Lesson №21

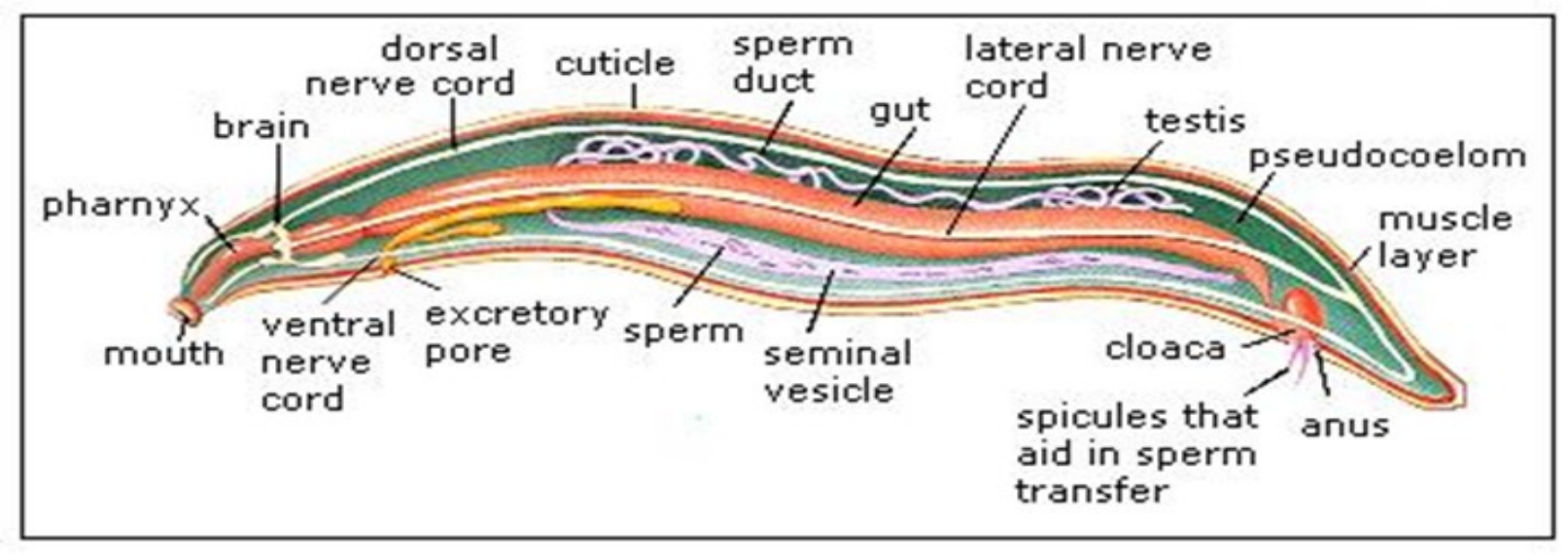
PHYLUM NEMATHELMINTHES, CLASS NEMATODA

General characteristic of the phylum Nemathelminthes and the class Nematoda

Over 15 000 species inhabit water, soil, decaying organic matter; many of them have adapted to a parasitic mode of life.

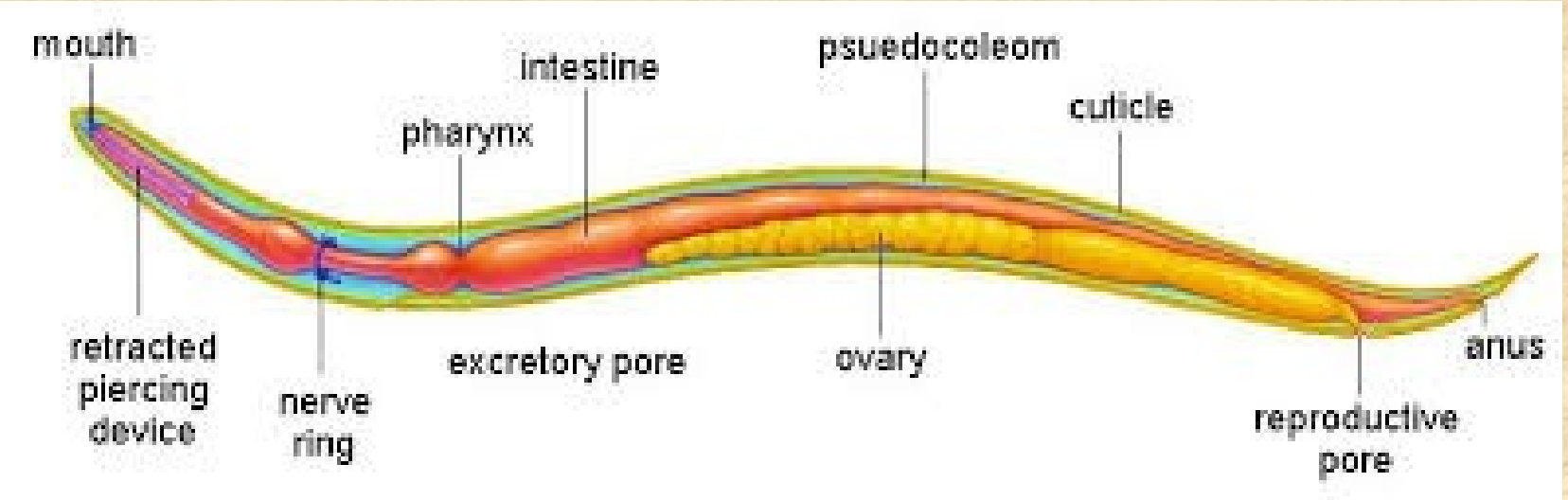
Characteristic features of the phylum:

1)three germ layers;
2)bilateral symmetry of the body;
3)cylindrical or spindle-like shape of the body;

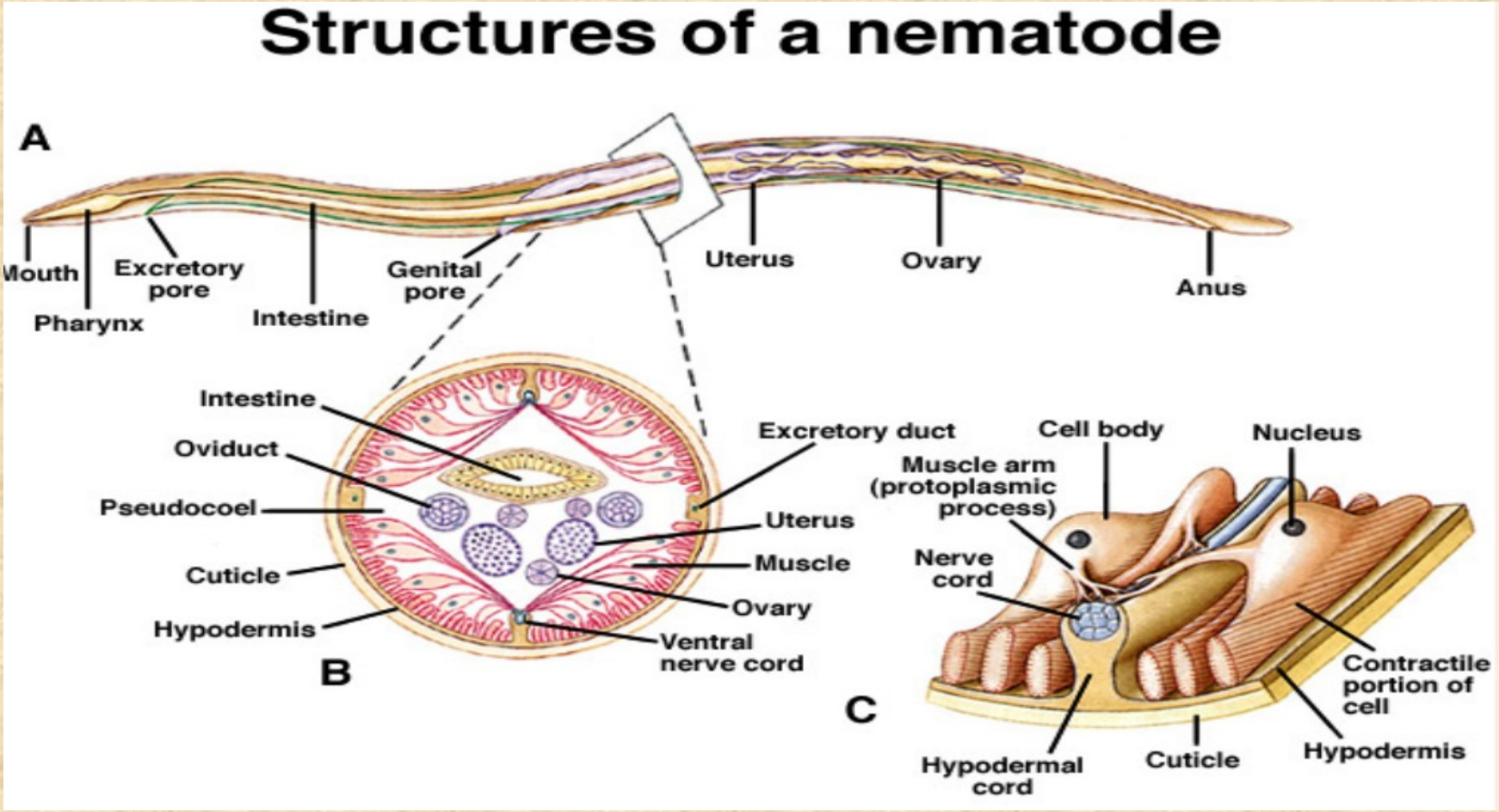


1) presence of a dermo-muscular body wall and the primary body cavity;
2) presence of nervous, digestive, excretory and reproductive systems;
3) they are dioecious (have separate sexes);
4) hindgut and the anus have appeared.

The phylum includes 5 classes. The class Nematoda has a medical significance.



