LESSON 13

PHYLUM NEMATHELMINTHES. GEOHELMINTS.

Introduction

Phylum Nemathelminthes is a diverse animal phylum inhabiting a very broad range of environments. The total number of nematode species has been estimated to be about 1 million, more than half are parasitic.

General characteristics (fig. 1).

1. Bilaterally symmetrical.
2. Unsegmented.
3. Pseudocoelomate(the body cavity filled with fluid which is under pressure).
4. Body is elongated, cylindrical, round in cross sections.
5. Body wall is made of 3 layers:

✓ Outer non-cellular cuticle.

✓ Subcuticular epithelium (hypodermis).

✓ Muscle layer divided into 4 groups by the longitudinal cords.

6. ***Digestive system****:* a simple tube extending from the mouth to the anus.
7. ***Excretory system***: nitrogenous waste is excreted in the form of ammonia through the body wall, and is not associated with any specific organs.
8. ***Nervous system***: four peripheral nerves run the length of the body on the dorsal, ventral, and lateral surfaces.
9. ***Reproductive system***: Nematodes have separate sexes and reproduces sexually; the female is usually larger than the male. The male typically has a coiled tail. The female system consists of two convoluted tubes differentiated into two ovaries, oviducts, uteri that join to form one vagina opening by the vulva; the male system is composed of a long convoluted tube differentiated into a testis, vas deferens, seminal vesicle and ejaculatory duct that opens in the cloaca.

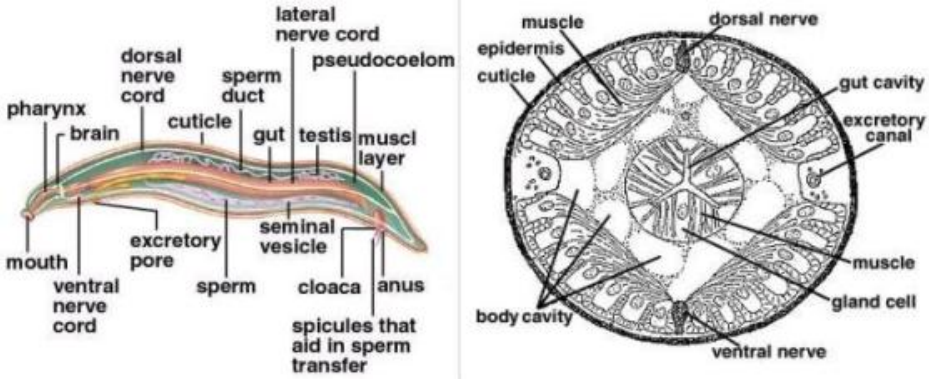


Fig. 1. Morphology of Nematodes.

Depending on the features of life cycle helmintic parasites can be classified as follows.

Geohelminthes which develop without alternation of hosts and part of their life cycle passes in soil.

Biohelminthes which develop with alternation of hosts; parasitic forms often have quite complicated life cycles, moving between several different hosts or locations in a host's body.

Contact helminthes in which all stages of parasite development pass in human organism. Direct contact with patient and host may occur by physical contact (through handgrip) or indirectly by contaminated objects (through pencils, toys).

CLASS NEMATODA

ASCARIS LUMBRICOIDES

Ascaris lumbricoides, giant roundworm, is the most common parasitic worm in humans. According to some estimates 25 % of humans are infected with Ascaris.

*Disease**:*** ascariasis.

Geographic distribution: worldwide, mostly in tropical and subtropical countries. It has highest prevalence in areas of poor sanitation and where human feces are used as fertilizer.

Localization in human body: small intestine.

Morphology: adult females are 20–35 cm long and 3–6 mm in diameter. Male worms are a little smaller reaching 15–30 cm in length and 2–4 mm in width.

Mode of transmission: by means dirty hands, water or food that has been contaminated with feces of an infected human.

Life Cycle (fig.2).

Pathogenesis: ascariasis can be asymptomatic, if there are only a few worms. If there are tens or hundreds of worms, symptoms might include: diarrhea, fever, nausea, stomach ache.

When larvae migrate through the lungs, the following pulmonary symptoms may occur: breathing difficulty, cough and/or coughing up blood, eosinophilic neumonitis.

Diagnosis:

- ✓ **m**icroscopic identification of eggs in stool specimens.
- ✓ microscopic identification of larvae in sputum.

