Introduction to Medical Parasitology (Helminthology)

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Medical Parasitology Ⅱ

Summer Semester

Lecture 1

14/08/2025

Learning outcomes

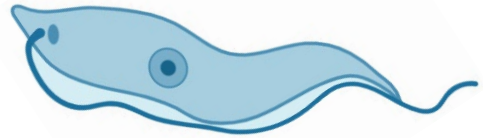
1. To define helminthes and explain their relevance in medical parasitology.
2. To describe the general characteristics and morphological stages of helminthes.
3. To discuss the impact of helminth infections on human health, including morbidity, mortality, and socioeconomic consequences.
4. To be able to perform and interpret general stool examination (GSE) for the detection of parasites, and apply this skill effectively in laboratory practice.

Introduction

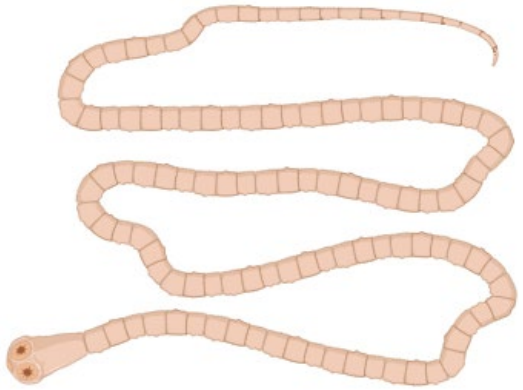
Medical parasitology deals with the parasites, which cause human infections and the diseases they produce.

It is broadly divided into two parts:

