

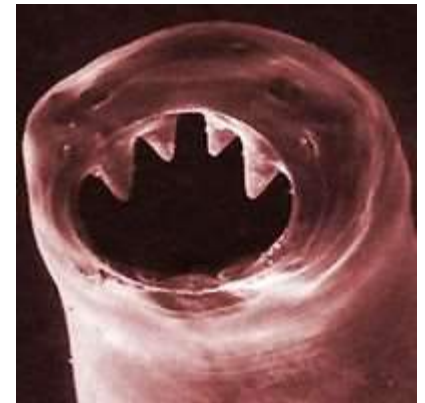
Lec.1: Medical helminthology



Lec.Dr.Ruwaidah F. Khaleel

introduction

- Medical helminthology is branch of **zoology** that studies worms, especially parasitic worms.
- The public health impact of medical helminthes is appreciable.
- Two billion people are infected by soil -transmitted helminthes such as *Ascaris*, hookworms, *Trichuris trichura* and by **Schistosomes**.



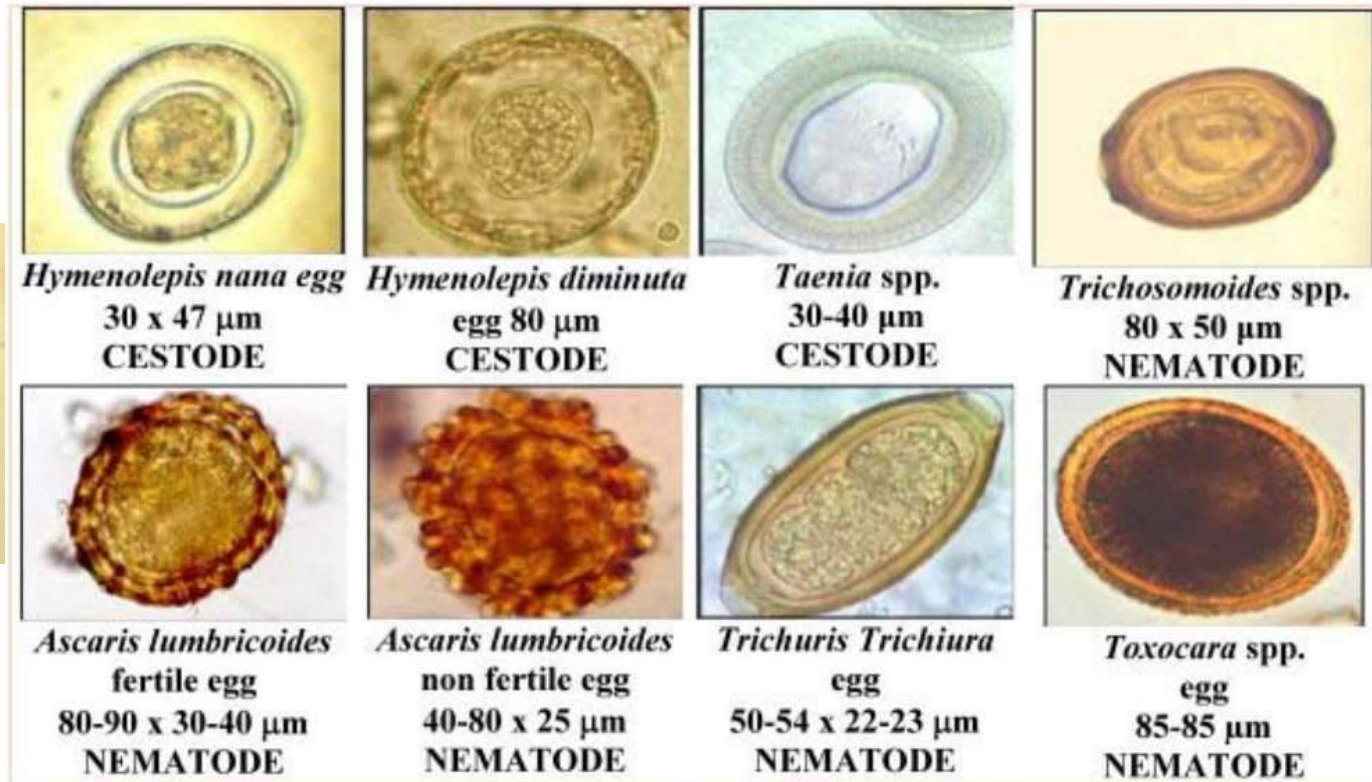
- Medical helminthes need to develop in a parasitized host, and sometimes this involves several disparate hosts.
- **Helminthes parasites are more complex than free-living helminthes,**
- ✓ **because 1.** they have evolved mechanisms to deal with the different environments of their various hosts and living conditions.
- **2.** They have developed host-finding behaviors, exquisite migration



- Patterns within each host, and the ability to evade the host immune and protective responses.
- **Helminthes:** are multicellular eukaryotic animals that generally possess **digestive, circulatory, nervous, excretory, and reproductive systems.** Some are free-living in **soil and water.**



- **Helminthes are studied in microbiology**
- ✓ because they cause infectious diseases and most are diagnosed by microscopic examination of eggs or larvae.
- Eggs may have **striations (lines)**, a **spine**, or an **operculum** (hatch by which the larva leaves).
- Helminthes infect more than one-third of the world population.



- **Helminthes infections differ from bacterial or protozoan infections**
- ✓ because the worms do not usually increase in number in the host.
- Symptoms are usually due to
 1. Mechanical damage,
 2. Eating host tissues, or competing for vitamins.



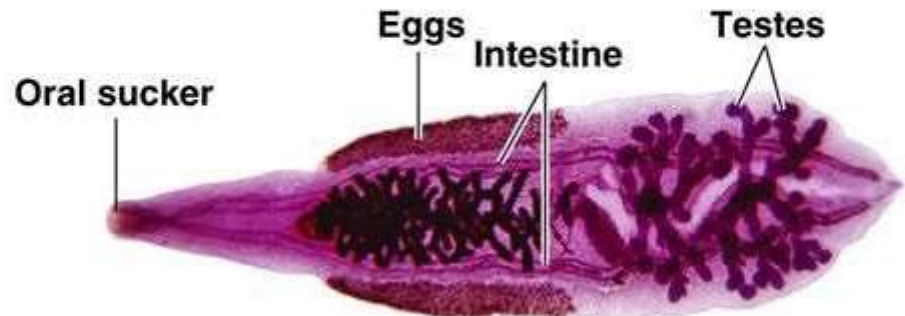
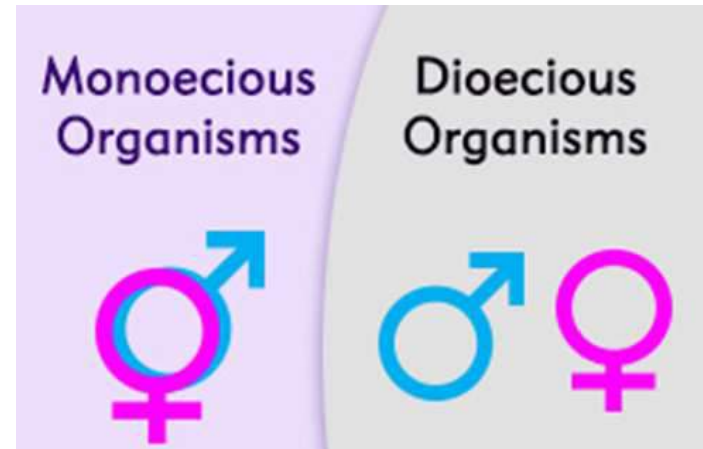
Life cycle

- Parasitic helminthes are highly modified compared to free-living helminthes. They often lack sense organs such as **eyes**, and may even lack a **digestive system**.
- Their reproductive system, however is often complex, which ensures infection of new hosts. Some flukes can produce **25,000 eggs per day**.



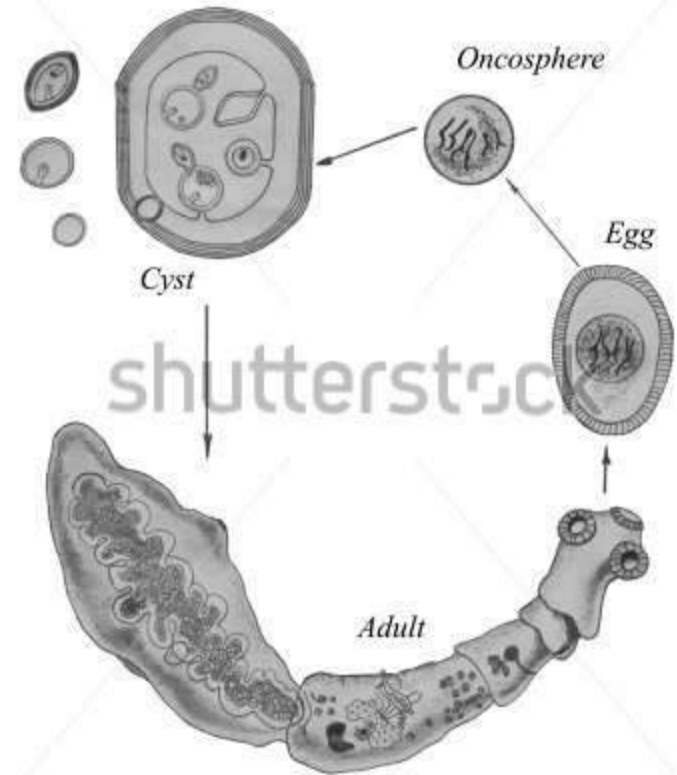
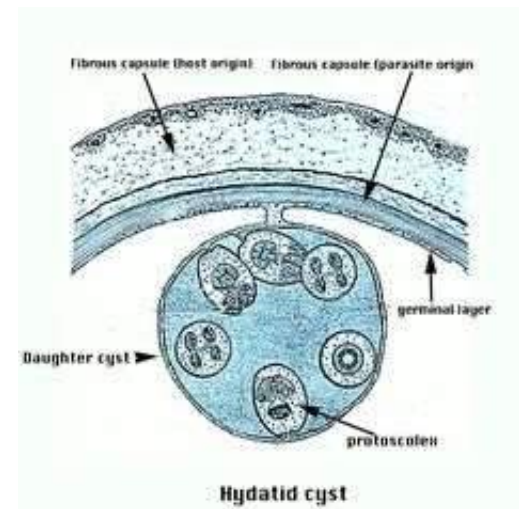
Life Cycle of Helminths

- **Monoecious (hermaphroditic)**
 - Male and female reproductive systems in one animal
- **Dioecious**
 - Separate male and female
- **Egg → larva(e) → adult**



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**
- Humans can serve as the intermediate host for the **dog tapeworm**.
- The larva encysts as a **hydatid cyst** in a variety of tissues including the **lungs or liver** and even the brain.



Definitive host:

- The host that contains the adult stages (reproductive mature) of a parasite called **definitive host**.
- Humans can serve as the definitive host for **beef, pork, and fish tapeworms**.



Infective stages:

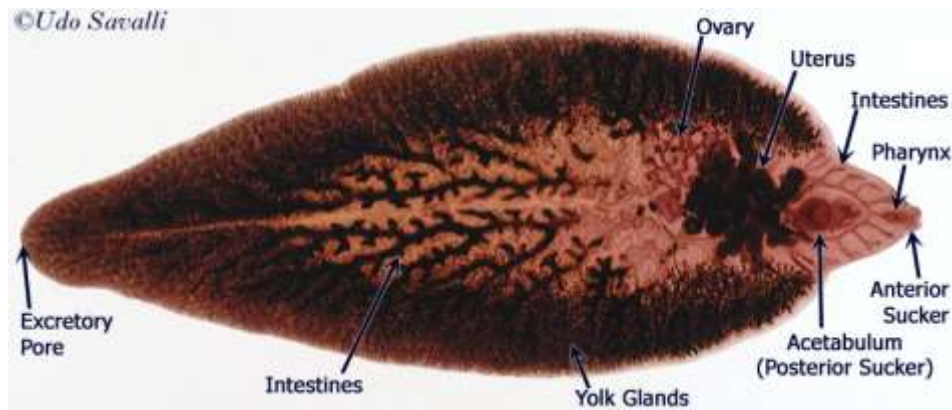
- Infective stages either eggs or larvae.
- The eggs of some parasitic round worms (**pin worm**) are infective for humans.
- The adults are found in the large intestine. From there, the female pinworm migrates to the anus to deposit her eggs on the **perianal skin**.
- The eggs can be ingested by the host or by another person exposed through **contaminated clothing or bedding** and immediately cause infection.
- Other parasites are infective for mammals in the larval stage, such as Larvae of filarial worms.



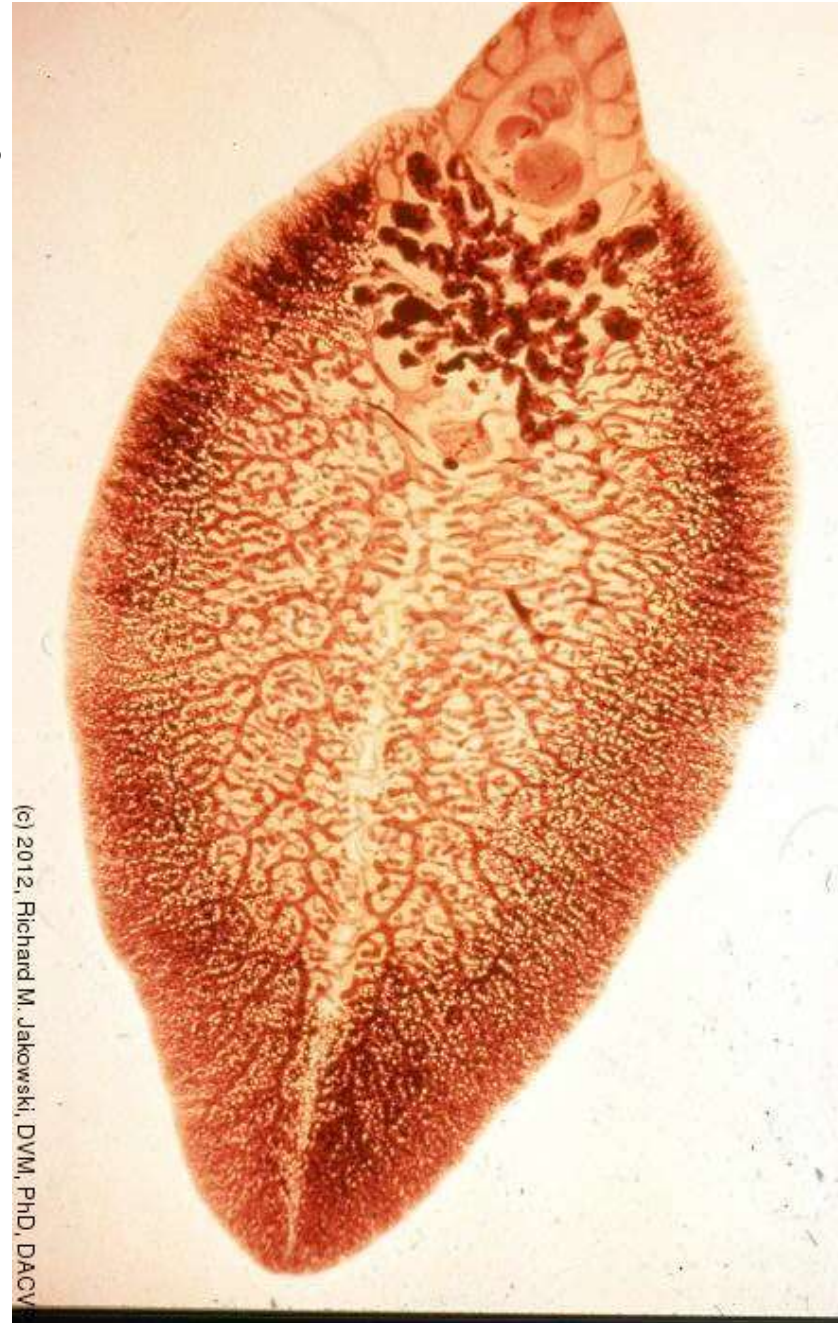
Phylum : Platyhelminthes

General character

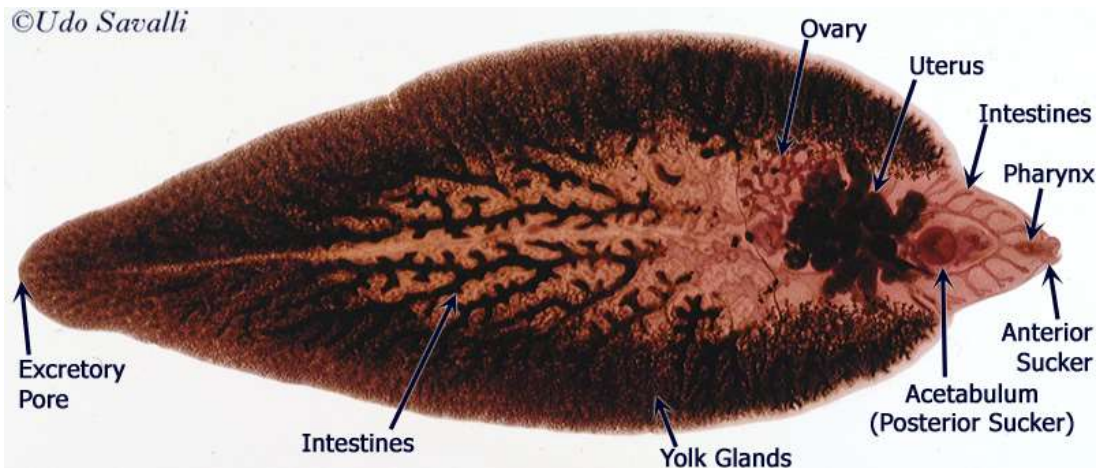
1. Platyhelminthes are bilaterally symmetrical, dorsoventrally flattened and triploblastic worms.
2. Body shape generally worm-like but varies from moderately elongated shape to long flat ribbons and leaf-like.
3. The flatworms are small to moderate in size varying from microscopic to extremely elongated forms measuring up to the **10-15 meters**.
4. Majority of flatworms are white, colorless, some derive color from the ingested food while the free-living forms are brown, grey, black or brilliantly colored.
5. Anterior end of the body is differentiated into the so called head



6. Presence of great variety of adhesive secretions, organs of attachment and adhesion(hooks and suckers).
7. The body of parasitic **trematodes and cestodes** covered with **cuticle**.
8. Exo and endoskeleton are completely absent, hence, the body is generally soft. Hard parts consist of **cuticle, spines, thorns, hooks, teeth, etc.**
9. Acoelomate, true coelom is absent.
10. Body space between the various organs is filled with a mesenchyme usually called parenchyma.

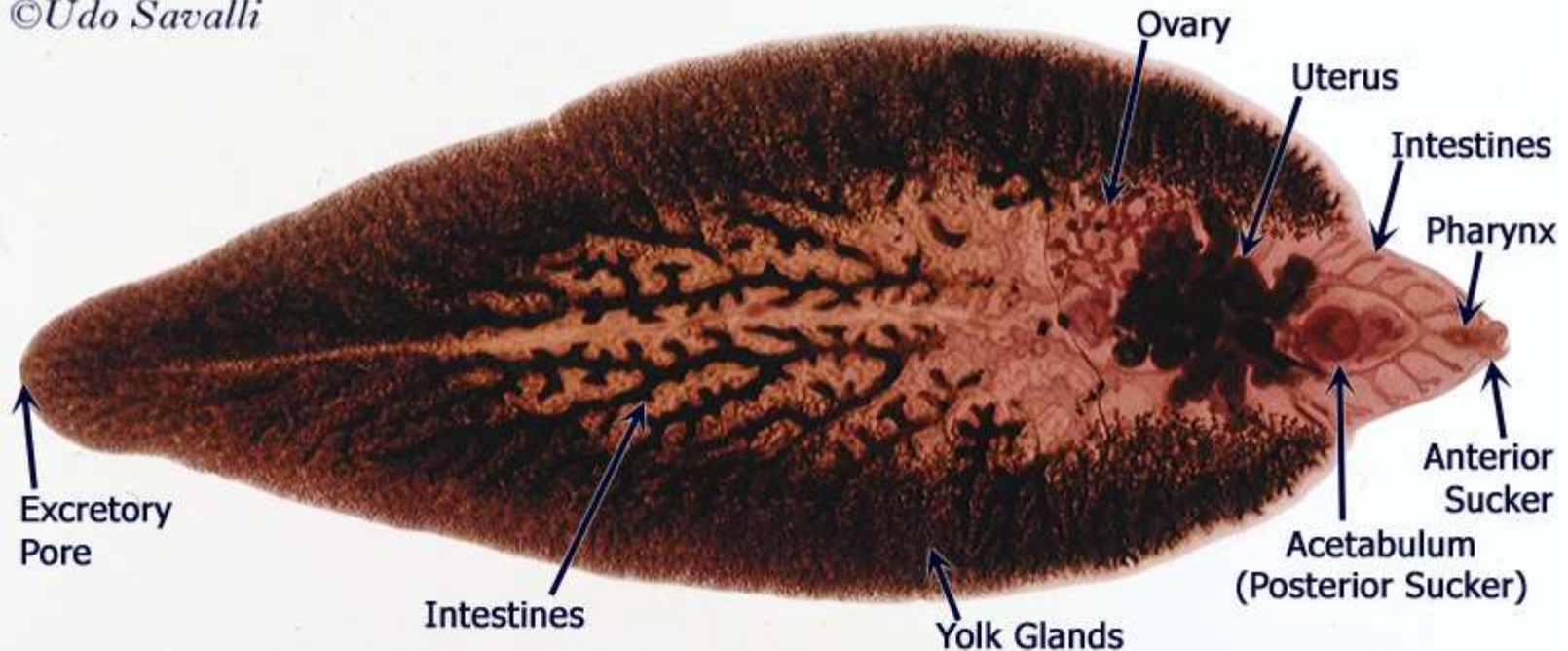


11. Digestive system is totally absent in tapeworms but in other flatworms is consist of mouth, pharynx and blind intestine(anus absent).
12. Respiratory and circulatory systems are absent.
13. Excretory system consists of single or paired **protonephridia** with flame cells or bulbs.
14. Nervous system is primitive. The main nervous system consists of a pair of cerebral ganglia or brain and one to three pairs of longitudinal nerve cords connected to each other by transverse commissures. This type of nervous system is called **ladder type of nervous system**.
15. Sense organs are of common occurrence in Turbellaria but these are greatly reduced in parasitic forms.



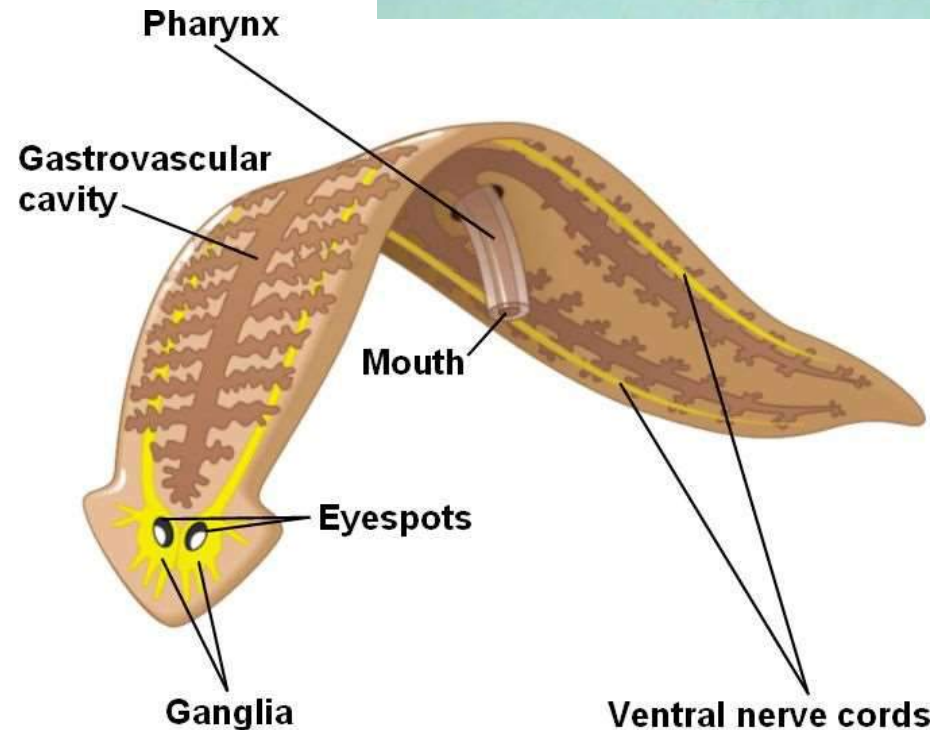
16. Sexes are united(hermaphrodite)with very few exceptions.
17. Reproductive system is highly evolved or complex in most of the forms.
18. Asexual reproduction by fission occurs in many freshwater Turbellaria.
19. Cross-fertilization in trematodes and self-fertilization in cestodes is very common. Fertilization is internal.
20. Life cycle complicated involves one or more hosts.

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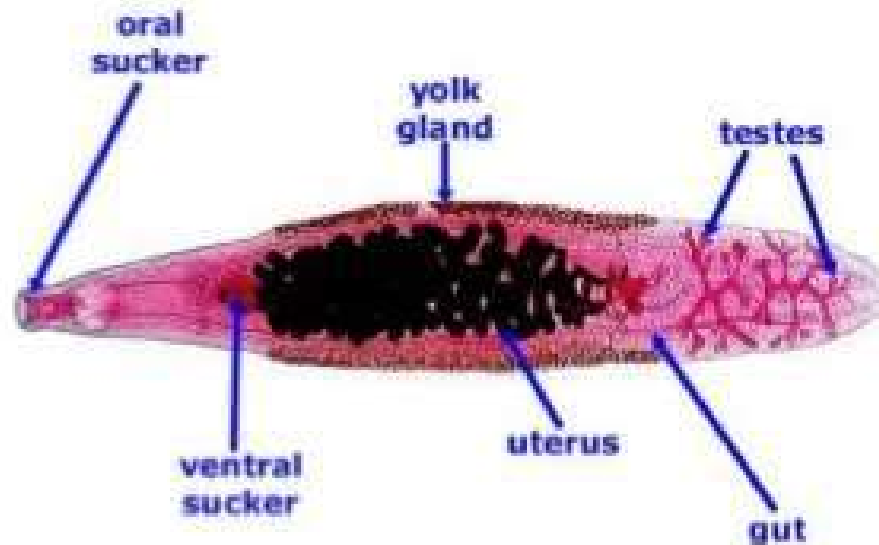
Classification

- Class 1. Turbellaria
 - (turbella = a little string)
1. Mostly free-living flatworms but some ecto-and endocommensals or parasitic.
 2. Body unsegmented.
 3. Body covered with a cellular or syncytial epidermis usually with mucous cells and which is usually partly ciliated.
 4. Life cycle simple.

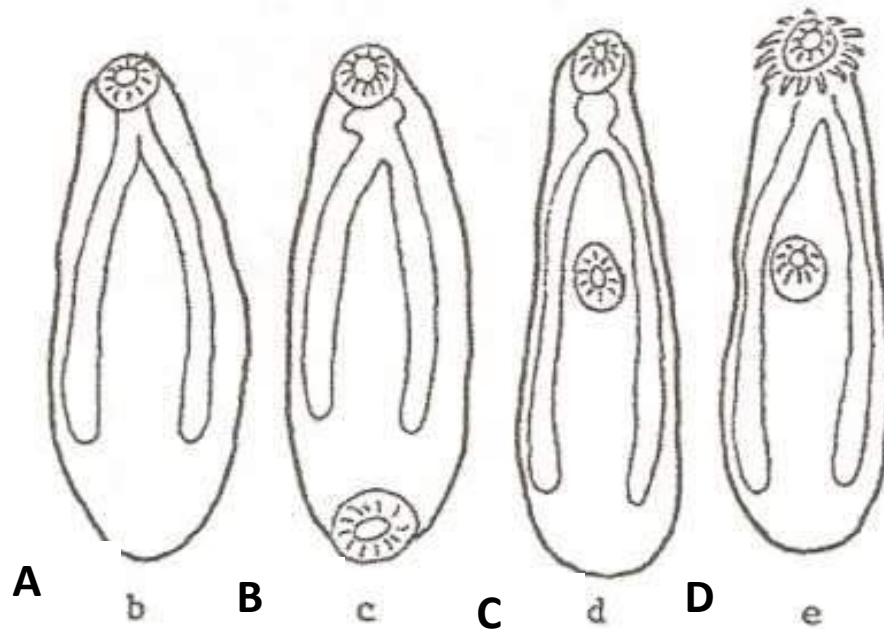


Class 2. Trematoda

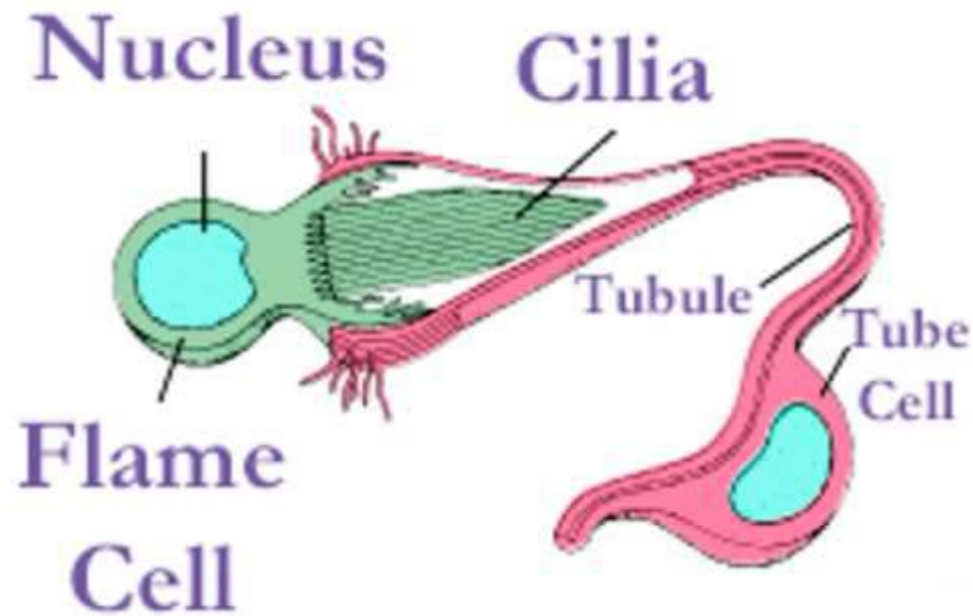
- (trematodes = having pores)
- 1. Ectoparasitic or endoparasitic forms, commonly called **flukes**.
- 2. Body shape usually Leaf-like, dorsoventrally flattened.
- 3. Body wall without epidermis and cilia.
- 4. Body undivided and covered with a cuticle.
- 5. Well developed suckers usually present, **ventral sucker** sometimes termed the **acetabulum**



- A. Monostome - mouth, no acetabulum example : *Notocotylus*
- B. Amphistome - acetabulum at end, as a "holdfast" example: *Paramphistomum*
- C. Distome - acetabulum at center, "normal" example: *Fasciola*
- D. Echinostome - spines around mouth example: *Echinostoma*

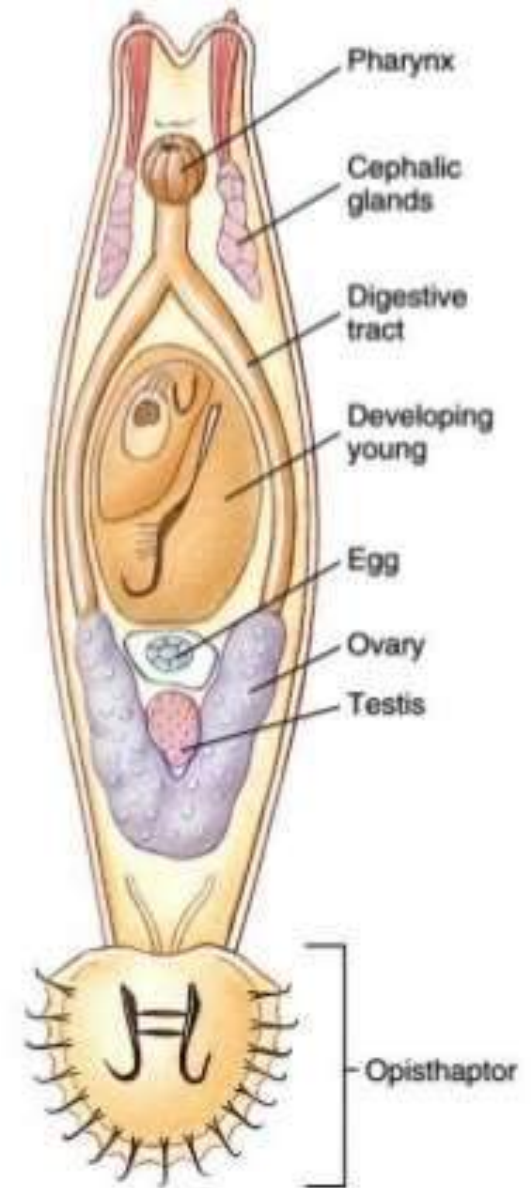


6. Digestive tract incomplete consisting of mouth, pharynx and two forked or many branched intestine; anus absent.
7. Cell **protonephridial excretory system** consisting of flame cells.
8. Mostly hermaphrodite (monoecious).
9. Ovary single, testes two to many.
10. Life cycle simple or complicated



Order 1. Monogenia

1. Ecto-or endoparasitic forms of vertebrates.
 2. Oral sucker either weak or absent.
 3. Anterior end provided with a pair of adhesive structures.
 4. Posterior end provided with an **adhesive disc (called opisthaptor)** Usually with hooks.
 5. Free- swimming ciliated larva called **onchomiracidium**
 6. Only one host in life cycle.
- **Example: Gyrodactylus**



Order 2. Aspidobothria

1. Endoparasites in the gut of **fish and reptiles**.
2. Oral sucker absent.
3. The anterior end without paired of adhesive structures.
4. Life cycle simple, no alternation of hosts.

Example: *Aspidogaster*

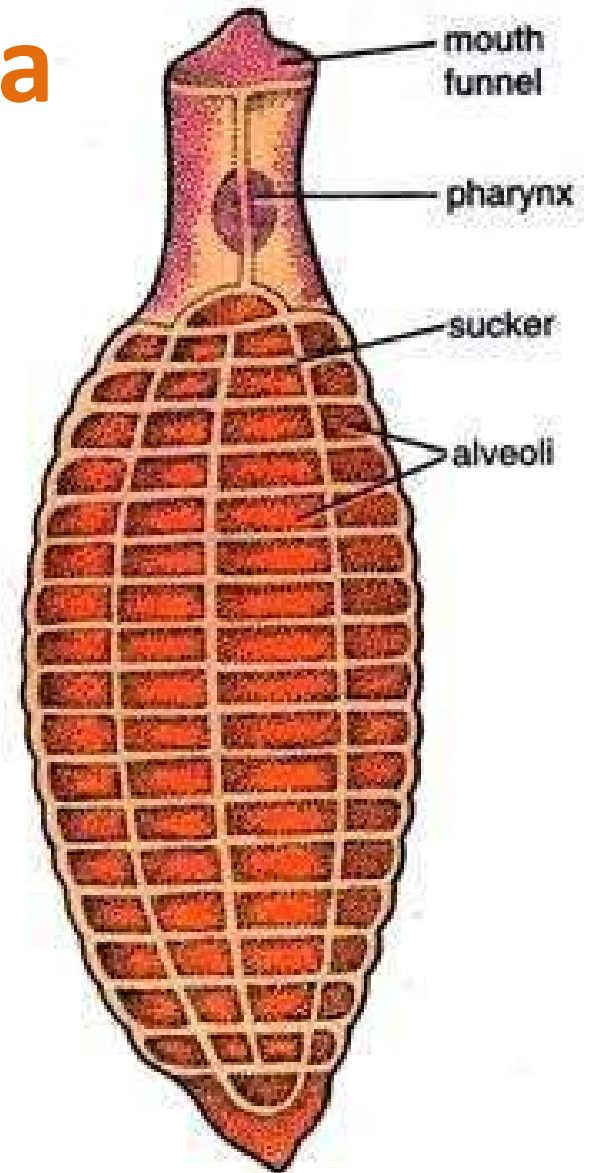
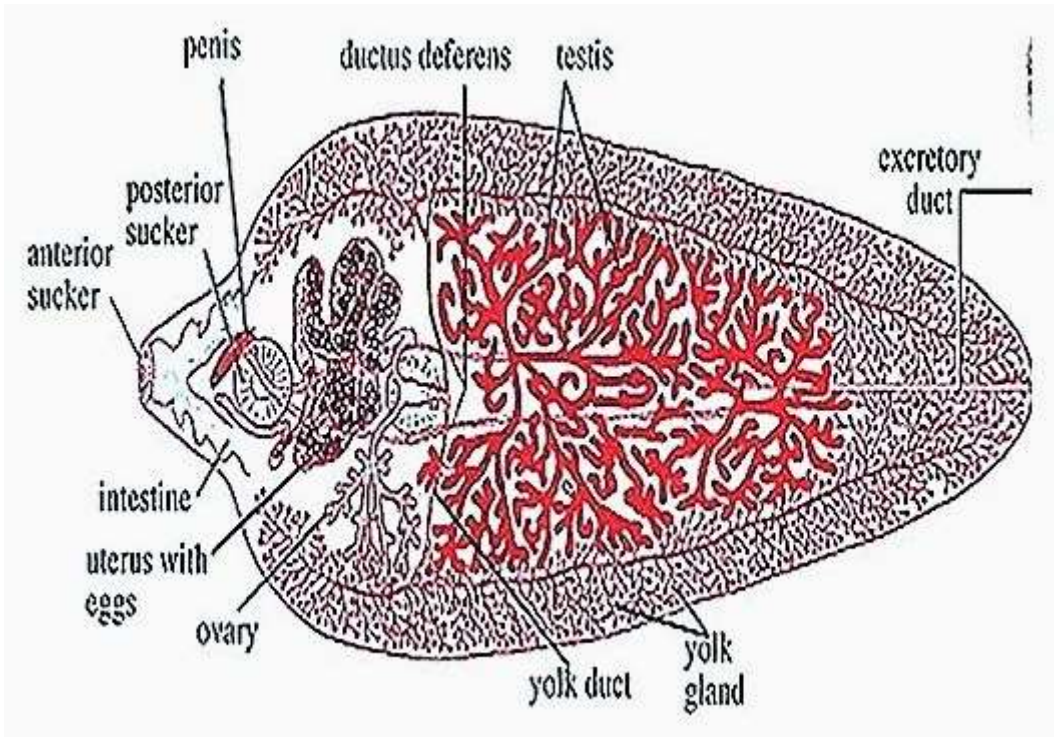


Fig. 43.4. *Aspidogaster*.

Order 3. Digenia

1. Endoparasites of vertebrates and invertebrates.
2. Mostly with two suckers without hooks;
3. Life cycle complicated involving many larval stages.
4. One to more intermediate hosts in life cycle.

