

- 1) Introduction to Parasitic Diseases
 - a) A definition: a **parasite** is any organism that takes metabolic advantage of another organism
 - i) Parasites take advantage of **disruptions of normal flora**
 - ii) Parasites take advantage of **naïve immune systems**
 - b) There are many different parasites
 - i) This course covers the following parasites:
 - (1) Protozoans
 - (2) Helminths (worms) include the following:
 - (a) Nematodes are non-segmented round worms
 - (i) Most nematodes are not parasitic
 - (ii) Almost 4 billion people harbor at least one species of parasitic nematode
 - (iii) Many people harbor more than one species of nematode
 - (iv) In terms of disability adjusted life-years, *Ascaris*, *Trichuris*, and hookworm cause more suffering than malaria, tuberculosis, and AIDS combined according to the WHO
 - (v) **Fecal-oral** is the main route of nematode transmission
 1. “Night soil” is a fertilizer used for growing fruits and vegetables
 2. Animal species (other than humans) may become infected
 - (vi) Most helminths elicit T_H2 protective immunity
 - (vii) Geohelminths include the following:
 1. *Enterobius vermicularis* (**pinworm**)
 2. *Trichuris trichiura* (**whipworm**)
 3. *Ascaris lumbrico-coides* (**giant intestinal worm**)
 4. *Toxocara canis* and *Toxocara cati* (**visceral larva migrans**)
 - (b) Cestodes are segmented flat worms
 - (c) Trematodes are non-segmented flat worms
 - (3) Arthropods
 - ii) This course does not cover the following parasites:
 - (1) Viruses
 - (2) Rickettsiae
 - (3) Bacteria
 - (4) Fungi
 - c) The lecture is organized as follows:
 - i) Morphology
 - ii) Life cycle
 - iii) Clinical disease
 - iv) Diagnosis
 - v) Treatment
 - vi) Prevention and control

- 2) Nematodes: *Enterobius vermicularis*, *Trichuris trichiura*, *Ascaris lumbrico-coides*, *Toxocara canis*, and *Toxocara cati*
 - a) *Enterobius vermicularis* (pinworm)
 - i) Morphology: the pinworm looks like a pin (slide 20)
 - ii) Life cycle
 - (1) Eggs are ingested
 - (2) Larvae hatch in the small intestine
 - (3) Larvae migrate to the colon
 - (4) Adults mature in the colon
 - (5) Gravid adults migrate out of the anus
 - (6) Adults lay eggs perianally
 - (7) Eggs embryonate perianally
 - (8) Eggs contaminate fingers
 - (9) Eggs are ingested
 - iii) Pinworm causes **no clinical disease**
 - iv) Eggs (slides 23 & 26) are identified on microscopic examination of sticky tape that has been applied perianally, although worms can be found in histological sections of tissues such as the appendix (slide 24)
 - v) Pinworm infection is treated with **mebendazole** which interferes with egg production by de-polymerizing all invertebrate tubulins (not vertebrate tubulins) and is therefore tolerated well
 - vi) Prevention and control of pinworm are difficult
 - b) *Trichuris trichiura* (whipworm)
 - i) Morphology: the whipworm looks like a whip (slides 30 & 31)
 - ii) Life cycle
 - (1) After a long incubation in soil, eggs are ingested
 - (2) Larvae hatch in the small intestine
 - (3) Larvae migrate to the colon
 - (4) Adults mature in the colon and produce prodigious numbers of eggs
 - (5) Unembryonated eggs pass out in feces
 - (6) Eggs, which can persist for long periods of time in harsh conditions, embryonate in soil
 - iii) Clinical Disease
 - (1) A high concentration of worms in the colon may lead to **diarrhea**
 - (2) A high concentration of worms in the colon may lead to **malnutrition** and **anemia**. Anemia may lead to PICA, heavy metal ingestion, neurological deficits, and further worm ingestion
 - (3) A high concentration of worms in the colon may cause fecal urgency leading to **rectal prolapse** (slide 35)
 - iv) Eggs (slide 37) are identified on microscopic examination of feces
 - v) Whipworm infection is treated with mebendazole
 - vi) Whipworm is prevented and controlled with **sanitary disposal of feces**
 - c) *Ascaris lumbrico-coides* (giant intestinal worm)
 - i) Morphology: the giant intestinal worm is very large (slide 43)
 - ii) The life cycle of the giant intestinal worm is complicated
 - (1) Eggs are ingested

- (2) Larvae hatch in the small intestine, burrow through the intestinal wall, enter the bloodstream, and migrate to the liver where they feed on the hepatic parenchyma
- (3) Larvae migrate to the heart
- (4) Larvae migrate into lung capillaries
- (5) Larvae enter alveolar spaces
- (6) Larvae migrate up the trachea and are swallowed
- (7) Adults mature in the small intestine where they feed on the food ingested by the host and produce prodigious numbers (even more so than whipworm) of eggs
- (8) Eggs pass out in feces and embryonate in soil where they can persist for long periods of time
- iii) Clinical disease
 - (1) Light infections are asymptomatic as long as the adult worms do not migrate
 - (2) Fever causes adult worms to migrate
 - (3) Heavy infections can have serious consequences
 - (a) Protein calorie malnutrition can cause **failure-to-thrive**
 - (b) A bolus of worms can cause **bowel obstruction** (slide 54) and allow for **proliferation of *C. difficile***
 - (c) **Aberrant migration** can lead to severe tissue damage
- iv) Eggs (slide 58) are identified on microscopic examination of feces
- v) Giant intestinal worm infection is treated with mebendazole
- vi) Giant intestinal worm is prevented and controlled with sanitary disposal of feces
- d) *Toxocara canis* and *Toxocara cati* (visceral larva migrans)
 - i) Morphology: *Toxocara* does not have a distinct morphology (slide 63)
 - ii) The life cycle of *Toxocara* in cats and dogs is the same as that of *Ascarus* in humans
 - iii) Clinical disease is nonspecific, but may include the following
 - (1) Fever
 - (2) **Aberrant migration** to the eye (slide 70) can **migraine headaches, loss of visual acuity, or blindness**
 - (3) Aberrant migration to the brain can lead to **learning disabilities**
 - iv) Because *Toxocara* does not produce eggs in humans, diagnosis is based on **serology** (ELISA)
 - v) Treatment
 - (1) Mebendazole interferes with egg production
 - (2) **Prednisolone** inhibits bystander activation
 - vi) Prevention and control includes the following:
 - (1) Sanitary disposal of dog and cat feces
 - (2) **Periodic de-worming** of pets
 - (3) **Covering public sandboxes** at night
- e) It is interesting to note that most people of the world do not suffer from (what we might consider) common allergies, ulcerative colitis or Crohn's Disease. Preliminary evidence suggests that intestinal worms deflect the immune system away from host tissues.