Eukaryotic Microbes

Parasites
Protozoa, Helminths, Arthropods

Protozoa

- Life Stages –
  - Trophozoite - vegetative; feeding, mostly motile
  - Cyst – dormant; protective thick wall
- Most are free living in water and soil
- Classified by motility & life cycle
- Subdivided by location in human host (GI, blood, GU)

1. Sarcodina - Amoeba - move by pseudopods
2. Ciliophora - Ciliates - move by cilia
3. Mastigophora - Flagellates - move by flagella
4. Apicomplexan - Sporozoa – complex life cycle
Diversity among Protozoa

- **Amoeba**
  - *Entamoeba histolytica* — Amoebic dysentery
  - *Naegleria* — primary amoebic meningoencephalitis
  - *Acanthamoeba* — contact lens contaminant

Amoebae

- Protozoa with no truly defined shape
- Move and acquire food through the use of pseudopodia
- Found in water sources throughout the world
- Few cause disease
**Entamoeba histolytica**

- Carried asymptptomatically in the digestive tracts of humans
- No animal reservoir exists
- Infection usually occurs by drinking water contaminated with feces that contain cysts
- Trophozoites migrate to the large intestine where they multiply

**Entamoeba histolytica**

- Three types of amebiasis can result from infection
  - Luminal amebiasis
    - Least severe form that is asymptomatic
  - Invasive amebic dysentery
    - More common form of infection
    - Characterized by bloody, mucus-containing stools and pain
  - Invasive extraintestinal amebiasis
    - Trophozoites carried via the bloodstream throughout the body
- Maintaining clean water is important in prevention

The Course of Amebiasis Due to *Entamoeba histolytica*
**Acanthamoeba and Naegleria**

- Cause rare and usually fatal brain infections
- Common inhabitants of natural waterways as well as artificial water systems
- Contact lenses wearers who use tap water to wash their lenses can become infected
- **Acanthamoeba diseases**
  - Infection occurs through cuts or scrapes, the conjunctiva, or through inhalation
  - *Acanthamoeba* keratitis results from conjunctival inoculation
  - Amebic encephalitis is the more common disease

**Naegleria disease**
- Infection occurs when swimmers inhale contaminated water
- Amoebic meningoencephalitis results when trophozoites migrate to the brain
- Prevention is difficult because these organisms are environmentally hardy

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**Flagellate**

- *Trichomonas vaginalis*
  - no cyst stage
  - Trichomoniasis - STI
- *Giardia lamblia*
  - intestinal malabsorption
  - Traveler’s diarrhea, day care centers, hikers

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Giardia

Hemoflagellates

- Trypanosoma
  - African sleeping sickness or Chagas disease
  - Transmitted by tsetse flies or reduviid bugs

- Leishmania
  - leishmaniasis – “Baghdad Boil” - Desert Storm
  - Transmitted by sand fly vector

Ciliates

- Complex cells with rudimentary mouth (cytostome)
  - *Balantidium coli* is the only human parasite
    - intestinal disease
    - associated with pork
- *Paramecium*
- *Vorticella*
Ciliates

- Protozoa that use cilia in their trophozoite stage
- *Balantidium coli* is the only ciliate known to cause disease in humans
- Commonly found in animal intestinal tracts
- Humans become infected by consuming food or water contaminated with feces containing cysts
- Trophozoites attach to the mucosal epithelium lining the intestine
- *B. coli* infections are generally asymptomatic in healthy adults

Ciliates

- Balantidiasis occurs in those with poor health
  - Characterized by persistent diarrhea, abdominal pain, and weight loss
  - Dysentery results in severe infections
- Presence of trophozoites is diagnostic for the disease
- Prevention relies on good personal hygiene and efficient water sanitation

Apicomplexans (Sporozoa)

- Characteristics:
  - Nonmotile, Intracellular parasites
  - Complex life cycles, Asexual/sexual reproduction
- *Plasmodium* – malaria
  - transmitted by *Anopheles* mosquito
- *Cryptosporidium* – diarrhea; AIDS related
- *Toxoplasma* – toxoplasmosis; AIDS related
**Plasmodium**

1. Infected mosquito bites human; sporozoites are injected into bloodstream to liver of human.
2. Sporozoites undergo schizogony in liver cell; merozoites are produced.
3. Merozoites released into bloodstream may infect new red blood cells.
4. Merozoites are released when red blood cell ruptures; some merozoites infect new red blood cells, and some develop into male and female gametocytes.
5. Another mosquito bites infected human and ingests gametocytes.
6. In mosquito’s digestive tract, gametocytes unite to form zygote.
7. Resulting sporozoites migrate to salivary glands of mosquito.

