Chapter 9: Nematoda

Roundworms

25,000 species
500,000 undescribed
most numerous
e.g. topsoil billions/acre

Trichinella spiralis

Unicellular (acellular)
protozoan protists

Poorly defined
tissue layers

Polypora
Placozoa

Uncertain
Priapulida
Chuergnatha
Gastrotricha
Entoprocta
Loricifera

Diploblastic

Cnidaria
Ctenophora

Triploblastic

Acoelomate

Platyhelminthes
Rynchocoea (Nemertea)
Mesozoa
Gnathostomulida

Protostomes

Annelida
Mollusca
Arthropoda
Onychophora
Pentastomida
Pogonophora
Sipuncula
Echiura

Multicellular (metazoa)

Coelomate

Nematoda
Kinorhyncha
Acanthocephala
Nematomorpha

Pseudocoelomate

Deuterostomes

Echinodermata
Hemichordata
Chordata
Main Distinguishing Characteristics & Life Styles

1. cylindrical shape, generally small
2. nonliving cuticle \( \Rightarrow \) desiccation \( \Rightarrow \) restricted to moist environments
3. cuticle shed during four juvenile growth stages
4. lack motile cilia or flagella, except for one species
5. only longitudinally muscles lie beneath the cuticle; no circular muscles
6. lack protonephridia; one or more large glands or similar structures serve for excretion (renette cells?)
7. express eutely = a set number of cells
8. pseudocoel (hydrostatic skeleton) longitudinal muscles contract
9. live in virtually all habitats
10. free-living: feed on bacteria, yeasts, fungal hyphae & algae
11. predatory: rotifers, tardigrades, small annelids & other nematodes
12. parasites: in nearly all animal & plant spp; economically important
13. important food for mites, insects, larvae and fungi
14. most nematodes dioecious with males smaller than females
noncellular cuticle secreted by underlying hypodermis

cuticle: layers of crisscrossing collagen → elasticity but constraining expansion
compression & stretching returns body to resting position when muscles relax

complete gut: mouth, pharynx, a non-muscular intestine, short rectum & anus
muscular pharynx sucks food in
intestine: one cell thick; food moves back as new food enters & body moves
defecation: opening anus & allowing pseudocoelomic pressure to expel feces
sensory papillae are at the head and tail; amphids pair of sensory organs on head lead into deep cuticular pit with modified cilia

parasitic nematodes bilateral pair of phasmids near posterior resemble amphids
Figure 15.04b  male: copulatory spicules hold female vulva open against hydrostatic pressure

Figure 15.02b  internal fertilization: eggs stored in the uterus until deposited
### Table 15.1

<table>
<thead>
<tr>
<th>Common and Scientific Names</th>
<th>Mode of Infection; Prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hookworm (Ankylostoma duodenale and Necator americanus)</td>
<td>Contact with soil; juveniles that burrow into skin; common in southern states</td>
</tr>
<tr>
<td>Pinworm (Enterobius vermicularis)</td>
<td>Inhalation of dust with eva and by contamination of fingers; most common worm parasite in United States</td>
</tr>
<tr>
<td>Intestinal roundworm (Ascaris lumbricoides)</td>
<td>Ingestion of embryonated eggs in contaminated food; common in rural areas of Appalachia and southeastern states</td>
</tr>
<tr>
<td>Trichina worm (Trichinella spp.)</td>
<td>Ingestion of infected muscle; occasional in humans throughout North America</td>
</tr>
<tr>
<td>Whipworm (Trichuris trichiura)</td>
<td>Ingestion of contaminated food or by unhygienic habits; usually common wherever Ascaris is found</td>
</tr>
</tbody>
</table>

---

**Figure 15.07**

**Life Cycle of Hookworms**

- **A**: Eggs passed in feces
- **B**: First-stage juvenile hatches
- **C**: Infective juveniles develop in soil
- **D**: Ankylostoma duodenale may infect humans by oral route
- **E**: Infective juveniles penetrate skin of human
- **F**: Juveniles migrate through circulatory system to lungs
- **G**: Juveniles break out of circulatory system into alveoli and then migrate to small intestine via the trachea
- **H**: Adult worms develop in small intestine, mate and produce eggs
Figure 15.06a: Mouth of hookworm with cutting plates.

Figure 15.06b: Esophageal glands secrete anticoagulant with muscular pharynx.
Nematode Parasites

**One Definitive Host**
A. Ascaris (intestine: feed on intestinal contents)
   1. Ascaris lumbricoides (max 49 cm length) human intestine
   2. Toxocara canis (dog) and T. cati (cat)

Hookworms (digestive tract: feed on blood) 380 million infected
1. Necator americanus

Pinworms (vertebrate/invertebrate gut)
1. Enterobius vermicularis affects children in the perianal region—children scratch anal area and lodge the eggs underneath fingernails which then can spread to other children or reinfect same host

**Trichinellosis**
Whipworms: Trichinella spiralis cysts in striated muscles of pig tissues—>trichinosis

**Intermediate & Definitive Hosts**
Filaricoids (lymphatic glands and other tissues)
   adults—filaria near lymph glands
   larvae-microfilariae: infective stage in blood when sucked up by intermediate hosts
   intermediate hosts: blood-sucking insects (fleas, certain flies, mosquitoes)
1. Wuchereria bancrofti (elephantiasis) enlargement of legs, scrotum, breast as result of increase in connective tissues
2. Dirofilaria immitis (heartworm) heart/pulmonary arteries of dogs, wolves, foxes
3. Loa loa (African eye worm)

Dracunculoids
1. Dracunculus medinensis (guinea worm) wind up on match stick—>caduceus (symbol of medical profession)
   larvae ingested by copepod crustaceans (Cyclops)

---

**Figure 15.10**

**Life Cycle of Wuchereria bancrofti**

- **A.** Mosquito ingests microfilariae when biting human
- **B.** Ingested microfilariae pass through mosquito gut into hemocoel and eventually develop into infective juveniles
- **C.** Infected mosquito transmits infective juveniles, which enter through wound puncture
- **D.** Juveniles migrate via lymphatics to regional lymph nodes
- **E.** Adult worms develop to sexual maturity in different lymphatic vessels
- **F.** Adult worms mate and female eggs birth to microfilariae
- **G.** Microfilariae migrate to bloodstream
- **H.** Blood vessel
**Figure 15.05a**

Ascaris lumbricoides

Infection up to 64% of people in some areas of the SE U.S. > 1.2 billion affected worldwide.

**Figure 15.05b**

Ascaris suum

pig intestine

pig intestine
Trichinella spiralis

juveniles in muscle cells
10-20 yrs
calcified
Figure 15.09a
Female pinworm *Enterobius vermicularis* from large intestine

Figure 15.09b
Pinworm eggs passing out of anus;
Scratching anus re-infection through fingernails or clothing
Figure 15.11

**elephantiasis**

Figure 15.12

**Dirofilaria immitis**

In right ventricle with worms extending up into right & left pulmonary arteries of 8 yr old Irish setter
SEX-DETERMINING GENE
Homology can be humbling. David Zarkower, an assistant professor in the Institute of Human Genetics at the University of Minnesota Medical School in Minneapolis, and coworkers have identified a shared DNA-binding region in a sex-determining gene in the nematode Caenorhabditis elegans, the fruitfly Drosophila melanogaster, and maybe humans (C.S. Raymond et al. Nature, 391:681-5, 1998). This is surprising, because determination differs substantially among animal lineages.

1. sex-determining genes
2. homeobox genes

Caenorhabditis elegans: model genomics & cell development & differentiation