

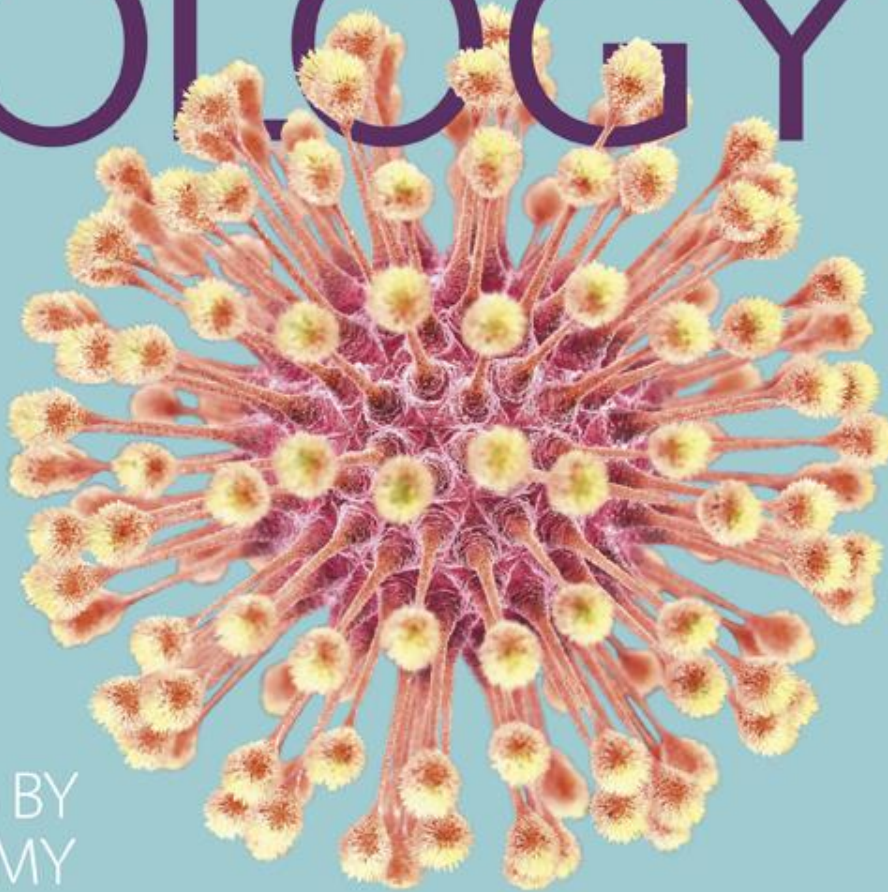
Chapter 19 – Pathogenic Gram-Positive Bacteria

NIMESH PATEL | HLSC 2400

OCTOBER 12, 2017

MICROBIOLOGY

5th Edition



WITH
DISEASES BY
TAXONOMY

ROBERT W. BAUMAN

PowerPoint® Lecture
Presentations prepared by
Mindy Miller-Kittrell,
North Carolina State
University

CHAPTER 19

Pathogenic Gram-Positive Bacteria

Streptococcus

- Facultative anaerobes
- Cocci arranged in pairs or chains
- **Catalase negative**
- Often categorized based on Lancefield classification (A through H, K through V)
 - Divided into serotypes based on bacteria's antigens
 - Lancefield groups A and B include the significant human pathogens

Streptococcus

- **Group A *Streptococcus*: *Streptococcus pyogenes***
 - Pathogenicity
 - Structural components to evade phagocytosis
 - M protein destabilizes complement
 - Hyaluronic acid capsule hides bacteria from leukocytes
 - Streptokinases
 - Break down blood clots
 - Help *Streptococcus* spread through tissues
 - Deoxyribonucleases
 - Reduce the firmness of pus
 - Facilitate the spread of *Streptococcus*

Streptococcus

- **Group A *Streptococcus*: *Streptococcus pyogenes***
 - Pathogenicity
 - C5a peptidase
 - Breaks down complement protein C5a
 - Decreases movement of white blood cells to the infection site
 - Hyaluronidase
 - Facilitates the spread of *Streptococcus* through tissues
 - Pyrogenic toxins
 - Can stimulate fever, rash, and shock
 - Streptolysins
 - Lyse red blood cells, white blood cells, and platelets

