Welcome to ***Parasitic Diseases***
Fall 2009

Dickson Despommier, Ph.D.
Charles Knirsch, MPH, MD
Josh Stillman, MD

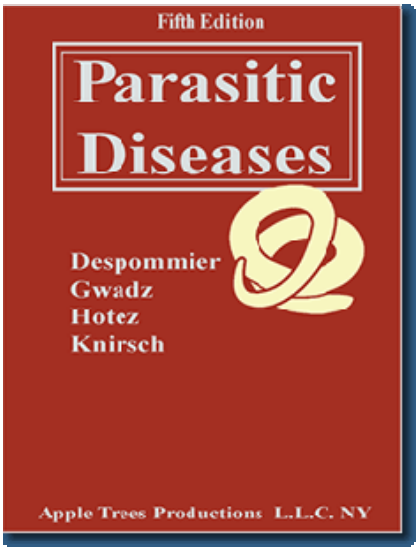
Parasite

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.

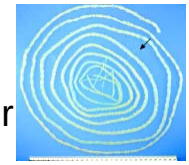


* Lots of really gross pictures!!!

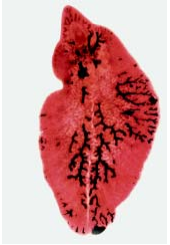
Helminths (Worms)

Nematodes - non-segmente
round worms

Cestodes - segmented flat wor



Trematodes - non-segmented
flat worms



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*

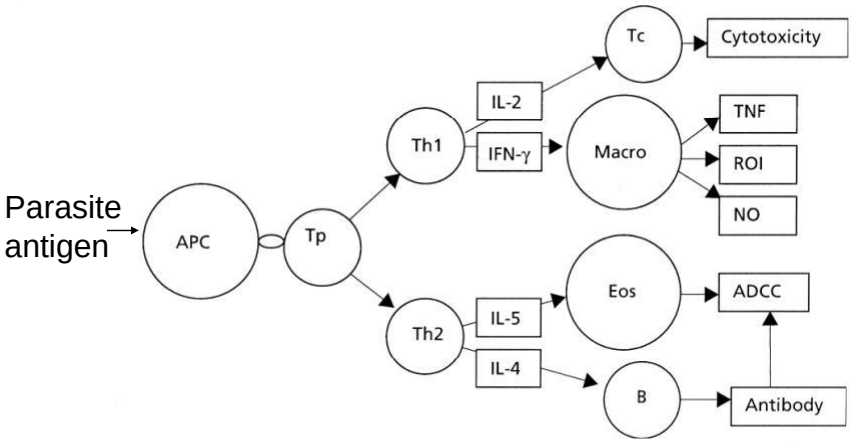
Strongyloides stercoralis

Use of human feces as fertilizer is commonplace

Wash all produce before eating

Why 1/2 of the world's humans harbor parasites

Immunity and Parasitism



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

Cytokines and Immunity to Parasites

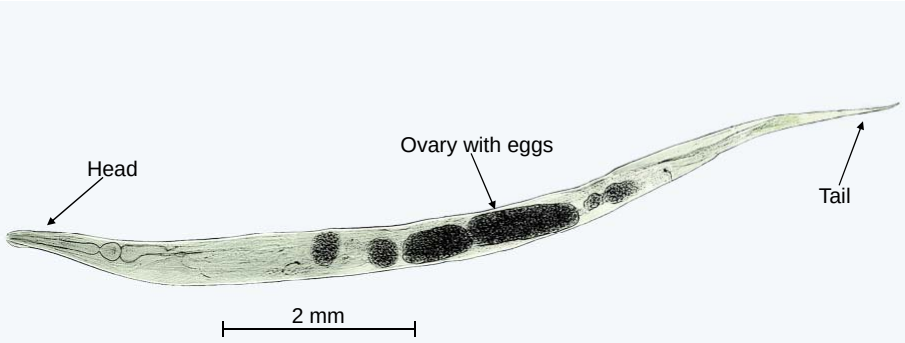
Th1 cytokines	Th2 cytokines	Pro-inflammatory cytokines	Counter-inflammatory cytokines	Cytokines that can lead to pathology (e.g. increased vascular permeability, tissue damage, circulatory collapse, multi-organ failure etc.)
IFN-γ*	IL-4*	IL-12	IL-4	IL-1
IL-2	IL-5*	IL-15	IL-10	IL-6
IL-3	IL-3	IL-18	TGF-β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

