**Genus Streptococcus**
Mostly commensals but may cause opportunistic infections (S.viridans)

- Few are primary pathogens causing wide range of infections and can trigger immunologic disorders (S.pyogenes, S.pneumoniae and S.agalactiae)

**General criteria:**
Oval Gram positive cocci arranged in pairs and short chains non-moltile, non-spore forming, mainly non-capsulated, all are catalase negative
They are facultative aerobes (few are strict anaerobes) require enriched media, can tolerate 9% NaCl and heating (60°C for 30 minutes) the colonies are small, semitransparent and low convex, hemolysis is variable according which streptococcus classified into:

- α-hemolytic
- β-hemolytic
- non-hemolytic

but for β-hemolytic Streptococci serotyped (Lancefiled serogrouping) according to differences in group specific polysaccharide antigen in the cell wall (A-H and K-V), on their M protein and on surface T antigen.

group A is the most important (S.pyogens) causing 95% of human infections with Streptococcus, all are bacitracin sensitive and produce B.hemolysis, so designated as (GABHS).

**Antigenic structures**

1. group specific carbohydrate
   serological specificity ← difference of amino sugar.

On bases of this antigen β-hemolytic Streptococci are divided in to 19 groups from A-U except I and J

A B C D E F G H K L M N O P Q R S T U (Lancefield groups)

2. M protein: It’s associated with virulence of group A streptococci. It’s type specific and on basis of this antigen, group A streptococci are subdivided into 60 types. It appears as hair like projection of the cell wall, it help the bacteria to resist phagocytosis.
3. T protein: surface antigen→ typing marker. It’s used in epidemiological studies but has no relation to the virulence of streptococci.

4. R protein: present in different forms→ unknown role.

5. Nucleoprotein: make the cell body→ little serologic specificity.

**Toxins and enzymes**

More than 20 extracellular products that are antigenic are elaborated by group A streptococci including:

1. Streptokinase (fibrinolysin)
   activate plasminogen→ plasmin→ dissolves fibrin.

2. D Nase (streptodornase)
   up to 4 types depolymerizes DNA in exudate, during pyoderma antibodies develop & used for diagnostic purposes protect bacteria from being trapped in neutrophil extracellular traps.

3. Hyaluronidase: (spreading factor) few isolates can secrete this enzyme due to gene mutation, although those do not secrete hyaluronidase can cause skin infection.

4. Erythrogenic toxin.
   S.pyogen← bacteriophage carrying gene
   → Scarlet fever with rash. Anti-toxin detected by (Dick test)← skin test.
5. C5a peptidase: cleave the potent (5a released by complement necessary for neutrophil chemotaxis early in infection.

6. Hemolysin (Streptolysin)
   - Streptolysin O: it is antigenic and inactivated by oxidation, antibodies are (ASO) which is important in diagnosis of rheumatic fever, it is cardiotoxic.
   - Streptolysin S: not antigenic but oxygen-stable.

7. Pyogenic toxin A: similar to TSST-super antigen responsible for the rash appearance.

8. Protease (Exotoxin B) rapidly destroys tissue → necrotizing fasciitis which are devoid of neutrophils (degrade IL-8→ prevent neutrophil migration)

**Clinical findings in S.pyogenes infection**

1. Pyogenic diseases as:
   - Pharyngitis and sore throat (characterized by inflammatory exudates, fever, leukocytosis and tender cervical lymph nodes) → otitis media, sinusitis, mastoiditis and meningitis.
   - Localized skin infection (impetigo)
   - Erysipelas and cellulitis (characterized by multiplication & lateral spread of S.pyogenes in the fascia→ necrotizing fasciitis.

2. Toxigenic diseases as:
   - Scarlet fever.
- Streptococcal TSS

3. Immunologic diseases (non suppurative post streptococcal)
   - Rheumatic fever (RF)

This is a cross reaction of joint antibodies

Group A streptococcal pharyngitis → 2wks → fever, migratory arthritis and carditis may develop.

- Acute glomerulonephritis (AGN)

strepococcal membrane is the inciting Ag → Ag-Ab complex on glomerular basement membrane

Impetigo with nephritogenic streptococci (M protein type 2,4,12,49,59,61) → 2-3 wks → hypertension, edema of face and ankle and smoky urine.

AGN is more frequent after skin infection than after pharyngitis

**Laboratory diagnosis**

- Microbiologic (smearing, culturing, bacitracin sensitivity) growth of GABH strep. Inhibited by bacitracin.