Structures of a nematode



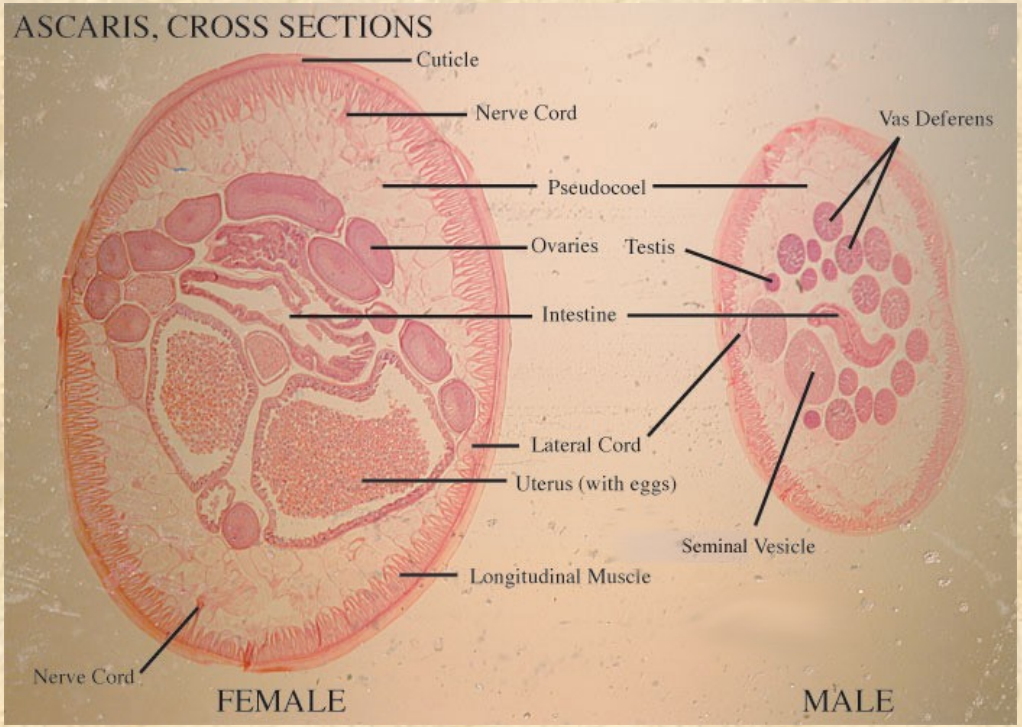
The body is spindle-like, its length can be from 1 mm to 1.5 m. Cross-section of the body is round. The body is covered with *dermo-muscular wall,* consisting of a cuticle, hypodermis and one layer of smooth muscles. The body cavity is primary (*pseudocoel*). It contains internal organs.

The digestive system consists of 3 regions: foregut, midgut and hindgut.

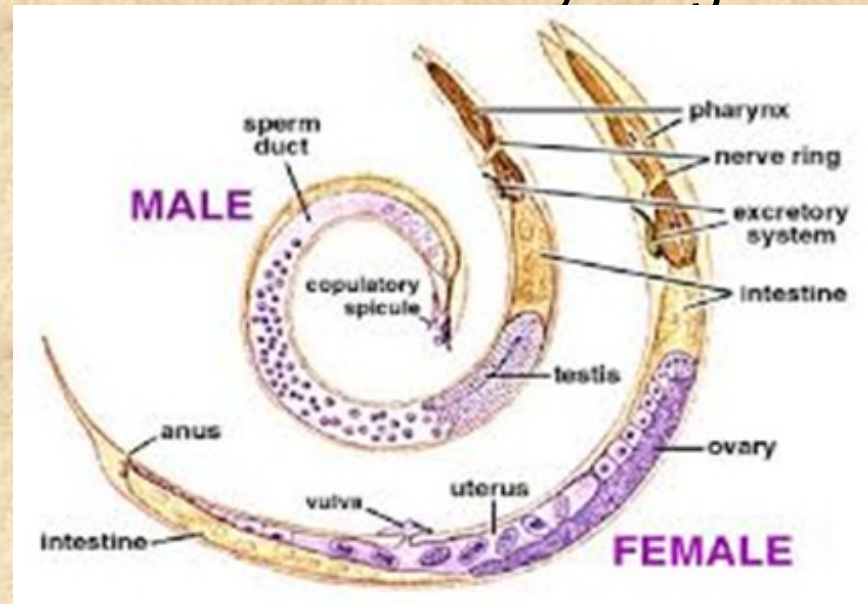
The excretory organs are 1–2 cutaneous glands. Removal of wastes is also performed by phagocytes.

The nervous system consists of a suprapharyngeal and subpharyngeal ganglions, circumpharyngeal nerve ring and longitudinal nerve chords. Nematodes have *tactile and chemical sense organs*.

You must draw this picture in your drawing book.

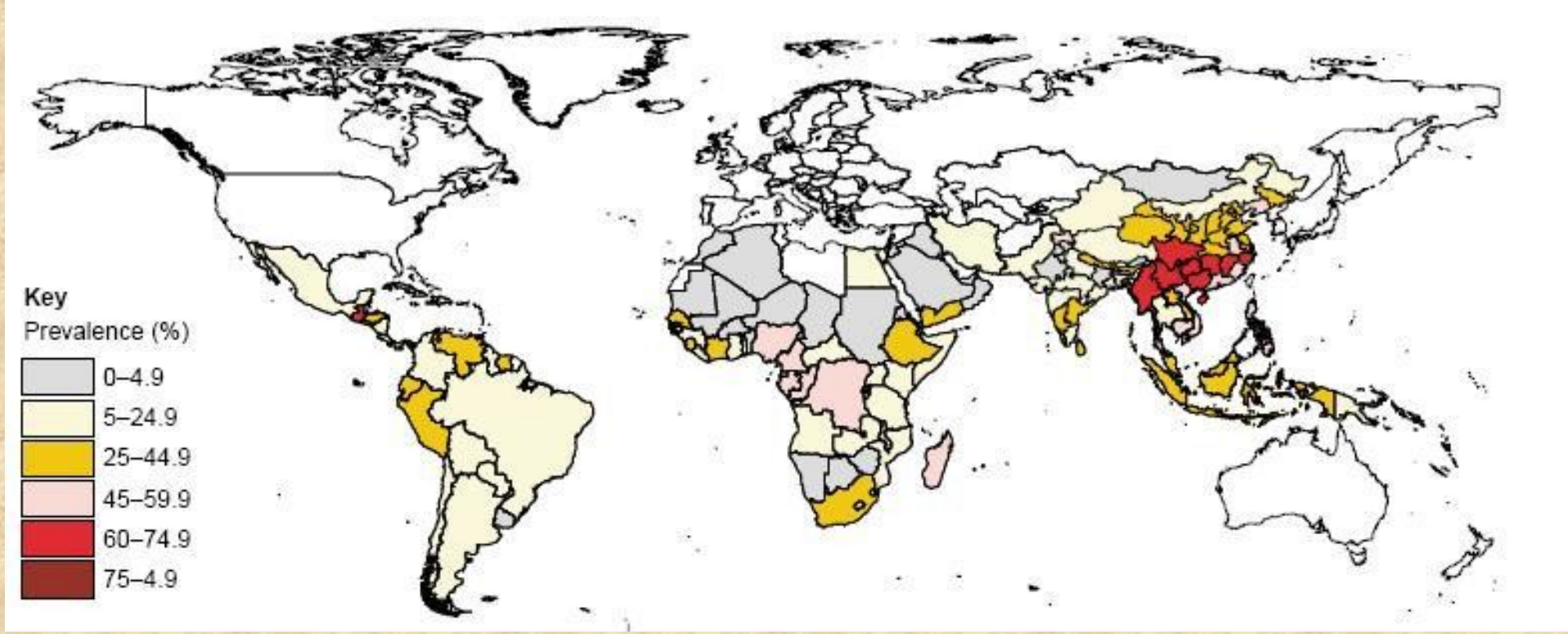


Nematodes are dioecious and have noticeable sexual dimorphism: males are smaller than females and their posterior end spirally curved. *The reproductive system* is tubular. In females it starts with long paired ovaries. Each ovarium widen to form an oviduct, the oviducts are followed by uteri which join together to form vagina. The reproductive system of males consists of an unpaired testis, vas defferens, ejaculatory duct that opens into the hindgut. Some species are viviparous. The majority of nematodes are geohelminthes. Diseases caused by ring worms are called *nematodoses*.



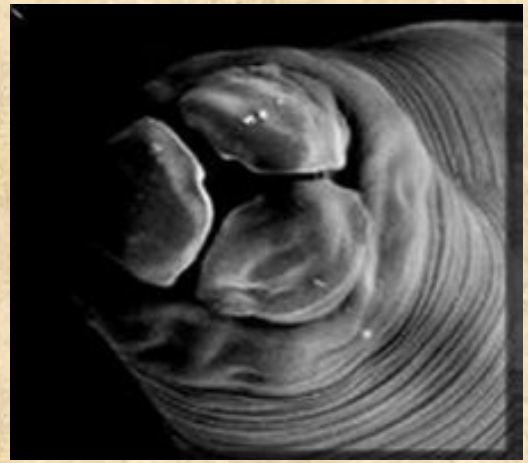
Ascaris lumbricoides

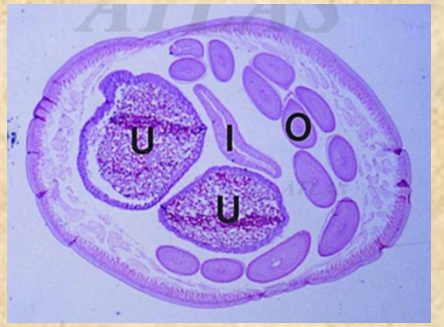
Ascaris lumbricoides is a geohelminth, pathogen of ascariasis. The disease is antroponosis. It is common everywhere exept arctic areas, deserts and semi-deserts.

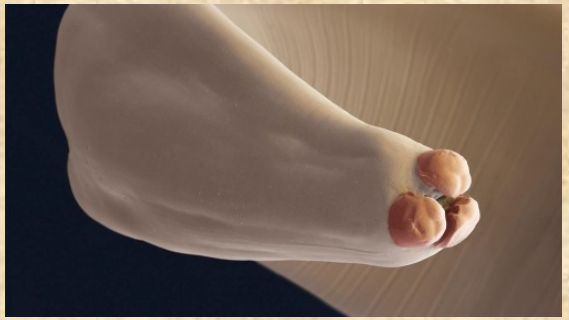


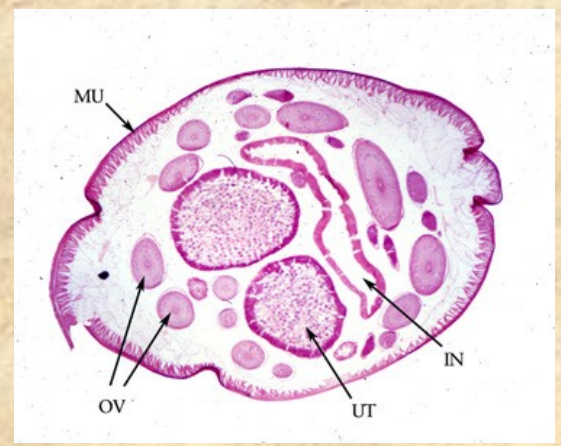
Ascaris lumbricoides

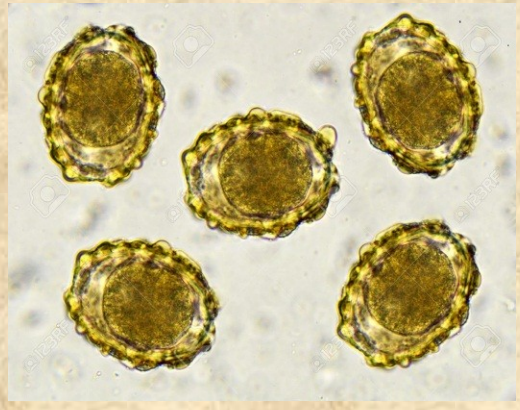
Morphological peculiarities: the length of a female is up to 40 cm, that of a male — 25 cm. The body is cylindrical, sharpened at the ends. There are cuticular lips on the anterior end of the body.



