Diagnostic Parasitology

Medically Important Nematodes (Roundworms)

Disclaimer

- This presentation was meant to provide students with both didactic and laboratory skills as they apply to clinical parasitology. It is meant for educational purposes only and does not represent Cleveland Clinic views or practices.
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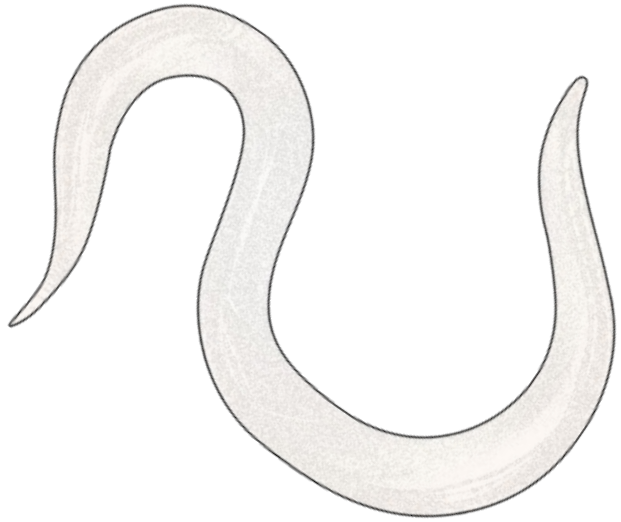
- Most of the information was adopted from the Textbook of Diagnostic Microbiology by Mahon & Lehman (see citation) but condensed for bite sized learning.

Helminths

- Multicellular parasites
- Classified based on structure
  - Trematodes (flukes)
  - Cestodes (tapeworms)
  - Nematodes (roundworms)

flatworms



- Complex life cycles where humans can serve as
  - Definitive hosts: Individual in which a parasite has its adult and or sexual reproductive stage.
  - Intermediate hosts: Individual in which a parasite has its larval and or asexual reproductive stage
  - Accidental hosts

The Nematodes

Intestinal

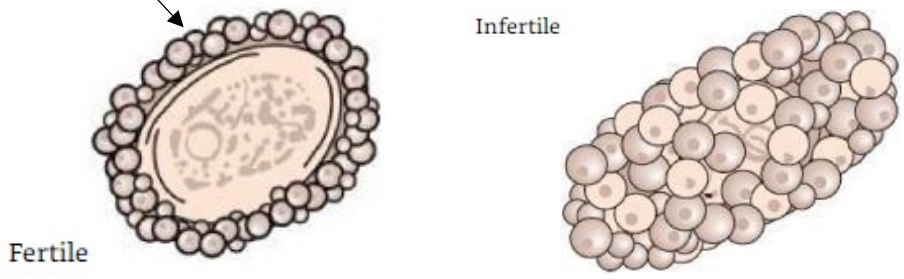
- Five medically important members
  - *Ascaris lumbricoides*
  - *Enterobius vermicularis*
  - *Trichuris trichiura*
  - *Hookworms*
  - *Strongyloides stercoralis*

Tissue

- Four medically important members
  - *Trichinella spiralis*
  - *Dracunculus medinensis*
  - *Toxocara species*
  - *Ancylostoma braziliense*

