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Microbiology
Second class\ Env. Health
2024-2025 (4 lec)

Gram positive cocci

Genus;- Streptococcus, Enterococcus

Key points

• Gram-positive cocci in chains
• Fastidious, requiring enriched media
• Small, usually haemolytic, translucent colonies
• Catalase-negative
• Facultative anaerobes, usually non-motile
• Commensals on mucous membranes
• Susceptible to desiccation
• Cause pyogenic infections

Genera and Species to be considered

Beta-hemolytic streptococci

• *Streptococcus pyogenes* (group A streptococci)
• *Streptococcus agalactiae* (group B streptococci) Groups C, F, and G beta-hemolytic streptococci
Streptococcus pneumoniae

Viridans streptococci (alpha-hemolytic)

• *Streptococcus mutans* group
• *Streptococcus salivarius* group
• *Streptococcus mitis* group
• *Streptococcus bovis* group
• *Streptococcus urinalis*
• *Streptococcus anginosus* group (also called *Streptococcus milleri* group)

Enterococci (most commonly isolated)

• *Enterococcus faecalis*
• *Enterococcus faecium*
• Other *Enterococcus* spp. isolated from humans
• *Enterococcus durans*
• *Enterococcus mundtii*
• *Enterococcus dispar*
• *Enterococcus gallinarum*

General Characteristics

- The *Streptococcaceae* consist of a large family of medically important species, including *Streptococcus* spp. and *Enterococcus* spp. 0.5 to 1.2 μm in diameter and arranged in pairs or chains.

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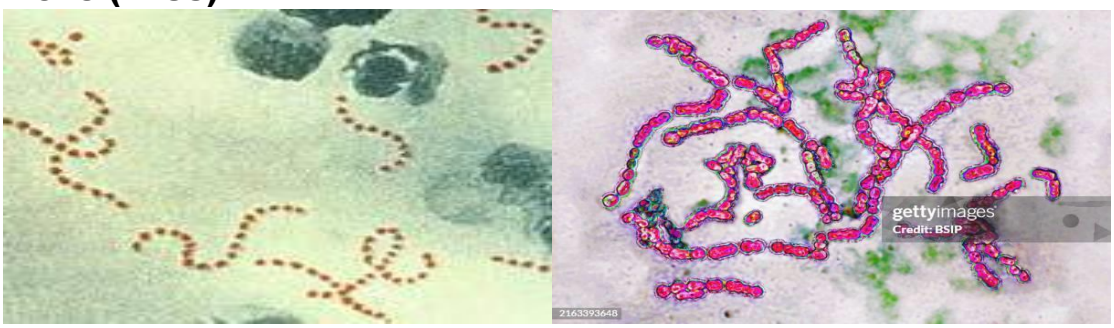

- **Organisms included are differentiated based on**
  - Cell wall structure,
  - Hemolytic patterns on sheep blood agar (beta, alpha, or gamma),
  - Reaction of antibodies to specific bacterial antigen, the Lancefield Classification scheme,
  - Biochemical identification relating to physiologic characteristics.

- This traditional system of classification is still useful within the clinical laboratory, although it differs in some cases with the molecular analysis of the 16S ribosomal ribonucleic acid (rRNA) sequences. Of the organisms that are most commonly encountered in infections in humans include *S. pyogenes, S. agalactiae, S. pneumoniae, E. faecalis, E. faecium,* and the viridans streptococci group.

- The other species are either rarely found in clinically relevant settings or are usually considered contaminants that can be mistaken for viridans streptococci or *enterococci.*

Epidemiology

- Many of these organisms are commonly found as part of the normal human microbiome of the pharynx, mouth, lower gastrointestinal (GI) tract, and vagina.

- The streptococci are distributed worldwide. Most species live as commensals on the mucosae of the upper respiratory tract and lower urogenital tract. These bacteria are susceptible to desiccation and survive for only short periods off the host.

- When other normal microbiota is depleted, bacterial inoculum is increased, virulence factors are heightened, and/or adaptive immunity is impaired, the bacteria can cause disease.

- However, some species are encountered in clinical specimens as contaminants or as components of mixed cultures with minimal or unknown clinical significance. When these organisms gain access to normally sterile sites (blood, cerebrospinal fluid [CSF], pleural fluid, peritoneal fluid, pericardial fluid, bone, joint fluids, organs, vitreous fluid, and vascular tissue), they can cause life-threatening infections.

- The upper respiratory tract and skin lesions serve as primary sites of infection and transmission of *S. pyogenes* which can cause pharyngitis, scarlet fever, streptococcus toxic shock, puerperal fever, infection of the skin, post-streptococcal disease, and a severe invasive infection sometimes called the “flesh-eating bacteria.” Although *S. pneumoniae* can be found as part of the normal upper respiratory microbiota in about half the population, if it invades the lower respiratory tract, it can cause pneumonia.

- *S. pneumoniae* causes 95% of all bacterial pneumonia. In addition, S. pneumoniae is the leading cause of bacterial meningitis in infants, young children, and adults in the United States, followed by Neisseria meningitidis and Haemophilus influenza.

- Similarly, *S. pyogenes* may be carried in the upper respiratory tract of humans; it should be deemed clinically important whenever it is encountered.

- *S. agalactiae* (group B) is a common cause of pneumonia in 0- to 2-month-old patients caused by inhalation of organisms as neonates pass down the birth canal. It can also cause meningitis and sepsis in neonates.