1. Protozoology (Unicelullar)



2. Helminthology (Multicelluar)

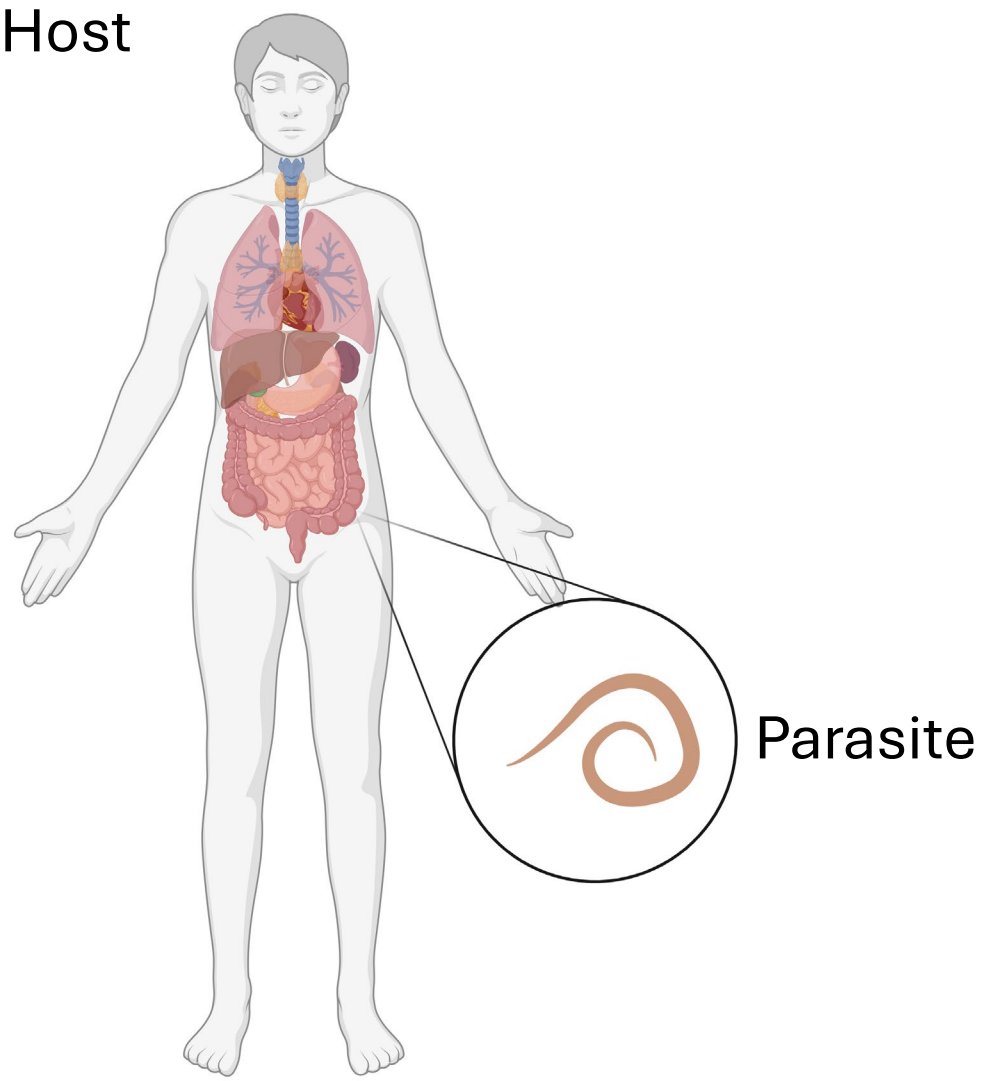


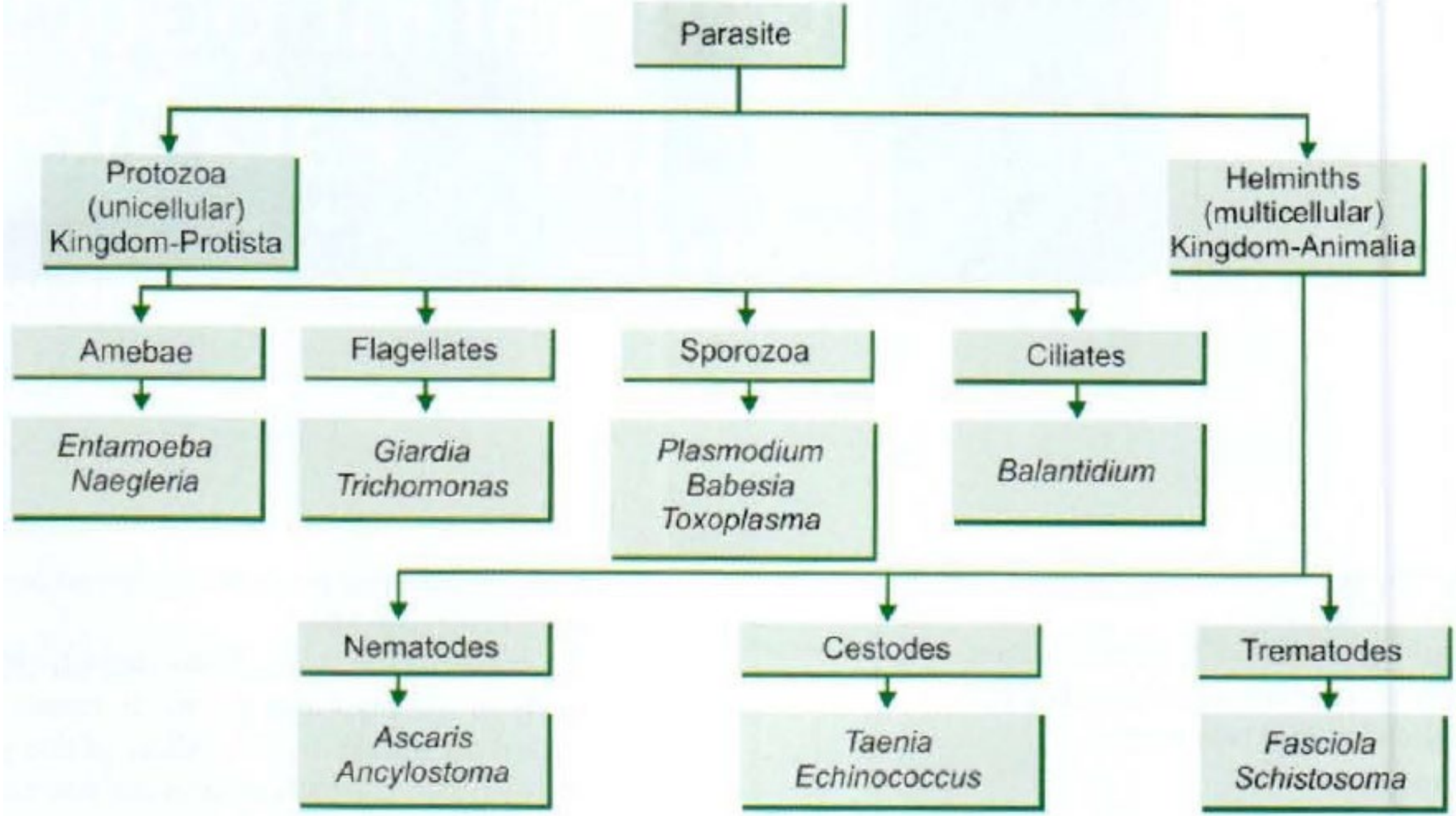
Parasite

Parasites are living organisms, which depend on a living host

for their nourishment and survival. They multiply or undergo

development in the host.

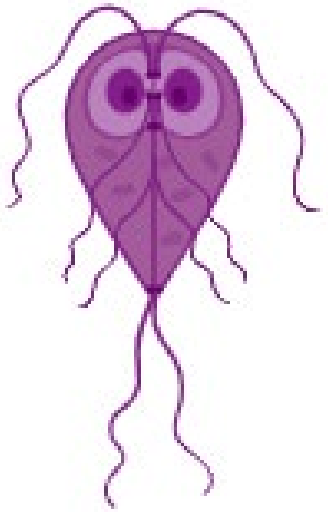


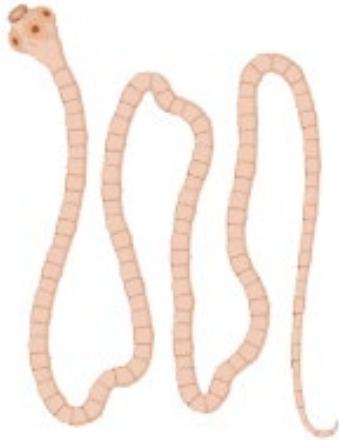

Parasite
Protozoa (unicellular) Kingdom-Protista
Helminths (multicellular) Kingdom-Animalia
Amebae
Flagellates
Sporozoa
Ciliates
Entamoeba Naegleria
Giardia Trichomonas
Plasmodium Babesia Toxoplasma
Balantidium
Nematodes
Cestodes
Trematodes
Ascaris Ancylostoma
Taenia Echinococcus
Fasciola Schistosoma

Parasites classification according to location:

1. **Ectoparasite:** Ectoparasites inhabit only the body surface of the host without penetrating the tissue. Lice, ticks and mites are examples of ectoparasites.

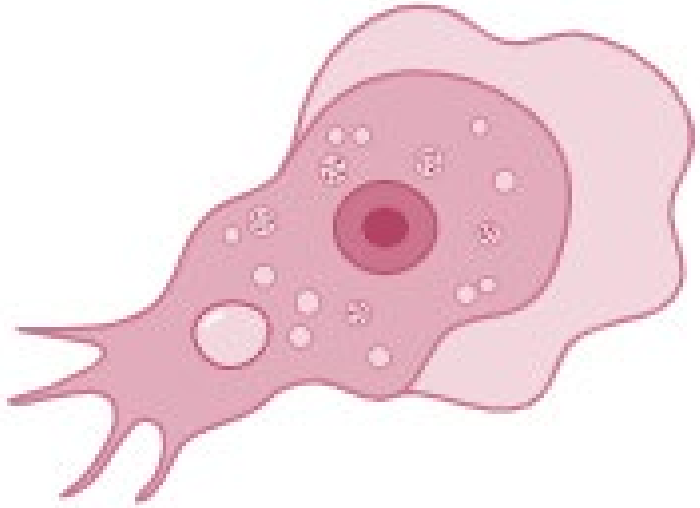
2. **Endoparasite:** A parasite, which lives within the body of the host and is said to cause an infection, is called an endoparasite. Most of the protozoan and helminthic parasites causing human disease are endoparasites.





Parasites classification according to location:

3. **Free-living parasite:** It refers to nonparasitic stages of active existence, which live independent of the host, e.g. cystic stage of Naegleria fowleri.



Endoparasites can further be classified as:

1. **Obligate parasite:** The parasite, which cannot exist without a host, e.g. *Toxoplasma gondii* and *Plasmodium*.

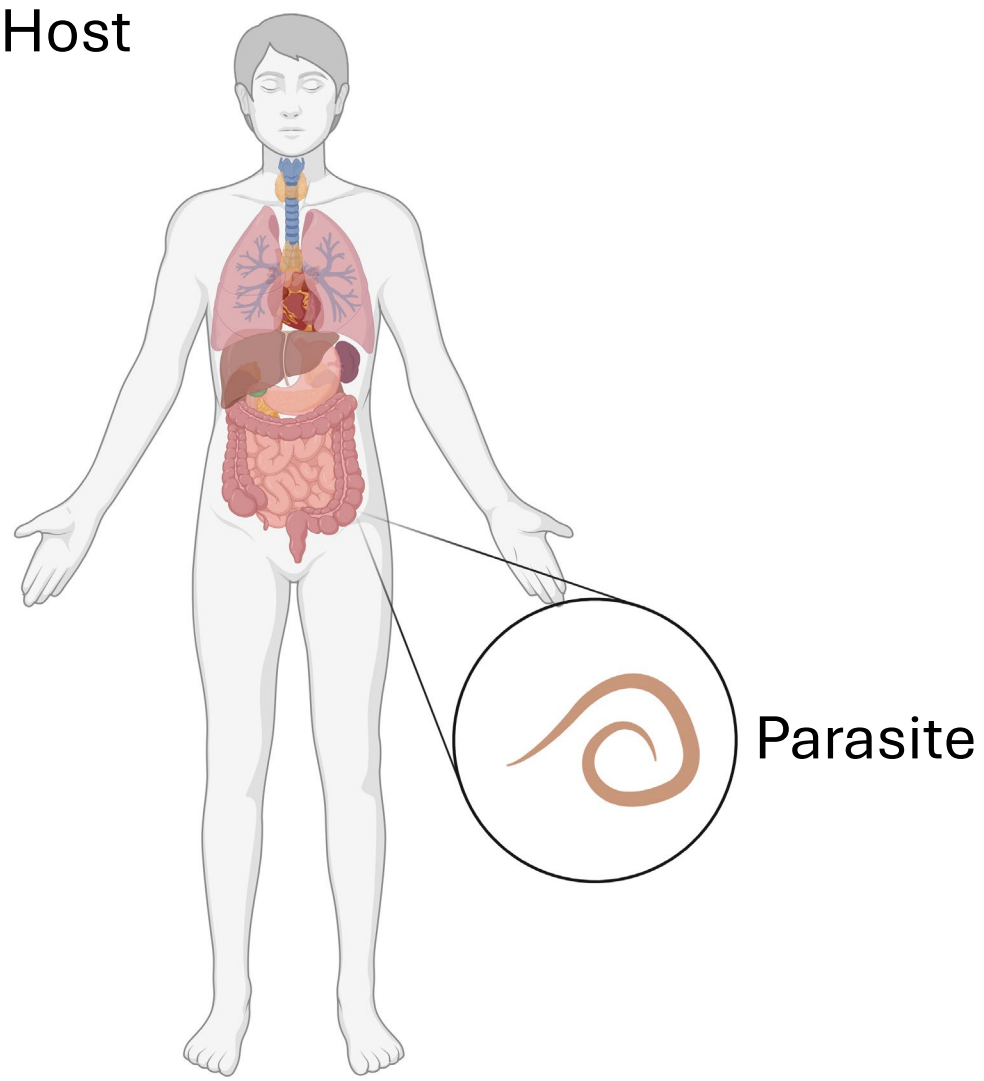
2. **Facultative parasite:** Organism which may either live as parasitic form or as a free-living form, e.g. Naegleria fowleri.

