Chapter 19  Pathogenic Gram-Positive Bacteria
Staphylococcus

- Normal members of every human's microbiota
- Can be opportunistic pathogens

Structure and Physiology
- Facultative anaerobes
- Cells occur in grapelike clusters
- Nonmotile
- Salt-tolerant
  - Tolerate salt on human skin
- Tolerant of desiccation, radiation, and heat
  - Survive on environmental surfaces
<table>
<thead>
<tr>
<th>Virulence Factor</th>
<th>S. aureus</th>
<th>S. epidermidis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein A</td>
<td>+</td>
<td>–</td>
</tr>
<tr>
<td>Coagulase</td>
<td>+</td>
<td>–</td>
</tr>
<tr>
<td>Slime layer</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Catalase</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Hyaluronidase</td>
<td>+</td>
<td>–</td>
</tr>
<tr>
<td>Staphylokinase</td>
<td>+</td>
<td>–</td>
</tr>
<tr>
<td>Lipase</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>β-lactamase (penicillinase)</td>
<td>+</td>
<td>–</td>
</tr>
<tr>
<td>Toxins (cytolytic, exfoliative,</td>
<td>+</td>
<td>–</td>
</tr>
<tr>
<td>toxic-shock, and entero-)</td>
<td></td>
<td></td>
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</tbody>
</table>
Staphylococcus

- **Staphylococcal Diseases**
  - Noninvasive Disease
    - Food poisoning
      - Due to ingestion of enterotoxin-contaminated food
  - Cutaneous Diseases
    - Various skin conditions
    - Scalded skin syndrome, impetigo, folliculitis
Figure 19.2  Staphylococcal scalded skin syndrome.
Figure 19.3 Impetigo.
Staphylococcus

- **Staphylococcal Diseases**
  - **Systemic Diseases**
    - Toxic-shock syndrome (non-streptococcal)
      - Some *Staphylococcus* strains produce TSS toxin
    - TSS toxin absorbed into the blood
      - Produces fever, vomiting, rash, and low blood pressure
Figure 19.5 The incidence of toxic shock syndrome in the United States, 1979–2014.

- Superabsorbent tampons withdrawn
- Food and Drug Administration requires tampon labeling
Staphylococcus Diseases and Treatment

• Systemic Diseases
  • Bacteremia
  • Endocarditis
  • Pneumonia
  • Osteomyelitis

• Diagnosis, Treatment, and Prevention
  • Diagnosis
  • Treatment
  • Prevention
Streptococcus

- Facultative anaerobes
- Cocci arranged in pairs or chains
- Often categorized based on Lancefield classification
  - Divided into serotypes based on bacteria's antigens
  - Lancefield groups A and B include the significant human pathogens
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

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

• **Pneumococcal Diseases**
  • Pneumococcal pneumonia
  • Sinusitis and otitis media
  • Bacteremia and endocarditis
  • Pneumococcal 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
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
**Clostridium perfringens**

- Pathogenesis, Epidemiology, and Disease
  - Produces toxins that can cause irreversible damage to body
  - Grows in the digestive tracts of animals and humans
- Diseases
  - Food poisoning
    - Abdominal cramps and watery diarrhea
  - Gas gangrene
    - Trauma introduces endospores into body
    - Endospores germinate and cause necrosis
Clostridium

• **Clostridium perfringens**
  • Diagnosis, Treatment, and Prevention
    • Diagnosis
      • Presence of minimum bacterial load in food or feces
      • Appearance of gas gangrene is usually diagnostic
    • Treatment
      • Food poisoning is self-limited
      • Gas gangrene requires removal of dead tissue and administration of antitoxin and penicillin
    • Prevention
      • Refrigeration of foods can reduce cases of food poisoning
      • Proper cleaning of wounds can prevent gas gangrene
Clostridium

• **Clostridium difficile**
  • Pathogenesis, Epidemiology, and Disease
    • Common member of the intestinal microbiota
    • Opportunistic pathogen in patients taking broad-spectrum antimicrobial drugs
    • Minor infections result in self-limiting explosive diarrhea
    • Serious cases can cause pseudomembranous colitis
      • Sections of the colon wall slough off, causing massive infection by fecal bacteria
      • Life-threatening condition