Intestinal Nematodes: *Ascaris lumbricoides* *(large intestinal roundworm)*

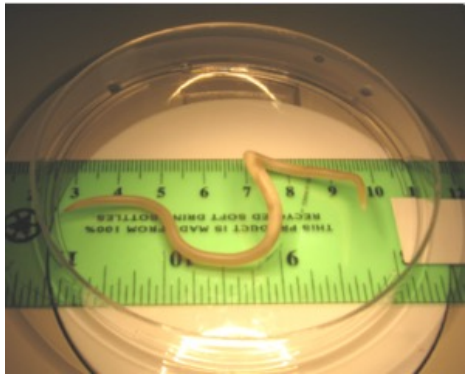
Mamillated



Egg

45-75 x 35-50 µm

Infertile up to 90 µm in length with highly refractive granules

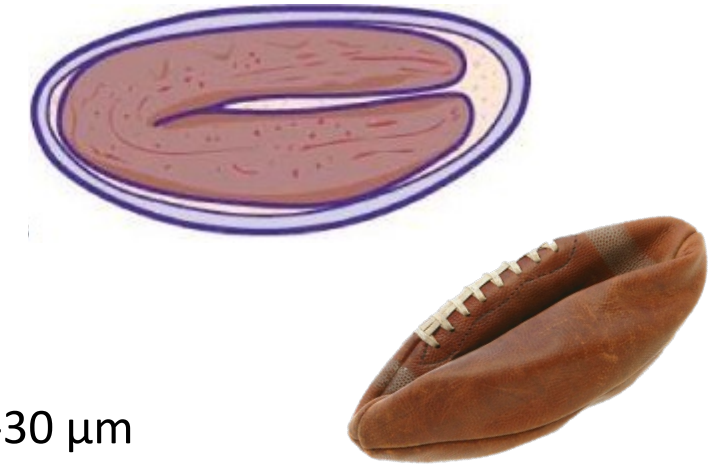


Lip

Adult

15-35 cm

Intestinal Nematodes: *Enterobius vermicularis* *(pinworm)*



Egg

50-60 x 20-30 µm

Flattened on one side

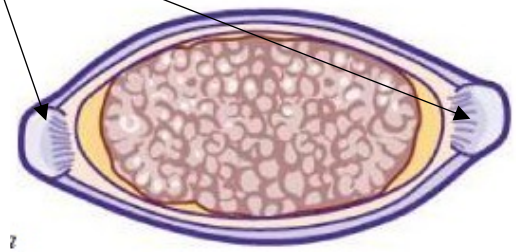
C-shaped larva inside

Adult

F: 8-13 mm

M: 2-5 mm with curved posterior

Intestinal Nematodes: *Trichuris trichiura* *(whipworm)*



Egg

50-55 x 22-23 µm

Adult

M: 30-45 mm

F:30-50 mm

May cause a prolapsed rectum

Intestinal Nematodes: Hookworm

Egg

50-60 µm long

Embryo in the 4-8 cell stage of cleavage

Cutting plates

Teeth

Necator americanus

Ancylostoma duodenale

Adult

N. americanus M: 5-9mm F: 9-11mm

A.duodenale M: 8-12mm F: 10-15 mm long

May produce iron deficiency anemia

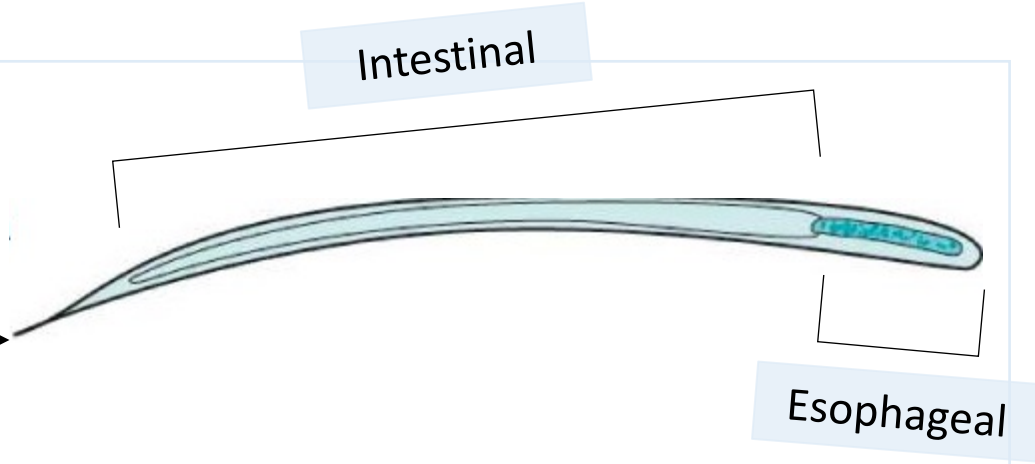
Intestinal Nematodes: Hookworm

Rhabditiform larva

250-300 µm long

Long buccal cavity

