

Ministry of Higher education and scientific research

University of Tikrit

College of science

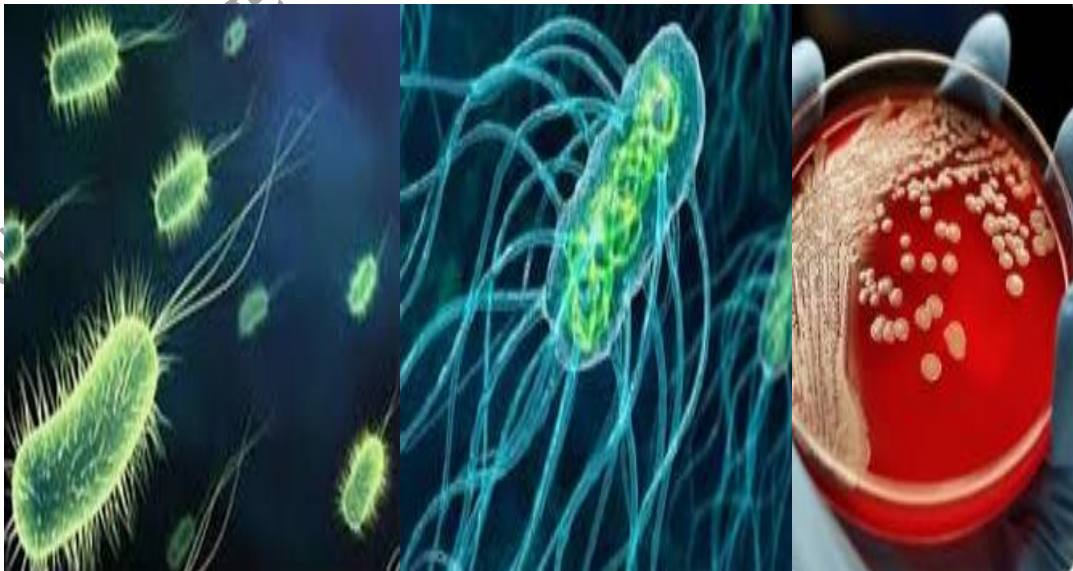
Department of Biology

## Lectures of Pathogenic Bacteria

For Diploma students – Pathological analyses - 2024-2025

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## Streptococci genus

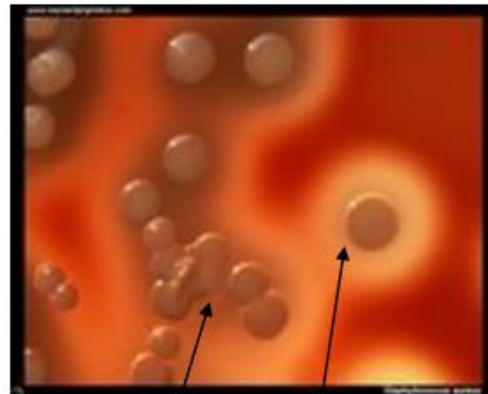
Are G<sup>+</sup>, non-motile, and catalase negative. Clinically important genera include Streptococcus and Enterococcus, they are ovoid to spherical in shape, occur as pairs or chains. Most are aero tolerant anaerobes because they grow fermentatively even in the presence of oxygen. and because of their complex nutritional requirements blood enriched medium is generally used for their isolation. Classification of streptococcus We can classify Streptococci according to

### 1- Hemolytic properties on blood agar

- $\alpha$  – hemolytic Streptococcus : appearance of green pigment that forms a ring around the colony.
- $\beta$ - hemolysis Streptococci: gross lysis of red blood cells resulting in a clear ring around the colony.
- $\gamma$ - hemolytic streptococci: cause no color change or lysis of the RBCs.



( $\alpha$ ,  $\beta$  and  $\gamma$ ) Haemolysis on Blood agar



$\alpha$ - Haemolysis       $\beta$ -Haemolysis

**2- Serologic (Lancefield) grouping** Many species of Streptococci have a polysaccharide in their cell walls known as C- substance. Thus on the bases of their C-substance. The clinically most important groups of  $\beta$ - hemolytic Streptococci are types A and B.

