

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

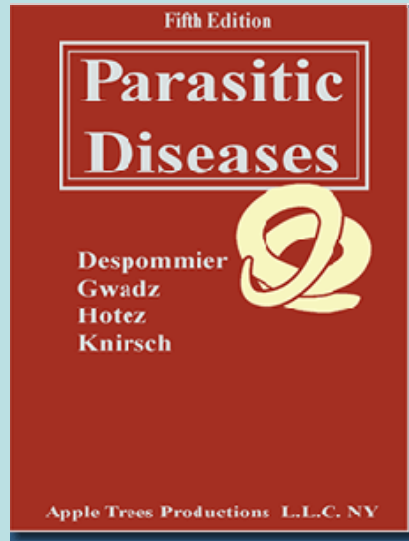
Cestodes - segmented flat worms

Trematodes - non-segmented flat worms

Arthropods\* - six and eight-legged critters

\* Covered in ***Parasitic Diseases***

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



\* Lots of really gross pictures!!!

## Helminths (Worms)

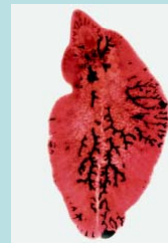
Nematodes - non-segmented  
round worms



Cestodes - segmented flat worms



Trematodes - non-segmented  
flat worms



## Nematodes - round worms

1. All are eukaryotes - *Caenorhabditis 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*

## *Site Location For Helminth Infections Of Humans*

|                               |             |
|-------------------------------|-------------|
| Alimentary tract              | 197 species |
| Cavities, organs, and tissues | 107 species |
| Circulatory system            | 21 species  |
| Skin and tissues              | 56 species  |

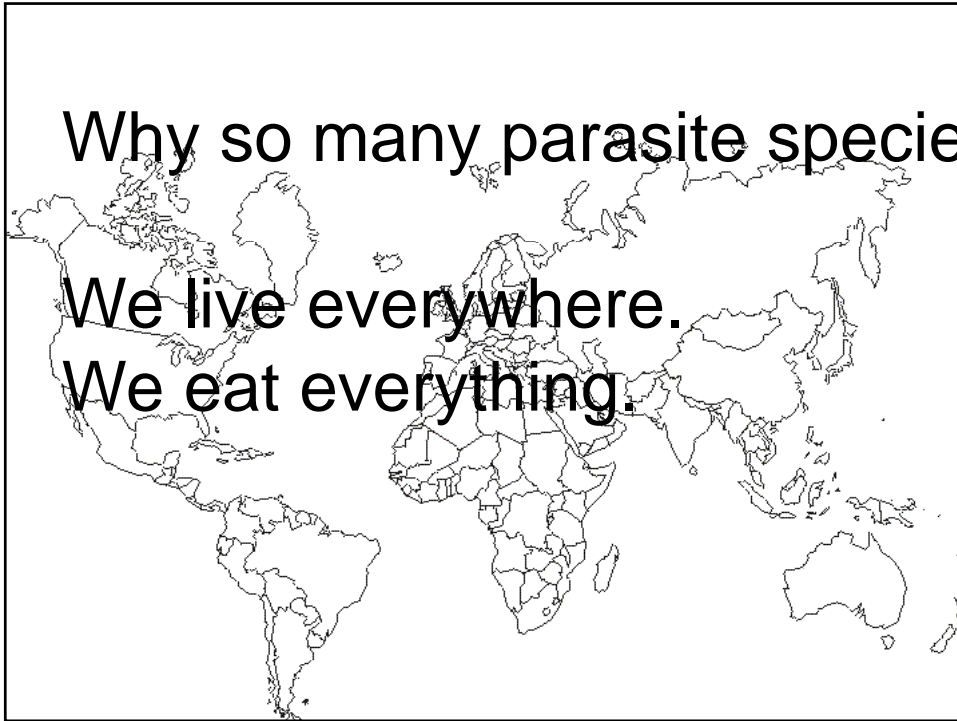
## *Helminths That Infect Humans*

|                 |             |
|-----------------|-------------|
| Acanthocephala  | 7 species   |
| Nematoda        | 138 species |
| Nematomorpha    | 24 species  |
| Platyhelminthes | 173 species |
| Digenea         | 113 species |
| Eucestoda       | 57 species  |
| Turbellaria     | 3 species   |
| <b>TOTAL</b>    | 342 species |

Why so many parasite species

We live everywhere.

We eat everything.



## Going Green !

(with brown and yellow)



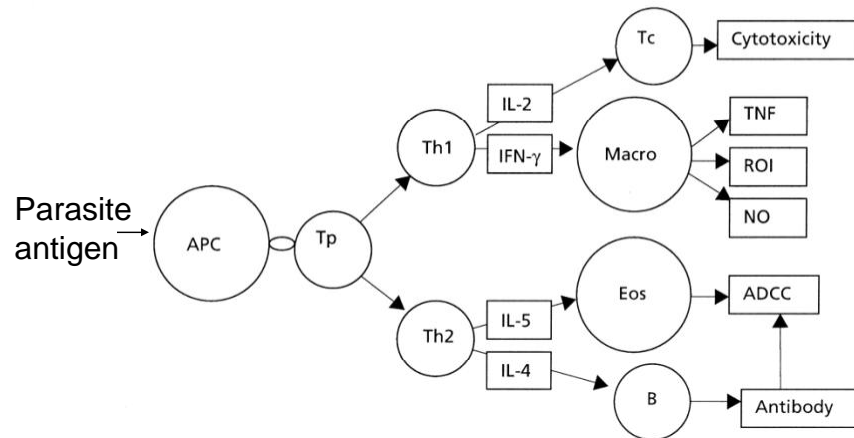
## Food Plus



This should never happen!