3. **Accidental parasites:** Parasites, which infect an unusual host, are known as accidental parasites. *Echinococcus granulosus* infects man accidentally, giving rise to hydatid cysts.

4. **Aberrant parasites:** Parasites, which infect a host where they cannot develop further, are known as aberrant or wandering parasites, e.g. Toxocara canis (dog roundworm) infecting humans.

Host

Host is defined as an organism, which harbors the parasite and provides nourishment and shelter to latter and is relatively larger than the parasite.

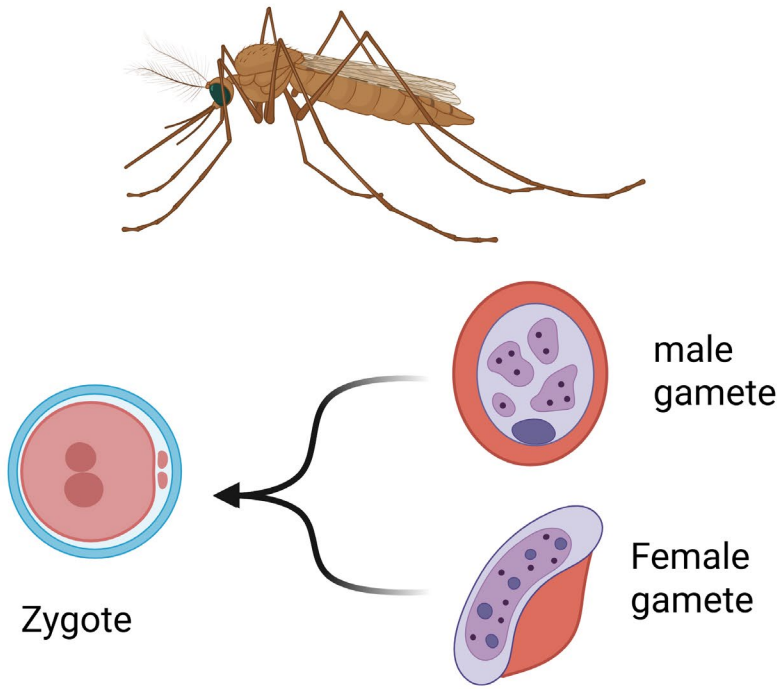


Types of host

1. **Definitive host:** The host, in which the adult parasite lives and undergoes sexual reproduction is called the definitive host

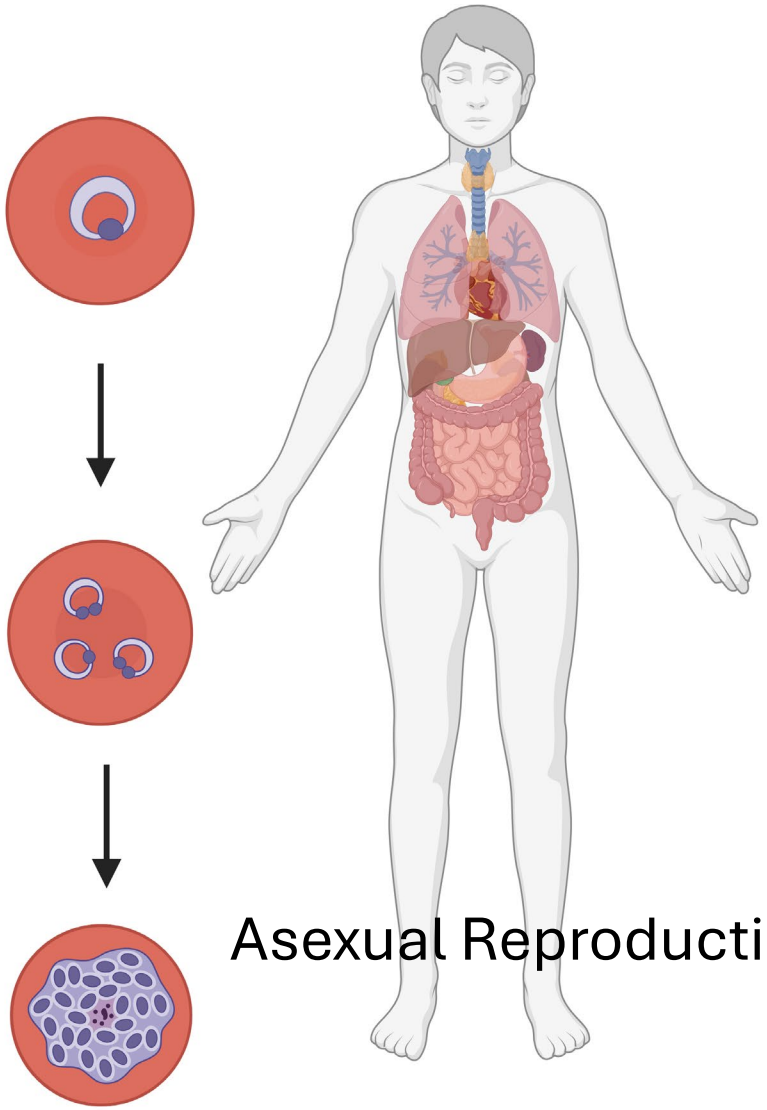
2. **Intermediate host:** The host, in which the larval stage of the parasite lives or asexual multiplication takes place is called the intermediate host. In some parasites, two different intermediate hosts may be required to complete different larval stages. These are known as first and second intermediate hosts, respectively

