Microbiology 1

2025-2024

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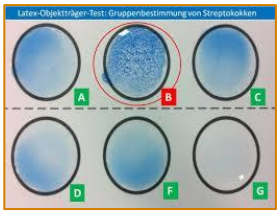
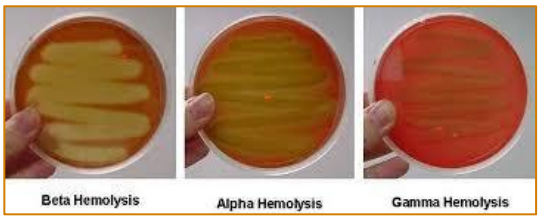
Streptococci

- **Classification of Streptococcus Species**
  - Classifying over 100 species in the *Streptococcus* genus is complex due to three overlapping methods:
    1. **Serologic Properties**: Lancefield groupings (A to W).



    2. **Hemolytic Patterns**: Types of hemolysis on blood agar:
       a. ***Beta (β):*** complete hemolysis
       b. ***Alpha (α):*** partial hemolysis
       c. ***Gamma (γ):*** no hemolysis



    3. **Biochemical Properties**: Based on physiological traits.

- **Key Pathogenic Species**:
  - These species are particularly relevant for human health due to their pathogenic potential
    - ✓ *Streptococcus pyogenes* (Group A Streptococcus/GAS)
    - ✓ *Streptococcus agalactiae* (Group B Streptococcus/GBS)
    - ✓ *Group D Streptococcus* (Enterococci)
    - ✓ *Streptococcus pneumoniae*
    - ✓ *Streptococcus viridans*

- **Streptococcus pyogenes (Group A Streptococcus, GAS)**
  - Characteristics & Culture:
    - ✓ Morphology: Spherical cocci (1-2 μm) in chains.
    - ✓ Colony Appearance: Forms 1-2 mm white colonies with large β-hemolysis zones on blood agar.
    - ✓ Identification: Contains Lancefield group A antigen.
  - Immune Evasion Mechanisms:
    - ✓ Capsule: Hyaluronic acid capsule inhibits phagocytosis.
    - ✓ M Protein: Blocks complement binding (C3b) and aids in adherence and invasion of host cells.
    - ✓ C5a Peptidase: Deactivates C5a, hindering immune cell recruitment.
  - Toxins and Enzymes:
    1. Streptococcal Pyrogenic Exotoxins (Spe): Act as superantigens, causing severe illnesses like necrotizing fasciitis, toxic shock syndrome, and scarlet fever rash.
    2. Streptolysin S: Oxygen-stable hemolysin causing β-hemolysis.
    3. Streptolysin O: Oxygen-labile hemolysin; induces antistreptolysin O (ASO) antibodies, useful for recent infection diagnosis.
    4. Streptokinase: Dissolves clots, aiding bacterial spread.
    5. DNases (A-D): Break down DNA in pus, enhancing tissue invasion.

- Epidemiology:
  - ✓ Prevalence: CDC estimates ~10 million annual noninvasive cases (pharyngitis and pyoderma).
  - ✓ Transmission: Spread via respiratory droplets, especially in crowded environments.
  - ✓ Infections: Caused by newly acquired strains colonizing the oropharynx or skin.

- Clinical Manifestations:

  1. **Suppurative (Pus-forming) Infections**:
     - ✓ Pharyngitis: Throat redness, exudates, lymphadenopathy.
     - ✓ Scarlet Fever: Red rash on chest/extremities (complication of pharyngitis).
     - ✓ Pyoderma: Skin infection with pustules.
     - ✓ Erysipelas: Painful, inflamed skin infection with systemic symptoms.
     - ✓ Cellulitis: Infection of skin and subcutaneous tissue.
     - ✓ Necrotizing Fasciitis: Severe infection destroying muscle and fat.
     - ✓ Streptococcal Toxic Shock Syndrome: Severe, systemic infection with bacteremia and fasciitis.

  2. **Non-suppurative (Post-infectious) Infections**:
     - ✓ Rheumatic Fever: Inflammatory disease affecting heart, joints, and skin, typically post-pharyngitis.
     - ✓ Acute Glomerulonephritis: Renal inflammation post-infection, with symptoms like edema, hematuria, and hypertension.