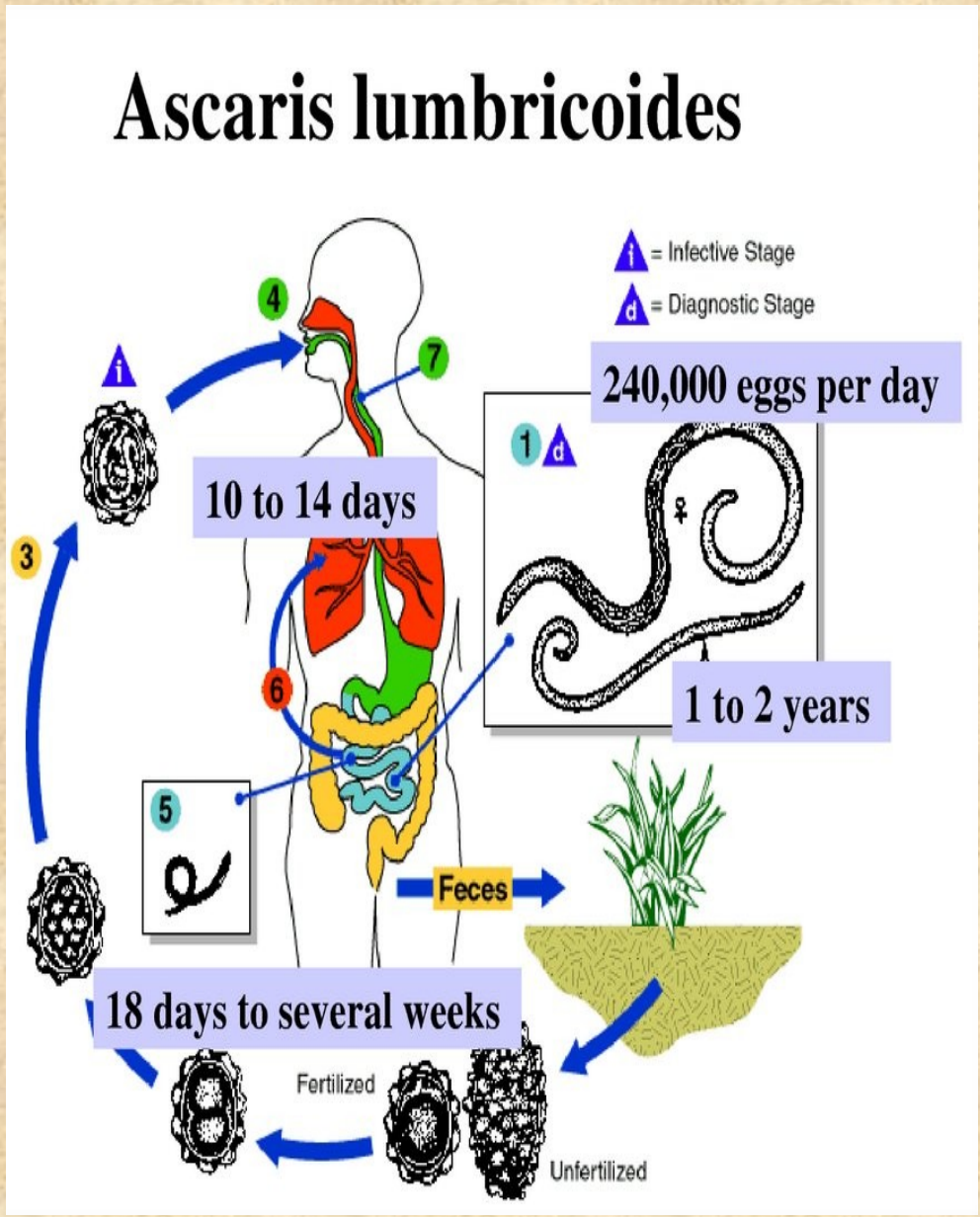




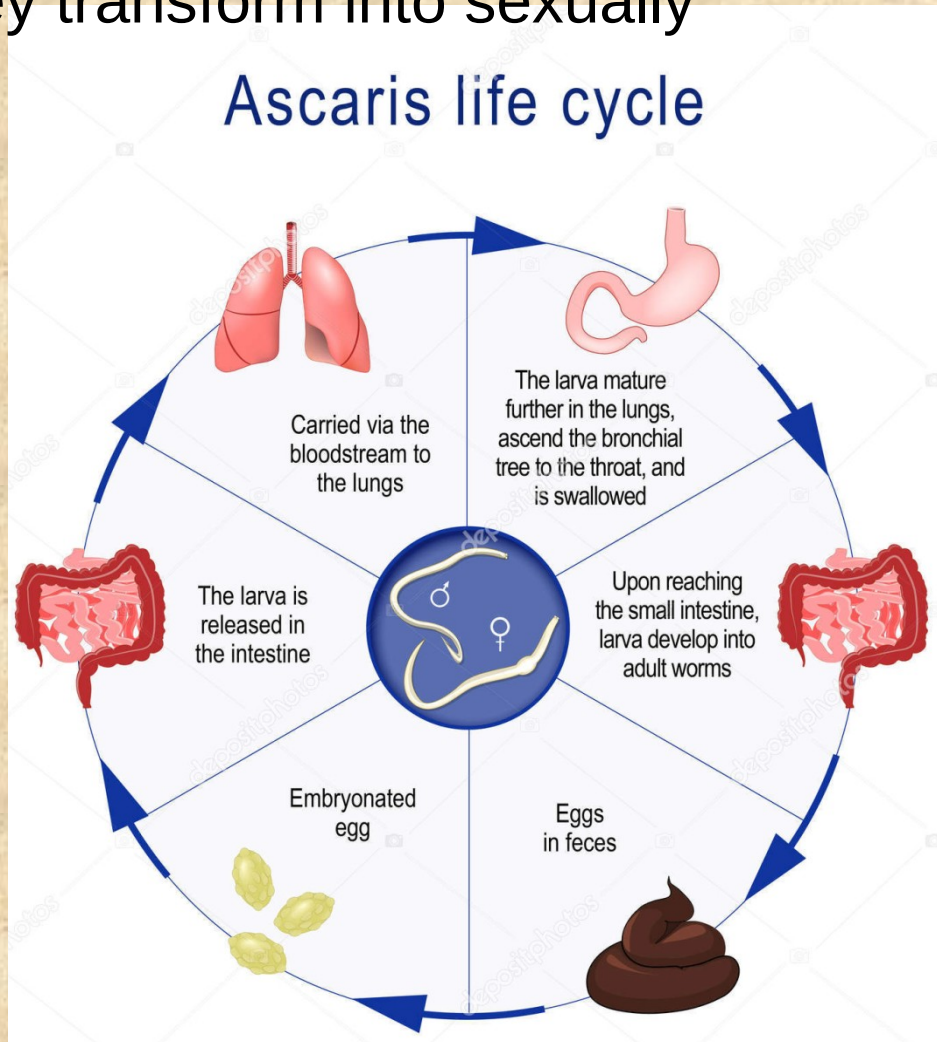




Life cycle: a sexually mature ascaris is located in a small intestine. A fertilized female lays up to 240 000 eggs per day, they are excreted into the environment with feces. Eggs develop in soil in proper temperature (20–25 °C), humidity and oxygen. This takes 21–24 days. Such eggs get into the human organism with unwashed vegetables, fruit and water. In the small intestine larvae come out of eggs, perforate its wall, get into blood vessels and *migrate.*



Blood carries them through the liver, right atrium, right ventricle, pulmonary trunk and alveolar capillaries. Through the capillary walls larvae get into alveoli, ascend to bronchioles, bronchi, trachea and get into the pharynx to be swallowed. In 2.5–3 months they transform into sexually mature worms in a small intestine. Larval migration lasts about 2 weeks. The life span of mature ascaris is about 1 year. Larvae of another ascaris species (ascaris of pigs, dogs, etc.) may also migrate in the human organism but cannot complete the life cycle. The syndrome they cause is called Larva migrans.



Pathogenic action:

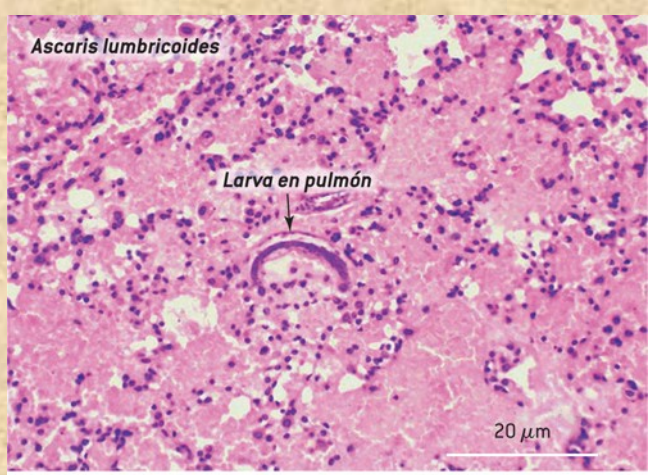
1. *Toxicoallergic* (poisoning by waste products).

2. *Mechanical* (injury of the liver, rupture of capillaries, injury of alveoli).

