Pathogenic Gram-Negative Cocci and Bacilli
Gram-Negative Bacteria

• Constitute largest group of human bacterial pathogens
  • Due in part to lipid A in the bacterial cell wall
    • Triggers fever, vasodilation, inflammation, shock, and disseminated intravascular coagulation (DIC)
• Most Gram-negative bacteria that breach skin or mucous membranes, grow at 37°C, and evade the immune system can cause disease in humans
Pathogenic Gram-Negative Cocci: *Neisseria*

- **Structure and Physiology of *Neisseria***
  - Only genus of Gram-negative cocci that regularly causes disease in humans
  - Aerobic, nonmotile, arranged as diplococci
  - Oxidase positive
    - Distinguishes from many other Gram-negative pathogens
  - Pathogenic strains have fimbriae, a polysaccharide capsule, and a cell wall containing lipid A
  - Two species are pathogenic to humans:
    - *N. gonorrhoeae*
    - *N. meningitidis*
Pathogenic Gram-Negative Cocci: *Neisseria*

- **The Gonococcus:** *Neisseria gonorrhoeae*
  - **Pathogenesis, Epidemiology, and Disease**
    - **Causes** gonorrhea
      - Only occurs in humans
      - Sexually transmitted disease
        - Increased risk of infection with increasing sexual encounters
      - Most cases in the United States occur in adolescents
      - Cases have declined over the past decades
      - More common in females than in males
Figure 20.3 Incidence of gonorrhea in the United States.
Pathogenic Gram-Negative Cocci: *Neisseria*

- **The Gonococcus: *Neisseria gonorrhoeae***
  - Pathogenesis, Epidemiology, and Disease
    - Gonorrhea in men
      - Inflammation causes painful urination and pus-filled discharge
    - Gonorrhea in women
      - Often asymptomatic
      - Can trigger pelvic inflammatory disease
    - Infections can occur outside the reproductive tract
      - Cause proctitis, pharyngitis, and gingivitis
    - Infection of the cornea or respiratory tract of newborns can occur during childbirth
The Gonococcus: *Neisseria gonorrhoeae*

- **Diagnosis, Treatment, and Prevention**
  - **Diagnosis**
    - Asymptomatic cases identified with genetic probes
    - Gram-negative diplococci in pus from inflamed penis
  - **Treatment**
    - Complicated due to resistant strains
    - Broad-spectrum intramuscular cephalosporins
  - **Prevention**
    - Sexual abstinence, monogamy, and proper condom use
    - Eye infections in newborns prevented with antimicrobials
Pathogenic Gram-Negative Cocci: *Neisseria*

- **The Meningococcus: *Neisseria meningitidis***
  - Pathogenicity, Epidemiology, and Disease
    - Most common cause of meningitis in individuals under 20 years of age
    - Can be normal microbiota of the upper respiratory tract
    - Bacteria transmitted by respiratory droplets among people living in close contact
    - Meningitis can cause death within 6 hours of symptoms
    - Meningococcal septicemia can also be life threatening
Figure 20.4 Petechiae in meningococcal septicemia.
Pathogenic Gram-Negative Cocci: *Neisseria*

- **The Meningococcus: *Neisseria meningitidis***
  - Diagnosis, Treatment, and Prevention
    - **Diagnosis**
      - Rapid diagnosis critical
      - Gram-negative diplococci in phagocytes of the CNS
    - **Treatment**
      - Immediate administration of intravenous penicillin
    - **Prevention**
      - Asymptomatic carriers make eradication unlikely
      - Vaccine against some meningococcal strains is available
Pathogenic, Gram-Negative, Aerobic Bacilli

• **Bordetella**
  - Pathogenesis, Epidemiology, and Disease
    - Small, aerobic, nonmotile coccobacillus
    - *B. pertussis* is the most important
      - Causes pertussis (whooping cough)
      - Most cases of disease are in children
      - Adhesins and toxins mediate the disease
        - *Pertussis toxin*
        - *Adenylate cyclase toxin*
        - *Dermonecrotic toxin*
        - *Tracheal cytotoxin*
    - Bacteria inhaled in aerosols multiply in epithelial cells
Figure 20.23  Reported cases of pertussis in the United States, 1960–2014.
Figure 20.25 The approximate time course for the progression of pertussis.

- **Incubation**: No symptoms
- **Catarrhal**: Rhinorrhea, sneezing, malaise, fever
- **Paroxysmal**: Repetitive cough with whoops, vomiting, exhaustion
- **Convalescent**: Diminishing cough, possible secondary complications

<table>
<thead>
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<th>Time in weeks</th>
<th>Incubation</th>
<th>Catarrhal</th>
<th>Paroxysmal</th>
<th>Convalescent</th>
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<td>Rhinorrhea</td>
<td>Repetitive</td>
<td>Diminishing</td>
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<tr>
<td>4</td>
<td>fever</td>
<td>exhaustion</td>
<td>exhaustion</td>
<td>secondary</td>
</tr>
</tbody>
</table>

Relative number of bacteria involved in interaction
Pathogenic, Gram-Negative, Aerobic Bacilli

• **Bordetella**
  • Diagnosis, Treatment, and Prevention
    • Diagnosis
      • Pertussis symptoms usually diagnostic
    • Treatment
      • Primarily supportive
    • Prevention
      • Immunization with diphtheria, tetanus, attenuated pertussis (DTaP) or Tdap vaccine
Pathogenic, Gram-Negative, Aerobic Bacilli

• **Pseudomonads**
  
  • *Pseudomonas aeruginosa*
    
    • Rarely part of normal human microbiota
    • Rarely causes disease
      • Despite producing various virulence factors
        • Fimbriae, adhesins, capsule, toxins, and enzymes
    • Opportunistic infections in immunocompromised patients
      • Can colonize almost any organ or system
    • Also infects the lungs of cystic fibrosis patients
      • Biofilm protects bacteria from phagocytosis
    • Treatment is difficult due to drug resistance
Figure 20.26 A *Pseudomonas aeruginosa* infection.