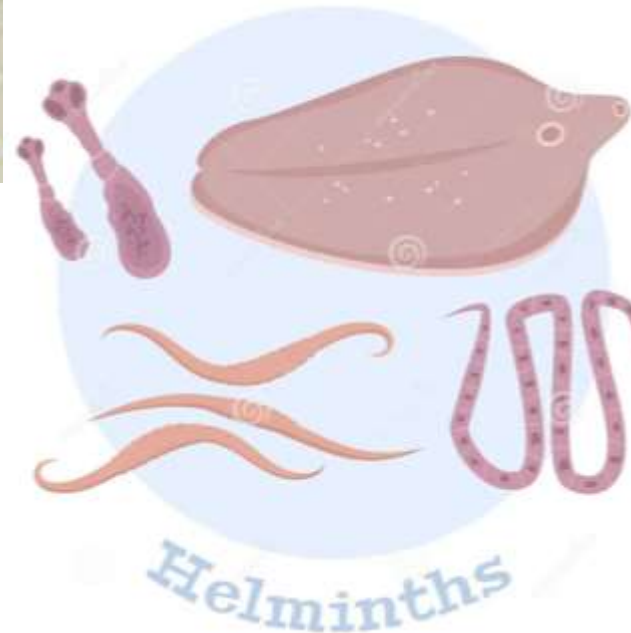




Introduction of Helminthes

Prepared & Presented by:

M.Sc. Ghadeer Mahmood



Lecture 1

Medical helminthology is a branch of zoology that studies worms, especially parasitic worms. **Helminth means worm.**

Definition of Parasitic Worms (Helminths) : Parasitic worms are organisms that live in a host organism and depend on it for feeding and living, often causing harm or disease to the host.

The public health impact of medical helminthes is appreciable.

Their motile activity is accomplished by **wriggling movements.**

- Helminths of medical importance belong to three main classes: **Nematoda**, **Trematoda**, and **Cestoda**.

Helminths, which occur as parasites in humans belong to 2 phyla:

Phylum Platyhelminthes (flatworms) – It includes 2 classes:

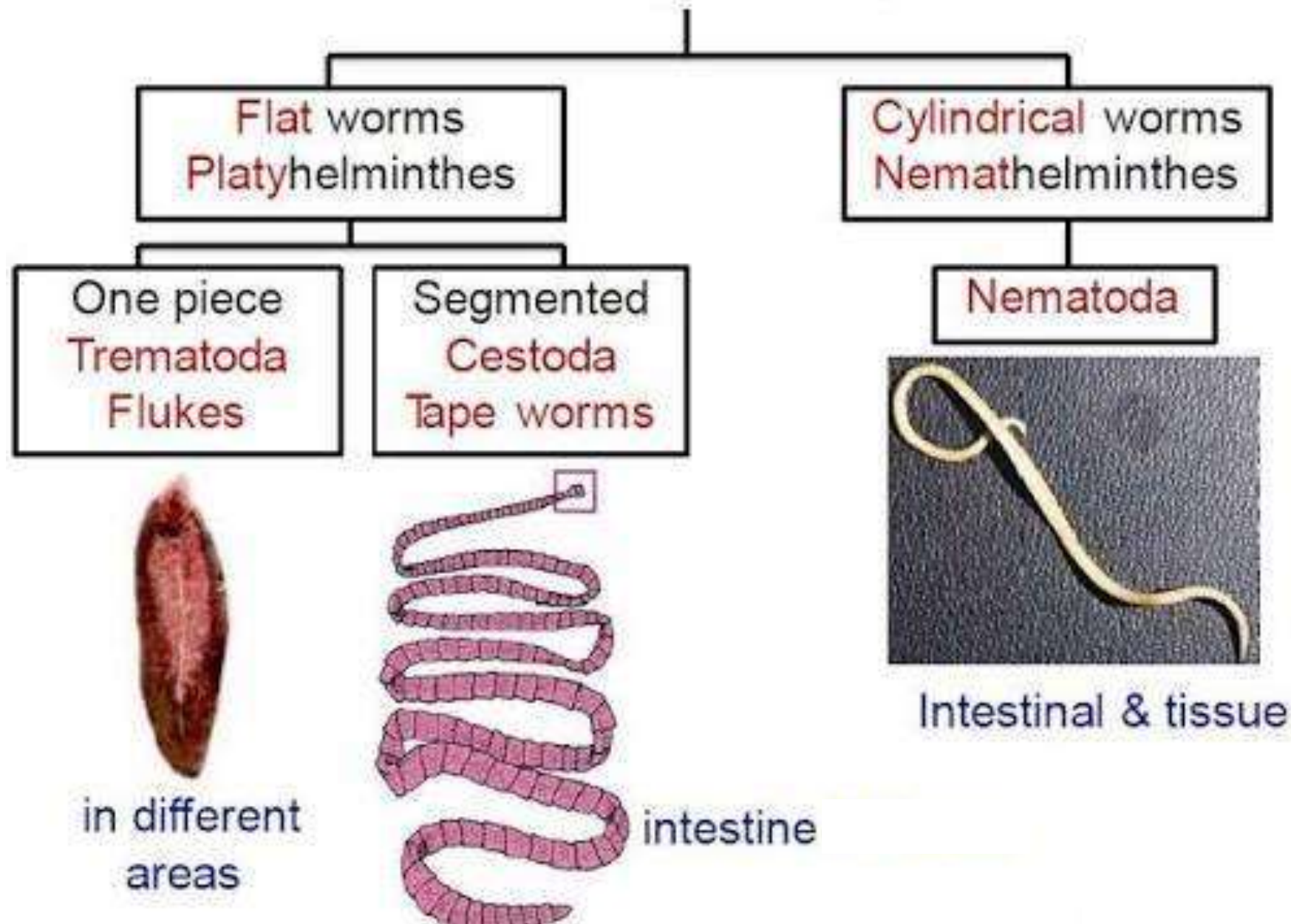
- Class – Cestoda (tapeworms)

- Class – Trematoda (flukes or digeneans)

Phylum Nematelminthes

- Helminthology is the study of parasitic worms and their effects on their hosts.

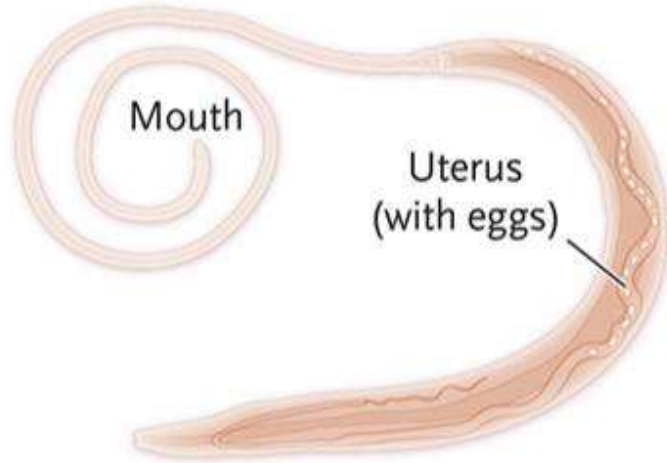
Helminths (worms)



Types of Helminth

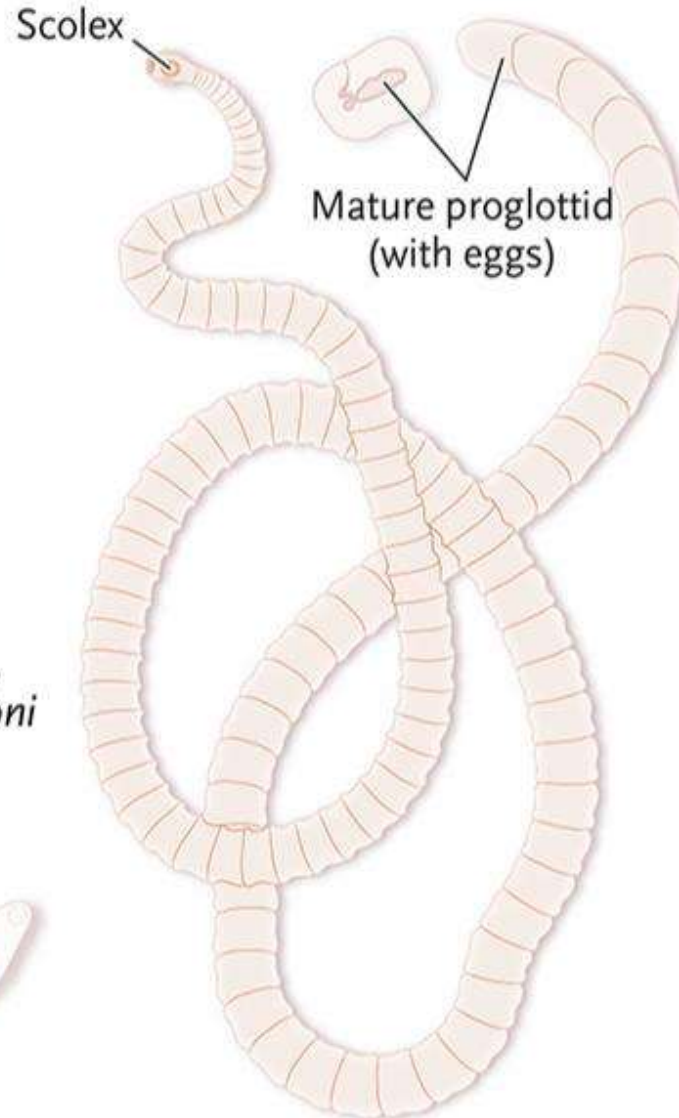
Roundworms (Nematodes)

e.g., *T. trichiura*, *A. duodenale*,
N. americanus



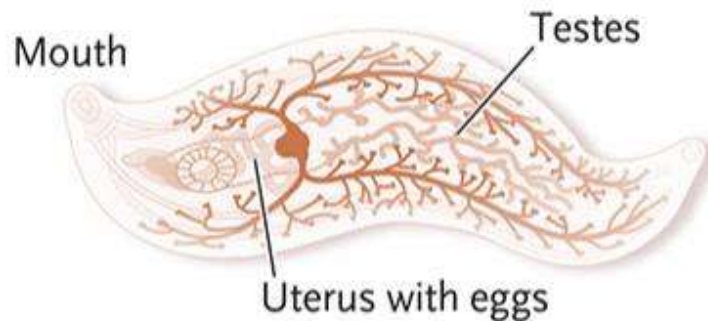
Tapeworms (Cestodes)

Hymenolepis and *Taenia* spp.



Flukes (Trematodes)

e.g., *Fasciola* spp., *Opisthorchis* spp.,
Clonorchis sinensis, *Schistosoma mansoni*



**Helminthes infect
more than one-third
of the world
population**

Adult: The mature stage of the parasite capable of sexual reproduction.

Larva: An immature, active stage that develops from the egg and undergoes further development and may be infective.

Egg: The stage produced by the adult worm which contains the developing embryo.

Monoecious : Both sexes present in one body.

Dioecious: Sexes are separate; males and females are distinct.

Parthenogenesis: Ability to produce offspring without fertilization.

Final host: The host that contains the **adult stages** (reproductive mature) of a parasite called final host.

Intermediate host : The host that contains the **larval stages** called intermediate host.

Some parasites have a different host for each larval stage, these called intermediate hosts .

Monogenia:

Single-host parasites (Monogenia) :This group completes its entire life cycle within a single host. Their life cycle is direct and does not require intermediate hosts.

Digenia:

Multiple-host parasites (Digenia) :This group requires two or more hosts to complete its life cycle. Their life cycle is indirect and involves one or more intermediate hosts.

Helminthes are studied in microbiology ? because they cause infectious diseases and most are diagnosed by microscopic examination of eggs or larvae.



What are the general characteristics of parasitic worms (helminths)?

Eukaryotic, multicellular animals that usually have digestive, circulatory, nervous, excretory and reproductive systems.

Parasitic helminths spend most or all of their lives in host.

- May lack a digestive system.
- Absorb nutrients from host body fluids or tissues.
- Have a reduced nervous system.
- Complex reproductive system.
- Individuals produce many eggs that can infect another host.
- Suckers with / without hooks: for attachment to host.
- Organs of locomotion: Absent, but in some species the suckers assist in movement.

Modes of Transmission of Helminth Parasites to Humans

1. Ingestion of Infective Eggs (Fecal–Oral Route)

Humans ingest parasite eggs from contaminated sources. Contaminated food (unwashed vegetables, fruits), Contaminated water, Dirty hands or fingernails.

2. Ingestion of Infective Larvae in Food (Food-borne Transmission)

Larvae are present in undercooked or raw food. Raw or undercooked fish , seafood or meat (beef, pork).

3. Skin Penetration by Larvae (Percutaneous Transmission)

Larvae actively penetrate intact human skin. Walking barefoot on contaminated soil ,Contact with contaminated freshwater.

4. Vector-Borne Transmission (Arthropod-Transmitted Larvae)

Larvae are transmitted through insect bites.

5. Autoinfection (Self-Reinfection)

The parasite completes its life cycle within the same host.

Medical Importance

Cause serious diseases affecting the digestive system, liver, lungs, blood, and other organs.