Prevention and control:

- ✓ Avoid touching soil that might be contaminated with human feces.
- ✓ When traveling to areas where hygiene and sanitation are poor, avoid food and water that might be contaminated with soil.
- ✓ Wash hands with water and soap before eating or preparing food.

✓ Wash, peel or cook all fruits and vegetables before eating.

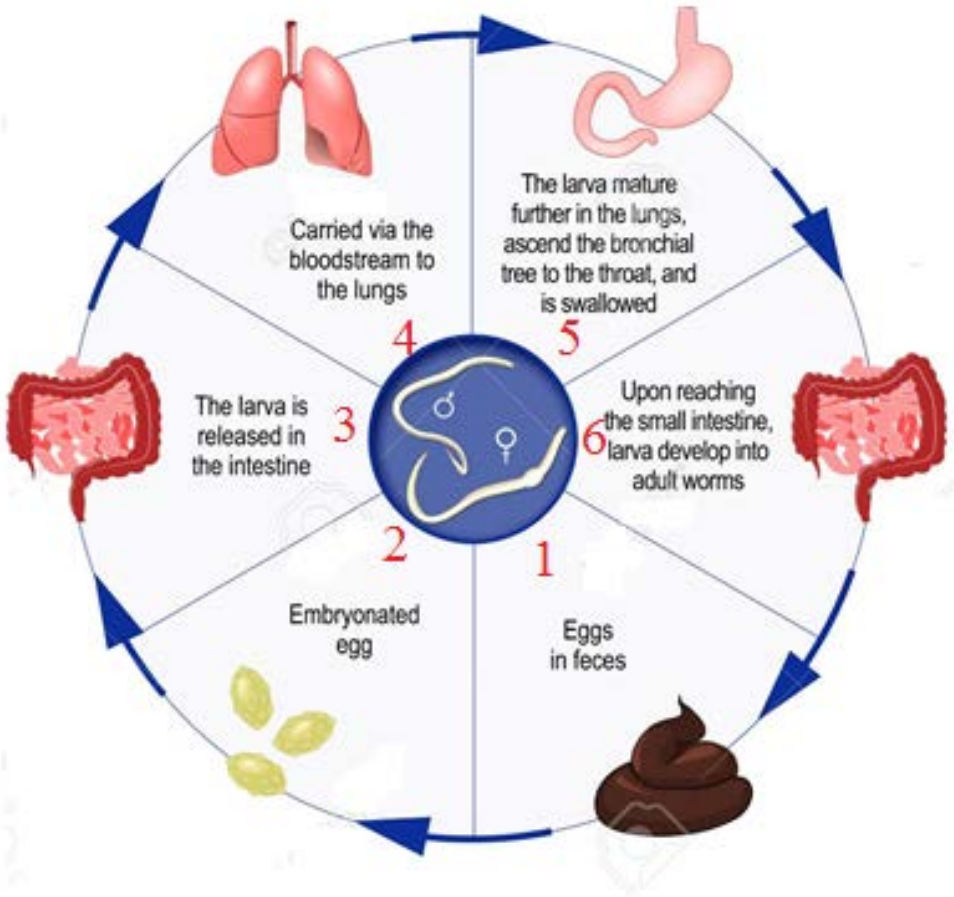


Fig. 2. Life cycle of Ascaris lumbricoides

ENTEROBIUS VERMICULARIS (PINWORM)

Human pinworm, *Enterobius vermicularis*, is the most common parasitic worm infection and are particularly common in children.

*Disease**:*** enterobiasis.

Geographic distribution: worldwide.

Localization in human body: small and large intestine.

Morphology: adults are white, thin worms. Males are 0.2 mm thick and 2–5 mm long whereas females are 0.5 mm thick and 8–13 mm long. Life expectancy for males is seven weeks whereas females live 5–13 weeks.

Mode of transmission:

✓ self-infection occurs by transferring infective eggs to the mouth with hands that have scratched the perianal area.

✓ person-to-person transmission can also occur through handling of contaminated clothes or bed linens.

- ✓ through surfaces in the environment that are contaminated with pinworm eggs (e.g., curtains, carpeting).
- ✓ some small number of eggs may become airborne and inhaled.

