Parasites

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Parasitism

- Intimate and obligatory symbiotic relationship between two organisms of different species
- Parasite is metabolically and physiologically dependent on host
- Short term (mosquito) or permanent (tapeworm)
- Very common way of life (50% of animal species)
- "True parasites" includes protozoans (single-celled), helminths (worms), and arthropods (ectoparasites)

Success of parasites defined in terms of:

- Prevalence in hosts
- Number of host species available
- Geographic range
- Number of offspring
- Available routes of transmission

Giardia lamblia (syn. G. duodenalis, G. intestinalis)

- History
  - First described by Leeuwenhoek in 1681
  - Demonstrated to be a true pathogen in the early 1900's
  - Most frequently identified intestinal parasite worldwide
- Symptoms:
  - Most infections are asymptomatic (carriers)
  - Acute giardiasis: diarrhea, weight loss, abdominal discomfort, nausea, vomiting
  - Retardation of growth and development in young children (failure to thrive)
- Prevalence
  - Most common protozoan infection of intestinal tract worldwide
  - 2-5% in industrialized world and 20-30% in developing world;
  - Prevalence rises through infancy and childhood and declines in adolescence (related to faecal-oral route of transmission)

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    - Other high risk groups include travelers and immunocompromised
- Life cycle
    - Excystation
    - Trophozoites in small intestine
    - Longitudinal binary fission
    - Encystation
    - Cysts shed with faeces
- Diagnosis
    - Microscopy (stool exam)
        - Cysts concentrated by flotation and identified using bright-field microscopy
        - Immunofluorecence microscopy using fluorochrome-conjugated mAb's that bind to cyst wall
    - Immunological Testing
        - Detection of Giardia-specific antigens in faeces (e.g. ELISA)
- Treatment
    - Nitroimidazole derivatives
        - Metronidazole and tinidalzole are the drugs of choice; 2 grams (single dose) daily for 3 days
        - NB: drug resistance to metronidazole and furazolidone has been described
- Control
    - Water Treatment
        - Resistance to chlorination
        - Fewer outbreaks in municipalities using water filtration
        - Ozone/ UV light promising
        - EPA method 1623
    - Public Health Education
        - Increase awareness of person to person transmission ; improve hygienic practices (e.g., daycares)
        - Food-borne infections (food handlers, wash produce)
        - Backpackers drinking raw surface water are at risk (portable filters, boil water)
        - Advice to travelers (avoid tap water, peeled fruits)

Trichomonas vaginalis:

- Possibly the most common sexually transmitted disease worldwide (200 million cases)

- Transmitted through mucous membrane contact (no resistant cyst stage)
- Symptoms
  - 40-50% asymptomatic carriage
  - Vaginitis (trichomoniasis) with itching, foul-smelling, sometimes frothy discharge
  - May increase susceptibility to cervical cancer and HIV infection
  - Infection during pregnancy may result in premature delivery and low birth weight
  - Males usually asymptomatic; occasionally urethritis, prostatitis
- Diagnosis:
  - Microscopy (wet mounts) to identify trichomonads in vaginal or urethral discharge
  - Vary greatly in size (10-30 um)
- Treatment
  - Metronidazole and tinidazole are drugs of choice
  - To avoid re-infection, testing and treatment of partners is important

Entamorba histolytica

- Common in developing tropical countries
- Transmitted through faecal-oral route (person to person), contaminated water, raw produce, food handlers, flies
- Largely related to poor sanitation and hygiene
- Symptoms:
  - Typical infections of the large intestine may be asymptomatic, or may result in diarrhea and constipation
  - Amoebic dysentery in some patients (bloody/mucoid diarrhea)
  - May spread through the blood to produce liver, lung or brain abscesses
- Diagnosis
  - Microscopic identification of trophozoites (18-30 um) or cysts in faeces or in lesions
- Treatment:
  - Luminal amoebicides (such as paromomycin, diloxanide furoate and iodoquinol) act on organisms in the intestinal lumen
  - For symptomatic intestinal disease, or extraintestinal infections (e.g., liver abscess), the drugs of choice are metronidazole or tinidazole, immediately followed by treatment with luminal amoebicides
- Control
  - Public health education