## Immunity and Parasitism



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

## Cytokines and Immunity to Parasites

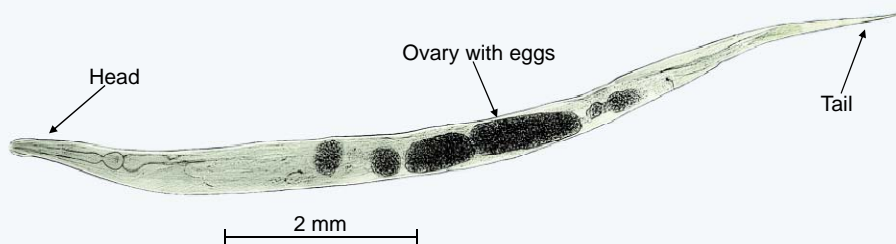
| Th1 cytokines   | Th2 cytokines | Pro-inflammatory cytokines | Counter-inflammatory cytokines | Cytokines that can lead to pathology (e.g. increased vascular permeability, tissue damage, circulatory collapse, multi-organ failure etc.) |
|-----------------|---------------|----------------------------|--------------------------------|--|
| IFN- $\gamma$ * | IL-4*         | IL-12                      | IL-4                           | IL-1   |
| IL-2            | IL-5*         | IL-15                      | IL-10                          | IL-6   |
| IL-3            | IL-3          | IL-18                      | TGF- $\beta$                   | IL-8   |
| TNF- $\alpha$   | IL-13         | IFN- $\gamma$              |                                | IL-12  |
| TNF- $\beta$    | IL-6          |                            |                                | TNF- $\alpha$  |
| GM-CSF          | IL-10         |                            |                                | MIF  |
|                 | TGF- $\beta$  |                            |                                |  |

\*most important in immune expulsion of protozoa and worms

Helminths:  
Nematoda

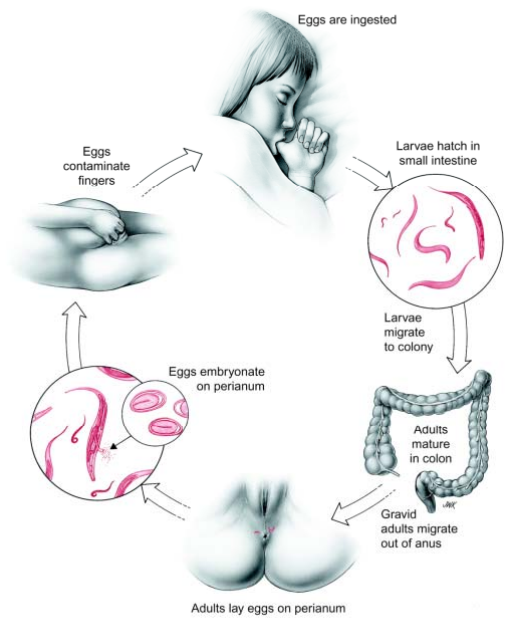
*Enterobius vermicularis*  
(Pinworm)

Adult Female *Enterobius vermicularis*





*Enterobius vermicularis*



Heavy Infection of *Enterobius vermicularis*



Photo: Martin Weber, MD, Children's Hospital; Hannover Medical School; Hannover, Germany

## Eggs of *Enterobius vermicularis*



Unembryonated



Larva

Embryonated

## *Enterobius vermicularis* in appendix



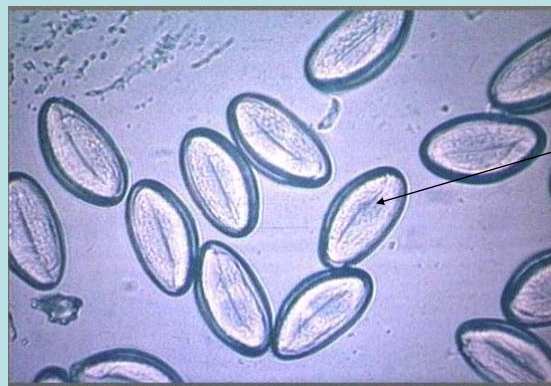
Alae

Clinical Disease:

None

Diagnosis:

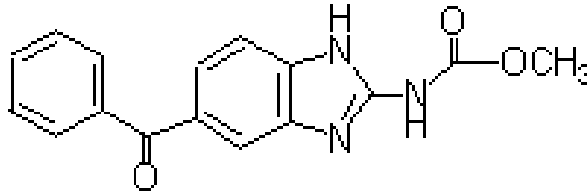
Eggs found on microscopic examination of clear sticky tape.



larva

Drug of Choice:

Mebendazole



Mode of Action:

De-polymerizes invertebrate tubulins, only.

