Microbial Diseases of the Digestive System
Structures of the Digestive System

- Digestive System Structures Are Divided into Two Groups
  - Gastrointestinal tract (GI tract)
    - The pathway from the mouth to the anus
    - Most organs of the GI tract are protected by the peritoneum
  - Accessory digestive organs
    - Organs involved in grinding food or providing digestive secretions
Structures of the Digestive System

• **The Gastrointestinal Tract**
  • Digests food, absorbs nutrients and water into the blood, and eliminates waste
  • Components of the gastrointestinal tract
    • Mouth
    • Esophagus
    • Stomach
    • Small intestine
    • Large intestine (colon)
    • Rectum and anus
Figure 23.1 Major structures of the digestive system.
Structures of the Digestive System

• The Accessory Digestive Organs
  • Tongue and teeth
  • Salivary glands
  • Liver
  • Gallbladder
  • Pancreas
Figure 23.2 Detailed structure of teeth and socket.
Structures of the Digestive System

• **Tell Me Why**
  • Why is the digestive system an important portal of entry for microorganisms?
Microbiome of the Digestive System

- Esophagus, stomach, and duodenum
  - These regions are almost free of microbes.
  - Peristalsis and rapid transport of food help prevent microbial colonization.
- Tongue, teeth, jejunum, ileum, colon, and rectum
  - Viridans streptococci are most prevalent in this region.
- Lower small intestine and colon
  - Microbiota here are microbial antagonists.
  - Mucous membrane prevents entry of microbes into the bloodstream.
Microbiome of the Digestive System

• Tell Me Why
  • Why does use of antibacterial drugs over an extended time increase the likelihood of oral candidiasis (thrush) and so-called *C. diff.* diarrhea?
Bacterial Diseases of the Digestive System

• Dental Caries, Gingivitis, and Periodontal Disease
  • Signs and symptoms
    • Caries
      • Appears as holes or pits in the teeth
    • Periodontal disease
      • Gums that are swollen, tender, bright red, or bleeding
  • Pathogen, virulence factors, and pathogenesis
    • *Streptococcus mutans* is a frequent cause of caries
      • Dextran and fimbriae allow biofilm formation on teeth
    • *Porphyromonas gingivalis* causes periodontal disease
      • Proteases break down gingival tissue
Figure 23.3 The process of tooth decay.

1. Plaque (biofilm)
2. Early stage of decay
3. Moderate stage of decay
4. Advanced stage of decay
Bacterial Diseases of the Digestive System

• Dental Caries, Gingivitis, and Periodontal Disease
  • Epidemiology
    • Most adults have experienced dental caries
    • Diets high in sucrose increase the risk of decay
  • Diagnosis, treatment, and prevention
    • Caries
      • Diagnosed by visual inspection
      • Treated by filling cavities if caught early
    • Gingivitis
      • Diagnosed by inspection of gums
      • Treated by scaling and use of antibacterial rinses
    • Prevention involves good oral hygiene
Bacterial Diseases of the Digestive System

• Peptic Ulcers
  • Signs and symptoms
    • Abdominal pain is main symptom
  • Pathogen and virulence factors
    • Caused by *Helicobacter pylori*
    • Numerous virulence factors
      • Flagella enable burrowing through stomach lining
      • Adhesins facilitate attachment to gastric cells
      • Urease neutralizes stomach acid
Figure 23.4 The role of *Helicobacter pylori* in the formation of peptic ulcers.

1. Bacteria invade mucus and attach to gastric epithelial cells.
2. *Helicobacter*, its toxins, and inflammation cause the layer of mucus to become thin.
3. Gastric acid destroys epithelial cells and underlying tissue.
Bacterial Diseases of the Digestive System

- **Peptic Ulcers**
  - Epidemiology
    - Fecal-oral transmission is likely
    - Stress may worsen ulcer symptoms
  - Diagnosis, treatment, and prevention
    - Diagnosis based on X-ray exam to identify ulcers and presence of *H. pylori* in clinical specimens
    - Treated with antimicrobials and drugs that inhibit stomach acid
    - Prevented by avoiding fecal-oral transmission
Bacterial Diseases of the Digestive System

- **Bacterial Gastroenteritis**
  - Inflammation of stomach or intestines caused by bacteria
  - Associated with contaminated food or water and poor living conditions
Bacterial Diseases of the Digestive System