- Improved sanitation and water treatment
- Wash fruits and vegetables

Toxoplasma gondii

- Recognized as a human pathogen in early 1900's
- Very high seroprevalence in humans world-wide
- Large number of mammals and birds act as intermediate hosts
- Cats are the only definitive host (shed oocysts)
- Transmission:
  - Ingestion of sporulated oocysts (10-12 um)
    - Contaminated soil/sand
    - Contaminated fruits and vegetables
    - Waterborne outbreaks
  - Ingestion of tissue cysts
    - Raw or poorly cooked meat
  - Congenital infection of fetus
    - Infection acquired during pregnancy (most severe if acquired in first trimester
- Symptoms:
  - Immunocompetent host
    - 90% asymptomatic, lymphadenopathy, headaches, muscle aches, fever, malaise
  - Immunocompromised host
    - Encephalitis, myocarditis, pneumonia (AIDS-defining disease)
  - Congenital infection
    - Hepatosplenomegaly, mental retardation, retinochoroiditis, hydrocephalus
- Treatment:
  - Diagnosis based on serological assays
  - Immunocompetent patient normally don't require treatment unless symptoms become severe or chronic
  - Immunocompromised patients require prompt treatment with a combination of pyrimethamine and sulfadiazine
  - Congenital infections
    - Mother/fetus can be treated to reduce incidence and severity of fetal infection
    - Infected newborns can also be treated to minimize sequelae

Malaria:

- Transmission:
  - Anopheline mosquitoes (vectors)
  - Blood transfusion/shared needles
  - Congenital infection
  - "airport malaria"
- Symptoms:
  - Spiking fever and chills
  - Flu-like symptoms (myalgias, headaches, abdominal pain, malaise)
  - Severe symptoms (P. falciparum): seizures, coma, renal failure, respiratory failure
- Prophylaxis and Treatment
  - Chloroquine and mefloquine are drugs of choice for prevention and treatment
  - Drug resistance is a serious problem
- Control
  - Largely a man-made disease (clearing of forests, building of irrigation canals
  - Eradication or control of mosquitoes (resistance to insecticides)
  - Protection against mosquito bites
    - Avoid rural areas at night
    - Long-sleeved shirts/long pants
    - Insect repellent
    - Bed netting

Cryptosporidium spp.

- Recognized as human pathogen (1976)
- Reported in humans worldwide
- The most common symptom is watery diarrhea; other symptoms include dehydration, weight loss, abdominal pain, fever, nausea, vomiting
- Chronic debilitating and potentially life-threatening symptoms in immunocompromised
- No drug treatment available
- Life cycle
  - Complex life cycle including both sexual and asexual phases (oocysts 4-6 um)
  - Obligate intracellular protozoan which infects the intestinal epithelial cells of the host (typically in small intestine)

- Transmission:
  - Water
    - Numerically the most important mode of transmission (contaminated drinking water)
    - Recently numerous outbreaks associated with water parks/pools

Cryptosporidium parvum

- Transmission
  - Person to person
    - Ingestion of oocysts due to poor hygiene (e.g., day cares, institutionalized patients)
  - Autoinfection
    - Thin-walled oocysts are released into the lumen and cause autoinfection
    - Responsible for chronic and life-threatening disease in immunocompromised
  - Zoonotic
    - Cattle serve as important reservoir hosts
    - Calves with diarrhea can excrete up to 10^10 oocysts/day
    - Environmental contamination; veterinary personnel and animal handlers at increased risk (petting zoo visitors)
- Diagnosis:
  - Microscopy
    - Oocysts shedding intermittent; multiple stools examined
    - Concentration methods can be used when low oocyst shedding
    - Wet-mounts or permanent stain are used (acid-fast)
    - Fluorescein-labelled IgG mAb is used in immunofluorescence microscopy
- Control
  - Water treatment
    - Watershed management
    - Flocculation/ sad filtration
    - Resistance to chlorination
    - Ozone, UV light
    - Water testing (EPA method 1623)
  - Public health education
    - In endemic areas, avoid drinking tap water/ice cubes, raw fruit and vegetables unless you can peel them
    - Immunocompromised patient should consider bottled water

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        - Exposure to temperatures above 60 degrees Celsius and below -20 degrees Celsius will kill oocysts
        - Because crypto Is spread person to person hand washing helps prevent infection
        - Precautions are required when caring for patients with crypto diarrhea; lack of effective disinfectants against oocysts (nosocomial infections)