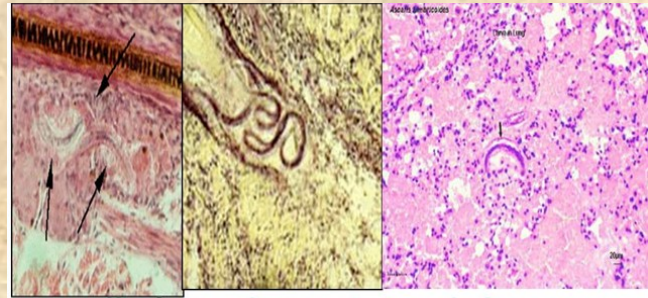
3. *Feeding at the expense of the host's organism and impairment of metabolic processes (absorption of nutrients and vitamins).*

4. *Mutagenic.*

Clinical manifestations of larval migration stage of ascariasis: persistent spastic cough especially at night, skin rash and itching, weakness, fever, headache, perspiration, oedema of lids and face.



Fuente: Werner Louis Apt Baruch: *Parasitología humana,* www.accessmedicina.com



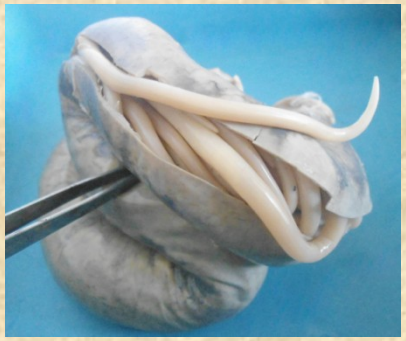
Loeffler`s syndrome: Larvae in lung

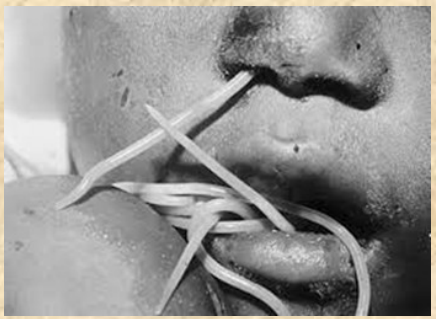
pnumonia,cough ,bloody sputum

Clinical manifestations of intestinal stage of ascariasis: pains in the abdomen, nausea, vomiting, diarrhea, worsening of appetite, weakness, irritancy, worsening of memory, loss of weight.

Complications of intestinal ascariasis: obstructive jaundice, purulent pancreatitis, purulent cholangitis, appendicitis, peritonitis, spastic and mechanic intestinal obstruction. Sometimes ascarides are found in frontal sinuses, cranial cavity, middle ear and ovaries.

Fig. 2. *A. lumbricoides* sticking out of the appendiceal orifice.
A. Lumbricoides *asomando por el orificio apendicular.*





Laboratory diagnostics: finding eggs in feces, detection of larvae in blood during migration

Personal prophylaxis involves observing rules of hygiene, washing vegetables, fruits and berries with hot water. It is necessary to protect food from flies and cockroaches as they are mechanical vectors for eggs of ascaris.

Social prophylaxis is revealing and treating sick people, protection of the environment from contamination with ascaris eggs, health education.

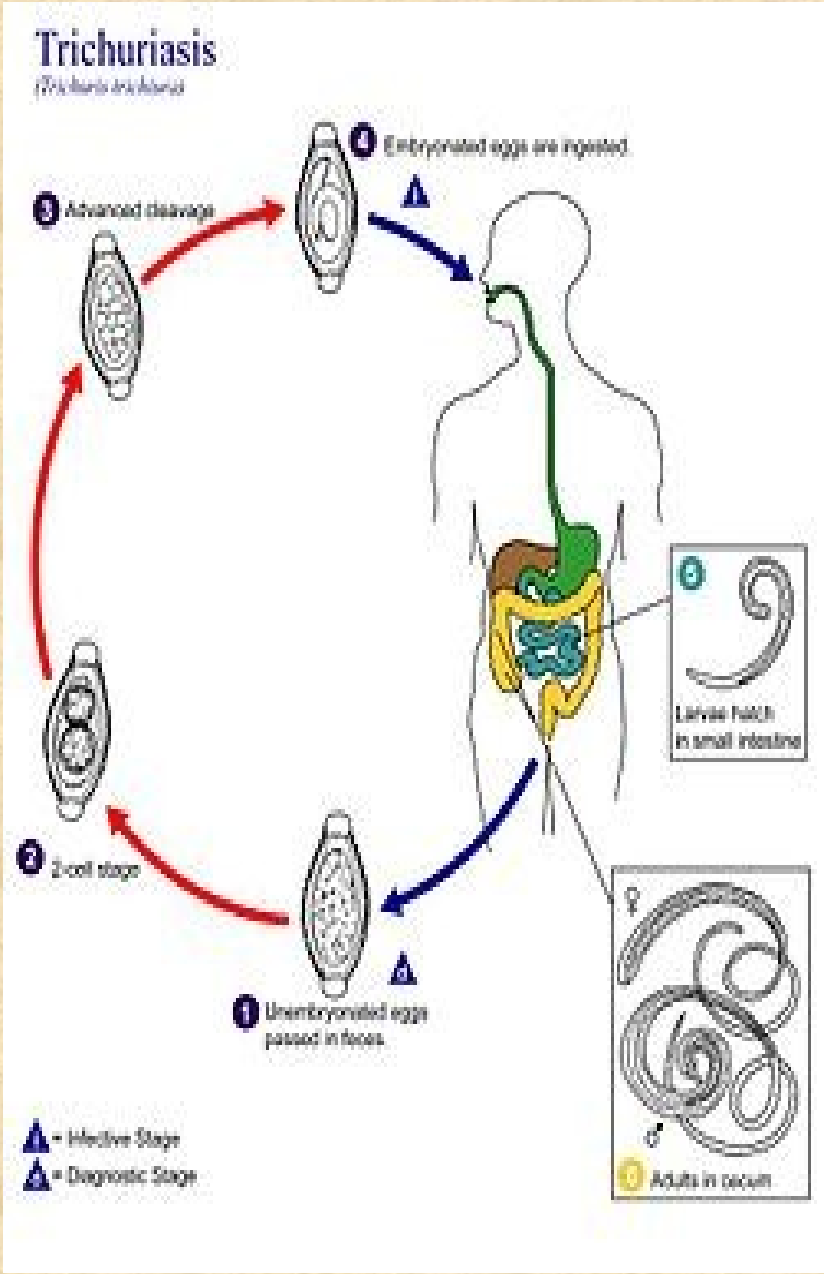
Trichocephalus trichiurus

Trichocephalus trichiurus (human whipworm) is a geohelminth, pathogen of trichocephaliasis. The disease is common everywhere.

Morphological peculiarities: the length of a female is up to 5 cm, males are a shorter. The anterior region of the body is thin and filament-like and contains only esophagous. The posterior one is thicker, it contains all other organs. Parasites are located in the upper region of the large intestine (mainly in the caecum).

You must draw this pictures in your drawing book.

Life cycle. A fertilized female lays up to 60 000 eggs a day; they are excreted to the environment with feces. The development of eggs occurs in soil. In optimal conditions (temperature 25–30 °C, high humidity, presence of oxygen), an invasion larva maturates in 25–30 days. The human gets infected while eating vegetables, fruit and water contaminated with parasite's eggs. In the intestine larvae come out of eggs and in 1–1.5 months become sexually mature. Migration of larvae does not occur. The whipworm's life span in the body is more than 5 years.



Pathogenic action:

1. *Mechanical* (injury of the mucous membrane of the intestine).

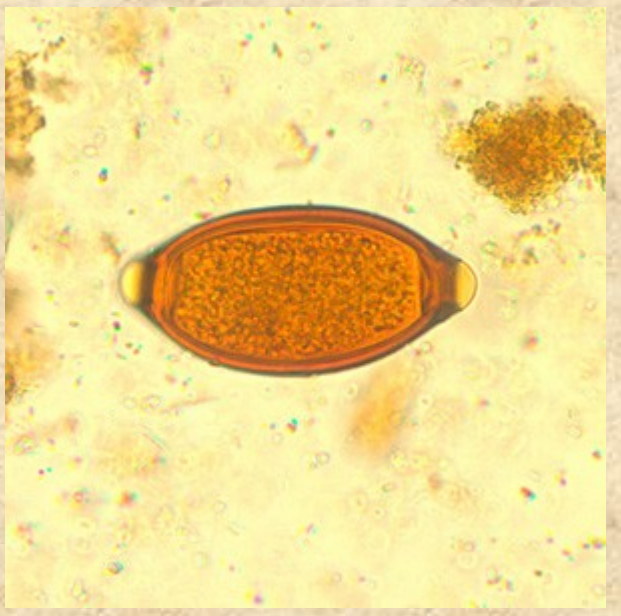
2. *Toxicoallergic* (poisoning by waste products).

3. *Feeding at the expense of the host's organism and impairment of metabolic processes* (they perforate intestinal mucous membrane by an anterior end and feed on blood).

4. *Mutagenic*.

Clinical manifestations: ache along the large intestine, irregular stool, meteorism, poor appetite, nausea, vomiting, weakness, headache. *Complications*: anemia, appendicitis and convulsive attacks.

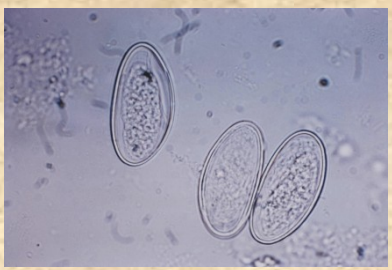
- **Laboratory diagnostics:** finding eggs in feces. Eggs have a lemon shape and «plugs» on the poles.
- **Prophylaxis:** the same as in ascariasis.