- **Bacterial Gastroenteritis**
  - General features
    - Similar manifestations despite different causative agents
      - Nausea, vomiting, diarrhea, abdominal pain, and cramps
    - Dysentery produces loose, frequent stool containing mucus and blood
    - Treatment involves fluid and electrolyte replacement
    - Prevent with proper handling, storage, and preparation of food
Figure 23.5 The danger zone.
Bacterial Diseases of the Digestive System

- **Bacterial Gastroenteritis: Shigellosis**
  - Pathogen and virulence factors
    - Caused by four species of *Shigella*
    - Virulence factors include *type III secretion systems* and *enterotoxins*
  - Pathogenesis and epidemiology
    - Pathogen colonizes cells of the small, then large intestine
  - Diagnosis, treatment, and prevention
    - Diagnosed by symptoms and presence of *Shigella* in stool
    - Supportive treatment and administration of antimicrobials
Figure 23.6 The events in shigellosis.

1. Shigella attaches to epithelial cell of colon.
2. Shigella triggers endocytosis.
3. Shigella multiplies in cytosol.
4. Shigella invades neighboring epithelial cells, thus avoiding immune defenses.
5. An abscess forms as epithelial cells are killed by the infection.
6. Shigella that enters the blood is quickly phagocytized and destroyed. No bacteremia.
Bacterial Diseases of the Digestive System

• **Bacterial Gastroenteritis: Traveler's Diarrhea**
  • Pathogen and virulence factors
    • Caused by *Escherichia coli*
    • Virulence factors: adhesins, fimbriae, and toxins
  • Pathogenesis and epidemiology
    • Diarrhea mediated by enterotoxins
    • Common in developing countries
  • Diagnosis, treatment, and prevention
    • Diagnosis is based on signs and symptoms
    • Treatment is based on fluid and electrolyte replacement
      • Antidiarrheal drugs prolong the symptoms
Bacterial Diseases of the Digestive System

• **Bacterial Gastroenteritis: *Campylobacter* Diarrhea**
  - Pathogen and virulence factors
    - Caused by *Campylobacter jejuni*
    - Virulence factors: adhesins, cytotoxins, and endotoxin
  - Pathogenesis and epidemiology
    - Virulence factors cause bleeding lesions and inflammation
    - Chickens are the main source of human infections
  - Diagnosis, treatment, and prevention
    - Diagnosis is based on signs and symptoms
    - Most cases resolve without treatment
    - Prevented with proper hygiene after handling raw poultry

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Figure 23.7 *Campylobacter jejuni*, the most common cause of bacterial gastroenteritis in the United States.
• **Bacterial Gastroenteritis: *C. diff.* (Antimicrobial-Associated) Diarrhea**
  
  • Signs and symptoms
    - Pseudomembranous colitis occurs in severe cases
  
  • Pathogen and virulence factors
    - Caused by *Clostridium difficile*
    - Antimicrobial use facilitates overgrowth of *C. difficile*
    - *C. difficile* produces two toxins
  
  • Pathogenesis
    - Toxins mediate inflammation and pseudomembrane formation
Figure 23.8 Pseudomembranous colitis.
Bacterial Diseases of the Digestive System

- **Bacterial Gastroenteritis: C. diff. (Antimicrobial-Associated) Diarrhea**
  - Epidemiology
    - By-product of modern medicine
    - Any antimicrobial can trigger the disease
  - Diagnosis, treatment, and prevention
    - Diagnosis is based on presence of bacterial toxin in stool
    - Treated with antimicrobials, experimental fecal transplants
    - Avoid unnecessary use of antimicrobials
Bacterial Diseases of the Digestive System

• Bacterial Gastroenteritis: Salmonellosis and Typhoid Fever
  • Pathogen and virulence factors
    • Caused by *Salmonella enterica* serotypes
      • Serotypes Typhi and Paratyphi cause typhoid fever
      • Serotypes Enteritidis and Typhimurium cause salmonellosis
    • Bacteria tolerate acidity of stomach and pass to the intestine
      • Toxins disrupt numerous cellular activities
  • Pathogenesis and epidemiology
    • Typhoid fever is acquired by contaminated food or water
    • Salmonellosis is often acquired by consuming contaminated eggs
Figure 23.9 The events in salmonellosis.