Life Cycle:

Eggs are deposited on perianal folds. These would be swallowed and follow the same development as ingested eggs . Following ingestion of infective eggs, the larvae hatch in the small intestine and the adults establish themselves in the colon. The time interval from ingestion of infective eggs to oviposition by the adult females is about one month. The life span of the adults is about two months. Gravid females migrate nocturnally outside the anus and oviposit while crawling on the skin of the perianal area. The larvae contained inside the eggs develop (the eggs become infective) in 4 to 6 hours under optimal conditions. Retroinfection, or the migration of newly hatched larvae from the anal skin back into the rectum, may occur but the frequency with which this happens is unknown (fig.3).

Pathogenesis: enterobiasis is frequently asymptomatic. The most typical symptom is perianal pruritus, especially at night, which may lead to excoriations and bacterial superinfection.

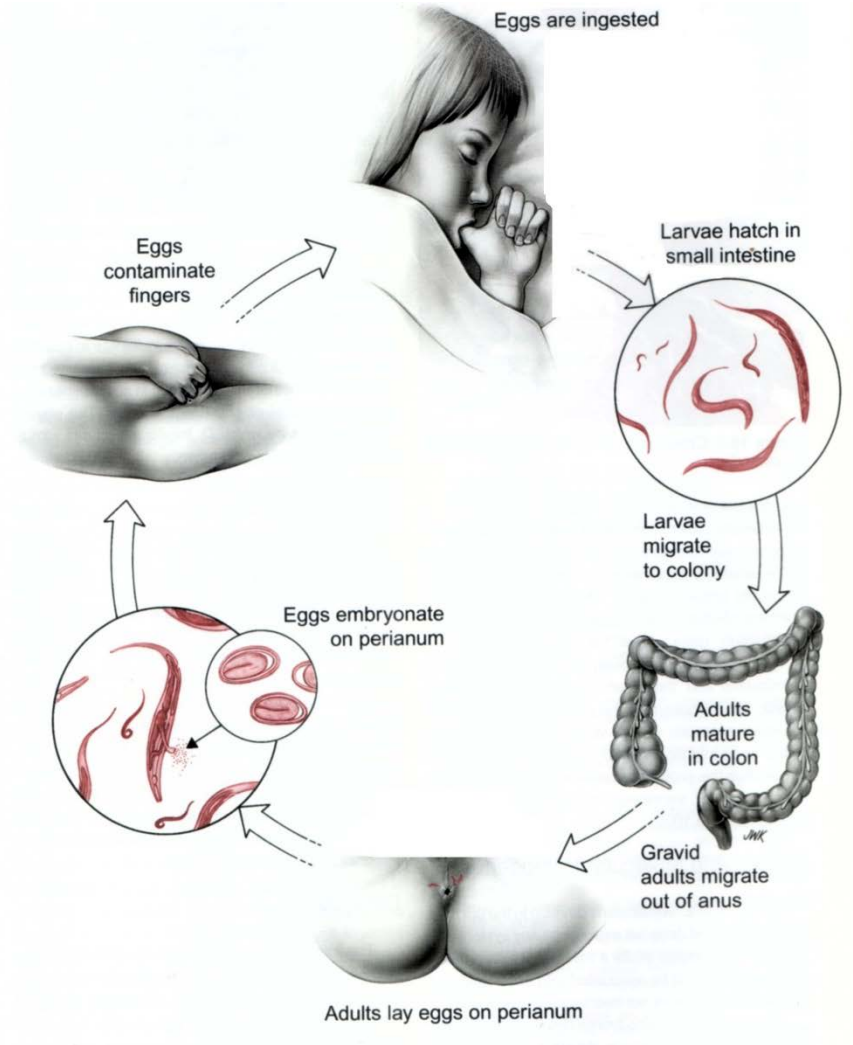


Fig. 3. Life cycle of Enterobius vermicularis

Diagnosis: microscopic identification of eggs ("Scotch test", cellulose-tape slide test) on the perianal skin and then examining the tape placed on a slide.

Prevention and control:

- ✓ keep fingernails short and do not bite your nails.
- ✓ wash your hands after using the toilet and before eating or preparing food.
- ✓ change clothing, towels, and sheets frequently and wash them in hot water, especially during and after pinworm treatment.
- ✓ if you have pets, keep them clean. The human pinworm, *Enterobius vermicularis*, does not infect other animals but pets can carry eggs in their fur.

TRICHURIS TRICHIURA (WHIPWORM)

Whipworm, *Trichuris trichiura*, is a parasitic worm infecting 500 million humans in tropical countries. It is estimated that 800 million people are infected worldwide.