Inconspicuous genital primordium



Filariform larva

500 µm long

Pointed tail

Esophageal-to-intestinal ratio 1:4

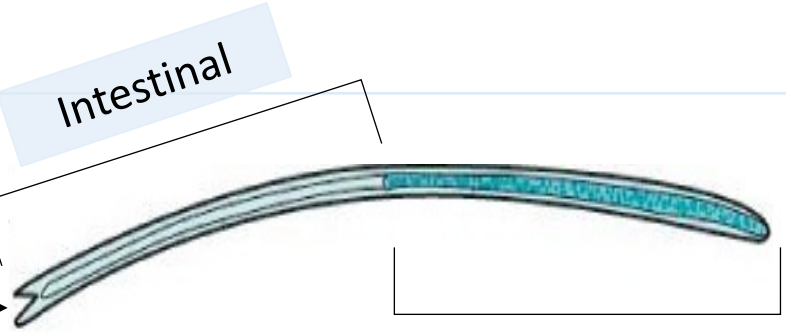
Intestinal Nematodes: *Strongyloides stercoralis* *(threadworm)*

Rhabditiform larva

200-250 µm long

Short buccal cavity

Prominent genital primordium



Filariform larva

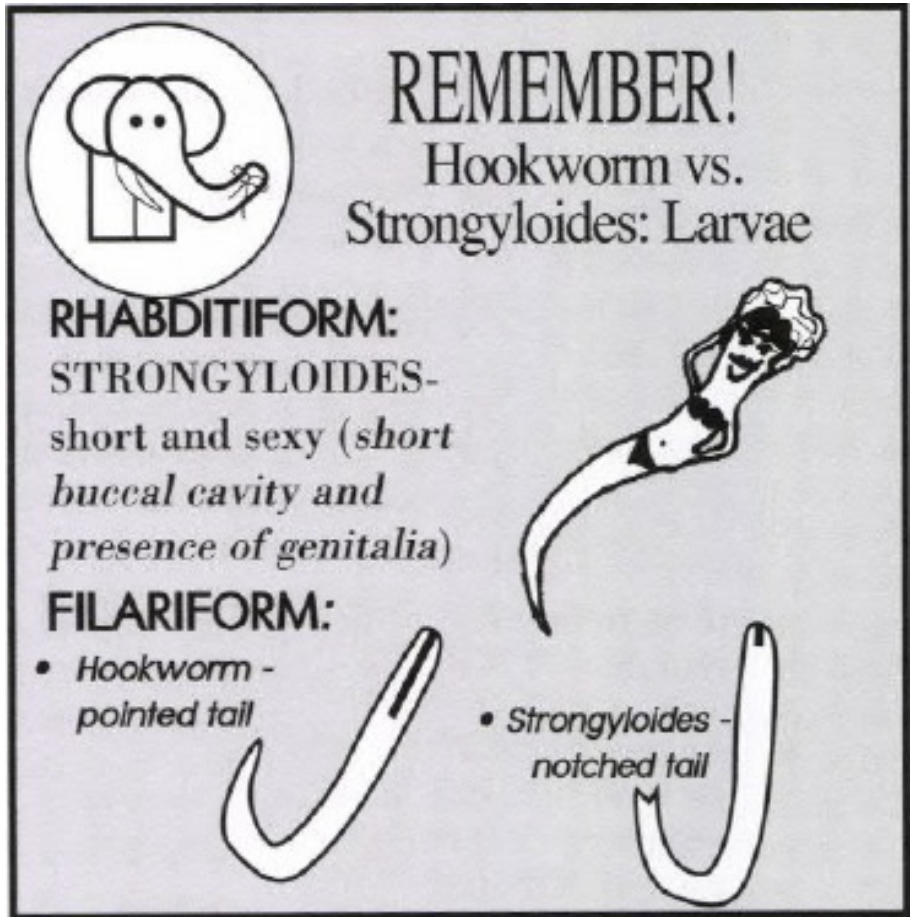
500 µm long

Notched tail

Esophageal-to-intestinal ratio 1:1

Intestinal Nematodes: Hookworm vs Threadworm larvae

- Treatment for hookworm is different from treatment for threadworm
- Laboratory professionals must be able to differentiate the rhabditiform and filariform larvae
- Rhabditiform larvae
  - Short (buccal cavity) and sexy (prominent genital primordium) = *Strongyloides stercoralis*
- Filariform larvae
  - Hookworm has a pointed tail like a hook



Tissue Nematodes: *Trichinella spiralis*

- Trichinosis
  - Humans ingest infected undercooked meat
  - Adults live in intestines
  - Larvae burrow in striated muscle
  - Diagnosis is achieved from histologically staining of biopsied muscle.