1. Salmonella attaches to epithelial cells lining the small intestine.

2. Salmonella triggers endocytosis.

3. Salmonella multiplies within food vesicle.

4. Salmonella kills host cell, inducing fever, cramps, and diarrhea.

5. Bacteremia: Salmonella moves into bloodstream.
Bacterial Diseases of the Digestive System

• Bacterial Gastroenteritis: Salmonellosis and Typhoid Fever
  • Diagnosis, treatment, and prevention
    • Diagnosis is made by finding *Salmonella* in stool
    • Salmonellosis is usually self-limiting
    • Typhoid fever can be treated with antimicrobial drugs
    • Prevented with proper hygiene
Bacterial Diseases of the Digestive System

• **Bacterial Gastroenteritis: Cholera**
  • Pathogen and virulence factors
    • Caused by *Vibrio cholerae*
      • Occurs in salt- and freshwater
    • Environment within the human body activates some *Vibrio* genes
    • Most important virulence factor is production of cholera toxin
  • Pathogenesis and epidemiology
    • Pandemics have occurred throughout history
Figure 23.10 The action of cholera toxin in intestinal epithelial cells.

1. Cholera toxin binds to membrane of epithelial cell.
2. Portion of toxin (part of A) enters cell.
4. Cyclic AMP (cAMP) is synthesized.
5. Cyclic AMP stimulates cell to secrete Cl⁻, Na⁺, and other electrolytes.
6. Water follows electrolytes into lumen.
Figure 23.11 Cholera pandemic.
Bacterial Gastroenteritis: Cholera

- Diagnosis, treatment, and prevention
  - Diagnosis is based on presence of "rice-water" stool
  - Treated with supportive care and administration of doxycycline
  - Available vaccine provides only short-lived immunity
  - Proper hygiene is an important preventive measure
Table 23.1 Common Forms of Bacterial Gastroenteritis (1 of 2)

