Chapter 25
Microbial Diseases of the Digestive System

Microbial Diseases of the Digestive System

- Second most common illness in U.S.
- Transmitted in food and water – ingestion of microbes or their toxins
- Fecal-oral cycle can be broken by:
  - Proper sewage disposal
  - Disinfection of drinking water
  - Proper food preparation and storage

Arctic Clear Water Treatment System

Even smaller than the previous system, the Arctic Clear serves as a small scale water treatment plant. Virtually any fresh water source: streams, ponds, lakes, cisterns, or even contaminated community water supplies can be treated. The UV sterilization system kills bacteria and viruses to the highest known standards, and the Arctic Clear is effective against all biological contaminants including salmonella, Giardia, hepatitis and cholera. Over 100 contaminants including sediments, iron, chlorine, mercury and pesticides are filtered out. A continuous monitor on UV light intensity automatically shuts off flow when the radiation level is below standard. The four-stage filter includes 80 mesh screen intake filter, 1 micron reusable cartridge filter, a KDF/Granulated Activated filter to remove heavy metals, hydrogen sulfide, iron and chlorine, and a .5 micron solid carbon block cartridge which removes harmful chemicals, pesticides and unpleasant odors and tastes. In essence this unit is a filter and a sterilizer with its own integrated pump. A flow rate of over one GPM. The Arctic Clear’s heavy-duty demand pump can lift water 10-14’ from its source and push it through the system at preset flow rates. Pump operates on 12V DC, 110V AC or 220V AC. All packaged in a case the size of a tool kit. Treats 1600-1800 gallons a day, capable of servicing the drinking water needs of up to 1000 people per day. Shipping wt. 45 lb.

The Digestive System

- GI tract:
  - Mouth
  - Pharynx
  - Esophagus
  - Stomach
  - Small intestine
  - Large intestine
- Accessory structures include teeth, tongue, salivary glands, liver, gallbladder, pancreas

Normal Microbiota

List examples of microbiota for each part of the gastrointestinal tract.

- >300 species in mouth
- Stomach and small intestine have few biota
- Large numbers in large intestine, including:
  - Bacteroides, E. coli, Enterobacter, Klebsiella, Lactobacillus, Proteus
  - These assist in degrading food and synthesizing vitamins
  - Up to 40% fecal mass is microbial cells

Dental Caries - Streptococcus

Describe the events that lead to dental caries and periodontal disease.

Caries begin when tooth enamel and dentin are eroded, exposing pulp to microbes.
Tooth Decay

- Streptococcus mutans uses sucrose to form dextran and lactic acid from fructose
- Bacteria adhere to teeth, producing sticky dextran and plaque
- Acid produced during carbohydrate fermentation destroys tooth enamel at plaque site
- Carbohydrates like starch, mannitol, sorbitol, and xylitol are not used by cariogenic bacteria to produce dextran

Periodontal Disease

- Caries of the cementum and gingivitis cause by streptococci, actinomycetes, anaerobic gram-negative bacteria
- Perodontitis can cause bone destruction, tooth loss – is due to inflammatory response to variety of bacteria growing on gums
- Acute necrotizing ulcerative gingivitis caused by Prevotella intermedia and spirochetes (doesn’t sound like fun!)

Bacterial Diseases of the Lower Digestive System

- Caused by growth of pathogens in intestines
- Symptoms usually include diarrhea, gastroenteritis, dysentery
- Treated with fluid and electrolyte replacement
- Infection caused by growth of pathogen
  - Incubation from 12 hr to 2 wk
  - Symptoms generally include fever
- Intoxication caused by ingestion of preformed toxin
  - Symptoms appear 1 - 48 hr after ingestion
  - Not usually with fever
- Both conditions may cause diarrhea, dysentery, gastroenteritis

Staphylococcal Food Poisoning

List the causative agents, suspect foods, signs and symptoms, and treatments for staphylococcal food poisoning, shigellosis, salmonellosis, typhoid fever, cholera, gastroenteritis, and peptic ulcer disease.

- Staphylococcus aureus enterotoxin is a superantigen
- Caused by ingestion of enterotoxin in improperly stored foods (room temp)
- Foods with high osmotic pressure and not immediately cooked
- Boiling for 30 minutes does NOT destroy exotoxin

Invasion of epithelial cell of intestinal wall by Shigella (4 spp.) bacterium.