Enterobius vermicularis

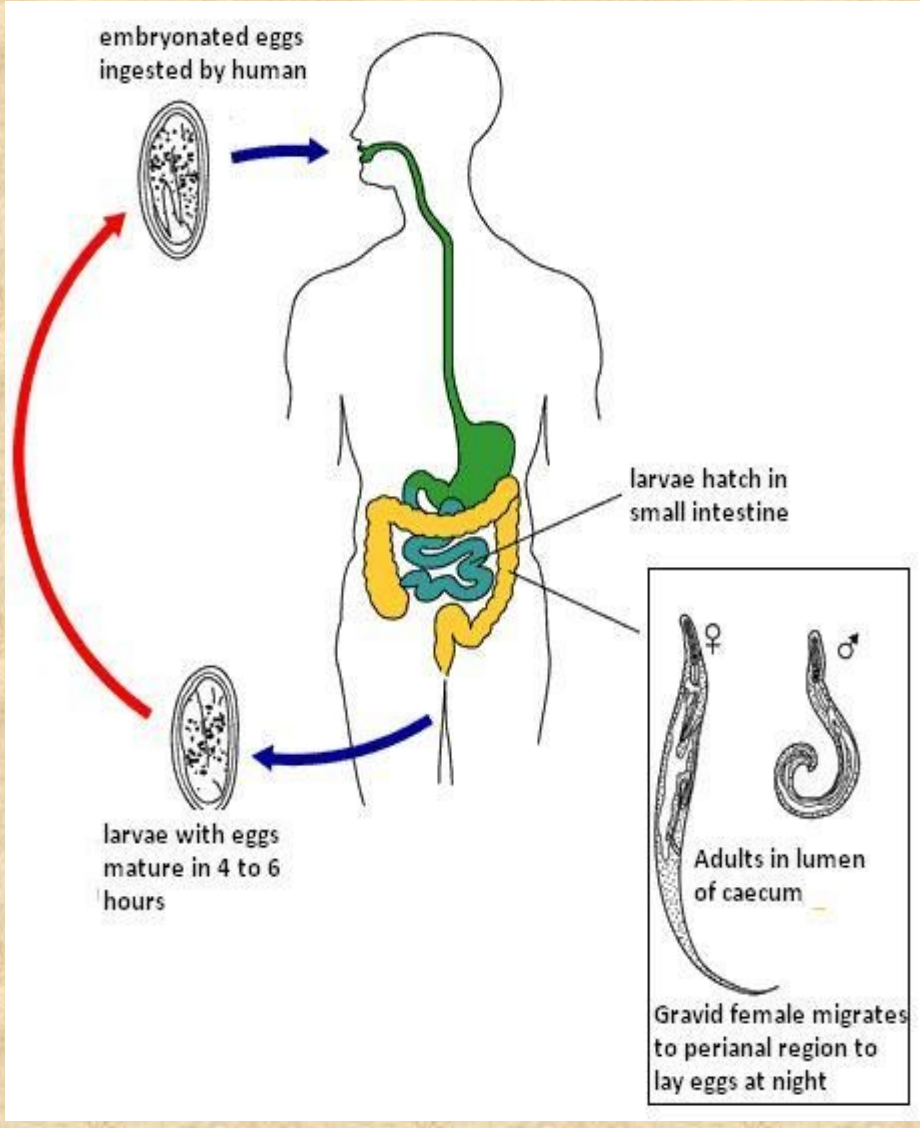
Enterobius vermicularis (**seatworm or pinworm)** a contact helminth, a pathogen of enterobiasis. The disease is common everywhere.

Morphological peculiarities: the length of a female is about 10 mm, that of a male is 2–5 mm . There are vesicles (cuticular swellings) at the anterior part of the body. Posterior part of the esophagus has a bulb — a ball-like dilation that takes part in fixation of the parasite to intestinal walls.

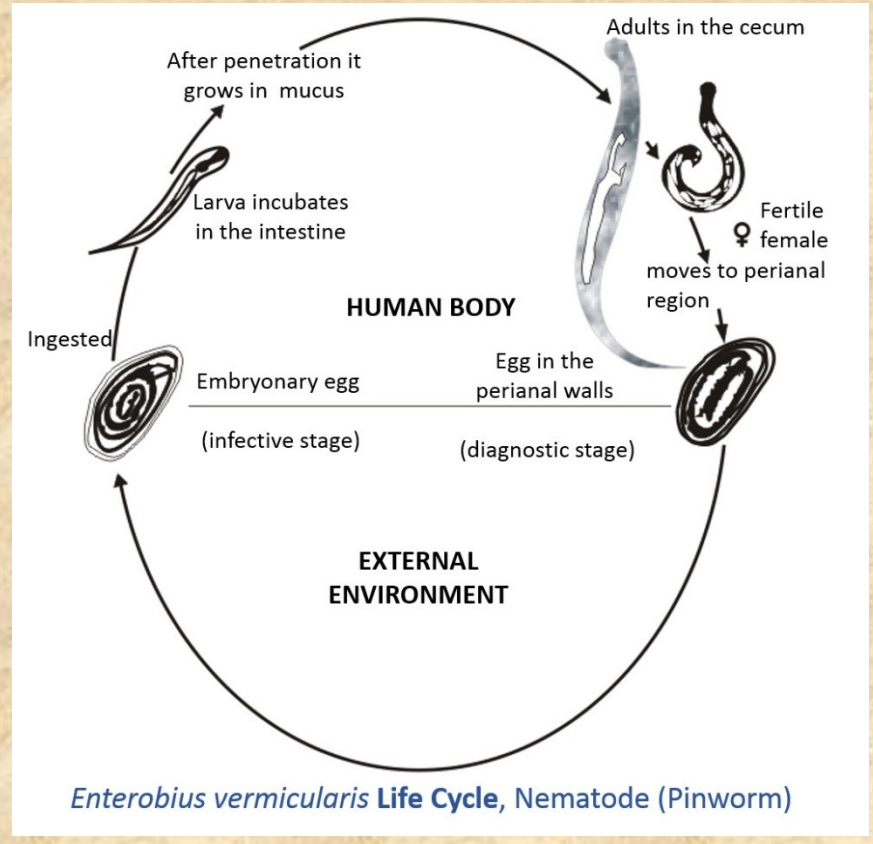


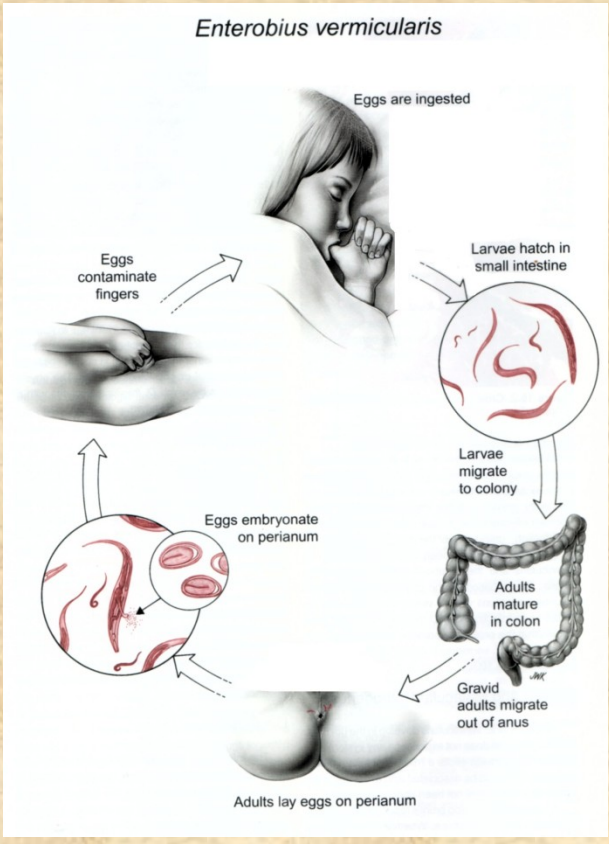
You must draw this picture in your drawing book.

Life cycle. Pinworms settle in the terminal region of the small intestine and in the beginning of the large intestine. After fertilization females crawl out of the anus, lay eggs on the skin of the perineum and excrete irritating fluid that causes itching. In proper conditions (temperature is 34–36 °C, humidity 70–90 %, oxygen), the eggs maturate in 4–6 hours.



Sick people scratch itching skin and eggs get under nails. Later on they can be brought into the mouth or household goods. If the eggs are swallowed and get to the intestine of the host, larvae come out of eggs and in 2 weeks reach sexual maturity. The life span of a seatworm is about a month. Pre-school and junior school children fall ill more often.





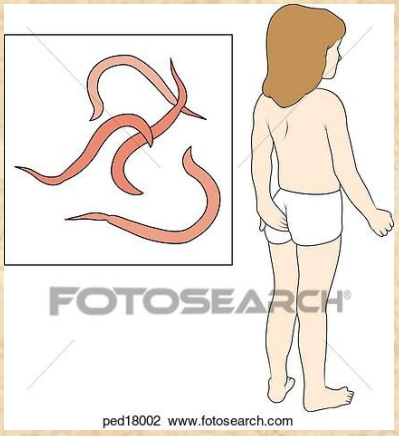
Pathogenic action:

1. *Mechanical* (injury of the intestinal mucous membrane).

2. *Toxicoallergic* (poisoning by waste products).

3. *Feeding at the expence of the host's organism and impairment of metabolic processes*.

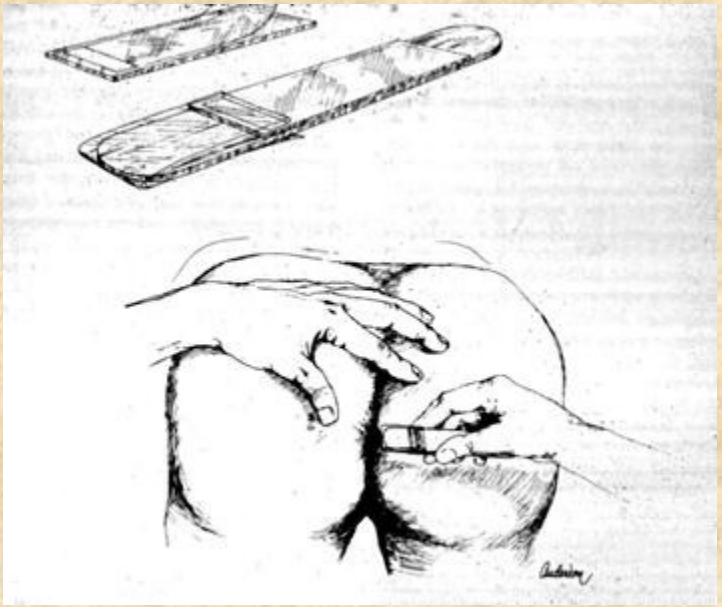
Clinical manifestations: itching and a burning sensation around the anus. Itching troubles patients day and night, becomes unbearable, spreads to the perineum, sex organs and abdomen. The well-being and sleep of patients become worse, there appears irritancy, diarrhea with mucus, nausea, vomiting, borbo-rygmus and aerocolia, academic progress of children worsens.



Laboratory diagnostics: finding eggs by an adhesive tape test. Eggs are colorless, asymmetric, one side is flattened.