## 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.

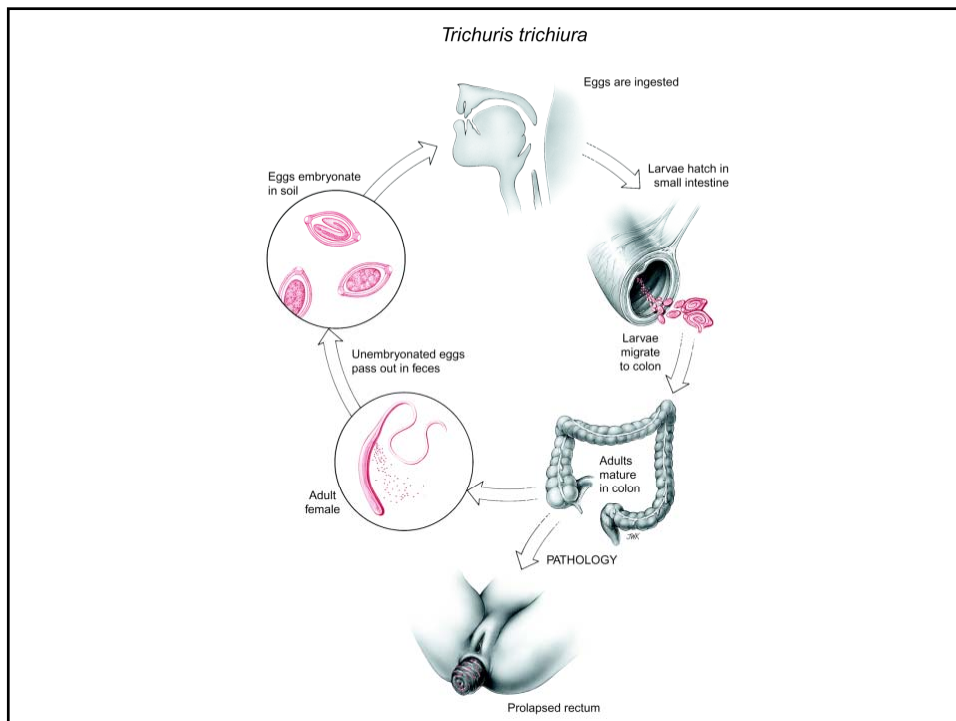
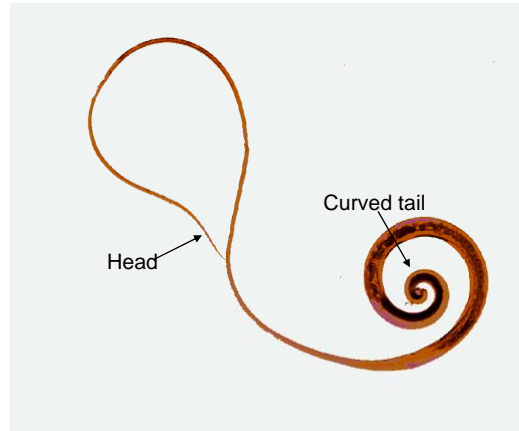
Helminths:  
Nematoda

*Trichuris trichiura*  
(Whipworm)

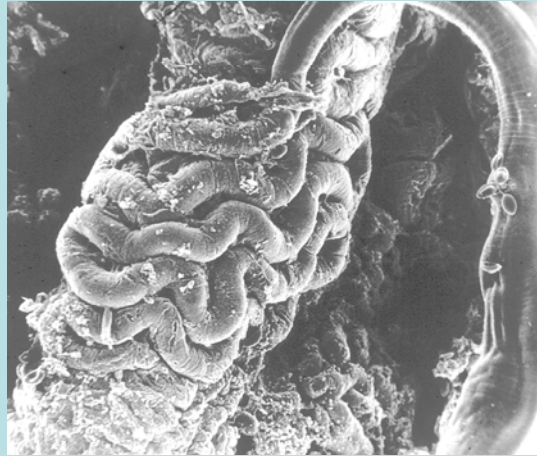
Female adult *Trichuris trichiura*



## Adult male *Trichuris trichiura*



Adult *Trichuris muris* in situ (SEM)



## 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.

## Approaches to helminth-based therapy of IBD

World J Gastroenterol. 2008 Sep 7;14(33):5125-32.

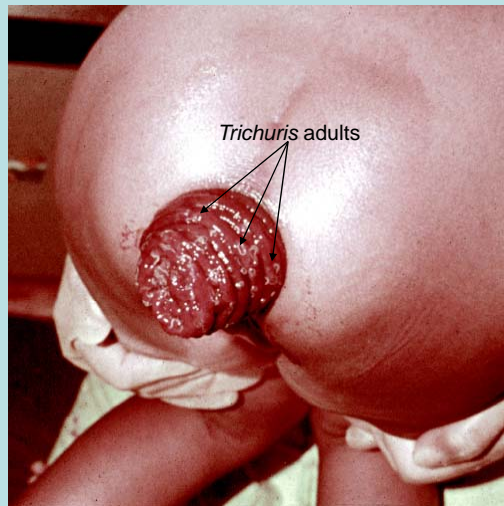
Helminth infections and intestinal inflammation.