*most important in immune expulsion of protozoa and worms

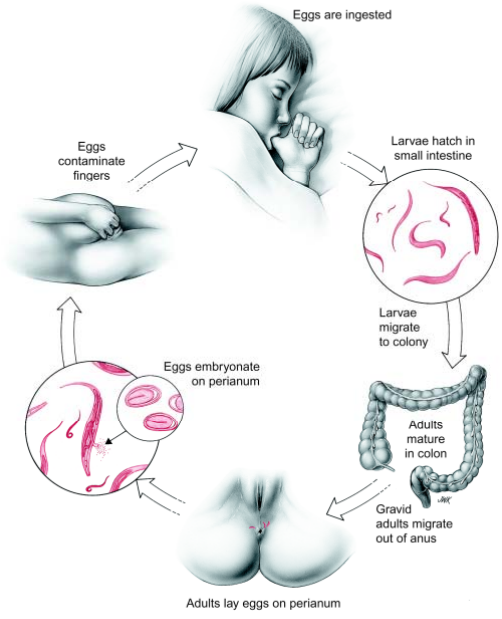
Helminths:
Nematoda

Enterobius vermicularis
(Pinworm)

Adult Female *Enterobius vermicularis*



Enterobius vermicularis

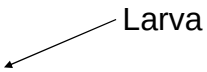


Adults on perianum deposit eggs

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

Eggs of *Enterobius vermicularis*

Unembryonated



Embryonated

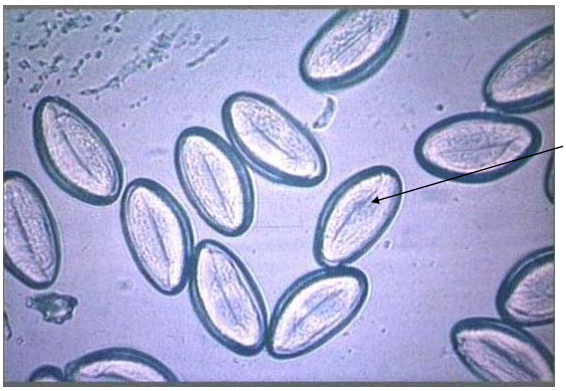
Enterobius vermicularis in appendix

Clinical Disease:

None

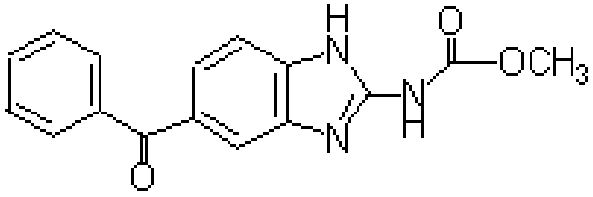
Diagnosis:

Eggs found on microscopic examination of clear sticky tape.



Drug of Choice:

Mebendazole



Mode of Action:

De-polymerizes invertebrate tubulins, only.

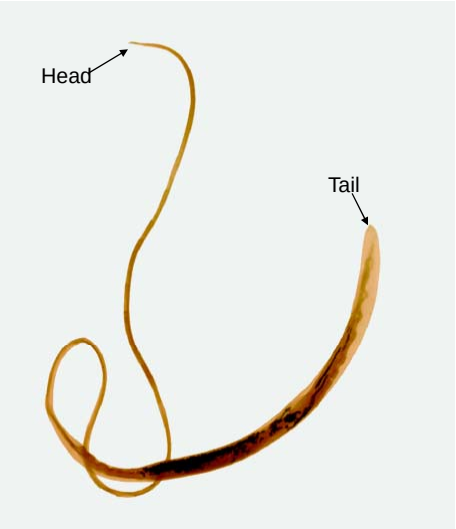
Prevention and Control:

Prevention is impossible among school-aged children, especially those attending day care facilities and lower grades. We “out-grow” our pinworm infections once we reach puberty.

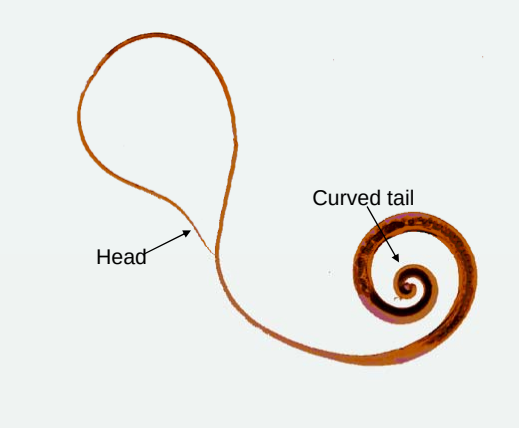
Helminths:
Nematoda

Trichuris trichiura
(Whipworm)