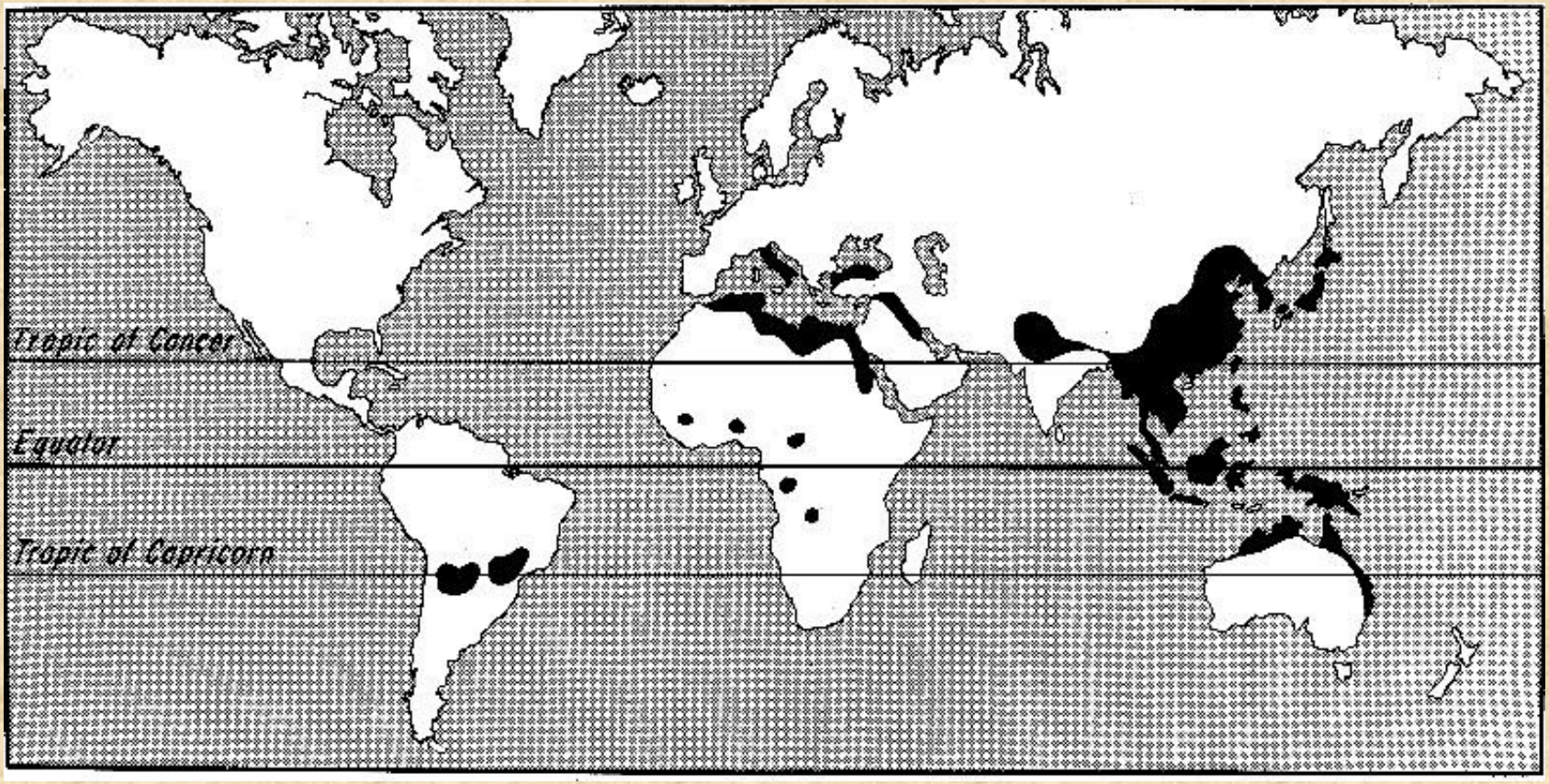
Personal prophylaxis: observing personal hygiene, clean hands and bed-linen.

Social prophylaxis inculcation of hygiene skills in children, examination of the staff of child-care establishments, isolation and treatment of sick people, regular wet cleaning of rooms, sanitary treatment of toys, health education of parents and educators of pre-school establishments.



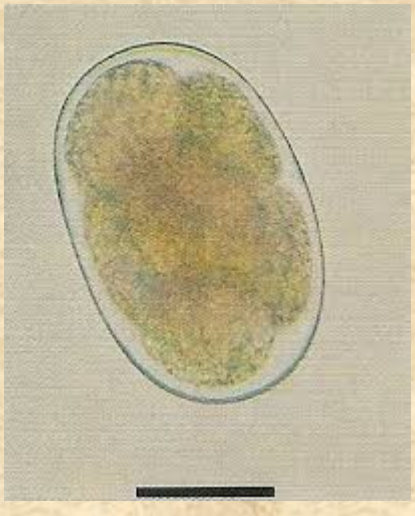
Ancylostoma duodenale (**Old World hookworm)**

Ancylostoma duodenale (**Old World hookworm)** is a geohelminth, a pathogen of ancylostomiasis. The disease is spread in countries with a subtropical and tropical climate.



Morphological peculiarities: length of a female is 10–13 mm, that of a male is 8–10 mm. There is a funnel-like buccal capsule with 4 cuticular teeth on the head.

You must draw this picture in your drawing book.



Life cycle: adult worms are located in the duodenum. After fertilization the female lays eggs that get into the environment with feces. Under optimal conditions in a day, non-infectious (rhabditiform) larvae come out of eggs in the soil. After several moltings they transform into infectious (filariform) larvae.

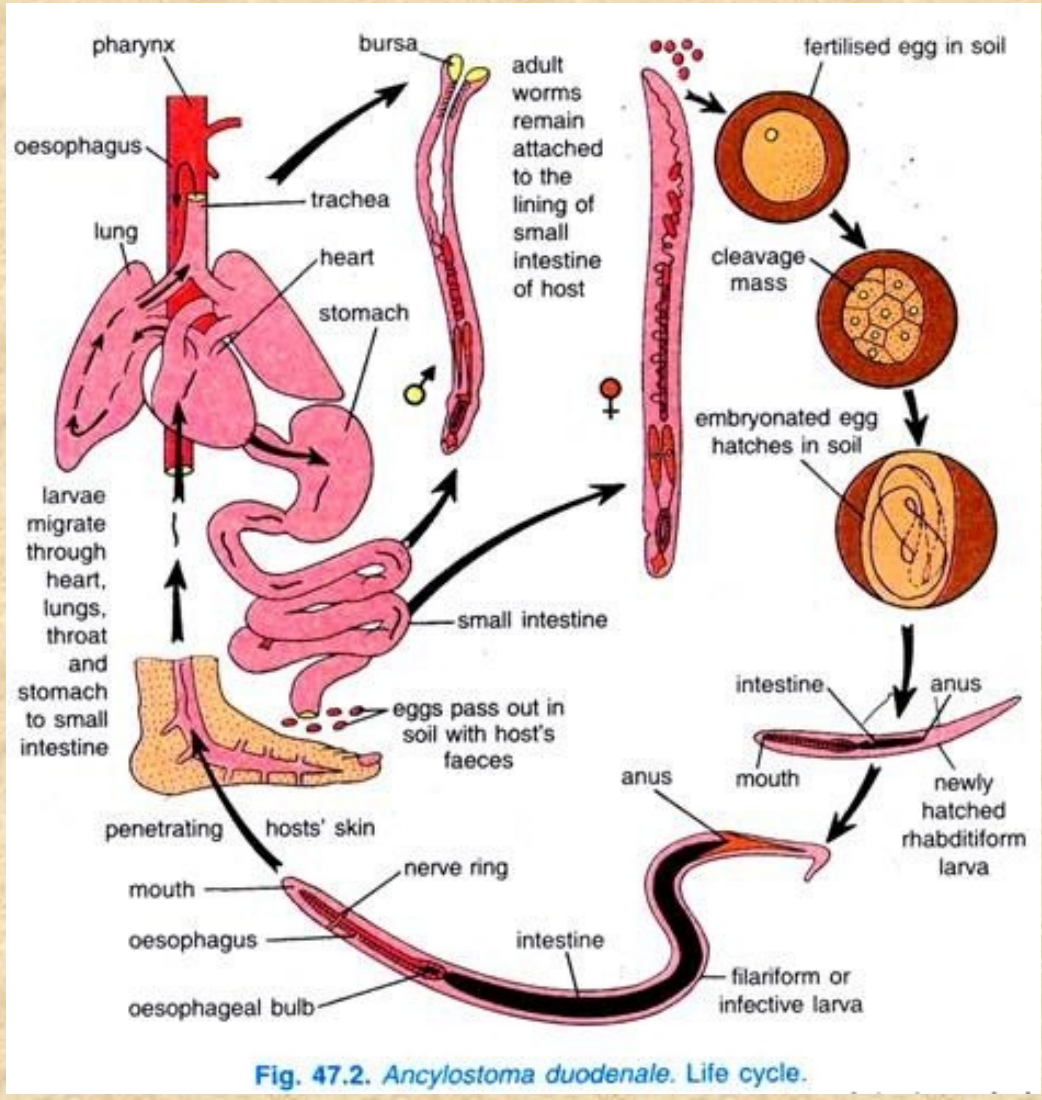


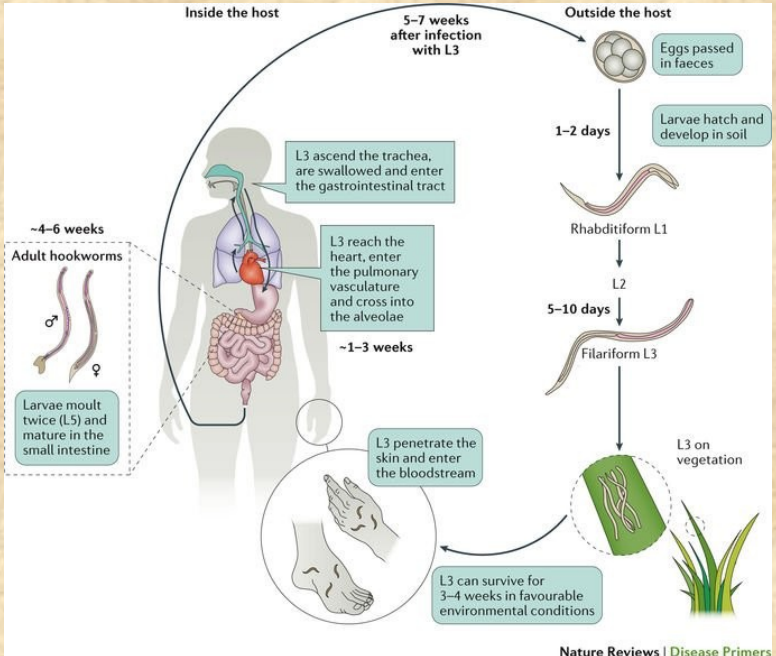
Fig. 47.2. *Ancylostoma duodenale*. Life cycle.