Definitive host



Sexual Reproduction

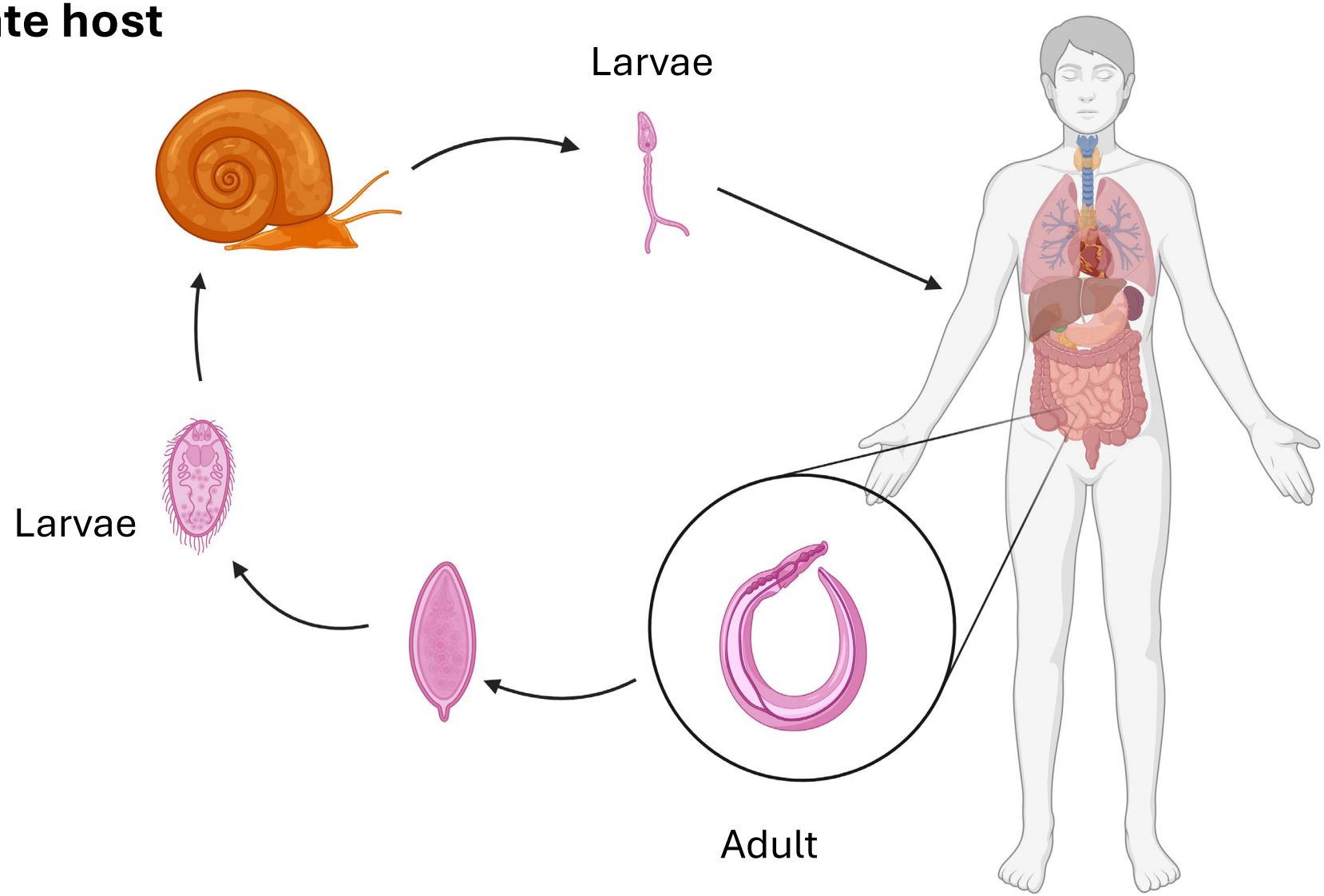
Intermediate host



Asexual Reproduction

Definitive host

Intermediate host



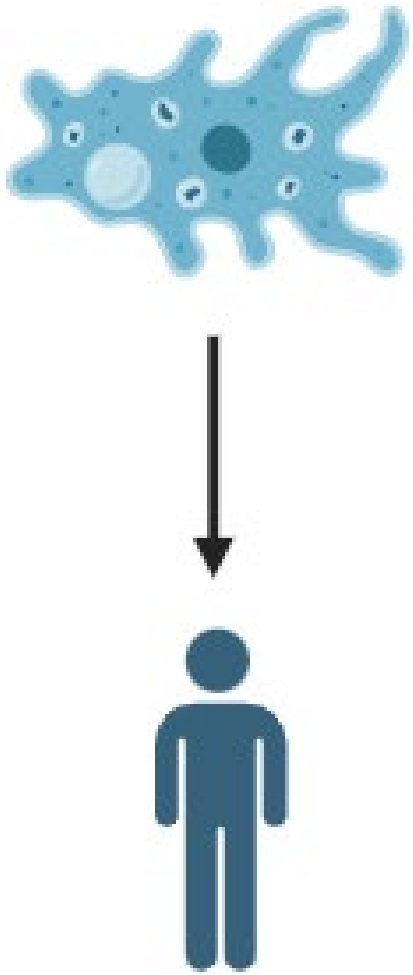
Types of host

3. **Reservoir host:** In an endemic area, a parasitic infection is continuously kept up by the presence of a host, which harbors the parasite and acts as an important source of infection to other susceptible hosts,

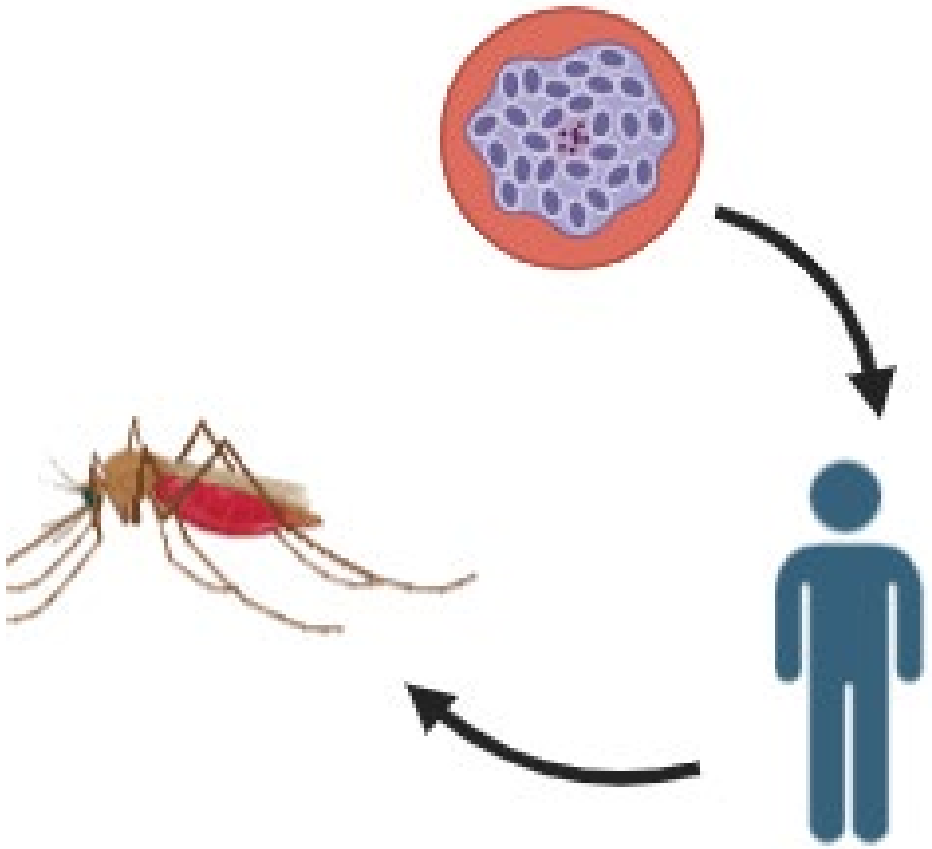
Life cycle of parasites

1. **Direct life cycle:** When a parasite requires only single host to complete its development, it is called as direct life cycle, e.g. Entamoeba histolytica requires only a human host to complete its life cycle.

2. **Indirect life cycle:** When a parasite requires two or more species of host to complete its development, the life cycle is called as indirect life cycle, e.g. malarial parasite requires both human host and mosquito to complete its life cycle



Direct lifecycle



Indirect lifecycle

Helminthes

The helminthic parasites are multicellular (metazoa) bilaterally symmetrical animals having three germ layers (triploblaslic melazoa) and belong to the kingdom Metazoa.

The term helminth (Greek helmins-worm) originally referred to intestinal worms, but now comprises many other worms, including tissue parasites as well as many free-living species.