Lead to symptoms such as anemia, malnutrition, abdominal pain, and organ damage.

Diagnosis is often done by microscopic examination of stool, urine, blood, or tissue samples, which is a key role of pathological analysis laboratories.

Importance for Pathological Analysis Students

Understanding flatworms is essential for:

Identifying parasite eggs, larvae, and adult forms

Accurate laboratory diagnosis

Supporting clinicians in treatment and disease control

Preventing parasitic infections through public health awareness

What is a Scientific Name and How to Write it?

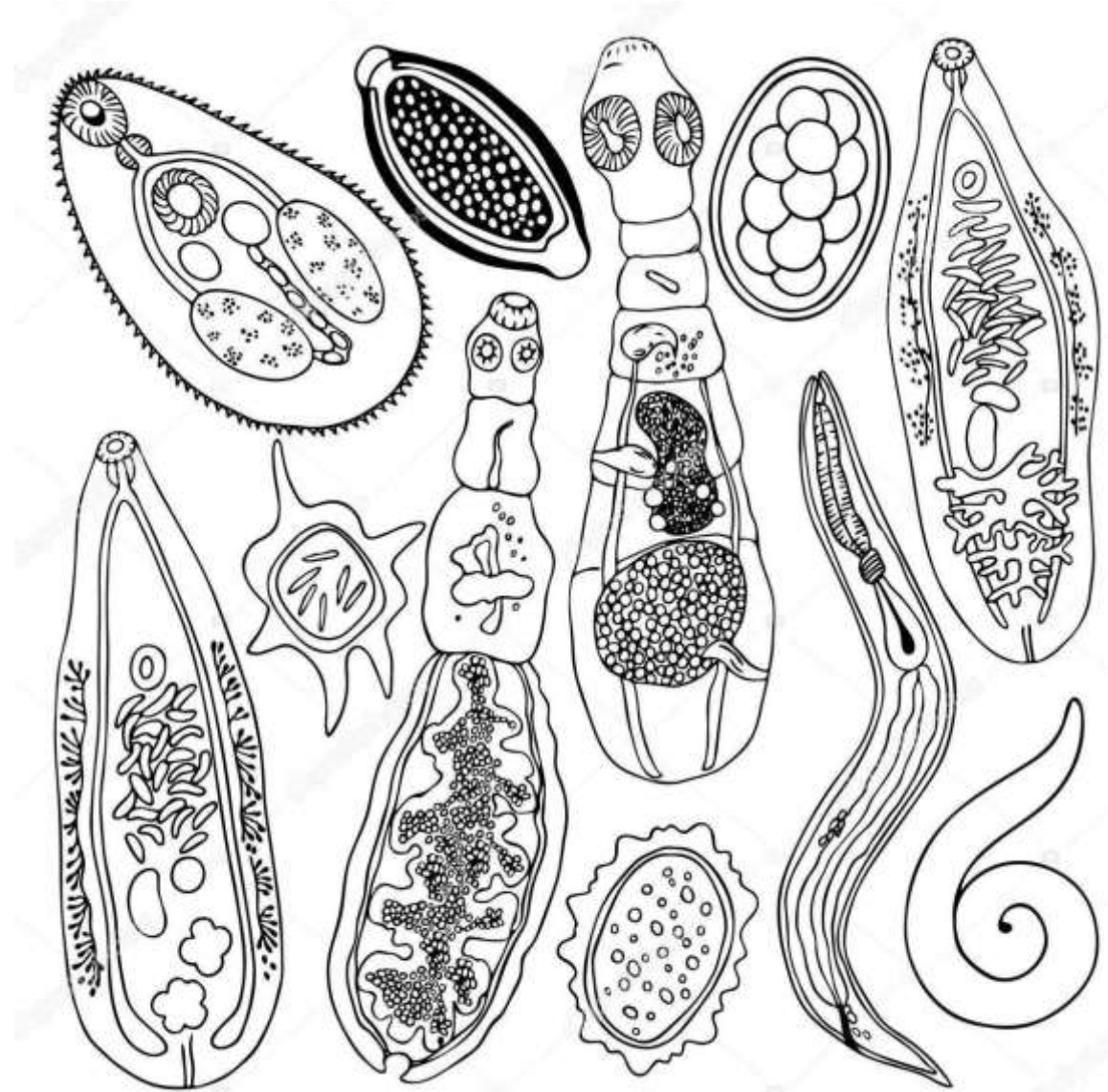
- **A scientific name:** is a universal system used to identify living organisms.
- It consists of two parts:
 1. Genus name: always starts with a capital letter.
 2. Species name: written in lowercase letters.
- If the species is unknown, we use **sp.**
- If more than one species is unknown, we use **spp.**
- Both genus and species should be written in ***italic*** or **underlined**.

Lecture 2

Helminth Parasites Flatworms & Nematodes

Prepared & Presented by:

M.Sc. Ghadeer Mahmood



Helminths (Parasitic Worms)

Flatworms (Platyhelminthes)

Trematodes (Flukes)

- e.g. *Fasciola hepatica*



- e.g. *Fasciola hepatica*

Cestodes (Tapeworms)

- e.g., *Taenia*



- e.g. *Taenia*

Roundworms (Nematodes)

Nematodes

- e.g., *Ascaris*



- e.g., *Enterobius*

Helminths are multicellular parasitic worms belonging to two major phyla important in medical parasitology :

Platyhelminthes (flatworms) and **Nematoda** (roundworms).

These organisms cause a wide range of human and animal diseases and are detected mainly through stool examination (microscopic eggs, larvae, or adult worms).

1. Platyhelminthes

General Characteristics

- Flat, soft-bodied worms with no true body cavity.
- Includes Trematodes (flukes) and Cestodes (tapeworms).

Trematoda (Flukes)

- Leaf-shaped worms, often with suckers for attachment.
- Many are trematodes parasites with complex life cycles often requiring intermediate hosts (e.g., snails, fish).
- Example: Fasciola hepatica – liver fluke causing **fascioliasis**, a zoonotic disease transmitted through ingestion of metacercariae on plants.

Cestoda (Tapeworms)

- Long, segmented flatworms; lack a digestive system; absorb nutrients from the tegument.
- May be have complex life cycles involving two hosts.
- Example: Taenia saginata and Taenia solium cause **taeniasis**.

They are transmitted to humans by ingesting the larval stage in raw or undercooked meat.

2. Nematoda –Roundworms)

- General Characteristics
- Elongated, cylindrical, unsegmented worms with a complete digestive system.
- Phylum Nematoda contains many **free-living and parasitic species**; several are major human pathogens (e.g., Ascaris lumbricoides, Enterobius vermicularis).

Life Cycles & Transmission

- Platyhelminthes often have complex life cycles with one or more intermediate hosts.
- Nematodes may have direct life cycles (soil–oral transmission) or indirect ones (vector-borne).
- **Diagnostic stages include eggs, larvae, or adults in feces, tissues, or blood.**

Laboratory Diagnosis

- Identify parasite eggs, larvae, or segments in stool or tissue.
- Many nematode eggs are distinct in size/shape (e.g., *Ascaris*, *Trichuris*).

First: Flatworms (Trematodes)

1-*Fasciola hepatica*

2-*Clonorchis sinensis*

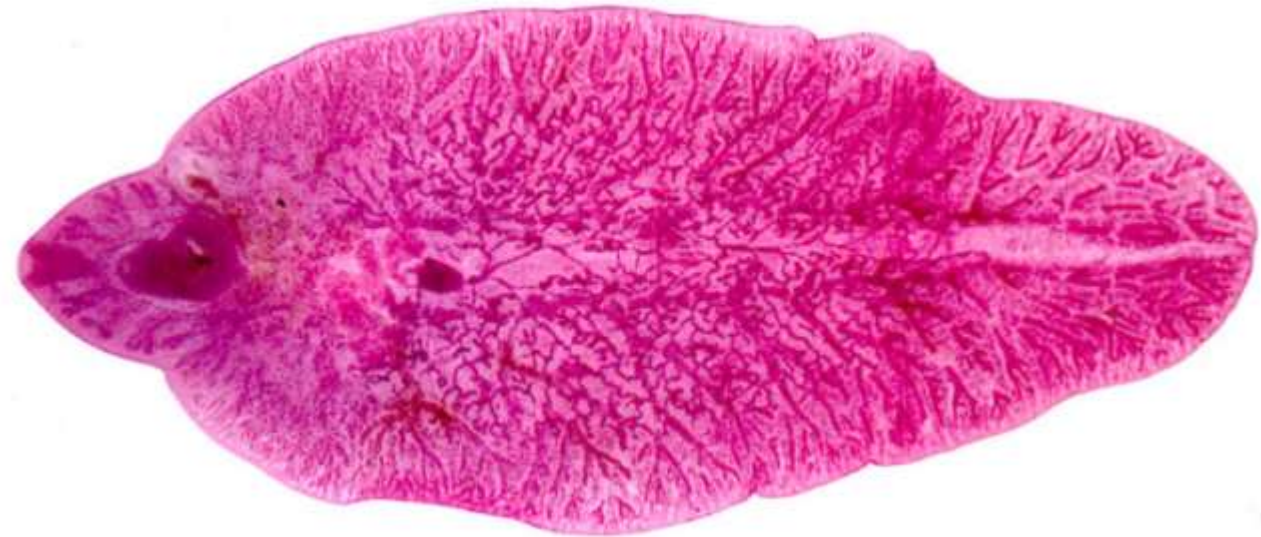
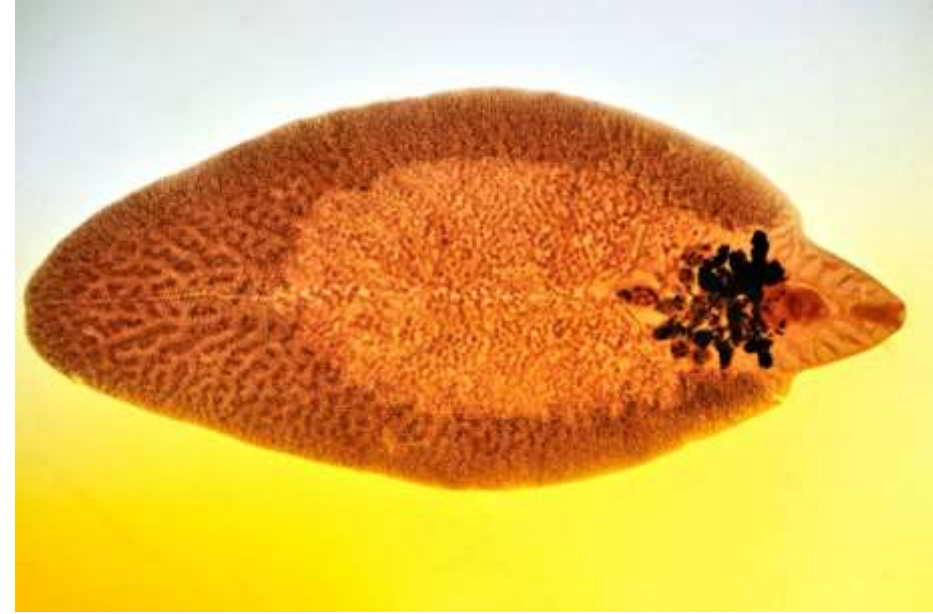


Fasciola hepatica

- Liver Fluke (Fasciola hepatica)
 - A globally distributed parasitic worm.
 - Mainly infects cattle and Sheep.
 - Infection occurs through ingestion of **aquatic plants contaminated** with encysted **metacercariae**.
 - The parasite inhabits the **liver and bile ducts**.
- Causes liver rot (**fascioliasis**).

Symptoms

- Hepatomegaly.
- Pain in the upper right abdomen.
- Abdominal colic.
- Diarrhea.
- Jaundice.
- Fever.



Hosts

final host

- Sheep, cattle
- Humans

Intermediate host

- Freshwater snail (*Lymnaea* species).

