

Introduction to Parasitology

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- Parasites that infect humans have various classifications, characteristics, and life cycles. The patient suffering from a parasite infection is referred to as the '**host**'. Most infections occur when a person is a **definitive host (aka final host)** which is defined as the organism in which a parasite passes its adult and sexual existence. Many animals are **intermediate hosts**, the organisms in which a parasite passes its larval or nonsexual existence. Parasites may be an **obligate parasite**, one that is entirely dependent upon a host for its survival, or a **facultative parasite**, one that may be parasitic upon another organism but can exist independently.
 - Protozoans
 - Apicomplexa
 - Helminths
 - Arthropods

- **Protozoa** are microscopic one-celled organisms that are categorized according to their method of movement.

- Amoeba - also known as sarcodina, are single celled organisms which include the pathogenic amoeba *Entamoeba histolytica* and *Endolimax nana* which cause amebiasis, or dysentery, in humans. These infections can be treated with metronidazole.

Entamoeba histolytica

- The third leading cause of death in the world and infects 10% of the world's population. High prevalence in Texas and other southern border states due to frequent travelers and immigrations. The acute phase causes fever, cramping, nausea, and bloody mucus stools (avg. 10-12 per day). Chronic carriers are asymptomatic and just pass the cyst stage on to others. The organism can move outside the digestive system and invade the blood stream and liver. Some cases have even shown infections in the lungs, brain and other organs. It takes about 100 cysts to be ingested to cause infection.
- Life cycle of *E. histolytica* starts with the ingestion of the cyst stage. The stomach acid and the small intestine alkaline Ph help the cyst's walls to dissolve. Once in the large intestine it may be in the trophozoite stage causing amebic dysentery or cyst stage with normal stools (like the chronic condition). The trophozoite stage causes tissue destruction; they also ingest hemoglobin from red blood cells. The trophs are resistant to compliment mediated lysis; they shed antibodies and are resistant to direct ingestion by macrophages.
- Diagnosing an intestinal parasite infection is usually done with a fresh stool (less than 30 min. old) used to create a 'wet mount' slide.

Endolimax nana

- Much smaller in size than *E. histolytica*. *E. nana* averages 5-8 μ and, in the troph stage, it has one nucleus with a faint nuclear envelope while the cyst stage has up to 4 nuclei. The organism has a similar life cycle to that of *E. histolytica*, but does not cause tissue damage and is much more susceptible to our immune defenses.

- Ciliates – Protozoa that move by means of short, hair-like projections. The only parasitic ciliate that causes disease in humans is *Balantidium coli* that cause an intestinal infection and diarrhea. It is a zoonotic infection, meaning the original host is usually a hog, which accidentally infects humans. The life cycle has an infective cyst stage that gets passed in stool of hog or human. The trophozoite stage is 15-50 μ and has sluggish non-directional motility and contains one large eccentric karyosome. The cyst stage is 15-25 μ and will be binucleated when young and maturing to up to 8 nuclei. Farmers, vets and butchers or others with lots of animal contact are most at risk. Usually self-limiting infection after a few weeks.

- Flagellates -- Three of the most common and medically significant includes *Giardia lamblia*, *Trypanosoma sp.*, and *Trichomonas vaginalis*.

Giardia lamblia

- (Commonly referred to as 'giardia') is the most common in the US and is passed by fecal-oral route or contaminated water. Resistant to chlorine and creates explosive foamy diarrhea that often self-resolves in 1-5 days or patients may be given Flagyl to treat infection. Can be prevented with simple hand washing. Very specific cyst and trophozoite forms and was even identified by Lavenhook in first microscope.

Trypanosoma sp.

- Known as hemo-flagellates as they are found in blood and tissue infections. Some examples include *Trypanosoma brucei gambiense* or *rhodesiense* which cause sleeping sickness and may take several years from infection to symptoms. These have extra stages in their life cycle but the two often seen are the amastigote (cyst-like and diagnostic stage) and trypomastigote (flagellate stage). The other two stages are only seen in the insect vectors and they are needed for replication. Causes the patient to be sleepy, headache, dizzy and, as the organisms replicate in the cerebral spinal fluid (CSF) eventually causes death. *Trypanosoma cruzi* causes Chaga's Disease and is passed by the kissing bug and all parts of the life cycle can occur in man in blood or tissue. Detected by heart biopsy or blood sample; causes death by heart failure.

Trichomonas vaginalis

- A flagellate that is infective in the trophozoite stage and does not have a cyst stage. It is passed sexually, usually by males, causing trichomaniasis. Males maybe asymptomatic or have mild irritation. Females may have any combination of symptoms including vaginal odor, itching, painful urination or intercourse, frothy discharge. A sample of discharge from male or female is viewed under a microscope where the organisms are able to move about freely. Treatment is metronidazole, (or Flagyl, brand name) is the drug of choice to treat infection. Condoms can easily prevent infection.

- Apicomplexa -- intracellular protozoa that include many human pathogens.