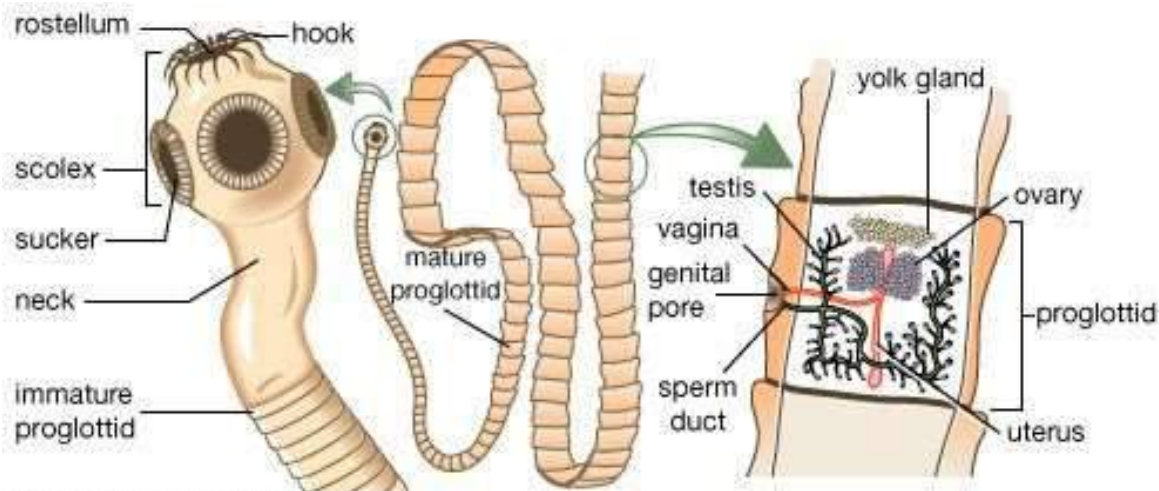
- **Example: Fasciola**



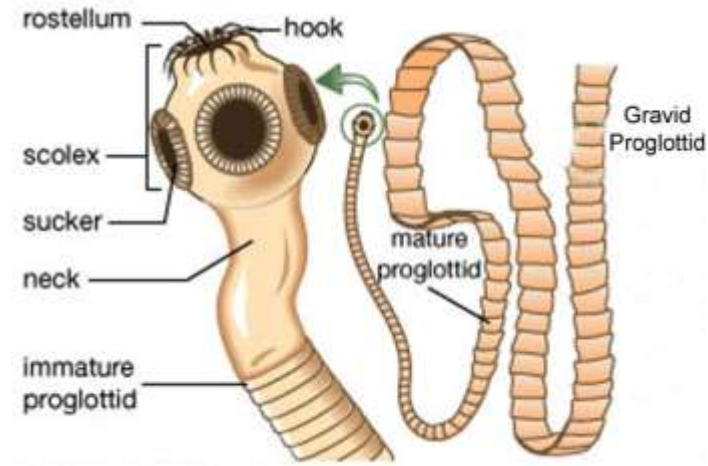
Class3. Cestoda

(keston = girdle + eidos = form)

1. (Endoparasites in the intestine of vertebrates.
2. Commonly called tapeworms.
3. Body without epidermis and cilia but covered with cuticle.
4. Body usually divided into few to many segments (proglottids), rarely undivided.
5. Anterior end (scolex) is provided with adhesive structures (hooks, suckers) except in **Cestodaria**.

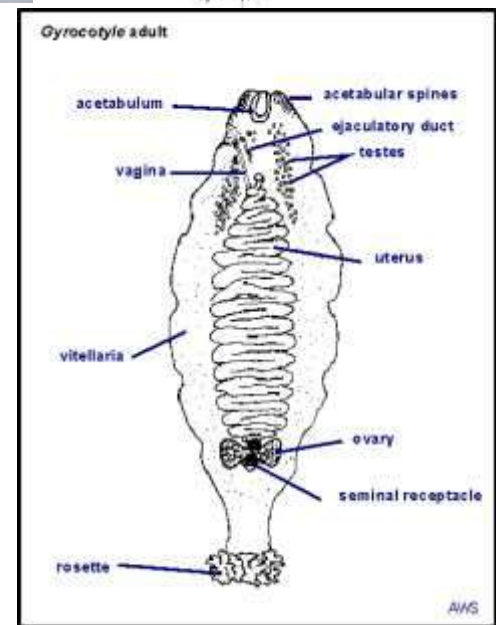
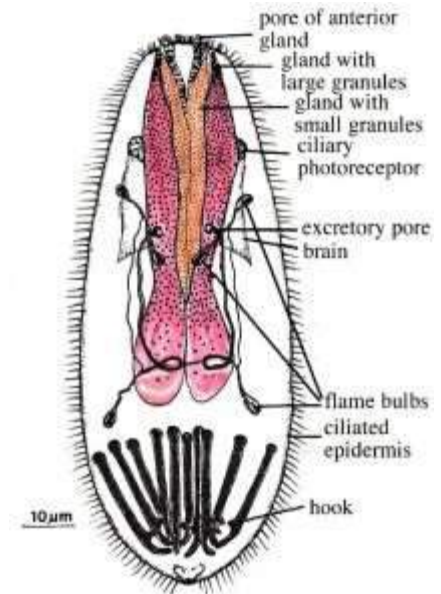


6. Mouth and digestive tract totally absent.
7. Excretory system consists of **protonephridia** with typical terminal flame bulbs.
8. Nervous system usually comprises a pair of ganglia and two lateral longitudinal nerve cords.
9. Each segment contains one or two sets of complete hermaphroditic reproductive system.
10. Life cycle complicated usually involving two or more hosts.
11. Embryos possess hooks.



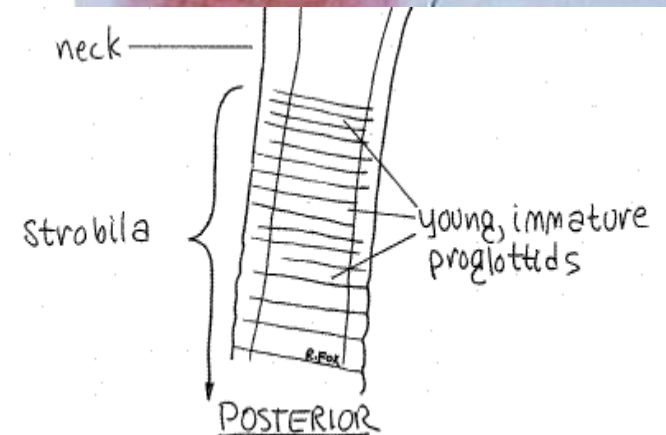
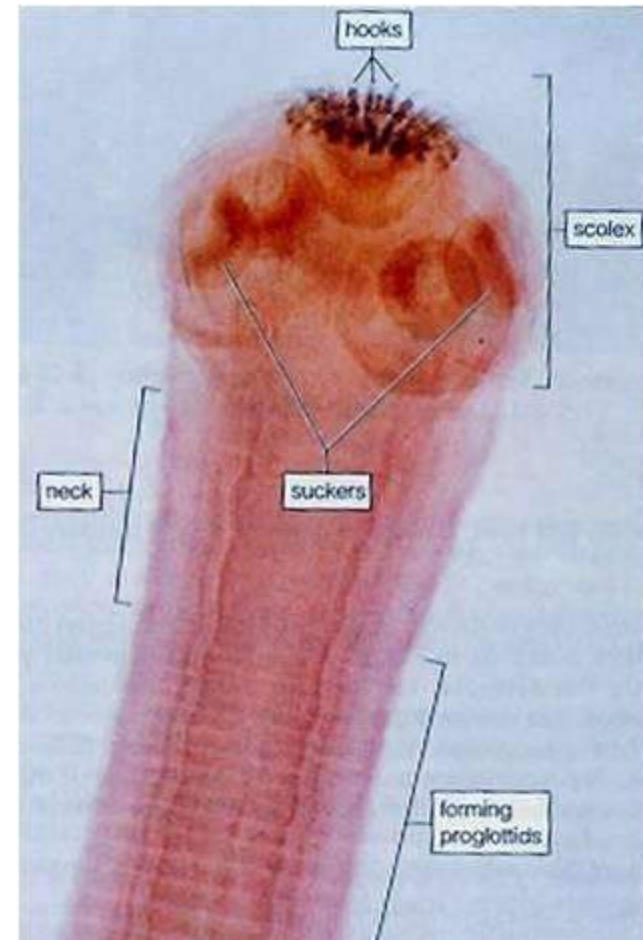
Subclass 1. Cestodaria

1. Endoparasitic in coelom or intestine of vertebrate
 2. Body undivided (**monozoic**).
 3. Scolex absent.
 4. Larva **lycophore** with ten hooks.
- Example: **Gyrocotyle**.



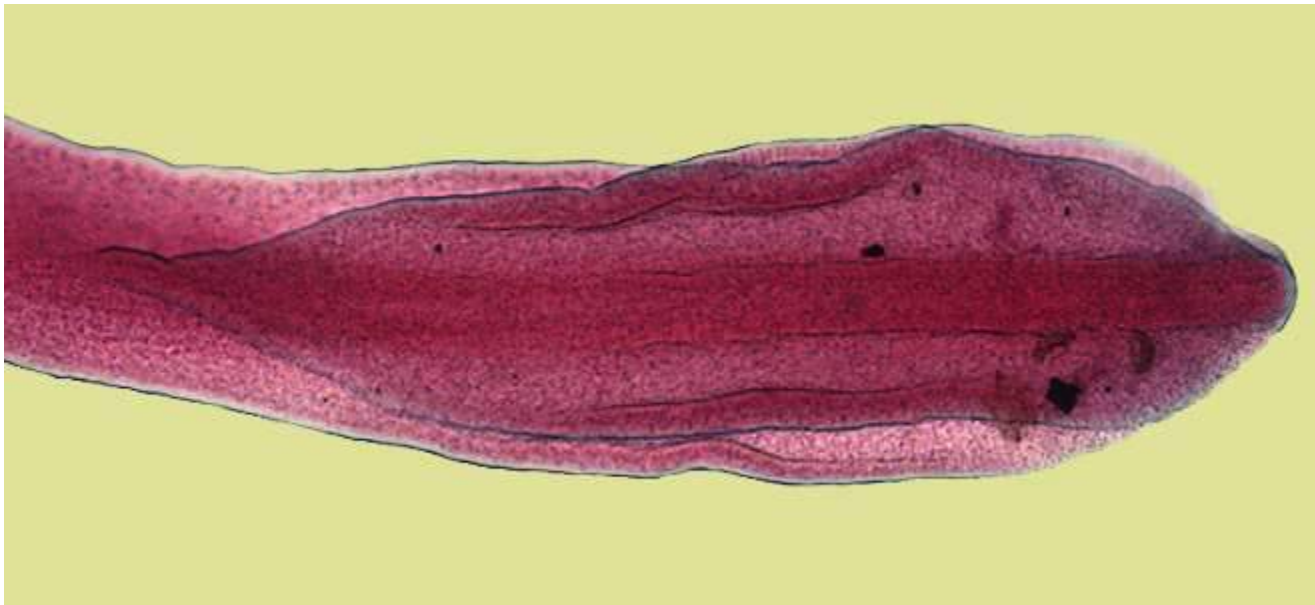
Subclass 2. Eucestoda

1. Endoparasitic forms in the intestine.
2. Body usually very elongated ribbon-like.
3. Body divided into anterior scolex, neck and strobila consisting of few to many proglottids (**polyzoic**).
4. Each proglottid with one or more than one set of monoecious reproductive organs.
5. larva with six hooks.



Order 1. Pseudophyllidae

1. Scolex with two to six shallow bothria(suckers).
 2. Ovary bilobed, testes numerous, follicular and scattered in the mesenchyma of proglottids.
 3. Vitellaria follicular, numerous.
 4. Gonopores midventral. The uterus with uterine pore.
- Example: *Diphyllobothrium latum*

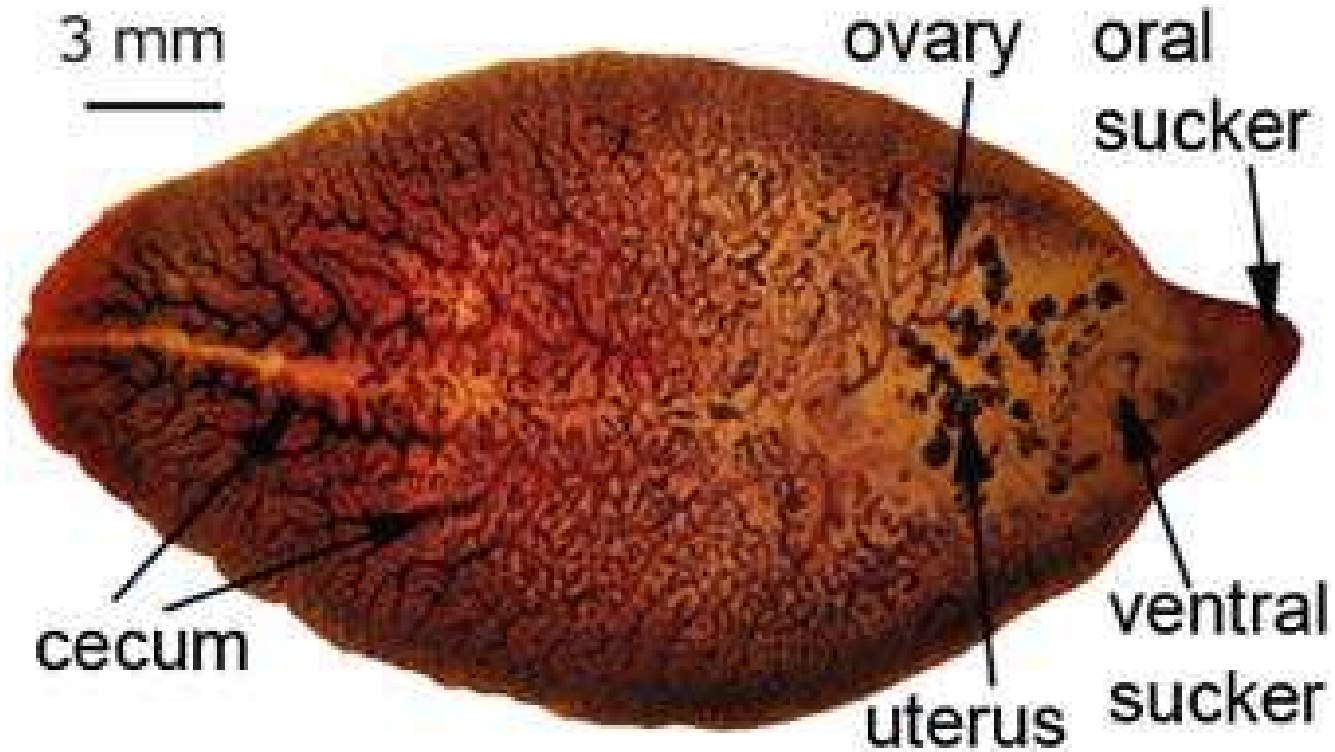


Order 2. Taenioidea or Cyclophyllidae

1. Parasites in the intestine **of reptiles, birds, and mammals.**
 2. Large-sized tape worms.
 3. Scolex bears four large cupped suckers (acetabula) often with an apical rostellum armed with hooks.
 4. Ovary two to many lobed; uterine opening absent.
 5. Gonopores on one or both margins.
 6. Vitellaria (yolk glands) single and compact.
- Example: *Taenia*



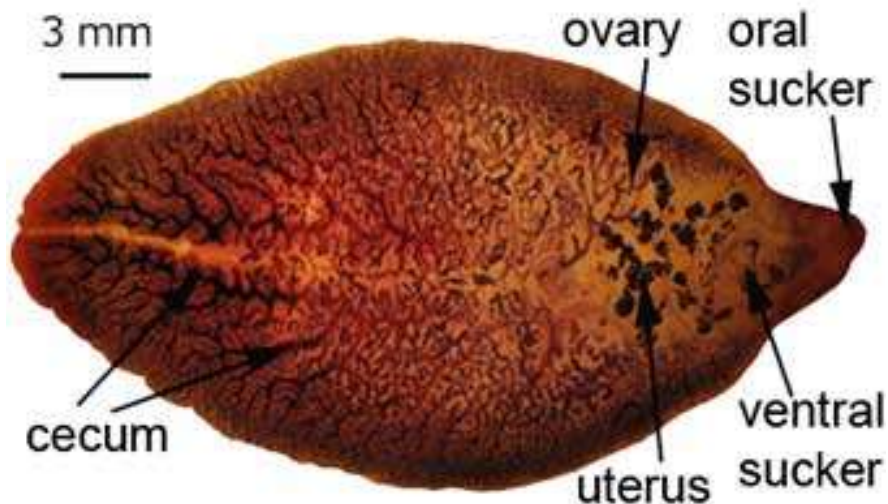
Lec2: Liver Flukes



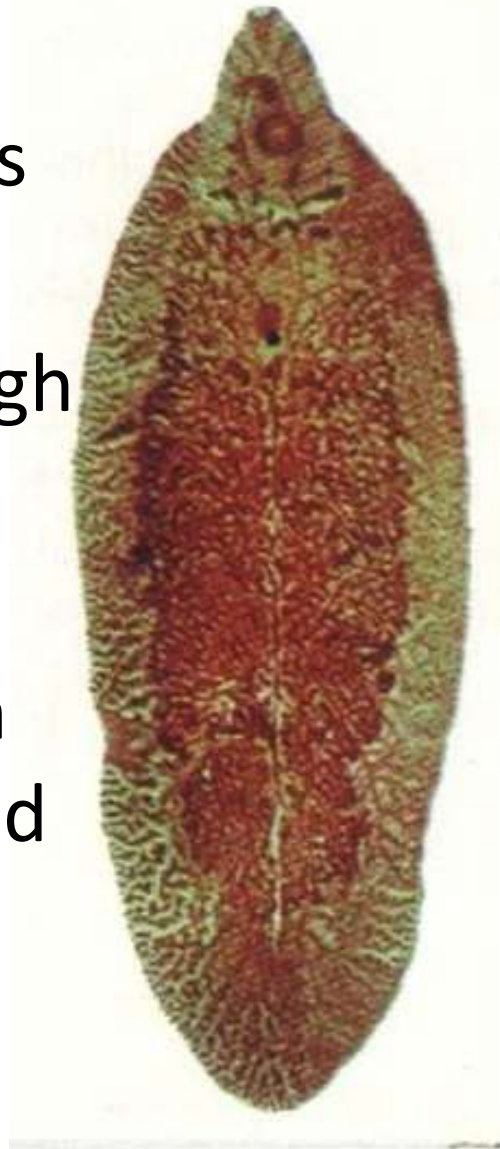
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Fasciola hepatica & *Fasciola gigantica*

- *Fasciola hepatica*: also known as (**common liver fluke or sheep liver fluke**), is a parasitic flatworm of the Class Trematoda, Phylum Platyhelminthes that infects the livers of various mammals, including humans. The disease caused by the fluke is called **fascioliasis** or **fasciolosis**.
- *F. hepatica* is worldwide distributed, and causes great economic losses in sheep and cattle.
- Liver fluke infestation is diagnosed by yellow-brown eggs in the feces.



- *Fasciola gigantica* also a parasitic flatworm of the Class Trematoda, which causes tropical fascioliasis. It is distributed in Asia and Africa.
- Estimates of infection rates are as high as **80-100%** in some countries.
- The **geographical distribution** of *F. gigantica* overlaps with *F. hepatica* in many African and Asian countries and sometimes in the same country, in regions with intensive sheep and cattle production.



Comparison

Characteristic	<i>Fasciola hepatica</i>	<i>Fasciolopsis buski</i>
Common name	Sheep liver fluke	Large Intestinal fluke
Infects	Sheep, Cattle, Humans	Pigs, Dogs, Rabbits, Humans
Location of adults	Bile Ducts	Intestine
Eggs	145 μm x 80 μm	145 μm x 80 μm
Adult fluke	2 - 3 cm long	~ 7 cm long

Fasciolosis:

- Also known as **Fascioliasis, distomatosis and liver rot**, is an important helminthes disease caused by two trematodes *F. hepatica* and *F. gigantica*. This disease belongs to the **plant-borne trematode zoonoses**.
- The **definitive host** range is very broad and includes many herbivorous mammals, including humans.
- The life cycle includes **freshwater snails** as an intermediate host of the parasite.



Geographic Distribution

- Human and animal fasciolosis occurs worldwide. While animal fasciolosis is distributed in countries with high cattle and sheep production, human fasciolosis occurs, excepting Western Europe, in developing countries.
- Fasciolosis occurs only in areas where suitable conditions for intermediate hosts exist.



Human fasciolosis:

- Human fasciolosis is an important public health problem.
- It has been reported from countries in **Europe, America, Asia, Africa and Oceania**.
- The incidence of human cases has been increasing in **51** countries of the five continents.
- High prevalence in humans is not necessarily found in areas where fasciolosis is a great veterinary problem.



Human infection is determined by

1. The presence of the intermediate snail hosts.
2. Domestic herbivorous animals.
3. Climatic conditions.
4. The dietary habits of man.



- **Sheep, goats and cattle** are considered the predominant animal **reservoirs**. While other animals can be infected, they are usually not very important for human disease transmission.
- Humans are infected by **ingestion of aquatic plants** that contain the infected **metacercariae**.



- Several species of aquatic vegetables (watercress) are known as a vehicle of human infection.

✓ Because *F. hepatica* cercariae also encyst on water surface, humans can be infected by drinking of fresh untreated water containing **metacercariae**.

✓ In addition, an experimental study suggested that humans consuming raw liver dishes from fresh livers infected with juvenile flukes could become infected.

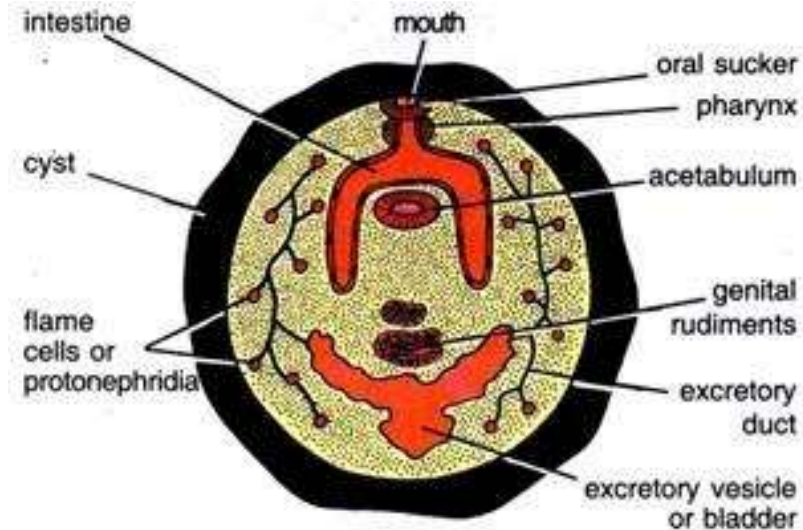
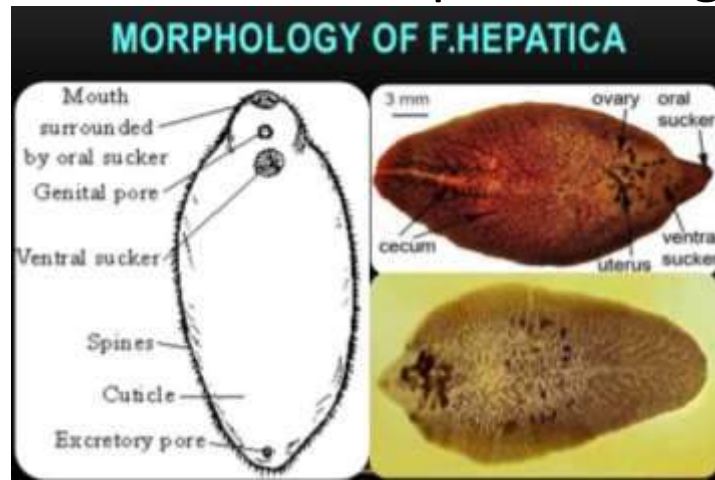


Fig. 41.20. *Fasciola hepatica*. Metacercaria.

Morphology:

- **The Adult Worm** - Averaging **30mm** in length and **13 mm** in width, *Fasciola hepatica* is one of the largest flukes in the world.
- The adult worm has a very characteristic **leaf shape** with the anterior end being **broader than the posterior end** and an **anterior cone-shaped projection**.
- The fluke possesses a powerful **oral sucker** at the end of the anterior cone and a **ventral sucker (acetabulum)** at the base of the cone which allow it to attach to the lining of the biliary ducts.
- Each worm possesses **ovaries** and **testes** which are highly branched and allow for individual flukes to produce eggs independently.



- **The Egg of *F. hepatica* is operculated and average 140 μm in length and 75 μm in width.**



Body wall:

- The wall of *F. hepatica* lacks a cellular layer of epidermis. However, it consists of
 - A thick layer of cuticle made of a homogeneous layer of **scleroprotein** to protect the fluke from the juices of the host.
 - A thin basement membrane. Smooth muscle layers consist of:
 1. An outer layer of **circular muscle fibers**
 2. Middle layer of **longitudinal muscle fibers**
 3. An inner layer of **diagonal muscle fibers.**

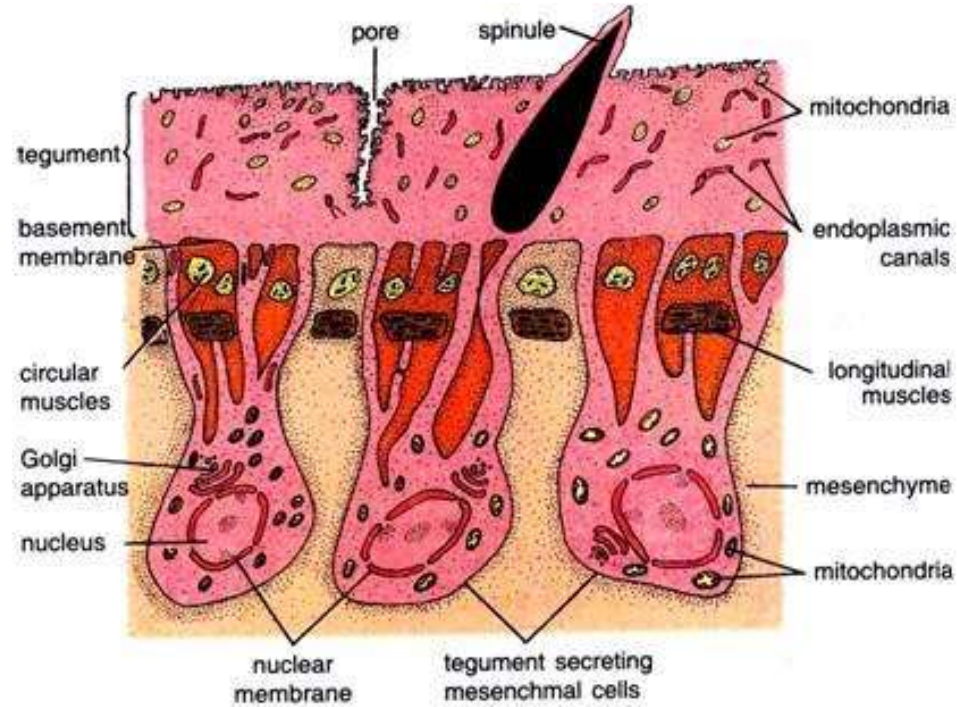


Fig. 41.3. *Fasciola hepatica*. V.L.S. body wall under electron microscope.

- **Mesenchyme** below the muscles with numerous loosely arranged uninucleate and binucleate cells with syncytial network of fibers having fluid filled spaces. **Mesenchyme helps in the transport of nutrients and wastes substances.**

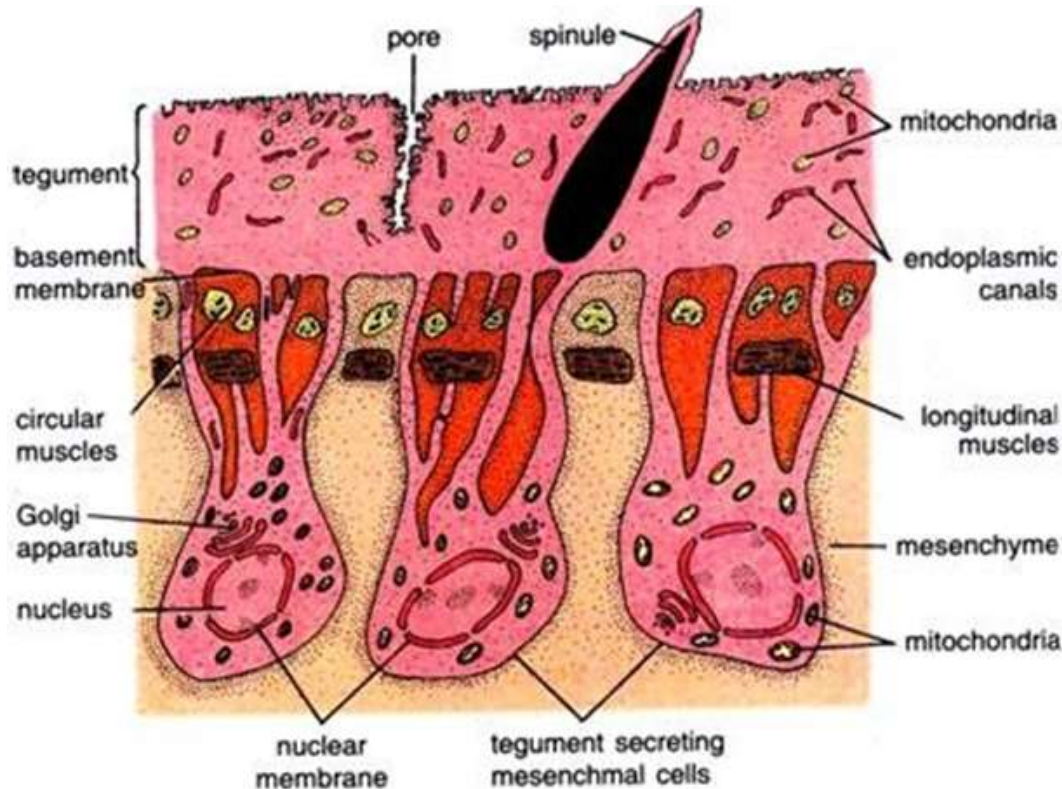


Fig. 41.3. *Fasciola hepatica*. V.L.S. body wall under electron microscope.

Digestive system:

- The alimentary canal of *F.hepatica* is **incomplete**.
- The digestive system begins with mouth surrounded by the oral sucker, highly muscular pharynx, esophagus and intestine but does not terminate in anus **that is why it is referred as incomplete.**
- The intestine immediately forks to form right and left limbs or branches that run along the either side of the body up to the posterior extremity and terminate blindly. These branches of the intestine are called as **crura** or **intestinal caeca**.

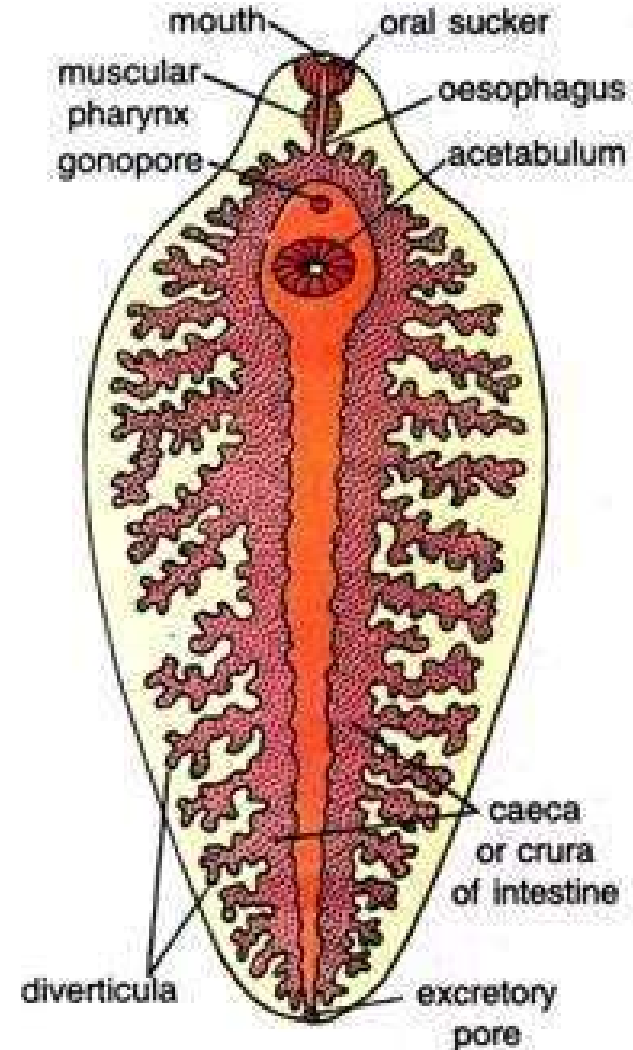


Fig. 41.4. *Fasciola hepatica*. Digestive system.

Note:

- ❖ The digestive system from the mouth up to the esophagus is lined by **cuticle**. This region of the alimentary canal is the fore gut region that serves as **efficient suckorial apparatus**.
- ❖ The intestine is lined by **columnar epithelial cells** that are endodermal in origin.
- ❖ Numerous secretory gland cells surrounded by a **thin muscular layer** consisting of **circular and longitudinal muscle fibers** are present in the caecal epithelium.

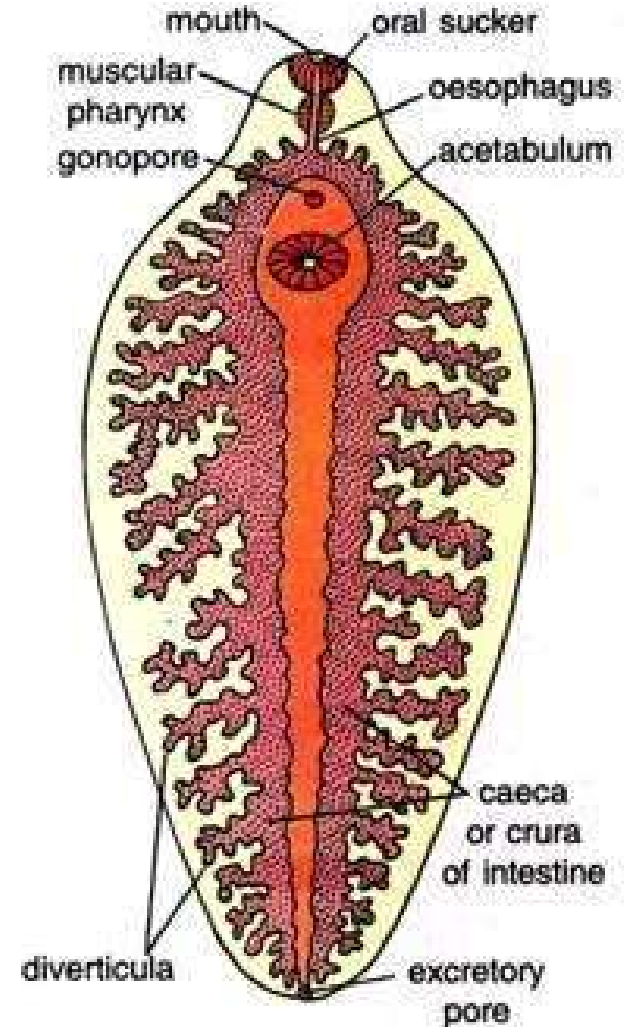


Fig. 41.4. *Fasciola hepatica*. Digestive system.

Feeding and Digestion:

- The fluke often migrates into the bile ducts and the capillaries of the host for nourishment.
- It feeds on blood, lymph, inflammatory exudates and bile juice which it sucks from the wall of the host's bile passages.

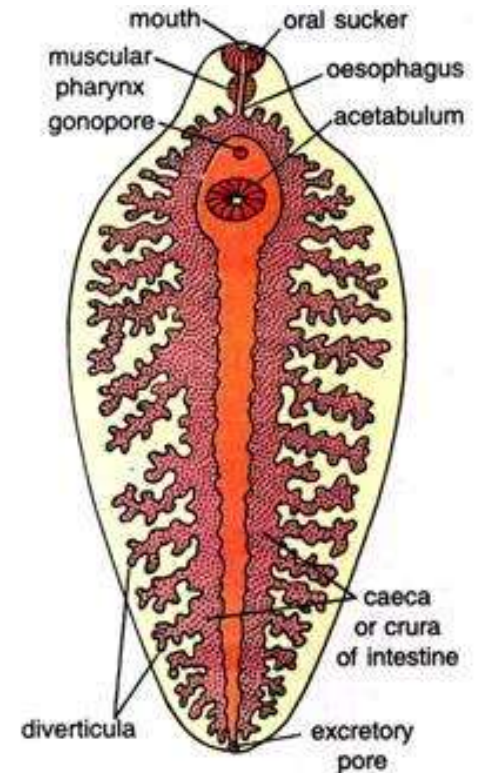
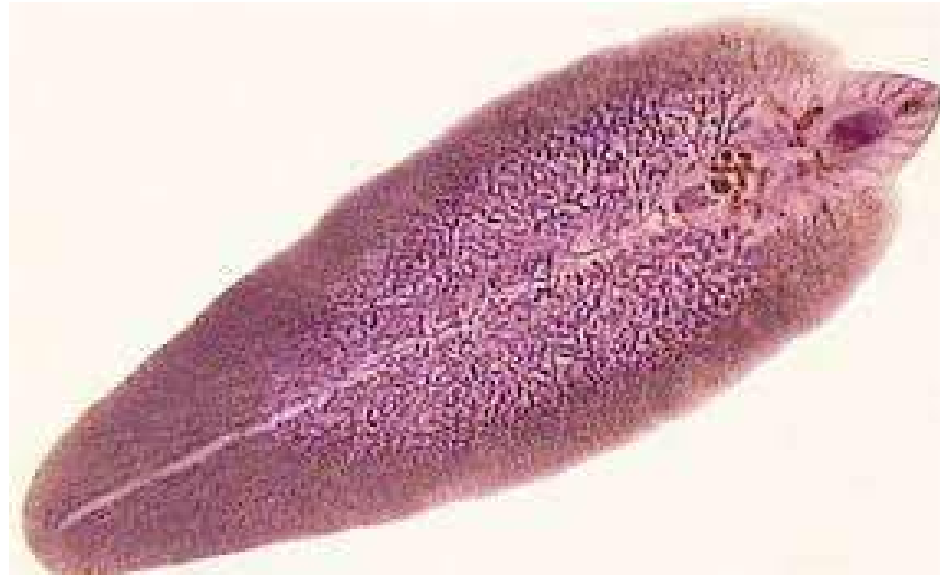


Fig. 41.4. *Fasciola hepatica*. Digestive system.

Respiration:

- Mode of respiration is **anaerobic or anoxybiotic**.
- **Glycogen** is metabolized to carbon dioxide and fatty acids releasing energy in the form of **heat**.
- **The carbon dioxide**, thus, produced is diffused out through general body surface and the fatty acids are excreted through the excretory system.



Excretory system:

- The excretory system of *Fasciola* is concerned with **excretion** as well as osmoregulation.
- It consists of a large number of **flame cells** or **flame bulbs** or **protonephridia** connected with a system of **excretory ducts to the excretory pore** at the posterior end.
- **Flame cells** are irregular in shape bulb like bodies; each has a thin elastic wall with **pseudopodia like processes** and nucleus.
- An intracellular cavity has many long cilia arising from basal granules.
- The cilia vibrate like a flickering flame, hence, the name flame cell.



Nervous system:

- A **nerve ring** surrounds the oesophagus, it has a pair of **cerebral ganglia** and a **ventral ganglion** below the esophagus, and small nerves are given out anteriorly from the ganglia.
- Posteriorly three pairs of longitudinal **nerve cords** arise the ganglia (**dorsal, lateral and ventral nerve cords**), the lateral nerve cords are best developed, and they run to the posterior end and give out many small branches. **Sense organs** are lost in adult fluke.