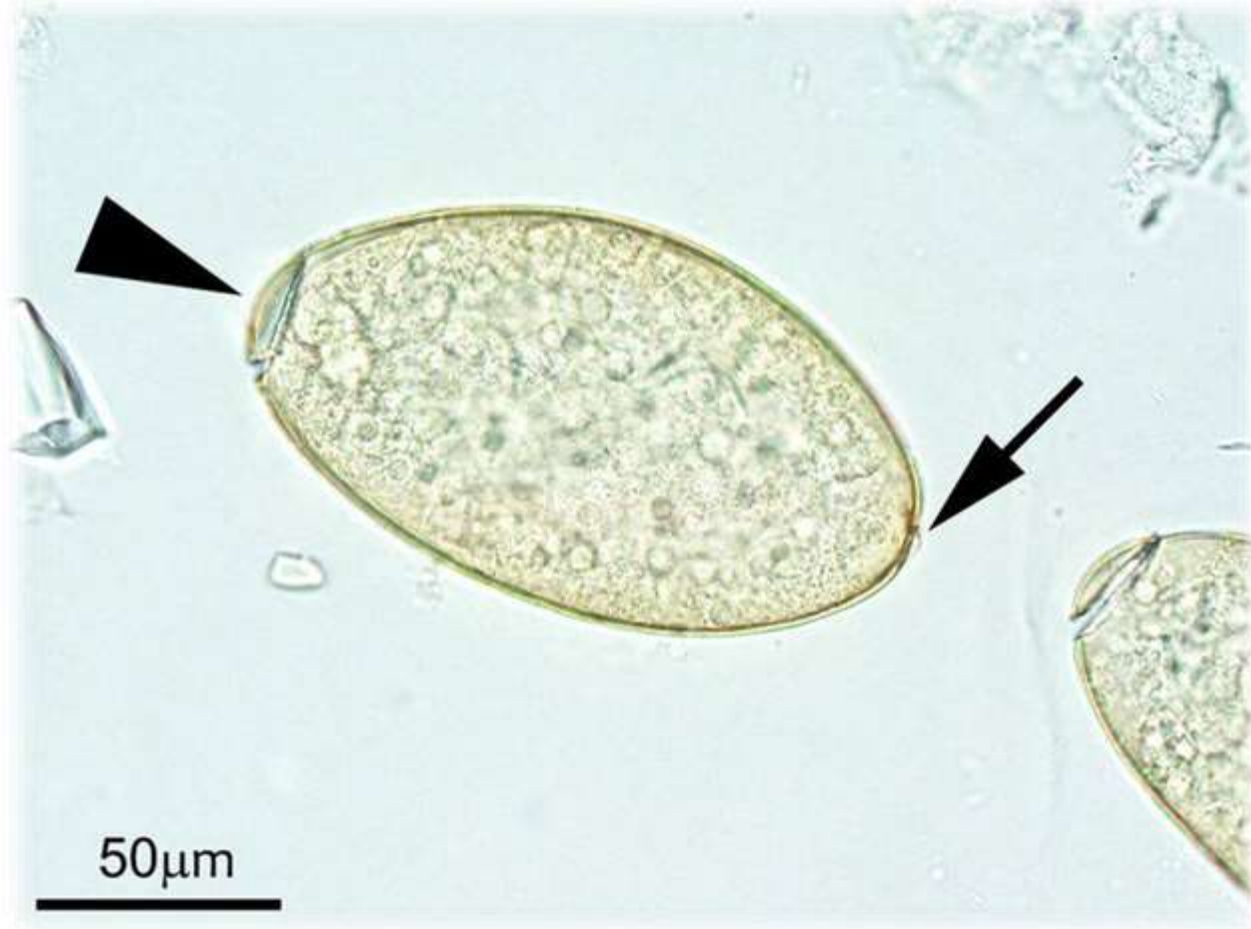
Site of infection

- Bile ducts of the liver

Infective stage : Metacercaria

Diagnostic stage : Eggs in stool



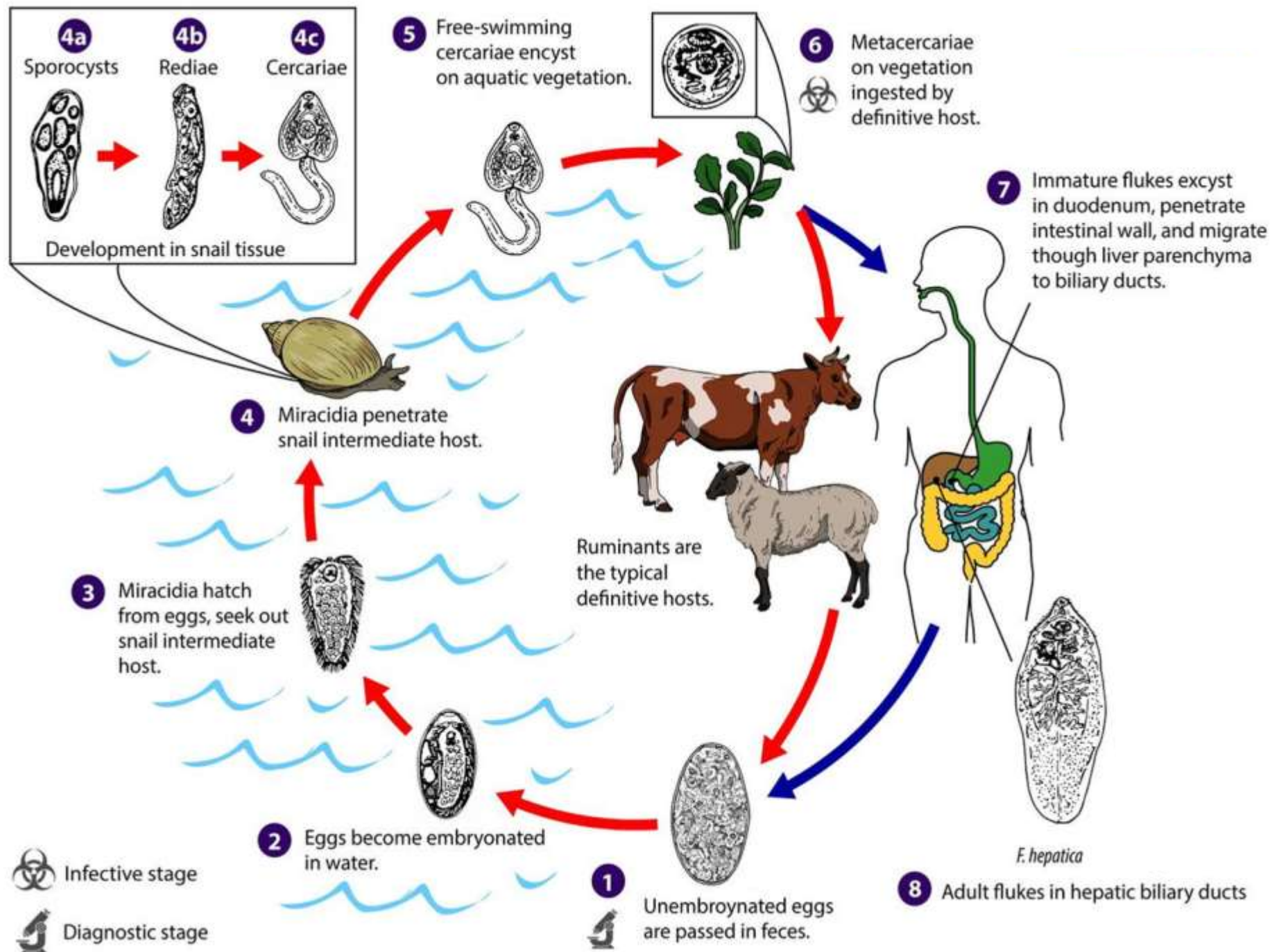


Large-sized eggs

- Oval in shape
- Yellowish-brown in color
- Operculated (with a distinct operculum at one pole)

Life cycle

1. Adult worms live in the bile ducts of the liver
2. Eggs are passed in the feces
3. In water, eggs hatch into Miracidium
4. Miracidium penetrates a freshwater snail
5. Inside the snail, it develops into:
 - Sporocyst
 - Redia
 - Cercaria
6. Cercaria leaves the snail and encysts on aquatic plants
7. It becomes Metacercaria
8. Humans or animals ingest contaminated aquatic plants
9. Larvae excyst in the intestine and migrate to the liver
10. Mature into adult flukes in bile ducts



Clonorchis sinensis

Geographical distribution

- Endemic in East Asia, especially , China , Korea , Vietnam , Taiwan .
- Human Liver Fluke** (Clonorchis sinensis)
- Inhabits the **terminal branches of the bile ducts** beneath the liver capsule.
- Humans become **infected by consuming fish contaminated with encysted metacercariae or drinking contaminated water.**
- Causes bile duct irritation.



Hosts

final host : Humans, fish-eating mammals (dogs, cats)

Intermediate hosts

First intermediate host : Freshwater snail.

Second intermediate host : Freshwater fish.

Site of infection

- Intrahepatic bile ducts

Infective stage Metacercaria in freshwater fish.

Diagnostic stage Eggs in stool.



Small

- Yellow-brown
- Operculated
- Prominent opercular shoulders
- Small terminal knob



Life cycle

1. Adult worms live in the intrahepatic bile ducts
2. Eggs are passed in the feces
3. Eggs are ingested by freshwater snails
4. Inside the snail, eggs develop into:
 - Miracidium
 - Sporocyst
 - Redia
 - Cercaria
5. Cercaria leaves the snail
6. Cercaria penetrates freshwater fish
7. Encysts in fish muscles as Metacercaria
8. Humans become infected by eating raw or undercooked fish
9. Metacercaria excysts in the duodenum
10. Adult worms migrate to bile ducts and mature

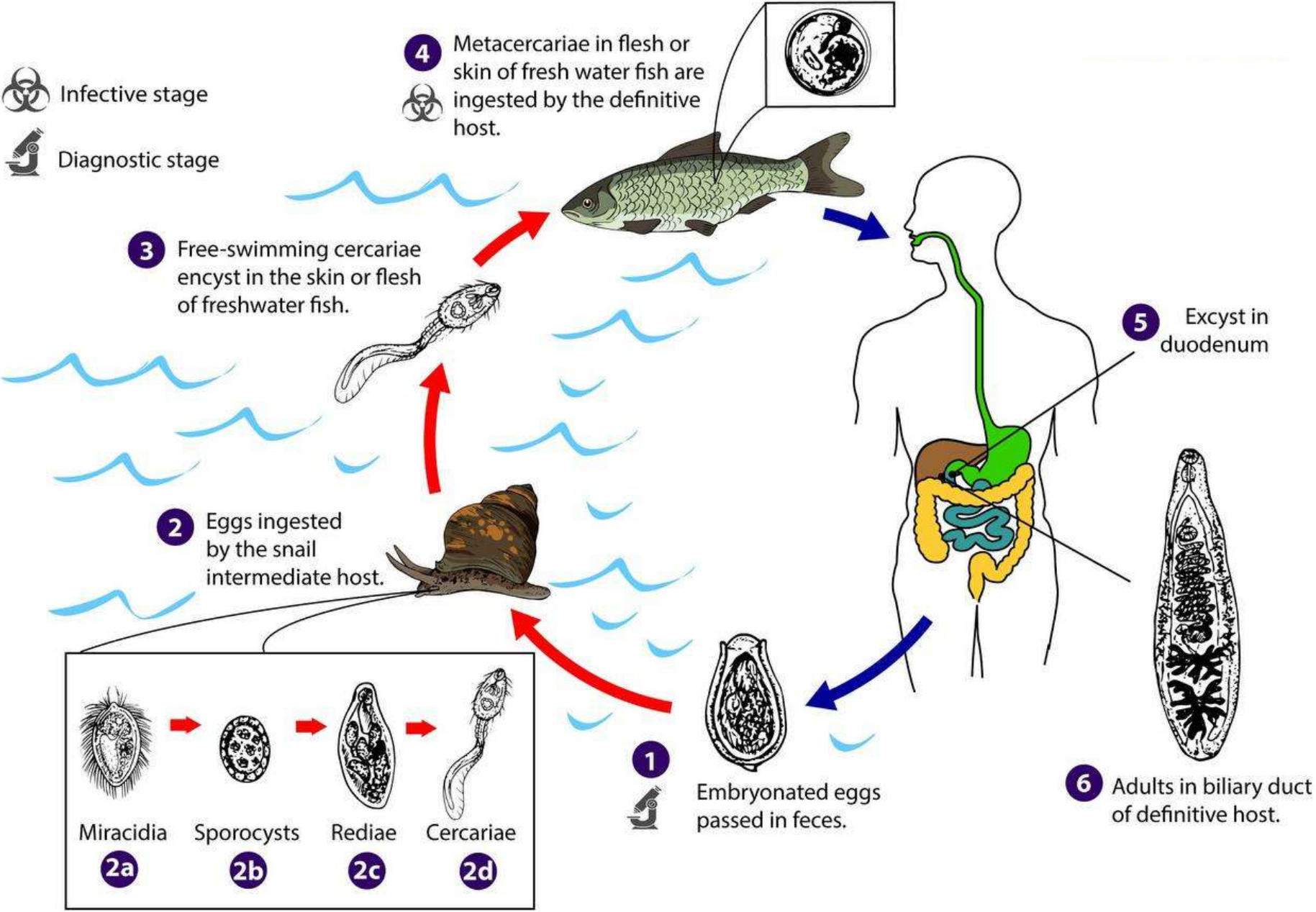
Clonorchis sinensis



Infective stage



Diagnostic stage



Schistosomiasis



Prepared & Presented by:
M.Sc. Ghadeer Mahmood

Lecture 3

Schistosomiasis is a chronic parasitic disease caused by flatworms known as Schistosoma.

Schistosomiasis was first described by German pathologist Bilharz while working in Egypt, where he identified the parasite in human tissues.

Schistosomes are **dioecious**, (sexes are separate) trematodes, which lead to **Schistosomiasis (bilharziasis)**.

These parasites are called schistosomes due to the presence of a **ventral groove (gynecophoric canal)** in the male.

Humans become infected through swimming or while washing clothes near the source of contamination.

The infection affects over 100 million people worldwide.