Cyclospora cayetanensis

- Identified as a coccidian protozoan parasite and named in 1993
- Cases reported in North, Central, south America, Caribbean, S.E. Asia, Europe, UK, India, Africa
- Endemic countries include Nepal, Haiti, Peru and Guatemala
- Symptoms:
    - Low infectious dose
    - Incubation period of about 1 week
    - Profuse and prolonged diarrhea
    - Abdominal pain, nausea, vomiting, fatigue, fever, loss of appetite
    - Effectively treated with bactrim
- Diagnosis:
    - Microscopic examination of wet mount stool of oocysts (brightfield, differential interference contrast, autofluorescence)
    - Staining methods (e.g. acid-fast)
- Transmission
    - Person to person transmission unlikely
    - Zoonotic transmission unlikely
    - Most earlier outbreaks were waterborne
    - 90-99% of cases in U.S. are foodborne
    - Numerous foodborne outbreaks in recent years
- Contamination of Foods
    - Direct contamination
        - Infected pickers, sorters, inspectors, or other food handlers (poor hygiene, sporulation)
    - Indirect contamination
        - Contaminated water used for irrigation, mixing pesticides, washing equipment, washing hands

Enterobius vermicularis (pinworm)

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- Prevalent world wide
- Highest incidence in school-age children
- Up to 50% of children in North America
- More of a nuisance than a health problem
- Eggs ingested (faecal-oral route)
- Symptoms:
  - Mild infection of caecum/colon
  - May cause itching (pruritus ani) leading to distrubed sleep, irritability
  - Scratching may cause secondary infections
- Diagnosis and Treatment
  - Scotch-tape test of perianal area
  - Microscopic identification of eggs; adult female works may also be present (8-13mm)
  - Drug of choice is pyrantel pamoate
- Control
  - Personal hygiene education for children (hand washing)
  - Discourage scratching, nail biting
  - Frequent bathing; regular change of underclothing, pajamas, and bedding

Trichinella spp.

- Small roungworm found worldwide in many carnivorous and omnivorous animals, including humans
- Transmitted through ingestion of larvae in raw or poorly cooked meat
- Survives as adult in small intestine; as larvae encysted in striated muscle
- Trichinella spiralis (domestic form)
  - Humans, swine, rates (responsible for endemicity)
  - Horses! (probably fed animal products as supplement)
- Trichinella nativa (sylvatic or wild form)
  - Humans, bears, wold boar, wolf, fox, walrus
- Trichinellosis symptoms
  - Dependent upon phase of life cycle
  - When larvae exist in small intestine - diarrhea, abdominal pain, vomiting
  - When next generation of larvae migrate into muscle tissue - facial edema, conjunctivitis, fever, myalgia
  - Occasional life-threatening manifestations include myocarditis, central nervous system involvement, and pneumonitis
- Treatment
  - Thiabendazole effective against intestinal phase

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    - Mebendazole and albendazole have some effect on tissue phases
    - Steroids may be used to reduce inflammation
- Control
    - Rodent control
    - Avoid garbage feeding to livestock
    - Inspection programs (trichinoscopy, digestion, ELISA)
    - Cooking/freezing (T. nativa very resistant to freezing)

Ascaris lumbricoides

- Very large intestinal nematode (adult females 20-35 cm; adult male 15-30 cm)
- High prevalence worldwide (especially warmer regions); most common human helminth infection (over 1 billion cases)
- Transmission
    - After shedding with the faeces, eggs mature and become infective after several days
    - Transmitted through ingestion of eggs in soil, fruits/veg, or water
    - Associated with poor sanitation
- Symptoms
    - Asymptomatic or vague abdominal discomfort
    - Vomiting and/or obstruction may occur
- Diagnosis and treatment
    - Stool examination (microscopy) for the presence of eggs
    - Mebendazole, albendazole or pyrantel pamoate
    - Surgery may be required to clear worm bolus

Anisakis simplex (whale worm or herring worm)

- Anisakiasis first reported in the Netherlands in the 1950's
- Highly prevalent in Japan (>1000 cases per year)
- Still quite rare in North America
- Most cases arise from home-prepared sushi, sashimin, and ceviche
- Hosts
    - Definitive hosts
        - Dolphins, porpoises, whales
    - First intermediate hosts
        - Marine crustaceans
    - Second intermediate hosts
        - Salmon, mackerel, cod, herring, tuna, squid
    - NB: Humans are "dead-end" hosts only