Classification of Helminthes

Helminths, which occur as parasite in humans belong to two phyla

1. **Phylum Platyhelminthes (flatworms):** It includes two classes:

- Class: Cestoda (tapeworms)
- Class: Trematoda (flukes or digeneans)

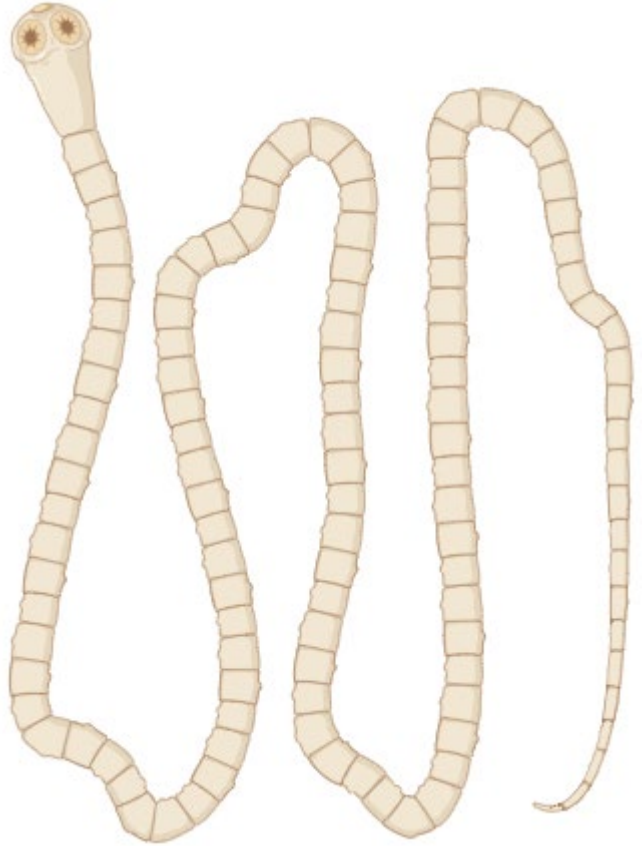
2. **Phylum Nemathelminthes: Nematoda**

Phylum Platyhelminthes

1. The Platyhelminthes are tape-like, dorsoventrally flattened worms.
2. They either lack alimentary canal (as in cestodes) or their alimentary canal is incomplete, lacking an anus (as in trematodes).
3. They are mostly hermaphrodites (monoecious).
4. Phylum Platyhelminthes includes two classes:
    - Class: Cestoda
    - Class: Trematoda.

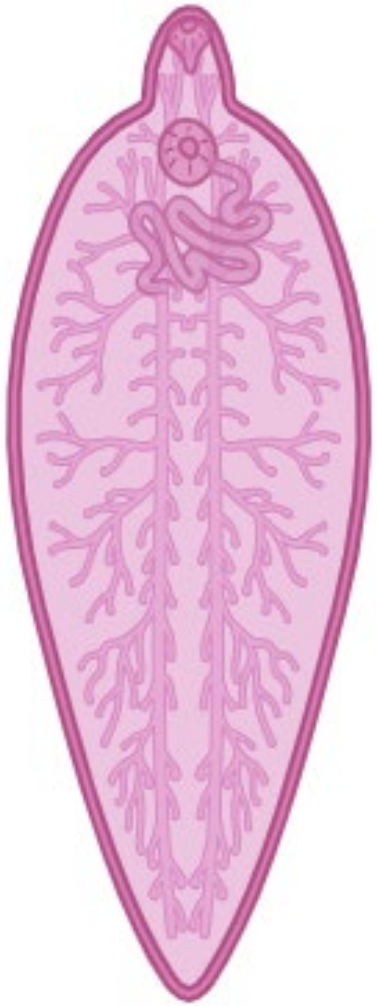
Class Cestoda

- Cestodes have tape-like, dorsoventrally flattened,
- segmented bodies.
- They do not possess an alimentary system.
- The head carries suckers, and some also have hooks.
- They possess scolex, neck and proglottids.
- They are monoecious and body cavity is absent.
- They are oviparous



Class Trematoda

- Trematodes have flat or fleshy, leaf-like unsegmented bodies.
- The alimentary canal is present but is incomplete, i.e. without an anus.
- They possess suckers but no hooks.
- The sexes are separate in the schistosomes, while the other flukes are hermaphroditic.
- They are oviparous.

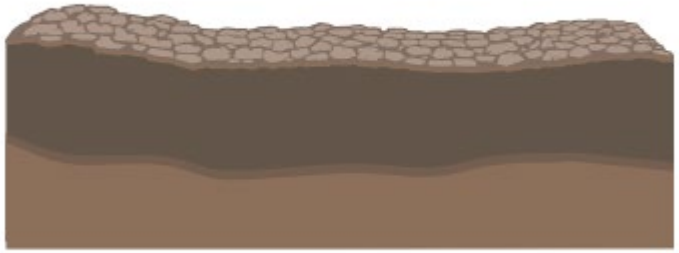


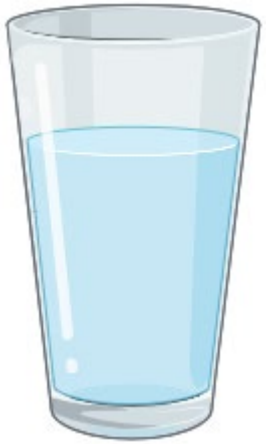
Phylum Nemathelminthes
Class: (Nematoda)

- Nematodes are elongated, cylindrical worms with an unsegmented body.
- They possess a relatively well-developed complete alimentary canal, with an anus.
- Body cavity is present.
- The head does not have suckers or hooks, but may have a buccal capsule with teeth or cutting plates.
- The sexes are separate (diecious) .
- They are either oviparous or viviparous.