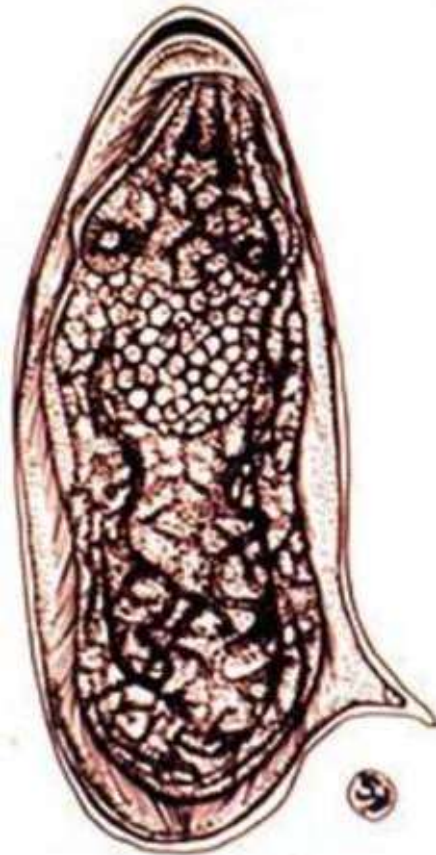
General Characteristics of Schistosoma

1. Belongs to phylum Platyhelminthes and class Trematoda.
2. Adult worms live in the body of humans.
3. Dioecious worms (separate male and female).
4. Male is short and thick; female is long and slender.
5. Life cycle requires two hosts:
 - Final host: human
 - Intermediate host: freshwater snail
6. The eggs have distinctive spines.
7. **Fork tail Cercaria** is the infective stage for humans.
8. Miracidium infects the snail host.
9. Pathology is mainly due to egg deposition in tissues.
10. Common in tropical and subtropical regions.

The main types of schistosomiasis are:

1. *Schistosoma mansoni*
2. *Schistosoma haematobium*
3. *Schistosoma japonicum*

S. mansoni



S. haematobium

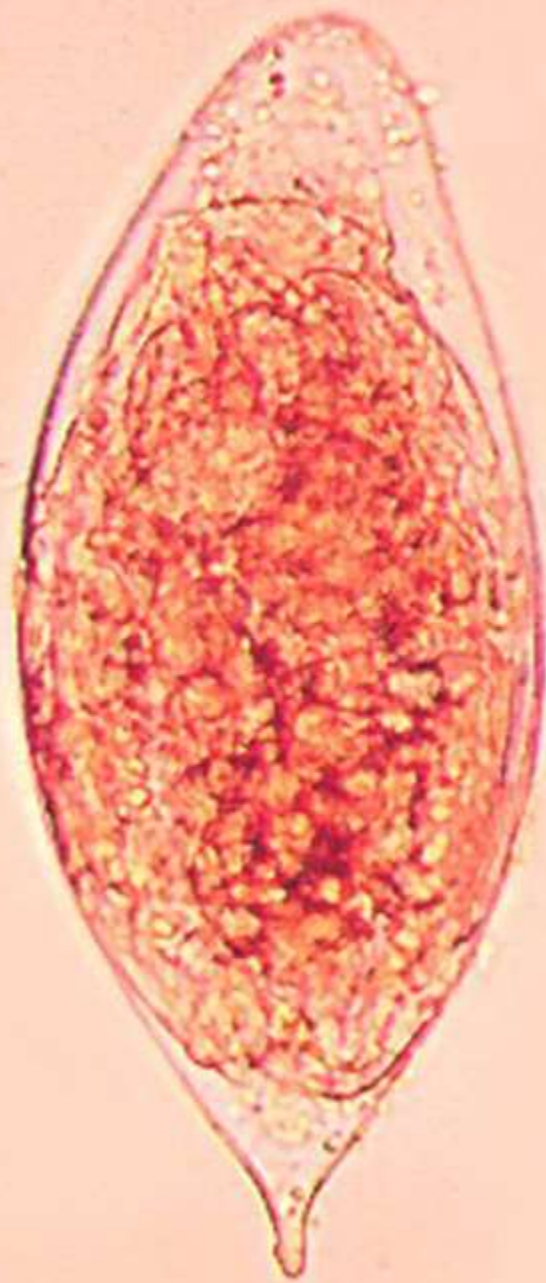


S. japonicum



Type of egg





1- Schistosoma manson

- Causes **intestinal schistosomiasis**.
- Found mainly in Africa, Brazil, Venezuela, and some Middle Eastern pockets.
- Intermediate hosts: **Biomphalaria snails**.

2- Schistosoma haematobium

- Causes **urogenital schistosomiasis** (urinary tract).
- Found mainly in Africa and the Middle East.
- Intermediate hosts: **Bulinus snails**.

3- Schistosoma japonicum

- Causes **intestinal/hepatic schistosomiasis**.
- Found mainly in China, the Philippines, and Indonesia (Japan is no longer endemic).
- Intermediate host: **Oncomelania snails**.

Symptoms and diagnostic methods

1. *S. Haematobium*

Symptoms

- Blood in urine
- Painful urination

Eggs

- Found in urine
- Terminal spine

Diagnostics

- Urine microscopy

2. *S. mansoni*(Intestinal)

Symptoms

- Bloody diarrhea
- Abdominal pain
- Hepatosplenomegaly

Eggs

- Found in stool
- Lateral spine

Diagnostics

- Stool microscopy

3. *S. japonicum* (Intestinal–Hepatic)

Symptoms

- Mild diarrhea
- Abdominal pain
- Hepatosplenomegaly

Eggs

- Found in stool
- Small & rounded

Diagnostics

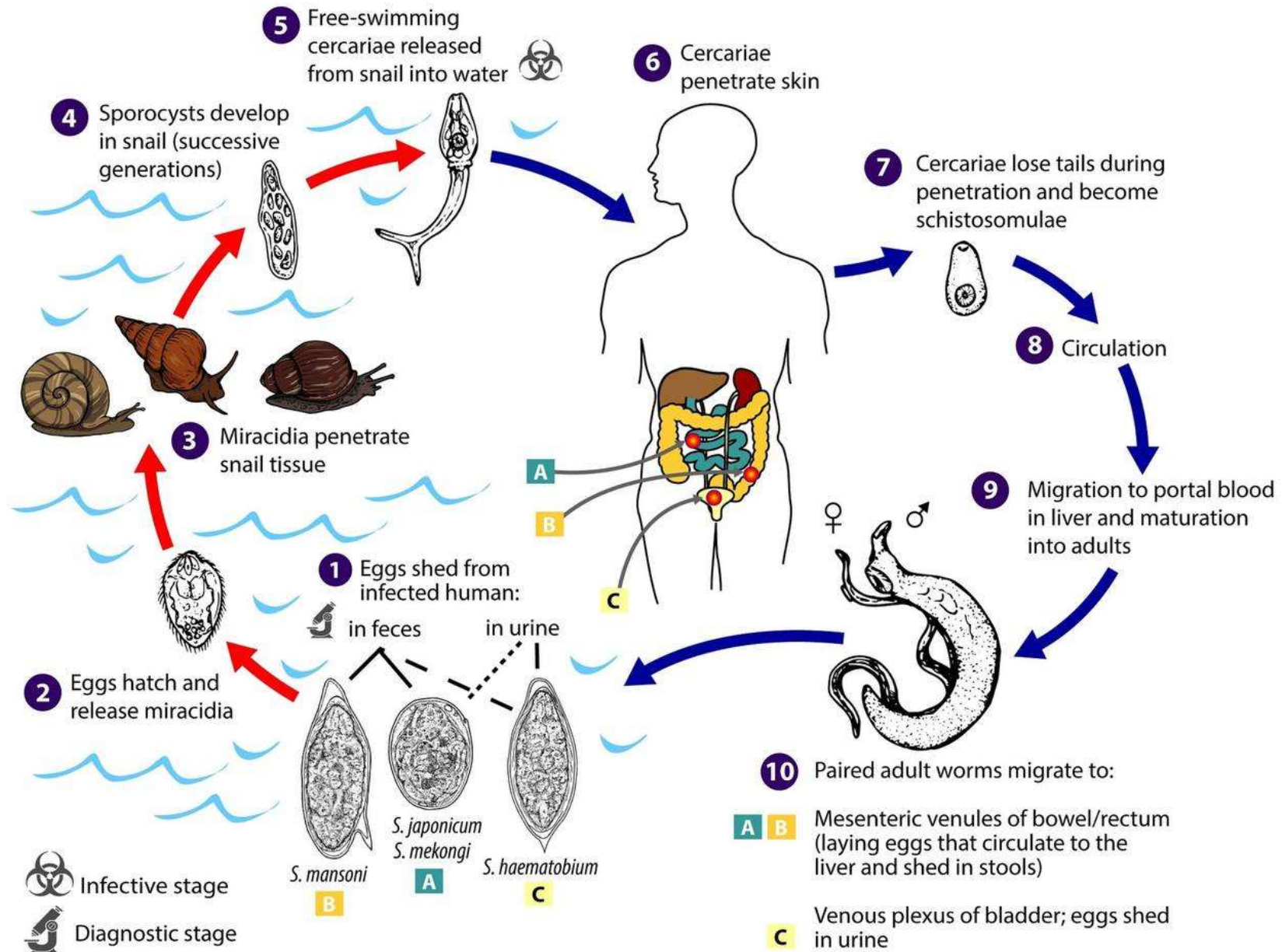
- Stool microscopy

Life cycle and Transmission

Schistosomes have a complex life cycle involving two hosts:

1. Eggs are passed in human urine or feces.
2. In freshwater they hatch into miracidia which infect specific snail hosts.
3. Within snails they multiply asexually and release cercariae.
4. Cercariae penetrate human skin in contaminated water — this is the infective stage.
5. They develop into adult worms in **blood vessels**; females lay eggs that continue the cycle.

Schistosoma spp.

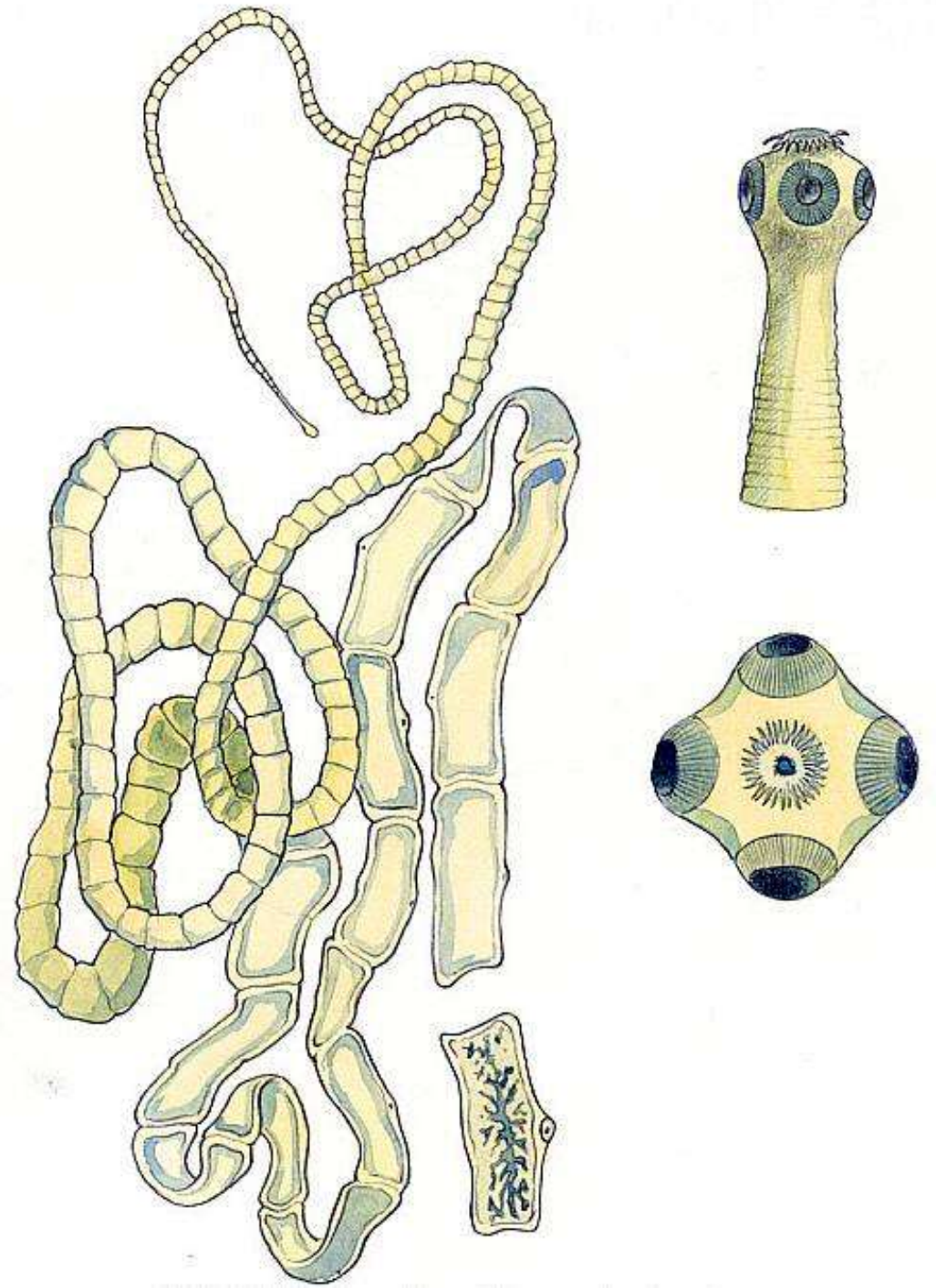


Taeniasis

Lecture 4

Prepared & Presented by:

M.Sc. Ghadeer Mahmood



Classification of Tapeworms (Cestodes)

Tapeworms belong to the **phylum** Platyhelminthes and the **class** Cestoda.