Human can be infected by several rotes:

1) by active permeation of larvae through the skin,
2) alimentary by swallowing larvae with contaminated food and water,
3) vertically (through the placenta).

Having permeated through the skin, larvae migrate: blood carries them through the heart to lungs where they pass through alveolar walls and get into the respiratory tract, ascend to the pharynx and are swallowed to reach the duodenum.

If a larva gets to the human organism through the mouth migration does not occur. In the intestine larvae of an ancylostoma maturate. The life span of sexually mature parasites reaches 5–6 years.



Pathogenic action:

1. *Mechanical* (rupture of capillaries, injury of alveoli, harm to the mucous membrane of the intestine by larvae and cuticular teeth of mature parasites).

2. *Toxicoallergic* (poisoning by waste products).

3. *Feeding at the expense of the host's organism* (each hookworm consumes 0.36–0.7 ml of blood per day) *and impairment of metabolic processes*.

Clinical manifestations:

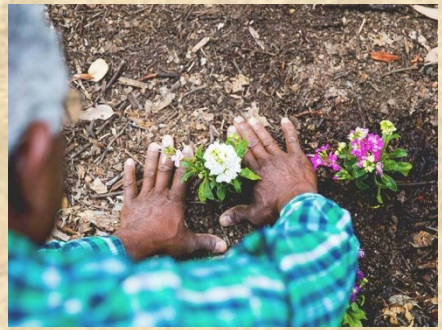
in sites of larvae permeation occur painfulness, later itching and erythema with red papules; pains in the epygastic area, nausea and diarrhea. Children are arrested in physical development. In chronicity of the disease there are, edema, headache, breathlessness, worsening of memory and workability.

Fig. 9-5-1. Adult *A. duodenale* attached to mucosa of duodenum. AFIP 75-14422. (Specimen contributed by Dr. Marcia Angela Paes Leme Marchevsky, Hospital Sousa Aguiar, Rio de Janeiro, Brazil.)

Laboratory diagnostics: revealing eggs or larvae in feces.

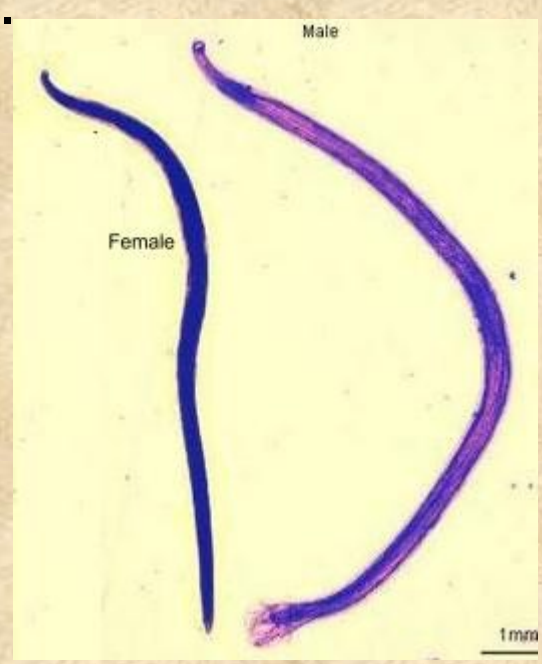
Personal prophylaxis: observing rules of hygiene. It is recommended not to walk barefoot or lie on the ground in foci of ancylostomiasis.

Social prophylaxis: revealing and treating sick people, building sanitary facilities in settlements (water supply, sewage systems), personal and social health education.

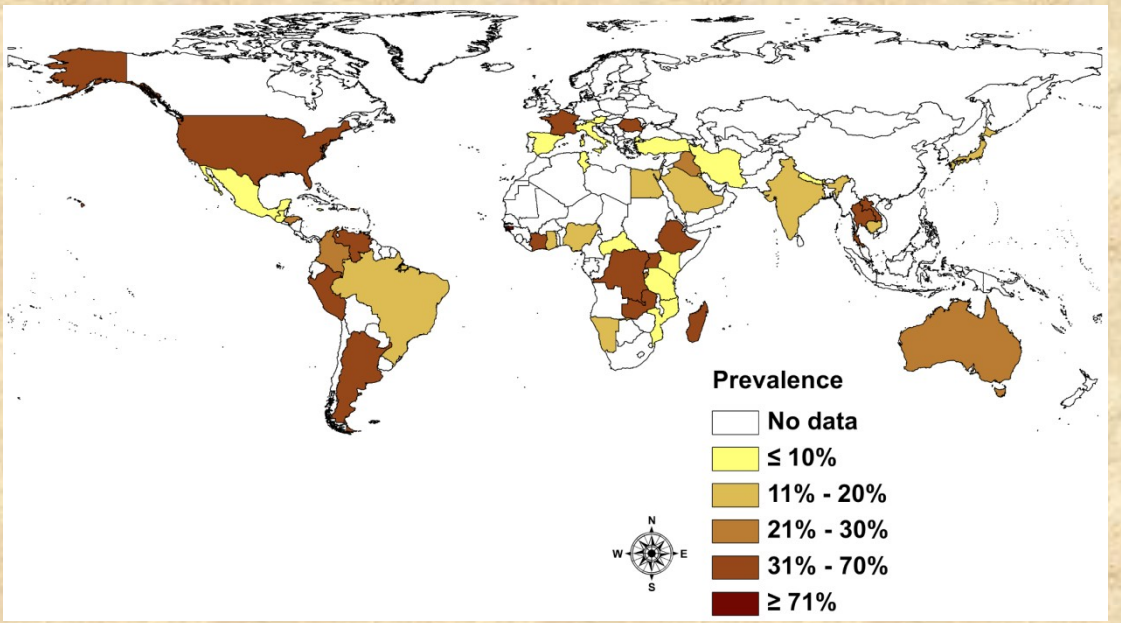


Necator americanus (**New World hookworm)** is a geohelminth, a pathogen of necatoriasis. The disease is common in tropical and subtropical regions of Asia and South America.

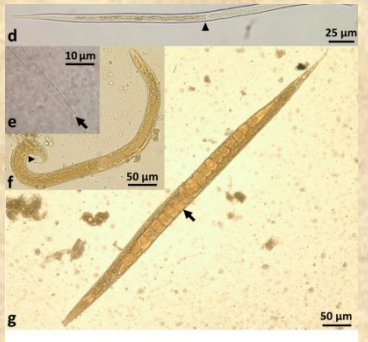
Morphological peculiarities: in comparison with the ancylostoma, it has 2 sharp plates in the buccal capsule insteed of teeth. **The life cycle, pathogenic action, clinical manifestations, laboratory diagnostics and prophylaxis** are same as in ancylostomosis.

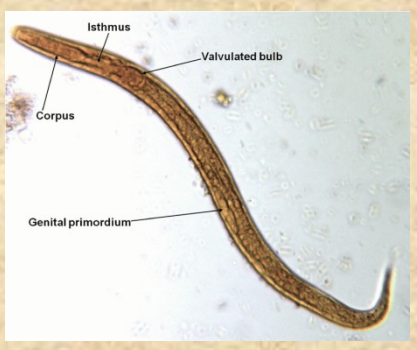


Strongyloides stercoralis (treadworm) is a geohelminth, pathogen of strongyloidiasis. The disease is common in the South-East Asia, East and South Africa and South America.

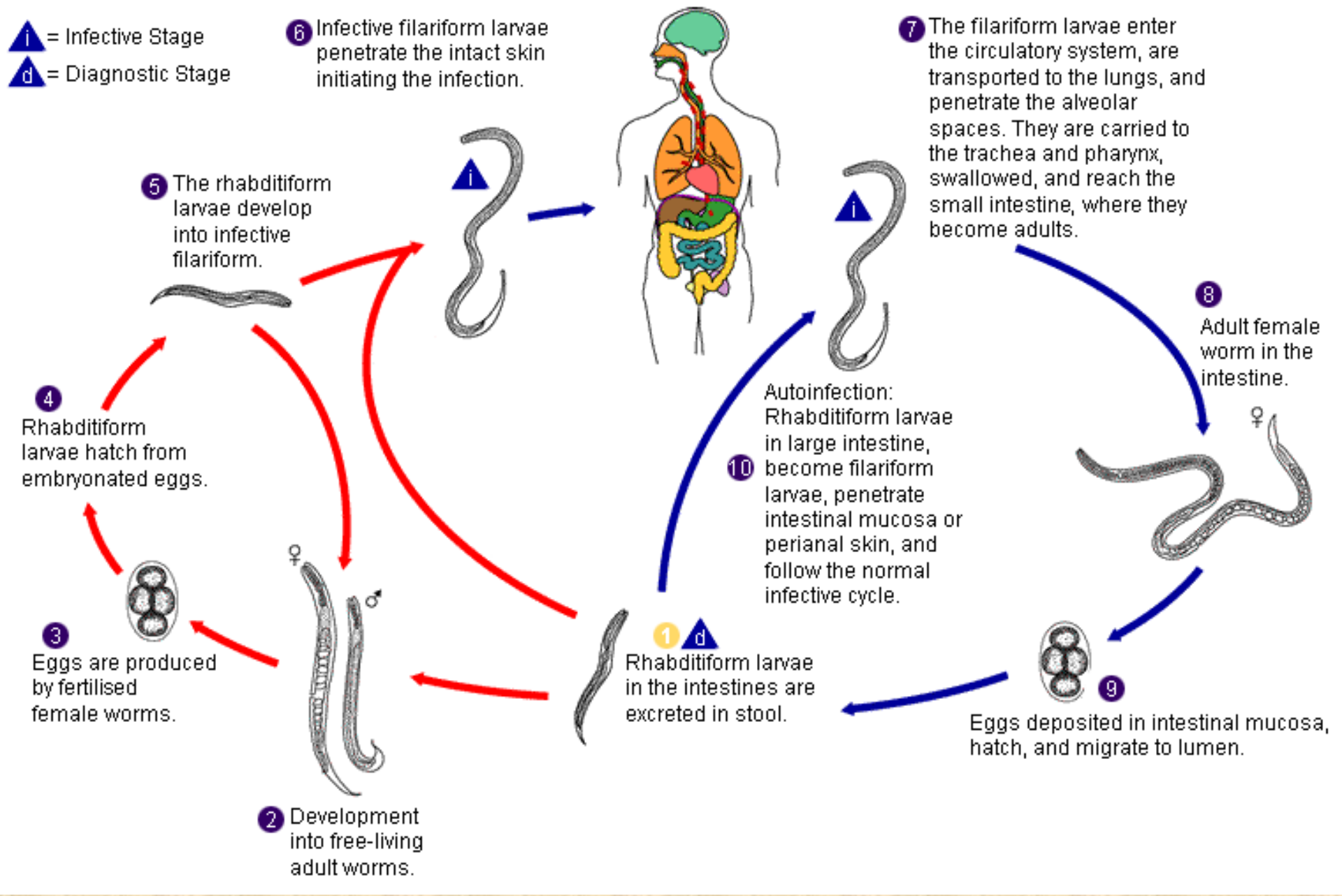


Morphological peculiarities: colorless thread-like nematodes 1–3 mm in size.