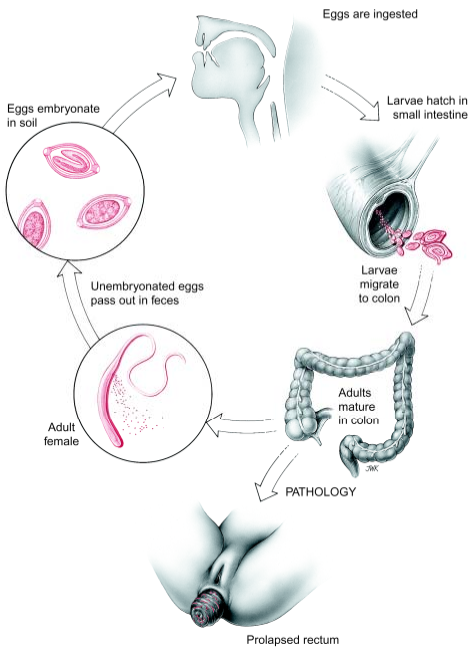
Female adult *Trichuris trichiura*



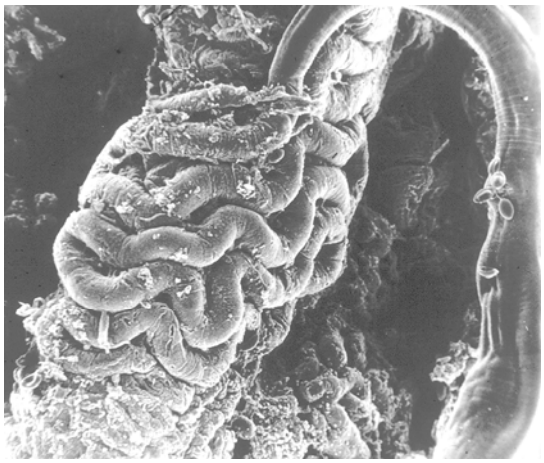
Adult male *Trichuris trichiura*



Trichuris trichiura



Adult *Trichuris muris* in situ (SEM)



Pathogenesis:

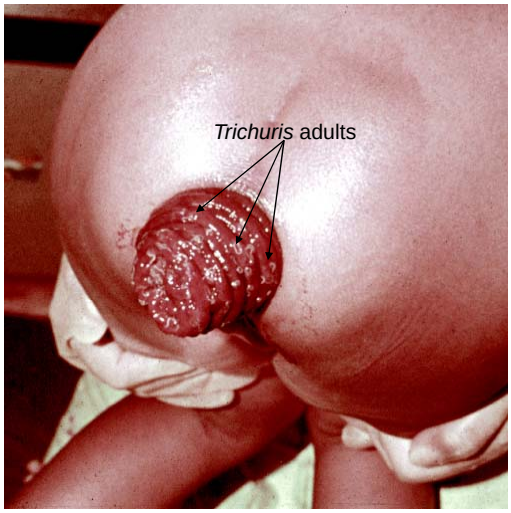
Trichuris adults secrete a pore-forming protein that may play a role in diarrhea. Adult worms ***do not*** feed directly on blood or other host tissues. Mechanism of anemia still unknown.

Crohn's Disease and iatrogenic Trichuris infection

1: Parasitol Res. 2007 Apr;100(5):921-7. Epub 2007 Jan 6. Links
The use of Trichuris suis and other helminth therapies to treat Crohn's disease.
Reddy A, Fried B.

Department of Biology, Lafayette College, Easton, PA 18042, USA. Adireddymd@gmail.com
Infections with gastrointestinal (GI) nematodes are prevalent worldwide, despite the fact that anti-helminthic medications are regarded as safe, efficient, and widely available globally. In this review, we highlight the potential therapeutic benefits that may be realized through the clinical use of Trichuris suis and other helminths for Crohn's disease (CD). Long-lived helminthic parasites are remarkable in their ability to down-regulate host immunity, protecting themselves from elimination, and also minimize severe pathological host changes. This review summarizes what is known about the underlying mechanisms that may account for the observed patterns in humans treated with helminths for CD. The Th2 arm of the immune system is emphasized as a component of primary importance in the association between the host immune system and GI nematode infections. Although GI nematode infections in humans cause significant morbidity and mortality, the existence and nature of protective mechanisms these helminths may confer remain largely unclear.

Prolapsed rectum with many adult *Trichuris trichiura*



Clinical Disease:

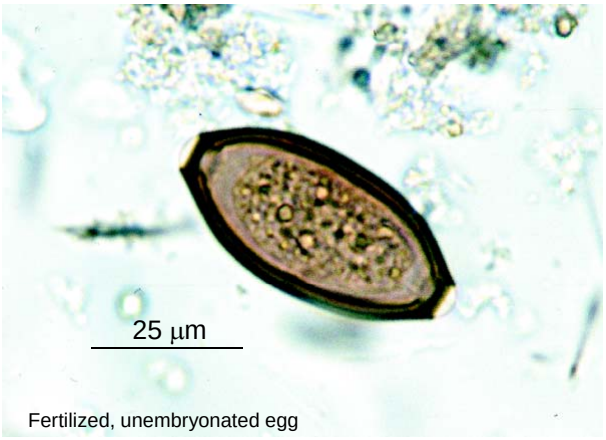
1. Diarrhea

2. Anemia

3. Malnutrition (protein calorie deficiency?)

Diagnosis:

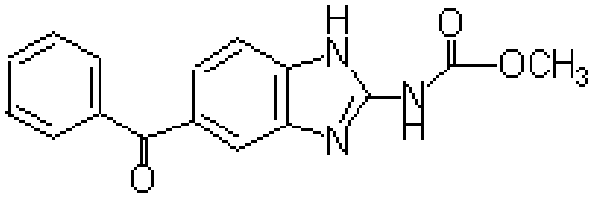
Microscopic examination of feces for eggs



Fertilized, unembryonated egg

Drug of choice:

Mebendazole



Mode of Action:
De-polymerizes invertebrate microtubules, only

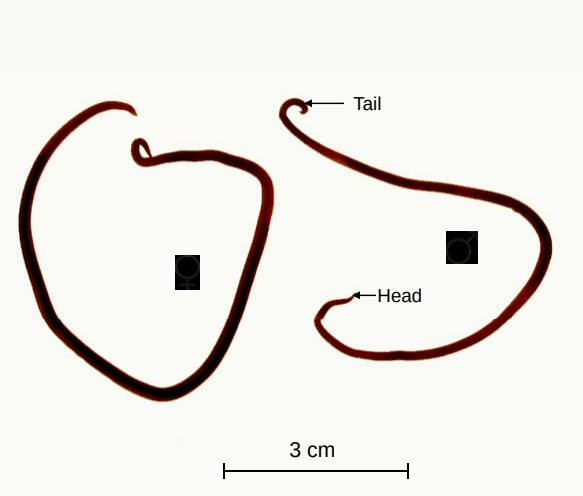
Prevention and Control:

Sanitary disposal of feces

Helminths:
Nematoda

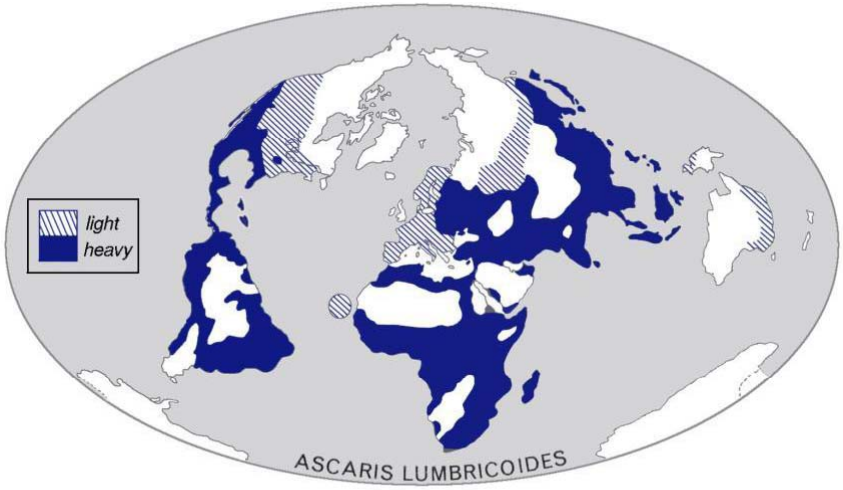
Ascaris lumbricoides
(Giant intestinal worm)