**Cryptosporidium parvum**

- Waterborne
- Found in cattle
- Attach to intestinal lining
- Cause watery diarrhea
- Acid-fast Oocysts
- Resistant to chlorine

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Helminths - worms

- Life Stages
  - egg, larva, adult; complex life cycles
  - infective stage: egg or larva
  - definitive host: harbors adult stage
  - intermediate hosts: may be more than one

- Classifications:
  - Nematodes - roundworms
  - Platyhelminthes - flatworms
    - Trematodes - flukes - nonsegmented
    - Cestodes - tapeworms - segmented

Nematodes - Roundworms

- Intestinal roundworms:
  - *Ascaris* (Giant intestinal roundworm)
  - *Enterobius* (Pinworm)
  - *Necator / Ancylostoma* (Hookworm)

- Tissue roundworms
  - *Trichinella spiralis* - trichinosis

Features of the Life Cycle of Roundworms

- Parasites of almost all vertebrates
- Have a number of reproduction strategies
  - Most intestinal nematodes shed their eggs into the lumen of the intestine
    - Eggs are eliminated in feces
    - Eggs are consumed in contaminated food or water
  - Some intestinal nematodes release their eggs into the soil
    - Larvae actively penetrate the skin of a host
    - Inside the body, they travel to the intestine
  - Other nematodes encyst in muscle tissue and are consumed in raw or undercooked meat
  - Mosquitoes transmit a few species of nematodes
- Adult sexually mature stages are found only in definitive hosts
Nematodes - roundworms

Pinworm disease is the most prevalent helminthic infection in the United States

- *Enterobius vermicularis*
- Life cycle
- Diagnosis with cellophane tape
- Transmission
Enterobius - Pinworm

Figure 12.29

Diagnosing Pinworm Disease

Necator or Ancylostoma - Hookworm
The Life Cycle of the Hookworms

Ancylostoma duodenale and Necator americanus

- Eggs enter the soil from human feces.
- Larvae emerge as infective larvae.
- They must be ingested by a new host.
- Larvae pass through the duodenum to mature in the intestine.

Trichinella

- Adult Trichinella spiralis invades muscle and produces larvae that infect muscles.
- Larvae infecting T. spiralis never encyst in human muscle tissue. Instead, they encyst in the intestine.
- In human intestines, oral fats are removed and T. spiralisede.
- Larvae enter the muscle fibers as cysts called trichinellas.
- (N) T. spiralis adult

Filariasis is a lymphatic system infection

- Wuchereria bancrofti
  - Life cycle
  - Transmission by mosquito
  - Symptoms
    - Elephantiasis

- The Life Cycle of Wuchereria bancrofti and Brugia malayi (Lymphatic Filariasis or Elephantiasis)
  - Larvae migrate to the lymph nodes, gaining lymphatic maturity.
  - The lymphatic tissue produces microfilariae, which are ingested by a mosquito in the blood meal.
  - The microfilariae develop into adult worms in the mosquito.
Platyhelminthes - Flatworms

- **Trematodes** – Flukes - nonsegmented
  - *Schistosoma* - blood fluke; Swimmer’s itch

- **Cestodes** – Tapeworms - segmented
  - *Taenia* – beef or pork tapeworm
  - *Echinococcus* – wild dog tapeworm

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**Trematodes - Flukes**

![Fluke anatomy](image1)

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**Schistosoma – blood fluke**

![Life cycle of Schistosoma](image2)
Cestodes - Tapeworms

• Tapeworm parts:
  - Scolex: head with attachment site
  - Proglottids: body segments with testes and ovaries

*Taenia saginata*
- beef tapeworm

*Taenia solium*
- pork tapeworm
- cysticercosis

A few other tapeworms also cause disease

- *Hymenolepis nana*, the dwarf tapeworm, most common human tapeworm worldwide
- *Echinococcus granulosus*, the dog tapeworm, humans are intermediate hosts
Arthropods as Vectors

- Kingdom: Animalia
  - Phylum: Arthropoda (exoskeleton, jointed legs)
    - Class: Insecta (6 legs)
      - Lice, fleas, mosquitoes
    - Class: Arachnida (8 legs)
      - Mites and ticks
      - May transmit diseases (vectors)
Arthropod Vectors

Figure 23.24

Scabies - mite

Arachnids

- Adult arachnids have four pairs of legs
- Ticks and mites resemble each other morphologically
- Ticks are the most important arachnid vectors
  - Serve as vectors for bacterial, viral, and protozoan diseases
  - Second only to mosquitoes in the number of diseases they transmit
  - Hard ticks are the most prominent disease vector
  - Transmit Lyme disease, Rocky Mountain spotted fever, tularemia, relapsing fever, and tick-borne encephalitis
Arachnids
- Parasitic mites are found wherever humans and animals coexist
  - Transmit rickettsial diseases among animals and humans

Insects
- Adults have three pairs of legs as well as a head, thorax, and abdomen
- Fleas
  - Most fleas are not associated with humans but a few do feed on humans
  - Plague is the most significant disease transmitted by fleas
- Body lice
  - Parasites that can also transmit disease
  - Most common among poor or overcrowded communities

Insects
- Flies
  - Among the most common insects
  - Those that transmit disease are generally bloodsuckers
- Mosquitoes
  - Most important arthropod vector of disease
  - Carry some of the world’s most devastating diseases
- Kissing bugs
  - Often take blood meals near the mouth of their human hosts
  - Feed on blood nocturnally while the host sleeps
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