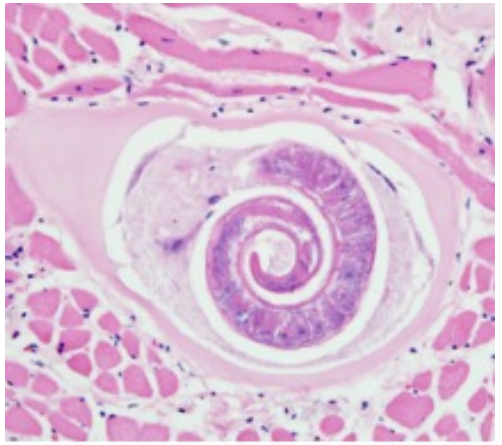


Figure A: *Trichinella* larva in tongue muscle of a rat, stained with hematoxylin and eosin (H&E). Image was captured at 400x magnification.

Tissue Nematodes: Larva migrans

- Larva migrans (humans are the accidental host)
  - Cutaneous
    - filariform larva of dog or cat hookworm (*Ancylostoma braziliense*)
    - Wanders through subcutaneous tissue
    - Allergic reaction causes itchy skin lesions [A]
    - Infection resolves on its own
  - Visceral
    - Eggs of dog roudnworm (*Toxocara canis*) or cat roundworm (*Toxocara cati*)
    - Larvae travel to lung, eye, liver or brain [B]
    - Diagnosis is made through serologic testing

Cutaneous larva migrans (CLM) in a patient's foot over the course of one week. Photos courtesy of Florida Department of Health, Duval County Epidemiology

[A]

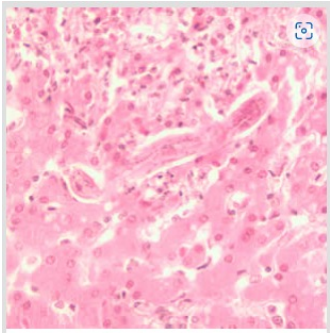


Figure B: Longitudinal section of a *Toxocara* sp. larva in liver tissue

[B]

Tissue Nematodes: *Dracunculus medinensis* *(guinea worm)*

- Dracunculiasis
  - Human drink unfiltered water containing infected copepods
  - Larvae mature in abdominal cavity
  - Adult female worm migrates to subcutaneous tissue and induces a blister typically on the foot [A]
  - Blister ruptures when exposed to water
  - Female must be slowly removed by wrapping around a stick [B]
  - Diagnosis based on symptoms

Figure A: The female Guinea worm induces a painful blister.

[A]

Guinea worm extraction. Photo credit: Emily Staub, 2001, The Carter Center.

[B]

The Nematodes

Blood

- Five medically important members
  - *Wuchereria bancrofti*
  - *Brugia malayi*
  - *Loa loa*
  - *Masonella ozzardi*
  - *Masonella perstans*

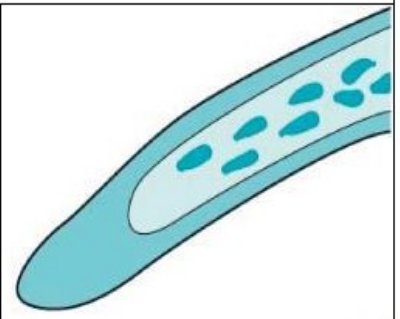
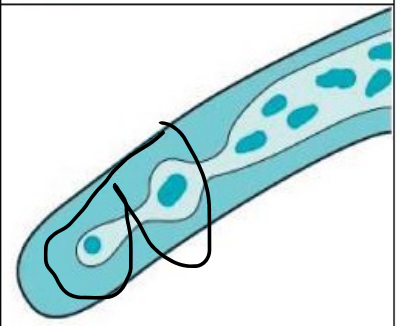
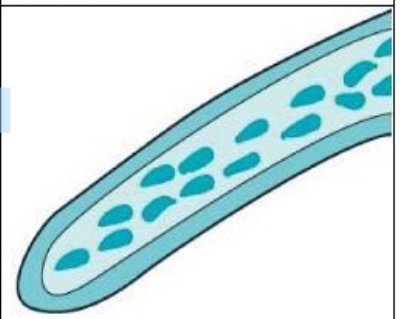
Tissue