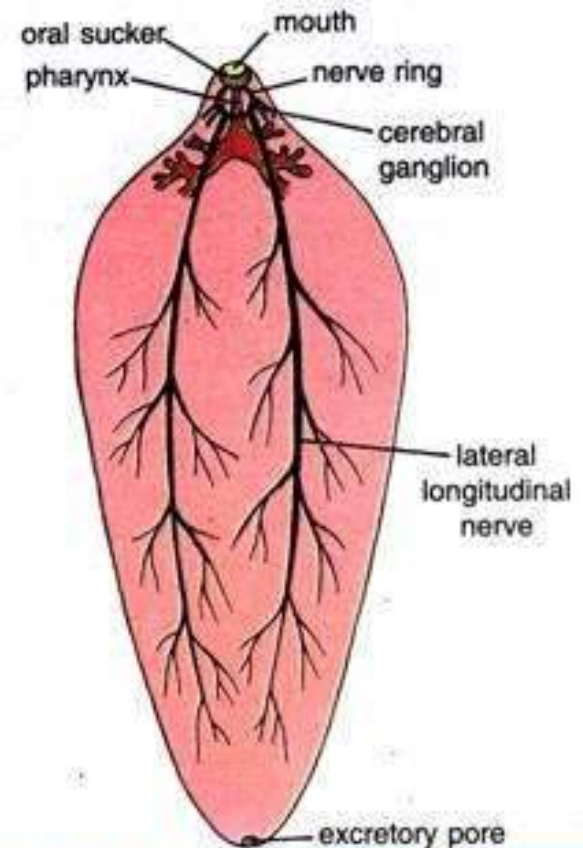
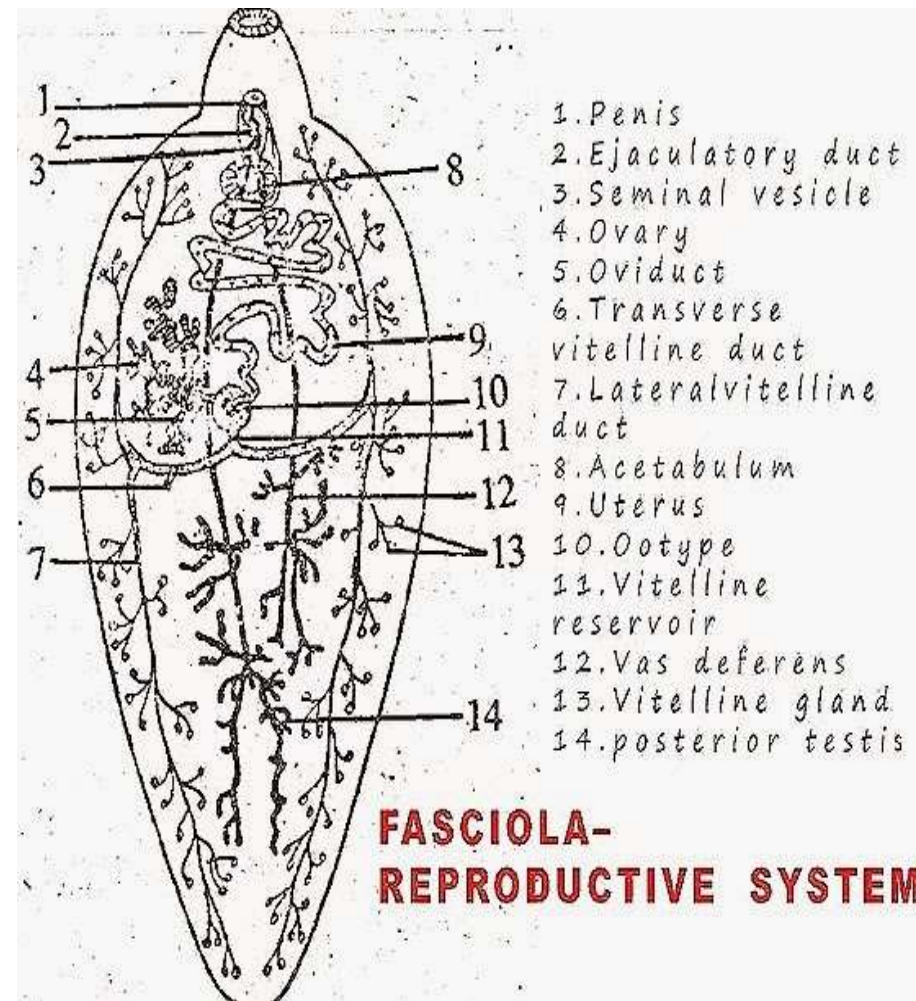


Fig. 41.7. *Fasciola hepatica*. Nervous system.

Reproductive system

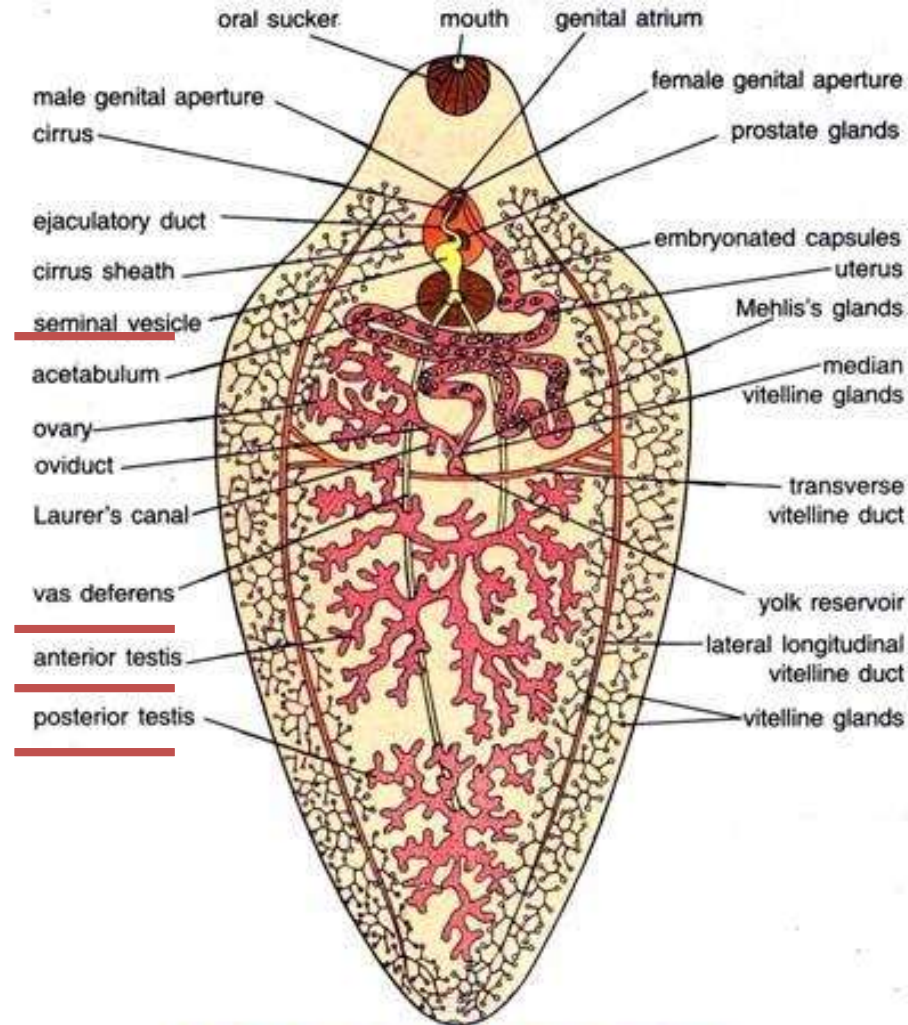
- *Fasciola hepatica* is **hermaphrodite**.
- The gonads are well developed and the male and female genital ducts open into a common chamber, **the genital atrium**.
- It is situated anteriorly in the body and opens to the exterior through the common **genital aperture** or **gonopore**, located ventrally in front of the acetabulum.



The Male Reproductive Organs

- The male reproductive organs are:

- 1. Testis:** greatly ramified, in the middle part of the body, one behind the other.
- 2. Vasa deferentia:** A narrow delicate duct, the vas deferens, emerges out from each testis and runs forward to meet the fellow of opposite side forming the common sperm duct just below the ventral sucker.
- 3. Seminal vesicle:** A large muscular pear-shaped sac, lies in front of ventral sucker.

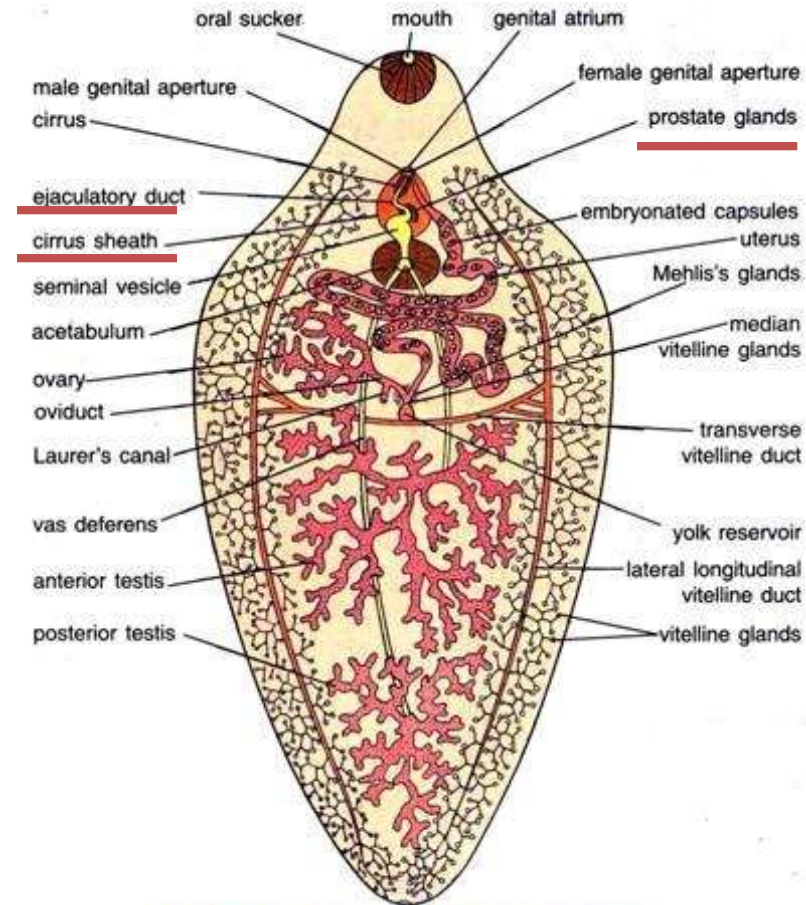


41.8. *Fasciola hepatica*. Reproductive system.

4. **Ejaculatory duct**: fine convoluted tube from the seminal vesicle runs forward in a zigzag fashion through the **cirrus** to open into the genital chamber through the male genital pore.

5. **Cirrus and cirrus sac**: The cirrus or penis is a muscular cylindrical structure traversed internally by the passage of ejaculatory duct. It can be pushed out and drawn in through the genital pore and thus helps in copulation. The cirrus and the seminal vesicle both are enclosed in a bag-like cirrus sac.

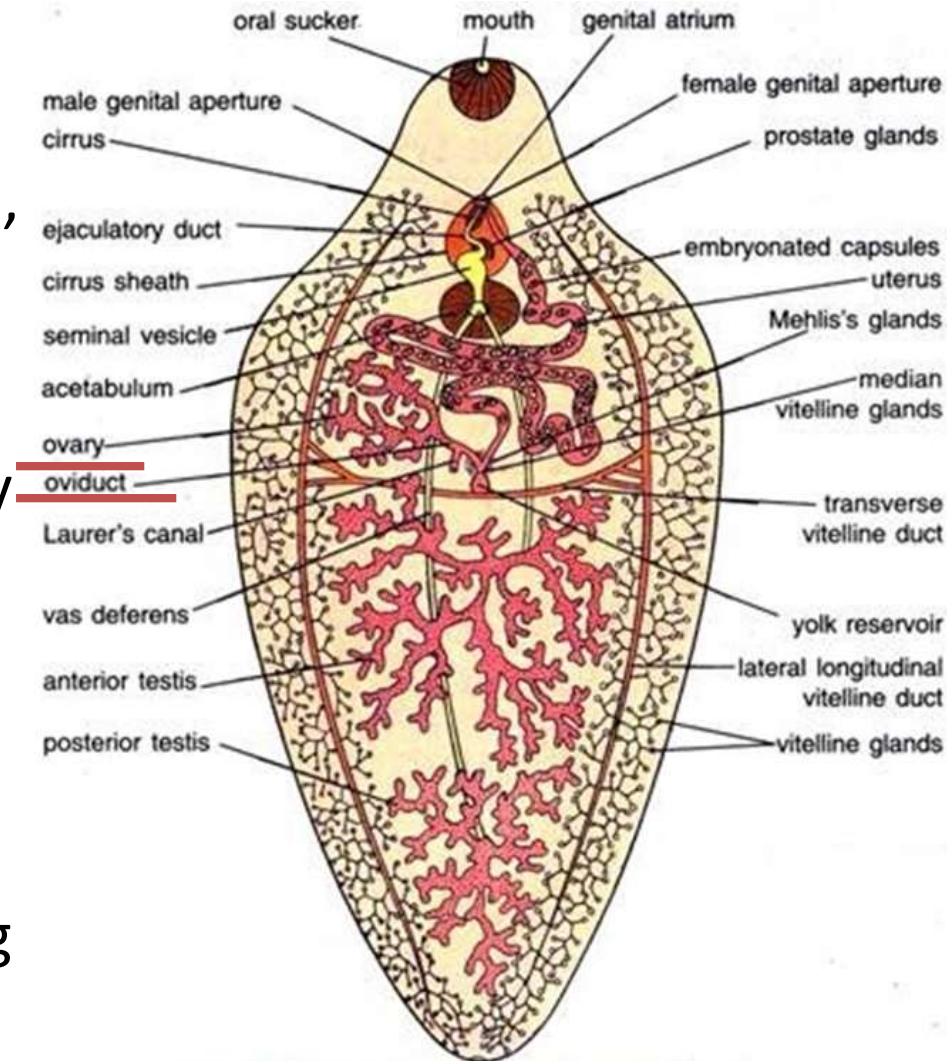
6. **Prostate glands**: Numerous unicellular prostate glands around the ejaculatory duct.



41.8. *Fasciola hepatica*. Reproductive system.

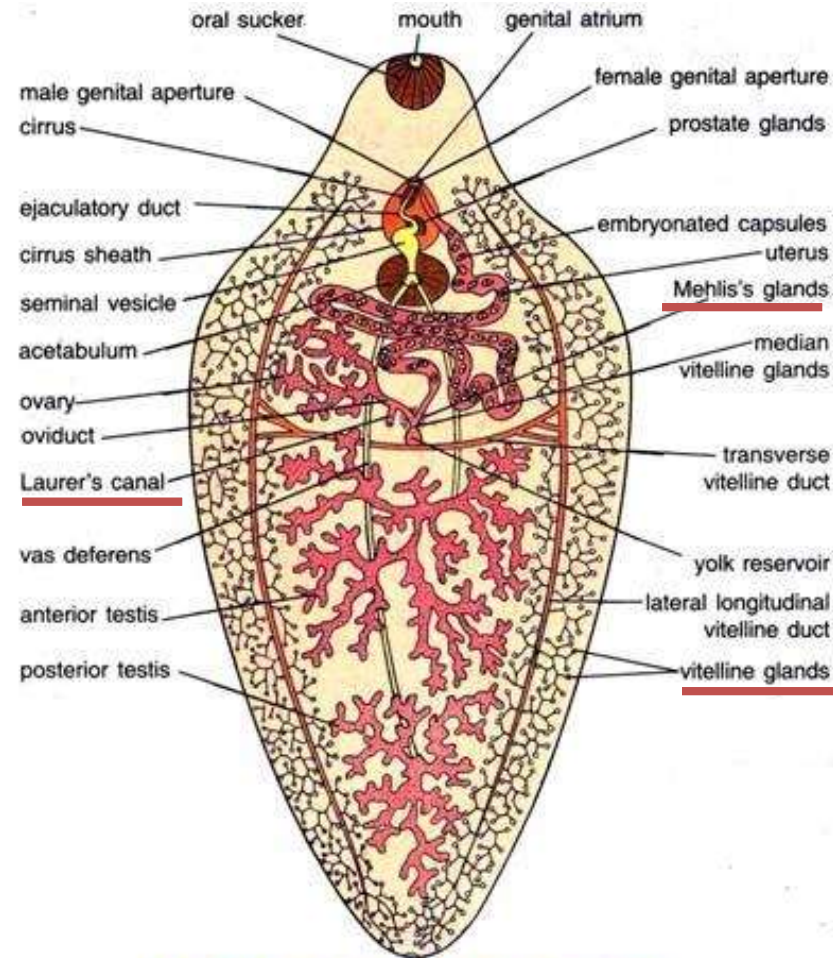
The Female Reproductive Organs

- 1) **Ovary**: A large, highly branched tubular structure on the right side in front of testes,
- 2) **Oviduct**: A short, narrow and convoluted duct runs downward to join the uterus,
- 3) **Uterus**: A long wide and highly convoluted tube that extends up to the genital atrium, opening into it through the female genital aperture, close to male genital pore on the left-side. It contains a large number of capsules containing fertilized eggs,

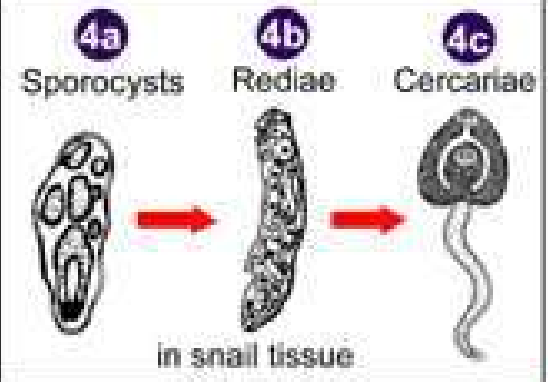


41.8. *Fasciola hepatica*. Reproductive system.

- 4) **Mehli's gland:** or shell glands, do not play any role in shell-formation, surrounding the base of the oviduct.
- 5) **Laurer's canal:** The Laurer's canal arises from the oviduct and acts as a sperm duct. It develops a temporary opening on the dorsal body surface during breeding season. It may serve as vagina.
- 6) **Vitellaria (Vitelline glands and vitelline ducts):** provide eggs with yolk.



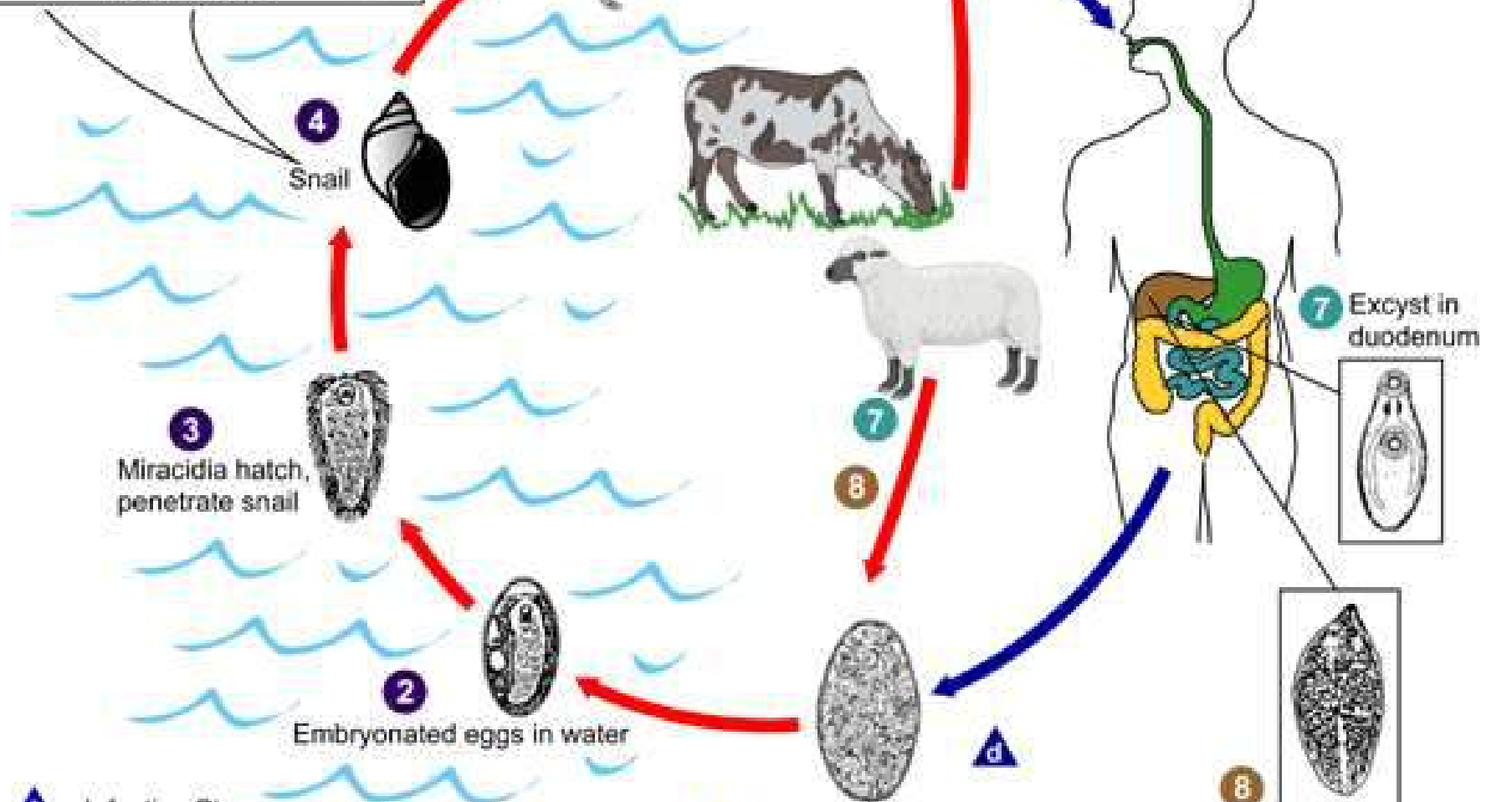
41.8. *Fasciola hepatica*. Reproductive system.



5 Free-swimming cercariae encyst on water plants



6 Metacercariae on water plant ingested by human, sheep, or cattle



▲ i = Infective Stage
▲ d = Diagnostic Stage

1 Unembryonated eggs passed in feces

8 Adults in hepatic biliary ducts

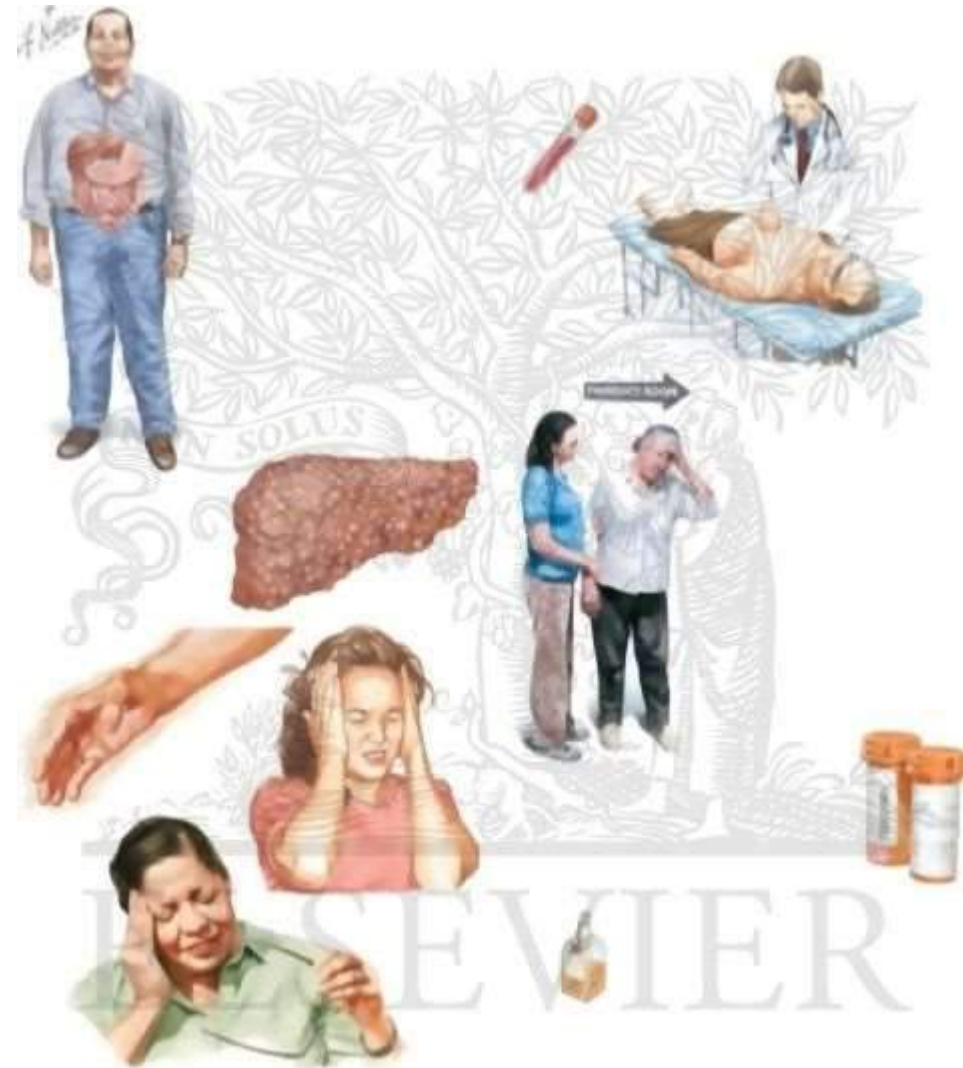
In humans

- **The course of fasciolosis in humans has 4 main phases:**
- **Incubation phase:** from the ingestion of **metacercariae** to the appearance of the first symptoms; time period: **few days to 3 months**; depends on number of ingested metacercariae and immune status of host.
- **Acute phase:** fluke migration up to the bile ducts. This phase is a result of **mechanical destruction of the hepatic tissue and the peritoneum** by migrating juvenile flukes causing localized and generalized toxic and allergic reactions



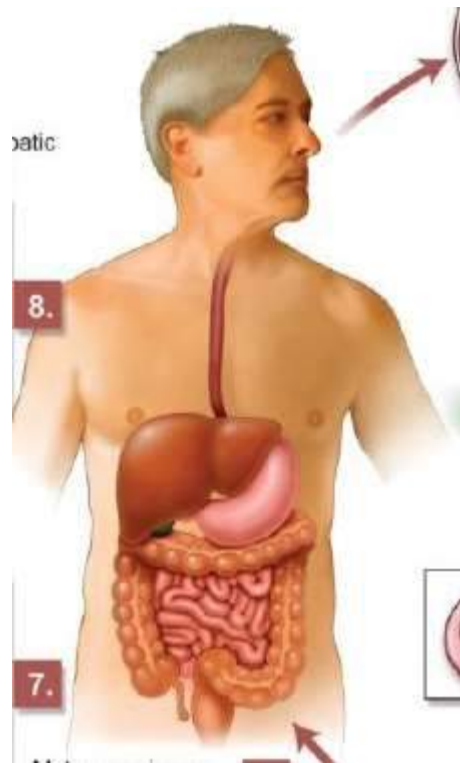
The major symptoms of this phase are:

1. **Fever:** usually the first symptom of the disease; 40-42°C o Abdominal pain
2. Gastrointestinal disturbances: loss of appetite, flatulence, nausea, diarrhea
3. Urticaria
4. Hepatomegaly and splenomegaly
5. Ascites
6. Anaemia
7. Jaundice



Latent phase:

- This phase can last for months or years. Symptoms in this phase are unknown.



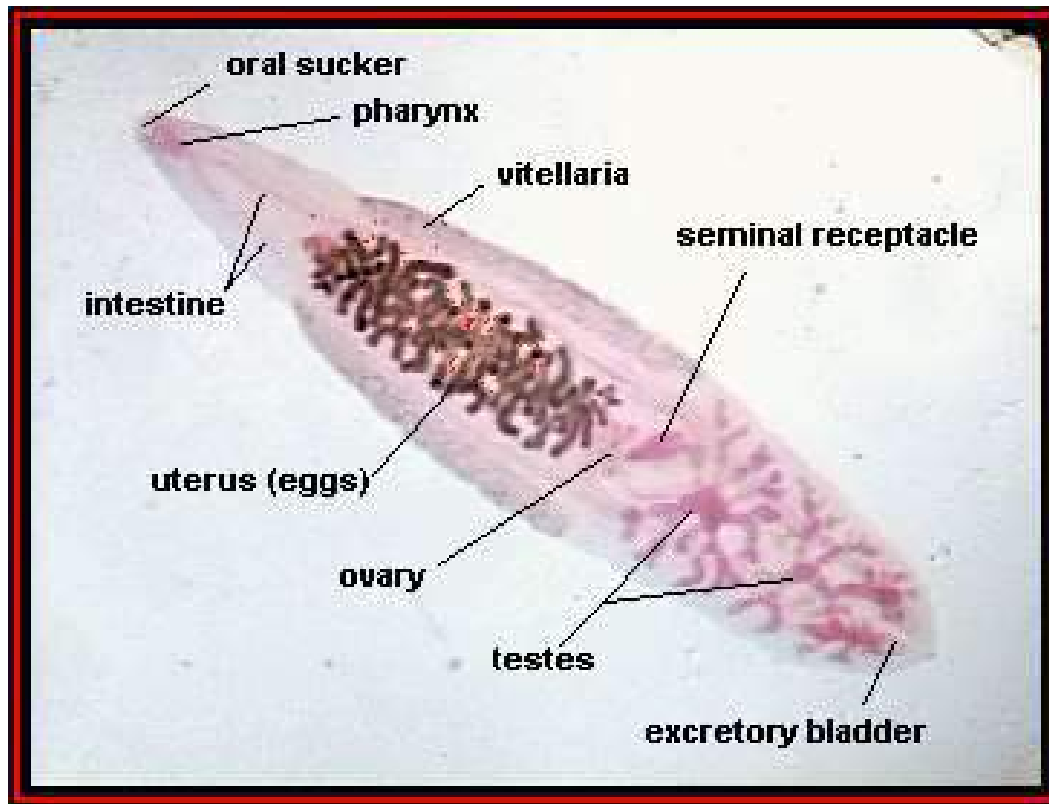
Chronic or obstructive phase

This phase may develop months or years after initial infection.

1. Adult flukes in the bile ducts cause **inflammation and hyperplasia of the epithelium**. The resulting **cholangitis and cholecystitis**, combined with the large body of the flukes, are sufficient to cause **mechanical obstruction of the biliary duct**.
2. In this case, the gall bladder is usually enlarged and edematous with thickening of the wall.
3. **Lithiasis** of the bile duct or gall bladder is frequent and the stones are usually small and multiple.



Lec3: Liver flukes



Lec.Dr.Ruwaidah F. Khaleel

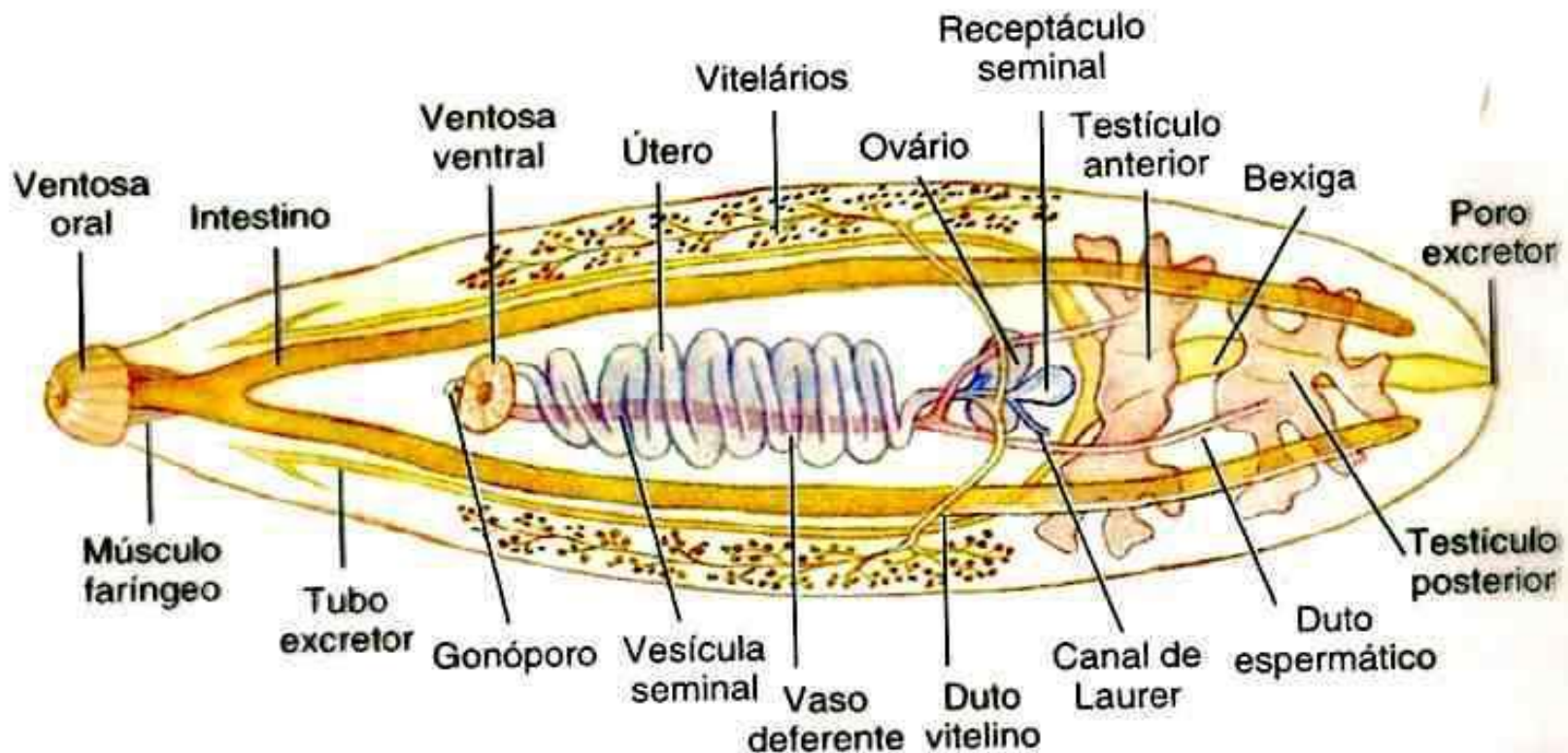
Liver flukes

2. *Clonorchis sinensis*

- This species is monoecious, having both male and female reproductive systems.
- **Kingdom:** Animalia
- **Class:** Trematoda
- **Order:** Opisthorchiida
- **Family:** Opisthorchiidae
- **Genus:** Clonorchis
- **Species:** sinensis
- **Binominal name:** Clonorchis sinensis

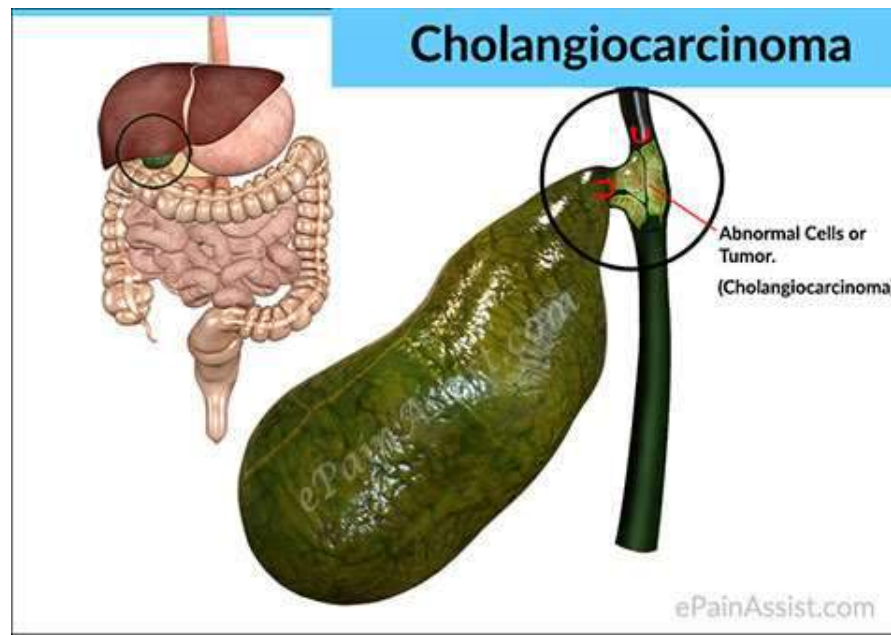


- The *Clonorchis sinensis*: is a human liver **fluke** in the class **Trematoda**, Phylum **Platyhelminthes**, this parasite lives in the liver of humans, and is found mainly in the common **bile duct and gall bladder**, feeding on bile. These animals, which are believed to be the third most prevalent worm parasite in the world
- **Endemic to Japan. China. Taiwan, and Southeast Asia.**



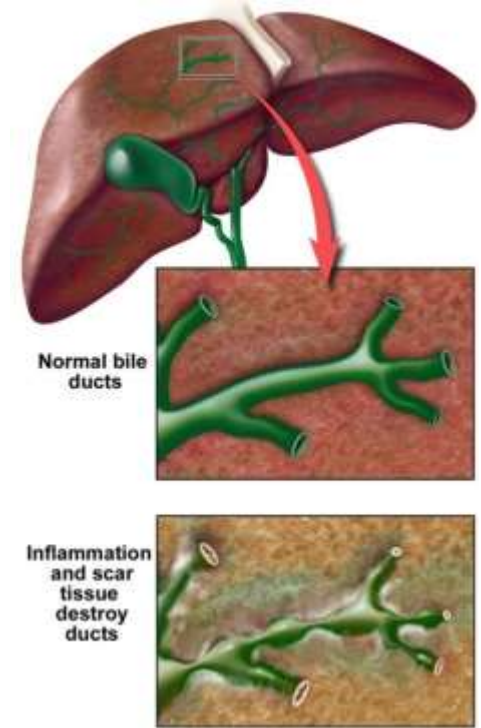
Effects on human health

- ❖ Dwelling in the **bile ducts**.
- ❖ *Clonorchis* induces:
 1. An inflammatory reaction.
 2. Epithelial hyperplasia.
 3. Cholangiocarcinoma.
- ✓ The incidence of which is raised in fluke-infested areas.



Adverse effects of clonorchis

- The adult metacercaria to consume all bile created in the liver
- ↓
- Inhibit the host human from digesting, especially fats.
- ↓
- Obstruction of the bile duct by the parasite or its eggs.
- ↓
- leading to **biliary obstruction** and cholangitis (specifically **oriental cholangitis**).

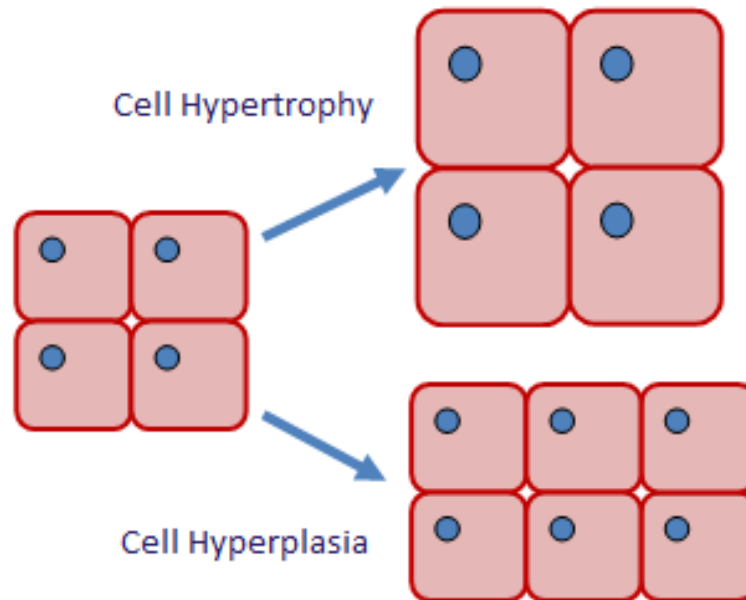


Treatment

- Drugs used to treat infestation include:
 - ❖ Triclabendazole.
 - ❖ Praziquantel
 - ❖ Bithionol
 - ❖ Albendazole and mebendazole.

