Welcome to *Parasitic Diseases*  
*Fall 2008*  
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**Parasite**  
Any organism that takes metabolic advantage of another organism  
- Viruses  
- Rickettsiae  
- bacteria  
- Fungi  
- Protozoa*  
- Helminths*  
  - Nematodes - round worms  
  - Cestodes - segmented flat worms  
  - Trematodes - non-segmented flat worms  
- Arthropods* - six and eight-legged critters  

* Covered in *Parasitic Diseases*

**Nematodes - round worms**  
1. All are eukaryotes. *Caenorhabitis elegans* is the best known example and is free-living in soil.  
2. Most nematodes are non-parasitic.  
3. Almost 4 billion people harbor at least one species of parasitic nematode. Many have more than one.

**Geohelminths**  
- *Enterobius vermicularis* (pinworm)  
- *Trichuris trichiura* (whipworm)  
- *Ascaris lumbricoides* (giant intestinal worm)  
- *Toxocara canis* and *T. cati* (visceral larva migrans)  
- Hookworms  
  - *Ancylostoma duodenale*  
  - *Necator americanus*  
  - *Strongyloides stercoralis*

Highly Recommended textbook*  
Available at bookstore. Still only $69.95

* Lots of really gross pictures!!!
Site Location For Helminth Infections Of Humans

<table>
<thead>
<tr>
<th>Site Location</th>
<th>Number of Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alimentary tract</td>
<td>197 species</td>
</tr>
<tr>
<td>Cavities, organs, and tissues</td>
<td>107 species</td>
</tr>
<tr>
<td>Circulatory system</td>
<td>21 species</td>
</tr>
<tr>
<td>Skin and tissues</td>
<td>56 species</td>
</tr>
</tbody>
</table>

Helminths That Infect Humans

<table>
<thead>
<tr>
<th>Helminth Family</th>
<th>Number of Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acanthocephala</td>
<td>7 species</td>
</tr>
<tr>
<td>Nematoda</td>
<td>138 species</td>
</tr>
<tr>
<td>Nematomorpha</td>
<td>24 species</td>
</tr>
<tr>
<td>Phyla Triumphes</td>
<td>13 species</td>
</tr>
<tr>
<td>Digenea</td>
<td>113 species</td>
</tr>
<tr>
<td>Eucestoda</td>
<td>57 species</td>
</tr>
<tr>
<td>Tubellaria</td>
<td>3 species</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>342 species</strong></td>
</tr>
</tbody>
</table>

Why so many parasite species?

We live everywhere.
We eat everything.

Going Green!
(with brown and yellow)

Food Plus

This should never happen!
Immunity and Parasitism

Parasite antigen → APC → Tp → Th1 → IFN-γ → TNF → NO → Antigen

Worm infections elicit Th2 protective immune responses. Protozoan infections elicit Th1 protective immune responses.

Cytokines and Immunity to Parasites

<table>
<thead>
<tr>
<th>Cytokine</th>
<th>Th1 Responses</th>
<th>Th2 Responses</th>
<th>Innate Immunity Responses</th>
<th>Cytokines that can lead to pathogenesis (e.g., increased vascular permeability, inflammation, asthma)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IFN-γ</td>
<td>L-1</td>
<td>L-15</td>
<td>L-15</td>
<td>IL-4</td>
</tr>
<tr>
<td>TGF-β</td>
<td>L-13</td>
<td>IFN-γ</td>
<td>TGF-β</td>
<td>IL-13, IL-6</td>
</tr>
<tr>
<td>GM-CSF</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>GM-CSF</td>
</tr>
</tbody>
</table>

*Most important in immune expulsion of protozoa and worms

Helminths: Nematoda

Enterobius vermicularis (Pinworm)

Heavy Infection of Enterobius vermicularis

Photo: Martin Weber, MD, Children's Hospital, Hannover Medical School, Hannover, Germany
**Eggs of Enterobius vermicularis**