*Disease**:*** trichuriasis.

Geographic distribution: worldwide, with infections more frequent in areas with tropical weather and poor sanitation practices, and among children.

Localization in human body: large intestine.

Morphology: the anterior end is thin and long whereas the posterior end is thicker. The thin front part is burrowed in your intestinal wall eating nutrients from the mucosa. Adult female is 35–50 mm, whereas male is about 30–45 mm long. Both sexes are white-pink in colour. Eggs are produced at the rate of 2000–10000 eggs per day.

Mode of transmission: by means soil-contaminated hands or food.

Life Cycle:

The unembryonated eggs are passed with the stool . In the soil, the eggs develop into a 2-cell stage , an advanced cleavage stage , and then they embryonate ; eggs become infective in 15 to 30 days. After ingestion (soil-contaminated hands or food), the eggs hatch in the small intestine, and release larvae that mature and establish themselves as adults in the colon . The adult worms (approximately 4 cm in length) live in the cecum and ascending colon. The adult worms are fixed in that location, with the anterior portions threaded into the mucosa. The females begin to oviposit 60 to 70 days after infection.. The life span of the adults is about 1 year.

Pathogenesis: most frequently asymptomatic. Heavy infections, especially in small children, can cause gastrointestinal problems (abdominal pain, diarrhea, rectal prolapse) and possibly growth retardation.

Diagnosis: microscopic identification of eggs in feces.

Prevention and control: personal hygiene.

ANCYLOSTOMA DUODENALE

NECATOR AMERICANUS

Hookworms are bloodsucking roundworms. There are thousands of hookworm species but only two of them target humans. ***Necator americanus*** and ***Ancylostoma duodenale*** infect over one billion people around the globe mostly in tropical and subtropical climates.

*Disease**:*** ancylostomiasis, necatoriasis.

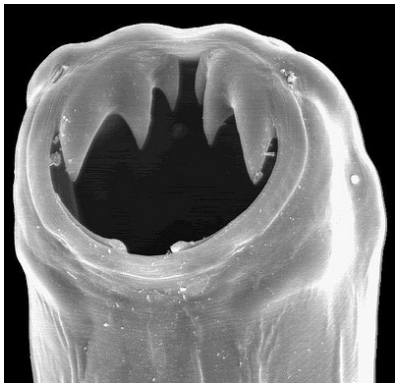
Geographic distribution: necatoriasis predominates in the Americas (North, Central and South America) and Australia, whereas ancylostomiasis occurs in the Middle East, southern Europe and North Africa.

Localization in human body: small intestine.

Morphology:

Necator americanus is gray-pink in colour; parasite has two dorsal and two ventral ***cutting plates*** around the anterior margin of the buccal capsule (fig.4). Male is 5–9 mm and female 10 mm long and about 0.5 mm thick. Usually they live a few years but can live up to 15 years. Females produce up to 10 000 eggs per day.

Ancylostoma duodenale is small cylindrical worm, greyish-white in color. It has ***four large teeth*** in the buccal capsule. Males are 8 mm to 11 mm long with a copulatory bursa at the posterior end. Females are 10 mm to 13 mm long, with the vulva located at the posterior end; females can lay 10,000 to 30,000 eggs per day. The average lifespan of Ancylostoma duodenale is one year.



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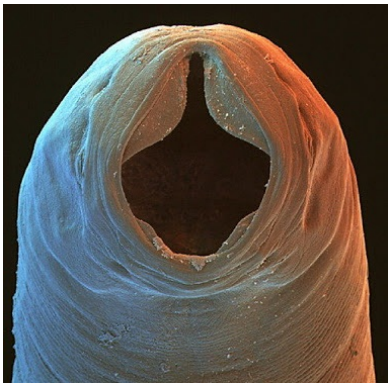

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Fig. 4. Structure of mouth part of Ancylostoma duodenale (1) and Necator americanus (2).

Mode of transmission: by penetration the skin by larvae; by the oral and transmammary route. *N. americanus*, requires a transpulmonary migration phase.