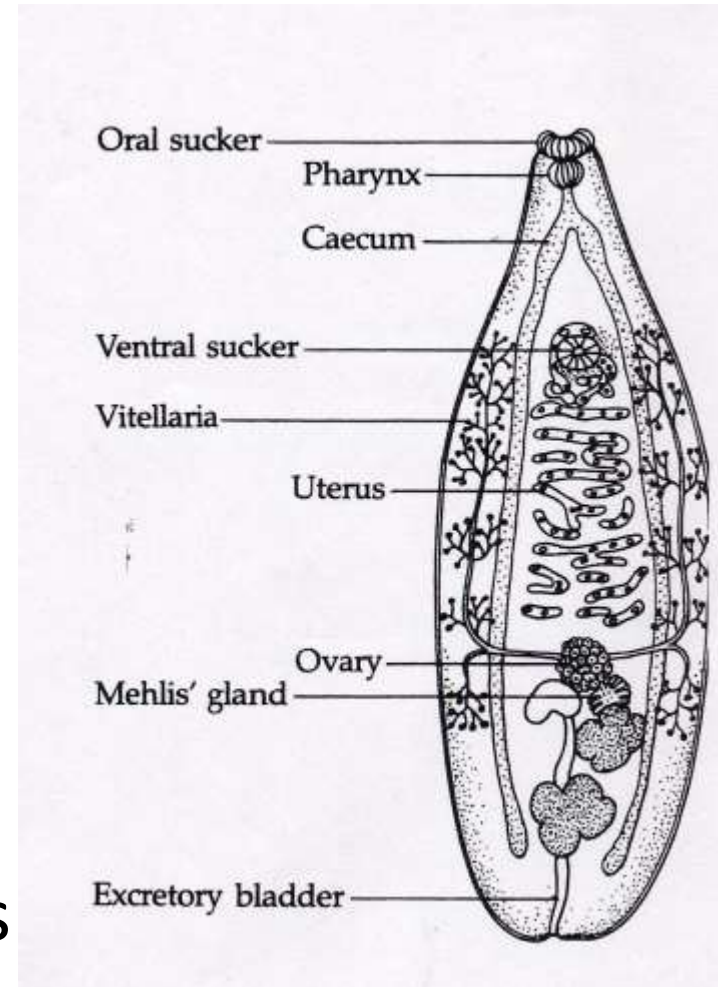
Terminology:

- **Incidence**: the proportion of a population infected or showing a disease over a particular time period.
- **Prevalence**: is the number of infected individual (percentage of infection).
- **Hyper plasia** : abnormal increase in number of cells in the tissue.
- **Hypertrophy**: abnormal increase in size of tissue.



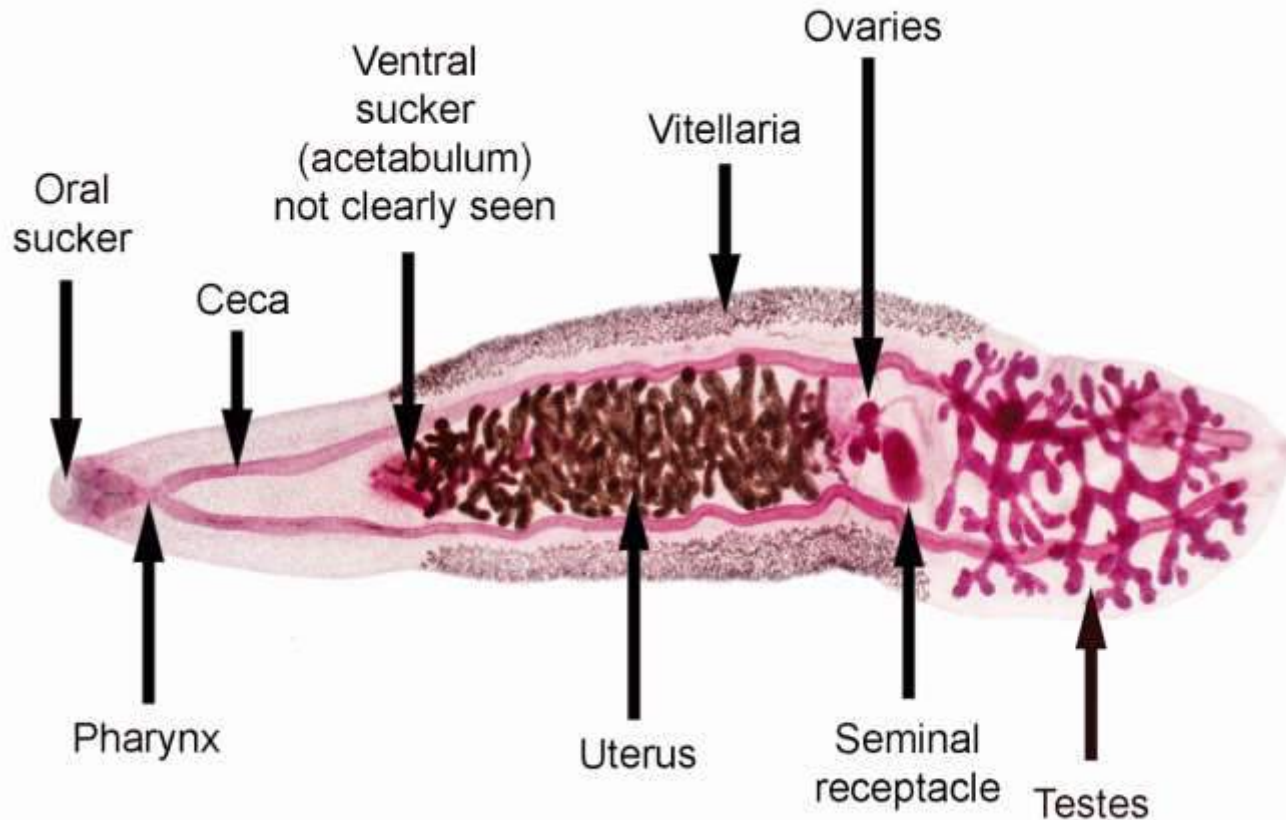
3- Opisthorchis felinus

- ❖ **Kingdom:** Animalia
- ❖ **Phylum:** Platyhelminthes
- ❖ **Class:** Trematoda
- ❖ **Subclass:** Diogenea
- ❖ **Order:** Opisthorchiata
- ❖ **Family:** Opisthorchiidae
- ❖ **Genus:** Opisthorchis
- ❖ **Species:** O. felinus
- ❖ **Binominal name:** Opisthorchis felinus



Opisthorchis felineus,

- Cat liver fluke is a trematode parasite that infects the liver in mammals, **Vinogradov** found it in a human, and named the parasite a "**Siberian liver fluke**".



1. The first "intermediate hosts" of the parasite are freshwater snails, *Bithvnia inflata*, *Bithvnia troschelii* and *Bithvnia leachii*.
 2. The second "intermediate hosts" are freshwater fish,
 3. The final host, which are fish-eating mammals such as felines and humans.
- It is estimated that **1.5 million** people in Russia are infected with the parasite. Inhabitants of Siberia acquire the infection by **consuming raw, slightly salted and frozen fish.**



- Opisthorchiasis, the disease caused by *Opisthorchis felineus*, ranges in severity from asymptomatic infection to severe illness.
- Patient outcome is dependent on early detection and treatment.



- Human cases of opisthorchiasis may affect the liver, pancreas, and gall bladder,
- **If not treated in the early stages, opisthorchiasis may cause**
 1. Cirrhosis of the liver
 2. Increased risk of liver cancer, but may be asymptomatic in children



- **Two weeks** after flukes enter the body, the parasites infect the biliary tract, Symptoms of infection include
 1. Fever.
 2. General malaise.
 3. Skin rash.
 4. Gastrointestinal disturbances.
- ❖ **The infected person for 1-2 months cause:**
 1. Severe anemia
 2. Liver damage may also incapacitate



Treatment

- Treatment of opisthorchiasis is generally with a single dose of praziquantel.

4. *Opisthorchis viverrini*

- **Genus:** *Opisthorchis*
- **Species:** *O. viverrini*
- **Binominal name:** *Opisthorchis viverrini*
- **Synonyms:** *Distoma viverrini*

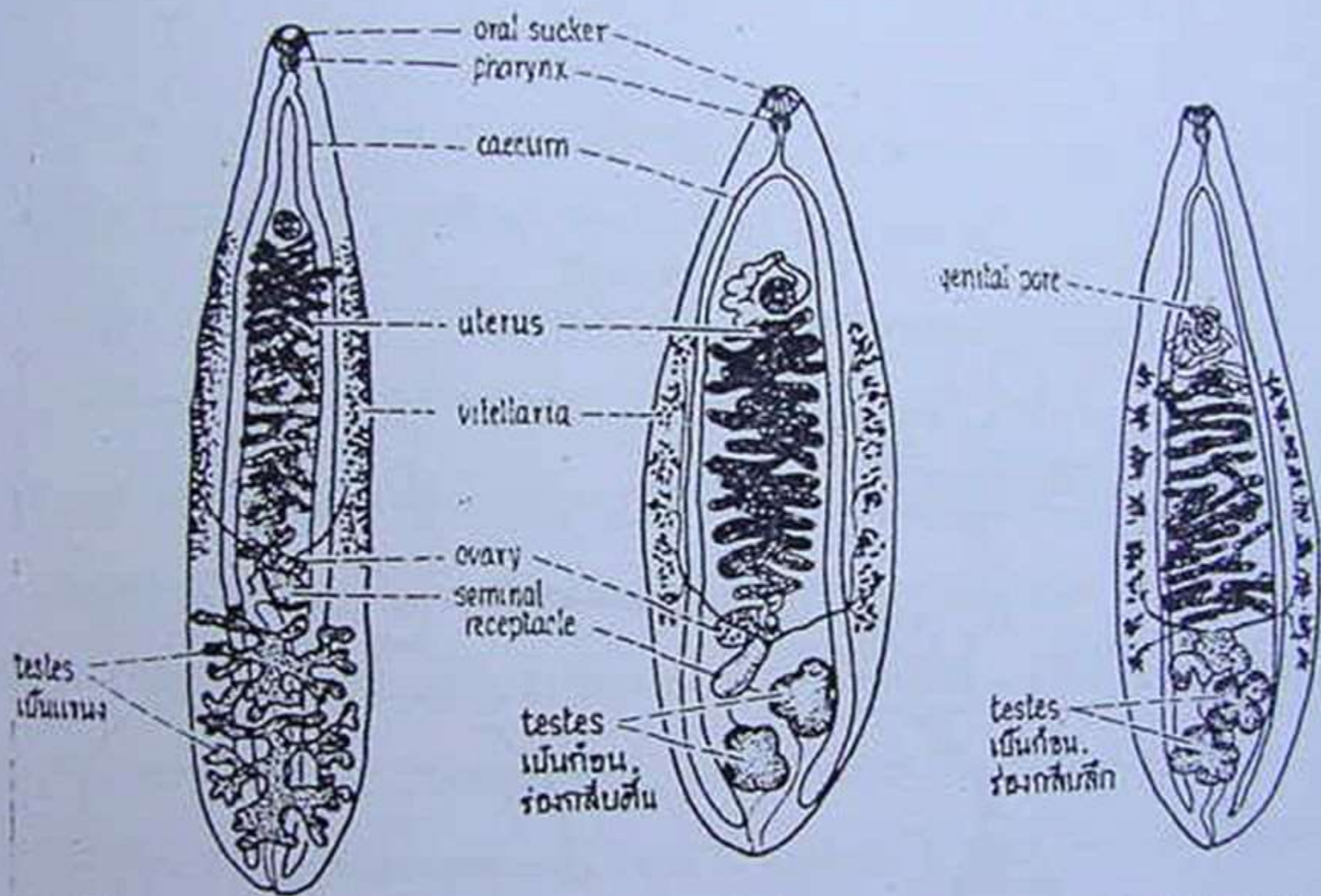


- *Opisthorchis viverrini*, common name **Southeast Asian liver fluke**, is a trematode parasite from the family Opisthorchiidae that attacks the area of the bile duct.
- Infection is acquired when people ingest raw or undercooked fish. It causes :
 1. The disease opisthorchiasis (also called clonorchiasis).
 2. Cholangiocarcinoma: a cancer of the gall bladder and/or its ducts.



- An adult *Opisthorchis viverrini* has these main **body parts**: oral sucker, pharynx, caecum, ventral sucker, vitellaria, uterus, ovary, Mehlis' gland, testes, excretory bladder.
- The testes of an adult *Opisthorchis viverrini* are lobed in comparison of dendritic testes of *Clonorchis sinensis*.
- The eggs of *Opisthorchis viverrini* are 30*12 μm in size and they are slightly narrower and more regularly ovoid than in *Clonorchis sinensis*.





Clonorchis sinensis

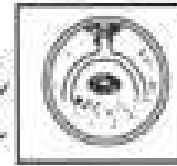
Opisthorchis felinus

O. viverrini

Opisthorchis viverrini is a hermaphroditic liver fluke. Its life cycle is similar to the life cycle of Clonorchis sinensis

i = Infective Stage
d = Diagnostic Stage

4 Metacercariae in flesh or skin of fresh water fish are ingested by human host.



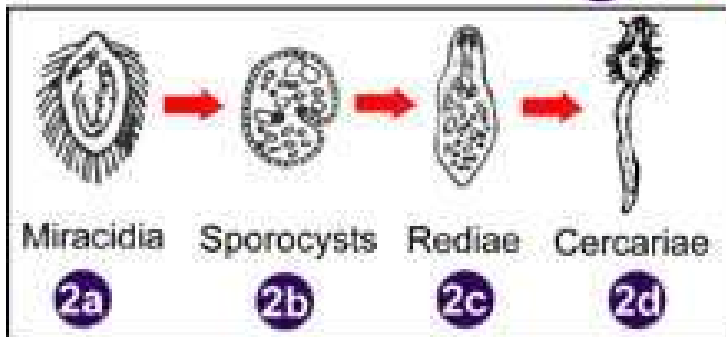
Free-swimming cercariae encyst in the skin or flesh of fresh water fish. **3**

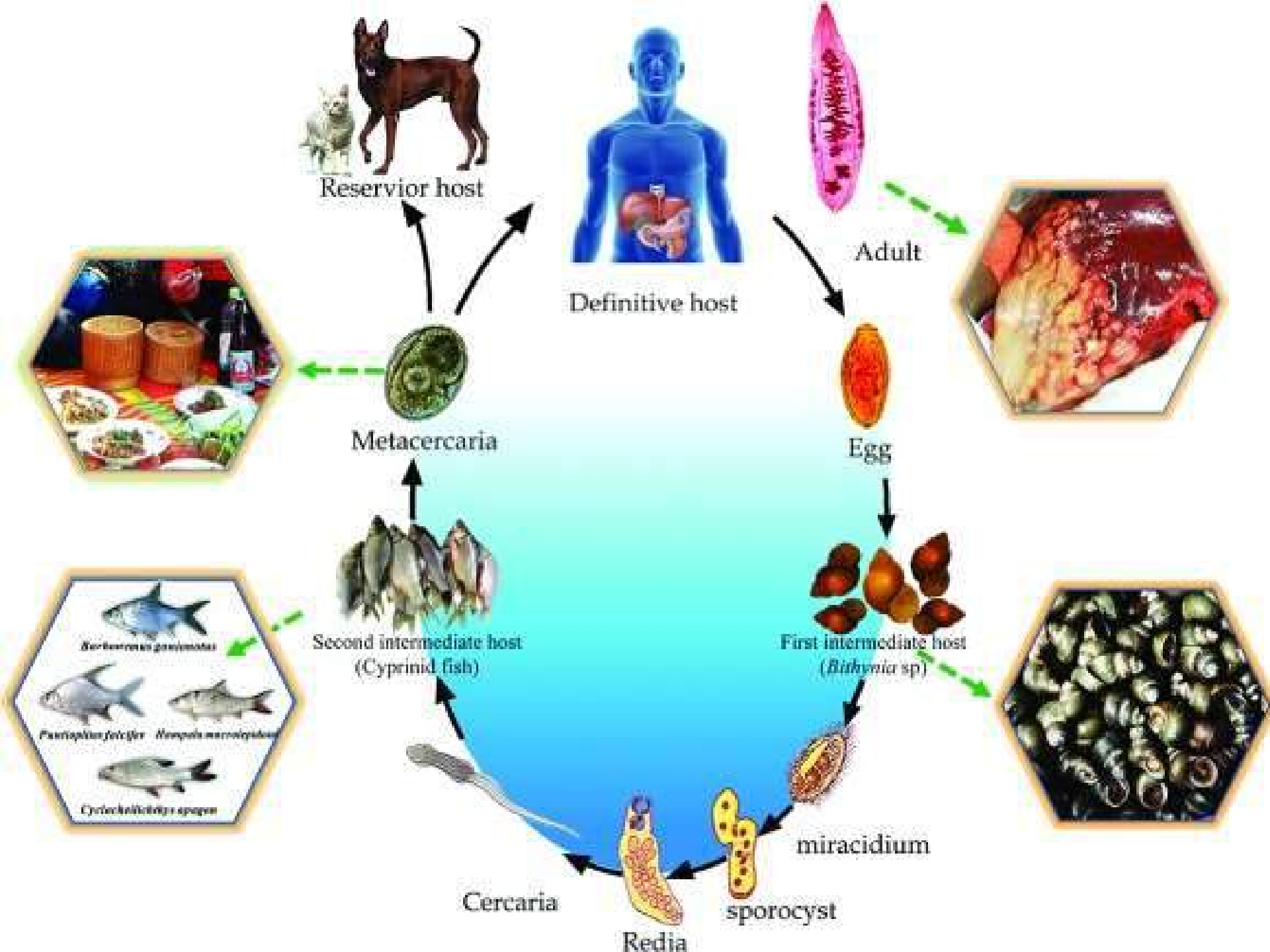
Eggs are ingested by the snail. **2**

5 Excyst in duodenum

1 Embryonated eggs passed in feces. **d**

6 Adults in biliary duct





Prevalence

- Opisthorchiasis is prevalent in geographical regions where raw cyprinid fishes are a staple of the diet of humans.
- The prevalence of human infection can be as high as **70%** in some regions.



Symptoms

- Symptoms of opisthorchiasis (caused by *Opisthorchis* spp.) are indistinguishable from clonorchiasis (caused by *Clonorchis sinensis*), so the disease should be referred as clonorchiasis.
- About **80%** of infected people has **no symptoms**, but they can **have eosinophilia**. This is when the infection is weak and there are less than **1000 eggs** in one gram in feces.
- When there are **10.000-30.000** eggs in one gram of feces, then the **infection is heavy**.



- **Heavy chronic infections**
- When parasites are long-lived may lead to
 1. Accumulation of fluid in legs (edema) and in the peritoneal cavity (ascites),
 2. enlarged non-functional gall-bladder
 3. Obstructive jaundice,
 4. Hepatomegaly and/or fibrosis of the periportal system.



- Importantly, both experimental and epidemiological evidence strongly implicates *Opisthorchis viverrini* infections in the etiology of a malignant cancer of the bile ducts (cholangiocarcinoma) in humans which has a very poor prognosis. Indeed, *Clonorchis sinensis* and *Opisthorchis viverrini* are both categorized by the International Agency for Research on Cancer (IARC) as Group 1 carcinogens.



Diagnosis

- For medical diagnosis there is need to find eggs of ***Opisthorchis viverrini*** in feces' An antigen 89 kDa of ***Opisthorchis viverrini*** can be detected by ELISA test.
- A PCR test capable of amplifying a segment of the internal transcribed spacer region of ribosomal DNA



Prevention

- Effective prevention by **cooking or deep-freezing (-20 °C for 7 days)** of food made of fish is sure method of prevention.



Treatment

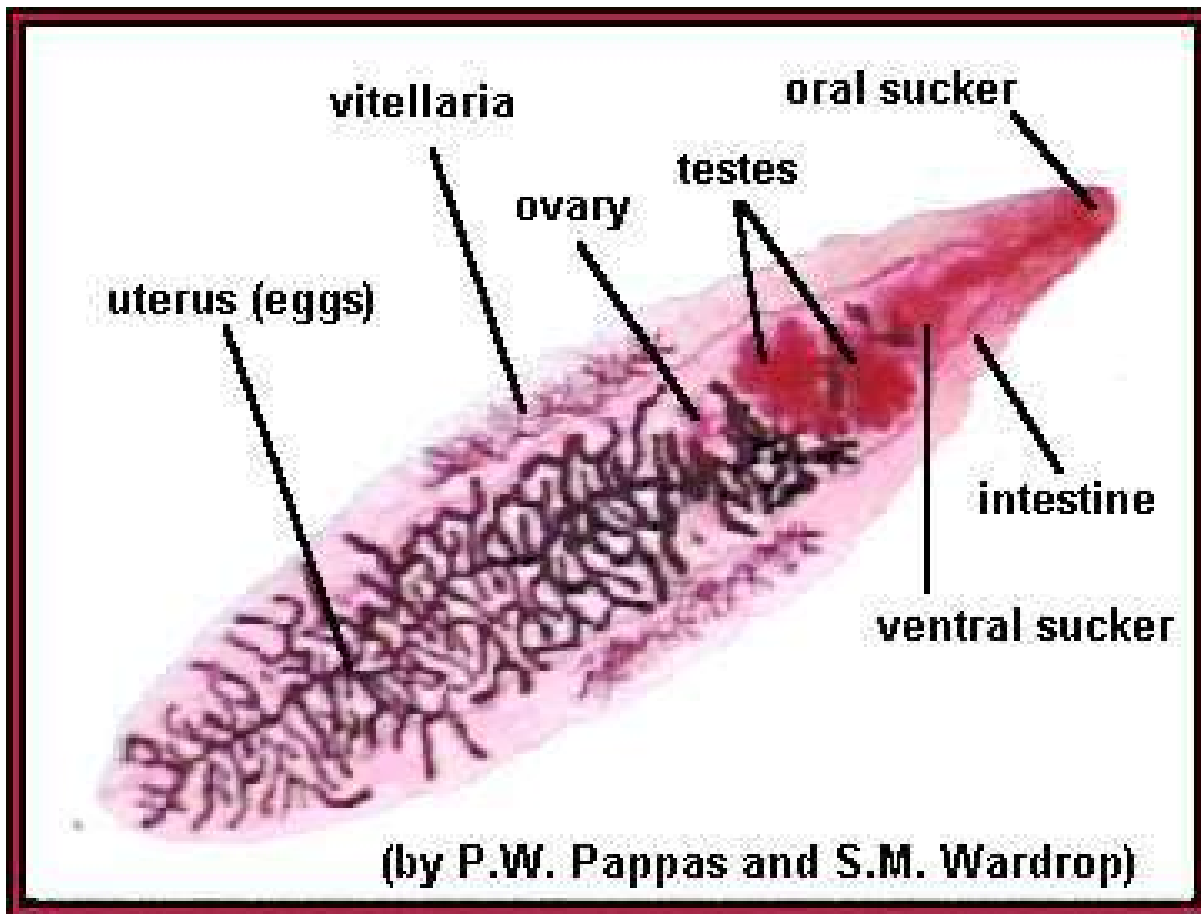
- Thus, currently, the control of opisthorchiasis relies predominantly on anthelmintic treatment with praziquantel. The single dose of praziquantel of 40 mg/kg is effective against opisthorchiasis and also against schistosomiasis.

5- Dicrocoelium dendriticum

- Lancet liver fluke
- **Kingdom:** Animalia
- **Phylum:** Platyhelminthes
- **Class:** Trematoda
- **Order:** Plaeiorchiida
- **Family:** Dicrocoeliidae
- **Genus:** Dicrocoelium
- **Species:** D. dendriticum
- **Binominal name:** dicrocolium dendriticum

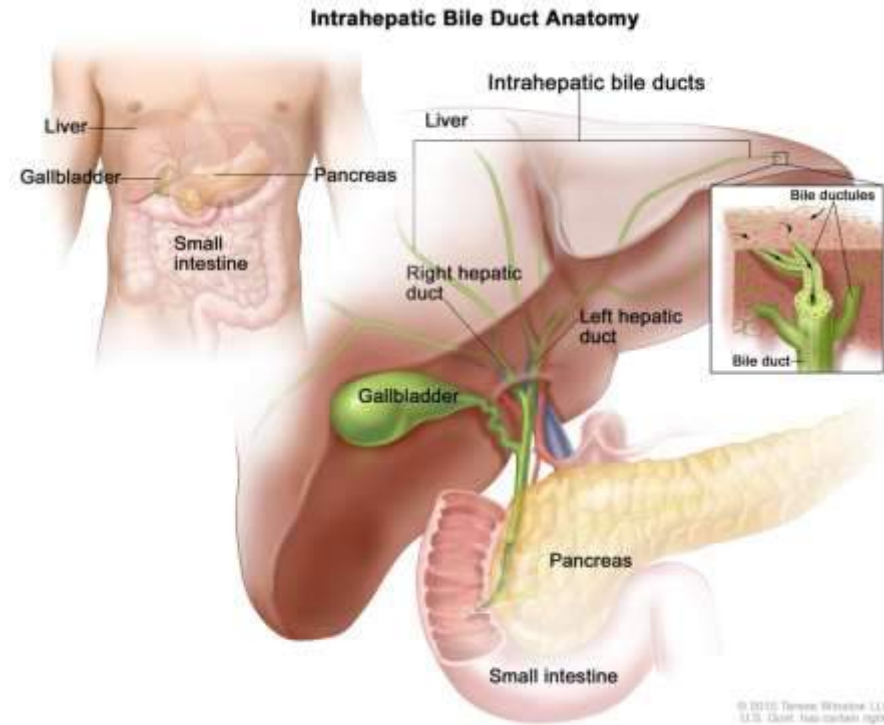


- The Lancet liver fluke (*Dicrocoelium dendriticum*) is a parasite fluke that tends to live in cattle or other grazing mammals.



Clinical presentation in humans

- *Dicrocoelium dendriticum* along with *Dicrocoelium hospes* are part of a group of trematodes that can infect the bile ducts of humans.
- ✓ Because the bodies of these parasites are long and narrow, infections are generally confined to the more distal parts of the bile ducts.
- As a result most *Dicrocoelium dendriticum* infections of the biliary tree produce only mild symptoms.

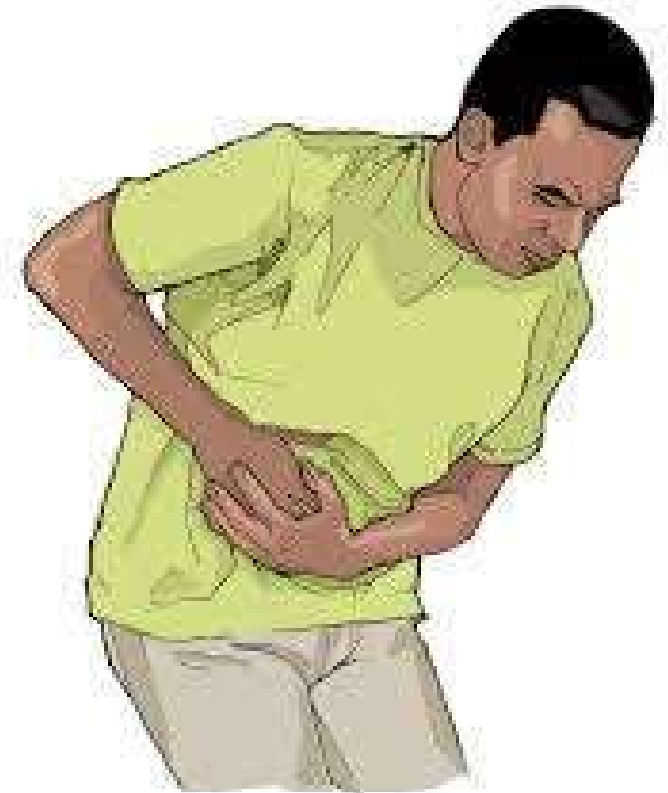


These symptoms can include:

- biliary colic and general digestive disturbances, including bloating and diarrhea.

❖ in heavier infections,

1. Bile ducts and the biliary epithelium may become enlarged
2. Generation of fibrous tissue surrounding the ducts, and as a result, causing an enlarged liver (hepatomegaly) or inflammation of the liver (cirrhosis).
3. In one unique case, an infection with *Dicrocoelium dendriticum* was associated with a skin rash urticaria



Transmission

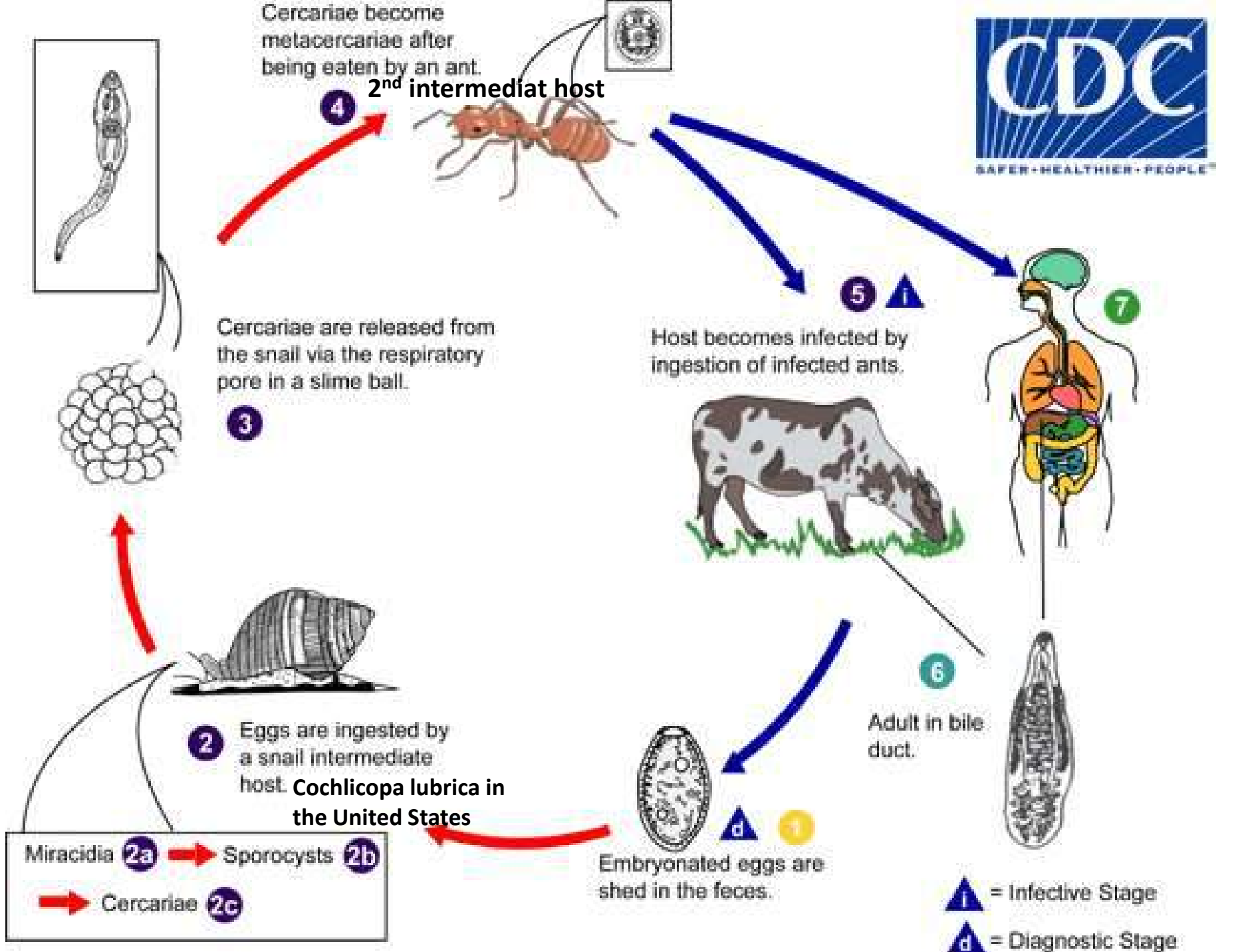
- Due to the highly specific nature of this parasite's life cycle, human infections are generally rare.
- **Ruminants** such as cows and sheep are usually the **definitive host**, but humans and other herbivorous mammals can also serve as definitive hosts through **ingestion of infected ants.** **One definitive case involved a man who ingested bottled water contaminated by infected ants.**



Morphology

- *Dicrocoelium dendriticum* egg in an unstained stool wet mount slide
- *Dicrocoelium dendriticum* has a similar morphology to *Chlonorchis sinensis*
- Except

<i>Dicrocoelium dendriticum</i>	<i>Chlonorchis sinensis</i>
distinguished by lobed testes in the anterior of the body	testes are located in the posterior



Cercariae become metacercariae after being eaten by an ant.

2nd intermediate host



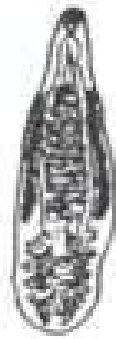
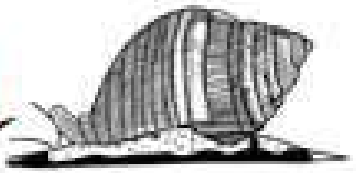
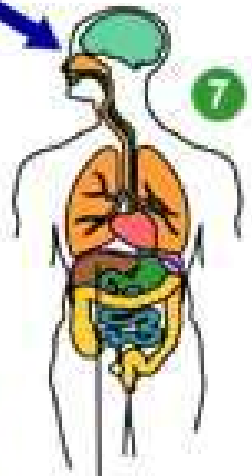
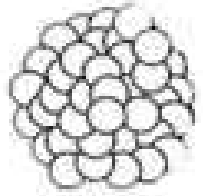
Cercariae are released from the snail via the respiratory pore in a slime ball.

Host becomes infected by ingestion of infected ants.

3

5

7



Eggs are ingested by a snail intermediate host. *Cochlicopa lubrica* in the United States

Adult in bile duct.

Embryonated eggs are shed in the feces.



i = Infective Stage
d = Diagnostic Stage

Diagnostic tests

- Traditionally, diagnosis for dicrocoeliasis infection involves the identification of *Dicrocoelium dendriticum* eggs in the faeces of a human or animal.



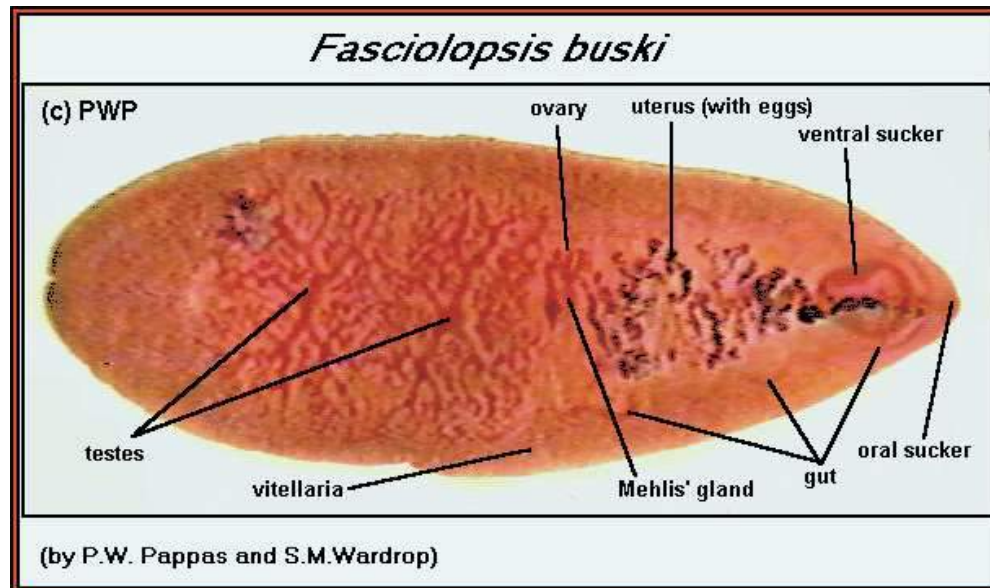
Treatment

- Because human infections with *Dicrocoelium dendriticum* are so rare, there are multiple suggestions for treatment. The standard treatment is with Praziquantel at 25 milligrams per kilogram three times a day for one day. In one German patient 600 mg of Praziquantel administered three times a day for three days also proved to be successful in eliminating the parasite from the body.

Intestinal flukees

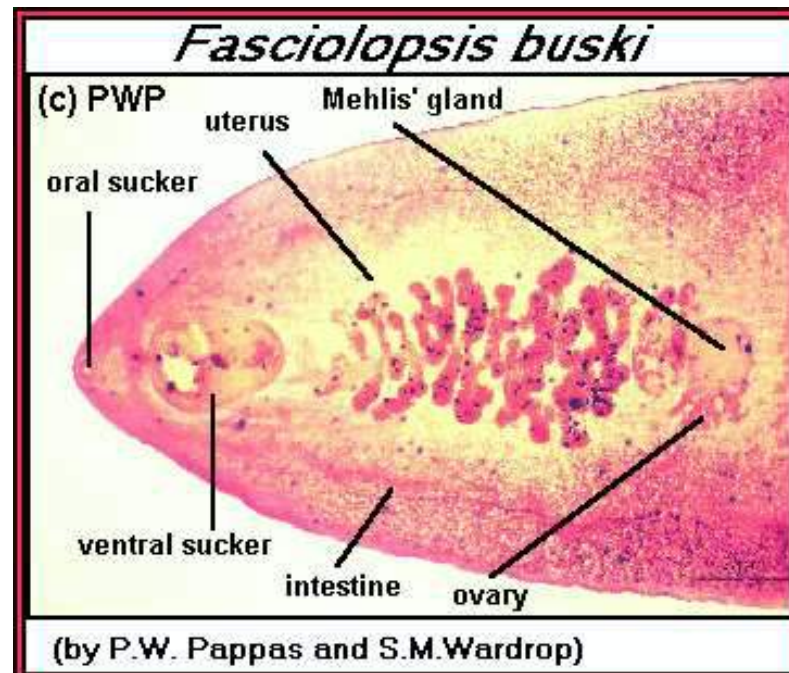
1. Fasciolopsis buski

- **Kingdom:** Animalia
- **Phylum:** Platyhelminthes
- **Class:** Trematoda
- **Genus:** Fasciolopsis
- **Species:** buski, magana
- **Binomial name:** Fasciolopsis buski, Fasciolopsis magana

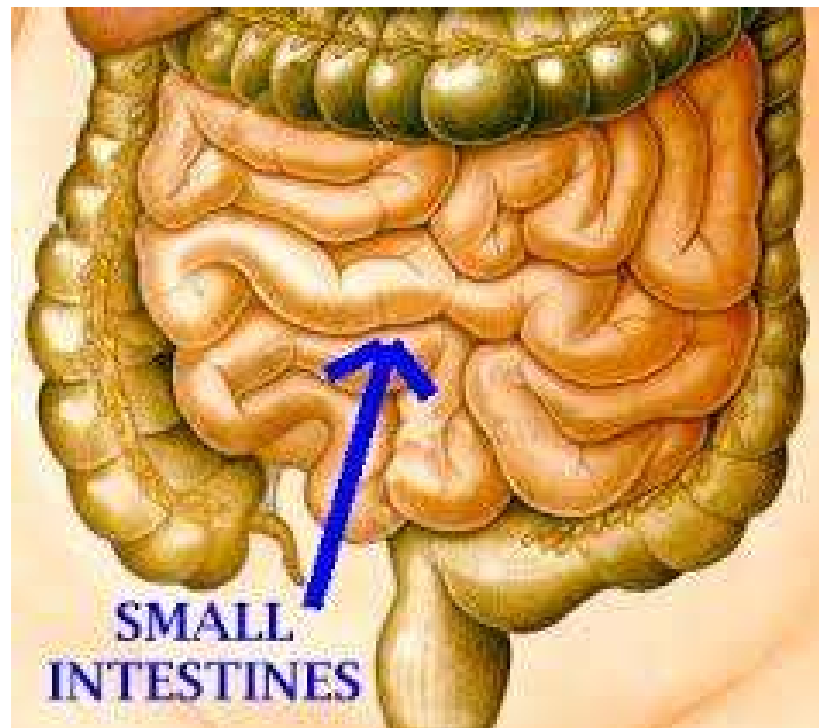


Fasciolopsis buski

- *Fasciolopsis buski* It is a common parasite of humans and pigs called the giant intestinal fluke, being the largest known parasitic fluke in humans.
- The body can be up to 7.5 cm in length and 2.5 cm in width.
- Most prevalent in Asia, mainly central and southeast Asia. It belongs to the class Trematoda. family Fasciolidae.