General Characteristics of Tapeworms

1. Dorsoventrally flattened worms : Tapeworms are flat in shape from the dorsal and ventral sides.
2. Body Structure : The body consists of three main parts:
 - Scolex (head)
 - Neck
 - Proglottids (body segments)
3. Scolex Features The scolex is have with four suckers.
In some species, it may also have hooks.

Behind the scolex is the neck, followed by a chain of segments (proglottids) that develop in stages:

- Immature proglottids
- Mature proglottids
- Gravid proglottids (containing eggs)

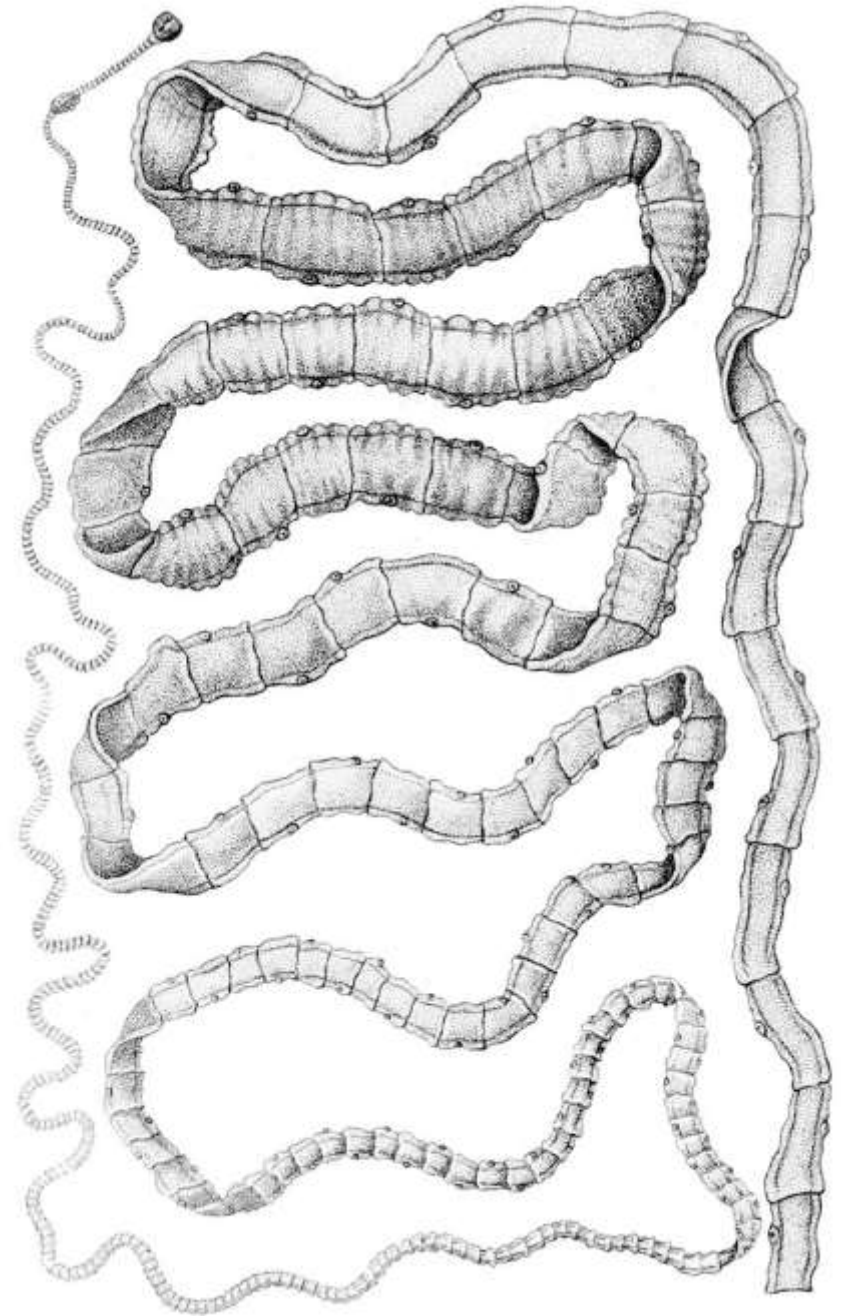
4. Absence of Digestive System

Tapeworms **lack a digestive tract**.

5. Nutrient Absorption

Nutrients are absorbed directly through the body surface (tegument).

6. Monoecious : Both sexes present in one body.



Taenia saginata (Beef tapeworm)

- It is widely distributed worldwide.
- It is common in communities where people eat raw or undercooked beef.
- The adult worm lives in the **small intestine** of humans.
- Morphology

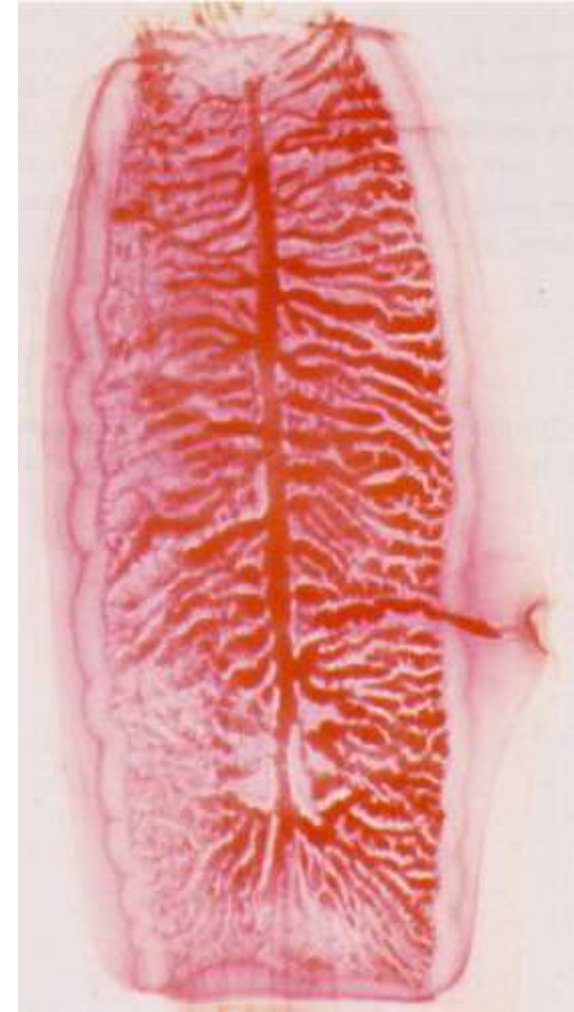
Length: about 5 meters (may reach up to 10 meters).

Number of proglottids (segments): 1000–2000 segments.

Scolex (head): Has 4 suckers and No hooks

Gravid proglottid : Uterus has 15–30

lateral branches Filled with eggs



- final host: Human
- Intermediate host: Cattle (cow)

The infective stage for humans is the **cysticercus larva** found in undercooked beef.

Disease Name : The disease is called **Taeniasis saginata** .

Pathogenesis and Symptoms

Most cases are asymptomatic.

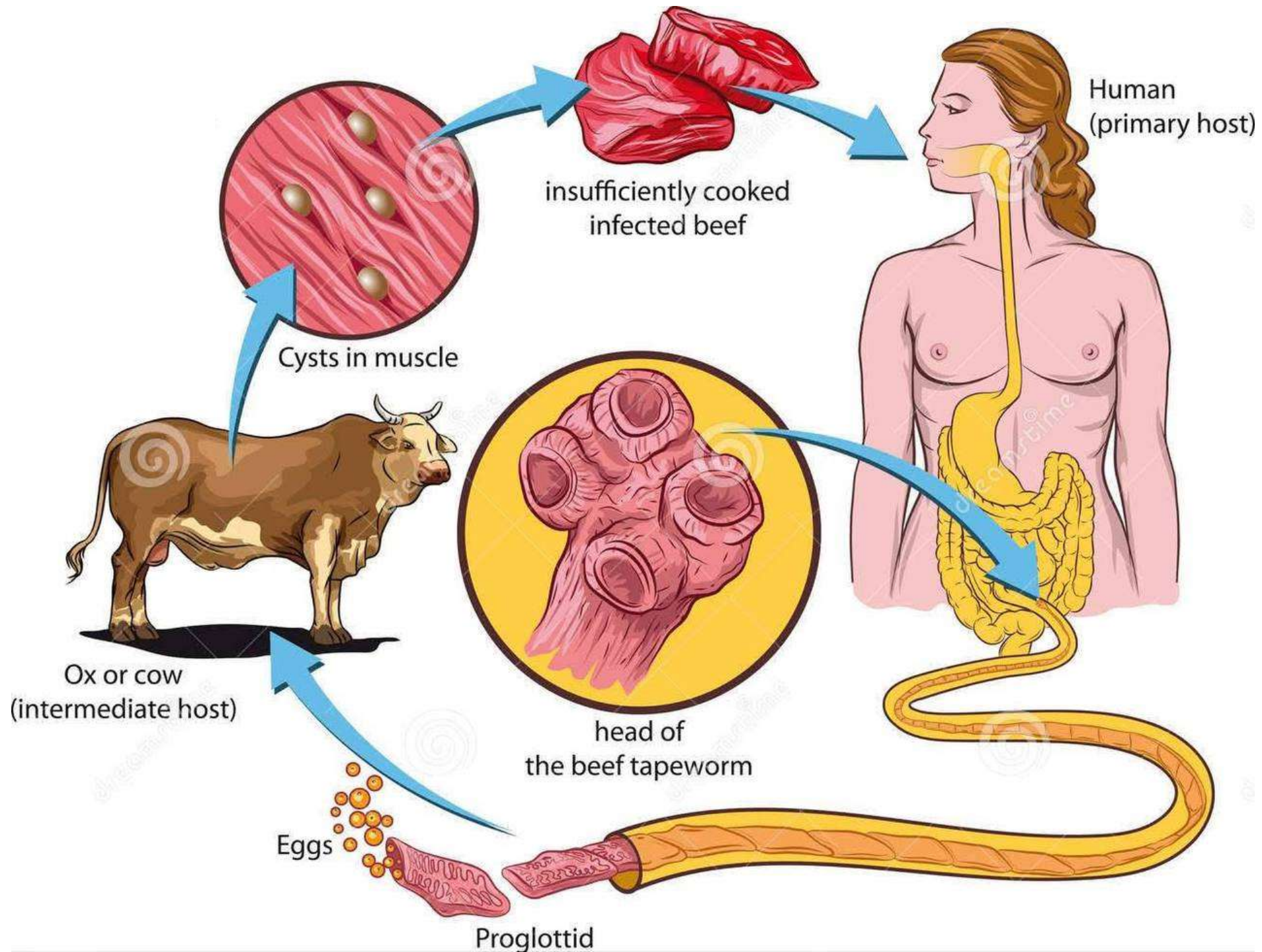
Possible symptoms include:

- fear due to the passage of motile proglottids in stool
- Mild diarrhea
- Weight loss
- Abdominal discomfort
- Intestinal obstruction



Life Cycle

1. Adult worm lives in the human small intestine.
2. Gravid proglottids containing eggs pass with feces.
3. Cattle ingest eggs or proglottids from contaminated food or water.
4. Eggs hatch in the intestine of cattle and release oncospheres.
5. Oncospheres penetrate the intestinal wall and migrate to muscles.
6. They develop into cysticerci (larval cysts) in muscle tissue.
7. Humans become infected by eating raw or undercooked beef containing cysticerci.
8. The cysticercus develops into an adult worm in the small intestine.





Taenia solium

Class: Cestoda (tapeworm)

Adult worm lives in the small intestine of humans.

Length: about 8 meters.

Proglottids: less than 1000 segments.

