

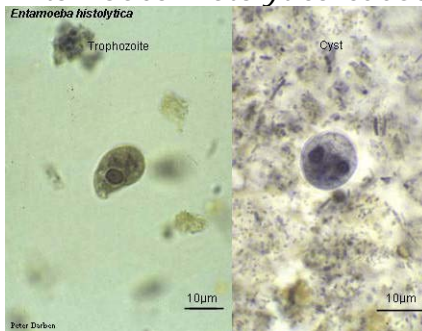
Unit 6 Lecture 15

Protozoans

Parasites kill a human every ten seconds, every day, year-in, year-out. Other parasites prefer to keep their host alive for food and shelter (In other words, a nice, comfortable home). This section looks at some of the more "pathogenic" parasites, what they do, and where they live in and on our bodies. Keep in mind that there are many other parasites.

Members of the Kingdom Protista can be differentiated on the basis of their means of motility: amoeboid (sarcodina), cilia, flagella, or non-motile (Apicomplexa). Apicomplexa are generally non-motile but have complex life cycle. A number of members of this group exist in two forms, cysts or trophozoites, at some time during their life cycle. The cyst is the dormant resting stage and the trophozoite is the active feeding stage. Infection with a protista usually generates a cell-mediated response. Since trophs are very fragile and disintegrate easily, specimens should be sent to labs in a preservative if fresh specimens are provided.

Entamoeba histolytica causes amebiasis. This amoeboid organism belongs to the phylum Sarcodina and moves by pseudopods. Both cyst and trophozoite forms are present. Transmission is via the fecal/oral route. Reservoirs are unknown. The primary infection of amoebic dysentery is dysentery. Most of the organisms just reside in the lumen of the gut ingesting bacteria. In a small percentage cases the organism causes a significant ulceration in large intestine by invasion of the epithelial mucosa. In these cases the trophozoites ingest RBC. They can disseminate primarily to liver where they cause abscesses and occasionally migrate to the lungs, brain, and spleen. This invasion can cause secondary bacterial infections. About 100,000 people die every year of amoebic dysentery. Treatment is with metronidazole or iodoquinol. There are other amoeboid protozoans, most of which are non-pathogens.



Naegleria fowleri and *Acanthamoeba* are free living soil amoebas. *Naegleria* forcefully pass through the cribriform plate of ethmoid and can cause hemorrhages and damage mainly in basilar portions of cerebrum and cerebellum. Diagnosis is usually determined at autopsy. *Acanthamoeba* causes keratitis and is associated with contaminated saline wash for contact lenses.

Balantidium coli belong to the phylum Ciliophora. Movement is via cilia. This organism also possesses a trophozoite and cyst stage. A key characteristic is the [macronucleus](#) and micronucleus. Transmission is via the fecal/oral route.

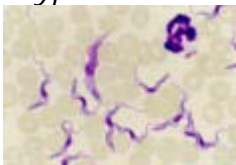
Reservoirs include both pigs and rodents. The symptoms of balantidial dysentery include diarrhea alternating with constipation. Extreme cases may mimic amebiasis. Treatment is with oral tetracycline, metronidazole, or iodoquinol.

Giardia lamblia is an intestinal flagellate. Locomotion is via flagella that are found in the trophozoite. *Giardia* belongs to the phylum Zoomastigina. With prominent paired nuclei and flagella, this organism has been called "the old man of the gut." *Giardia* live in fresh waters and the beavers and muskrats serve as the natural reservoir. Transmission is via ingestion of cysts in contaminated water. The primary infection causes intestinal distress, severe cramping, and diarrhea that can lead to dehydration and electrolyte imbalance. Because this organism is found in day care centers, it is the number one intestinal protozoan recovered in this area. Treatment includes Metronidazole (Flagyl) and quinines. There are other intestinal flagellates of lesser significance.