Streptococcus

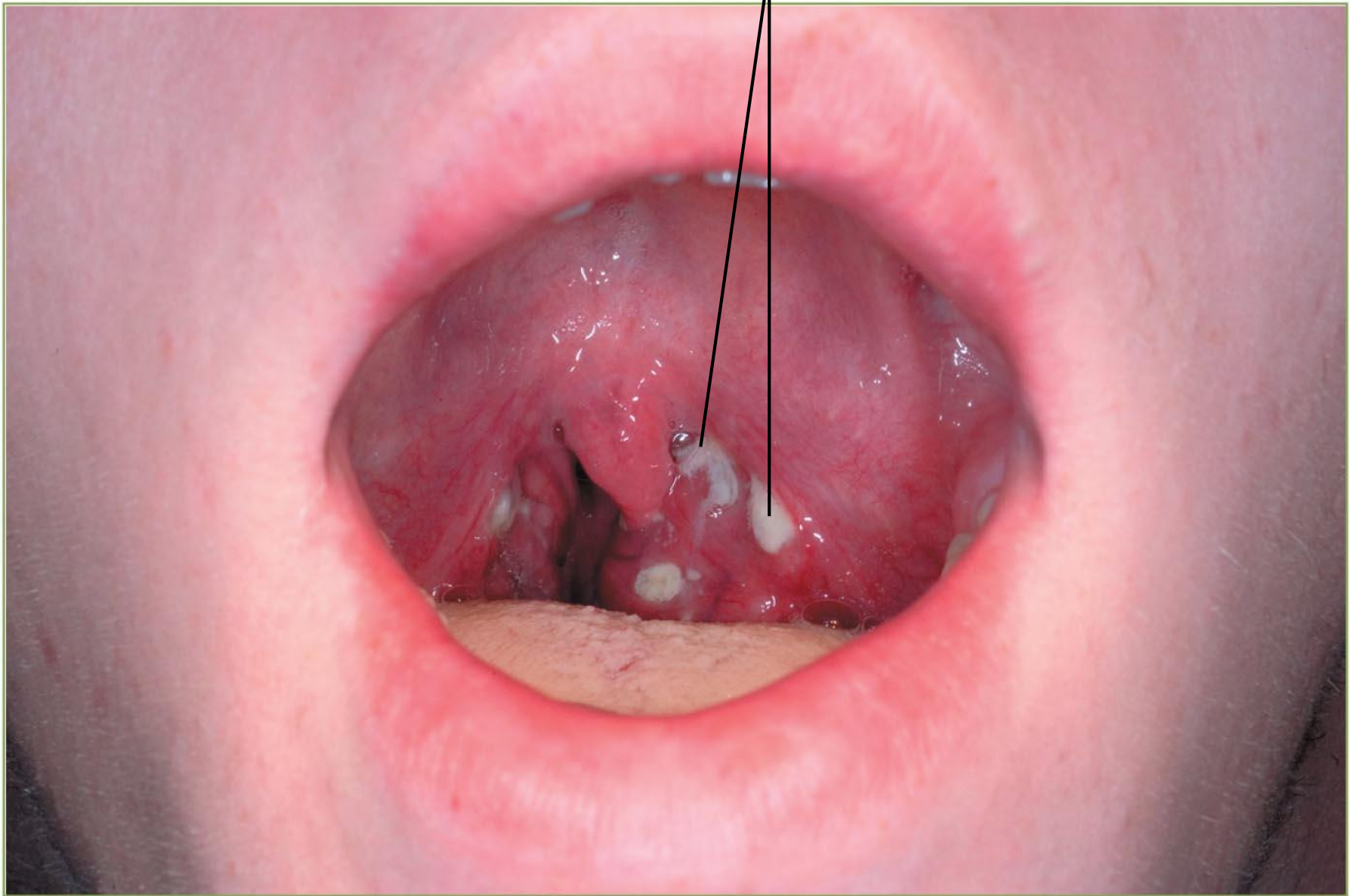
- **Group A *Streptococcus*: *Streptococcus pyogenes***
 - Epidemiology
 - Typically infects the pharynx or skin
 - Often causes disease when normal microbiota are depleted or immunity is impaired
 - Spreads via respiratory droplets

Streptococcus

- **Group A *Streptococcus*: *Streptococcus pyogenes***
 - Group A Streptococcal Diseases
 - **Pharyngitis** ("strep throat")
 - Inflammation of the pharynx
 - Rheumatic fever
 - Complication of untreated streptococcal pharyngitis
 - Inflammation damages the heart valves and muscle
 - Autoimmune response against heart antigens
 - Scarlet fever
 - Can occur following streptococcal pharyngitis infections
 - Chest rash develops that spreads across the body
 - “Sandpaper rash” and strawberry tongue

Figure 19.6 Pharyngitis.