- Two medically important members
  - *Onchocerca volvulus*
  - *Masonella streptocerca*

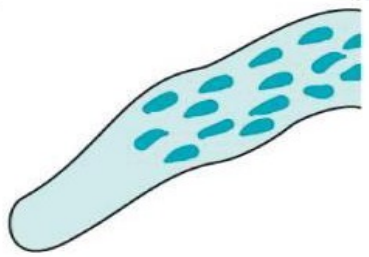
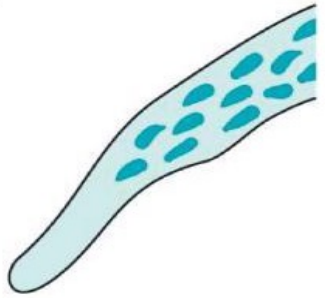
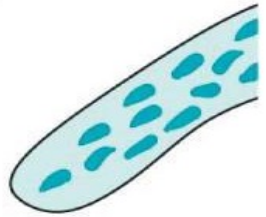
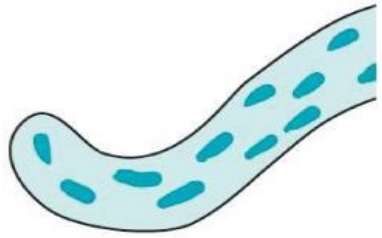
Organism	Vector	Disease
Wuchereria bancrofti	Mosquito	Elephantiasis
Brugia malayi		
Loa Loa	Deer fly	Calabar swellings
Mansonella species	Midge	Asymptomatic
Onchocerca volvulus	Black fly	River blindness