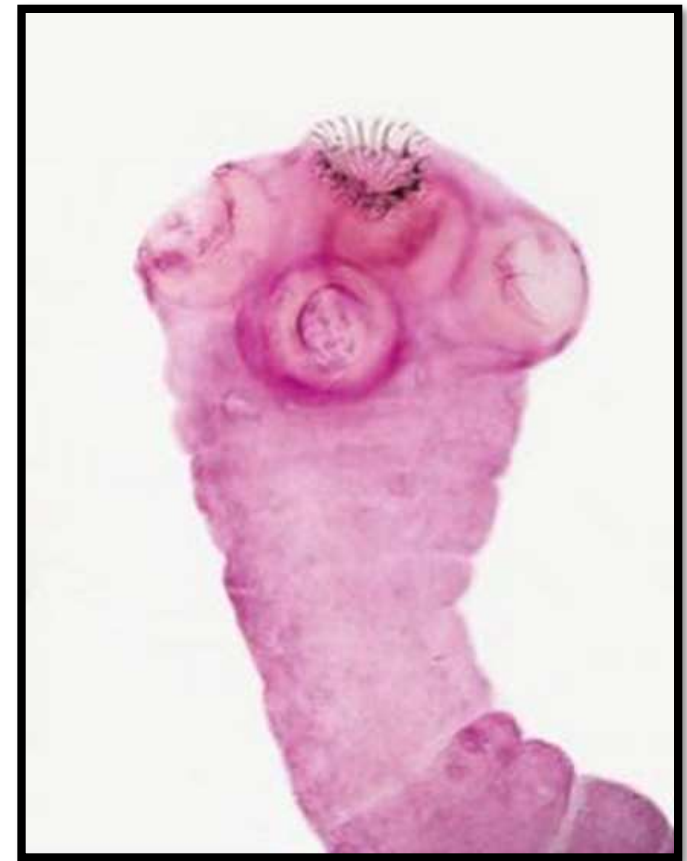
final host: Human (adult worm).

Intermediate host: Pig (larval stage).

Scolex (Head) 4 suckers and with 22–32 hooks (diagnostic point).

Gravid Proglottid : 7–13 lateral uterine branches (diagnostic point).

- Infective Stages :Cysticercus (larval) → causes intestinal infection.



- **Diseases:** Taeniasis solium

Due to adult worm in intestine.

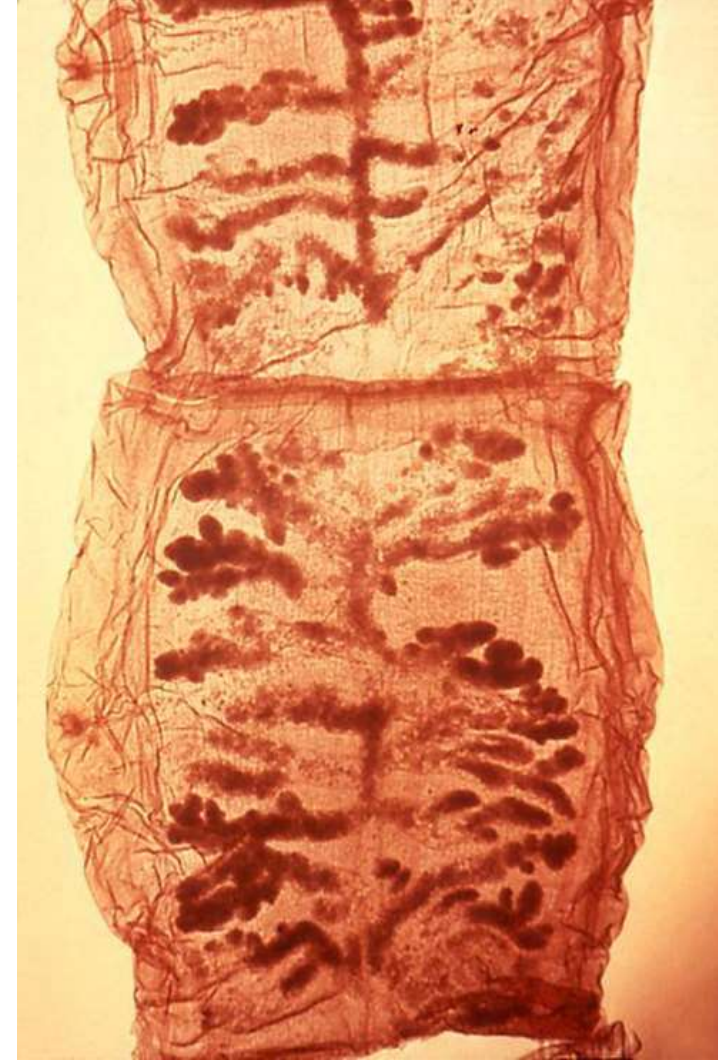
Abdominal discomfort

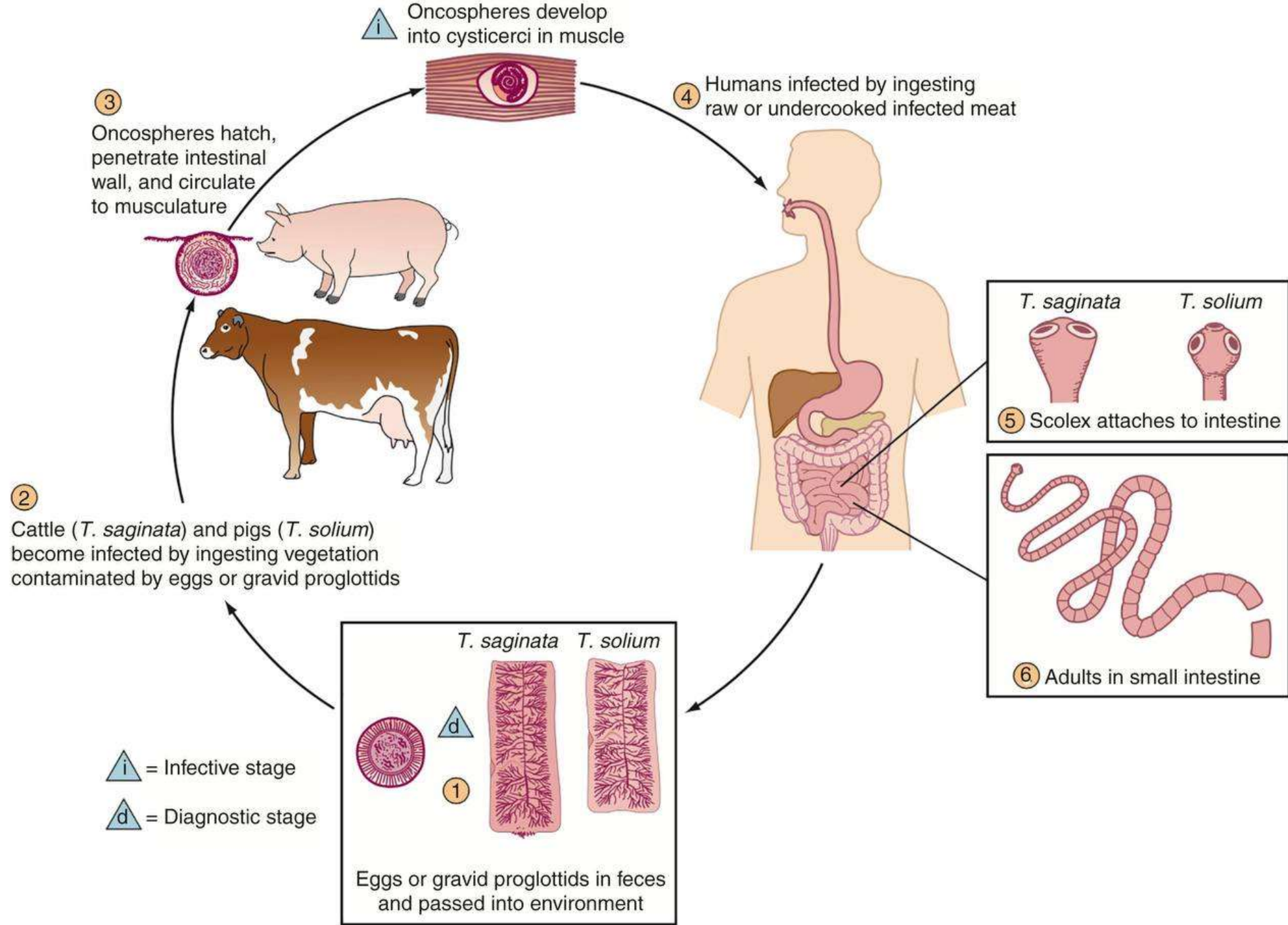
Passage of segments in stool

Diagnosis: Stool examination (eggs or proglottids).

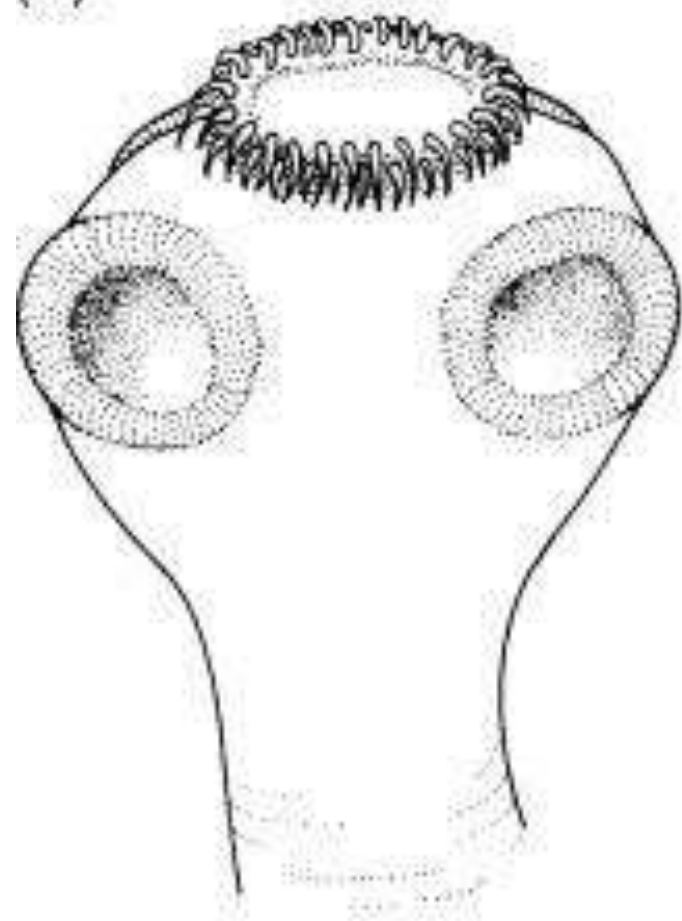
Life Cycle

1. Eggs or gravid segments passed in human feces.
2. Pig ingests eggs.
3. Oncosphere penetrates pig intestine → reaches muscles.
4. Develops into *Cysticercus cellulosae*.
5. Human eats undercooked pork → cysticercus develops into adult worm in intestine (2–3 months).
6. If human ingests eggs → cysticercosis develops



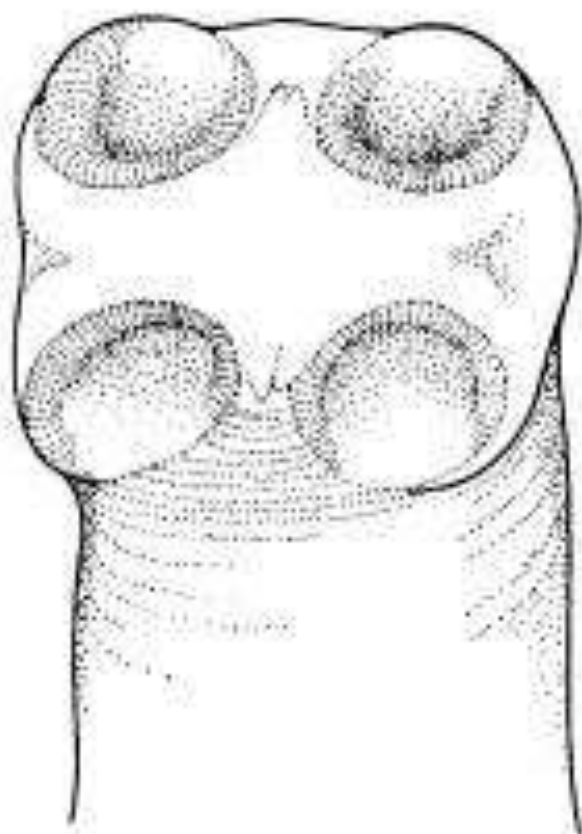


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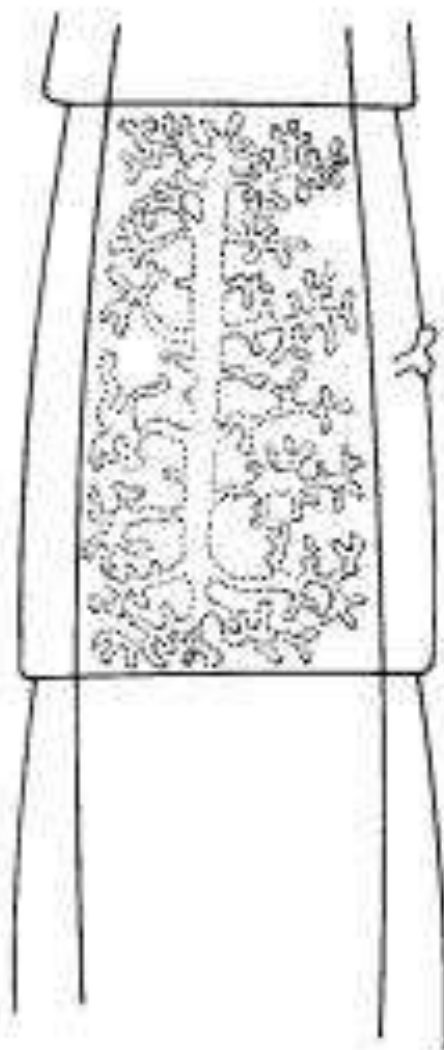