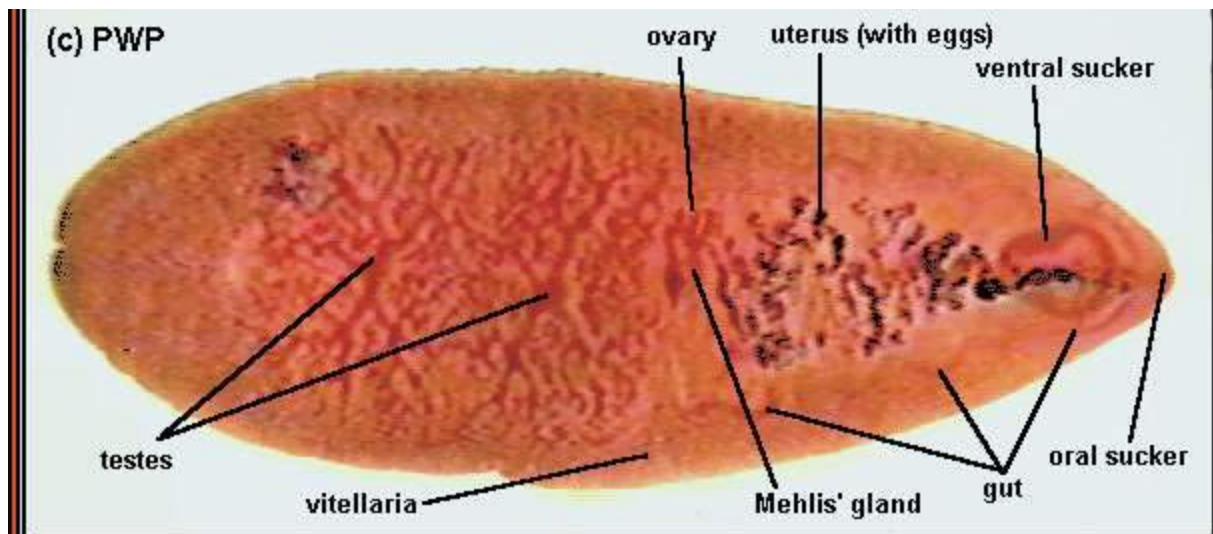


- The reason for its common name is due to the fact that it is one of the largest flukes to infect humans.
- **The worm** inhabits the upper region of the **small intestine** and, when abundant, can also be found in the **lower areas of the intestine and the stomach**.
- *Fasciolopsis buski* is the cause of the disease fasciolopsiasis.



Morphology

- *F. buski* is a large leaf-shaped, dorso-ventrally flattened worm that is characterized by a **blunt anterior end**, undulating, unbranched ceca (sac-like cavity with a single opening), tandem, dendritic testes, branched ovaries, and ventral suckers to attach itself to the host.
- The acetabulum is larger than the oral sucker. It has extensive vitelline follicles.
- It can be distinguished from other fasciolids by **a lack of cephalic cone or "shoulders" and the unbranched ceca.**



Symptoms

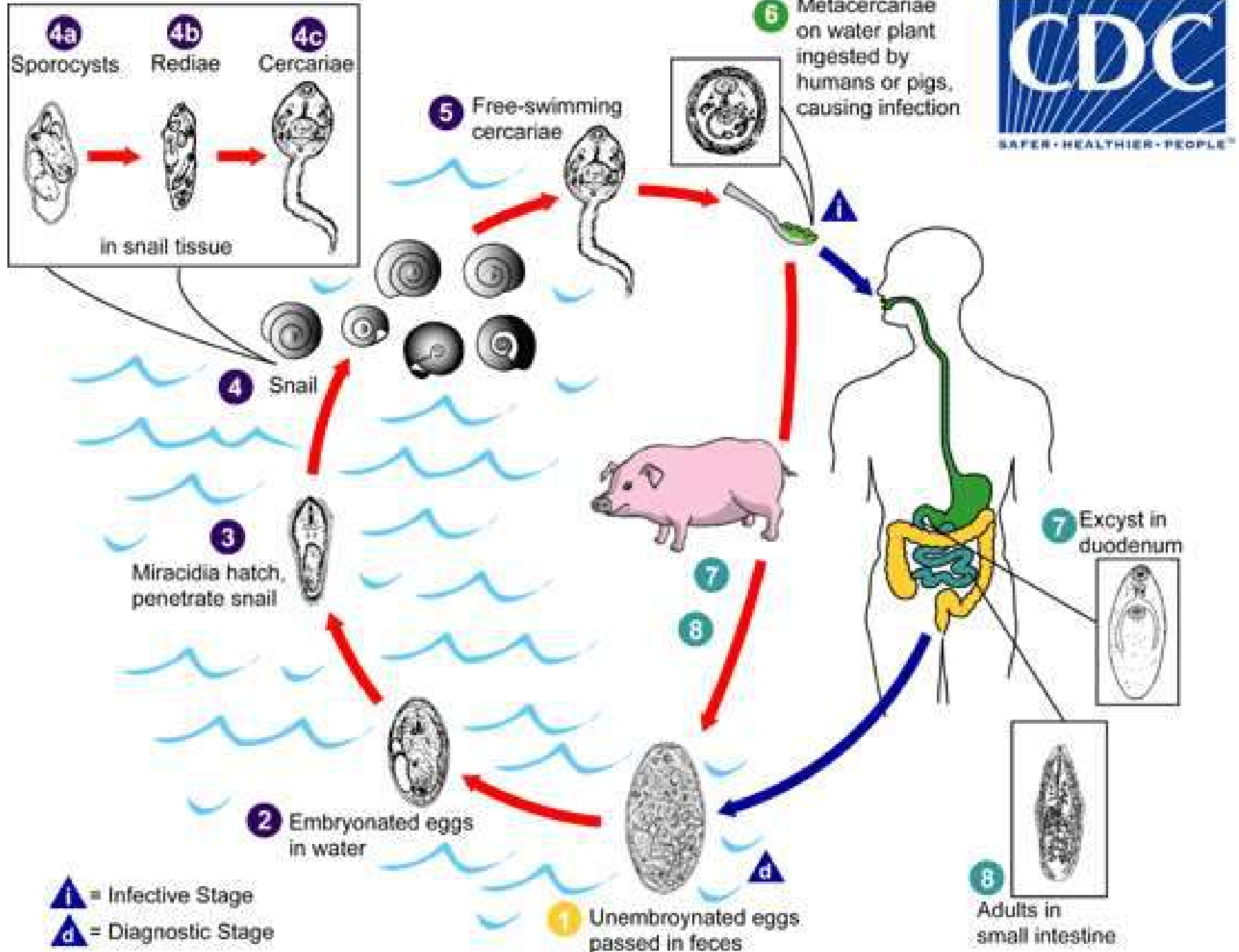
- Most infections are light and Asymptomatic.
- In heavy infections, symptoms can include :
 - 1) Abdominal pain.
 - 2) Chronic diarrhea.
 - 3) Anemia.
 - 4) Ascites.
 - 5) Toxemia.
 - 6) Allergic responses: sensitization caused by the absorption of the worms allergenic metabolites (may eventually cause death of patient), and intestinal obstruction.



Laboratory diagnosis

- Microscopic identification of eggs, or more rarely of the adult flukes, in the stool or vomit is the basis of specific diagnosis.
- The eggs are indistinguishable from those of *Fasciola hepatica*.





Treatment

- Praziquantel is the drug of choice for treatment.

Prevention

- **Prevention can be easily achieved by:**
 1. Immersion of vegetables in boiling water for a few seconds to kill the infective metacercariae,
 2. Avoiding the use of night soil as a fertilizer, and
 3. Maintenance of proper sanitation and good hygiene.
 4. Snail control should be attempted.



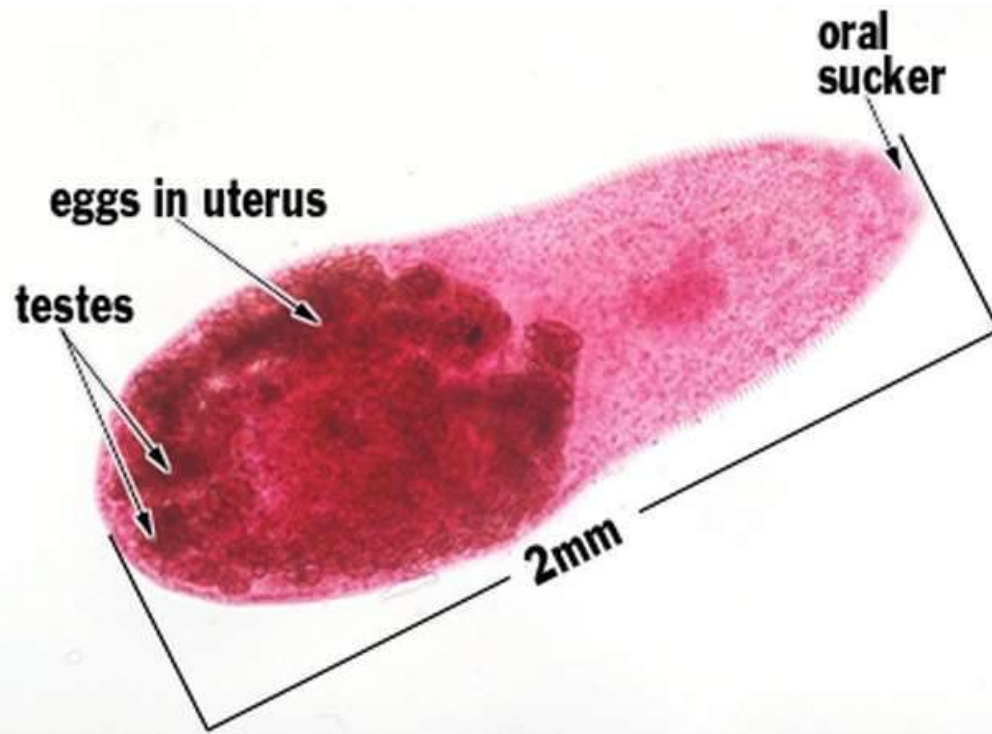
Epidemiology

- ❖ Distribution of *Fasciolopsis buski* is endemic in Asia including China, Taiwan, South-East Asia, Malaysia and India.
- ❖ It has a prevalence of up to **60%** in India and mainland China and has an estimated 10 million human infections.
- ❖ **Infections occur most often in school-age children or in impoverished areas with a lack of proper sanitation systems.**



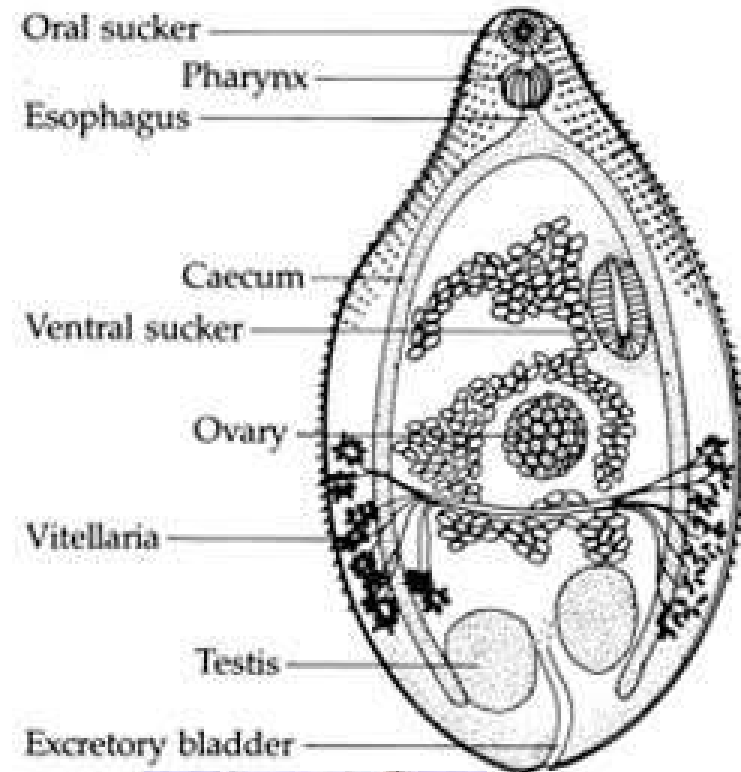
2- Heterophyes heterophyes

- *Heterophyes heterophyes* is a large family of parasites with many subfamilies and many species are important human parasites minute **teardrop-shaped flukes** found in the small intestines of fish-eating birds and mammals.

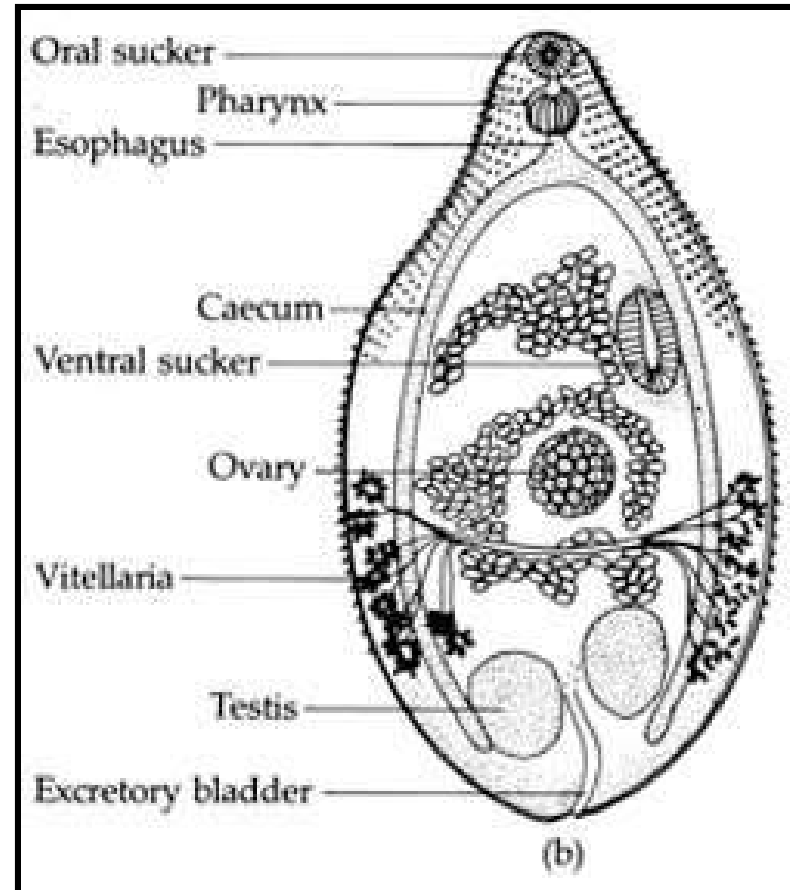


Morphology

1. Minute teardrop-shaped flukes found in the small intestines of fish-eating birds and mammals.
2. The eggs are hard to tell apart from other related species so there is no accurate estimate of human infection.
3. The adult flukes range from 1,0mm to 1.7mm long and about 0.35mm at their greatest width.
4. The body of the fluke is covered in scales mostly concentrated at the anterior end. Also at the anterior end is an oral sucker. Located in the medioanterior of the body is the acetabulum.
5. At the posterior end of the fluke are two oval testes.



6. The vas deferens leading from the testes expands to form a seminal vesicle and then narrows again to form an ejaculatory duct.
7. The fluke also has female reproductive organs. Located medioposterior is the fluke's one ovary and leading away from the ovary is the vitellaria.
8. The uterus is a long tube like structure that also leads away from the ovary and joins up with the ejaculatory duct to form the genital duct which leads to a genital sinus.
9. The sinus leads to the genital pore which is lined with 60-90 toothed spines.
10. The genital pore is where the fluke releases its eggs.



Pathology

1. Each worm causes a mild inflammatory reaction at its site of contact with the intestine.
2. In heavy infections which are common cause damage to the mucosa and produce intestinal pain and mucosa diarrhea.
3. Sometimes eggs can enter the blood and lymph vascular systems through mucosa go into the ectopic sites in the body.
4. The heart can be affected with tissue reaction in the valves and myocardium that cause heart failure.
5. Eggs can also get into the brain or spinal cord and cause neurological disorders and sometimes fatalities.



Heterophyes heterophyes

Cercariae penetrate the skin of fresh/brackish water fish and encyst as metacercariae in the tissue of the fish

4

5 Host becomes infected by ingesting undercooked fish containing metacercariae

i

3 Cercariae released from snail

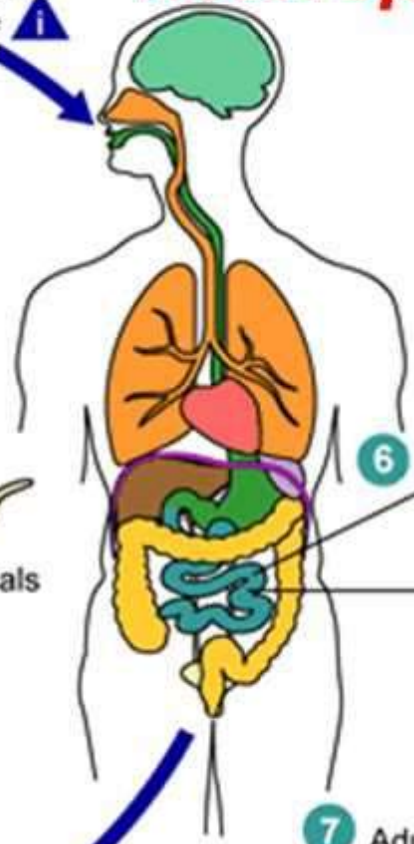
2

Snail host ingests eggs, miracidia emerge from eggs and penetrate the snail's intestine



8

Fish-eating mammals and birds can be infected as well



6

Metacercariae excyst in the small intestine

7

Adult in small intestine



d

Embryonated eggs each with a fully-developed miracidium are passed in feces

i = Infective Stage

d = Diagnostic Stage

2a

2b

2c

Sporocysts → Rediae → Cercariae in snail tissue

Diagnosis

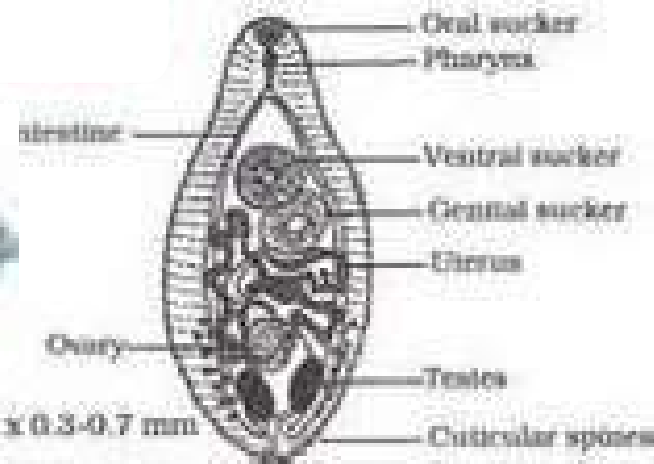
- Diagnosis done by stool examination is difficult when adult worms are not present because the eggs are hard to distinguish from *C.sinensis*.

Treatment

Praziquantel, a quinolone derivative.

3. Metagonimus yokogawai

- **Metagonimus yokogawai**: leaf-shaped parasitic worm similar to most trematodes. It is one of the smallest intestinal flukes, and is only slightly larger than Heteropheres.
- **Metagonimiasis**: is a disease caused by an intestinal trematode. most commonly *Metagonimus yokogawai*, but sometimes by *M. takashii* or *M. miyatai*. The metagonimiasis causing flukes are one of two minute flukes called the heterophyids.



adult size 1.0-1.7 mm x 0.3-0.7 mm

Cercariae penetrate the skin of fresh/brackish water fish and encyst as metacercariae in the tissue of the fish

5 Host becomes infected by ingesting undercooked fish containing metacercariae

3 Cercariae released from snail

2 Snail host ingests eggs, miracidia emerge from eggs and penetrate the snail's intestine

6 Metacercariae excyst in the small intestine

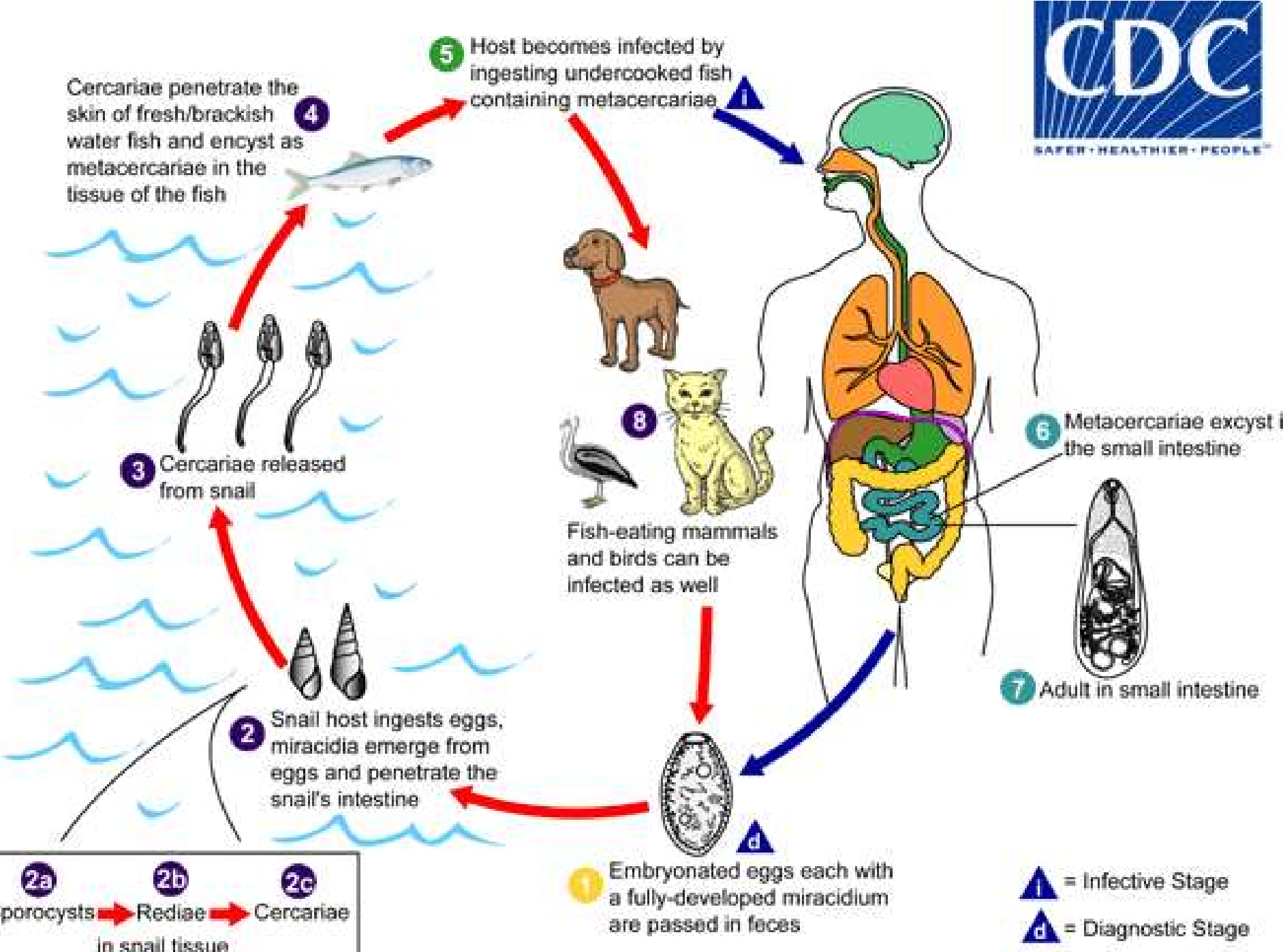
7 Adult in small intestine

8 Fish-eating mammals and birds can be infected as well

Embryonated eggs each with a fully-developed miracidium are passed in feces



▲ = Infective Stage
 ▲_d = Diagnostic Stage



Symptoms

- In acute metagonimiasis, clinical manifestations are developed only 5-7 days after infection.
 1. Heavy infection has also been associated with epigastric distress.
 2. Fatigue, and malaise.
 3. Occasionally, flukes invade the mucosa and eggs deposited in tissue may gain access to circulation. This can then lead to eggs embolizing in the brain, spinal cord, or heart.
 4. Granulomas may form around eggs and can cause seizures, neurologic deficits, or cardiac insufficiency.
- ❖ **The incubation period is around 14 days and infestation may persist for more than one year**



Diagnosis

- Metagonimiasis is diagnosed by eggs seen in feces. Only after antihelminthic treatment will adult worms be seen in the feces, and then can be used as part of a diagnostic procedure..



Treatment

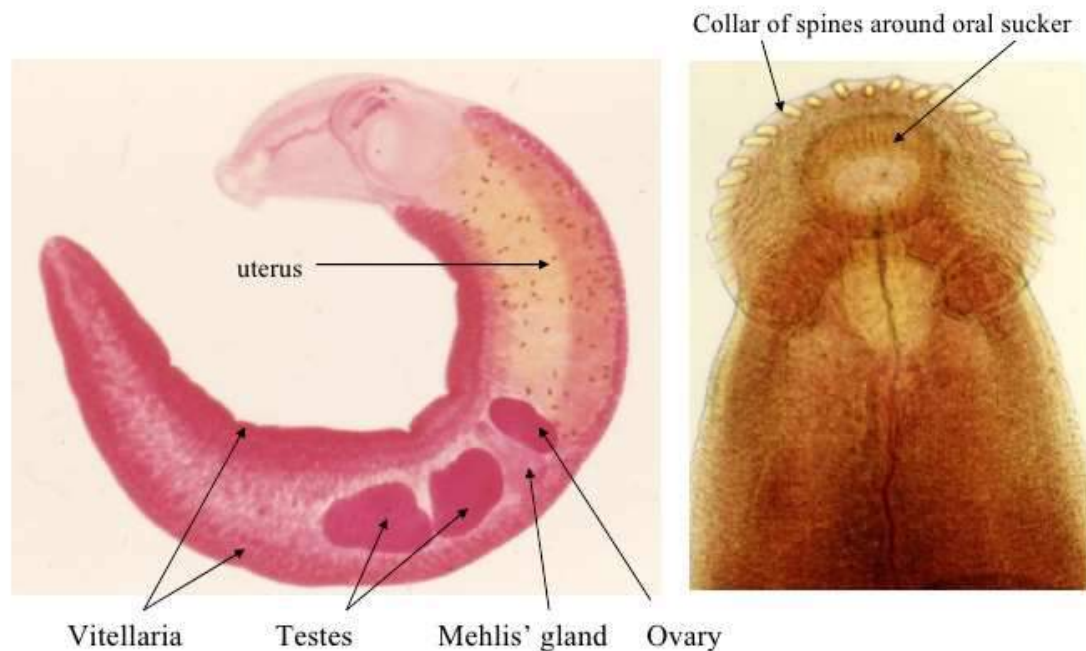
- Praziquantel is recommended in both adult and pediatric cases with dosages of 75 mg/kg/d in 3 doses for 1 day
- **Epidemiological information**
- Worldwide distribution

4. Echinostoma

- **Human echinostomiasis** is caused by digenetic trematodes of the genus *Echinostoma* (“echino” = spiny; “stoma” = mouth). Many echinostome trematodes are found in the intestines of birds and mammals throughout the world.
- At least 16 different species of this intestinal fluke is attributed to human cases of echinostomiasis with *E. ilocanum* as the most common cause of human echinostomiasis.
- In humans, it is usually seen as a rare intestinal parasite of little clinical importance except in heavy infections

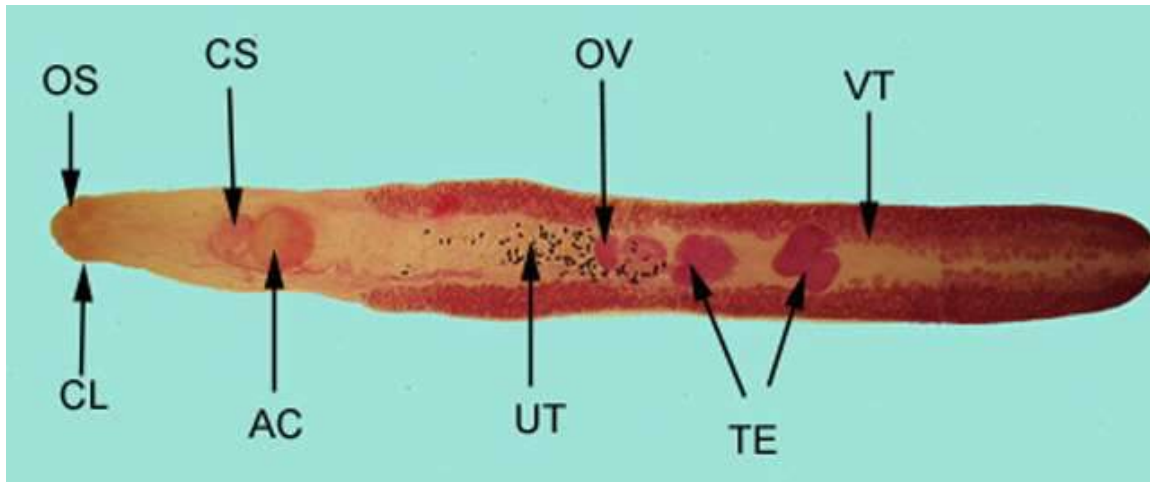


- Adults of *Echinostoma* spp. are much longer than wide and measure about 2- 10 mm long by 1-2 mm wide, depending on the species.
- The oral sucker is surrounded by a collar of spines, the number of which varies among species.
- The oral and ventral suckers are located fairly close to one another. A single ovary is situated near the large, paired testes.
- Adults reside in the small intestine of the definitive host.



4. Echinostoma revolutum

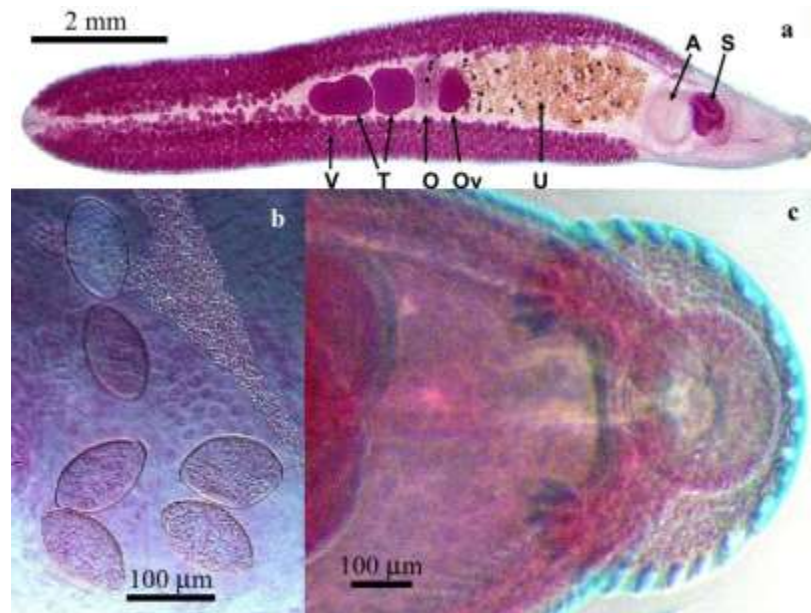
- **Kingdom:** Animalia
- **Phylum:** Platyhelminthes
- **Class:** Trematoda
- **Order:** Echinostomida
- **Family:** Echinostomidae
- **Genus:** Echinostoma
- **Species:** E. revolutum
- **Binominal name:** Echinostoma revolutum

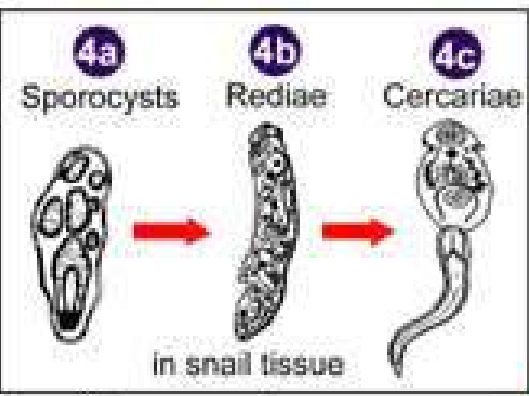


Adult of *E. revolutum*, stained with carmine. Structures illustrated in this figure include: oral sucker (OS), armed collar (CL), cirrus sac (CS), ventral sucker, or acetabulum (AC), uterus containing eggs (UT), ovary (OV), paired testes (TE), and vitelline glands (VT). This species has been recorded from humans in Taiwan.

Echinostoma revolutum

- Is a fluke that can be a parasite in humans, infection of *Echinostoma revolutum* usually results from ingestion of **raw snails or frogs** that serve as an **intermediate host**. This parasite is predominantly found throughout North America.

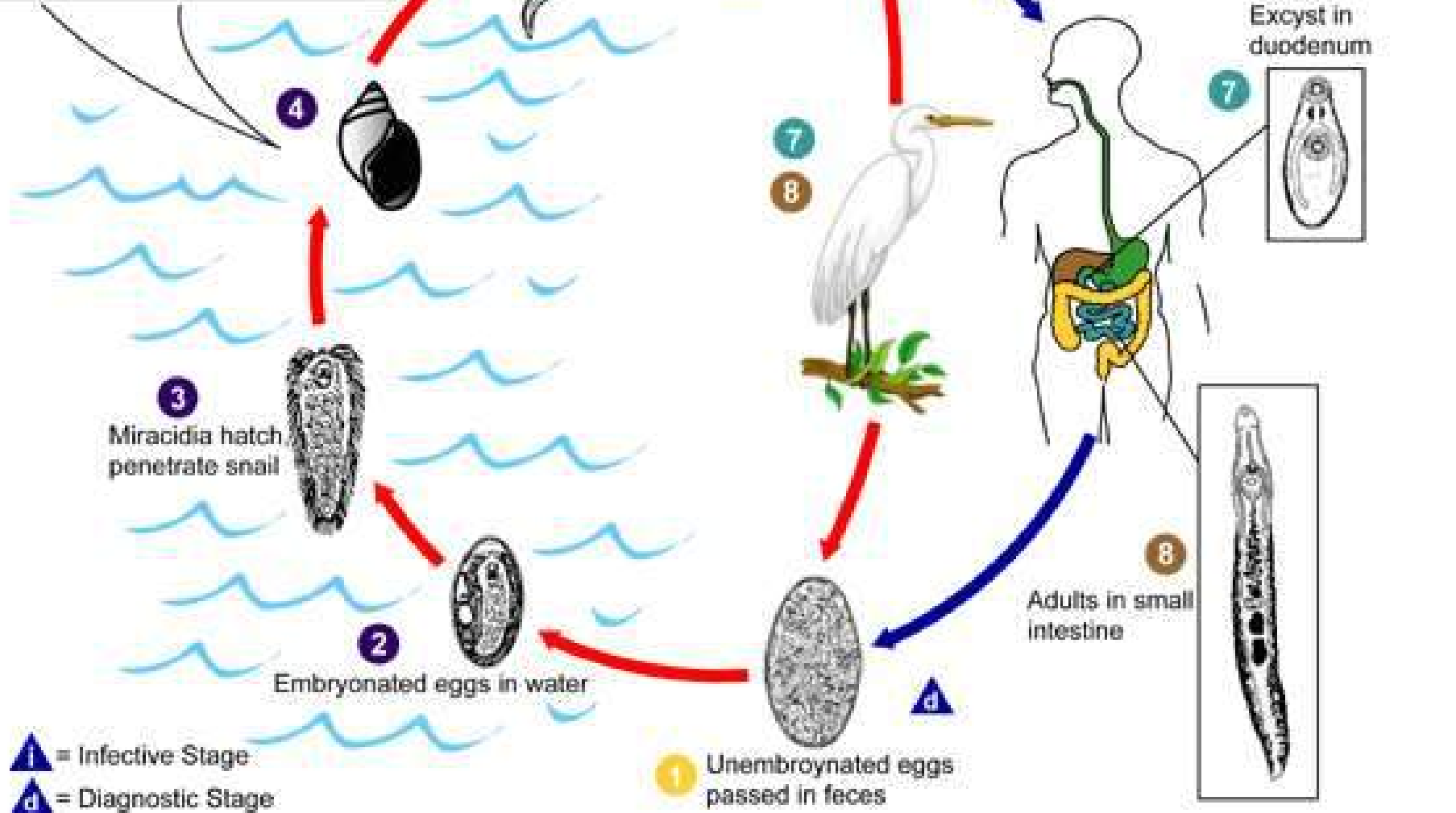




5 Free-swimming cercariae invade second intermediate host.



Metacercariae in second intermediate host; eaten by humans, aquatic birds, etc.



1 = Infective Stage
d = Diagnostic Stage

Hosts of *Echinostoma revolutum* include:

- *Lymnaea stagnalis*.
- *Radix auricularia*



Symptoms

- Weakness and emaciation.
- In cases where infection is heavy: hemorrhagic enteritis can occur.



Diagnosis

- *E. revolutum* could be detected through observing feces containing eggs under a microscope.



Treatment

- Albendazole and praziquantel are typically prescribed to rid the parasite from the body

5. Paramphistomum cervi

- Paramphistomosis (or amphistomosis) is a disease caused by digenean trematodes of the family Paramphistomatidae parasitising the rumen of ruminants worldwide.
- Clinical disease on the other hand is confined to warmer tropical and sub-tropical areas of the world .
- The genus name, *Paramphistomum*, is derived from the Greek 'amphistomos' meaning having a **double mouth**.



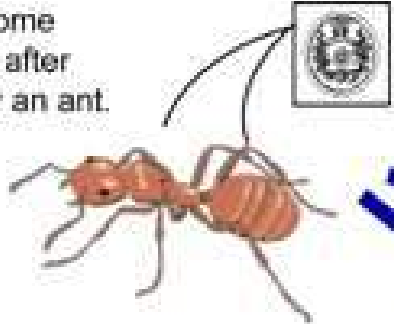


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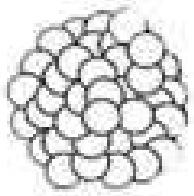
Cercariae become metacercariae after being eaten by an ant.

4



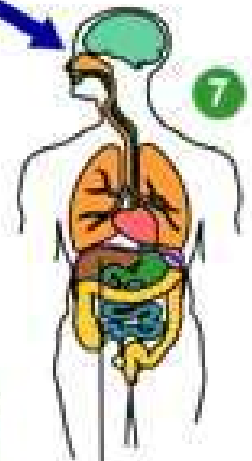
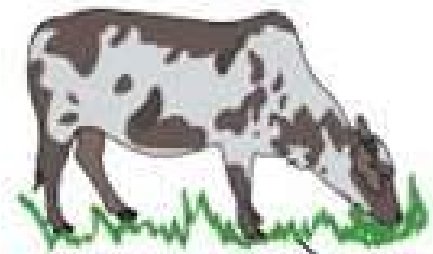
Cercariae are released from the snail via the respiratory pore in a slime ball.