Wang LJ, Cao Y, Shi HN.

Mucosal Immunology Laboratory, Massachusetts General Hospital, Building 114 16th Street, Room 3504, Charlestown, Massachusetts 02129, United States. shiha@helix.mgh.harvard.edu

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 damaging 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 will reveal novel, more effective and safer.

## Prolapsed rectum with adult *Trichuris trichiura*





## Clinical Disease:

1. Diarrhea
2. Anemia
3. Malnutrition (protein calorie deficiency?)

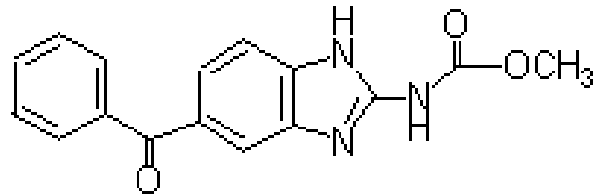
## Diagnosis:

Microscopic examination of feces for eggs



## Drug of choice:

Mebendazole



Mode of Action:

De-polymerizes invertebrate microtubules, only

## Prevention and Control:

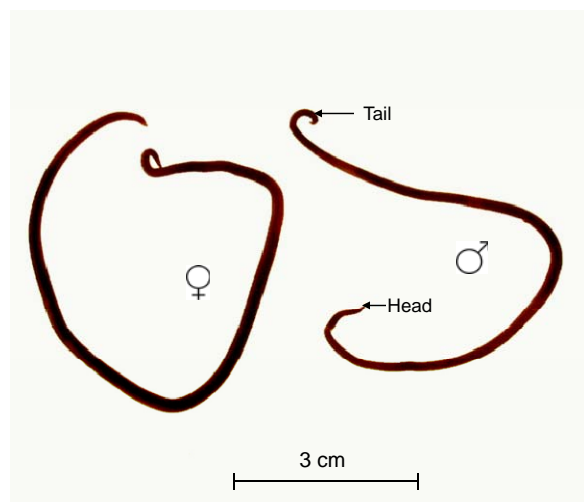
Sanitary disposal of feces



# Helminths: Nematoda

*Ascaris lumbricoides*  
(Giant intestinal worm)