Blood and mucus in stools, abdominal cramps, fever

Similar to invasion by Salmonella bacteria
Shigellosis

- *Shigella* spp. producing Shiga toxin
- *Shigella* toxin causes inflammation and bleeding

Salmonellosis

- *Salmonella enterica* serovars such as *S. enterica* Typhimurium
- Nausea, abdominal pain, diarrhea 12 – 36 hours after eating
- Mortality (<1%) due to septic shock caused by endotoxin (infants, elderly) – can result in carrier state
- Possible fever
- Cooking generally kills

Salmonellosis and Typhoid Fever Incidence

Typhoid Fever

- *Salmonella typhi* – transmitted by human feces
- Bacteria spread throughout body in phagocytes
- Fever and malaise after 2-week incubation, lasts 2 – 3 weeks
- 1-3% recovered patients become carriers, harboring *Salmonella* in their gallbladder
- Vaccines are available

Cholera

- *Vibrio cholerae* serotypes that produce cholera exotoxin that alters membrane permeability of intestinal mucosa; vomiting and diarrhea cause dehydration
- Incubation ~ 3 days, untreated results in 50% mortality
- Slightly curved morphology, isolation from feces

Cholera epidemic in Latin America
### Noncholera Vibrios
- Ingestion can result in mild diarrhea
- Usually from contaminated crustaceans or mollusks
  - *V. vulnificus* or *V. parahaemolyticus*

### Escherichia coli Gastroenteritis
- Caused by enterotoxigenic or enteroinvasive strains of *E. coli*
- Occurs as traveler's diarrhea and epidemic diarrhea in nurseries
- Usually self-limiting (self-curing) in adults
- 50% of feedlot cattle may have enterohemorrhagic strains in their intestines
- Enterohemorrhagic strains such as *E. coli* O157:H7 produce Shiga toxin that causes inflammation and bleeding of colon (colitis)
  - Can affect kidneys to cause hemolytic uremic syndrome

### Campylobacter Gastroenteritis
- Second most common cause of diarrhea in U.S.
- *Campylobacter jejuni*
- Usually transmitted in cow's milk

### Helicobacter Peptic ulcer disease
- Produces ammonia that neutralizes stomach acid
- Bacteria colonize stomach mucosa, causing peptic ulcers
- Treated with antibiotics and bismuth
- *H. pylori* causes stomach cancer

### Helicobacter pylori Peptic ulcer disease

### Yersinia Gastroenteritis
- *Y. enterocolitica* and *Y. pseudotuberculosis*
- Can reproduce at 4°C (refrigerated foods)
- Usually transmitted in meat and milk
**Clostridium perfringens Gastroenteritis**
- Self-limiting gastroenteritis
- Endospores survive heating and germinate when foods (meat) stored at room temperature
- Grow in intestinal tract producing exotoxin
- Diagnosis based on isolation and identification from stool samples

**Bacillus cereus Gastroenteritis**
- Ingestion of food contaminated with soil saprophyte

**Viral Diseases of Digestive System: Mumps**
- Mumps virus enters through respiratory tract
- 16 – 18 days after exposure, virus causes inflammation of parotid glands, fever, pain during swallowing
- Virus found in blood, saliva, urine
- Prevented with MMR (measles, mumps, rubella) vaccine

**Hepatitis**
- Inflammation of the liver
- Symptoms include loss of appetite, malaise, fever, jaundice
- Hepatitis may result from drug or chemical toxicity, EB (Epstein-Barr) virus, CMV (cytomegalovirus), or the Hepatitis viruses

**Hepatitis (A, B, C, D, E)**
- Hepatitis A –
  - HAV ingested in contaminated food/water, grows in cells of intestinal mucosa, spreads to liver/kidneys/spleen in the blood
  - Virus eliminated with feces
  - Diagnosis based upon IgM antibodies
  - Vaccine available
- Hepatitis B –
  - Frequently serious, unlike HAV which is subclinical
  - Transmitted by blood transfusions, syringes, saliva, sweat, breast milk, semen
  - Blood tested for HBsAg before transfusion
  - 3 month incubation, recovery usually complete
  - Vaccine available
- Hepatitis C –
  - Transmitted via blood
  - Incubation 2 – 22 weeks, usually mild
  - Blood tested for HCV antibodies before transfusion
- Hepatitis D (Delta) –
  - Circular strand of RNA
  - Uses HBsAg as a coat
- Hepatitis E –
  - Spread by fecal-oral route
  - Evidence of existence of hepatitis F and G
### Hepatitis (A, B, C, D, E)

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<th>Causative agent</th>
<th>Chronic liver disease</th>
<th>Vaccine</th>
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<tr>
<td>Hepatitis A</td>
<td>Fecal-oral</td>
<td>Picornaviridae</td>
<td>No</td>
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<tr>
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<td>Parenteral, STD</td>
<td>Hepadnaviridae</td>
<td>Yes</td>
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<tr>
<td>Hepatitis C</td>
<td>Parenteral</td>
<td>Flaviviridae</td>
<td>Yes</td>
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<td>Hepatitis D</td>
<td>Parenteral, HBV coinfection</td>
<td>Deltaviridae</td>
<td>Yes</td>
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<tr>
<td>Hepatitis E</td>
<td>Fecal-oral</td>
<td>Caliciviridae</td>
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Table 25.1

### Hepatitis B Virus

![Hepatitis B Virus](image)

### Effects of Hepatitis C on human liver

![Effects of Hepatitis C on human liver](image)

### Viral Gastroenteritis

List the causative agents, mode of transmission, and symptoms of viral gastroenteritis.