- Serologic

  - ASO titer: Serum titer >200 I.U. is considered abnormal.

  - Titer of anti-DNase: high in group A streptococcal infections used as indicator for prior streptococcal infections in patients with AGN.
**Group B streptococci (S.agalactiae)**
Present as ano-genital commensals in the mother causing septicemia and meningitis in neonates during normal vaginal delivery. Commensals in large amount in urinary tract but may cause Pneumonia, arthritis and endocarditis in immune compromised patients.

**Group C & G streptococci**
(β-hemolytic) → sore throat and endocarditis

**Group D (Genus enterococcus)**
Non-hemolytic commensals of mouth and intestine, found in large number in faeces → urinary and biliary tract infections and suppurative abdominal lesions. Also may contaminates open wounds and bed sores.

**α -hemolytic (Streptococcus viridans)**
Normal flora of the mouth→ associated with oral infection and dental carries by which it had opportunity to deep infections. they are the leading cause of subacute bacterial endocarditis (SBE) following dental extraction.
The γ-hemolytic Streptococci lack group specific carbohydrate in their cell wall

**Peptostreptococci**
Strict anaerobes produce variable hemolysis present as normal flora of the gut and female genital tract and may participate in mixed anaerobic infections
**Streptococcus pneumoniae** (pneumococcus)

40%-70% of normal individuals are carriers of these bacteria. No animal reservoir, i.e. transmission is from infected to normal persons by direct route. It is the major cause of bacterial pneumonia, sinusitis and otitis media and may lead to bacteremia complicated by meningitis and septic arthritis.

**Morphologic characters**

Gram positive cocci occurring in pairs (diplococci). Lancet shaped. Non motile, non-sporing and all fresh isolates are capsulated (virulence factor → interfere with phagocytosis → enhance invasiveness and the capsular polysaccharide can activate B cell response)

In old culture they are Gram's negative and later on will lyse spontaneously due to autolytic activity and finally we can find only gram negative debris, no intact cells are found in the culture.

**Cultural characters**

- Aerobic and facultative anaerobes.
- Grow on media containing 5-10% blood or serum.
- Grow under 5-10% CO₂.
Colonies are small, smooth, semitransparent and surrounded by a narrow greenish zone of hemolysis (just like α-hemolytic viridance) & can be differentiated by the following tests:

1. Bile solubility test.
   broth culture of pneumococci ← 10% ox bile
   or
   the growth will be lysed 2% sodium deoxycholate

2. Inulin fermentation test
   pneumococci ferment inulin → acid only.

3. Capsule swelling test (Quelling reaction)
   Pneumococci specific anti-polysaccharide
   Mixing
   ↓
   capsular swelling
   (seen by negative staining)
4. Optochin sensitivity
pneumococci produce clear large zone if inhibition (sensitivity)
around 0.001% of ethyl hydrocuprein hydrochloride.

5. Animal pathogenesity
intraperitoneal injection of mouse → peritonitis and septicemia
then death within 1-3 days.

**Antigenic structures**

1. Capsular polysaccharide → (specific soluble substance SSS)
   It is highly antigenic, type specific antisera differentiate
   pneumococci into more than 85 serotypes

2. Somatic portions
   a. M protein (characteristic for each type).
   b. Group specific CHO antigen (−𝑝𝑝𝑡𝐶−reactive protein)

**Pathogenesis**

They produce IgA protease → enhance colonization at
respiratory tract → multiply in tissues → inflammation of
alveoli (fluid, red and white blood cells → consolidation →
recovery → ingestion of debris). We inhale these bacteria
continuously but they are phagocytosed. In some individuals
such bacteria colonize in the mucosa of URT and those
become carriers. If resistance becomes low, the bacteria will
invade the lung producing pneumonia.

Predisposing factors include alcohol, abnormal RT, abnormal
circulatory dynamics, spleenectomy and chronic diseases as
sickle cell anemia.

**Clinical findings**

- Sudden chills, fever cough and pleuritic pain
- Sputum is red or rusty.
- Bacteremia may develop in (15-25%)
- Spontaneous recovery after 5-10 days ← development of anti-capsular Ab.
- May cause also otitis media sinusitis meningitis and sepsis.

**Laboratory diagnosis**
- Stained smear
- Culture: on chocolate agar
- Quelling reaction
- Optochin sensitivity
- Bile solubility
- Antibiotic sensitivity → most are susceptible to penicillin and erythromycin but resistance may develop due to changes in penicillin binding protein.