Malaria

- Caused by the *Plasmodium sp* including *P. vivax*, *P. malariae*, *P. ovale* and *P. falciparum* with *P. vivax* being the most common and *P. falciparum* being the most deadly. Mosquito vector, the definitive host, transmits infection after feeding on an infected person and then transmitting to the next person bitten. With malaria man is the intermediate host and the mosquito is the definitive host (opposite of most parasitic infections). All *Plasmodium sp.* cause fever cycles that are often timed and help identify species. Side effects can cause kidney damage and *P. falciparum* can migrate to the brain causing blocked capillaries that can lead to strokes and coma. Chloroquine, Mefloquine or a combination with Pyrimethamine/Sulfadiazine can be given for prophylaxis while Quinine and Primaquine can be given during infection or to prevent relapse.

Babesia microti

- Transmitted by hard or ‘deer’ ticks causing babesiosis that clinically presents very similarly to malaria. Often found in the NE US near Martha’s Vineyard and Nantucket Island. Treatable with Clindamycin and quinine after identification by antibody testing usually done by the CDC.

Toxoplasma gondii

- Affects up to 50% of the US population and has worldwide distribution. Commonly called 'Toxo' causes may be asymptomatic or cause mild flu-like symptoms and when no longer active resides in the tissues. Can be passed to a fetus and cause serious birth defects. Definitive host (sexual and asexual reproduction) is the household cat. Oocytes are passed in cat feces which become actively infectious after two days and can be inhaled or ingested. Identified by serologic testing for IgG or IgM specific antibodies.

- **Helminths** are worm-like parasites. The clinically relevant groups are separated according to their general external shape and the host organ they inhabit. The intensity of the disease process caused by the parasite is often measured by the worm burden, or the number of worms an individual host carries which, depending on the worm, can be measured either directly, or indirectly.

Tapeworm (**cestoda**)

- Infections begin by ingestion of the larval stage in the flesh of an animal and they reside in the small intestine. They absorb digested carbohydrates and proteins while secreting a substance that keeps them from being digested. Man is the definitive host while animals are the intermediate hosts. They may be from 3-4,000 segments long and live up to 25 years.

Roundworms (**nematodes**)

- Need time outside the body for eggs to mature and many will penetrate through the skin to infect. Several need time in the blood to before going to the intestines. The worm burden is still an issue as the more there are, the bigger the problem, and in children they can cause a lag in physical and mental development.

Enterobius vermicularis aka Pinworms

- Have separate sexes and a simple digestive system but no circulatory system. Attaches to the host using a type of lip at the anterior end, and forms a thick cuticle layer that keeps it from being digested. Worldwide distribution affecting mainly small children and their families causing generalized and intestinal symptoms. The human is the only known host passing it from person to person.
- Life cycle of the pinworm is complicated; the male averages about 8-13mm and is rarely ever seen. The female migrates out of the anus at night and lays eggs on the skin of the perianal area and migrates back inside. The eggs are the infective stage and can be airborne and usually cause itching that can lead to ingestion (from scratching and carrying them to mouth due to bad hand hygiene). Once eggs are ingested (from hands or inhalation) the larva is released and molts into the adult. Retroinfection can be caused by larva migrating back into the anus and adding to the worm burden.
- Diagnosis is made by collecting eggs from the perianal area first thing in the morning with sticky tape that is then placed on a glass slide. Once confirmed the whole family gets treatment and all bedding is cleaned, nails shortened and diligent hand washing are all needed to beat infection.

Trichuris trichuria aka Whipworm

- Worldwide distribution, especially in the tropics, and may cause light worm burden that is asymptomatic to heavy worm burden causing chronic diarrhea, malnourishment and can lead to rectal prolapse. Treatments are expensive and have very toxic side effects. Humans are the primary host and it is prevented by personal and community sanitation.
- Life cycle takes about 3 months and involves a male and female that creates eggs that are passed through the feces and take about 3 weeks to become infective. Once infective egg is ingested the larva is released, molts into an adult, and begins making more eggs.

Wuchereria bancrofti

- A filarial worm spread by a mosquito vector, the intermediate host. *W. bancrofti* causes lymphatic filariasis and can lead to a chronic condition known as elephantiasis.
- The life cycle of *W. bancrofti* is similar to other filarial worms. It begins with the adults in the lymphatic system producing live born larva. The larva, or microfilaria, migrate to the circulatory system and are ingested by the blood sucking insect (mosquito in this case). While in the insect the microfilaria develops into infective flariform larvae or juveniles. The mosquito bites another human and regurgitates the filariform into their blood stream where it migrates to the liver to develop into a fertile adult.