<table>
<thead>
<tr>
<th>Disease</th>
<th>Pathogen (Minimum Infectious Dose)</th>
<th>Source of Infection</th>
<th>Incubation Period</th>
<th>Distinguishing Manifestations</th>
<th>U.S. Annual Incidence</th>
<th>Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shigellosis</td>
<td><em>Shigella dysenteriae</em>, <em>S. flexneri</em>, <em>S. boydii</em>, <em>S. sonnei</em> (200 cells)</td>
<td>Self-inoculation from fecally contaminated hands, secondarily through consumption of fecally contaminated foods; direct person-to-person spread</td>
<td>1–7 days</td>
<td>Purulent (containing mucus and pus) bloody stools, cramping, rectal pain, fever, vomiting, and nausea lasting 2–3 days</td>
<td>14,000 cases</td>
<td>Severe dehydration; febrile seizures, confusion, and other neurological complications may appear in children</td>
</tr>
<tr>
<td>Traveler's Diarrhea</td>
<td>Enterotoxigenic strains of <em>Escherichia coli</em> (unknown)</td>
<td>Fecally contaminated food or water</td>
<td>24–72 hours</td>
<td>Nausea, vomiting, and diarrheal symptoms lasting 1–3 days</td>
<td>Unknown, as reporting is not required; estimated &gt;80,000 cases</td>
<td>Dehydration</td>
</tr>
<tr>
<td><em>E. coli</em> O157:H7 Infection</td>
<td>Enterohemorrhagic strains of <em>E. coli</em> such as strain O157:H7 (10 cells)</td>
<td>Fecally contaminated milk, fruit juice, or ground beef</td>
<td>24–72 hours</td>
<td>Bloody diarrhea, fatal hemorrhagic colitis, hemolytic uremic syndrome—destruction of erythrocytes and kidney failure</td>
<td>2000–3000 cases</td>
<td>Death</td>
</tr>
<tr>
<td>Campylobacter Diarrhea</td>
<td><em>Campylobacter jejuni</em> (500 cells)</td>
<td>Zoonotic from domestic poultry, dogs, cats, rabbits, pigs, cattle, and minks through consumption of food, milk, or water contaminated with animal feces; close contact with infected humans</td>
<td>2–5 days</td>
<td>10 or more bowel movements per day lasting 2–5 days; blood may be present in diarrhea</td>
<td>More than 1 million cases estimated</td>
<td>Sepsis, arthritis, Guillain-Barré syndrome (temporary nerve paralysis), death</td>
</tr>
<tr>
<td>Disease</td>
<td>Pathogen</td>
<td>Source of Infection</td>
<td>Incubation Period</td>
<td>Distinguishing Manifestations</td>
<td>U.S. Annual Incidence</td>
<td>Complications</td>
</tr>
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<td>-------------------------------------</td>
</tr>
<tr>
<td>C. diff. (Antimicrobial-Associated) Diarrhea</td>
<td>Clostridium difficile (unknown)</td>
<td>5% of Americans carry C. difficile normally; 20% of hospital patients are infected</td>
<td>48 hours to 6 weeks</td>
<td>Numerous, watery, foul-smelling stools; pseudomembranes</td>
<td>Estimated 500,000 cases</td>
<td>Pseudomembranous colitis, death</td>
</tr>
<tr>
<td>Salmonellosis</td>
<td>Salmonella enterica serotypes Enteritidis and Typhimurium (&gt;10⁶ cells)</td>
<td>Zoonotic from domestic poultry through consumption of fecally contaminated meat or eggs, or consumption of inadequately pasteurized contaminated milk; close contact with infected reptiles; contact with human carriers</td>
<td>8–18 hours</td>
<td>Nonbloody diarrhea, nausea, vomiting, fever, headache, and pain lasting 1–2 weeks; rash of tiny rose spots may appear on the skin</td>
<td>50,000 cases</td>
<td>Dehydration</td>
</tr>
<tr>
<td>Typhoid Fever</td>
<td>Salmonella enterica serotypes Typhi and Paratyphi (&gt;10⁶ cells)</td>
<td>Primarily contaminated water</td>
<td>8–48 hours</td>
<td>High fever (40°C), headache, muscle and stomach pain, malaise, loss of appetite, rose-colored spots</td>
<td>300–400 cases</td>
<td>Intestinal perforation, hemorrhaging, kidney failure, peritonitis, and death</td>
</tr>
<tr>
<td>Cholera</td>
<td>Vibrio cholerae (&gt;10⁶ cells)</td>
<td>Fecally contaminated food or water</td>
<td>48–72 hours</td>
<td>Rice-water stool (watery, colorless, odorless stools flecked with mucus) lasting 2–3 days; patients may lose up to 1 L of fluid per hour</td>
<td>0–8 cases</td>
<td>Death can occur within 48 hours of symptom onset if untreated (25–50% mortality rate)</td>
</tr>
</tbody>
</table>
Bacterial Diseases of the Digestive System

- **Bacterial Food Poisoning (Intoxication)**
  - Signs and symptoms
    - Nausea, vomiting, diarrhea, and cramping
  - Pathogen and virulence factors
    - Caused by *Staphylococcus aureus*
    - Virulence factors include five enterotoxins
  - Pathogenesis and epidemiology
    - Outbreaks are associated with social functions
  - Diagnosis, treatment, and prevention
    - Diagnosis is based on signs and symptoms
    - Treated with fluid and electrolyte replacement
    - Proper hygiene can reduce incidence
Bacterial Diseases of the Digestive System

• Tell Me Why

  • Why is the elimination of sucrose sugar from the diet not enough to prevent the formation of all dental caries?
Viral Diseases of the Digestive System

- **Oral Herpes**
  - Signs and symptoms
    - Presence of cold sores
    - Infections may extend beyond the oral cavity
      - Herpetic gingivostomatitis
      - Herpetic pharyngitis
      - Herpes esophagitis
  - Pathogen and pathogenesis
    - Most cases caused by *human herpesvirus 1* (HHV-1)
    - Virions form syncytia to avoid host’s immune system
    - Latency established in the trigeminal nerve ganglion
Figure 23.12 Oral herpes lesion.
Figure 23.13  Latency and reactivation of oral herpesviruses.
Viral Diseases of the Digestive System

• Oral Herpes
  • Epidemiology
    • Infections occur by casual contact in childhood
    • Primary infections are usually asymptomatic
  • Diagnosis, treatment, and prevention
    • Diagnosis is based on characteristic lesions
    • Topical penciclovir, acyclovir, or valacyclovir limits duration of lesions
    • Avoid direct contact with infected individuals
Viral Diseases of the Digestive System