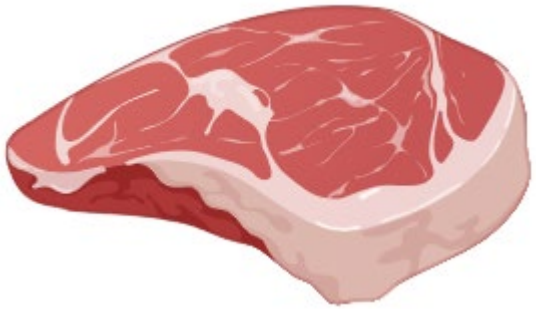
Source of infection

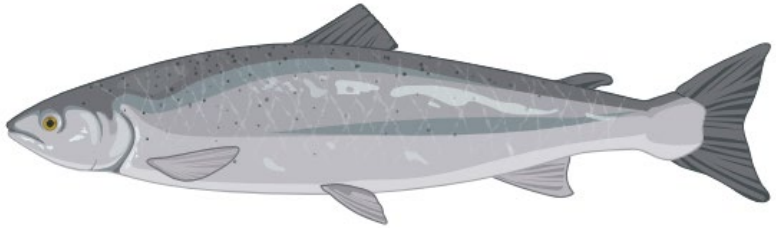
1. Contaminated soil and water





2. Food

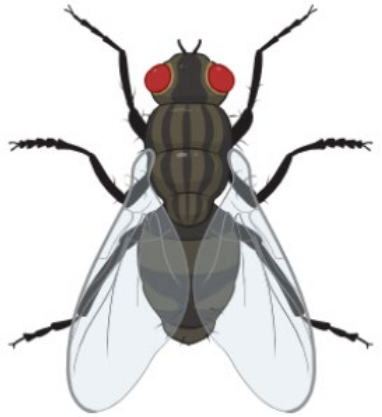




Source of infection

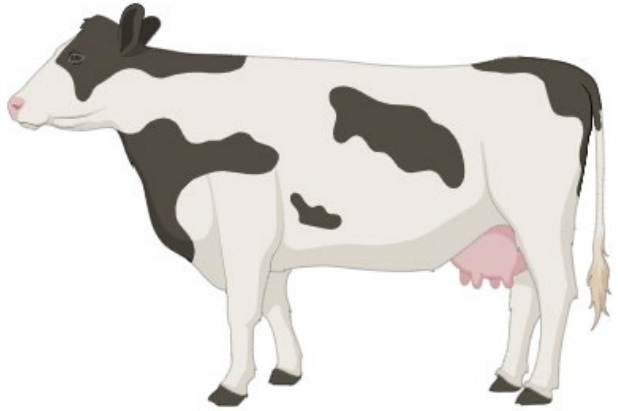
3. Vector

Biological



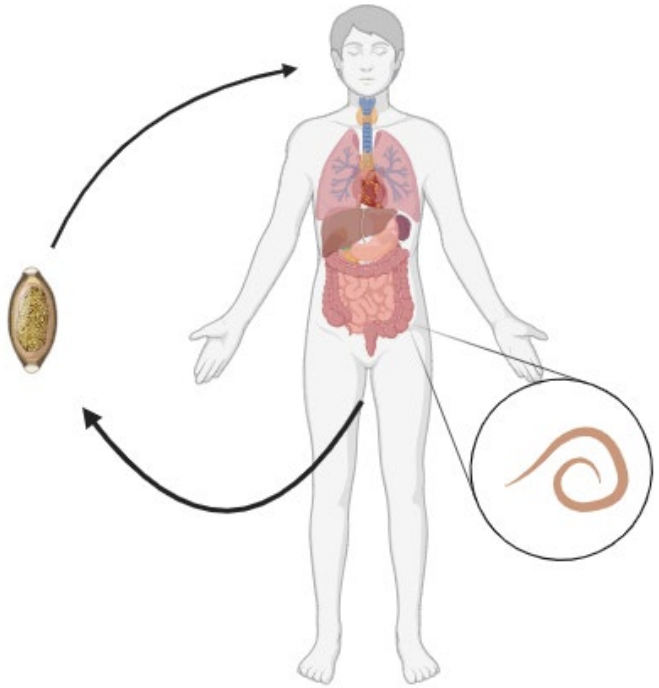
Mechanical

4. Animal



Source of infection

5. Self (Autoinfection)



Mode of transmission

- **Fecal–oral route:** Ingestion of infective eggs or larvae from contaminated food, water, or hands.

  Examples: Ascaris lumbricoides (eggs)

- **Skin penetration:** Infective larvae penetrate intact skin from contaminated soil or water.

  Examples: Necator americanus / Ancylostoma duodenale

- **Ingestion of undercooked or raw intermediate host:** Eating meat, fish, or aquatic plants containing larval stages.

  Examples: Taenia saginata (beef tapeworm)

- **Vector-borne transmission:** Bite of an insect that delivers infective larvae.

  Examples: Wuchereria bancrofti,

Why We Study Medical Helminthes – Medical Importance

1. Public health – Many causes widespread illness, malnutrition, and disability.
2. Diagnosis & treatment – Recognize infections and provide correct therapy.
3. Epidemiology & prevention – Break transmission cycles and control outbreaks.
4. Zoonoses – Prevent diseases passed from animals to humans.
5. Research – Develop new drugs, vaccines, and control strategies.

Nematoda

Case study

A 6-year-old boy was brought by his mother with **intense perianal itching** for 2 weeks, worse at night, She noticed **tiny white worms** near his anus. **The Scotch tape method** revealed **D-shape eggs** of **Enterobius vermicularis (pinworm)**. He was treated with **mebendazole**, and the family was advised on hygiene measures including handwashing, daily change of underwear, and washing bedding, leading to complete recovery.

Enterobius vermicularis

The name Enterobius vermicularis means a tiny worm living in the intestine (Greek enteron-intestine, bias-life and vermiculus-small worm). The term Oxyuris means "sharp ta il'; a feature of the female worm, from which the name "pinworm" is also derived.

Epidemiology

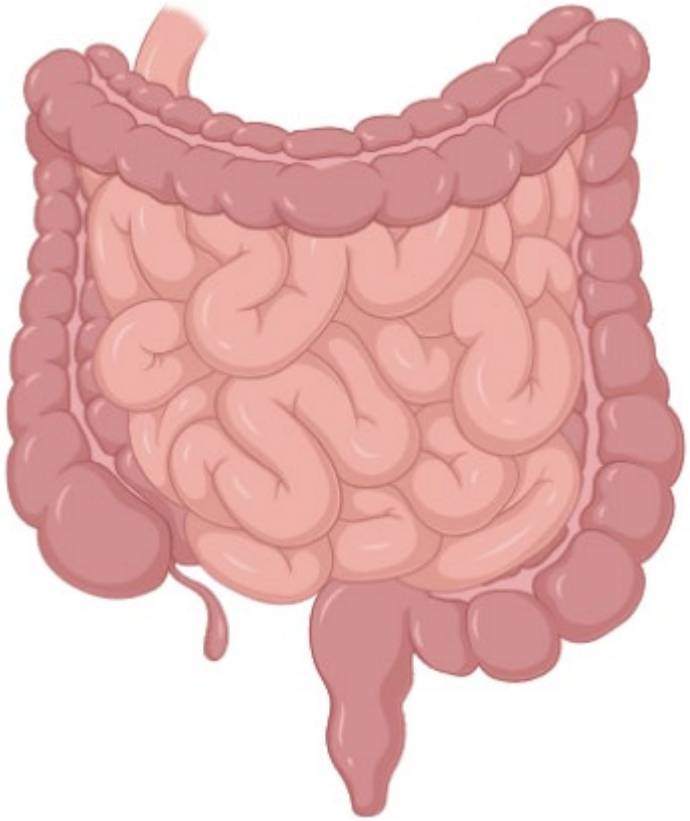
Global distribution: Found worldwide in both temperate and tropical climates; most common helminth infection in developed countries.

Prevalence: Estimated 200–400 million cases globally at any given time.

Age group: Highest incidence in children aged 5–14 years, especially in schools and daycare centers.