Pus pockets on tonsils



Streptococcus

- **Group A *Streptococcus*: *Streptococcus pyogenes***
 - Group A streptococcal diseases
 - Pyoderma and erysipelas
 - Pyoderma-pus-producing lesion often on exposed skin
 - Erysipelas-infection and inflammation of lymph nodes surrounding a streptococcal infection
 - Streptococcal TSS
 - Bacteremia that causes severe multisystem infections
 - Can cause organ failure, shock, and death

Figure 19.7 Erysipelas.



Streptococcus

- **Group A *Streptococcus*: *Streptococcus pyogenes***
 - Group A streptococcal diseases
 - **Necrotizing fasciitis**
 - Streptococci enter the body and spread along the fascia
 - Secrete enzymes and toxins that destroy tissue
 - **Glomerulonephritis**
 - Caused by antibody-bound streptococcal antigens that accumulate in the glomeruli of the kidneys
 - Inflammation causes hypertension and low urine output
 - Adults may suffer irreversible kidney damage

Streptococcus

- **Group A *Streptococcus*: *Streptococcus pyogenes***
 - Diagnosis, Treatment, and Prevention
 - Diagnosis
 - Skin infections diagnosed by the presence of Gram-positive bacteria in short chains or pairs
 - Rapid strep test used to diagnose respiratory infections
 - **Streptococci in the pharynx are not diagnostic**
 - Treatment
 - Penicillin is effective
 - Prevention
 - Antibodies against M protein provide protection

Streptococcus

- **Group B *Streptococcus*: *Streptococcus agalactiae***
 - Cocci that form chains
 - Distinguished from group A *Streptococcus*
 - Group-specific cell wall antigens
 - Smaller zone of beta-hemolysis
 - Resistant to bacitracin

Streptococcus

- **Group B *Streptococcus*: *Streptococcus agalactiae***
 - Pathogenicity
 - Often infects newborns without specific antibodies
 - Produces enzymes whose roles are not yet understood
 - Epidemiology
 - Colonizes the gastrointestinal, genital, and urinary tracts
 - Wound infections and childbirth cause most adult infections
 - Newborns often inoculated at birth

Streptococcus

- **Group B *Streptococcus*: *Streptococcus agalactiae***
 - Diseases
 - Associated with neonatal bacteremia, meningitis, and pneumonia
 - Older immunocompromised patients also at risk
 - Diagnosis, Treatment, and Prevention
 - Enzyme-linked immunosorbent assay (ELISA) test used to identify group B *Streptococcus*
 - Treat with penicillin or ampicillin
 - Prophylactic use of penicillin during childbirth reduces newborn infections
 - Immunization of women can protect future children

Streptococcus

- **Other Beta-Hemolytic Streptococci**
 - *Streptococcus equisimilis*
 - Causes pharyngitis
 - *Streptococcus anginosus*
 - Infection produces pus-filled abscesses
 - Penicillin effective against both species

Streptococcus

- **Alpha-Hemolytic Streptococci: The Viridans Group**
 - Lack group-specific carbohydrates
 - Cannot be grouped by Lancefield system
 - Many produce a green pigment when grown on blood media
 - Inhabit mouth, pharynx, GI tract, genital tract, and urinary tract
 - Opportunistic pathogens
 - One cause of dental caries and dental plaques
 - Can cause meningitis and endocarditis if it enters the blood