- Rotavirus (wheel shape – Norwalk or norovirus family)
  - 3 million cases annually
  - 1-2 day incubation, 1 week illness
- Norovirus
  - 50% of U.S. adults have antibodies
  - 1-2 day incubation. 1-3 day illness
- Treated with rehydration

![Viral Gastroenteritis](image)

### Fungal Diseases of Digestive System: Mycotoxins

Identify methods for preventing ergot and aflatoxin poisoning.

- Mycotoxins are produced by some fungi:
  - Affect blood, nervous system, kidneys, liver
  - *Claviceps purpurea*
    - Grows on cereal grains
    - Produces ergot poisoning
    - Toxin restricts blood flow to limbs; causes hallucination
  - *Aspergillus flavus*
    - Grows on peanuts
    - Produces aflatoxin
    - Toxin causes liver damage; liver cancer

![Fungal Diseases of Digestive System: Mycotoxins](image)

### Protozoan Diseases of Digestive System: Giardiasis

List the causative agents, modes of transmission, symptoms, and treatments for giardiasis, amoebic dysentery, cryptosporidiosis, and Cyclospora diarrheal infection.

- *Giardia lamblia* grows in human and animal intestines
  - Transmitted by contaminated water
  - Symptoms: malaise, nausea, flatulence, weakness, abdominal cramps
  - Diagnosed by microscopic examination of stool for ova and trophozoite, protozoa in intestine
  - Treated with metronidazole

![Protozoan Diseases of Digestive System: Giardiasis](image)
Cryptosporidiosis

- Cryptosporidium parvum causes diarrhea
- Transmitted by oocysts in contaminated water
- Diagnosed by acid-fast staining of stool or presence of antibodies by FA or ELISA
- Treated with oral rehydration

Cyclospora Diarrheal Infection

- Cyclospora cayetanensis
- First identified in 1993
- Transmitted by oocysts in contaminated produce
- Diagnosed by microscopic examination for oocysts in feces
- Treated with trimethoprim and sulfamethoxazole

Amoebic Dysentery

- Entamoeba histolytica in large intestine
- Amoeba feeds on RBCs and GI tract tissues
- Severe infections result in abscesses
- Diagnosis by observing trophozoites in feces and serological tests
- Treated with metronidazole

Amoebic Dysentery – flask-shaped ulcer

Amoebic Dysentery

(b) Entamoeba histolytica

Helminthic Diseases of the Digestive System

List the causative agents, modes of transmission, symptoms, and treatments for tapeworms, hydatid disease, pinworms, hookworms, ascariasis, and trichinosis.
Tapeworms

- *Taenia* spp. – scolex attaches to intestinal mucosa
- Transmitted as cysticerci (encysted larvae) in undercooked meat
- Eggs shed in feces
- Diagnosed by observing proglottids and eggs in feces
- Treatment with praziquantel
- Neurocysticercosis (pork tapeworm larvae) may require surgery

Hydatid Disease

- *Echinococcus granulosus* tapeworm
- Definitive host: Dogs, wolves
- Intermediate host: Sheep and other herbivores; Humans
- Transmitted by ingesting *E. granulosus* eggs
- Treatment is surgical

Nematodes: Pinworms

- *Enterobius vermicularis*
- Definitive host: Humans
- Transmitted by ingesting *Enterobius* eggs
- Treatment with pyrantel pamoate or mebendazole
## Hookworms

- Larvae in soil hatched from eggs shed in feces
- Larvae bore through skin; migrate to intestine
- Treated with mebendazole

## Ancylostoma Hookworms

![Image of Ancylostoma Hookworms]

## Ascariasis

- *Ascaris lumbricoides*
- Lives in human intestines
- Transmitted by ingesting *Ascaris* eggs
- Treated with mebendazole

## Trichinosis

- *Trichinella spiralis*
- Larvae encyst in muscles of humans and other mammals
- Transmitted by ingesting larvae in undercooked meat
- Adult females mature in intestine, lay eggs, new larvae migrate to muscles
- Treated with mebendazole to kill adults worms

## Trichinosis – *Trichinella spiralis*

1. Adult *Trichinella spiralis* develop, invade intestinal wall of pig, and produce larvae that invade muscles.
2. Capsule
3. Section showing *T. spiralis* larvae encysted in pig’s muscle tissue (capsule is 0.25 to 0.5 in length)
4. Meanwhile, other animals are infected by eating infected meat that has been dumped.
5. Human eats undercooked pork containing *T. spiralis* larvae
6. In human intestine, cyst walls are removed, and *T. spiralis* adults develop. Adults produce larvae that encyst in muscles.
7. *T. spiralis* adult
### Table 35.2: Bacterial Diseases of the Digestive System

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<td>Salmonella typhi</td>
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