- Unembryonated
- Embryonated

**Diagnosis:**
Eggs found on microscopic examination of clear sticky tape.

**Drug of Choice:**
Mebendazole

**Mode of Action:**
De-polymerizes invertebrate tubulins, only.

**Clinical Disease:**
None

**Prevention and Control:**
Prevention is difficult among children, especially those attending day care facilities and lower grades in school. We “out-grow” our pinworm infections once we reach puberty.
Helminths: Nematoda

*Trichuris trichiura* (Whipworm)

**Female adult *Trichuris trichiura***

**Adult *Trichuris muris* in situ (SEM)**

**Adult male *Trichuris trichiura***

**Pathogenesis:**

*Trichuris spp.* secrete a pore-forming protein that may play a role in anemia and diarrhea. Adult worms do not feed directly on blood or other host tissues. Mechanism of anemia still unknown.
Evidence from epidemiological studies indicates an inverse correlation between the incidence of certain immune-mediated diseases, including inflammatory bowel diseases (IBD), and exposure to helminths. Helminth parasites are the classic inducers of Th2 responses. The Th2-polarized T cell response driven by helminth infection has been linked to the attenuation of some Th1-driven inflammatory responses, preventing some Th1-mediated autoimmune diseases in the host, including experimentally induced colitis. Helminth parasites (the porcine whipworm, Trichuris suis) have been tested for treating IBD patients, resulting in clinical amelioration of the disease. As a result, there is a great deal of interest in the research community in exploring the therapeutic use of helminth parasites for the control of immune-mediated diseases, including IBD. However, recent studies have provided evidence indicating the exacerbating effects of helminths on bacterial as well as non-infectious colitis in animal models. Therefore, a better understanding of mechanisms by which helminths modulate host immune responses in the gut reveals novel, more effective and safer approaches to helminth-based therapy of IBD.
Helminths: Nematoda

*Ascaris lumbricoides* (Giant intestinal worm)

**Adult* Ascaris lumbricoides**

“Jar-O-Worms”
Collected from one rural village in Bangladesh in a single day!

**Cross section of adult *Ascaris lumbricoides***
Larvae of *Ascaris lumbricoides* in liver

Clinical Disease:
1. Light infections are asymptomatic as long as the adult worms do not migrate.
2. Heavy infection leads to:
   a. protein calorie malnutrition - “failure to thrive” syndrome.
   b. bowel obstruction.
   c. aberrant migratory events.

Larva of *Ascaris lumbricoides* in lung

Pathogenesis:
1. “Verminous” pneumonia, lung tissue damage due to migratory larvae.
2. Bowel obstruction - too many adult worms.
3. Parasite secretes trypsin inhibitor, prevents host from digesting proteins.
4. Aberrant migration of “irritated” adult worms to:
   a. Ampulla of Vater
   b. Common duct
   c. Liver
   d. Pharynx
   e. Peritoneum

Child with heavy *Ascaris lumbricoides* infection

The result of successful treatment!
Infant with heavy Ascaris infection

Ascaris adults in liver (fatal case)

Bolus of *Ascaris lumbricoides* in small intestine

Bolus of *Ascaris lumbricoides* (fatal case)

*Ascaris lumbricoides* adult in appendix

Diagnosis:
Microscopic examination of feces for eggs

Fertilized, unembryonated egg
Drug of choice:
Mebendazole

Mode of Action:
De-polymerizes invertebrate microtubules, only

Helminths:
Nematoda

Toxocara canis
Toxocara cati
Visceral and ocular larva migrans

Medical Ecology

Prevention and Control:
Sanitary disposal of feces
Embryonated egg of *Toxocara canis*

Granuloma in retina due to *Toxocara canis*

Pathogenesis:
Tissue damage (systemic) due to migratory 3rd stage larva

Clinical Disease:
1. Fever
2. Loss of visual acuity
3. Blindness
4. Learning disabilities

Diagnosis:
Serological tests (ELISA-based)
Drugs of choice:

Mebendazole

Steroids

Prevention and Control:
Sanitary disposal of dog and cat feces:
- Not practical
- Pooper-scooper
- Potty-trained cat!

Prevention and Control (cont’d):
2. Periodically de-worm pets.
3. Cover public sand boxes at night.