Blood Nematodes: Microfilariae with sheathes

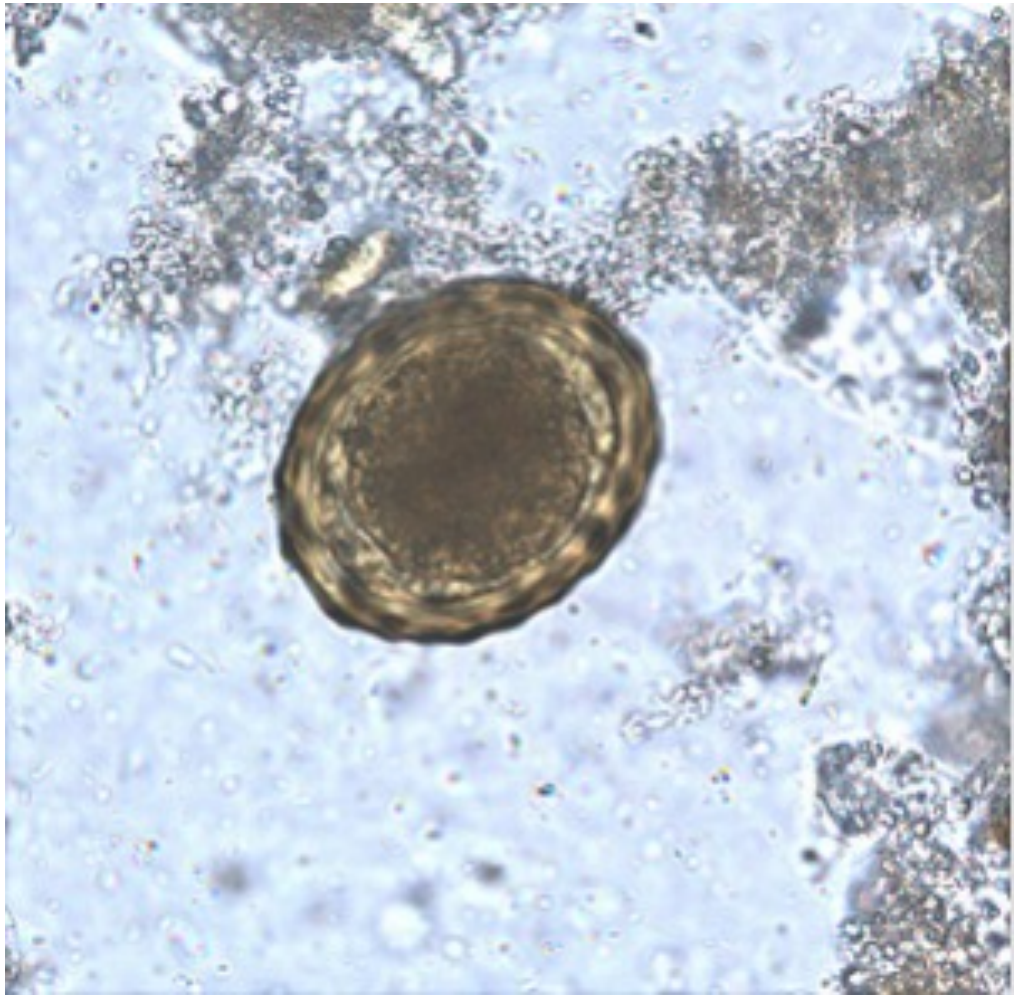
Wears
Long
Britches

Organism	Arthropod vector	Periodicity	Location of adult, microfilaria	Tail morphology	
Wuchereria bancrofti	Mosquito (*Culex, Aedes, Anopheles* spp. and others)	Nocturnal	Lymphatics, blood	Sheathed Nuclei do not extend to tip of tail	
Brugia malayi	Mosquito (*Aedes, Mansonia* spp.)	Nocturnal	Lymphatics, blood	Sheathed Terminal nuclei separated	
Loa loa	Fly (*Chrysops* sp.)	Diurnal	Subcutaneous tissue, blood	Sheathed Nuclei extend to tip of tail	

Blood Nematodes: Microfilariae without sheathes

Organism	Arthropod vector	Periodicity	Location of adult, microfilaria	Tail morphology	
Onchocerca volvulus	Fly (*Simulium* sp.)	Nonperiodic	Subcutaneous nodule, subcutaneous tissue	Unsheathed Nuclei do not extend to tip of tail	
Mansonella ozzardi	Midge (*Culicoides* sp.)	Nonperiodic	Body cavity, blood, skin	Unsheathed Nuclei do not extend to tip of tail	
Mansonella perstans	Midge (*Culicoides* sp.)	Nonperiodic	Mesentery, blood	Unsheathed Nuclei extend to blunt tip of tail	
Mansonella streptocerca	Midge (*Culicoides* sp.)	Nonperiodic	Subcutaneous, skin	Unsheathed Nuclei extend to tip of hooked tail	

Nematodes: Ova and Parasite Examination (OVAP)



Iodine wet preparation

Nematodes: Ova and Parasite Examination (OVAP)

Iodine wet preparation

Nematodes: Ova and Parasite Examination (OVAP)

Wet preparation

Iodine wet preparation

Nematodes: Ova and Parasite Examination (OVAP)

Iodine wet preparation

Nematodes: Ova and Parasite Examination (OVAP)

Wet preparation

Iodine wet preparation

Nematodes: Blood Parasite

Thick smear

Citations

- Mahon, C. R., & Lehman, D. C. (2023). *Textbook of Diagnostic Microbiology* (7th ed., pp. 639-707). Elsevier.
- Centers for Disease Control and Prevention (2019, November 20). DPDx-Laboratory Identification of Parasites of Public Health Concern. Retrieved November 13, 2023, from https://www.cdc.gov/dpdx/az.html
- Jarreau, P., & Bakeer, M. (2011). *Clinical laboratory science review: A bottom line approach*. Louisiana State University Health Sciences Center Foundation.