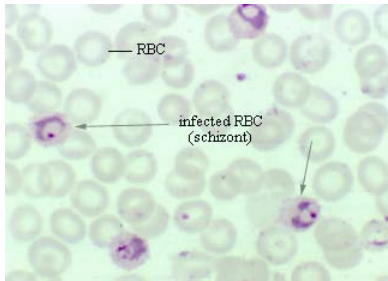
Trichomonas vaginalis causes the sexually transmitted disease trichomoniasis. This flagellate only has a [trophozoite stage](#). Identification is made by observing the live actively motile organisms in urine, vaginal secretions or urethral discharges. In females, the primary infection causes an intense vaginal itching (vaginitis) and vaginal discharge. In males, there may be urethral itching (urethritis) and a foul-smelling discharge. Usually there is less discomfort in males than in female who have the infection. Treatment of both sex partners with Metronidazole (Flagyl) is required to prevent reinfection.

Hemoflagellates are protozoans that move in the blood stream via flagella. *Trypanosoma brucei* has two varieties *T. gambiense* and *T. rhodesiense* that are indistinguishable from each other. The Rhodesian variety ([geographic location](#)) causes an acute infection with many people dying within a few months. The Gambiense variety produces a more chronic infection. Both produce sleeplessness in the patient at night which causes them to want to sleep during the day. The disease caused is trypanosomiasis or "African sleeping sickness." This organism is transmitted by the tsetse fly. The main reservoirs are cattle and sheep. Trypanosomes have a single flagellum and there is only the trophozoite stage. Secondary infections occur in the lymph nodes of the neck. Often there is CNS and heart destruction causing typical lethargy and death. Treatment with arsenicals may be successful if treated early. Because of the organism's ability to change its surface antigens, once infected, a patient is incapable of ever clearing the infection and becoming immune.



South American sleeping sickness ([Chagas' disease](#)) is caused by *Trypanosoma cruzi*. Transmission is by means of the [reduviid](#) (kissing bug). The primary infection is a slight sore on lips where the bug bites. The organisms multiply in sore and then move via the blood stream to cardiac and smooth muscle. Chronically infected usually die within 2 years. Secondary infections involve the reticuloendothelial system and the CNS. [Leishmania donovoni](#) is another hemoflagellate, yet only the nonmotile amastigote occurs in mammals. The sand fly transmits this organism causing a variety of diseases: visceral leishmaniasis (Kala-azar), cutaneous leishmaniasis (Baghdad boil, Oriental sore), or mucocutaneous leishmaniasis. There are about 1.5 million cases per year resulting in about 45,000 deaths.

The main blood sporozoa are the plasmodia which cause malaria. These organisms belong to the phylum Apicomplexa. Four species of *Plasmodium* (*P. falciparum*, *P. vivax*, *P. malariae*, and *P. ovale*)



all can cause malaria. They are nonmotile but have several morphological stages in their [life cycle](#). The sexual reproduction occurs in the *Anopheles* mosquito. The asexual stages occur in man or other mammals (RBC's and liver). Transmission is through the skin via mosquitoes taking a blood meal. Reservoirs include all mammals. When an infected mosquito takes a blood meal sporozoites

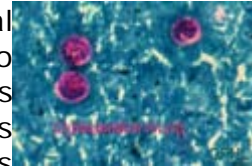
are injected into the blood and travel to the liver where they invade liver cells and develop into merozoites. The primary infection of liver is called the exoerythrocytic stage because it occurs outside of the blood cells. After the merozoites mature, the liver cell ruptures releasing the merozoites to invade RBC and develop into trophozoites. The Red blood cells stage is known as the erythrocytic stage. At some point in time some of the trophozoites develop into microgametocytes and macrogametocytes. Another mosquito takes in the gametocytes into its gut via a blood meal. Sexual reproduction resulting in sporozoites occurs in the mosquito gut.

Symptoms include fever and chills due to invasion and rupture of the liver and blood cells. There are 2-3 days of good health depending on the species of malaria transmitted before a recurrence of symptoms. Tertian malaria (one sick + two well days) versus quartan malaria (one sick + three well) are the cycles. In the patient liver reinfection and latency, splenomegaly and "blackwater fever" due to lysis of RBC along with cerebral malaria are some of the more serious complications. There are over 300-500 million new cases of malaria in the world each year with 1-3 million deaths per year, mostly children. Treatment (Quinine or chloroquine) is dependent on the species and severity of disease. Primaquine is best for liver treatment.