Life cycle: parasite settles the duodenum, bile and pancreatic ducts. After fertilization females lay eggs and males die. Rhabditiform (non-infectious) larvae come out of eggs, which are excreted into the environment with feces. The further development of rhabditiform larvae occurs in soil **in two ways**: 1) if the environmental conditions are unfavorable, they turn into filariform (invasive) larvae that able to penetrate the host's skin and migrate as ancylostoma's larvae do; 2) if the conditions are favorable, the rhabditiform larvae transform into free living males and females. After fertilization free living females lay eggs. New formed rhabditiform larvae can transform into sexually mature free-living worms or in filariform larvae. Development also may proceed in the organism of one host: rhabditiform larvae undergo several moltings and transform into filariform ones in the intestine, they migrate and maturate. Migrating larvae may maturate already in the lungs.


i = Infective Stage
d = Diagnostic Stage
1 d Rhabditiform larvae in the intestines are excreted in stool.
2 Development into free-living adult worms.
3 Eggs are produced by fertilised female worms.
4 Rhabditiform larvae hatch from embryonated eggs.
5 The rhabditiform larvae develop into infective filariform.
6 Infective filariform larvae penetrate the intact skin initiating the infection.
7 The filariform larvae enter the circulatory system, are transported to the lungs, and penetrate the alveolar spaces. They are carried to the trachea and pharynx, swallowed, and reach the small intestine, where they become adults.
8 Adult female worm in the intestine.
9 Eggs deposited in intestinal mucosa, hatch, and migrate to lumen.
10 Autoinfection: Rhabditiform larvae in large intestine, become filariform larvae, penetrate intestinal mucosa or perianal skin, and follow the normal infective cycle.

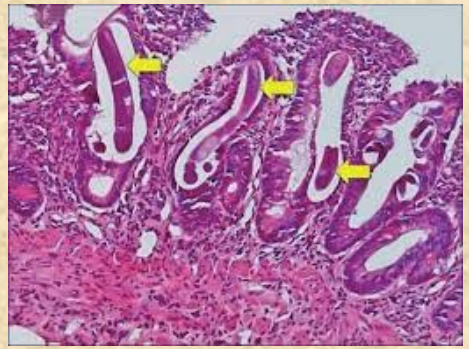
Pathogenic action:

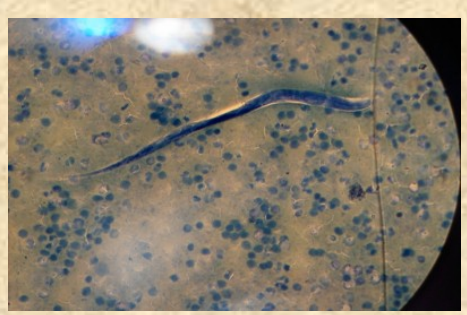
1. *Mechanical* (rupture of capillaries and alveoli by larvae, injury of the mucous membrane of a small intestine).

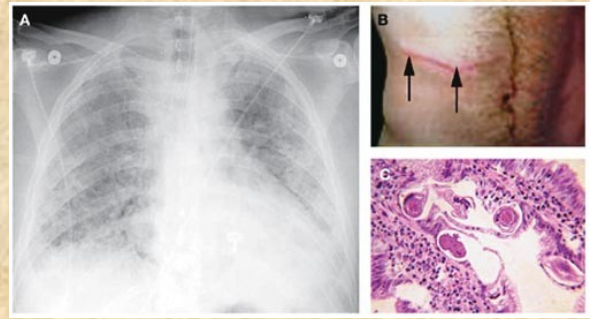
2. *Toxicoallergic* (poisoning by waste products).

3. *Feeding at the expense of the host's organism* (content of the intestine) *and impairment of metabolic processes.*

Clinical manifestations: skin inflammation, weakness, irritancy, headache, skin itching, symptoms of bronchitis, pneumonia. Then appear signs of enteritis, gastroenteritis. Complications: perforation of the intestine with peritonitis, pancreatitis.







Laboratory diagnostics: finding rabditform larvae in fresh feces, sometimes in duodenal content, sputum, vomited matter. A high eosinophilia reaching 70-80 % is noted.

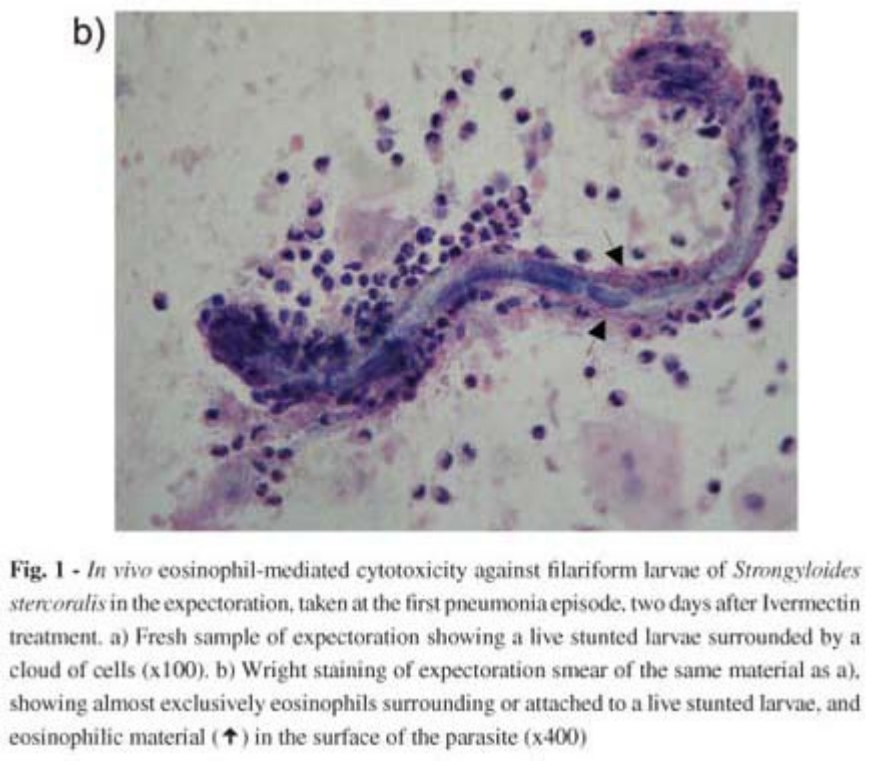
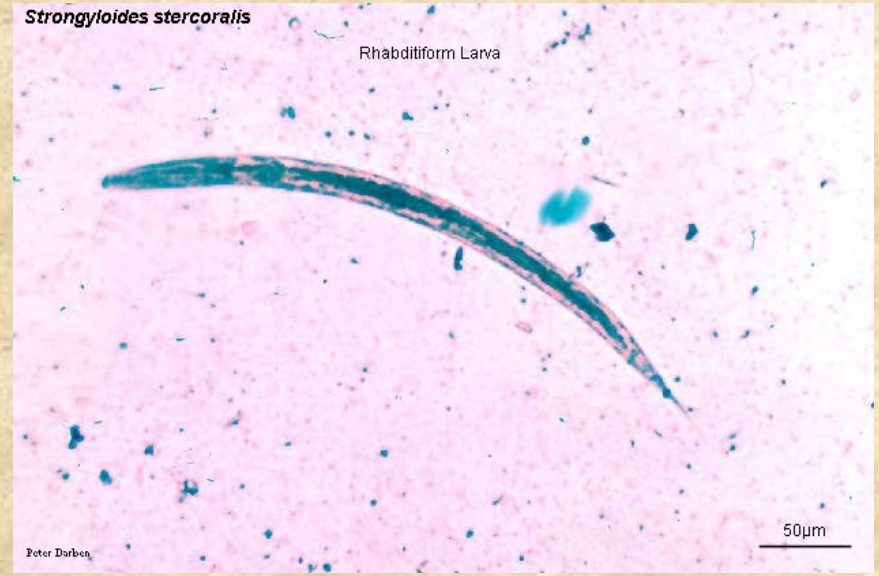
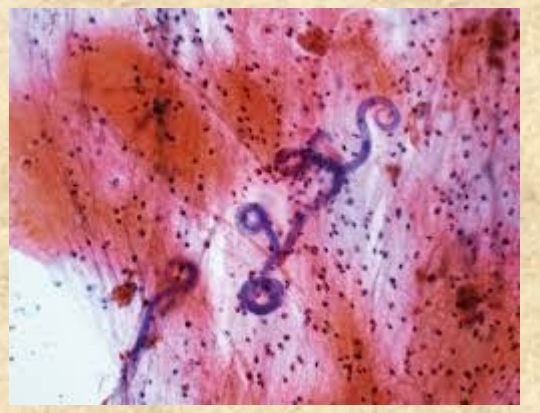


Fig. 1 - *In vivo* eosinophil-mediated cytotoxicity against filariform larvae of *Strongyloides stercoralis* in the expectoration, taken at the first pneumonia episode, two days after Ivermectin treatment. a) Fresh sample of expectoration showing a live stunted larvae surrounded by a cloud of cells (x100). b) Wright staining of expectoration smear of the same material as a), showing almost exclusively eosinophils surrounding or attached to a live stunted larvae, and eosinophilic material (↑) in the surface of the parasite (x400)





Prophylaxis is the same as in ancylostomiasis.

- You must draw in your drawing book:
- 1. cross section of **Ascaris lumbricoides**, 2. appearance of **Trichocephalus trichiurus (human whipworm)**
- 3. **egg of Trichocephalus trichiurus (human whipworm)**
- 5. look of **Enterobius vermicularis**
- 6. look of **Ancylostoma duodenale** .
- Write down their classification.

Go TEST