Ascaris lumbricoides

- The giant round worm in humans that causes the disease [ascariasis](#) and is thought to be the most common parasitic worm in humans.
- The life cycle of *A. lumbricoides* begins with eggs, which become infectious after 2-3 weeks outside a host, being ingested (fecal-oral route due to poor sanitation). The lipid layer around the egg helps it survive through the stomach and harsh exterior conditions. Once in the intestines it matures to the first larval stage, burrows through the intestinal wall and into the circulation where it may get into the liver, heart then the lungs, where it will mature in the alveoli. The second larval stage is coughed up the trachea and swallowed down the esophagus again. Once in the intestines, it has reached the adult stage and will be male or female. Fertilization can now occur and the female can produce up to 200,000 eggs a day.

Flukes (trematoda)

- Rare in the US and often seen in immigrants. They have a leaf like appearance (except schistomas) and absorb nutrients through their skin and have no real digestive system. They range from several millimeters up to 3 inches in size. Most eggs must reach water for development and they have multiple larval stages and multiple hosts. A general fluke life cycle may look like this:
Egg excreted in feces – Once in fresh water matures to Miracidium (1st larval stage) – 1st intermediate host (snail) and matures to cercaria (2nd larval stage) – back into water and many different steps at this point lead to second intermediate host that is usually ingested by man (fish, crab, crayfish, water vegetation).

Flukes (trematoda)

- *Fasciolopsis buski*: giant intestinal fluke, found in the human duodenum of the small intestines, contracted from dogs or chestnuts. As worm burden increases causes diarrhea, nausea, obstruction and Vitamin B12 absorption problems
- *Heterophyes heterophyes* and *Metagonimus yokogawai* cause infections in the small intestines and are found in under-cooked fish. Mostly inconsequential and a very high worm burden is needed to show symptoms.
- *Paragonimus westermani* causes lung infections and often found in Asia and the Philippines. From fresh water they are ingested in crab or crayfish and they burrow through the intestines and diaphragm into the lungs. Symptoms arise once the fluke is in the lungs and creates chest pain, fever, bloody sputum and passes eggs in sputum and feces as sputum gets coughed up and swallowed.
- *Faciola hepatica*, sheep liver fluke, and *Opisthorchis spp.*, Chinese liver fluke, are both liver flukes that get swallowed and burrow through the intestinal wall into the liver. Primary host is snails or fish and reservoir host may be sheep, cats or dogs but maturation includes the water stage.
- *Schistosoma spp.* have split bodies, are both male and female, and may live up to 30 years. There are several species and they may live in the veins of the bladder, large intestines, or small intestines depending on the species. They infect by direct skin penetration and burrow to preferred sites.

- **Arthropod** is the name of the phylum that includes spiders, mosquitoes and human parasites like ticks, lice, and others.

Pediculus humanus humanus, or the body louse

- Is found on or near the seams of clothing. Body lice must feed on blood and usually travel to skin to feed. They cause intense itching and are a nuisance, but may pass on other infections when feeding. Most infestations are short lived if the host has access to regular bathing and laundered clothes and sheets.
- The body louse life cycle begins with the eggs, or nits, that are often laid in the seams of clothing near the waist line or under arms. Occasionally they may attach to human hair and they take 1-2 weeks to hatch. The nymph, or immature louse, hatches from the nit and feeds as it matures in 9-12 days. The mature louse looks like the nymph only larger and is about the size of a sesame seed. The adult louse feeds to survive and will die if separated from its person at room temperature.
- Treatment is to wash all clothing at high temperatures or to leave all clothing unwashed and unworn for 1 week. Either technique inactivates or kills eggs and lice. Medication can be given if needed but regular laundering and bathing is often enough.

Pediculus humanus capitus or head louse

- An obligate ectoparasite of humans and prefers to lay its nits on human scalp hair rather than on clothing. The head louse has a similar appearance and follows a very similar life cycle to the body louse but is much harder to treat. Infestations are spread usually from head to head contact and much less often through contact with shared items like combs or pillows. Many chemical options are available and wet combing for nits and lice is suggested every 3 to 7 days for the whole household. Unlike the body louse the head louse does not pass on other diseases.

Phthirus pubis is also known as the pubic or crab louse

- Affects 2% of the world wide population. The crab louse is commonly found in pubic hair or eyelashes. It is an obligate ectoparasite of humans and follows a similar life cycle to the body and head lice. The crab louse has a very different appearance as it is very round and the back pair of legs is very large. An infestation is known as pediculosis pubis or phthiriasis pubis. They are transferred by close sexual contact and rarely through sharing bedding, towels or other linens. The main symptom is itching and there are many chemical treatments available for topical use.

Pulex irritans or the human flea

- A small, wingless insect that has great jumping ability. Humans can be host for other varieties of fleas as well. Fleas feed on blood meals from the host, and as a result can serve as a vector for passing infections from one species to another. Microorganisms passed by fleas include several varieties of bacteria (including *Yersinia pestis* or the bubonic plague), viruses, helminthes and protozoa. The site of a feeding can become raised and itches or may trigger a rash response. Human treatments are limited to treating the symptoms while animals and homes can be treated with chemicals to destroy fleas and eggs.