Toxoplasma gondii is a coccidian protozoan also belonging to the phylum Apicomplexa and as such is nonmotile. Microscopically the parasite looks like a pair of half-moons. The reservoir is primarily cats. [Transmission](#) is via the fecal/oral route from contaminated cat litter or from ingestion of raw beef

(pseudocyst in tissue). It is estimated to be nearly universal. The primary infection is a mild GI infection. The problem arises when a fetal infection occurs during pregnancy. Fetal brain infection results in retardation, hydrocephaly or death. In addition to brain lesions, it may also disrupt the heart and lungs. Treatment is usually not necessary because it is a self-limiting disease except in immune suppressed or immune-deficient patients where it can cause a variety of diseases.

Cryptosporidium parvum causes a moderate GI infection represented by a profuse watery diarrhea and cramps in patients with normal immune system. Symptoms are generally self limiting after 10-15 days. Reservoirs include cattle, cats, rodents and birds. Transmission is via fecal/oral route mainly from contaminated cattle fecal runoff into surface waters. In immunosuppressed patients, disease lasts weeks to months to years and the patient may die. There is no effective antimicrobial available and since the disease is self-limiting treatment is not needed except in the immune-suppressed or immune-deficient. *Cryptosporidium* infected about 400,000 residents of the Milwaukee area in 1993 and studies show that one in three freshwater sources contain this parasite.



Helminthes

Helminth infections are worm infections. The worms are all found in the Kingdom Animalia. There are three classes of worms: nematodes (round worms), trematodes (flat worms), and cestodes (tape worms). Helminthes have a number of stages. Eggs or ova are the result of sexual reproduction. All ova have a covering for protection. Ova are important in transmission of the disease. The larva is found in an intermediate stage or stages. Larva often travel through the host. The adult stage occurs when the adult worm is able to sexually reproduce in the definitive host. Sexual reproduction produces the ova that are diagnostic for infection and are observed in microscopic observations. Tapeworms are hermaphrodites. Flukes are either hermaphrodites or separate sexes. Nematodes have separate sexes. A key response in the patient with a helminth infection is the presence of eosinophilia.

Adult Nematode (roundworm) infections

This class of parasites is very successful. Adult nematodes cause some form of GI distress ranging from starvation to rashes and allergic symptoms to an occasionally anemia.

Infections that are spread via ingestion of ova in fecal contaminated soil or water

Ascaris lumbricoides and *Trichuris trichiura* (whipworm): ova are passed from the definitive host and contaminate water or soil. Contaminated soil is ingested, larvae develop and the life



cycle is completed in the human. More than one billion humans are hosts for *Ascaris*. The dog ascarid, *Toxocara canis*, causes visceral larval migrans in which the larva migrates through the human because the worm recognizes that the human is not the definitive host in which it can develop into an adult.

Enterobius vermicularis (pinworm): Transmission is by ingestion of ova, self-contamination or reinfection. [Ova](#) are laid surrounding anus usually during night. The ova are very contagious. The life cycle is completed in the human.

Some nematode infections are spread via larval penetration of skin in fecal contaminated soil. *Necator americanus* (American) and *Ancylostoma duodenale* (European or Old World) are hookworms. The [ova](#) are shed in feces to contaminate soil. Larvae develop and emerge from the ova and penetrate skin. The life cycle is completed in human. These ova are indistinguishable from each other. The adult forms are needed to identify the correct species. Roughly 600-800 million humans have hookworm infections. Dog and cat hookworms cause cutaneous larval migrans because as with the dog ascarid, the parasite recognizes that the human is not the definitive host in which to mature. *Strongyloides stercoralis*, the threadworm, causes an infection similar to hookworm infections. This parasite can complete life cycle within or outside of body. One looks for both larval forms and ova to make the correct diagnosis. Treatment for all helminthes infections utilizes antihelminthic agents which cause disintegration or detachment of the worm, starvation diets, which aren't very effective, copious enemas, or in radical cases, surgical removal.



