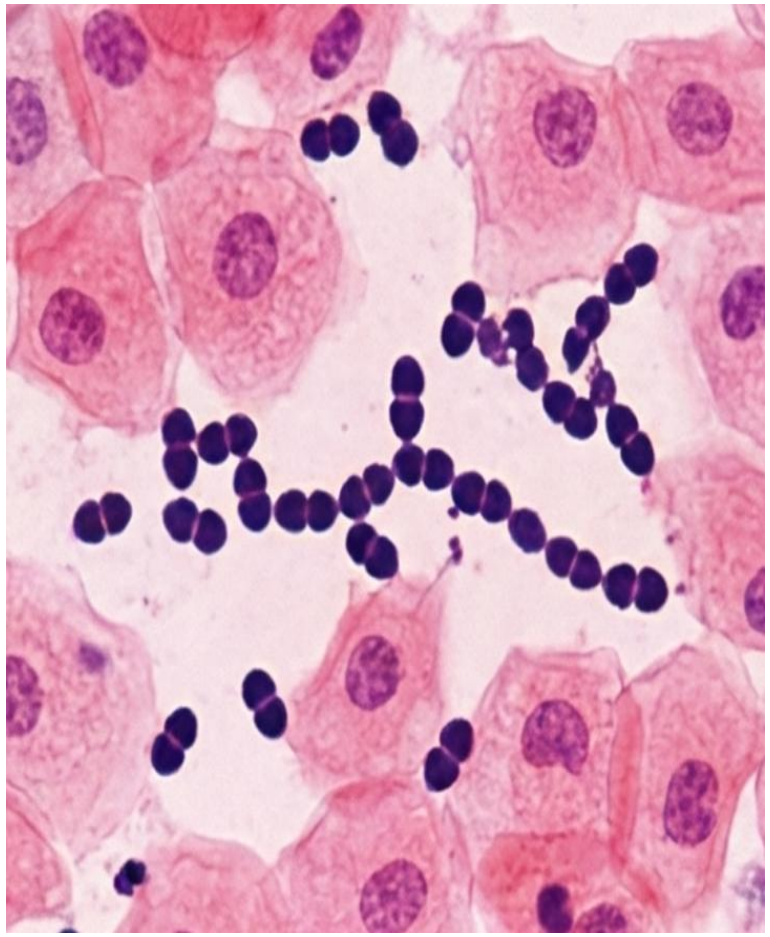
The Enterococci

Formerly Group D Streptococci; *Enterococcus faecalis* is the most common species (85-90% of infections).

Morphology: Gram-positive cocci in pairs or short chains.

Able to grow in extreme conditions (high temp, pH, and salt concentration)

Key test : growth on bile esculin agar



Clinical significance

A major cause of nosocomial (hospital acquired) infections ,particularly in immunocompromised patients.

Infections: Urinary tract infections(UTI), wound infections, biliary tract infections.

Known for developing a wide range of antibiotic resistance (e.g., vancomycin, aminoglycosides, and beta-lactams).

Feature	*S. pyogenes* (GAS)	*S. agalactiae* (GBS)	*S. pneumoniae*	Viridans Group
Hemolysis	β	β	α	α (or γ)
Key Differentiating Test	Bacitracin Sensitive	CAMP Positive	Optochin Sensitive	Optochin Resistant
Primary Habitat	Skin, Oropharynx	Female Genital Tract	Oropharynx	Oral Cavity
Key Clinical Syndromes	Pharyngitis, Rheumatic Fever, STSS	Neonatal Sepsis/Meningitis	Pneumonia, Meningitis	Endocarditis, Dental Caries
Key Virulence Factor	M Protein	-	Polysaccharide Capsule	Polysaccharides (for caries)

THANK YOU