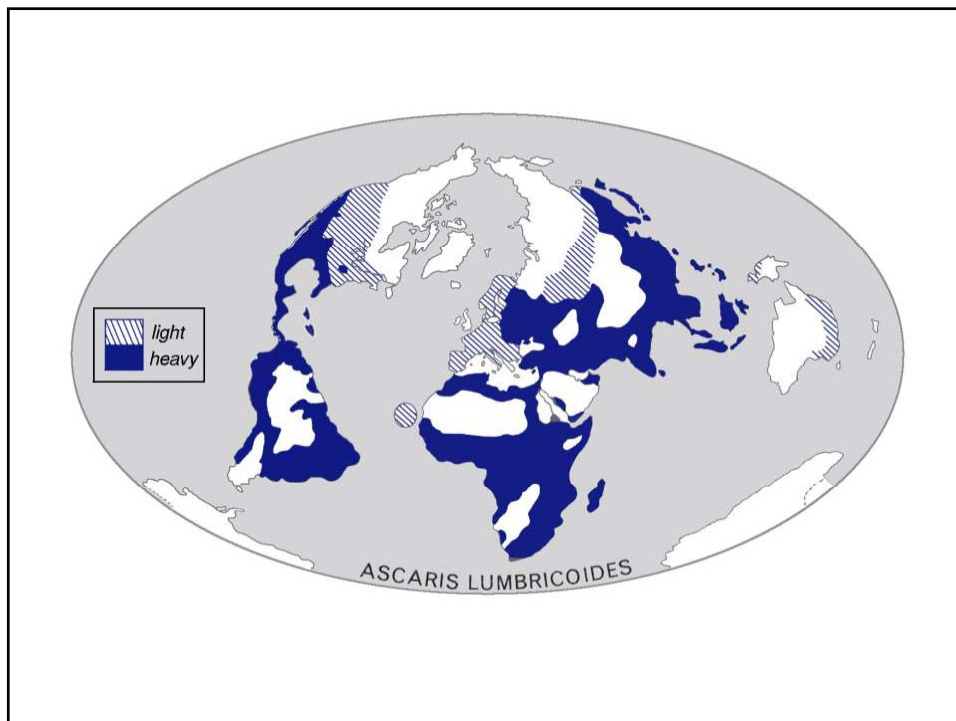
## Adult *Ascaris lumbricoides*

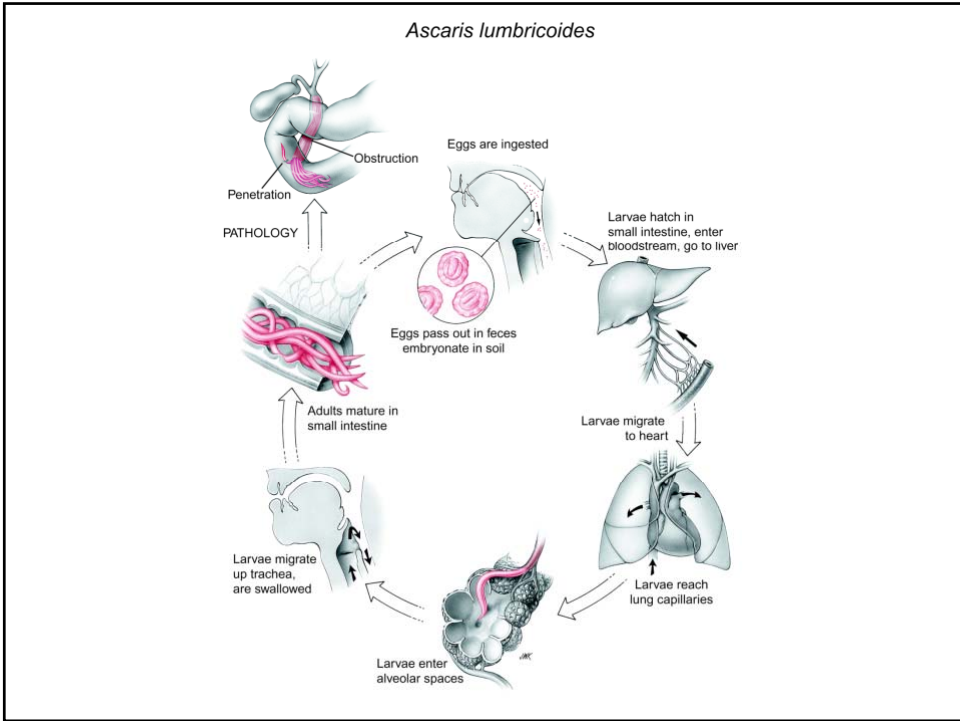




## “Jar-O-Worms”

Collected from one rural village in Bangladesh in a single day!

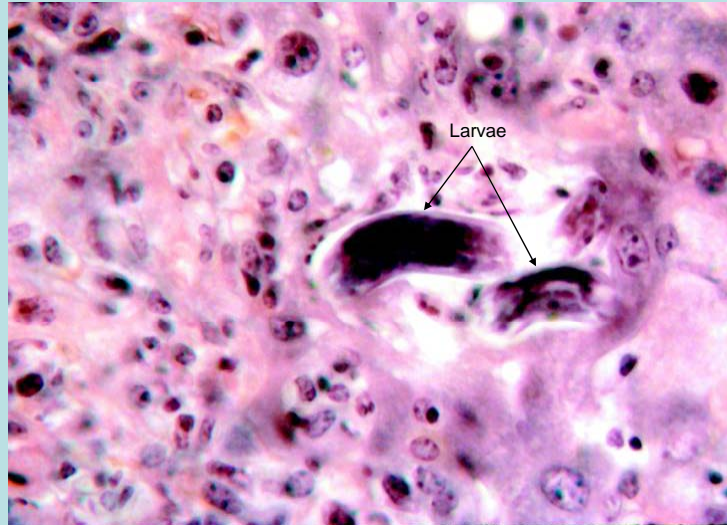




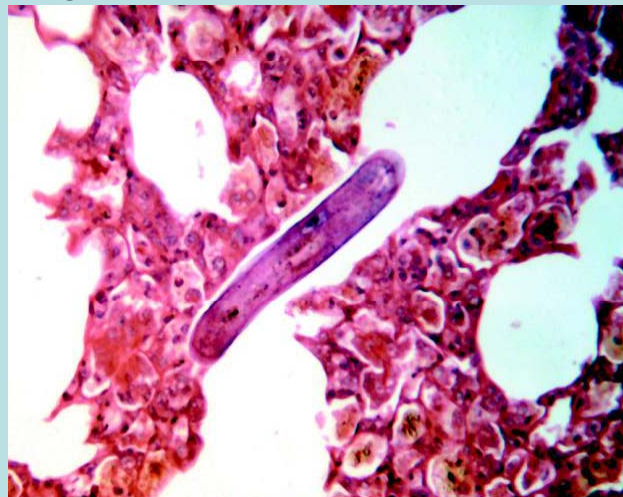
Cross section of adult *Ascaris lumbricoides*



Larvae of *Ascaris lumbricoides* in liver



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

## 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.

Child with heavy *Ascaris lumbricoides* infection



The result of successful treatment!