- **Streptococcus agalactiae (Group B Streptococcus, GBS)**
  - Identification:
    - ✓ GBS Antigen Detection: Distinguishes GBS from other streptococci.
    - ✓ Biochemical Reactions: Resistant to bacitracin.
  - Colonization:
    - ✓ Commonly found in the lower gastrointestinal and genitourinary tracts.
    - ✓ Vaginal Carriage in Pregnancy: Observed in 10-30% of pregnant women, posing a risk for newborn infections.
  - Infections in Adults:
    - ✓ Primarily affects older adults or those with underlying health conditions.
    - ✓ Common Infections: Bacteremia, pneumonia, bone and joint infections, and skin/soft tissue infections.

- **Streptococcus pneumoniae**
  - Characteristics:
    - ✓ Morphology: Encapsulated, gram-positive, oval-shaped diplococci (0.5-1.2 μm).
    - ✓ Hemolysis: Displays α-hemolysis on blood agar due to pneumolysin activity, which degrades hemoglobin and produces a green product.
  - Virulence & Structure:
    - ✓ Polysaccharide Capsule: Virulent strains have a capsule, used for serotyping and included in polyvalent vaccines.
    - ✓ Pneumolysin: Destroys ciliated epithelial and phagocytic cells, aiding infection spread.
    - ✓ Phosphorylcholine: Found in the cell wall, it assists in host cell invasion and immune evasion.

- Epidemiology:
  - ✓ Colonization: Commonly inhabits the throat and nasopharynx, especially in children and adults living with children.
  - ✓ Spread of Disease: From the nasopharynx to lungs (pneumonia), sinuses (sinusitis), ears (otitis media), and meninges (meningitis).
  - ✓ Vaccination: Pediatric and adult vaccines have lowered disease incidence.

- Pathogenesis:
  - ✓ Immune Response: Host immune reaction to bacterial components (not toxins) causes symptoms.
  - ✓ Secretory IgA Protease: IgA protease neutralizes host defenses in the respiratory tract, while pneumolysin damages host tissues.
  - ✓ Amidase: Triggers immune response by releasing cell wall components that activate complement.

- Clinical Relevance:
  - ✓ Capsule's Role in Virulence: Only encapsulated strains are virulent, making the capsule essential for infection potential.

- **Viridans Streptococci**
  - Characteristics:
    - ✓ Hemolysis: Primarily α-hemolytic, producing a green color on blood agar (from Latin "vĭrĭdis," meaning green). Some strains are nonhemolytic.
  - Colonization:
    - ✓ Commonly found in the oropharynx, gastrointestinal tract, and genitourinary tract.
  - Clinical Significance:
    - ✓ Although generally less virulent, viridans streptococci can cause infections, especially in immunocompromised individuals and as a contributor to endocarditis following bloodstream entry.

- **Enterococcus**
  - Characteristics:
    - ✓ Morphology: Gram-positive cocci, often in pairs or short chains.
    - ✓ Habitat: Found primarily in the **large intestine** and **genitourinary tract**, with high concentrations in feces.
    - ✓ Growth: Facultatively anaerobic, tolerant to a wide temperature (10°C–45°C), pH range (4.6–9.9), and high levels of **NaCl** and **bile salts**.
    - ✓ Hemolysis: Variable patterns observed.

  - Virulence:
    - ✓ Adherence: Strong ability to adhere to tissues and form biofilms, contributing to infection persistence.
    - ✓ Antibiotic Resistance: Known for resistance, especially in healthcare settings, complicating treatment.

  - Clinical Significance:
    - ✓ Nosocomial Infections: A leading cause of hospital-acquired infections, particularly **urinary tract infections** associated with catheter use or instrumentation.

- **Case Example - Scarlet Fever Management**:
  - **Symptoms**: Fever (101.8°F), sore throat with swollen tonsils and exudate, sandpaper-like rash.
  - **Diagnosis**: Positive throat culture for *Streptococcus pyogenes* (Group A strep).
  - **Treatment**: Penicillin for infection, paracetamol for fever, and lozenges for throat pain.
  - **Outcome**: Fever and rash resolved after 48 hours; completion of antibiotics prevents complications like rheumatic fever.

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