Chapter 23 Parasitic Protozoa
Protozoan and helminthinic parasites exist worldwide
Occur among people in rural, undeveloped, or overcrowded places
Emerging as serious threats in developed nations
Parasitic infections often involve several hosts
  • Definitive host
  • Intermediate host
Parasites can infect humans in one of three ways:
  • Ingestion
  • Vectorborne transmission
  • Direct contact
Figure 23.1 The major routes by which humans acquire parasitic infections.

**Contact and Penetration of Eyes**
- Acanthamoeba

**Inhalation**
- Acanthamoeba
- Enterobius
- Naegleria

**Vector-Borne**
- Kissing bug: Trypanosoma
- Mosquito: Plasmodium, Wuchereria
- Sand fly: Leishmania
- Tsetse fly: Trypanosoma

**Fecal-Oral, Ingestion**
- Anisakis
- Ascaris
- Balantidium
- Cryptosporidium
- Cyclospora
- Echinococcus
- Entamoeba
- Enterobius
- Fasciola
- Giardia
- Taenia
- Toxoplasma

**Contact and Penetration of Skin**
- Ancylostoma
- Necator
- Schistosoma

**Sexual Contact**
- Entamoeba
- Giardia
- Trichomonas
Protozoan Parasites of Humans

- Protozoa are unicellular eukaryotes
- Protozoa that enter the body via ingestion have two morphological forms:
  - Trophozoite
    - Feeding and reproducing stage that lives within the host
  - Cyst
    - Infective form that survives in the environment
    - Undergoes excystment when ingested, developing into trophozoites
- Trophozoites undergo encystment before leaving the host in feces
- Parasites classically grouped by their mode of locomotion
  - Ciliates, amoebae, flagellates, and apicomplexans
Protozoan Parasites of Humans

• **Amoebae**
  - Protozoa with no truly defined shape
  - Move and acquire food through the use of pseudopods
  - Found in water sources throughout the world
  - Few cause disease
Protozoan Parasites of Humans

- **Amoebae**
  - *Entamoeba*
    - *Entamoeba histolytica* carried asymptptomatically in the digestive tracts of humans
      - Carriers predominate in less-developed countries
    - No animal reservoir exists
    - Infection most commonly occurs by drinking contaminated water
    - Excystment occurs in the small intestine
      - Trophozoites migrate to the large intestine
Protozoan Parasites of Humans

- **Amoebae**
  - *Entamoeba*
    - Three types of amebiasis can result from infection:
      - *Luminal amebiasis*
        - Asymptomatic infections in healthy individuals
      - *Invasive amebic dysentery*
        - Severe diarrhea, colitis, appendicitis, and ulceration of the intestinal mucosa
      - *Invasive extraintestinal amebiasis*
        - Trophozoites in the blood are carried through the body
    - Amebic dysentery and invasive extraintestinal amebiasis can be fatal
Figure 23.2  Cyst of *Entamoeba histolytica* in fecal smear.
Protozoan Parasites of Humans

- **Amoebae**
  - *Entamoeba*
    - Diagnosis based on identification of cysts or trophozoites from stool samples or intestinal biopsies
    - Asymptomatic infections treated with paromomycin
    - Symptomatic amebiasis treated with idoquinol
    - Oral rehydration therapy often coupled with drug treatment
    - Maintaining clean water is important in prevention
Protozoan Parasites of Humans

• **Flagellates**
  • Protozoa that possess at least one flagellum
  • Number and arrangement of flagella help determine the species
Protozoan Parasites of Humans

- **Flagellates**
  - *Trypanosoma cruzi*
    - Causes **Chagas' disease** - Endemic in Central and South America
    - Opossums and armadillos are the primary reservoir
    - Transmission occurs through bite of insects in genus *Triatoma*
      - "Kissing bugs" feed preferentially from blood vessels in the lips
Figure 23.3 The life cycle of *Trypanosoma cruzi*.