3



Host becomes infected by ingestion of infected ants.

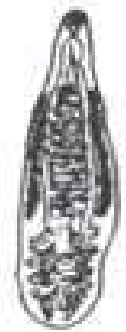
5



7

Adult in bile duct.

6

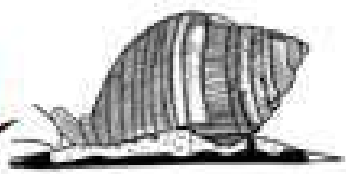


Embryonated eggs are shed in the feces.



Eggs are ingested by a snail intermediate host.

2

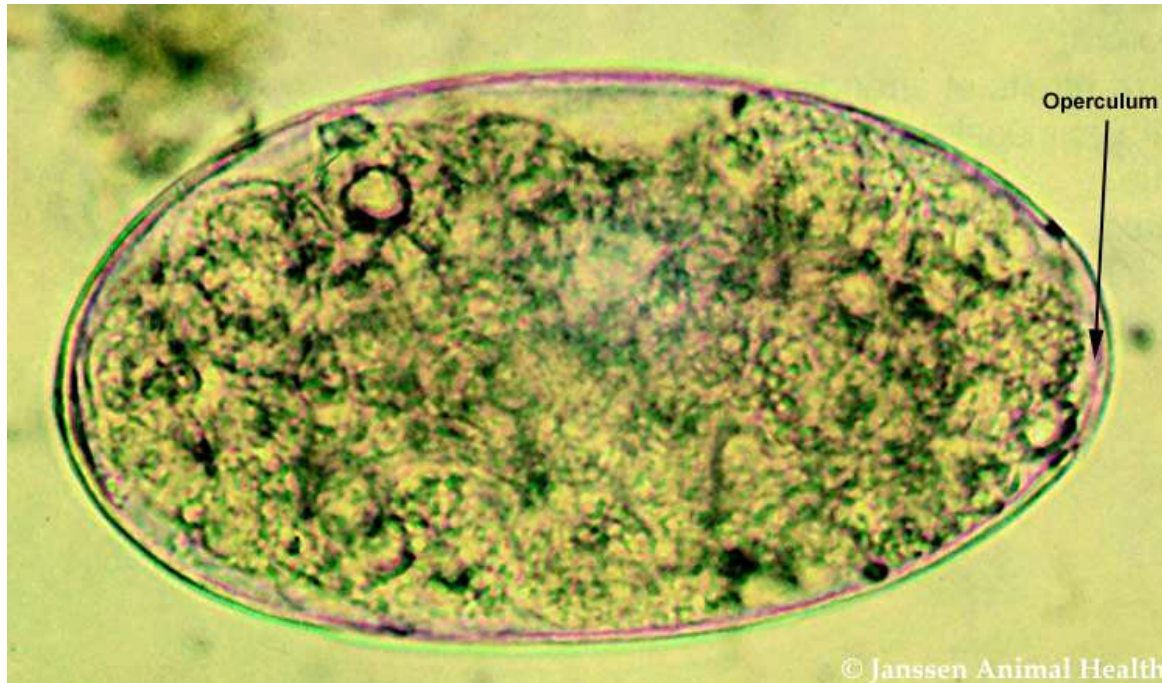


Miracidia 2a → Sporocysts 2b
 → Cercariae 2c

i = Infective Stage
d = Diagnostic Stage

Epidemiology

- Flooding, caused by heavy rains, results in the dispersal of snails from permanent water masses, such as lakes and ponds.
- Paramphistome eggs, deposited in these areas by grazing animals, hatch and infect the snails.



Pathology and clinical disease

- **Acute paraphistomosis** is caused by massive infection with immature worms in the small intestine.
- They attach themselves to the intestinal mucosa, drawing pieces of the mucosa into the suckers causing:
 1. **Strangulation.**
 2. **Necrosis.**
 3. **Hemorrhage.**



❖ Acute paramphistomosis usually occurs in young cattle

less than two years of age and is characterized by

1. Listlessness and anorexia.
2. Profuse diarrhea (which can sometimes be projectile) develops two-four weeks after infection.
3. The feces are very fluid and may even contain immature flukes.
4. Sub-mandibular oedema has been noted in several outbreaks and anaemia has also frequently been described.



Diagnosis

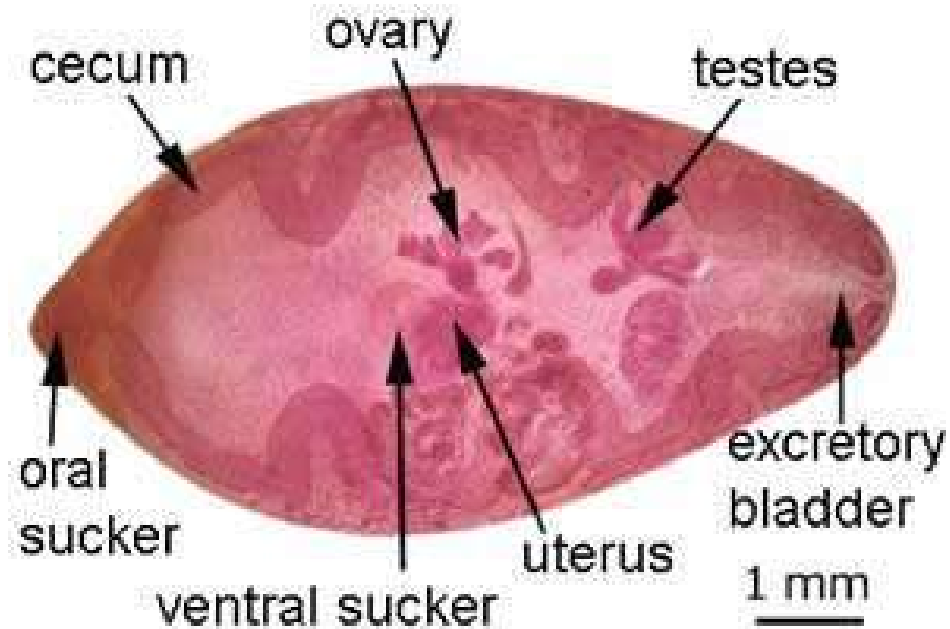
- **Provisional diagnosis is usually made on**
 1. The history and clinical signs of disease.
 2. The presence immature paramphistomes in the fluid faeces or at post mortem examination.
 3. Faecal examination for eggs at this stage is usually unrewarding as the disease is in the prepatent phase.
- **Immature flukes** are conical, pink in colour and 1-5mm long.
- 4. The faecal sedimentation technique (McCaughey and Hatch, 1964) commonly used for Fasciola diagnoses is the most accurate to identify eggs in faeces.
- The eggs are oval and operculate, resembling that of *F. hepatica*; however, they are slightly larger and clear (transparent) rather than yellow in color.
- ❖ The addition of a contrast stain such as methylene blue may help to differentiate these two species of eggs.
- The adult flukes are pear-shaped and red in colour, approximately 1 cm long with a sucker at the tip of the cone and another sucker ventrally at the posterior end



Treatment

- Most drugs licensed for the treatment of fasciolosis are not effective against
- paramphistomosis. Only a few drugs have been shown to have an efficacy against either the immature and/or mature flukes namely; niclosamide, oxiclozanide, rafoxinide and resorantel,

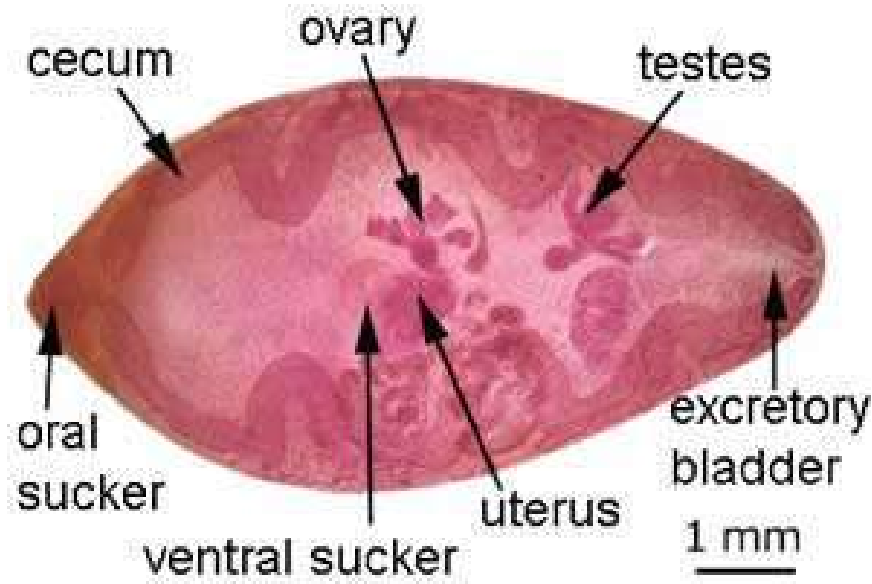
Lec5: Lung fluke



Lec.Dr.Ruwaidah F. Khaleel

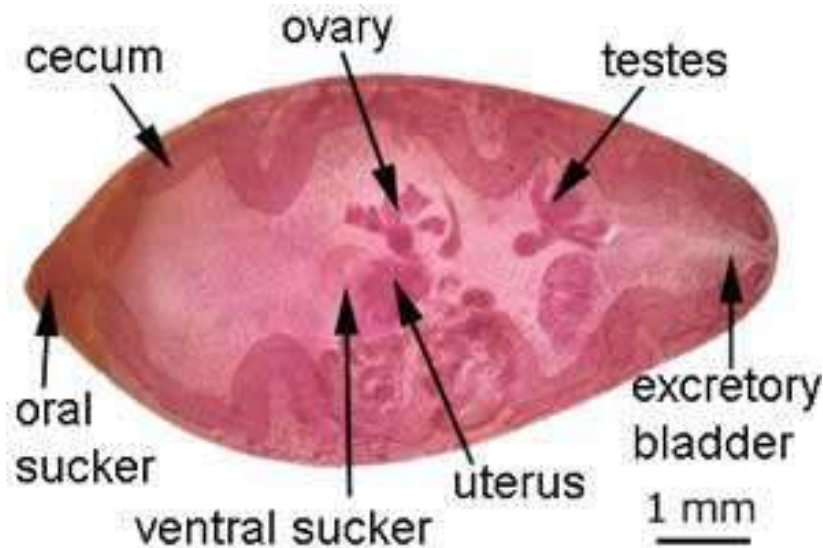
Paragonimus westermani

- **Kingdom:** Animalia
- **Phylum:** Platyhelminthes
- **Class:** Trematoda
- **Family:** Paragonimidae
- **Genus:** Paragonimis
- **Species:** p. westermani



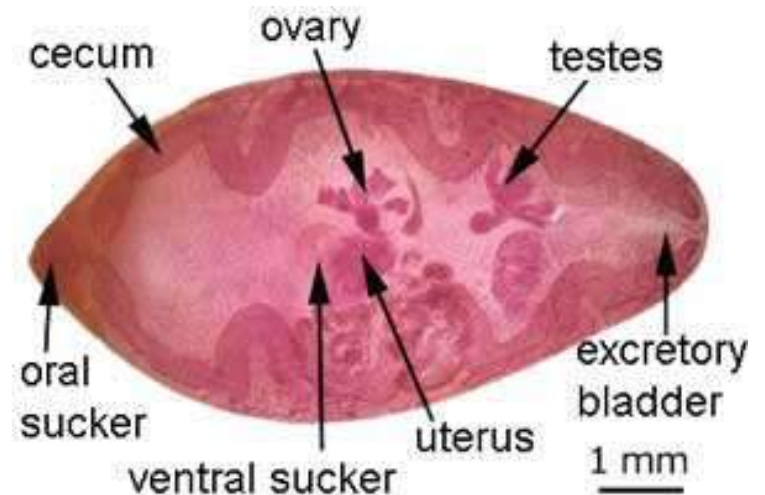
Paragonimus westermani

- *Paragonimus westermani*: is a lung fluke and is most prominent in Asia and South America (**the oriental lung fluke**), It is a food-borne parasitic infection. Reservoir hosts of *Paragonimus spp.* include numerous species of carnivores including felids, canids, some rodents and pigs. Humans become infected after eating raw fresh water crabs or crawfish that have been encysted with the metacercaria.
- ❖ **Southeast Asia** is more predominately more infected because of lifestyles. Raw seafood is popular in these countries.



Morphology

1. **Adult worms** are typically reddish brown and ovoid, measuring **7 to 16 mm** by **4 to 8 mm**.
2. They are hermaphroditic, with a lobed ovary located anterior to two branching testes. Like all members of the Trematoda.
3. **The skin of the worm (tegument)** is heavily covered with scale like spines.
4. **The oral and ventral suckers** are similar in size, with the later placed slightly pre-equatorially.
5. **The excretory bladder** extends from the posterior end to the pharynx.

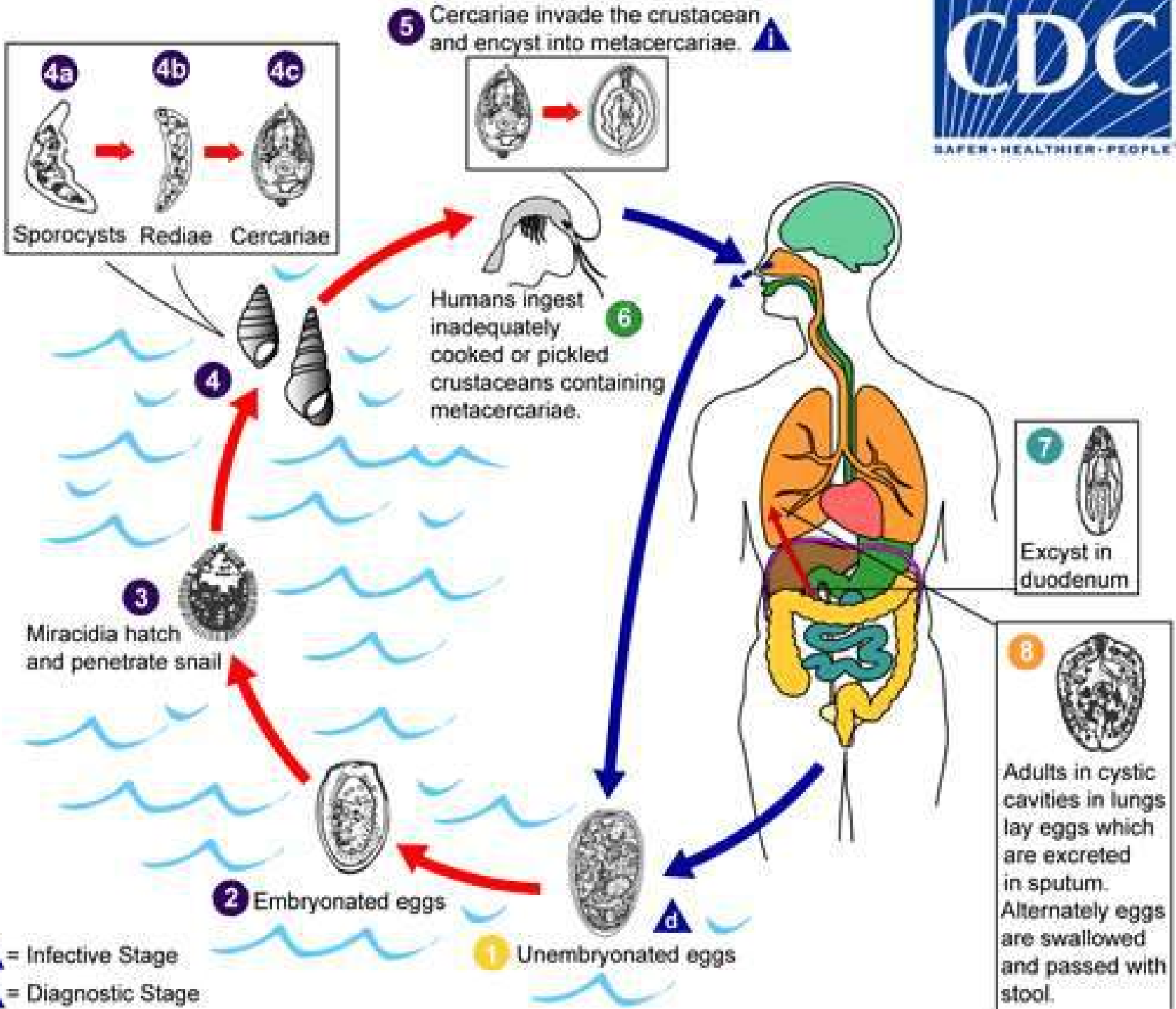


- **The lobed testes** are adjacent from each other located at the posterior end.
- **The lobed ovary** is off-centered near the center of the worm (**slightly postacetabular**).
- **The uterus** is located in a tight coil to the right of the acetabulum, which is connected, to the vas deferens.
- **The vitelline glands**, which produce the yolk for the eggs, are widespread in the lateral field from the pharynx to the posterior end.



- **Eggs**: range from 80 to 120 mm long by 45 to 70 mm wide. They are yellow-brown, ovoid or elongate, with a thick shell, and often asymmetrical with one end slightly flattened. At the large end, the operculum is clearly visible. The opposite end is thickened. The eggs are unembryonated when passed in sputum or feces.
- **Cercaria**: is often indistinguishable between species. There is a large posterior sucker, and the exterior is spined.
- **Metacercaria**: are usually encysted in tissue. The exterior is spined and has two suckers.





i = Infective Stage

d = Diagnostic Stage

8

Adults in cystic cavities in lungs lay eggs which are excreted in sputum. Alternately eggs are swallowed and passed with stool.

Incubation period

- Time from infection to oviposition (laying eggs) is 65 to 90 days. Infections may persist for 20 years in humans.
- **Pathology**
- The symptoms are localized in the pulmonary system, which include:
 - Bad cough.
 - Bronchitis.
 - Blood in sputum (hemoptysis).
 - Granulation of lung tissues.
 - Inflammation.



Diagnosis:

1. Microscopic demonstration of eggs in stool or sputum, but these are not present until 2 to 3 months after infection.
2. Antibody detection is useful in light infections.
3. Radiological methods can be used to X-ray the chest cavity and look for worms.



Treatment:

- Praziquantel is the drug of choice to treat paragonimiasis

Prevention strategies:

- Prevention programs should promote more hygienic food preparation by encouraging safer cooking techniques and more sanitary handling of potentially contaminated seafood.
- The elimination of the first intermediate host, the snail, is not tenable due to the nature of the organisms' habits.



Blood flukes

- **Schistosoma**: commonly known as blood-flukes and **bilharzia**, includes flatworms which are responsible for the most significant parasitic infection of humans by causing the disease schistosomiasis, and are considered by the **World Health Organization (WHO)** as the second most important parasitic disease, next only to malaria, with hundreds of millions infected worldwide.
- **Schistosomiasis**: (also known as **bilharzia, bilharziosis or snail fever**) is a parasitic disease caused by several species of the genus *Schistosoma*.



- Although it has a low mortality rate, schistosomiasis often is a chronic illness that can damage internal organs and, in children, impair growth and cognitive development.
- The **urinary form of schistosomiasis** is associated with increased **risks for bladder cancer in adults**.
- This disease is most commonly found in **Asia, Africa, and South America, especially in areas where the water contains numerous freshwater snails, which may carry the parasite.**
The disease affects many people in developing countries, particularly children who may acquire the disease by swimming or playing in infected water.



Scientific classification

- **Kingdom:** Animalia
- **Phylum:** Platyhelminthes
- **class:** Trematoda
- **Subclass:** Digenea
- **Order:** Strigeidida
- **Family:** Schistosomatidae
- **Genus:** Schistosoma



Parasitism of humans by *Schistosoma* appears to have evolved at least three occasions in both Asia and Africa.

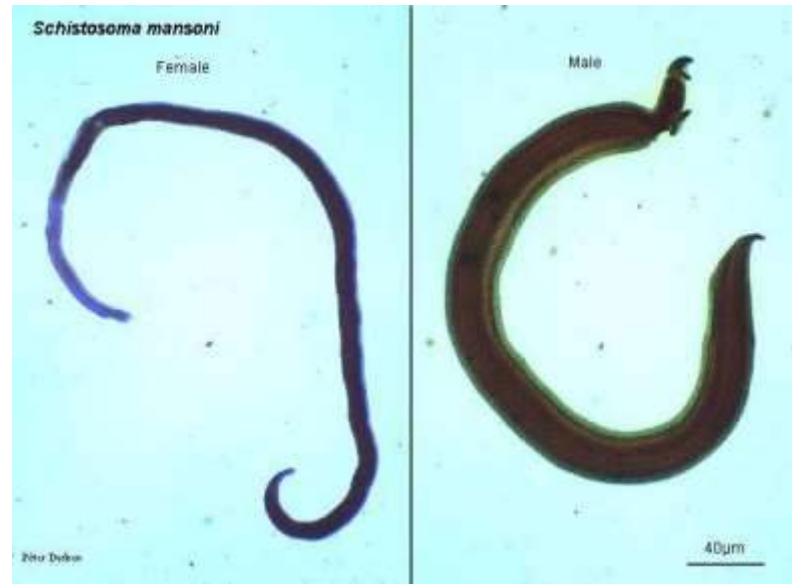
- *S. guineensis*, a recently described species, is found in West Africa. Known snail intermediate hosts include *Bulinus forskalii*.
- *S. haematobium*, commonly referred to as the **bladder fluke**, originally found in Africa, the Near East, and the Mediterranean basin, was introduced into India during World War II. Freshwater snails of the *Bulinus* genus are an important intermediate host for this parasite. Among **final hosts humans** are most important. Other final hosts are rarely **baboons and monkeys**.



- *S. intercalatum*. The usual final hosts are humans. Other animals can be infected experimentally.
- *S. japonicum* whose common name is simply blood fluke is found widely spread in Eastern Asia and the southwestern Pacific region. In Taiwan this species only affects animals, not humans. Freshwater snails of the *Oncomelania* genus are an important intermediate host for *S. japonicum*. Final hosts are humans and other mammals including **cats, dogs, goats, horses, pigs, rats and water buffalo.**



- ***S. malayensis*** This species appears to be a rare infection in humans and is considered to be a zoonosis. The natural vertebrate host is von Muller's rat (*Rattus muelleri*). The snail host(s) is not yet known.
- ***S. mansoni***, found in Africa, Brazil, Venezuela, Suriname, the lesser Antilles, Puerto Rico, and the Dominican Republic. It is also known as ***Manson's blood fluke*** or ***swamp fever***. Freshwater snails of the ***Biomphalaria*** genus are an important intermediate host for this trematode. Among final hosts humans are most important. Other final hosts are baboons, rodents and raccoons.

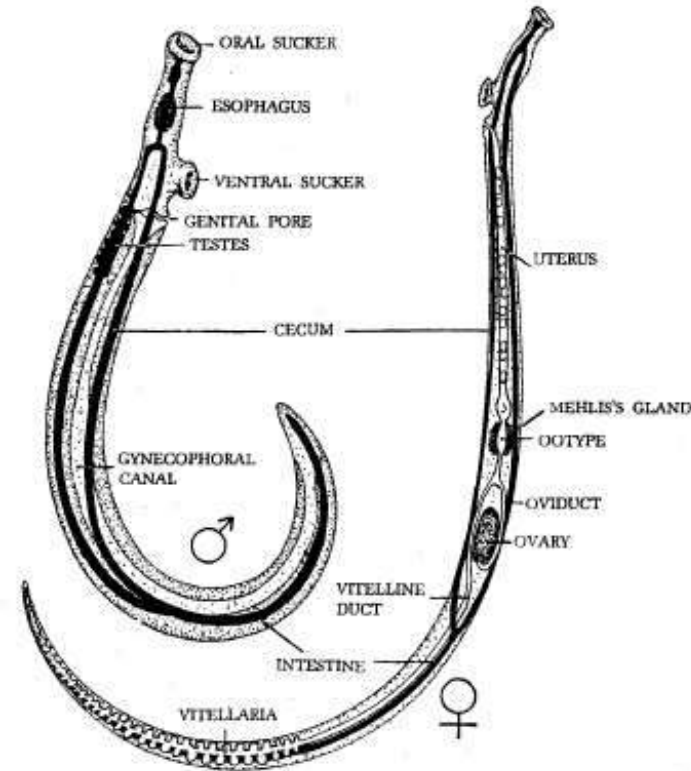


- ***S. mekongi***, is related to *S. japonicum* and affects both the superior and inferior mesenteric veins. Final hosts are humans and dogs.

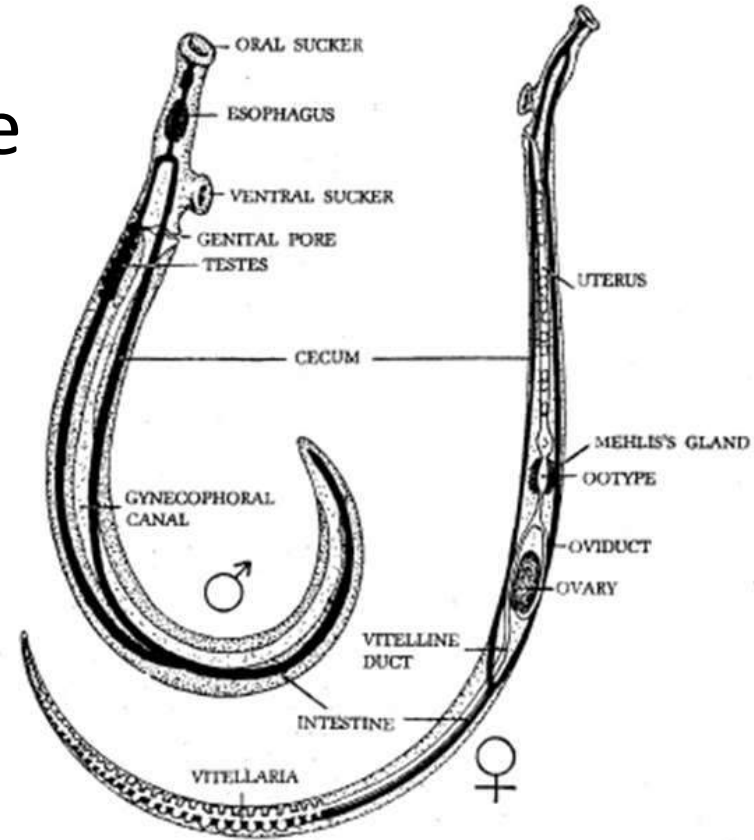


Morphology

1. Adult schistosomes share all the fundamental features of the digenea:
2. Adult worms tend to be 10-20 mm in long.
3. Adult worms parasitize mesenteric blood vessels.
4. They are unique among trematodes or any other flatworms in that they are dioecious with distinct sexual dimorphism between male and female.
5. They have a basic bilateral symmetry, oral and ventral suckers, a body covering of a syncytial tegument.

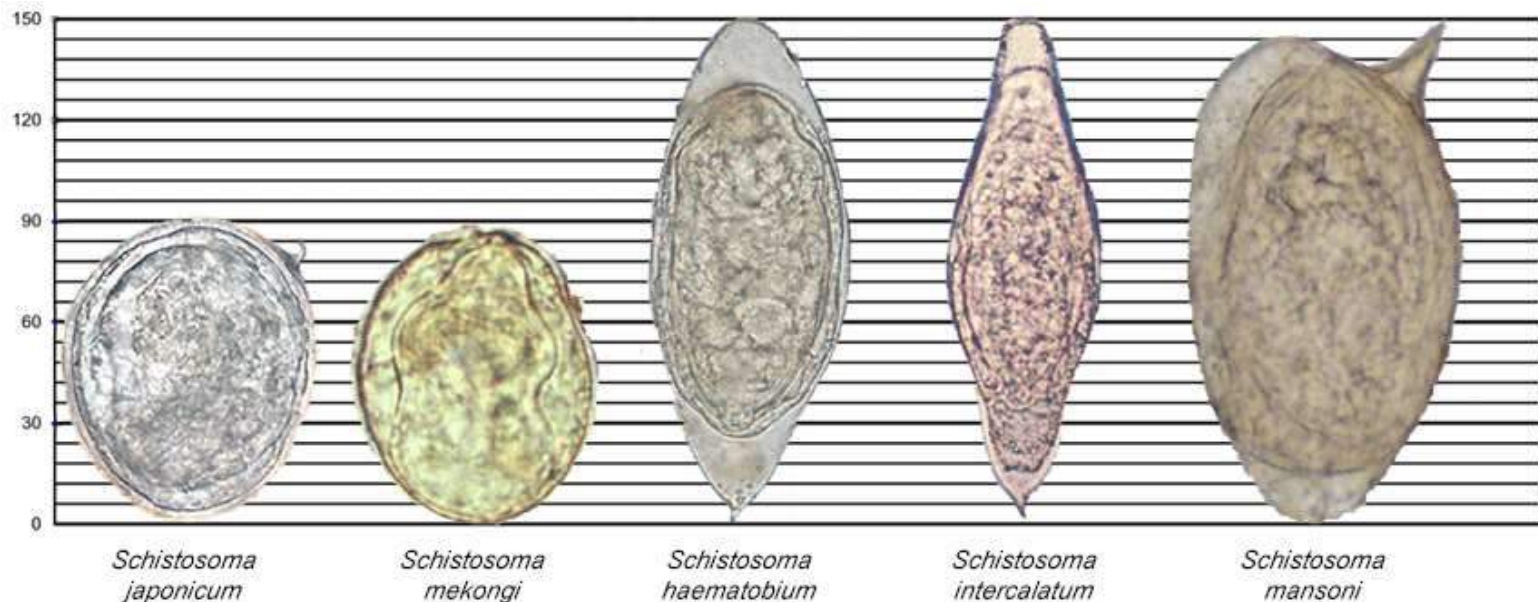


6. Blind-ending digestive system consisting of mouth, esophagus and bifurcated caeca; the area between the tegument and alimentary canal filled with a loose network of mesoderm cells.
7. An excretory or osmoregulatory system based on flame cells.
8. Adult worms use globins from their hosts' hemoglobin for their own circulatory system.



Notes:

- Up to half the eggs released by the worm pairs become trapped in the mesenteric veins, or will be washed back into the liver, where they will become lodged.
- Trapped eggs mature normally, secreting antigens that elicit a vigorous immune response.
- Worm pairs can live in the body for an average of four and a half years, but may persist up to 20 years.



Symptoms:

1. Acute schistosomiasis: or (Katayama fever) occurs with onset of egg laying, typically 2 to 4 wk after heavy exposure.

Symptoms include

- 1) Fever.
- 2) Chills.
- 3) Cough.
- 4) nausea.
- 5) Abdominal pain.
- 6) Malaise.
- 7) Myalgia.
- 8) Urticarial rashes.



marked eosinophilia, resembling serum sickness.

- ❖ Manifestations are more common and usually more severe in visitors than in residents of endemic areas and typically last for several weeks.

2. Chronic Schistosomiasis:

1. Results mostly from host responses to eggs retained in tissues.
2. Intestinal mucosal ulcerations caused by *S. mansoni* or *S. japonicum* may bleed and result in bloody diarrhea.
3. As lesions progress, focal fibrosis,
4. Strictures,
5. Fistulas, and papillomatous growths may develop.



Symptoms of *S. haematobium*,

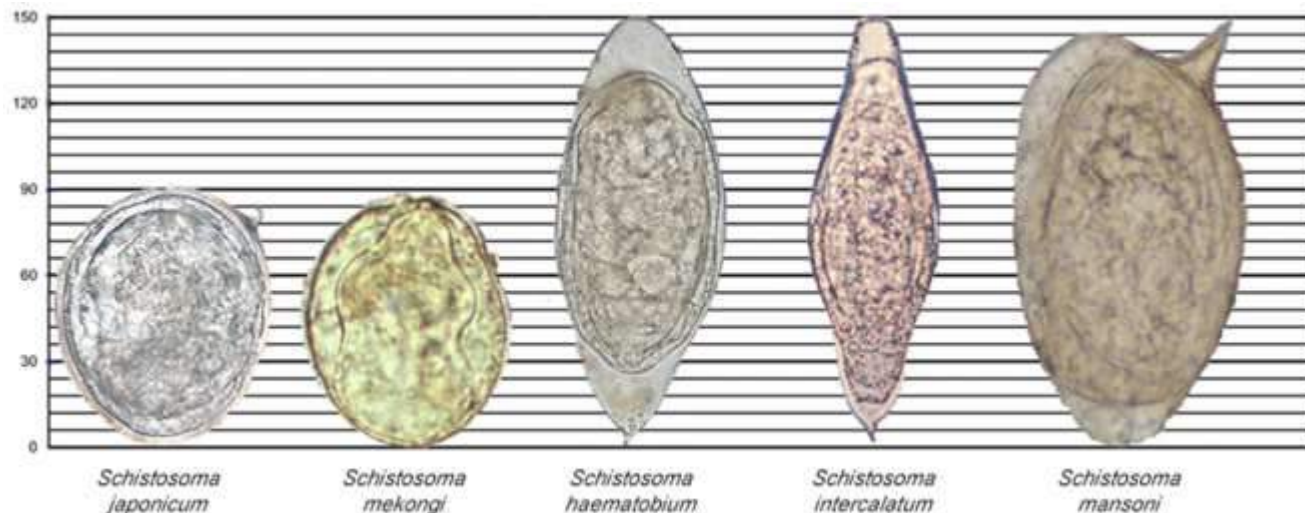
1. Ulcerations in the bladder wall may cause dysuria, hematuria, and urinary frequency.
2. Chronic cystitis develops.
3. Papillomatous masses in the bladder are common,
4. Squamous cell carcinoma may develop.
5. Blood loss from both GI and GU tracts frequently results in anemia.



S. haematobium

Diagnosis

- Microscopic examination of stool (*S. japonicum*, *S. mansoni*) or urine (*S. haematobium*) is examined for eggs. Repeated examinations using concentration techniques may be necessary.
- If the clinical picture suggests schistosomiasis but no eggs are found after repeated examination of urine or feces, intestinal or bladder mucosa can be biopsied to check for eggs.
- Serologic tests may be sensitive and specific for infection, but they do not provide information about worm burden, clinical status, or prognosis.



Treatment

- Praziquantel is recommended. However, treatment does not affect developing schistosomula. Oxamniquine has been effective in treating infection due to *S. mansoni* in some areas where praziquantel has been less effective. African strains are more resistant to this drug than South American strains and require higher doses.
- o Patients should be examined for living eggs 3 and 6 months after treatment. Retreatment is indicated if egg excretion has not decreased markedly.

Prevention

- Avoiding contact with contaminated freshwater prevents infection.
- The sanitary disposal of urine and feces reduces the likelihood of infection.
- Adult residents of endemic areas are more resistant to reinfection than children, suggesting the possibility of acquired immunity.
- Vaccine development is under way.



Schistosoma dermatitis

- Swimmer's itch, also known as duck itch, cercarial dermatitis, and Schistosome cercarial dermatitis : is a short-term, immune reaction occurring in the skin of humans that have been infected by water-borne schistosomatidae.



Other names

- **Swimmer's itch** has various other names.
- In eastern nations, it is often named in reference to the rice paddies where it is contracted, producing names which translate to "rice paddy itch". For example,
- in Japan it is called "kubure" or "kobanyo".
- in Malaysia, "sawah".
- in Thailand, "hoi con".
- In the United States it is known as "clam digger's itch".
- In certain parts of Canada, it is known as "Duck Lice" and "Beaver Lice". In Australia it is known as "pelican itch".



Symptoms

- itchy, raised papules, commonly occur within hours of infection and do not generally last more than a week.



Causal agent:

- ❖ The flatworm parasite schistosomatidae, that causes the **swimmer's itch**



- ❖ Uses both **freshwater snail and vertebrates**, in this case mostly **waterfowls**, as hosts in their parasitic life cycles.



- ❖ During one of these life stages the lavers, cercaria, leave the water snails and swim freely in the fresh water looking for water birds and thus can accidentally hit the skin of the swimmer.



- ❖ The schistosomatidae penetrates, dies in the skin immediately and cannot infect humans, but gives inflammatory, immune reactions.



- ❖ This gives initially mildly itchy spots on the skin.



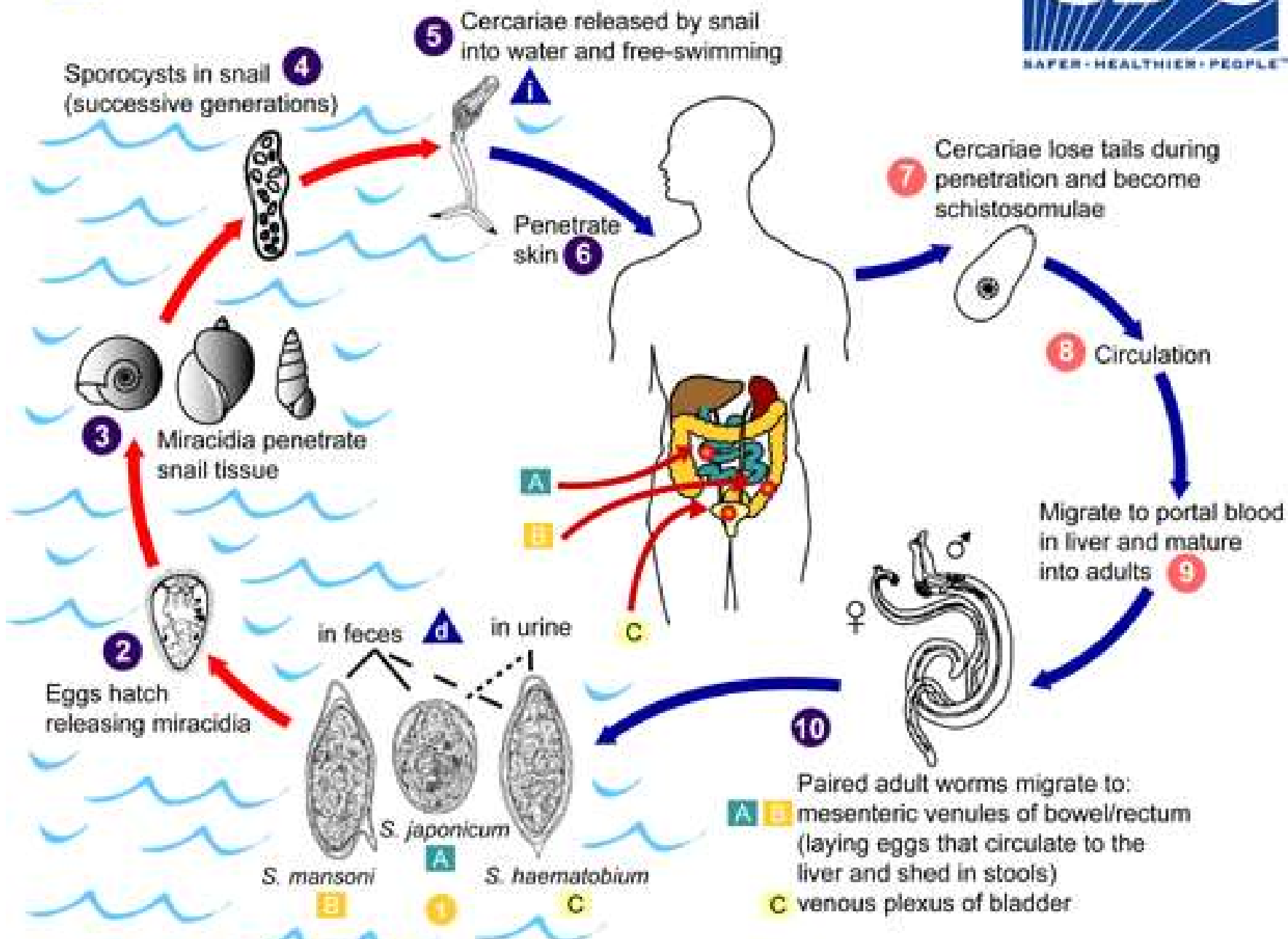
- ❖ Within hours, these spots become raised papules that are intensely itchy.