Trichinella spiralis causes "trichinosis" and is a larval nematode infection. Transmission is via ingestion of larvae in undercooked meat. The larvae hatch in intestine and develop into adults which mate in intestine. The ova hatches in intestine and develops into larva that leave intestine to [encyst in striated muscle](#). Symptoms include GI distress during reproduction of worms and penetration and muscle pain during encystment of larval forms. There may be heart muscle disturbance due to larval forms. The cysts become calcified and remain permanently. Reservoirs include swine, bears and rodents. Man is a dead-end host unless cannibalism is practiced or if eaten by a predator. Prevention is best treatment.

Microfilaria ([tissue nematodes](#))

Loa loa ([African eye worm](#)), *Wuchereria bancrofti* ([elephantiasis](#)), and *Onchocerca volvulus* ([River blindness](#)) are all examples of tissue nematodes. An insect vector transmits the larva which circulates in the bloodstream and lymphatic system. When the larva develops into adults in the tissue, the female will produce many microfilariae that also circulate freely in the blood and lymphatic systems.

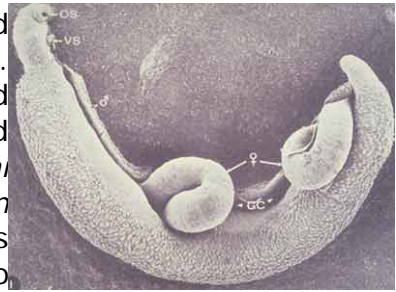
Trematodes (Fluke or flatworm) infections

Ova are shed from human into the water supply. The [first larval form](#) enters a snail that is eaten by another life form, encysts and becomes a second larval form. Humans eat the life form with cyst. The cyst hatches in intestine and may leave intestine to become adult in another site.

Clonorchis sinensis, (Chinese liver fluke), infection occurs via ingestion of larvae in raw fish. The adult forms develop in liver causing clonorchiasis which is characterized by liver blockage and destruction and signs of hepatitis. Ova leave in feces.

Fasciola hepatica, (sheep liver fluke), infection occurs via ingestion of larvae in contaminated water and water plants.

[Schistosomiasis](#) is a disease caused by blood flukes. Intermediate larva (cercaria) penetrates the skin and pass to the liver where they achieve sexual maturity. Male and female worms remain permanently entwined to facilitate mating. The adults lodge in small blood vessels at specific sites: *S. japonicum* and *S. mansoni* lodge in the mesenteric venules and *S. haematobium* in the venous plexus of the bladder. Swimmer's itch is caused by bird schistosomes that don't know where to migrate to because the parasite doesn't recognize the definitive host.



Cestodes (tapeworm) infections cause GI distress and starvation. Hymenolepiasis is caused by *Hymenolepis nana*, the dwarf tapeworm. Transmission is via ingestion of ova. Reservoirs include mostly rodents.

Taeniasis is caused by *Taenia saginata* ([beef tapeworm](#)) and *Taenia solium* (pork tapeworm). Although the [ova](#) are virtually indistinguishable from each other the proglottids can be used to identify the causative worm. Transmission is via ingestion of larvae in uncooked meat. Cysticercosis is the migration of larval stages to all tissues of the body, and occurs only with the pork tapeworm.

Diphyllobothriasis is caused by *Diphyllobothrium latum* ([fish tapeworm](#)). Transmission is via ingestion of larvae in uncooked meat or fish. Reservoirs include bears and raccoons which pass numerous ova into the water supply. This tapeworm can achieve lengths of greater than ten meters. Treatment involves removing the scolex and drugs.

A larval tapeworm infection ([Hydatid cyst disease](#)) is caused by *Echinococcus granulosus* ([dog tapeworm](#)). Transmission occurs via ingestion of ova from infected dog feces. The ova hatch in intestine, larvae burrow into blood vessels where they embed in soft tissues to create hydatid cyst. Treatment is surgical if possible.

Arthropods

Arthropods are considered with parasites because of their role in the transmission of other diseases. Mosquitoes, ticks, lice, mites, and flies transmit a number of bacterial and viral diseases.