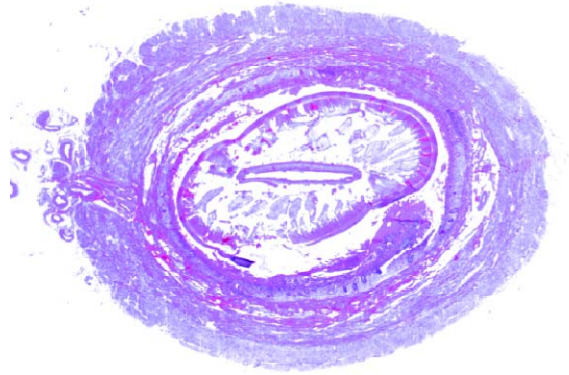
Infant with heavy *Ascaris* infection



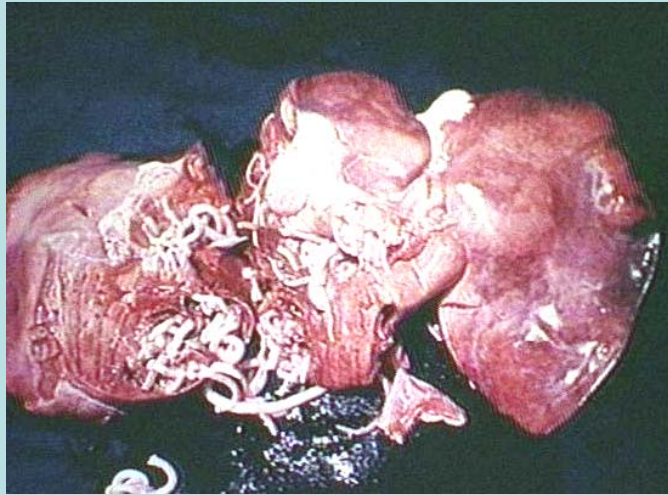
Bolus of *Ascaris lumbricoides* in small intestine



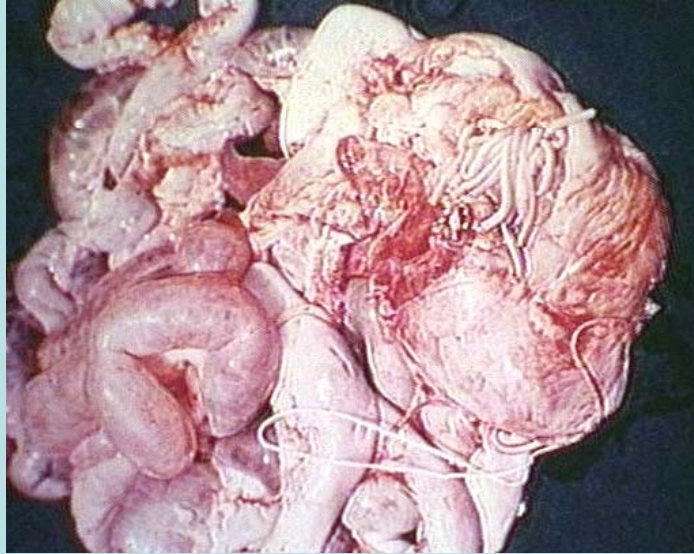
*Ascaris lumbricoides* adult in appendix



Ascaris adults in liver (fatal case)

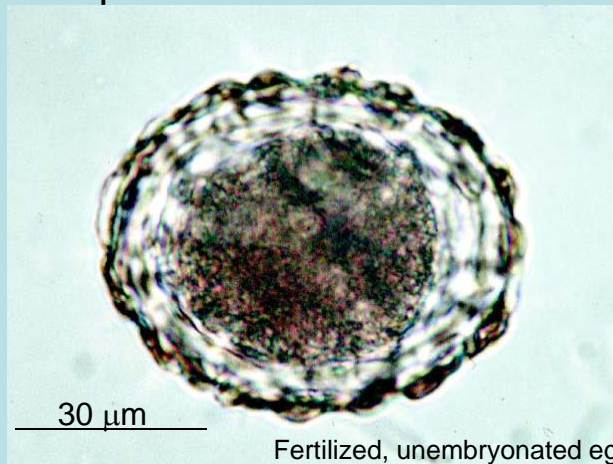


Bolus of *Ascaris lumbricoides* (fatal case)



**Diagnosis:**

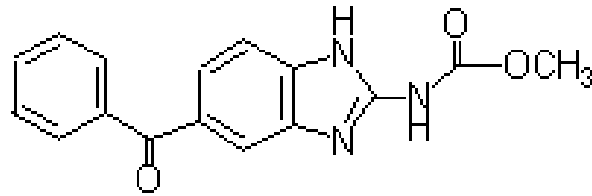
Microscopic examination of feces for eggs



Fertilized, unembryonated egg

Drug of choice:

Mebendazole

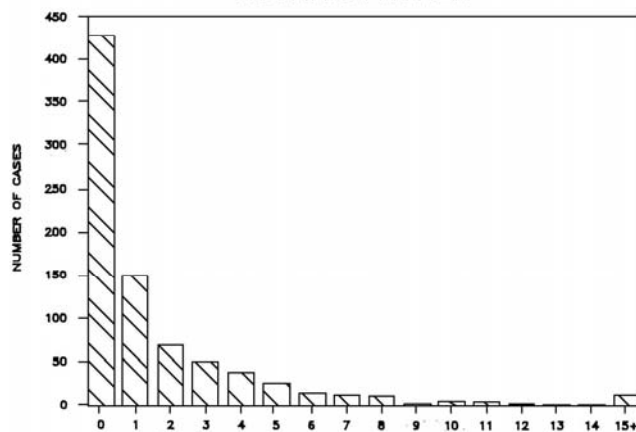


Mode of Action:

De-polymerizes invertebrate microtubules, only

## Medical Ecology

*ASCARIS* : KOREA



## Prevention and Control:

Sanitary disposal of feces



## Helminths: Nematoda

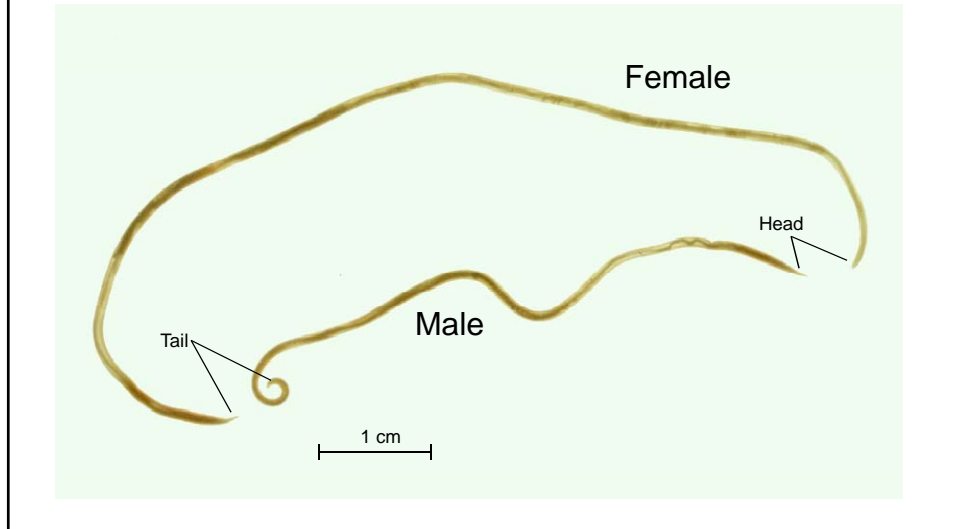


*Toxocara canis*

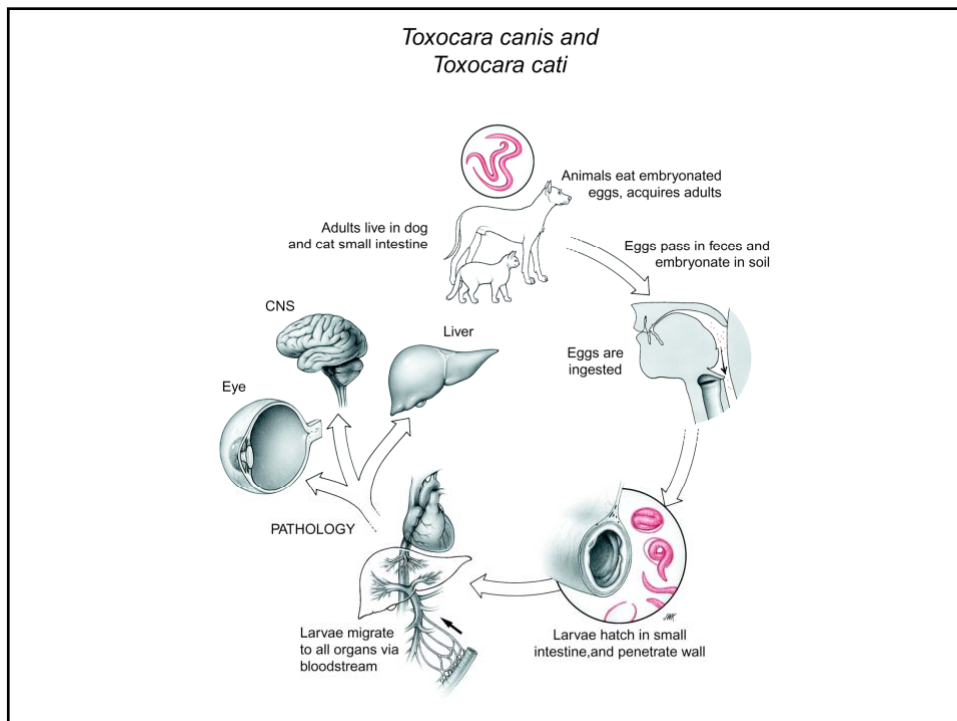
*Toxocara cati*

*Visceral and ocular larva migrans*

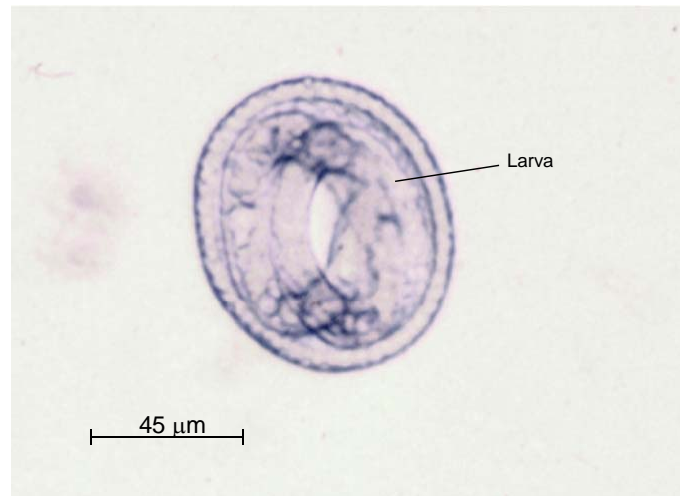
## Adult *Toxocara canis*



## *Toxocara canis* and *Toxocara cati*



Embryonated egg of *Toxocara canis*



## Pathogenesis:

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