#### \*Group A $\beta$ - hemolytic Streptococci

*S. pyogenes* : The most clinically important member of this group of G<sup>+</sup> cocci, it can invade apparently intact skin or mucous membranes, causing some of the most rapidly progressive infections known. *S. pyogenes* is usually spread person to person by skin contact and via the respiratory tract.

**A- Structure and physiology** It appears as individual cocci, pairs, or clusters of cells in gram stains of samples from infected tissues.

**1- Capsule: Hyaluronic acid** , identical to that found in human

connective tissue , form outer most layer of the cell. This capsule is not recognized as foreign by the body , and therefore , is non-immunogenic . The capsule also antiphagocytic .

**2- The cell wall** : The cell wall contains a number of clinically important components

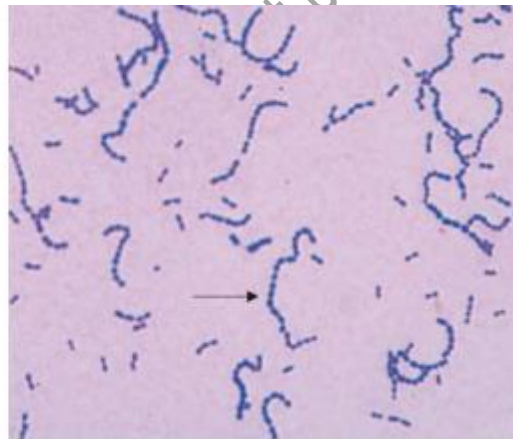
a- M protein: *S. pyogenes* is not infectious in the absence of M-protein . This protein is highly variable especially the N- terminal regions , resulting in over 80 different antigen types , M- protein are antiphagocytic and they form a coat that interferes with complement binding .

b- Group A: Specific C- substance ,this component is composed of rhamnose and N-acetylglucosamine(All group A streptococci contain this antigen ).

c- Protein F (Fibronectin – binding protein):mediates attachment to fibronectin in the pharyngeal epithelium .

**3- Extracellular products** : *S. pyogenes* secretes a wide range of exotoxins that often vary from one strain to another and play roles in the pathogenesis of disease caused by these organisms .

**FIGURE 25-1. Group A streptococcus (GAS) Gram stain.**  
Note the oval cocci chaining end to end (arrow). (Image contributed by Professor Shirley Lowe, University of California, San Francisco School of Medicine, with permission.)



#### **Pathogenesis :**

*S. pyogenes* cells , perhaps in an inhaled droplet attach to the pharyngeal via actions of protein F , lipoteichoic acid , and M protein. Bacteria may grow and secrete toxins causing damage to surrounding cells , invading the mucosa . there is sufficient spread that the blood stream is significantly invaded , possibly resulting in septicemia and / or seeding of distant sites.

#### **Clinical significance :**

1- Acute pharyngitis or pharyngotonsillitis

It is the most common type of *S. pyogenes* infection. This type pharyngitis called "Strep throat" the syndrome is designated scarlet fever. Laboratory confirmation is important for accurate diagnosis and

treatment of streptococcal pharyngitis particularly for the prevention of subsequent acute rheumatic fever and rheumatic heart disease .

2-Impetigo : Typically affecting children , it can cause severe and extensive lesion on the face and limbs .

3-Erysipelas : Affecting all age groups, advancing erythema especially on face

4-Puerperal sepsis : Its caused by exogenous transmission (ex. By nasal droplets from an infected carrier) or endogenously from the mothers vaginal flora .

5-Invasive group A Streptococcal disease (GAS): Patients may have a deep local invasion either without necrosis (cellulitis) or with it (necrotizing fasciitis / myositis ) . Invasive GAS disease often spreads rapidly , leading to bacteremia and sepsis .

6-Streptococcal toxic shock syndrome: The syndrome is mediated by the production of streptococcal pyogenic exotoxin that function as super antigen causing massive , nonspecific T-cell activation cytokine release.