Taenia solium

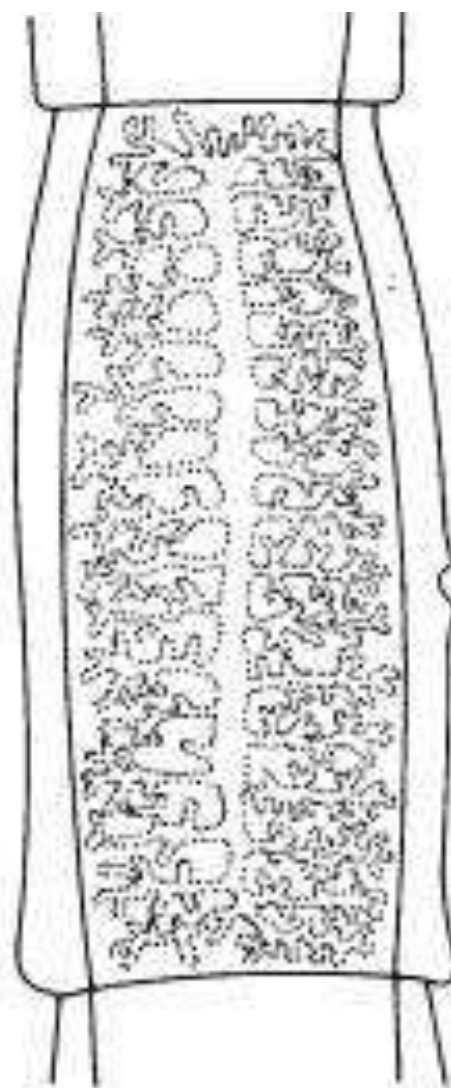
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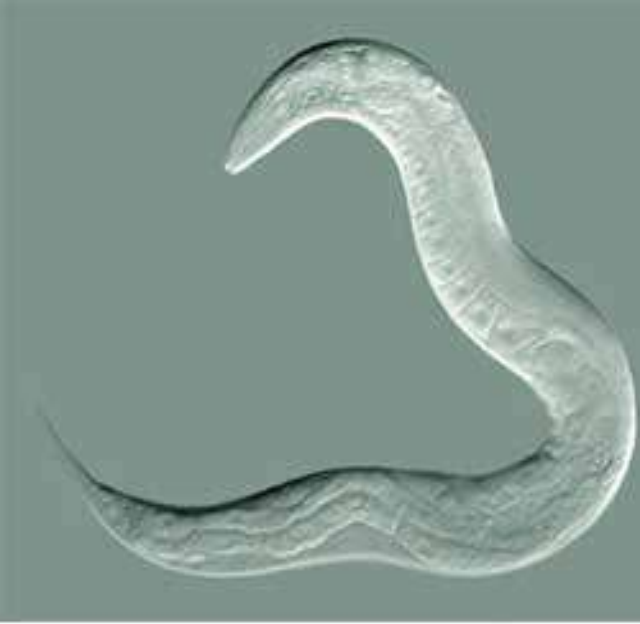
Taenia saginata



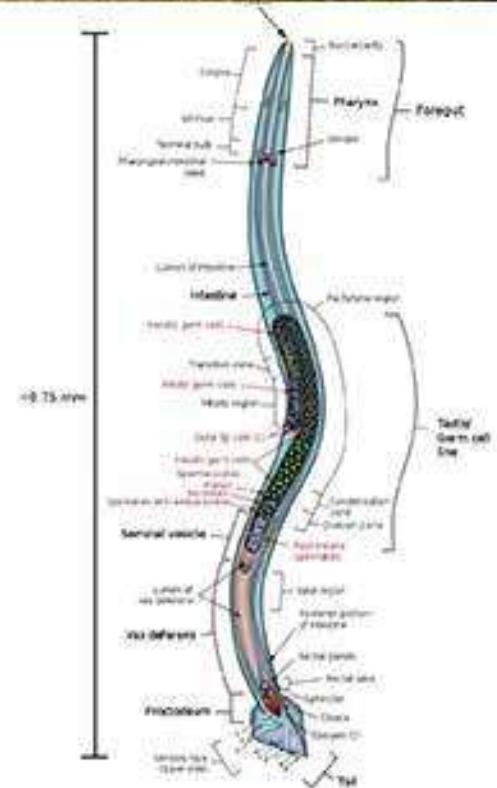
Taenia solium



Taenia saginata



Phylum Nematoda



General Characteristics

The digestive system is complete.

The nematodes are **diecious** i.e. the sexes are separate.

Nematodes are elongated, cylindrical, unsegmented.

Unlike trematodes and cestodes, all of which are parasitic, most nematodes are **free-living** forms found in soil and water.

The largest number of helminthic parasites of humans belong to the class of nematodes. There are an estimated 500,000 species of nematodes.

The life cycle of nematodes consists typically of **4 larval stages** and the adult form.

Nematodes **molt** because they possess a non-living external cuticle.

The process of molting is called **Ecdysis**.

Enterobius vermicularis

It is worldwide in distribution.

parasite, which specially affects the children.

Adult worms are found in the **caecum**.

Disease caused: **Enterobiasis**

Final host : The human is the only natural host.

Intermediate host : There is no intermediate host.

Habitat in the body : Adult worms live in the large intestine, particularly the cecum and colon.

Adult have a cylindrical body with a rounded anterior end and a pointed posterior end.



Sometimes, adult worms can be seen in the stool.

The rounded anterior end bears lateral expansions known as alae (**cervical alae**).

- The female is longer and thicker than the male.
- The female measures approximately **8–13 mm** in length.
- The male measures about **2–5 mm**; its posterior end is curved and equipped with a single **copulatory spicule**.

Eggs of *Enterobius vermicularis* infection:

- The eggs are oval in shape.
- They have a thin, transparent shell.
- The eggs are colorless.
- They usually contain a developing larva.



- They are asymmetrical (one side is flat and the other side is curved).



Main symptoms:

Intense perianal itching (especially at night)

Sleep disturbance

Sometimes abdominal discomfort

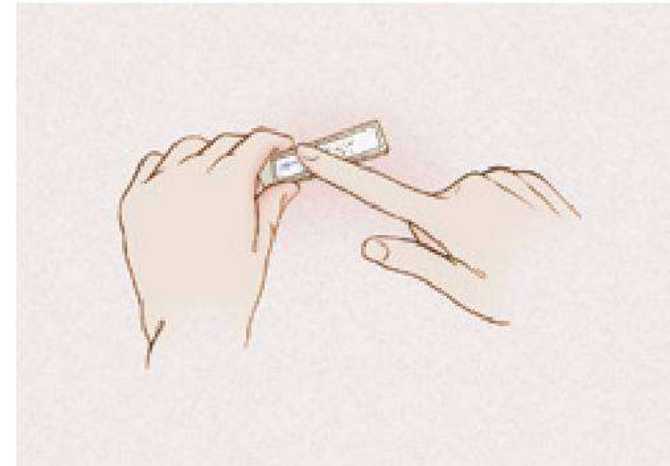
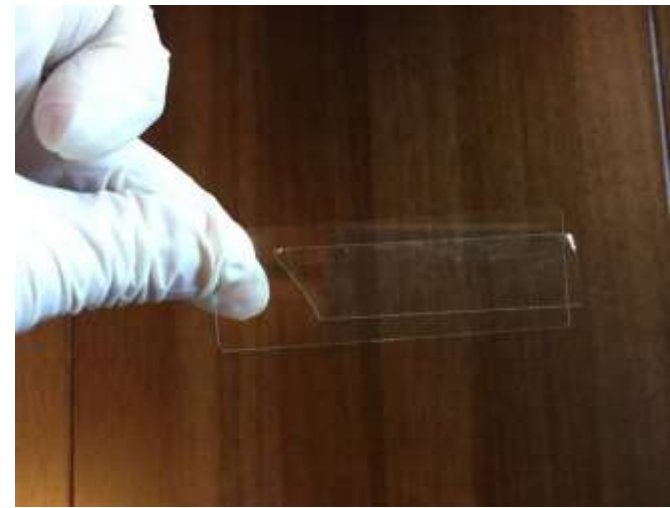
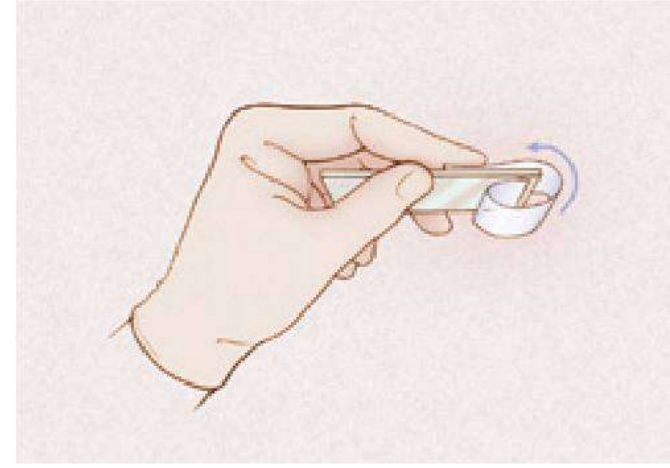
They may cause inflammation of the vagina when present in it.

Laboratory diagnosis:

Scotch **tape test** (cellophane tape test).

Microscopic detection of eggs from perianal area

Eggs and adult worms in the stool.

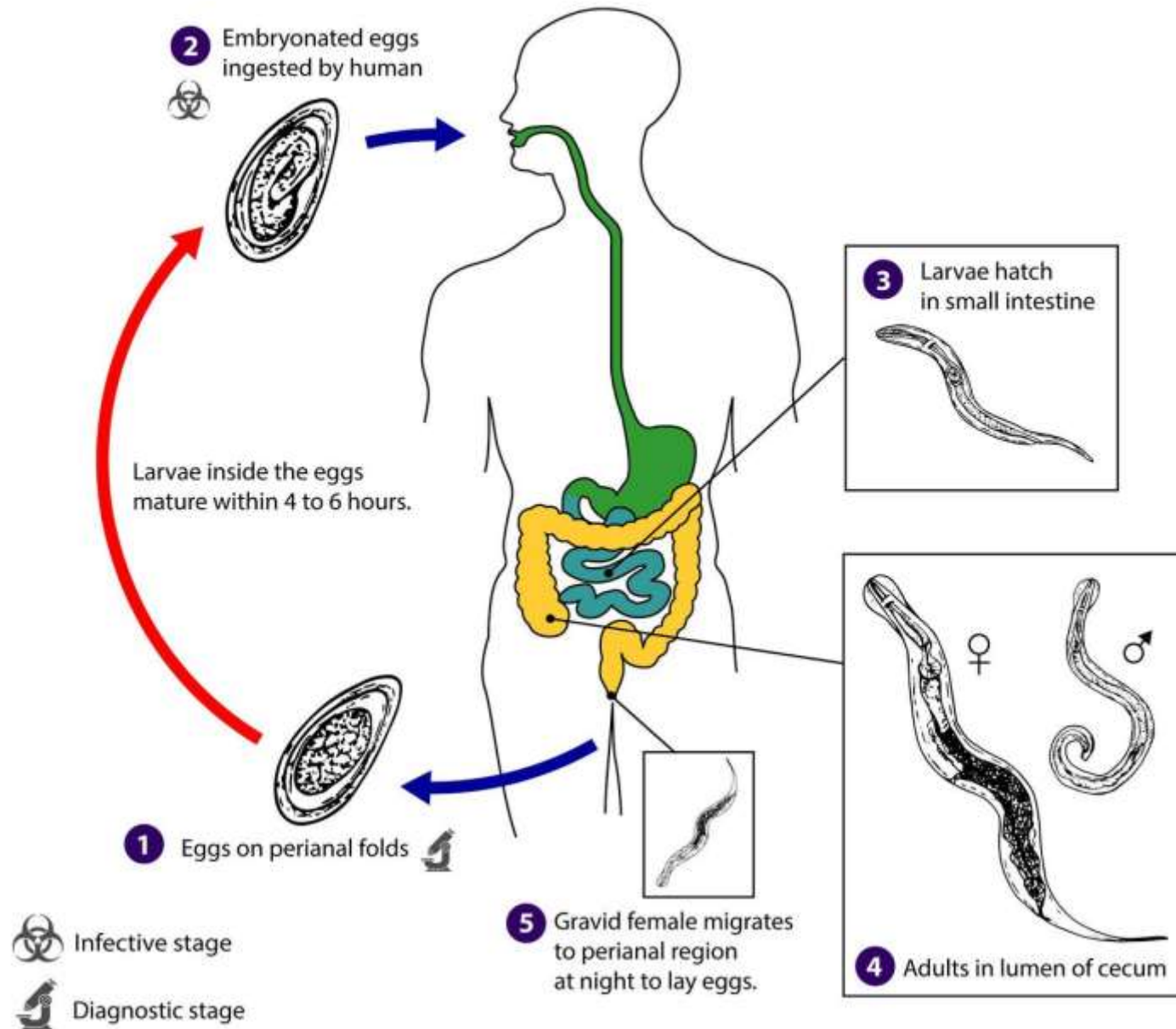


Life cycle

The life cycle is simple and direct:

1. Adult worms live in the colon.
2. Gravid female worms migrate at night to the perianal region.
3. They deposit thousands of eggs on the perianal skin.
4. Eggs become infective within 4–6 hours.
5. Infection occurs when eggs are swallowed from contaminated fingers, food, or objects.
6. After ingestion, eggs hatch in the small intestine.
7. Larvae develop into adults in the colon within about 2–4 weeks.