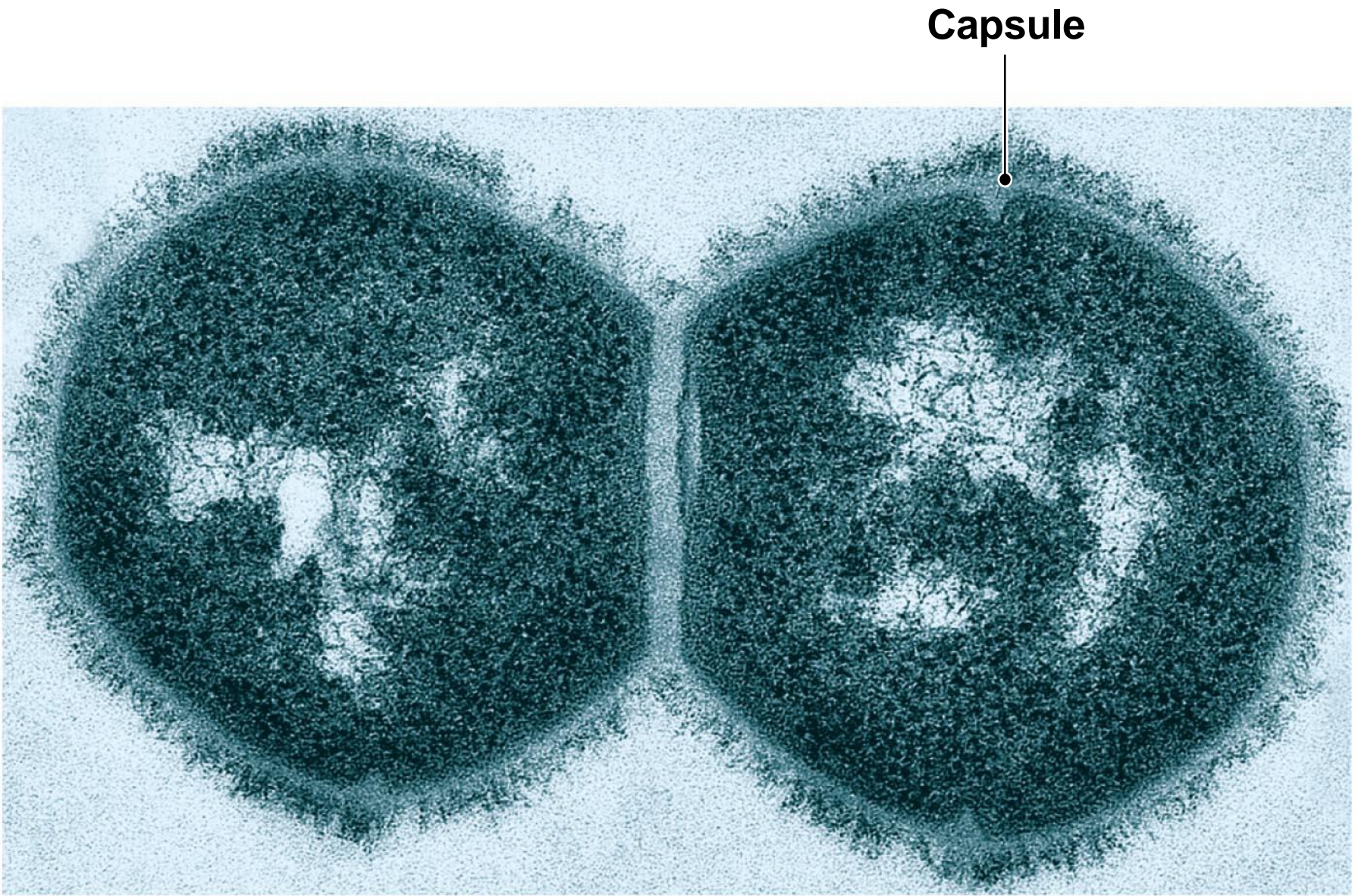
Figure 19.8 Dental caries.



Streptococcus

- ***Streptococcus pneumoniae***
 - Cocci that most commonly form pairs
 - Form unpigmented, alpha-hemolytic colonies on blood agar
 - Lacks Lancefield antigens

Figure 19.9 *Streptococcus pneumoniae*.



TEM

200 nm

Streptococcus

- ***Streptococcus pneumoniae***
 - Pathogenesis and Epidemiology
 - Polysaccharide capsule
 - Phosphorylcholine
 - Stimulates cells to phagocytize the bacteria
 - Protein adhesin
 - Mediates binding of cells to epithelial cells of pharynx
 - Secretory IgA protease
 - Destroys IgA
 - Pneumolysin
 - Lyses epithelial cells

Streptococcus

- ***Streptococcus pneumoniae***
 - Pathogenesis and Epidemiology
 - Present in the mouths and pharynges of most humans
 - Causes disease when it travels to the lungs
 - Infections occur most often in children and the elderly