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- Symptoms
    - Often invasive (penetrates mucosa)
    - Abdominal pain, nausea, vomiting
- Diagnosis and Treatment
    - Diagnosis difficult - no eggs in stool
    - Endoscopic and radiologic examinations may be useful
    - Symptoms often mistaken for appendicitis; exploratory surgery may reveal larvae which are then removed
    - Drug treatment is not effective
- Control
    - Inspection of fillets at processing plant
    - Candling on a light table will reveal larvae
    - Cooking/freezing very effective

Diphyllobothrium spp. (Broad fish tapeworm)

- Large tape work (10m long)
- Adult tapeworm inhabits the small intestine of humans and other fish-eating mammals
- Larval stages in freshwater fishes (e.g. pike, trout, perch, whitefish, salmon) which act as intermediate hosts
- Transmitted through the consumption of raw or poorly cooked freshwater fish containing infective larvae
- Symptoms
    - Most cases are asymptomatic
    - Abdominal pain, dizziness, fatigue, vomiting, diarrhea/ constipation
    - Vitamin B12 deficiency with pernicious anemia
- Diagnosis and Treatment
    - Stool examination for eggs (microscopy) or proglottids (segments)
    - Anthelmintic drugs effective (Praziguantel)

Taenia spp.

- Large tapeworms (up to 20m in length)
- Adult stage only found in humans
- Transmitted through ingestion of larvae in raw or poorly cooked meat
- Taenia saginata - beef tapeworm
- Taemia solium - pork tapeworm
- Symptoms (adult tapeworm)
    - Mild abdominal complaints

    - Mild abdominal complaints
- Diagnosis
    - Eggs or prolottids in stool
    - Serological techniques
- Treatment
    - Anthelmintic drugs (Praziquantel)
    - Surgery
- Control
    - Both species are rare in Canada
    - Routine inspections in Canada by CFIA
    - Cooking meat readily kills larvae
    - In endemic countries - sanitation; prevent access of pigs to human faeces

Taenia Solium nerocysticercosis

- Infection with larval stage following ingestion of T. solium eggs (humans act as the intermediate host)
- Larvae migrate and develop in brain
- Intracranial hypertension, hydrocephalus, convulsive seizures

Schistosoma spp. (Blood flukes)

- Worldwide, 200-300 million cases
- Free-swimming larvae in fresh water penetrate skin and develop in blood vessels surrounding intestine or bladder
- Three main species: S. haematobium, S. japonicum and S. mansoni
- Symptoms:
    - Rare except in heavily infected individuals
    - Rash, itchiness from penetrating larvae
    - Fever, lymphadenopathy, hepatosplenomegaly
- Diagnosis
    - Microscopic examination for eggs in faeces or urine
    - Treated with praziquantel
- Control
    - Eliminate habitat for snails which acts as intermediate hosts (e.g. drainage channels)
    - Spraying with molluscicides
    - Improved sanitation
    - Avoid contact with fresh water in endemic areas

Parasite transmission depends on:

- Water quality
- Sanitation
- Hygiene
- Proximity to animals
- Agricultural practices
- Climate
- Over crowding
- Poverty
- International travel and trade

Mechanisms of Transmission

- Person to person [faecal-oral route] (Giardia, cryptosporidium)
- Water
- Food
- Zoonotic
- Sexual
- Insect vectors
- Blood/organ transplant (sleeping sickness)
- Congenital - pregnant women to fetus (malaria)
- Penetration through skin (hookworm)

Kingdom Protozoa (single-celled eukaryotes)

- Phylum Sarcomastigophora
    - Superclass mastigophora (flagellates) - Giardia, Trichomonas
    - Superclass Sarcodina (amoeba) - Entamoeba
- Phylum Ciliophora (ciliates) - Balantidium
- Phylum Apicomplexa (sporozoans) - Cryptosporidium, Cyclospora, Toxoplasm
- Phylum Microspora
- Phylum Platyhelminthes
- Phylum Nematoda (roundworms)
- Phylum Arthropoda (act as parasites and vectors
    - Class arachnida (ticks, mites)
    - Class insecta (fleas, lice, misquitos)

Giardia Lamblia genotupes (zoonotic transmission)

- Zoonotic
    - Assemblage A - humans, livestock, cats, dogs, beavers
    - Assemblage B - humans, likestock, dogs, beavers

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- Non-zoonotic:
  - Assemblage C to F - dogs