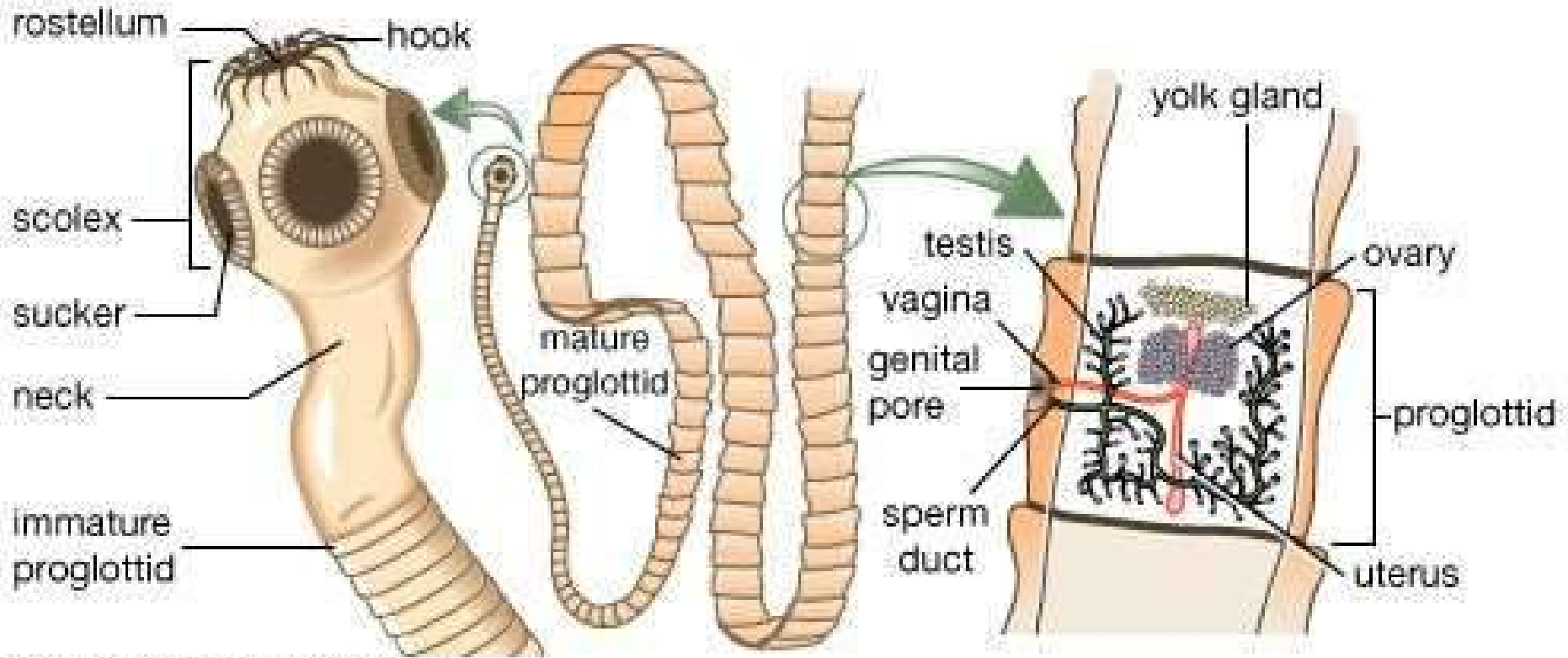
- ❖ Each papule corresponds to the penetration site of a single parasite

	S. haematobium	S. mansoni	S.japonicum
The disease	Urinary bilharziasis or Vescical schistosomiasis	Intestinal schistosomiasis	Oriental schistosomiasis
Definitive host	Human	Human, rodents & monkeys	Human, domestic animals, rodents
Intermediate host	Bulinus	Biomphalaria or Australorbis	Oncomelania
Site of infection in human	Urinary & vesicle veins, pelvic plexus	Inferior mesenteric veins & hemorrhoid plexus	Superior mesenteric veins & gastric mesenteric veins
Ova Size Spine Location	(170-192) x(40-70) p Terminal spine Excrete with urine	(114-175)x(45-68) p Lateral spine Throw out with feces	(70-100) x (50-60) p Small lateral spine Throw out with feces
Male Size Tegument Intestine Testes	0.09 x 1.3 cm Fine papillae Joint in 2nd half of body 4-5 large testes	0.11 x 1 cm Coarse papillae Joint in anterior 3rd 6-9 small testes	0.055 x1.5 cm Smooth Joint in posterior 3rd 6-8 testes
Female Size Ovary Uterus	0.025 x 2 cm In the 2nd half of body Long, 20-30 eggs.	0.016x1.4 cm 1st half of the body Short, 1-4 eggs	0.03x1.9 cm Middle of the body Long, 50-100 eggs

i = Infective Stage
d = Diagnostic Stage



Lec 6: Cestoda



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Lec. Dr. Ruwaidah F. Khaleel

The Class Cestoda is divided into two subclasses,

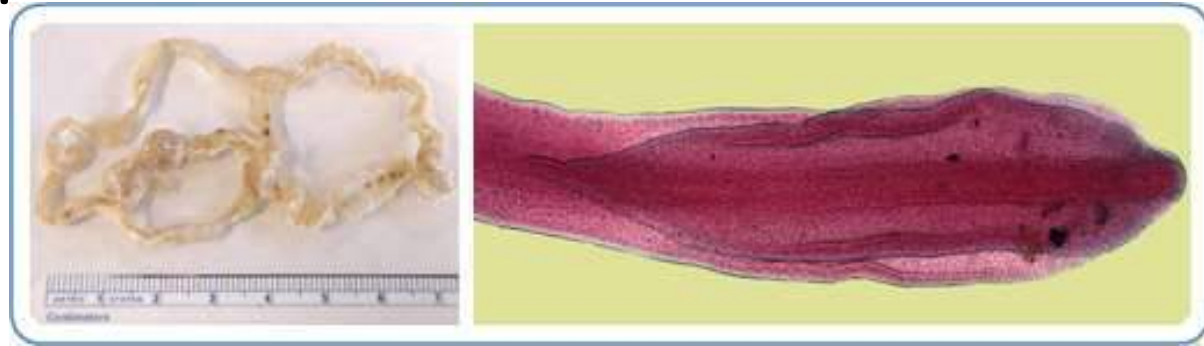
I. The Cestodaria contains:

1. Only a few species of unusual worms,
2. Their bodies are **unsegmented** and roughly oval in shape,
3. They have only one set of reproductive organs and the larvae have **10 hooks** for attachment.

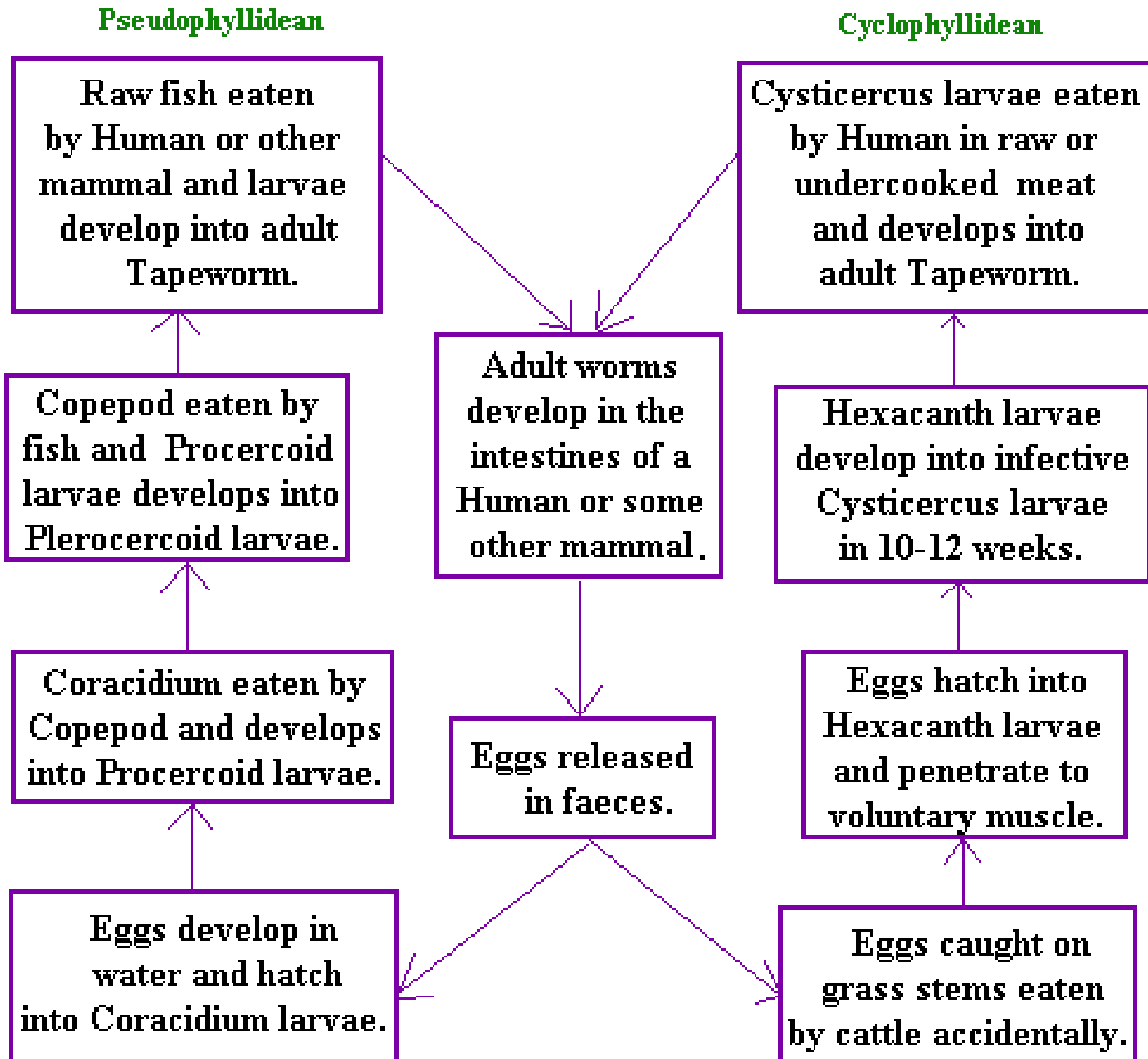


ii. The Eucestoda: contains

- All the animals we usually think of as tapeworms.
- The larvae have **6 attachment hooks**.
- The adult body consists of a head, called a '**Scolex**'.
- There is no eye.
- There is no mouth.
- Reproductive segments called '**Proglottids**'.
- The tapeworms hermaphrodites.
- In some species such as the Fish tapeworm (*Diphyllobothrium latum*) can reach **10 meters** in length, contain **3,000** proglottids and produce millions of eggs every day.



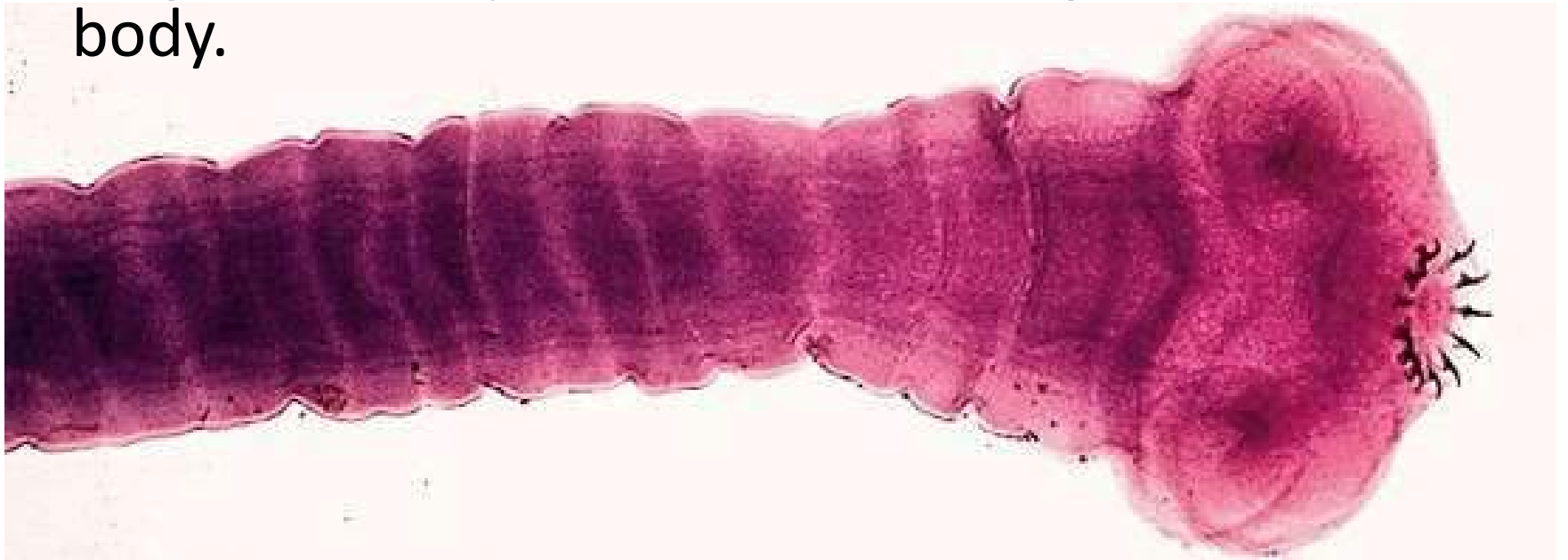
Two Different Cestode Life Cycles



	Pseudophyllidea	Cyclophyllidea
Size	Few meters	Few mms to several meters
Scolex shape	Almond	Globular
Suckers	Pseudo(2 grooves)	True 4 suckers
Rostellum	Absent	Present or absent
Common genital pore	Ventral	Lateral
Vitelline glands	Small follicles on the sides	Mass behind the ovary
Uterus	With pores	Blind sac
Egg shape	Operculated	Non-operculated

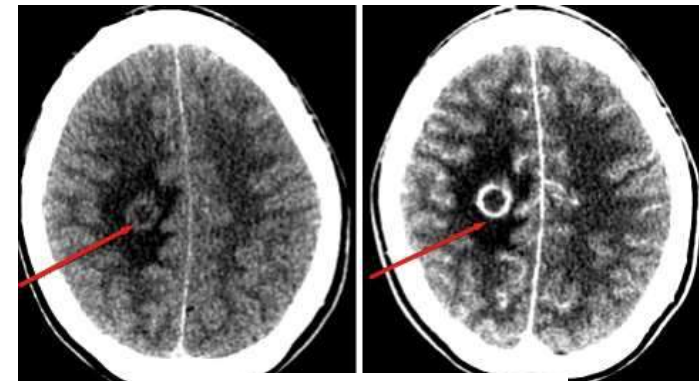
Cestodiasis.

- The disease that results from a human being infested or infected with Cestodes or Tapeworms.
- There are two forms of Cestodiasis
 1. Larval Cestodiasis.
 2. Adult Cestodiasis.
- Depending on whether or not it is the adult or larval stage of the tapeworm that is living in the humans body.



1. Larval Cestodiasis occurs in mankind in three forms:

- 1. Sparganosis:** which is caused by Plerocercoid larvae of Cestodes from the genus *Spirometra*.
 - 2. Cysticercosis** which is caused by Cysticercus larvae of the Pork Tapeworm *Taenia solium*.
 - 3. Echinococcosis or Hydatid Disease** which is caused by Hydatid Cyst larvae of *Echinococcus granulosus*.
- ❖ In all three cases mankind is not the normal host and is only occasionally infected.



Hydatid Cysts



2. Adult Cestodiasis in humans

- Is both far more common and far less pathogenic **(makes people less ill)**.
- Only heavy infestations are able to cause physical damage **(of the gut wall)**, and possible blockage of the intestines.
- The most serious possibility is for people infected with *Taenia solium*



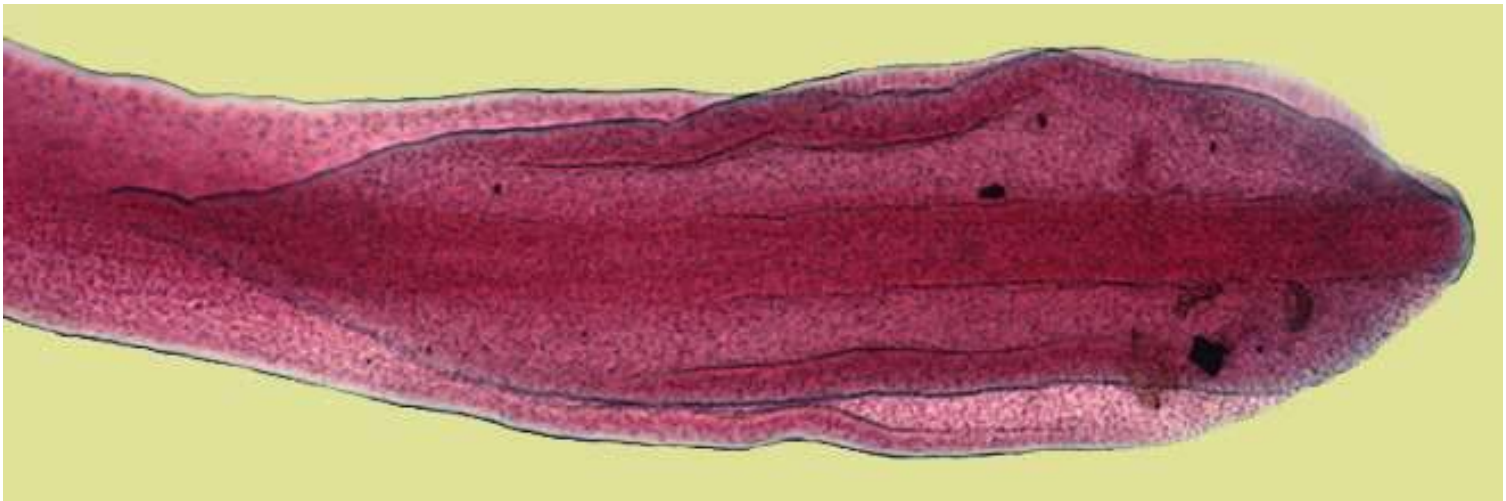
Diphyllobothrium latum

- **Kingdom:** Animalia
- **Phylum:** Platyhelminthes
- **Class:** Cestoda
- **Subclass:** Eucestoda
- **Order:** Pseudophyllidea
- **Family:** Diphylobothriidae
- **Genus:** Diphylobothrium



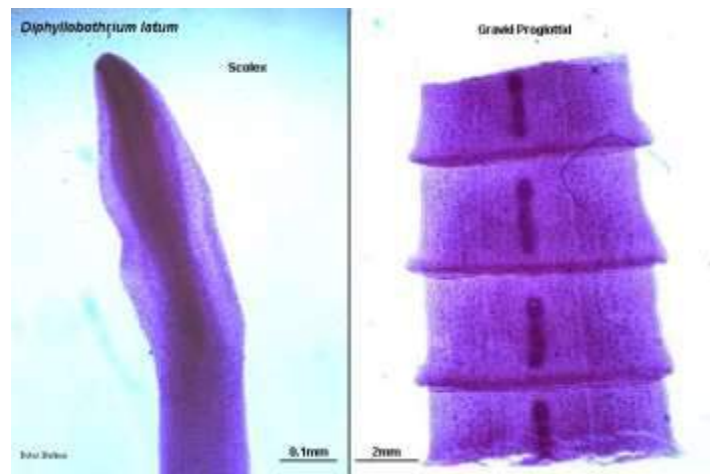
Diphyllobothrium latum

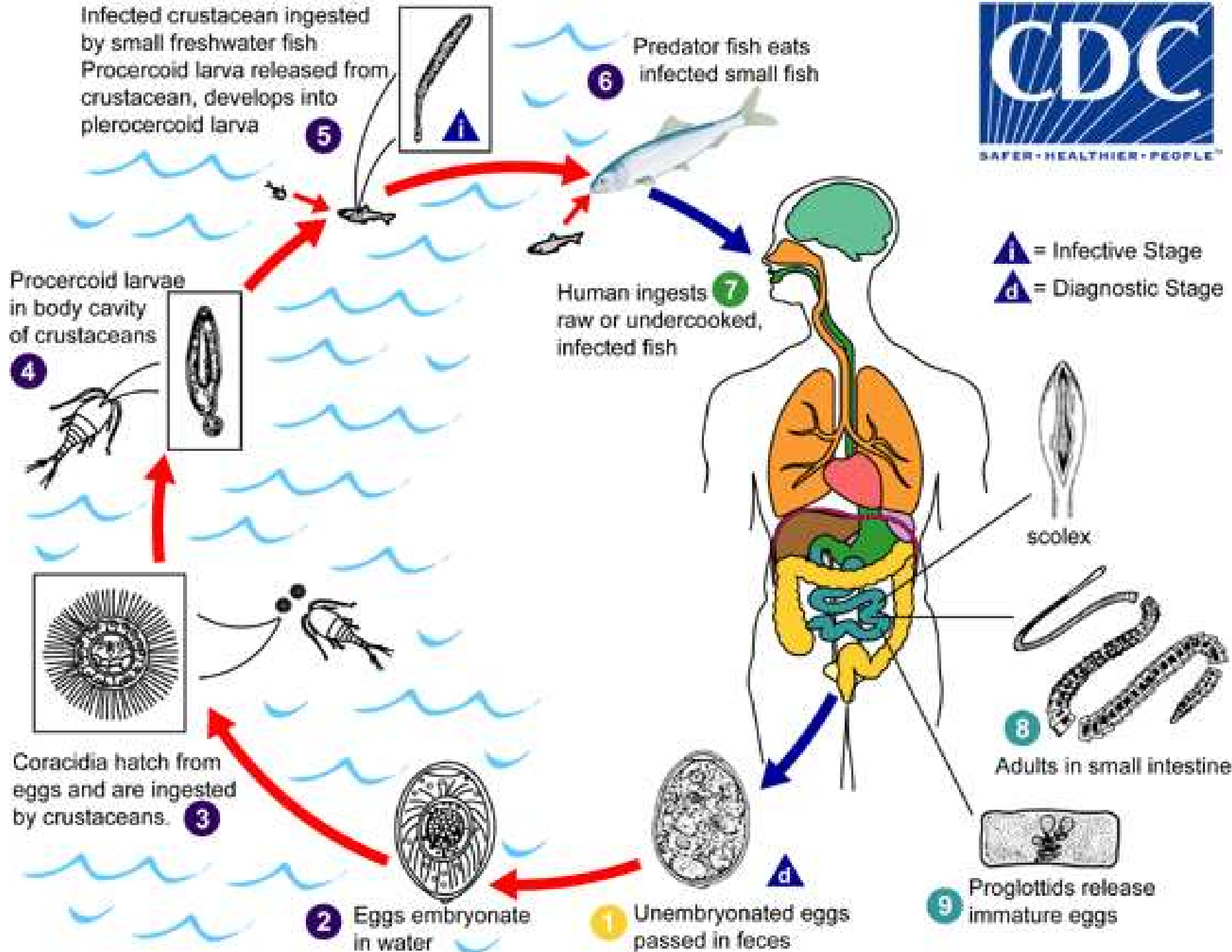
- Known as the broad or fish tapeworm, or broad fish tapeworm: it is a genus of tapeworm which can cause Diphyllobothriasis in humans through consumption of raw or undercooked fish.
- *D. latum* is native to Scandinavia, western Russia, and the Baltics, though it is now also present in North America, especially the Pacific Northwest.



Morphology

- The adult worm is composed of three fairly distinct morphological segments: the scolex (head), the neck, and the lower body.
- Each side of the scolex has a slit-like groove, which is a bothrium (tentacle) for attachment to the intestine.
- The scolex attaches to the neck, or proliferative region.
- From the neck, grows many proglottid segments which contain the reproductive organs of the worm. *D. latum* is the longest tapeworm in humans, averaging ten meters long.
- Adults can shed up to a million eggs a day.
- In adults, proglottids are wider than they are long (hence the name *broad tapeworm*).
- As in all pseudophyllid cestodes, the genital pores open midventrally.





Clinical symptoms including occasional parasite-induced B12 deficiency

- Symptoms of diphyllorhynchiasis are generally mild, and can include:

1. Diarrhea.
2. Abdominal pain.
3. Vomiting.
4. Weight loss.
5. Fatigue.
6. Constipation and discomfort.



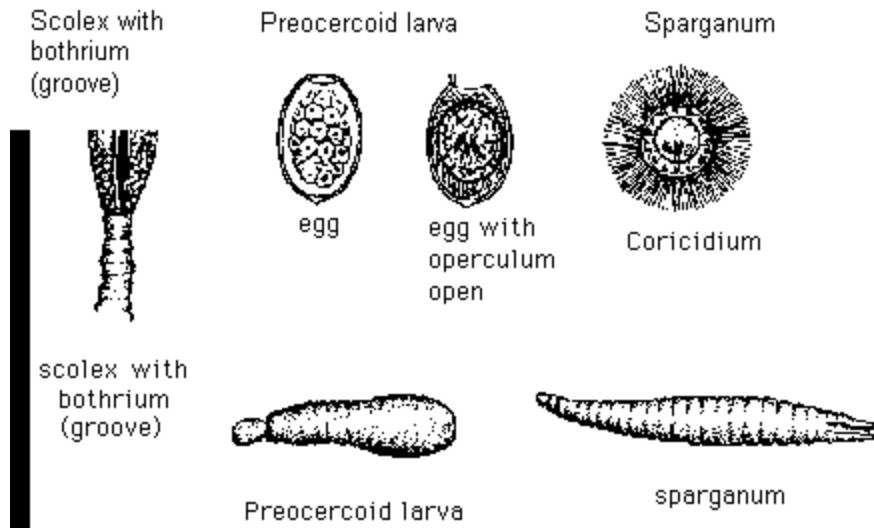
Approximately four out of five cases are asymptomatic and may go many years without being detected.

- **In a small number of cases, this leads to severe vitamin B12 deficiency due to the parasite absorbing 80% or more of the host's B12 intake,**
- **Megaloblastic anemia Infection for many years is ordinarily required to deplete the human body of vitamin B-12 to the point that neurological symptoms appear.**



Diagnosis

- Diagnosis is usually made by **identifying proglottid segments, or characteristic eggs in the feces.**
- **PCR** can be performed on samples of purified eggs, or native fecal samples following sonication of the eggs to release their contents.
- **Sparganosis** : is a parasitic infection caused by the plerocercoid larvae of **diphyllobothroid tapeworms.**



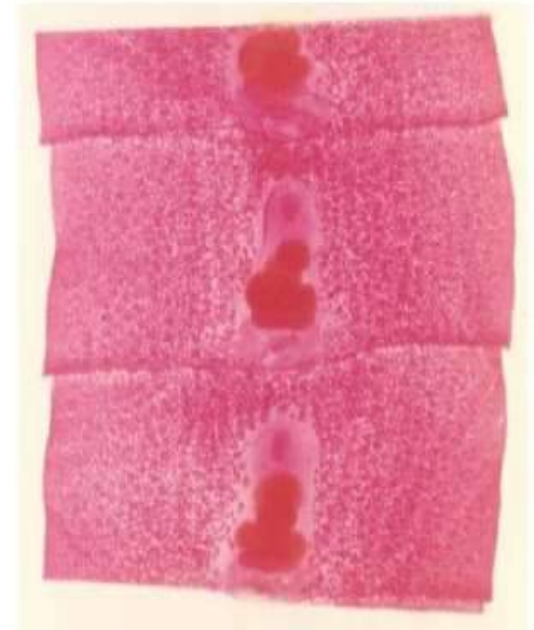
Treatment

- Upon diagnosis, treatment is quite simple and effective. The standard treatment for diphylobothriasis, as well as many other tapeworm infections is a single dose of Praziquantel, 5—10 mg/kg PO once for both adults and children. An alternative treatment is Niclosamide, 2 g PO once for adults or 50 mg/kg PO once.

Diphyllobothrium mansonioides

- **Kingdom:** Animalia
- **Phylum:** Platyhelminthes
- **Class:** Cestoda
- **Subclass:** Eucestoda
- **Order:** Pseudophyllidea
- **Family:** Diphylobothriidae
- **Genus:** Diphylobothrium
- **Species:** *D. mansonioides*

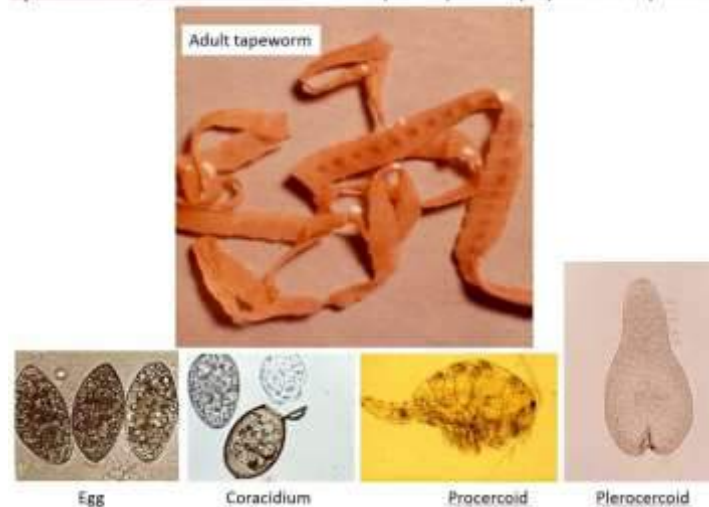
Adult tapeworm is morphologically similar to *D. latum*.



Diphyllobothrium mansonoides

- **(also known as Spirometra mansonoides)** is a species of tapeworm (cestodes) that is endemic to North America. Infection with *D. mansonoides* in humans can result in sparganosis.
- *D. mansonoides* is similar to *D. latum* and *Spirometra erinacei*.
- When the organism was discovered, scientist did not know if *D. mansonoides* and *S. erinacei* were separate species.
- PCR analysis of the two worms has shown the two to be separate but closely related organisms

Spirometra mansonoides -- Example of pseudophyllidean tapeworm

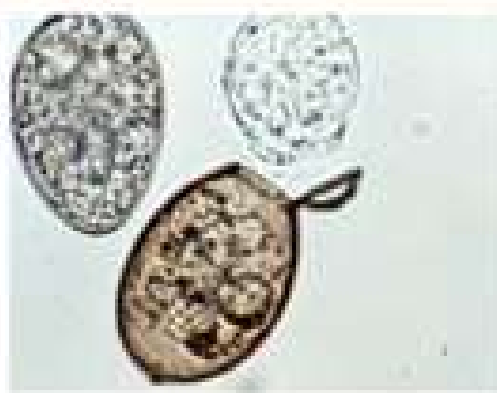


Distribution

- *D. mansoni* is typically found in the southern US.
- *D. mansoni* is found in freshwater.
- **1st intermediate hosts:** The eggs, coracidia and copepods inhabit freshwater
- **2nd intermediate hosts:** The plerocercoids are found in the muscles of hosts (frog, snake, mammals)
- **Definitive host:** The adult stage is found in various organs (CNS, eye, muscles, etc) of the (cat, dog, birds, and other mammals).
- **The incubation period** of *Spirometra* is 20 days to 3 years.



Egg



Coracidium

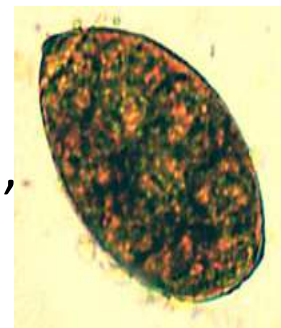
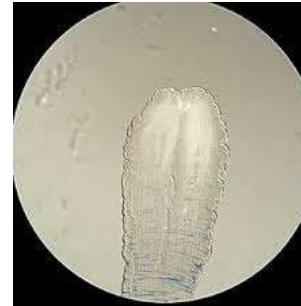


Plerocercoid

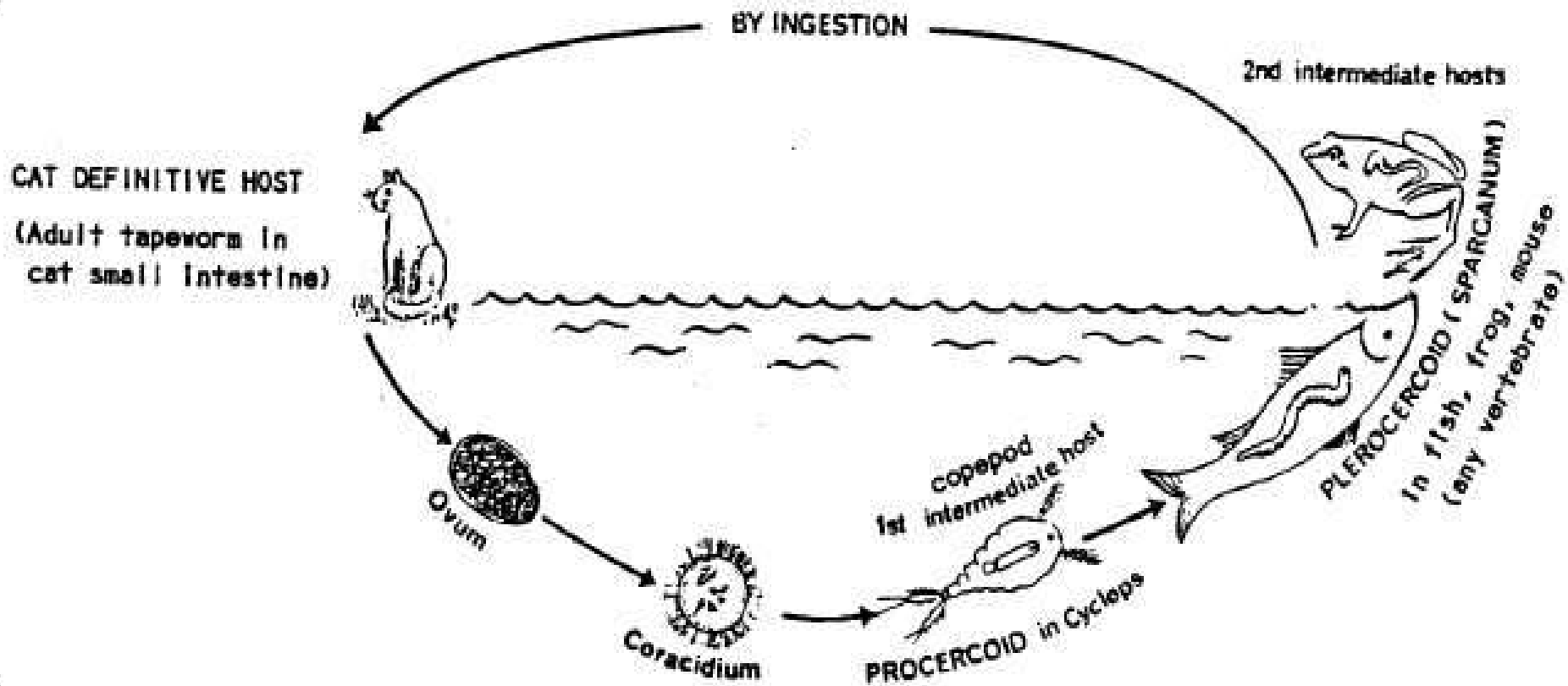


Morphology

1. **The sparganum larvae** are white, wrinkled, and ribbon-shaped, they range from a few millimeters in length to several centimeters.
2. The anterior end can invaginate and bears suggestions of the sucking grooves that are present in the scolex of the mature worm.
3. **The absence of a scolex or protoscolex in Spirometra is a key difference in differentiating between Taenia solium and Spirometra.**
4. The worm's body is also characterized by a stromal network of smooth muscle.
5. The eggs of *S. mansoni* provide an example of the general morphological characteristics of Spirometra eggs.
6. *S. mansoni* eggs resemble the eggs of *D. latum*, with some specific differences.
7. *S. mansoni* eggs measure **57-66 pm by 33-37 pm**, which is smaller than the eggs of *D. latum*.
8. The eggs of *S. mansoni* are also ovoid and have a conical, prominent operculum.

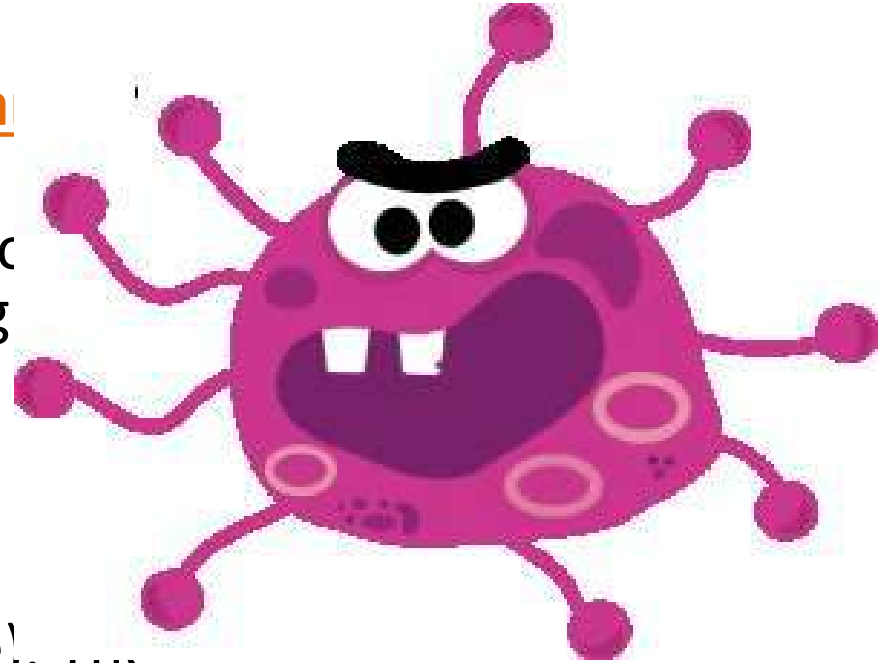


Life Cycle of *Diphyllobothrium mansonoides*



Disease

- Infection with *Diphyllobothrium mansonoides* results in sparganosis.
- Sparganosis is the development of plerocercoids in tissues.
- **There are several routes of human infection:**
 1. When a human mistakenly eats or drinks the proceroid-containing copepod, becoming the 2nd intermediate host.
 2. When a human ingests the plerocercoid-containing 2nd intermediate host (frog or snake), the human then becomes the paratenic host.
 3. When a human uses the 2nd intermediate host as a poultice on the skin, or eyes.