Habitat

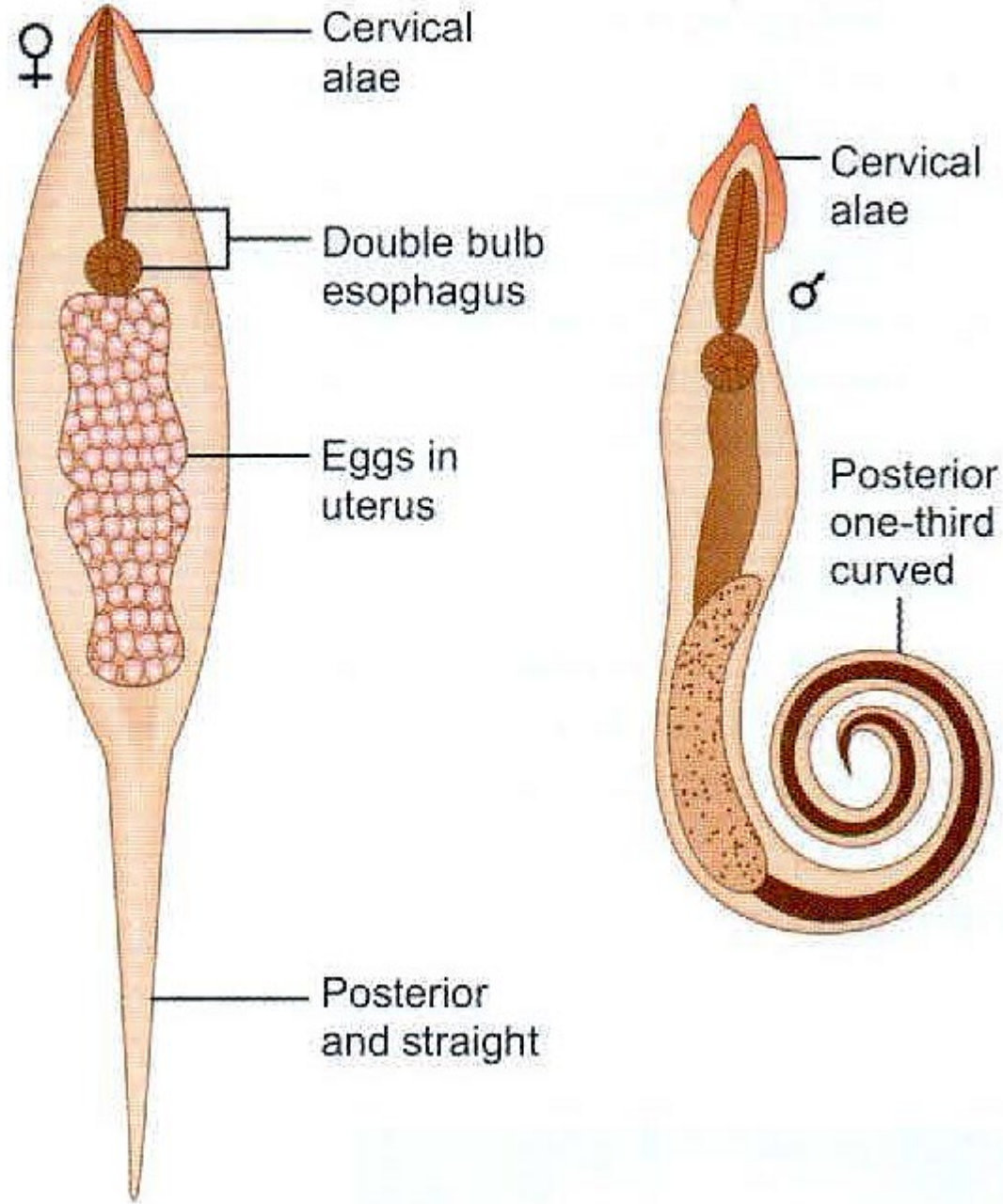
Adult worms are found in the cecum, appendix and adjacent portion of ascending colon.



Morphology

Adult worm

- Adult worms are small, white, thread-like with pointed ends, and have a mouth surrounded by three wing-like cervical alae plus a double-bulb esophagus.
- The female (8–13 mm × 0.3–0.5 mm) has a thin pointed tail, vulva in front of the middle third, and when gravid, her body is packed with thousands of eggs. She is oviparous and lives 5–12 weeks.
- The male (2–5 mm × 0.1–0.2 mm) is smaller, with a tightly curved posterior end bearing a copulatory spicule and survives 7–8 weeks.


♀
Cervical alae
Double bulb esophagus
Eggs in uterus
Posterior and straight
♂
Cervical alae
Posterior one-third curved

Morphology

Egg

- The egg is colorless and not bile-stained and D-shaped.
- It has a characteristic shape, being elongated ovoid, flattened on one side and convex on the other (planoconvex), measuring 50-60 µm by 20-30 µm.
- The eggshell is double-layered and relatively thick, though transparent. The outer albuminous layer makes the eggs stick to each other and to clothing and other objects.
- Under cool, moist conditions, the egg remains viable for about 2 weeks.
- A single female worm lays 5,000-17,000 eggs

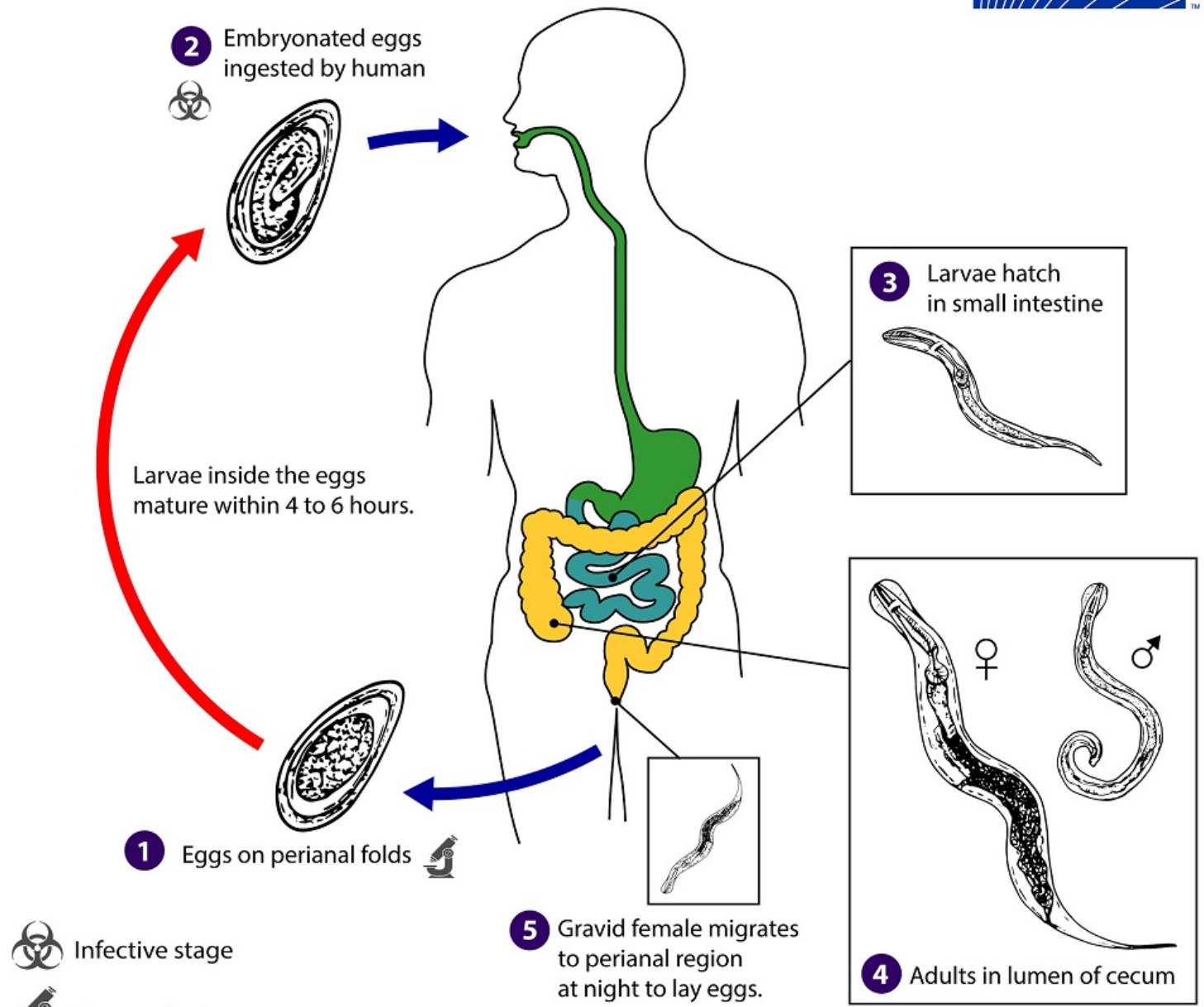
Life Cycle

1. Ingestion of infective eggs via contaminated hands, food, water, or surfaces.
2. Larvae hatch in the small intestine.
3. Adult worms mature and reside in the cecum and appendix.
4. Gravid females migrate to the perianal region at night to lay eggs.
5. Eggs become infective within a few hours in the perianal area.
6. Autoinfection: Eggs from the perianal area are transferred to the mouth via contaminated fingers after scratching, common in children.
7. Retroinfection: Eggs hatch on the perianal skin, and larvae migrate back through the anus to the colon.
8. Indirect transmission can occur via contaminated clothes, bedding, or airborne eggs.