• **Mumps**
  • Caused by the mumps virus
    • Humans are the only natural host
  • Once a very common childhood disease
  • Nearly nonexistent in developed countries because of immunization
  • No specific treatment for mumps
  • Infected individuals develop lifelong immunity
Viral Diseases of the Digestive System

• **Viral Gastroenteritis**
  • Signs and symptoms
    • Similar to those of bacterial gastroenteritis
    • Dehydration is common complication
  • Pathogens and pathogenesis
    • Caused by caliciviruses, astroviruses, and rotaviruses
    • These viruses infect cells lining the intestinal tract
  • Epidemiology
    • More cases occur in winter
    • Rotaviruses are important cause of childhood deaths in developing countries
Figure 23.14 Some viruses causing gastroenteritis.
Figure 23.15 Deaths from rotaviral diarrhea are most common in developing countries.
Viral Diseases of the Digestive System

- **Viral Gastroenteritis**
  - Diagnosis, treatment, and prevention
    - Serological test distinguishes among viruses
    - Treatment is based on fluid and electrolyte replacement
    - Prevention involves proper treatment of water and sewage and good hygiene practices
    - Vaccine for rotavirus exists
Viral Diseases of the Digestive System

• **Viral Hepatitis**
  • Signs and symptoms
    • Jaundice, abdominal pain, fatigue, vomiting, and weight loss
    • Symptoms may occur years after initial infection
  • Pathogen and pathogenesis
    • Liver damage due mostly to host immune response
    • Five different viruses cause hepatitis
      • Hepatitis A virus (HAV)
      • Hepatitis B virus (HBV)
      • Hepatitis C virus (HCV)
      • Hepatitis delta virus (HDV)
      • Hepatitis E virus (HEV)
## Table 23.2  Comparison of Hepatitis Viruses

<table>
<thead>
<tr>
<th>Feature</th>
<th>Hepatovirus Hepatitis A Virus (HAV)</th>
<th>Orthohepadnavirus Hepatitis B Virus (HBV)</th>
<th>Hepaciviruses Hepatitis C Virus (HCV)</th>
<th>Deltavirus Hepatitis Delta Virus (HDV)</th>
<th>Hepeniviruses Hepatitis E Virus (HEV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virus Family</td>
<td>Picornaviridae</td>
<td>Hepadnaviridae</td>
<td>Flaviviridae</td>
<td>Arenaviridae</td>
<td>Hepeviridae</td>
</tr>
<tr>
<td>Genome</td>
<td>+ssRNA</td>
<td>Partly ssDNA, partly dsDNA</td>
<td>+ssRNA</td>
<td>−ssRNA</td>
<td>+ssRNA</td>
</tr>
<tr>
<td>Envelope Present?</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Transmission</td>
<td>Fecal-oral</td>
<td>Needles; sex; blood and fluids</td>
<td>Needles; sex</td>
<td>Needles; sex</td>
<td>Fecal-oral</td>
</tr>
<tr>
<td>Incubation Period</td>
<td>15–45 days</td>
<td>70–100 days</td>
<td>42–49 days</td>
<td>7–24 days</td>
<td>15–60 days</td>
</tr>
<tr>
<td>Severity (Mortality Rate)</td>
<td>Mild (&lt;0.5%)</td>
<td>Occasionally severe (15–25%)</td>
<td>Usually subclinical (0.5–4%)</td>
<td>Requires simultaneous hepatitis B infection to replicate; together severity may be very high (10–20%)</td>
<td>Mild (1–3%; pregnant women 15–25%)</td>
</tr>
<tr>
<td>Chronic Carrier State?</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Common Name of Disease</td>
<td>Infectious hepatitis</td>
<td>Serum hepatitis</td>
<td>Non-A, non-B hepatitis; chronic hepatitis</td>
<td>Hepatitis delta</td>
<td>Enteric hepatitis</td>
</tr>
<tr>
<td>Other Disease Associations</td>
<td>—</td>
<td>Hepatic cancer</td>
<td>Hepatic cancer</td>
<td>Cirrhosis</td>
<td>—</td>
</tr>
</tbody>
</table>
Viral Diseases of the Digestive System