## Clinical Disease:

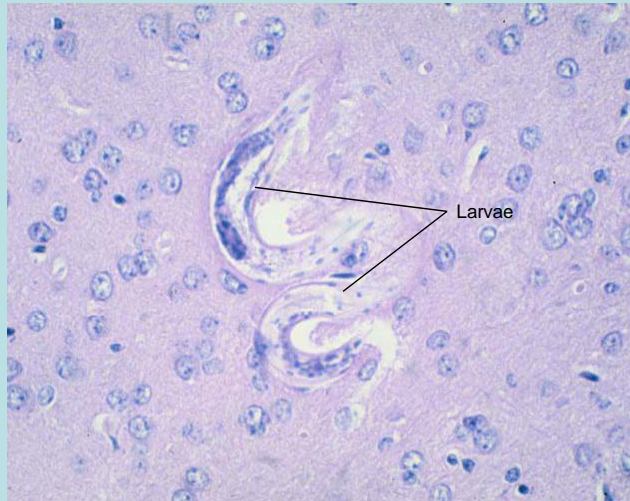
1. Fever
2. Loss of visual acuity
3. Blindness
4. Learning disabilities

Granuloma in retina due to *Toxocara canis*

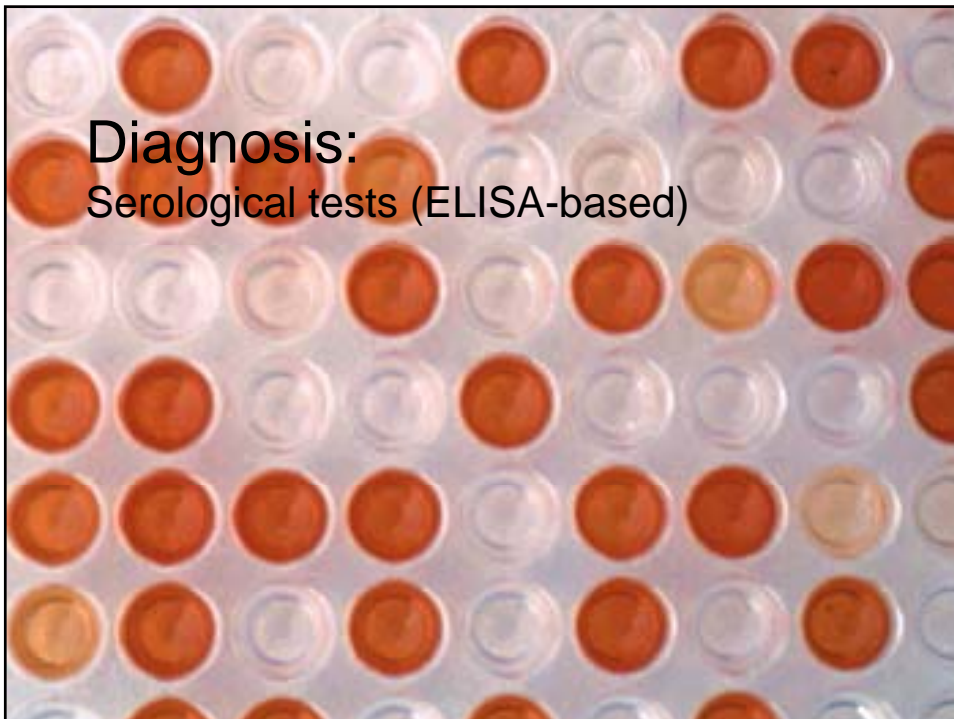




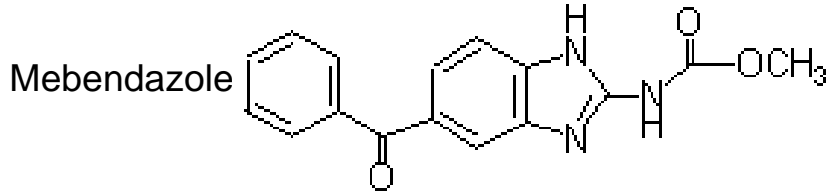
Larvae of *Toxocara canis* in mouse brain



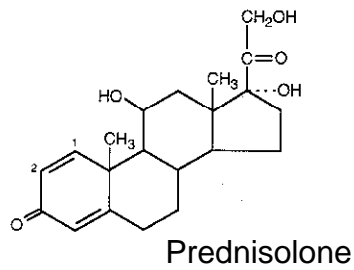
Diagnosis:  
Serological tests (ELISA-based)



## Drugs of choice:



## 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.