Enterobius vermicularis



Ascaris lumbricoides

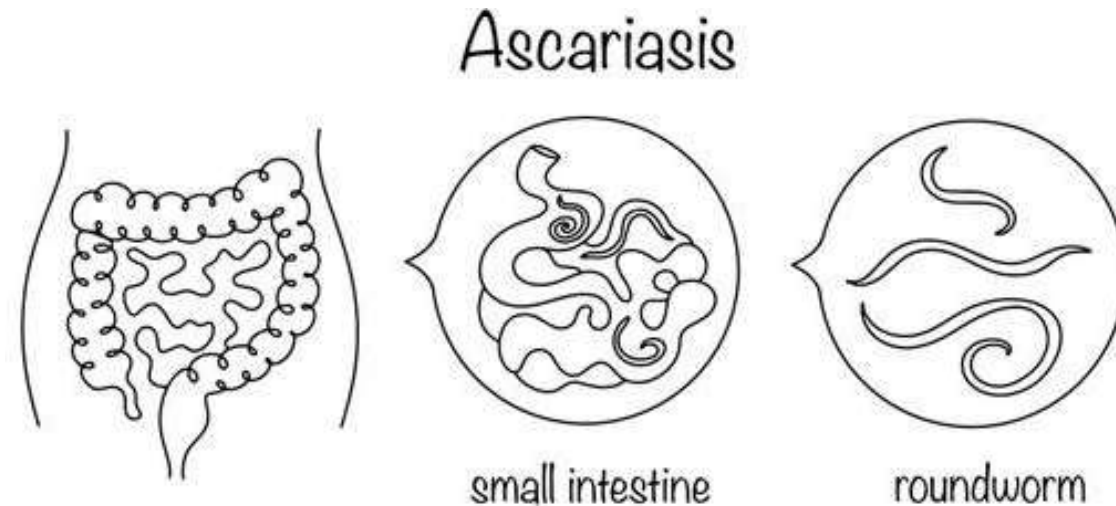
Ascariasis occurs worldwide but is most common in tropical and subtropical regions.

Disease caused : The disease caused by this parasite is called **Ascariasis**.

About 900 million people are infected worldwide.

Infection occurs through **soil contaminated with eggs**.

- It is more prevalent in regions where human feces are used as fertilizer.
- The eggs remain infective for up to two years and are resistant to desiccation and some chemical disinfectants.



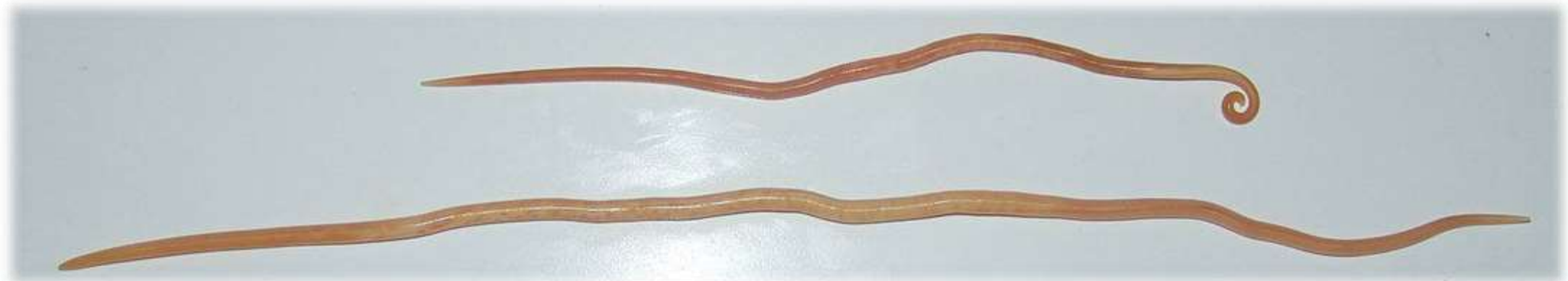
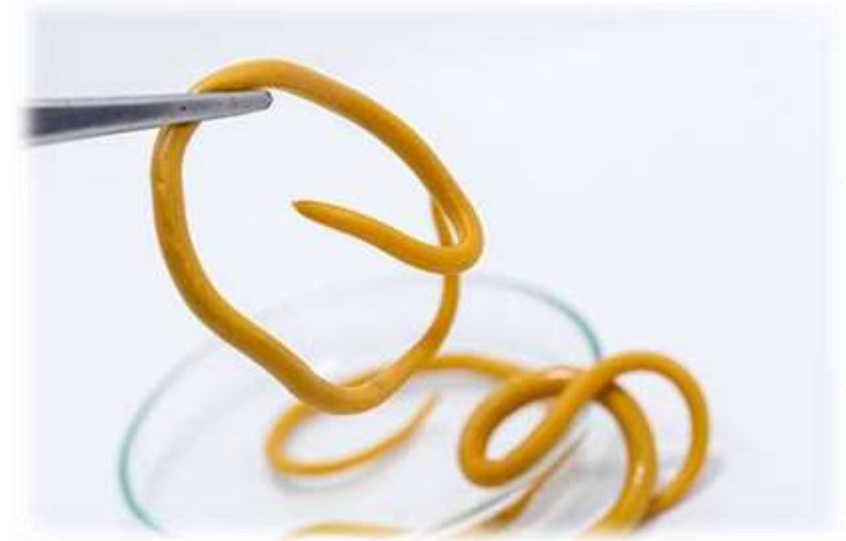
Final host: The human is the main final host where the adult worms live in the **small intestine**.

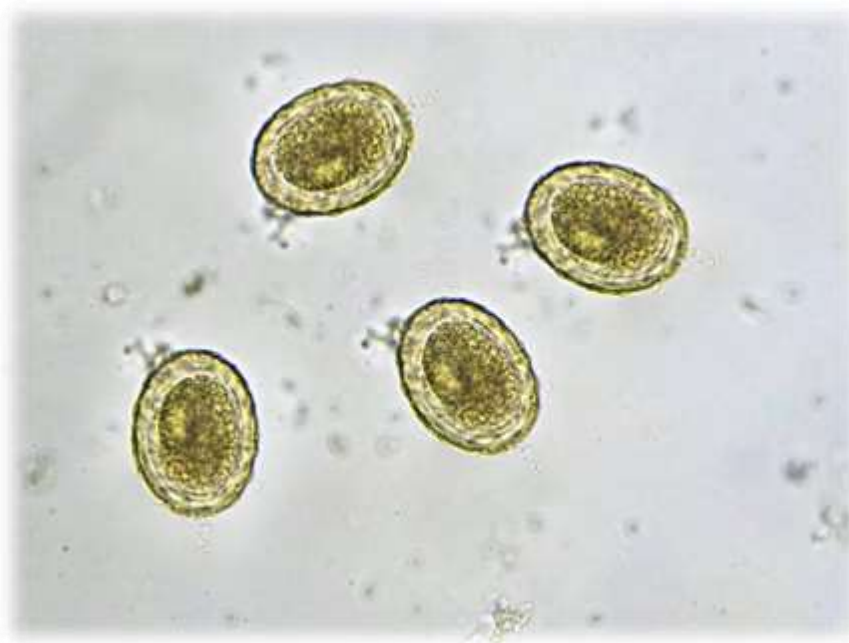
Intermediate host : There is no intermediate host in the life cycle.

Habitat in the body : Adult worms live in the lumen of the small intestine, particularly the jejunum.

Cylindrical worms, **whitish-yellow** in color.

- The female measures about 35 cm in length and has a rounded posterior end.
- The male measures about 20 cm in length and has a curved posterior end.





- Oval or round in shape
- Brownish in color
 - Thick-shelled
 - Outer surface is rough

Life cycle

Adult worms live in the small intestine of humans.

After mating, females lay eggs that are passed in feces.

Eggs become infective and are ingested via contaminated food or water.

Larvae hatch in the small intestine.

They penetrate the intestinal wall and travel via blood to the liver, heart, then lungs.

Larvae move through the lungs → bronchi → trachea → pharynx, then are swallowed.

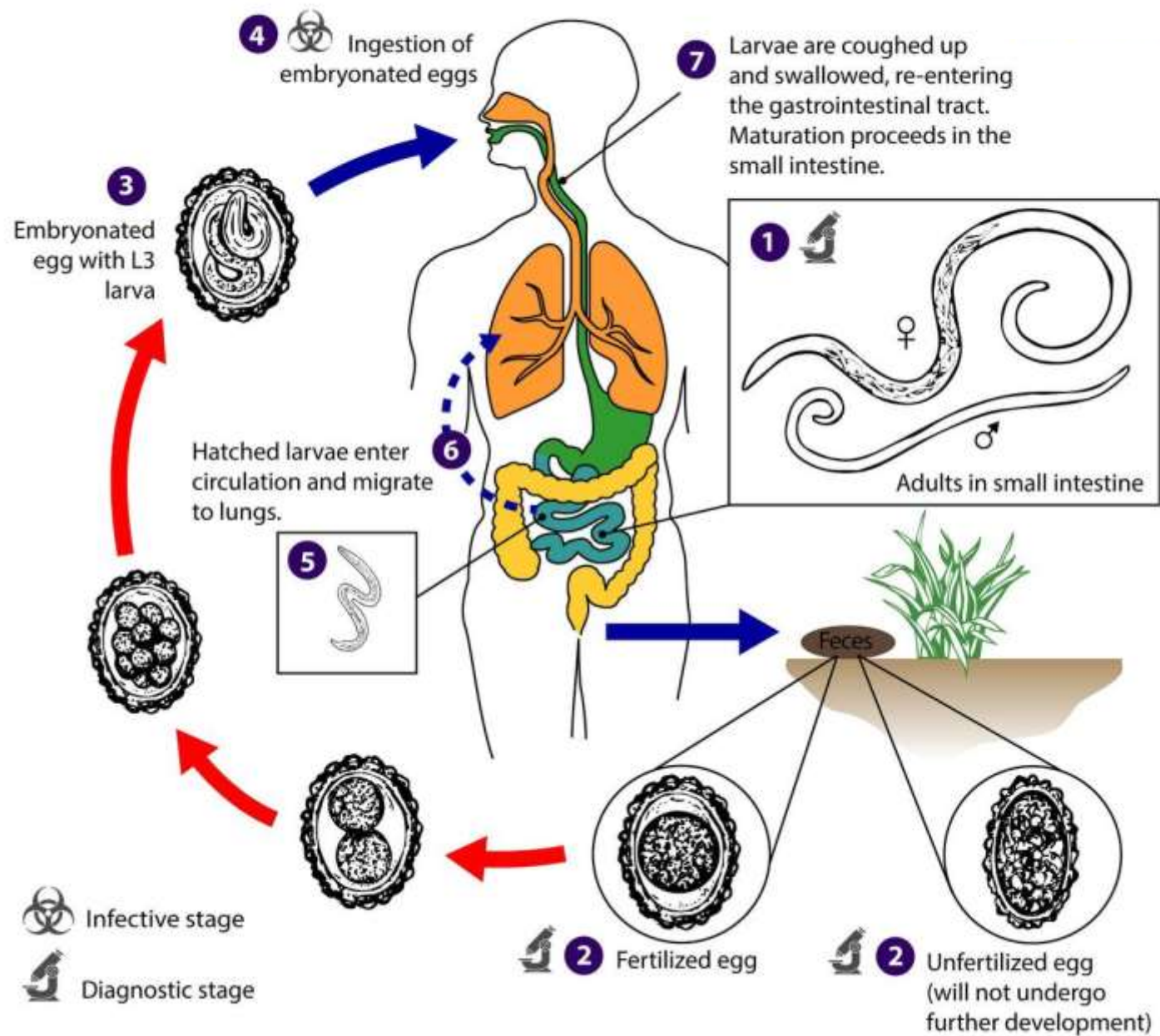
They return to the intestine and develop into adult worms.

Life cycle duration: about 2–2.5 months.

Worms may live in the host for 1–1.5 years.

Eggs develop into the infective stage in soil within 1–2 weeks under suitable conditions (moisture, warmth, oxygen, shade).

Ascaris lumbricoides



Pathogenesis and Clinical

Acute abdominal pain

- Diarrhea
- Intestinal obstruction (in heavy infections)
- Appendicitis
- Nutritional depletion due to consumption of host carbohydrates and proteins
- Larval or adult migration may occur:
- Penetration of the intestinal wall
- Ectopic migration to organs such as the eye and pharynx, causing tissue destruction
- Acute pneumonia
- Shortness of breath



Diagnosis

- Microscopic examination of stool for ova (eggs)
- Detection of adult worms in stool
- Radiological imaging (in cases of obstruction or aberrant migration)
- Sputum examination.