7-Post-streptococcal sequelae

a- Acute rheumatic fever: this autoimmune disease occurs 2 to 3 weeks after initiation of pharyngitis ,its caused by cross reactions between antigen of the heart and joint tissyes and the streptococcal antigen (especially the M protein epitopes)

b- Acute glomerulonephritis : This rare , post infectious squal occurs as soon as 1 week after impetigo or pharyngitis .



**FIGURE 25-9. Streptococcal erysipelas.** The diffuse erythema and swelling in the face of this woman are characteristic of GAS cellulitis at any site. (Reproduced with permission from Connor DH, Chandler FW, Schwartz DQ, et al: *Pathology of Infectious Diseases*. Stamford CT: Appleton & Lange, 1997.)

### Laboratory identification:

Rapid latex antigen kits for direct detection of group A streptococci in patient samples are widely used.

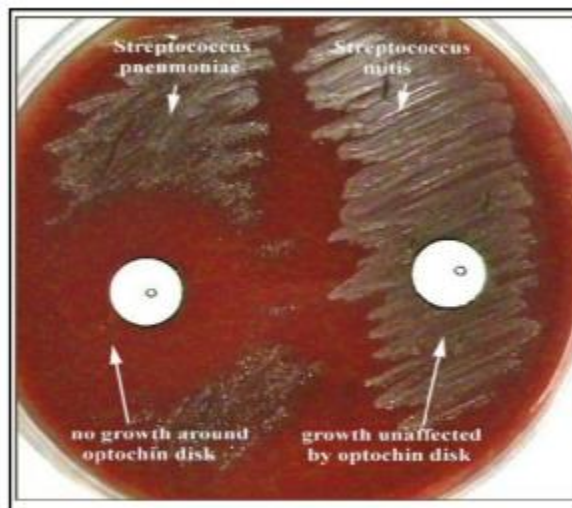
1- Specimens: For lab. analysis can be obtained from throat swabs , pus and lesion samples, sputum , blood or spinal fluid .

2- Sensitivity test: this organism is highly sensitive to bacitracin .

3- *S. pyogenes* is catalase negative .

4- Optochin resistant.

5- Serological tests .



### Optochin Susceptibility

#### Treatment:

1- Penicillin G . For hypersensitive patients to penicillin G , Macrolide such as clarithromycin or azithromycin are preferred drugs.

**Prevention:** Rheumatic fever is prevented by rapid eradication of infecting organism.

### Group B $\beta$ -hemolytic streptococci

Represented by the pathogen

- *S. agalactiae* are G+ catalase – negative organism , is found in the vaginocervical tract of female carriers , and the urethral mucous membrane of male carriers as well as in the GIT. Can be transmitted sexually among adults and from an infected mother to her infant at birth. Group B streptococci are a leading cause of meningitis and septicemia in neonates , with high mortality rate and may cause infection in post-partum women (endometrities) , also septicemia and pneumonia in person with impaired immune system .

- *Streptococcus pneumonia* (*Pneumococcus*) Are G+ , non-motile , encapsulated cocci , and their tendency to occur in pairs as *Diplococcus pneumoniae* this bacteria commonly cause



- 1- Acquired pneumonia
- 2- Adult bacterial meningitis
- 3- Important cause of otitis media , sinusitis and mastoiditis .

Like other streptococcus , Strept. Pneumoniae is fastidious (has complex nutritional requirements )and routinely cultured in blood agar . It release  $\alpha$  – hemolysin that damage red cell membrane , causing colonies to be  $\alpha$  – hemolytic .

### Epidemiology

Strept. Pneumoniae is an obligate parasite of human and can be found in the nasopharynx of many healthy individuals . This organism is extremely sensitive to environment agents . Pneumococcal infections can be either endogenous (residing in the nasopharynx of a carrier who develops impaired resistance to the organism . and also can be exogenous , for example

#### • Pathogenesis

The bacterial capsule of Strept. Pneumoniae is the most important virulence factor , and is the basis for classification of serotypes of this organism . The cell- associated enzymes pneumolysin and autolysin contribute to its pathogenicity.