Adult *Ascaris lumbricoides*

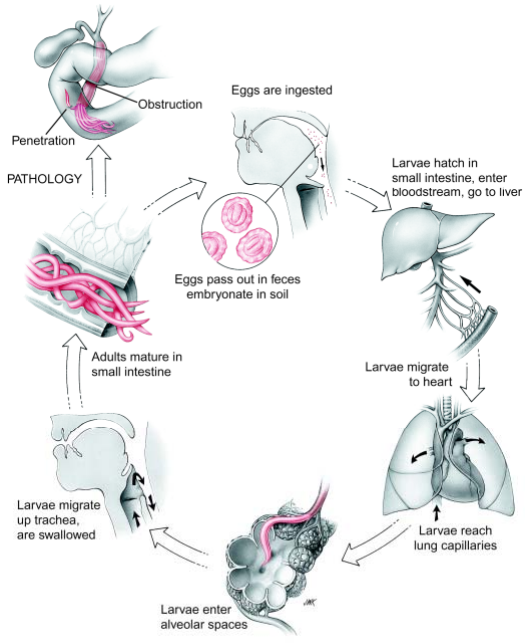


Jar of Ascaris adults

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

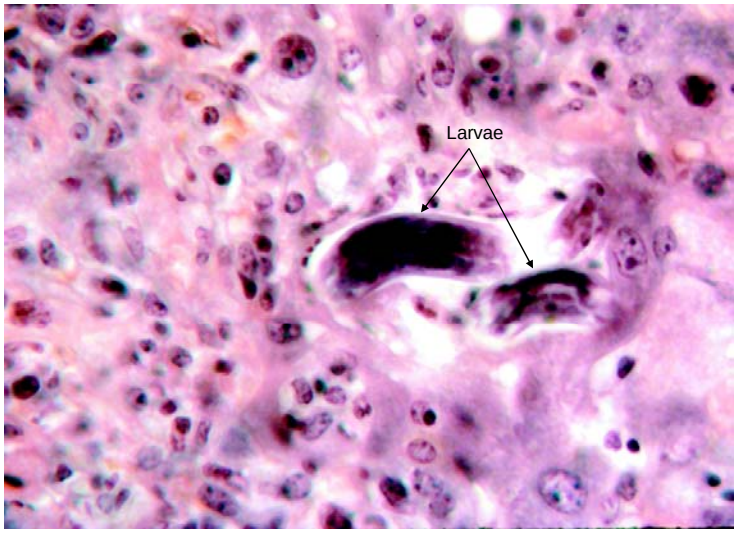


Ascaris lumbricoides

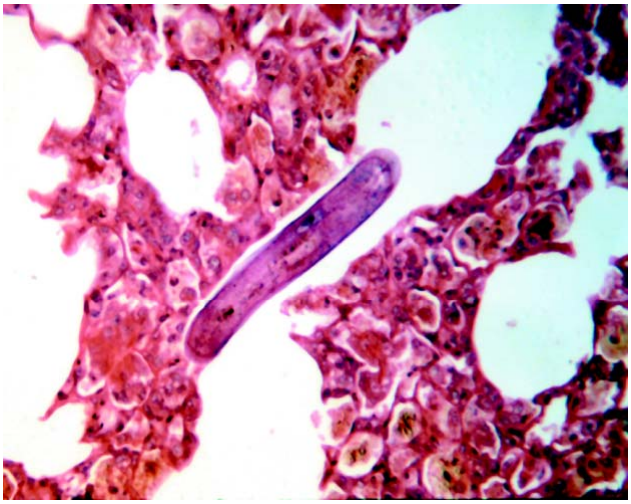


Cross section of adult *Ascaris lumbricoides*

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; cause of malnutrition.

4. Aberrant migration of adult worms to:
    a. Ampula 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:

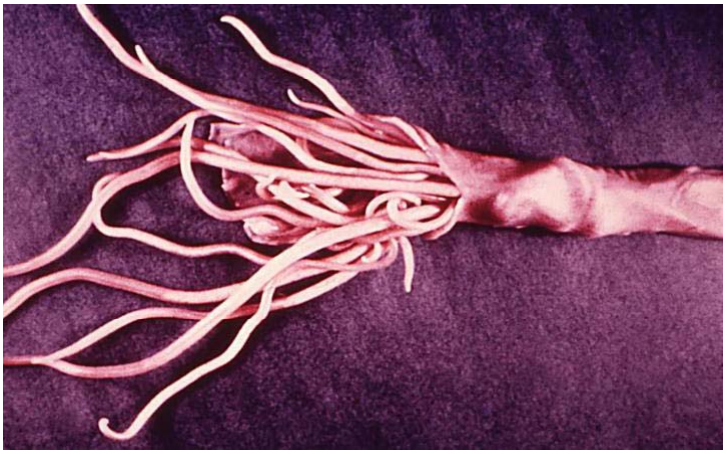
   a. protein calorie malnutrition - “failure to thrive” syndrome.
   b. bowel obstruction.
   c. aberrant migratory events.

Child with heavy *Ascaris lumbricoides* infection

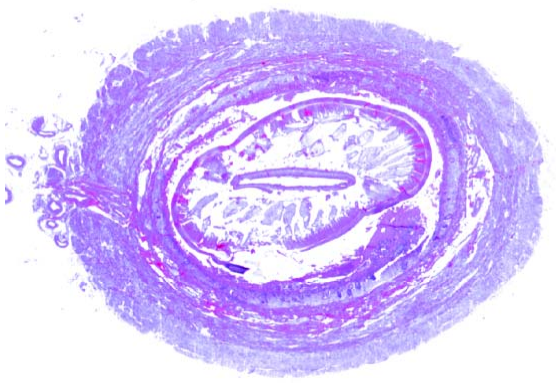
The result of successful treatment

Infant with heavy Ascaris infection

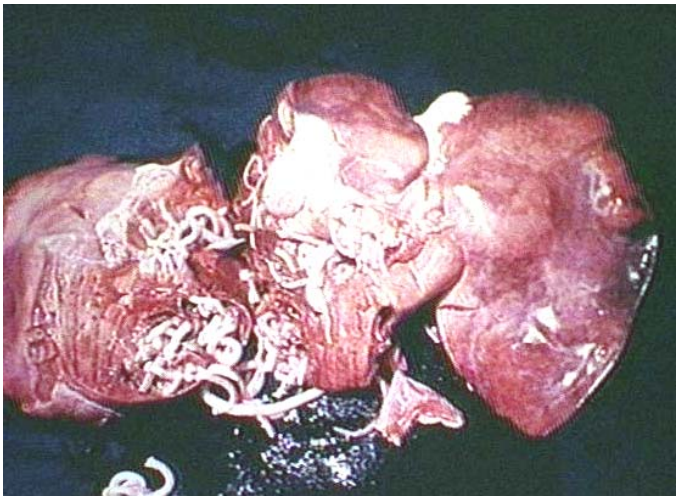
Bolus of *Ascaris lumbricoides* in small intestine