• **Viral Hepatitis**
  • Diagnosis, treatment, and prevention
    • Initial diagnosis made by observation of jaundice, enlarged liver, or fluid in the abdomen
    • Serological testing can identify viral antigens
    • HBV diagnosed by viral proteins in body fluids
    • Supportive care for symptoms
    • Alpha interferon and nucleotide analogs help reduce levels of virus
    • Prevented with good hygiene and protected sex or abstinence
    • Vaccines are available against HAV and HBV
Figure 23.16 Three types of viral protein particles produced by hepatitis B viruses.
Viral Diseases of the Digestive System

• **Tell Me Why**
  
  • In areas of poor sanitation, which form of hepatitis would you expect to be most common—infected liver, serum hepatitis, or chronic hepatitis? Why?
Protozoan Diseases of the Intestinal Tract

• **Giardiasis**
  • Signs and symptoms
    • Often asymptomatic
    • Diarrhea and associated symptoms can last up to four weeks
  • Pathogen
    • Caused by *Giardia intestinalis*
    • *G. intestinalis* cysts are resistant to chlorine, heat, drying, and stomach acid
Disease in Depth: Giardiasis: Multiple Giardia attached to the intestinal wall

Giardiasis is one of the more common waterborne gastrointestinal diseases in the United States. The Giardia life cycle is shown below:

**GIARDIA LIFE CYCLE**

1. A host, who can be an animal or person, ingests a cyst from contaminated food, water, or hands. An infective dose can be as few as ten cysts.

2. An ingested cyst survives passage through the esophagus, stomach, and duodenum to release a trophozoite in the small intestine.

3. Trophozoites attach to the intestinal lining via a ventral adhesive disk or remain free.

4. Trophozoites multiply via binary fission.

5. Trophozoites can cover the intestinal surface, interfering with absorption and resulting in a large quantity of underdigested food.

6. The intestinal wall is scanned from Giardia ventral adhesive disk attachment.

7. As trophozoites pass into the colon, engulfment occurs.

8. Both trophozoites and cysts are expelled in the host’s feces, but only cysts survive outside host.
Protozoan Diseases of the Intestinal Tract

- Giardiasis
  - Epidemiology
    - Occurs in developed and developing countries
    - Individuals ingest cysts from contaminated water, food, or hands
    - Hikers, campers, and swimmers are at particular risk
  - Diagnosis, treatment, and prevention
    - Diagnosed by microscopic observation of *Giardia* in stool
    - Treated with tinidazole or metronidazole (U.S.)
    - Oral rehydration therapy may be needed
    - Prevention relies on using good hygiene and filtering water in endemic areas
Protozoan Diseases of the Intestinal Tract

• **Dr. Bauman’s Microbiology Video Tutor**
  • For more information, listen to the Disease in Depth video tutor on giardiasis.
Protozoan Diseases of the Intestinal Tract

• **Cryptosporidiosis**
  • Signs and symptoms
    • Severe watery diarrhea with potentially serious complications
  • Pathogen and pathogenesis
    • Caused by *Cryptosporidium parvum*
    • Pathogenicity of *C. parvum* is unclear
  • Epidemiology
    • Infection results from drinking contaminated water
  • Diagnosis, treatment, and prevention
    • Presence of oocysts in feces is diagnostic
    • Treated with fluid and electrolyte replacement
    • Prevented with proper hygiene
Figure 23.17 Oocysts of *Cryptosporidium parvum* in feces.
Protozoan Diseases of the Intestinal Tract

• Amebiasis
  • Signs and symptoms
    • Luminal amebiasis is asymptomatic
    • Invasive amebic dysentery causes severe diarrhea, colitis, and appendicitis
    • Invasive extraintestinal amebiasis causes necrotic lesions in various organs
  • Pathogen, virulence factors, and pathogenesis
    • Caused by *Entamoeba histolytica*
    • Virulent strains produce numerous proteins that are toxic to cells and facilitate invasion
    • Trophozoites in the peritoneal cavity or blood cause symptoms
Protozoan Diseases of the Intestinal Tract

• Amebiasis
  • Epidemiology
    • Transmitted by consumption of contaminated food or water, from contaminated hands, or by oral-anal intercourse
    • Majority of individuals develop luminal amebiasis
    • Human carriers help maintain transmission
  • Diagnosis, treatment, and prevention
    • Diagnosed by microscopic observation of Entamoeba in stool or intestinal biopsy
    • Treated with oral rehydration therapy and antiamebic drugs
    • Prevent with proper hygiene and safe sex practices
    • Individuals in endemic areas should drink bottled water and avoid uncooked vegetables or unpeeled fruits
Protozoan Diseases of the Intestinal Tract