DPDx

Enterobius vermicularis

CDC

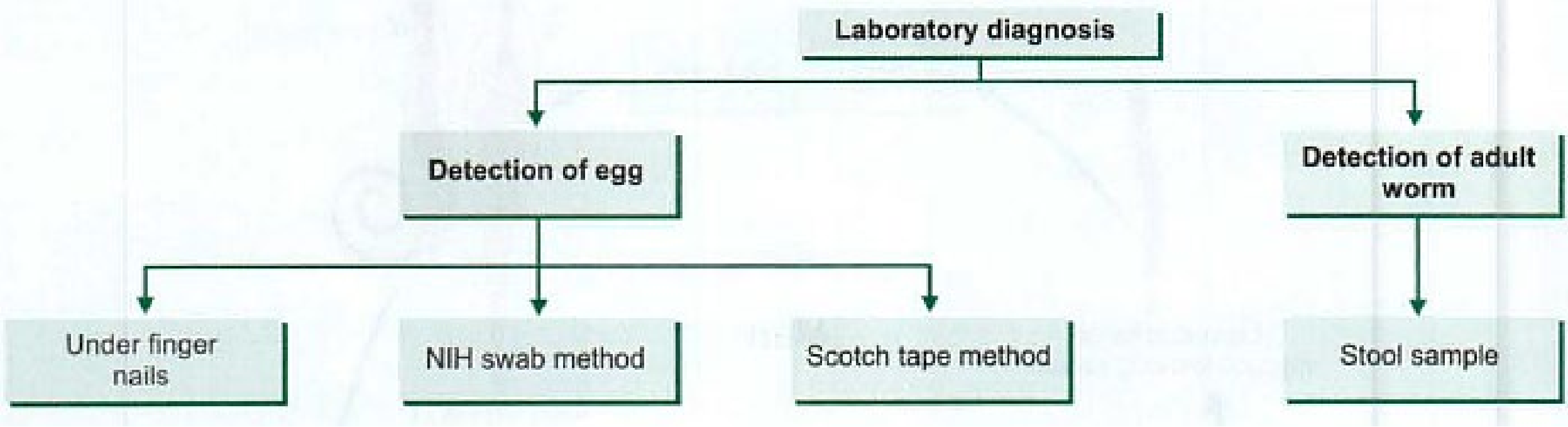


Sign and Symptoms

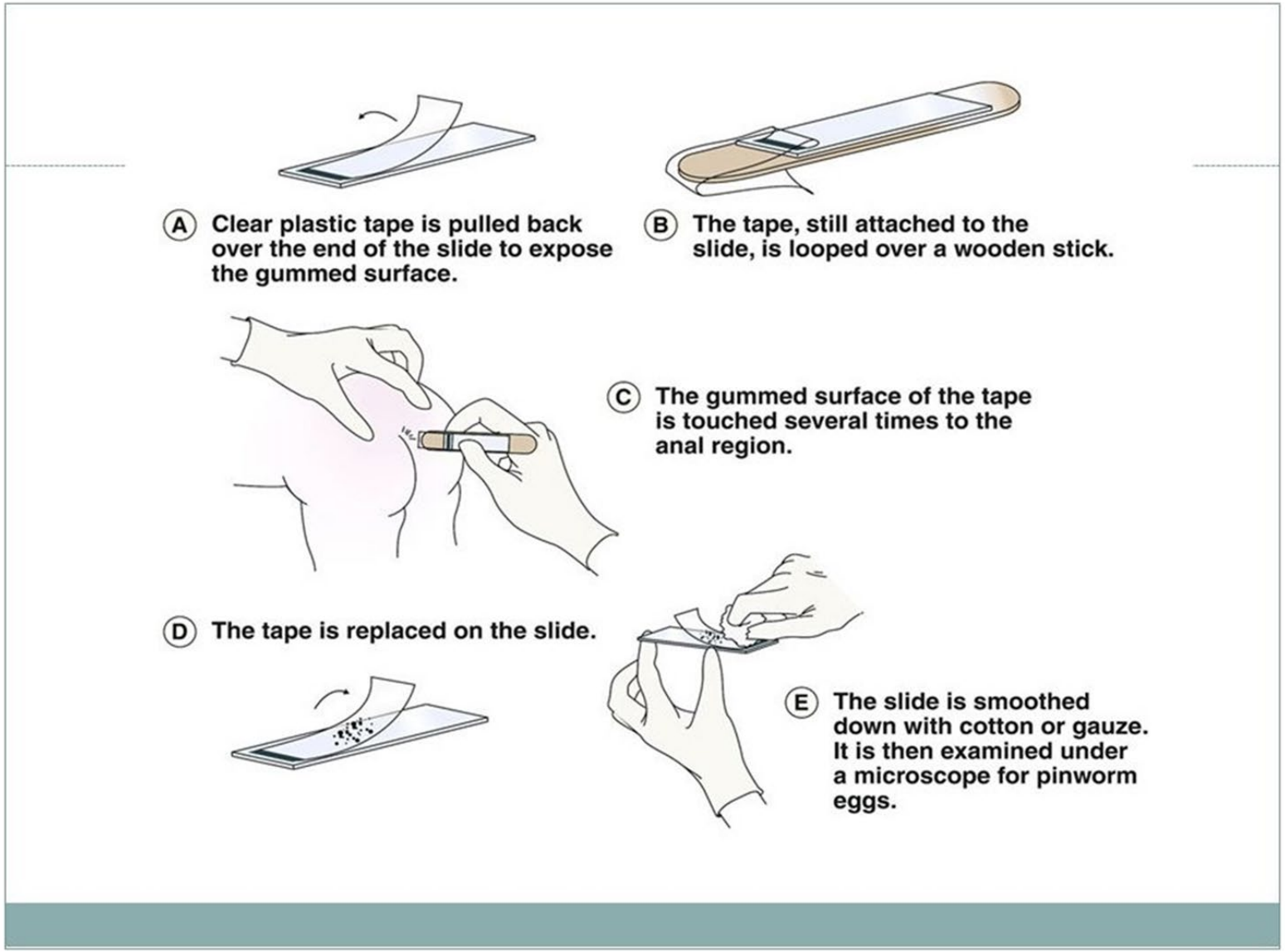
Most people have no symptoms or signs of a pinworm infection. If a person does, it typically itching in the perianal region.

Occasionally, invasion of the female genital tract can occur causing inflammation of the vulva and vagina with rare inflammatory reactions occurring in the pelvis or peritoneum. Appendicitis has been associated with pinworm infection in rare cases.

Diagnosis


Laboratory diagnosis
Detection of egg
Detection of adult worm
Under finger nails
NIH swab method
Scotch tape method
Stool sample

Scotch tape method



Treatment

Albendazole (400 mg once) or **Mebendazole** (100 mg once) can be used

Treatment involves two doses of medication with the second dose given two weeks after the first dose. The medications kill worms but cannot kill eggs. The second dose is important to prevent infection by newly hatched adult worms that were not killed by the first treatment because they were still eggs.

Prevention

- Maintenance of personal and community hygiene such as frequent hand washing, finger nail cleaning and regular bathing.
- Frequent washing of night clothes and bed linen.

References

- Paniker, C. K. J. & Ghosh, S. 2021. *Paniker's textbook of medical parasitology,* New Delhi, Jaypee Brothers Medical Publishers.
- https://www.cdc.gov/pinworm/hcp/clinical-overview/index.html