Life Cycle:

Eggs are passed in the stool, and under favorable conditions (moisture, warmth, shade), larvae hatch in 1 to 2 days. The released ***rhabditiform larvae*** grow in the feces and/or the soil , and after 5 to 10 days (and two molts) they become ***filariform*** (third-stage) larvae that are

infective . These infective larvae can survive 3 to 4 weeks in favorable environmental conditions. On contact with the human host, the larvae penetrate the skin and are carried through the blood vessels to the heart and then to the lungs. They penetrate into the pulmonary alveoli, ascend the bronchial tree to the pharynx, and are swallowed. The larvae reach the small intestine, where they reside and mature into adults. Adult worms live in the lumen of the small intestine, where they attach to the intestinal wall with resultant blood loss by the host . Most adult worms are eliminated in 1 to 2 years, but the longevity may reach several years (fig. 5).

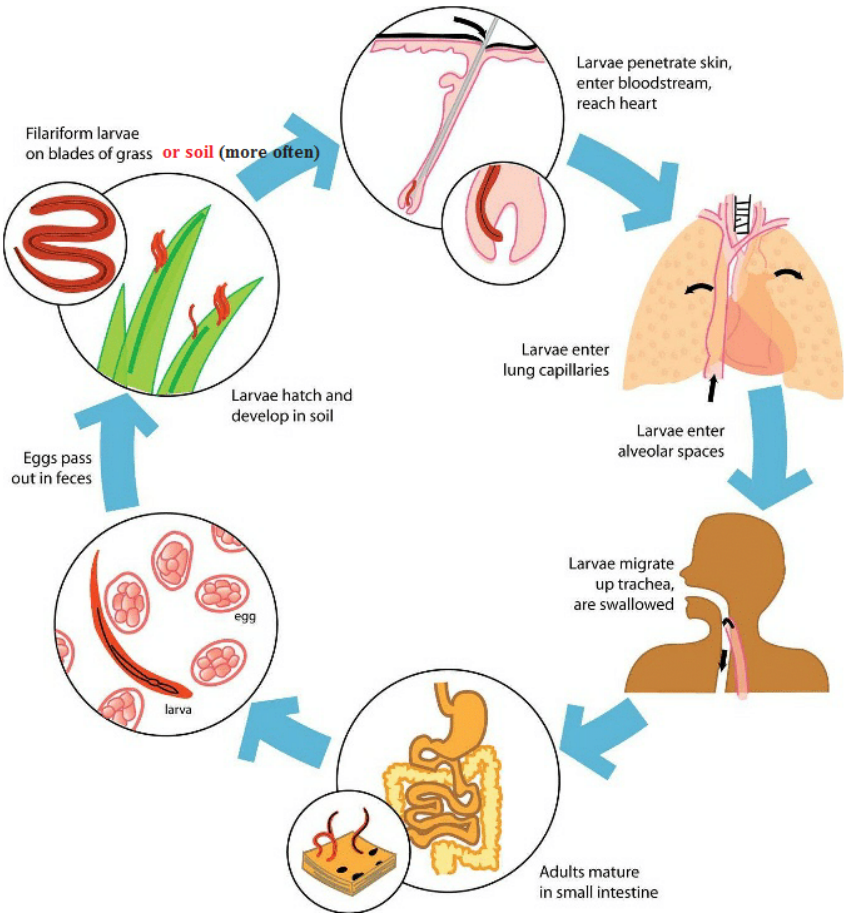

Fig. 5. Life cycle of Ancylostoma duodenale and Necator americanus

Pathogenesis:

Infected humans are more often adult men who work barefoot on fields. Hookworm infection is the most problematic for women and children. Women lose blood with menstrual flow once a month. They also need extra nutrients for babies. In some developing countries 30 % of pregnant women are infected with hookworms. Their newborn babies might have low birth weights or even die. When a woman gives birth, she excretes certain hormones into the bloodstream. The sleeping larvae (only*Ancylostoma duodenale*) in the muscles wake up and find their way into the mammary glands. When the mother breastfeeds her baby, the child gets infected, too.

Hookworms can cause some of the following **symptoms**:

- ✓ anemia (pale skin etc.) and protein deficiency caused by blood loss.
- ✓ congestive heart failure.
- ✓ dizziness.
- ✓ dyspnea (shortness of breath).
- ✓ excessive coughing during larvae migration.
- ✓ fatigue (tiredness).

Diagnosis: microscopic identification of eggs in feces.

Prevention and control:

- ✓ not to walk barefoot in areas where hookworm is common and where there may be human fecal contamination of the soil.
- ✓ avoid other skin contact with such soil and avoid ingesting it.
- ✓ not defecating outdoors and by effective sewage disposal systems.