• **Tell Me Why**
  • Why does the visually distinctive appearance of *Giardia* trophozoites improve the success of medical treatment of giardiasis as compared to that for amebic infections?
Helminthic Infestations of the Intestinal Tract

• Helminths are macroscopic, multicellular worms.
• Helminths can infest the GI tract as non-disease-causing parasites.
Helminthic Infestations of the Intestinal Tract

- **Tapeworm Infestations**
  - Tapeworm is the common name for a cestode
    - Flat, segmented, parasitic helminth
    - Intestinal parasites that lack own digestive system
  - Signs and symptoms
    - Usually asymptomatic
    - Nausea, abdominal pain, weight loss, and diarrhea may occur
  - Pathogens
    - *Taenia saginata*: beef tapeworm
    - *Taenia solium*: pork tapeworm
    - Life cycle split between primary and intermediate host
Figure 23.18 Features of tapeworm morphology.
Figure 23.19  Life cycle of *Taenia solium*.

1. Eggs and egg-filled proglottids are passed into the environment in feces.
2. Intermediate hosts ingest eggs on contaminated food.
3. Eggs hatch into larvae that penetrate the intestinal wall and migrate to other tissues.
4. Larva develops into a cysticercus in muscle.
5. Human ingests cysticercus in raw or undercooked contaminated meat.
6. Cysticercus excysts and attaches to mucosa of small intestine as a scolex, which matures.
7. Adult worm forms new proglottids.
Helminthic Infestations of the Intestinal Tract

• **Tapeworm Infestations**
  • Epidemiology
    • *Taenia* species live worldwide where beef and pork are food
    • High incidence
      • Regions of inadequate sewage treatment
      • Regions where humans live in close contact with livestock
  • Diagnosis, treatment, and prevention
    • Diagnosed by presence of proglottids in fecal sample
    • Treated with niclosamide or praziquantel
    • Prevention relies on thorough cooking of meats
• **Pinworm Infestations**
  • Pinworms are nematodes
    • Long, thin, unsegmented, cylindrical helminth
  • Signs and symptoms
    • Perianal itching, irritability, and decreased appetite
    • One-third of cases are asymptomatic
  • Pathogen and infestation
    • Caused by *Enterobius vermicularis*
    • Females deposit eggs in the perianal region at night
      • Eggs can be dislodged and spread the disease
Figure 23.20  Nematodes.
Helminthic Infestations of the Intestinal Tract

• Pinworm Infestations
  • Epidemiology
    • Infections commonly occur in children
    • *Enterobius* is the most common parasitic worm in the United States.
  • Diagnosis, treatment, and prevention
    • Diagnosis is based on identification of eggs or adult pinworms
    • Treated with pyrantel pamoate or mebendazole
    • Prevention requires strict personal hygiene
Helminthic Infestations of the Intestinal Tract

• **Anisakiasis**
  - Anisakiasis results from infestation by several parasitic nematodes
  - Signs and symptoms
    - Typically asymptomatic
    - Abdominal pain, nausea, vomiting, and fever may occur
    - Some individuals develop an allergic rash
  - Pathogen and infestation
    - Most commonly caused by *Anisakis simplex*
    - Complex life cycle with several larval stages
Figure 23.21 Life cycle of *Anisakis*.

1. Marine mammals excrete eggs.
2. Two larval stages develop inside eggs.
3. Eggs hatch, and larvae swim freely.
5. Fish eat krill.
6. Fish eat fish.
7a. Marine mammals eat infected fish. Larvae mature, mate, and lay eggs in intestine.
7b. Humans eat infected, raw, or undercooked fish and become accidental hosts.
Helminthic Infestations of the Intestinal Tract

- **Anisakiasis**
  - Epidemiology
    - About 20,000 cases occur worldwide
  - Diagnosis, treatment, and prevention
    - Diagnosis is generally made using endoscopy to visualize worms
    - Treatment involves removing worms from the intestine
    - Prevented by avoiding raw and undercooked marine fish
Helminthic Infestations of the Intestinal Tract

• *Tell Me Why*

  • Tapeworm infestation of an intermediate host requires consumption of eggs in food contaminated with feces. Why is it possible for humans to become accidental intermediate hosts for *T. solium*?