Organism	Habitat (reservoir)	Mode of Transmission
Streptococcus pyogenes (group A)	Not considered normal microbiota Inhabits skin and upper respiratory tract of humans; carried on nasal, pharyngeal, and sometimes anal mucosa; presence in specimens is almost always considered clinically significant	Direct contact: person to person Indirect contact: aerosolized droplets from coughs or sneezes
Streptococcus agalactiae (group B)	Normal microbiota: female genital tract and lower gastrointestinal tract Occasional colonizer of upper respiratory tract	Endogenous strain: gaining access to sterile site(s) probable Direct contact: person to person from mother in utero or during delivery; or nosocomial transmission by unwashed hands of mother or health care personnel
Groups C, F, and G beta-hemolytic streptococci	Normal microbiota: skin, nasopharynx, gastrointestinal tract, genital tract	Endogenous strain: gain access to sterile site Direct contact: person to person
Streptococcus pneumoniae	Colonizer of nasopharynx	Direct contact: person to person with contaminated respiratory secretions
Viridans streptococci	Normal microbiota: oral cavity, gastrointestinal tract, female genital tract	Endogenous strain: gain access to sterile site; most notably results from dental manipulations
Enterococcus spp.	Normal microbiota: humans, animals, and birds *E. faecalis* and *E. faecium* are normal flora of the human gastrointestinal tract and female genitourinary tract Colonizers	Endogenous strain: gain access to sterile sites Direct contact: person to person Contaminated medical equipment; immunocompromised patients are at risk of developing infections with antibiotic-resistant strains

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Pathogenesis and Spectrum of Disease

The capacity of the organisms to produce disease and the spectrum of infections they cause vary widely with the different genera and species.

Streptococcus pyogenes

(Virulence Factors)

1. Protein F mediates epithelial cell attachment (fibronectin binding.
2. hyaluronic acid capsule inhibits phagocytosis؛
3. M protein is antiphagocytic (100 serotypes); produces several enzymes and hemolysins that contribute to tissue invasion and destruction, including streptolysin O، streptolysin S, streptokinase, DNase, and hyaluronidase.
4. Streptococcal pyrogenic exotoxins (SPEs) mediate production of rash (i.e., scarlet fever) or multisystem effects that may result in death؛

Diseases

Acute pharyngitis ، impetigo، cellulitis، erysipelas، necrotizing fasciitis and myositis، bacteremia with the potential for infection in any of several organs، pneumonia ، scarlet fever and streptococcal toxic shock syndrome.

Streptococcus agalactiae

Uncertain; capsular material interferes with phagocytic activity and complement cascade activation Infections

Diseases

Infections most commonly involve neonates and infants, often preceded by premature rupture of mother's membranes; transient vaginal carriage in 10%-30% of females.
infections often present as multisystem problems, including sepsis, fever, meningitis, respiratory distress, lethargy, and hypotension.
Infections in adults usually involve postpartum infections such as endometritis, which can lead to pelvic abscesses and septic shock.
infections in other adults include bacteremia, pneumonia, endocarditis, arthritis, osteomyelitis, and skin

Streptococcus pneumoniae

Polysaccharide capsules that inhibit phagocytosis are a primary virulence factor.
pneumolysin has various effects on host cells, and several other factors likely are involved in eliciting a strong cellular response by the host; secretory IgA, protease

Diseases

A leading cause of meningitis and pneumonia with or without bacteremia; also causes sinusitis and otitis media.

Viridans streptococci

Generally considered to be of low virulence; production of extracellular complex polysaccharides (e.g., glucans and dextrans) enhance attachment to host cell surfaces, such as cardiac endothelial cells or tooth surfaces in the case of dental caries.

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Enterococcus spp.

Little is known about virulence; adhesions, cytolysins, and other metabolic capabilities may allow these organisms to proliferate as nosocomial/healthcare-associated pathogens; multidrug resistance also contributes to the proliferation.

Most infections are health care–associated and include urinary tract infections, bacteremia, endocarditis, mixed infections of abdomen and pelvis, wound infections, and occasionally, ocular infections; central nervous system and respiratory infections are rare.

Diagnostic procedures

1. Streptococci are highly susceptible to desiccation and specimens should be cultured promptly. Pus or exudate collected on swabs should be placed in transport medium if specimens cannot be processed immediately.
2. A sensitive technique using the polymerase chain reaction has been developed.
3. Antigen detection screening methods are available for several streptococcal antigens. Detection of antigens is possible using latex agglutination or enzyme-linked immunosorbent assay (ELISA) technologies.
4. Chains of Gram-positive cocci may be demonstrable in smears from specimens.
5. Specimens should be cultured on blood agar, selective blood agar and MacConkey agar. Plates are incubated aerobically at 37°C for 24 to 48 hours. Streptococci will grow on gram-positive selective media such as Columbia agar with colistin and nalidixic acid (CNA) , phenylethyl alcohol agar (PEA) and Edward agar.
6. Identification criteria for isolates:
   – Small, translucent colonies, some of which may be mucoid
   – Type of haemolysis on blood agar
   – Chains of Gram-positive cocci
   – No growth on MacConkey agar with the exception of *Enterococcus* species
   – Negative catalase test
   - gram-positive selective media such as Columbia agar with colistin and nalidixic acid (CNA) , phenylethyl alcohol agar (PEA) and Edward agar.

7. Lancefield grouping.
8. Biochemical test profile.