- 1- Capsule : its polysaccharide and antiphagocytic and antigenic
- 2- Pili: Not all pneumococci are pilated , but those clinical isolates that express pili are more virulent.
- 3- Chronic –binding protein A:Is a major adhesion attach to carbohydrates .
- 4- Autolysins : Are enzymes that hydrolyze the components of a biological cell in which its produced and responsible for the release of intracellular virulence factors .
- 5- Pneumolysin : Its retained within the cytosol of intact pneumococci , important virulence factor, this toxin bind to cholesterol therefore interact with all cell types.

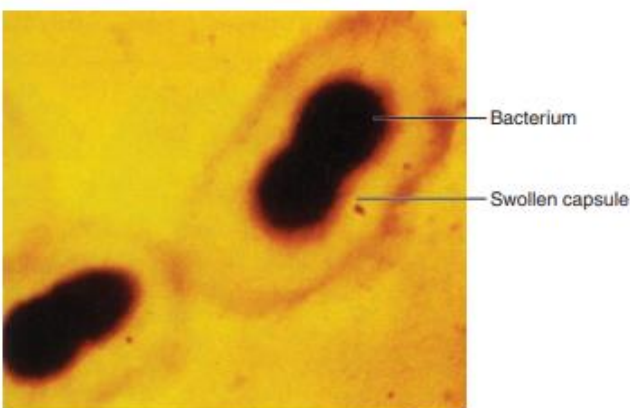
#### • Clinical significance

- 1- Acute bacterial pneumonia
- 2- Otitis media
- 3- Bacteremia /sepsis
- 4- Meningitis

#### • Laboratory identification

- Specimens for Lab. evaluation can be obtained from nasopharyngeal swab , blood , pus , sputum or spinal fluid.
- A- hemolytic colonies on blood agar
- G+ diplococcus
- Can inhibited by low concentration of surfactant optochin , and the cells are lysed by bile acids .
- Capsular swelling .when treated with type- specific antiserum (Quellung reaction ) .

**FIGURE 25-12. Pneumococcal capsule.** In this test, live *Streptococcus pneumoniae* have been mixed with antibody specific to the capsular polysaccharide. The opsonizing antibody defines the capsule, which appears "swollen" when compared with preparations without antibody. (Reproduced with permission from Willey JM: Prescott, Harley, & Klein's Microbiology, 7<sup>th</sup> edition. McGraw-Hill, 2008.)



#### • Prevention

:By 1- Pneumococcal polysaccharide vaccine . 2- Pneumococcal conjugate vaccine.

#### Enterococcus genus :

Contain C-substance that reacts with group D antisera . Its clinically most important species are *E. faecalis* and *E. faecium* . Enterococcus can be  $\alpha$  ,  $\beta$  or nonhemolytic . Its one of nosocomial infection as a result of their multiple antibiotic resistance .

A- Epidemiology : It's part of normal fecal flora , can colonize oral mucosa membrane and skin , highly resistance to environmental and chemical agents .

B- Diseases: Enterococcus can spread to normally sterile sites , causing urinary tract infection (UTI), bacteremia /sepsis , endocarditis , biliary tract infection, or intra-abdominal abscesses. C- Lab.

identification :

- 1- Can survive in the presence of bile salt.
- 2- Hydrolyze the polysaccharide esculin (producing black colonies on esculin- containing plates.
- 3- Enterococcus grow in 6.5% NaCl.

4- Yield positive pyrazinamide test

### **Non-enterococcal group D streptococci**

**Streptococcus bovis** is the most clinically of the non-enterococcus group D streptococci part of normal fecal flora , they are either  $\alpha$  or non-hemolytic cause UTI and endocarditis , the latter especially in association with colon cancer . It tends to be sensitive to penicillin and other antibiotics .

- **Viridans streptococci**: Include group of streptococci, many G+ , catalase negative ,  $\alpha$  or  $\gamma$  hemolytic ,main facultative oral flora , relatively virulent.

- **Strept. mutans and other members of viridans group** cause dental caries can infect heart valves during bacteremia causing endocarditis , rheumatic fever.

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