1. Trypanosomes become infective in hindgut of kissing bug.
2. Infective trypanosomes are deposited in feces of kissing bug at bite wound site.
3. Scratching introduces infective trypanosomes into blood.
4. Trypanosomes travel in blood, penetrate cells, and transform into a nonflagellated form.
5. Nonflagellated trypanosome multiplies by binary fission inside cells.
6. Nonflagellated trypanosomes transform, each developing a flagellum attached to the parasite's body with an undulating membrane; these flagellated forms burst out of infected cells into the blood. These trypanosomes cannot multiply in the blood.
7. Some flagellated cells infect other body cells, becoming nonflagellated in the process.
8. Flagellated trypanosomes in the blood are ingested by kissing bug while it feeds.
9. Flagellated parasites develop in the midgut of the bug into a different flagellated form that multiplies by binary fission.
Protozoan Parasites of Humans

• **Flagellates**
  - *Trypanasoma cruzi*
    - Chagas' disease progresses through four stages
      - Acute stage characterized by chagomas
      - Generalized stage
      - An asymptomatic chronic stage
      - Symptomatic stage characterized by congestive heart failure following formation of pseudocysts
    - Parasite-induced heart disease is a leading cause of death in Latin America
Protozoan Parasites of Humans

- **Flagellates**
  - *Trypanasoma cruzi*
    - Identification of trypomastigotes or their antigens in clinical specimens is diagnostic
    - Xenodiagnosis is an alternative diagnostic method
      - Uninfected kissing bugs allowed to feed on individual
      - Presence of parasites in the hindgut of the bug after four weeks indicates the individual is infected
    - Early Chagas' disease treated with nifurtimox or benznidazole
    - Late stages of the disease cannot be treated
    - Prevention involves limiting contact with kissing bugs
Protozoan Parasites of Humans

• Flagellates
  • *Giardia*
    • *Giardia intestinalis*
      • Causative agent of giardiasis
        • Common gastrointestinal disease in the United States
      • Ingest cysts in contaminated food, water, or hands
      • Giardiasis ranges from asymptomatic infection to gastrointestinal disease
        • Diarrhea, pain, bloating, nausea, vomiting, and fever
Disease in Depth

**GIARDIA LIFE CYCLE**

1. A host ingests a cyst from contaminated food, water, or hands.

2. An ingested cyst survives passage through the acidic stomach and excysts to release a trophozoite in the small intestine.

3. Trophozoites multiply via binary fission.

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

Side view of Giardia attached to intestinal wall. The flagella were cut off during preparation of the protozoan for microscopy.
Trophozoites can cover the intestinal surface, interfering with absorption and resulting in a large quantity of undigested food.

The intestinal wall is scarred from *Giardia* ventral adhesive disk attachment.

As trophozoites pass into the colon, encystment occurs.

Both trophozoites and cysts are expelled in the host's feces, but only cysts survive outside the host.
U.S. 2010 confirmed/probable giardiasis cases per 100,000

- None reported
- ≤5.0
- ≥5.1–7.5
- ≥7.6–10.0
- ≥10.1–12.5
- ≥12.6
• **Giardia intestinalis**
  - Diagnosis based on cyst identification in stool specimens or presence of *Giardia* DNA
  - Tinidazole is the preferred treatment outside the U.S.
  - Infections in the U.S. are treated with metronidazole
  - Prevent infections in endemic areas by use of filtered water
Flagellates

- *Trichomonas*
  - *Trichomonas vaginalis*
    - Most common protozoan causing human disease in industrialized nations
    - Lives in the genitourinary system of men and women
    - Transmitted almost exclusively via sex
    - Occurs in people with preexisting STD or multiple sex partners
Protozoan Parasites of Humans

• Flagellates
  • *Trichomonas*
    • *Trichomonas vaginalis*
      • Infection of women results in vaginosis
        • Causes odorous discharge, vaginal and cervical lesions, abdominal pain, and painful urination and intercourse
      • Infection of men is typically asymptomatic
      • Presence of trophozoites in vaginal or urethral secretions is diagnostic
      • Infections treated with nitroimidazole drugs
      • Prevention involves abstinence and safe sex