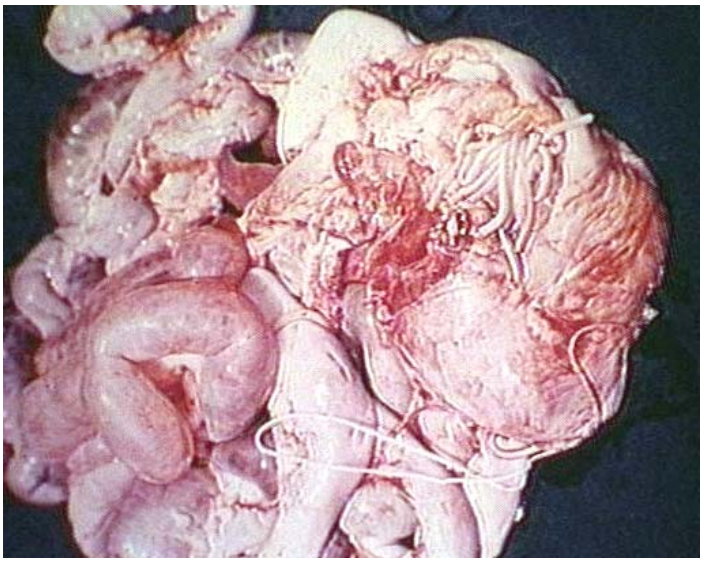
Ascaris lumbricoides adult in appendix



Ascaris adults in liver (fatal case)

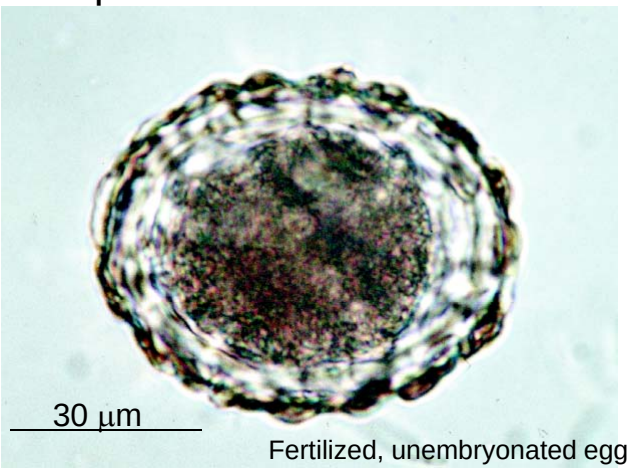


Bolus of *Ascaris lumbricoides* (fatal case)



Diagnosis:

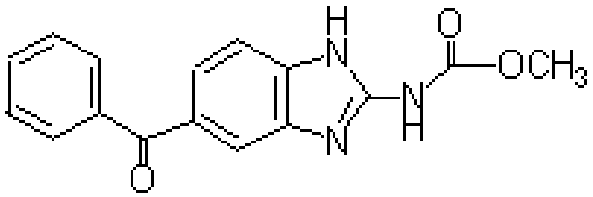
Microscopic examination of feces for eggs



Fertilized, unembryonated egg

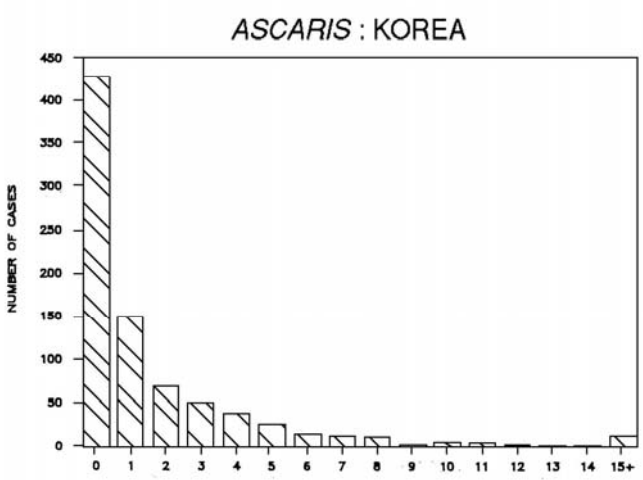
Drug of choice:

Mebendazole



Mode of Action:
De-polymerizes invertebrate microtubules, only

Medical Ecology



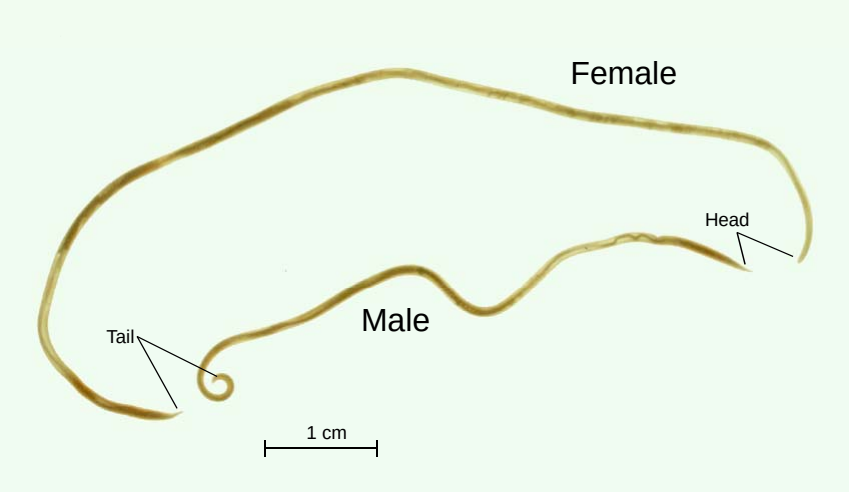
Prevention and Control:

Sanitary disposal of feces

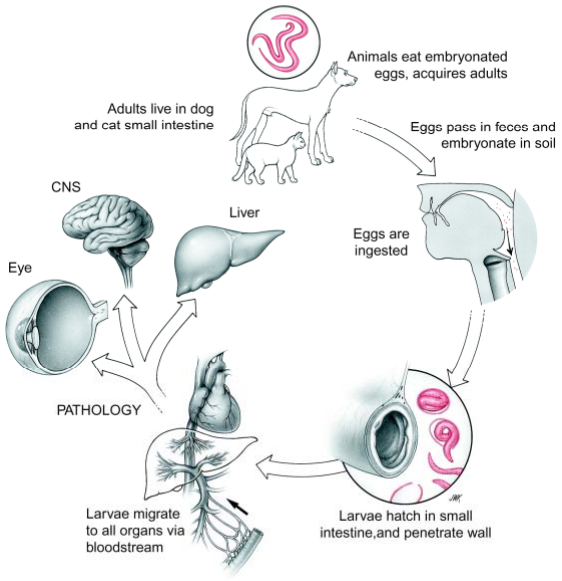
Helminths:
Nematoda

Toxocara canis
Toxocara cati
Visceral and ocular larva migrans

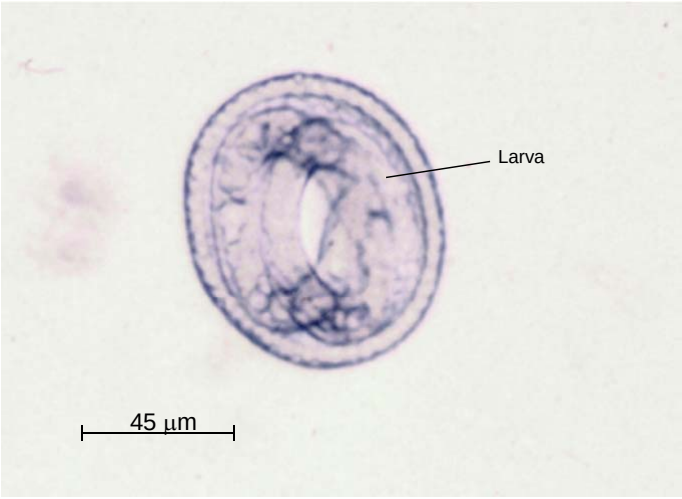
Adult *Toxocara canis*



Toxocara canis and
Toxocara cati



Embryonated egg of *Toxocara canis*



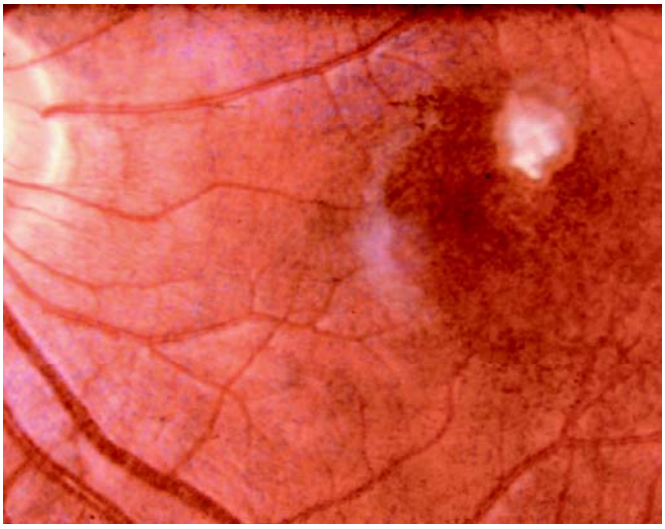
Pathogenesis:

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

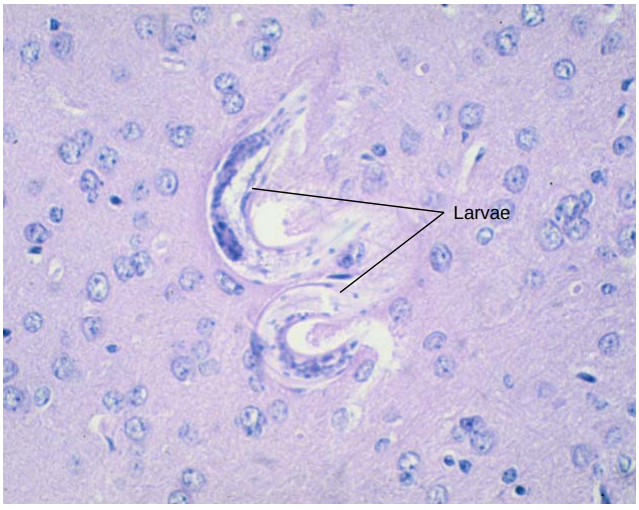
Clinical Disease:

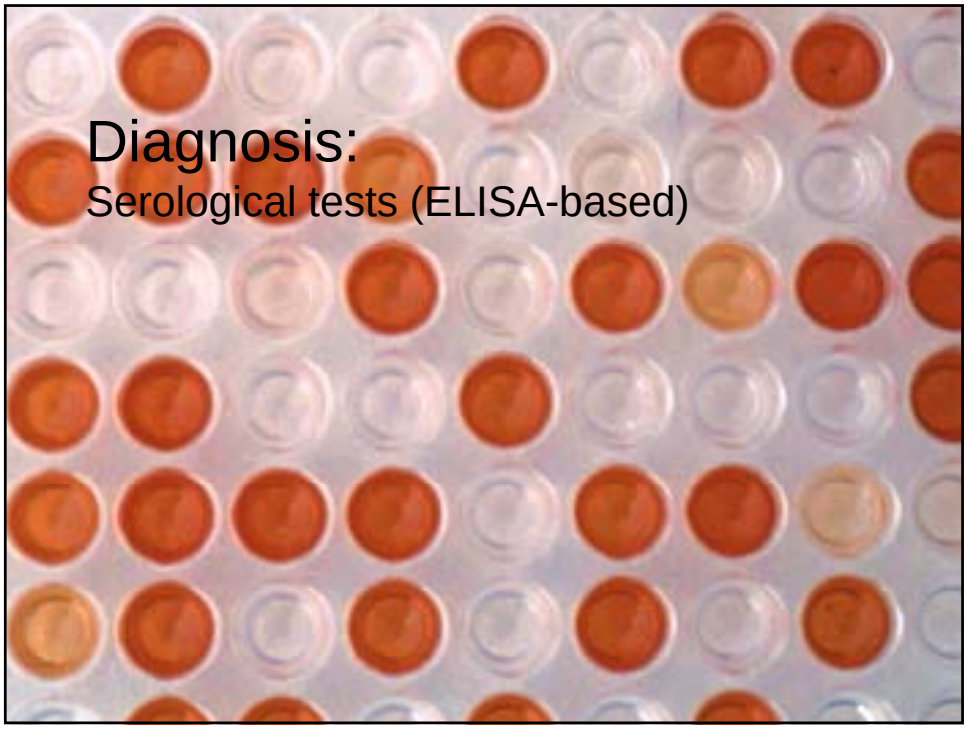
1. Fever
2. Loss of visual acuity
3. Blindness
4. Learning disabilities

Granuloma in retina due to *Toxocara canis*



Larvae of *Toxocara canis* in mouse brain



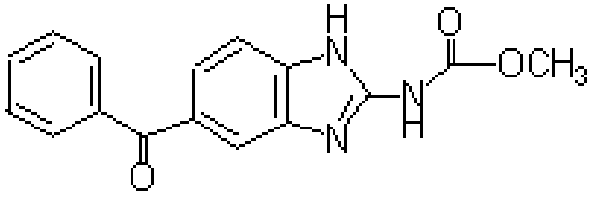


Diagnosis:

Serological tests (ELISA-based)

Drugs of choice:

Mebendazole



Steroids

Prednisolone

Prevention and Control:

Sanitary disposal of dog and cat feces

Cover sand boxes at night

Regular treatment of pets