Streptococcus

- ***Streptococcus pneumoniae***
 - Pneumococcal Diseases
 - Pneumococcal pneumonia
 - Most common disease caused by *S. pneumoniae*
 - Sinusitis and otitis media
 - Sometimes occur following viral infections
 - Bacteremia and endocarditis
 - *S. pneumoniae* can enter the blood through lacerations or tissue damage
 - Pneumococcal meningitis
 - Mortality rate higher than other causes of meningitis

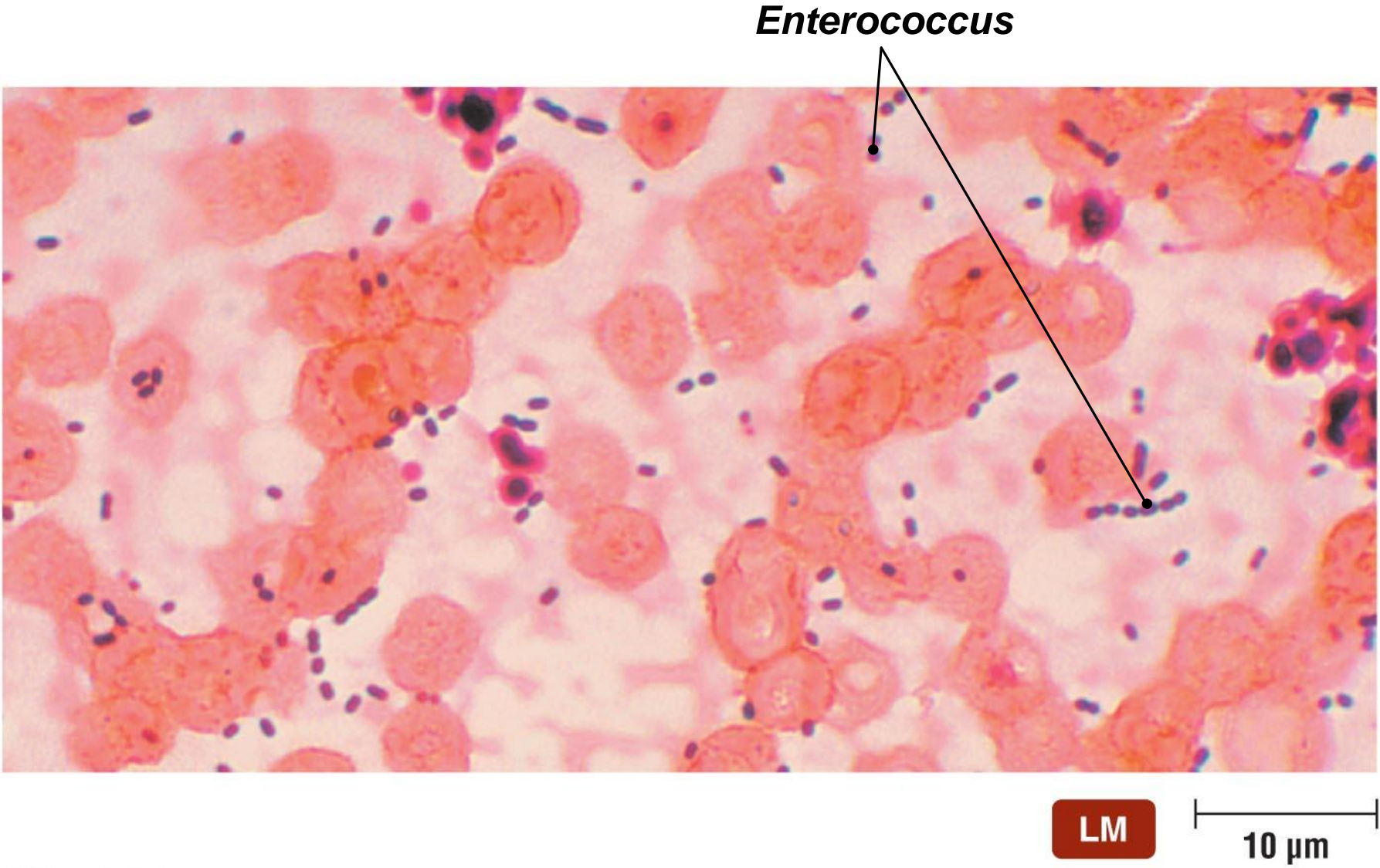
Streptococcus

- ***Streptococcus pneumoniae***
 - Diagnosis, Treatment, and Prevention
 - Diagnosis
 - Gram stain of sputum smears
 - Confirmed with Quellung reaction
 - Treatment
 - Penicillin
 - Resistant strains have emerged
 - Prevention
 - Vaccine made from purified capsular material

Enterococcus

- Previously classified with group D streptococci
- Reclassified as a separate genus
- All enterococci live in the intestinal tracts of animals

Figure 19.10 *Enterococcus faecalis* in lung tissue.



Enterococcus

- **Structure and Physiology**

- Form short chains and pairs
- Lack a capsule, can grow at temperature up to 45C
- Two species cause disease in humans:
 - *E. faecalis*
 - *E. faecium*

- **Pathogenesis, Epidemiology, and Diseases**

- Found in the human colon
 - Rarely pathogenic at this site
- Can cause disease if introduced into other parts of the body
- Important cause of healthcare-associated infections

Enterococcus

- **Diagnosis, Treatment, and Prevention**
 - Diagnosis
 - *Enterococcus* distinguished from *S. pneumoniae* by its sensitivity to bile
 - Treatment
 - Difficult to treat enterococcal infections
 - Enterococci often resistant to antimicrobials
 - Prevention
 - Prevention is difficult in health care setting
 - Patients often have weakened immune systems
 - Good hygiene and aseptic techniques minimize transmission

Table 19.2 Characteristics of Pathogenic Streptococci

TABLE 19.2 Characteristics of Pathogenic Streptococci				
Lancefield Group	Scientific Name	Hemolytic Pattern	Significant Characteristics	Characteristic Diseases
A	<i>S. pyogenes</i>	Large zone of beta-hemolysis	1- to 2-mm white colonies on blood agar; bacitracin sensitive	Pharyngitis, rheumatic fever, scarlet fever, pyoderma, erysipelas, streptococcal toxic shock syndrome, necrotizing fasciitis, glomerulonephritis
B	<i>S. agalactiae</i>	Small zone of beta-hemolysis	2- to 3-mm butyry colonies on blood agar; bacitracin resistant	Puerperal fever, neonatal bacteremia, meningitis, pneumonia
C	<i>S. equisimilis</i>	Large zone of beta-hemolysis	1- to 2-mm white colonies on blood agar	Pharyngitis, glomerulonephritis
C, F, or G	<i>S. anginosus</i>	Small zone of beta-hemolysis	1- to 2-mm white colonies on blood agar	Purulent abscess
—	<i>S. mutans</i>	Alpha-hemolysis	Viridans group (produce green pigment when grown on blood agar)	Dental caries; rarely bacteremia, meningitis, endocarditis
—	<i>S. pneumoniae</i>	Alpha-hemolysis (aerobic); beta-hemolysis (anaerobic)	Diplococci; capsule required for pathogenicity; bile sensitive	Pneumonia, sinusitis, otitis media, bacteremia, endocarditis, meningitis
D	<i>Enterococcus faecalis</i> , <i>E. faecium</i>	None (gamma-hemolysis)	Diplococci; no capsule; bile insensitive	Urinary tract infections, bacteremia, endocarditis, wound infections

Bacillus

- **Structure, Physiology, and Pathogenicity**
 - Facultative anaerobes
 - Bacilli that occur singly, in pairs, or in chains
 - Form endospores
 - Pathogenic strains produce anthrax toxins
- **Epidemiology**
 - Humans contract from infected animals
 - Transmission occurs via one of three routes:
 - Inhalation of spores
 - Inoculation of spores through break in the skin
 - Ingestion of spores

Figure 19.11 *Bacillus anthracis* as it appears in tissue.

Bacillus anthracis



SEM

10 μ m

Bacillus

- **Disease**

- *Bacillus anthracis* only causes anthrax
- Three clinical manifestations:
 - Gastrointestinal anthrax
 - Rare in humans
 - Inhalation anthrax
 - Rare in humans
 - Requires inhalation of airborne endospores
 - High mortality rate
 - Cutaneous anthrax
 - Produces ulcer called an eschar
 - Fatal in 20% of untreated patients

Figure 19.12 Cutaneous anthrax.



Eschar

Bacillus

- **Diagnosis, Treatment, and Prevention**
 - Diagnosis
 - Large, nonmotile, Gram-positive bacilli in lung or skin samples
 - Treatment
 - Many antimicrobials are effective against *B. anthracis*
 - Prevention
 - Control of disease in animals
 - Effective vaccine available
 - Requires multiple doses and boosters