Development of disease

- Once a human becomes infected

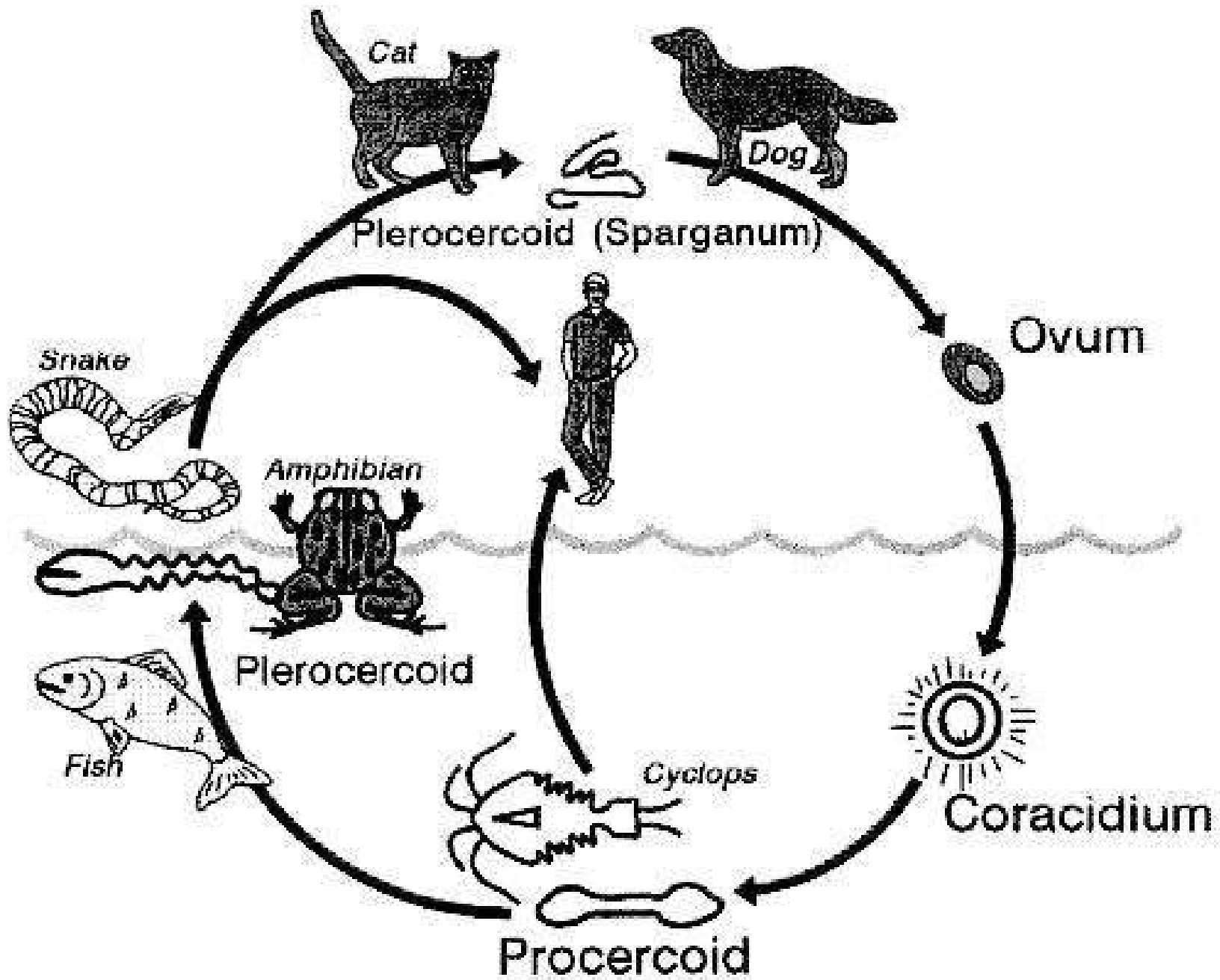


- the plerocercoid larvae migrate to a subcutaneous location, (develop into a painful nodule).



1. Migration to the brain results in cerebral sparganosis,
 2. while migration to the eyes results in ocular sparganosis.
- **Diagnosis:** is typically not made until the sparganum larvae has been surgically removed.

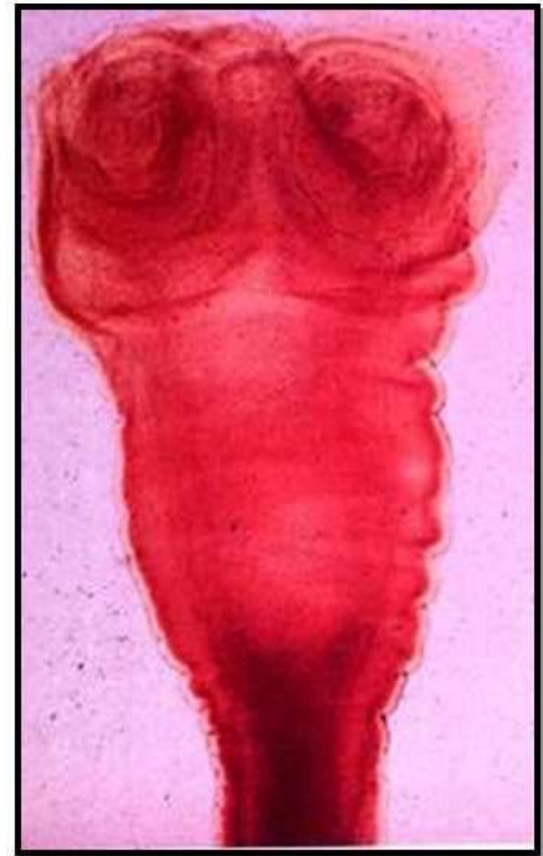
Treatment: Praziquantel is the drug of choice, although its efficacy is unknown and surgical removal of the sparganum is generally the best treatment.



Taenia saginata

- **Phylum:** Platyhelminthes
- **Class:** Cestoda
- **Order:** Cyclophyllidea
- **Family:** Taeniidae
- **Genus:** Taenia
- **Species:** T. saginata

Taenia saginata



Taenia saginata

- Also known as *Taeniarhynchus saginata* or the **beef tapeworm**, is a parasite of both **cattle and humans**, causing taeniasis in humans.
- *Taenia saginata* occurs where:
 1. Cattle are raised by infected humans maintaining poor hygiene, human feces are improperly disposed of.
 2. Meat inspection programs are poor.
 3. Where meat is eaten without proper cooking.
- The disease is relatively common in **Africa**, some parts of **Eastern Europe**, **Southeast Asia**, and **Latin America**.

Taenia saginata

Taenia saginata

4 suckers

Smooth - no rostellum



Description

1. *T. saginata* length very large, over 20 m long in some situations.
2. The body is whitish in color, divided into the anterior scolex, followed by a short neck and a highly extended body proper called **strobila**.
3. The strobila is composed a series of ribbon-like segments called proglottids.
4. **Unlike other tapeworms the scolex does not have a rostellum or scolex armature.**
5. The scolex is composed of 4 powerful suckers.
6. The segments are made up of mature and gravid proglottids.
7. *T. saginata* is the largest of genus Taenia consisting between 1000 to 2000 proglottids and can also have a lifespan of 25 years in a hosts intestine.
8. The mature proglottid contains: **the uterus (unbranched), ovary, genital pore, testes, and vitelline gland.**

Taenia saginata

Taenia saginata

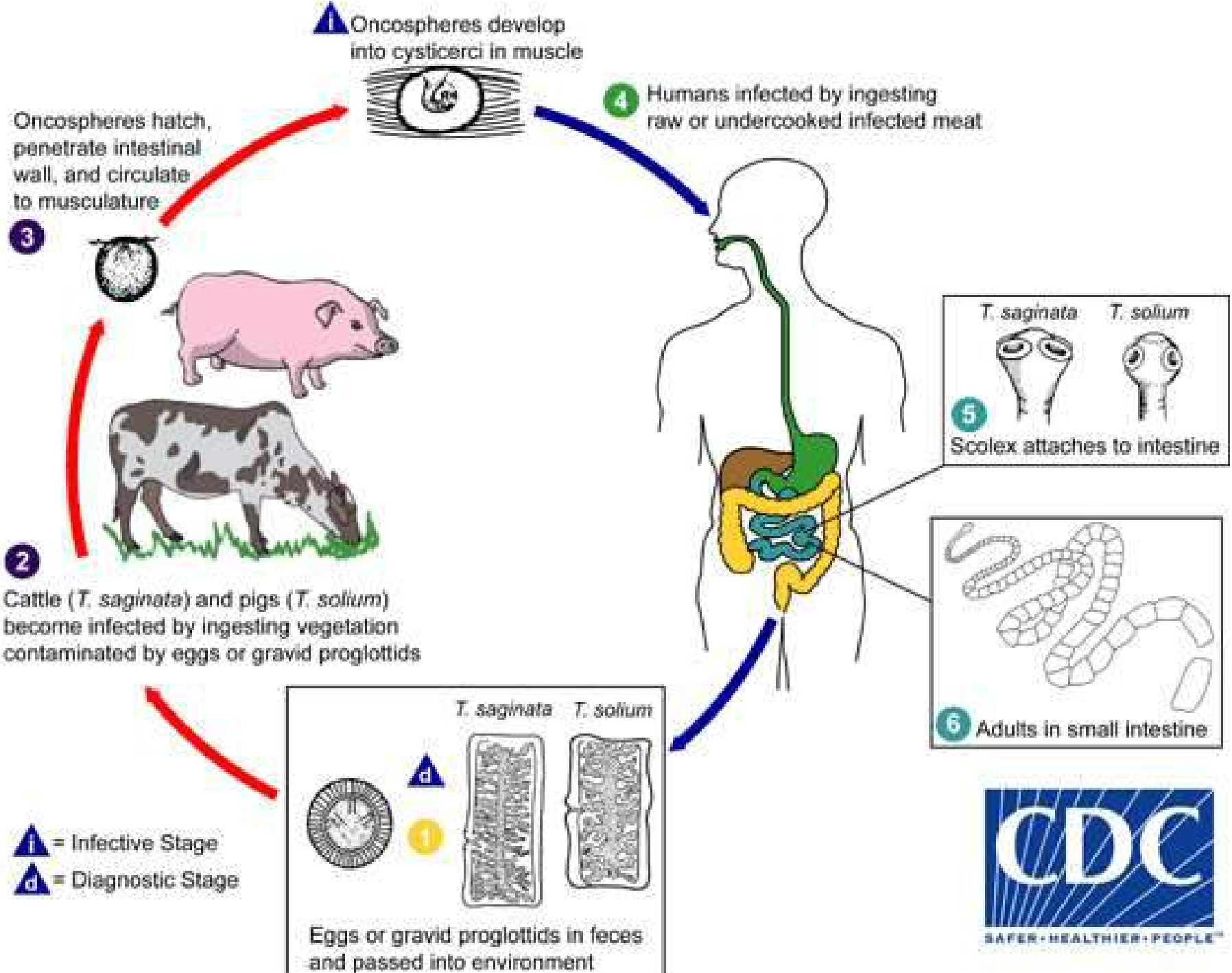
4 suckers

Smooth - no rostellum



9. It does not have a digestive system, no mouth, no anus, or digestive tract.
10. It is also an acoelomate, meaning that it does not have a body cavity.
11. In the gravid proglottid, the uterus is branched and is filled with eggs.
12. The gravid segments detach and are passed in the feces.
13. Each of these segments can act like a worm.
14. When they dry up, the proglottid ruptures, and the eggs are released.
15. The egg can only infect cattle, the intermediate host.
16. Inside the cow's duodenum the **oncosphere hatches** with the help of the gastric and intestinal secretions and migrates through the blood to the muscle.
17. There it develops into infective cysticerci.





Symptoms

- Tapeworms are usually asymptomatic.
- Heavy infection often result in:
 1. Intestinal upset.
 2. Weight loss.
 3. Dizziness.
 4. Abdominal pain.
 5. Diarrhea.
 6. Headaches.
 7. Nausea.
 8. Constipation, or chronic indigestion.
 9. Loss of appetite.
 10. There can be intestinal obstruction in humans and this can be alleviated by surgery.
 11. The tapeworm can also expel antigens that can cause an allergic reaction in the individual.

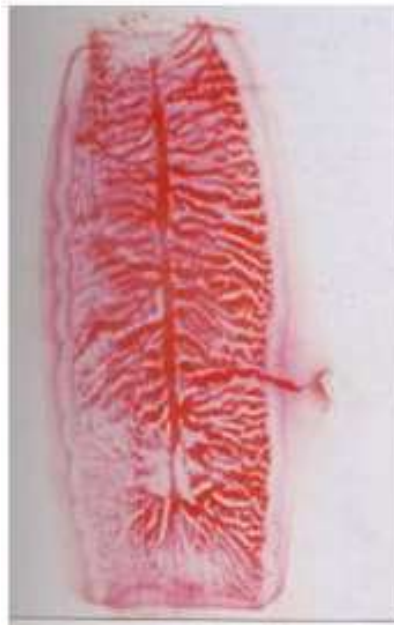


Diagnosis

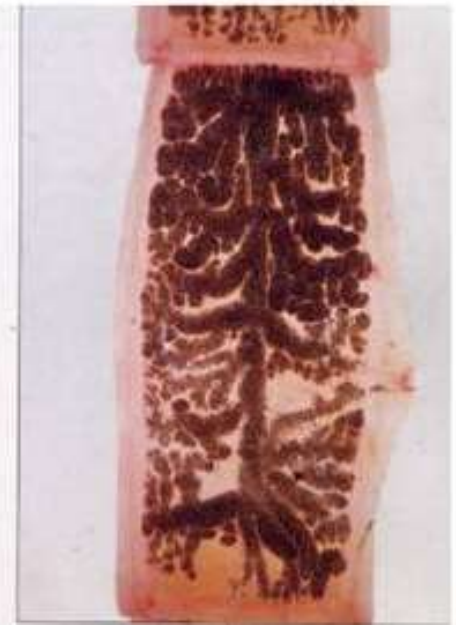
- The basic diagnosis is done from a stool sample. Feces are examined to find parasite eggs. The eggs look like other eggs from the family Taeniidae,
- Proglottids sometimes trickle down the thighs of infected humans and are visible with unaided eye and aid with identification.
- Counting the uterine branches enables some identification (*Taenia saginata* uteri have more branches (15 to 20) on each side, while other species like *Taenia solium* only have (7-10)).



T.saginata



T.solium



Treatment

- Treatment for cestode infection can be done with the drug praziquantel. Praziquantel opens membrane calcium channels causing paralysis of the worm, aiding the body in expelling the parasite through peristalsis. Niclosamide, used to treat many different kinds of infections with trematodes and adult tapeworms, is quite effective

Taenia solium

- **Kingdom:** Animalia
- **Phylum:** Platyhelminthes
- **Class:** Cestoda
- **Order:** Cyclophyllidea
- **Family:** Taeniidae
- **Genus:** Taenia
- **Species:** T. solium
- **Binominal name:** Taenia solium



Taenia solium

- Also called the pork tapeworm: is a cyclophyllid cestode in the family Taeniidae, it has four suckers on its scolex, also has two rows of hooks, it infects pigs and humans
- Found in Asia, Africa, South America, parts of Southern Europe, and pockets of North America. Like all cyclophyllid cestodes.



Description

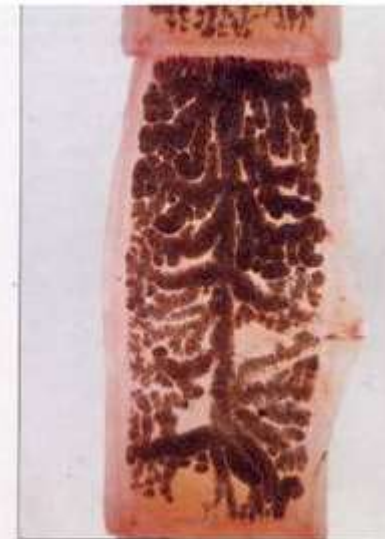
- *T. solium* has a very similar life cycle to *Taenia saginata*.
- Eggs can be diagnosed only to the family (biology) level, but if a proglottid's uterus is stained with India ink, the number of visible uterine branches can help identify the species: unlike the *Taenia saginata* uteri, *T. solium* uteri have only seven to ten uterine branches on each side.



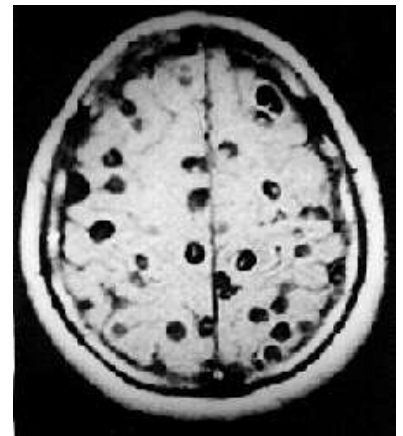
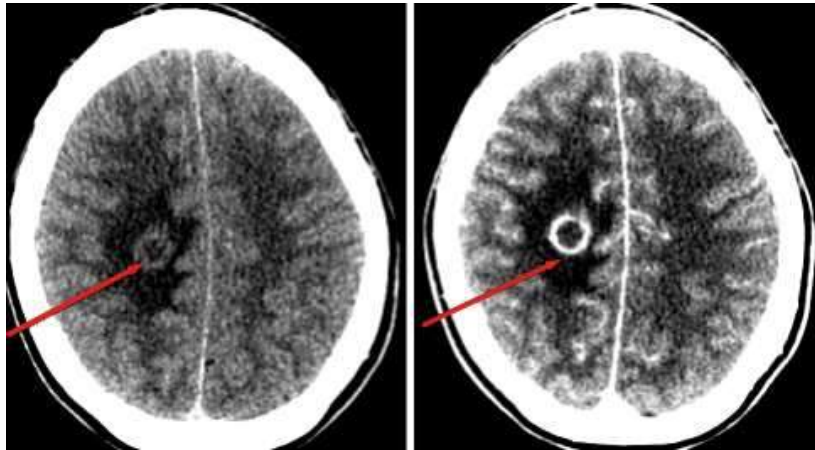
T.saginata



T.solium

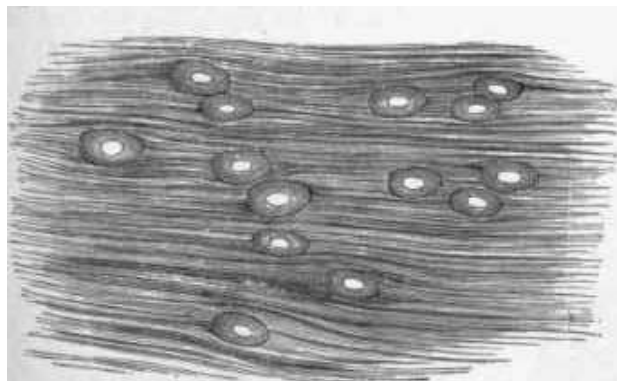
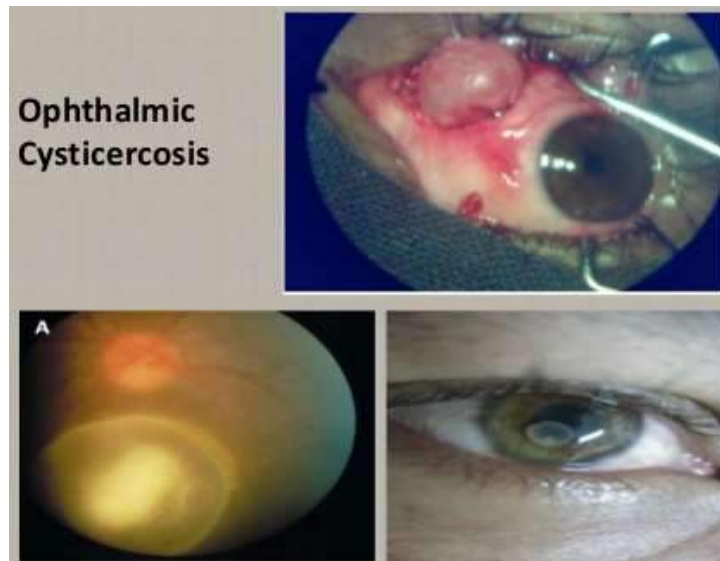
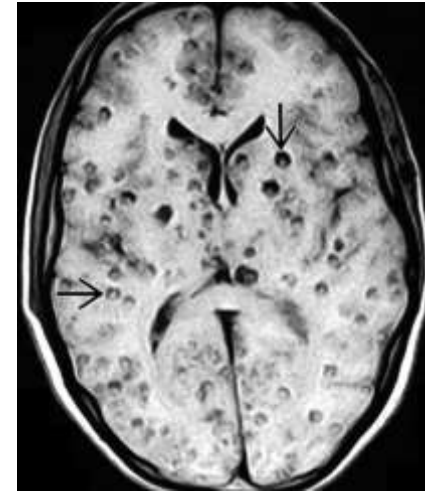


- **Cysticercosis**, is an infection which results from the ingestion of the eggs of the pork tapeworm. Taenia solium The human is the final or definitive host in which the tape worm develops to maturity producing eggs which are passed out in the faeces.
- **Neurocysticercosis**, is when the brain or spinal cord (central nervous system CNS) is affected by the larval stage of T. solium , neurocysticercosis is the most common (tapeworm) infestation to affect the CNS worldwide and is the prime cause of **acquired epilepsy**.
- **Cysticerci** often occur in the CNS, which can cause major neurological problems like hydrocephalus, paraplegia, meningitis, convulsions and even death. The condition of having ceysticerci in one's body is called **cysticercosis**.



Clinical presentations in humans

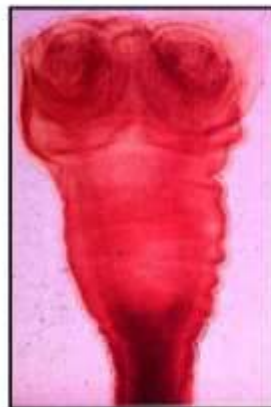
1. Cysticercosis in muscles
2. Neurocysticercosis
3. Ophthalmic Cysticercosis
4. Subcutaneous Cysticercosis

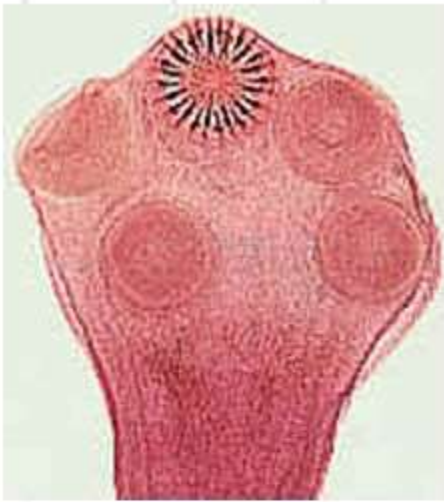


Differences between *T.solium* and *T.saginata*

Adult	<i>T. solium</i>	<i>T. saginata</i>
Length	2-7 meters	25 meters
Number of segment	800-900	1000-2000
	thin and transparent	thick but opaque
Scolex	1mm in diameter with 4 suckers and hooklets	2mm in diameter, with 4 suckers but no hooklets
Mature proglottid	3 lobes of ovary	2 lobes of ovary
Gravid proglottid	7-13 uterine lateral branches each side	15-20 uterine lateral branches each side

Taenia saginata & *Taenia solium* scolex

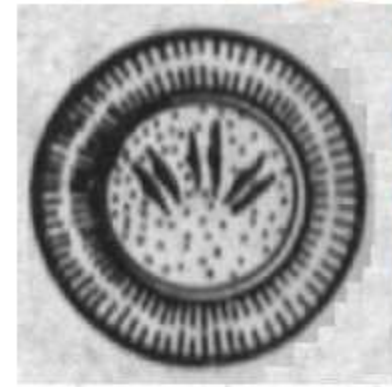




Scolex of *T. solium*



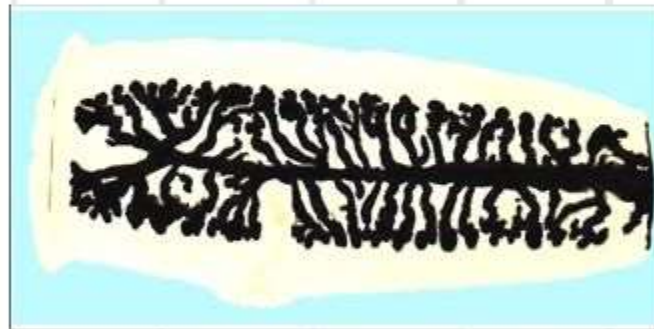
**Gravid segment
of *T. solium***



egg of tapeworm



Scolex of *T. saginata*



**Gravid segment
of *T. saginata***



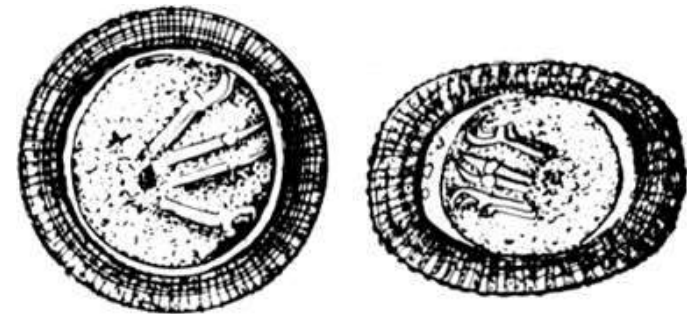
**Protoscolex of *Echinococcus
granulosus***

Treatment

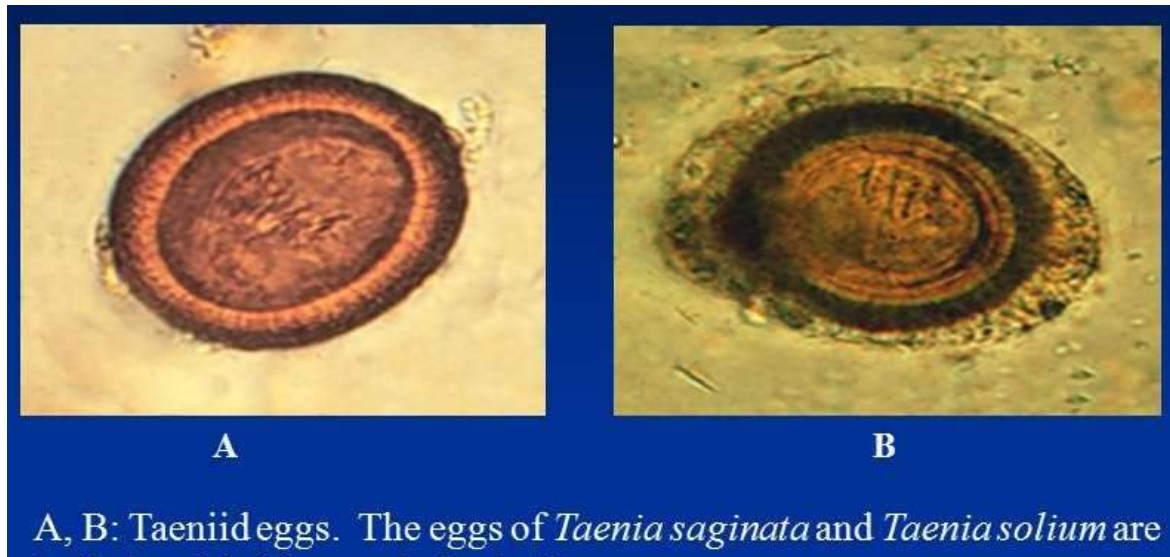
- PZQ (praziquantel) is the drug of choice for the treatment of *T. solium* infection. For cysticercosis, one can be treated with albendazole combining with steroid to reduce the inflammation. Surgical intervention may be necessary to treat CNS lesions. Albendazole appears to be more effective and a safe drug for Neurocysticercosis, infection of the brain with *T. solium* larvae.

Diagnosis

- The traditional method of demonstrating *T. solium* eggs in stool samples diagnoses only taeniasis. Though the presence of *T. solium* eggs or proglottids in the feces
- Neuroimaging with CT or MRI is the most useful method to diagnose neurocysticercosis.



Taenia saginata *Taenia solium*



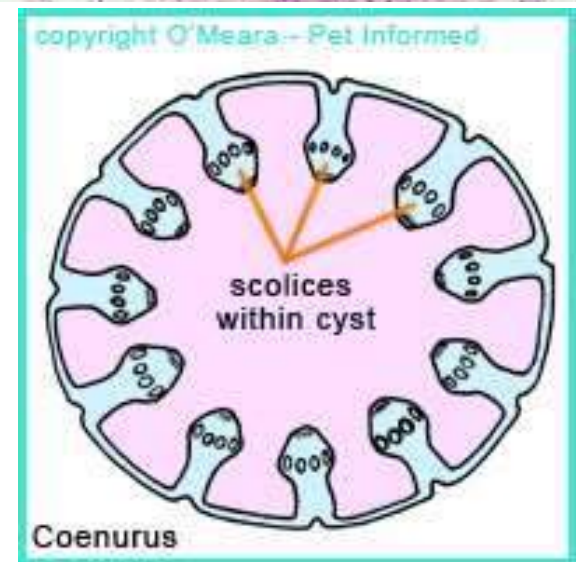
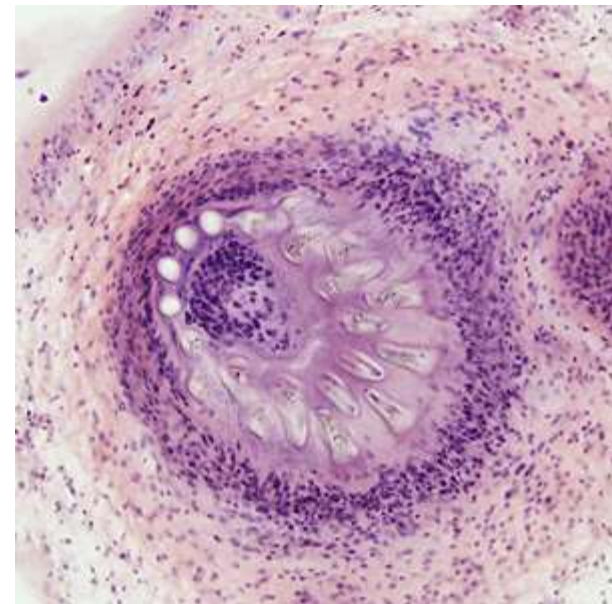
A, B: Taeniid eggs. The eggs of *Taenia saginata* and *Taenia solium* are

Treatment

- The treatment is based only on intra-cranial surgery with known limitations.

Coenurosis

- is a parasitic infection that develops in the intermediate hosts of some tapeworm species (*Taenia multiceps*) and are caused by the coenurus, the larval stage of these worms.
- This disease occurs mainly in sheep and other ungulates, but **occasionally can occur in humans too by accidental worm eggs ingestion.**
- Adult worms of these species develop in the small intestine of the definitive hosts canids, causing a disease from the group of taeniasis
- Humans cannot be definitive hosts for these species of tapeworms.

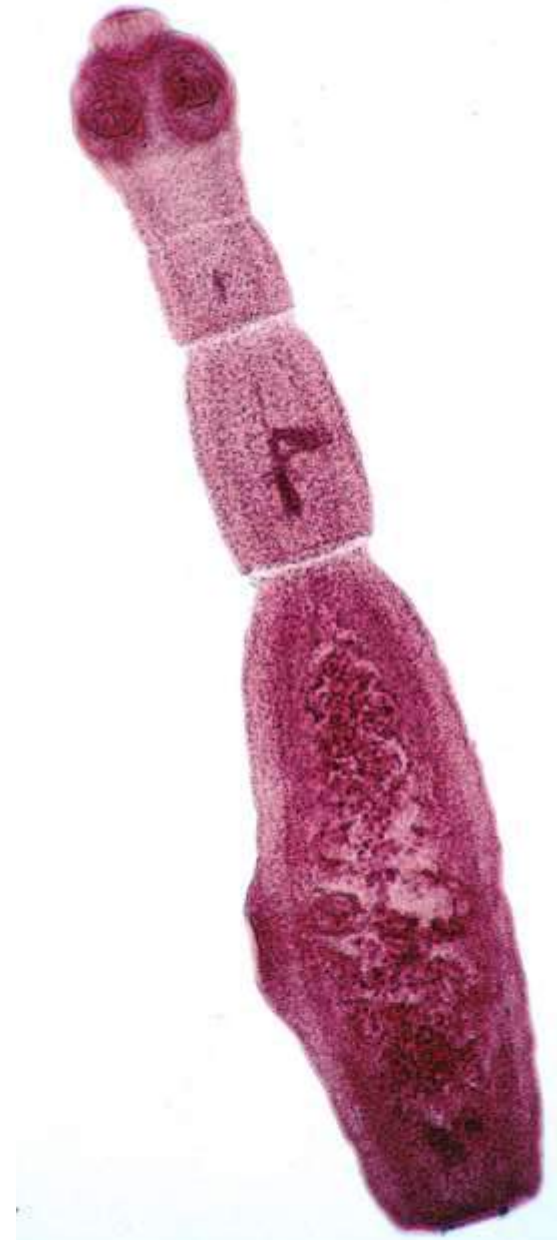


Lec 7: *Echinococcus*



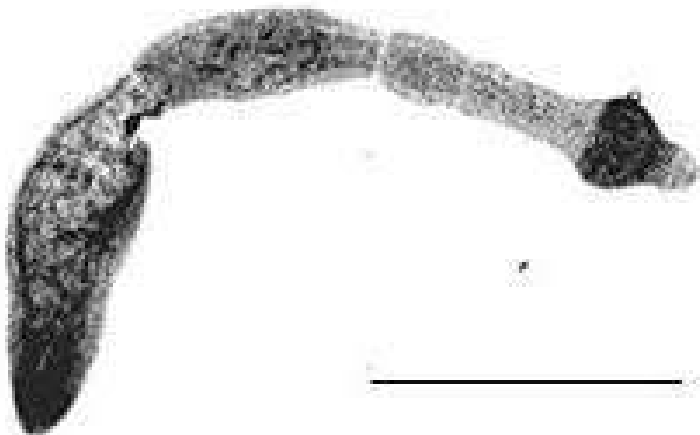
Lec.Dr.Ruwaidah F. Khaleel

- **Kingdom:** Animalia
- **Phylum:** Platyhelminthes
- **Class:** Cestoda
- **Order:** Cyclophyllidea
- **Family:** Taeniidae
- **Genus:** *Echinococcus*
- **Species**
- *Echinococcus granulosus*
- *Echinococcus multilocularis*
- *Echinococcus oligarthrus*
- *Echinococcus vogeli*



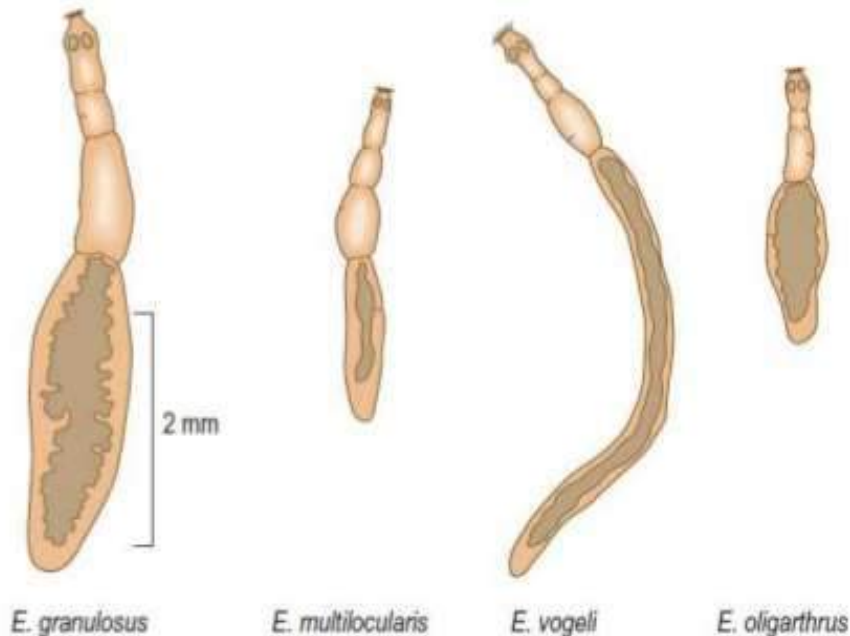
Disease causal agent:

- Human echinococcosis (hydatidosis, or hydatid disease) is caused by the larval stages of cestodes (tapeworms) of the genus *Echinococcus*.
- Echinococcus granulosus*** causes cystic echinococcosis, The form most frequently encountered.
 - E. multilocularis*** causes alveolar echinococcosis.
 - E. vogeli*** causes polycystic echinococcosis.
 - E. oligarthrus*** is an extremely rare cause of human echinococcosis.



Geographic Distribution:

- 1. *E. granulosus*** occurs practically worldwide, and more frequently in rural, grazing areas where dogs ingest organs from infected animals.
- 2. *E. multilocularis*** occurs in the northern hemisphere, including central Europe and the northern parts of Europe, Asia, and North America.
- 3. *E. vogeli* and *E. oligarthrus*** occur in Central and South America.



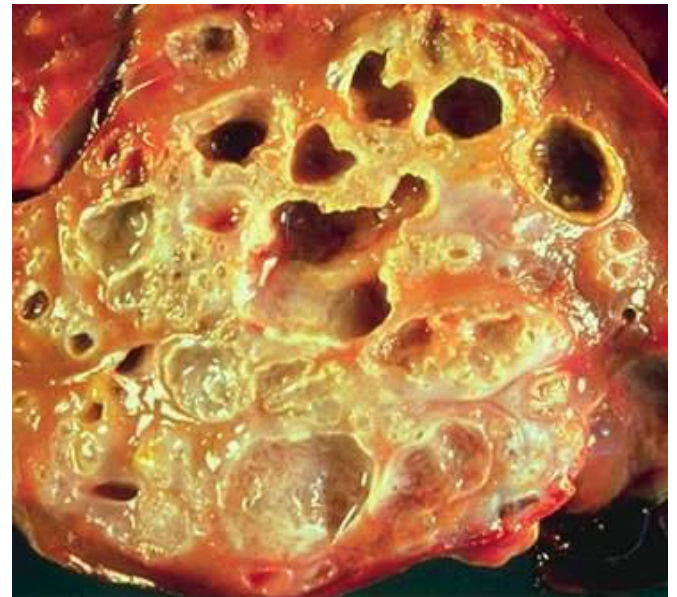
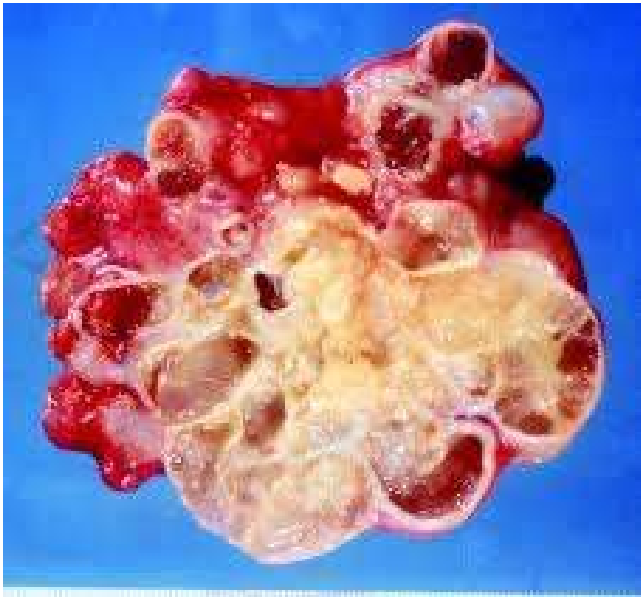
Echinococcosis:

- Echinococcosis, which is often times referred to as hydatid disease or echinococcal disease: is a parasitic disease that affects both humans and other mammals, such as sheep, dogs, rodents and horses.
- There are three different forms of echinococcosis found in humans, that is caused by the larval stages of genus *Echinococcus*.
 1. Cystic echinococcosis is the most common form found in humans is (also known as unilocular echinococcosis), which is caused by *Echinococcus granulosus*.
 2. Alveolar echinococcosis (also known as alveolar hydatid disease, alveolococcosis, multilocular echinococcosis, "small fox tapeworm), which is caused by *Echinococcus multilocularis* .
 3. Polycystic echinococcosis (also known as human polycystic hydatid disease, neotropical echinococcosis), which is caused by *Echinococcus vogeli* and very rarely, *Echinococcus oligarthus*.



Note:

- ❖ Alveolar and polycystic echinococcosis are rarely diagnosed in humans and are not as widespread as **cystic echinococcosis**.
- ❖ Polycystic echinococcosis is relatively new on the medical science and is often left out of conversations dealing with echinococcosis, and are considered to be the rarest form of echinococcosis.
- ❖ Alveolar echinococcosis is a serious disease that not only has a significantly high fatality rate but also has the potential to become an emerging disease in many countries.



Morphology of parasitic agents:

- **Egg**

- ✓ *Echinococcus* eggs contain an embryo that is called an oncosphere or hexacanth.
- ✓ The name of this embryo stems from the fact that these embryos have **six hooklets**.
- ✓ The eggs are passed through the feces of the definitive host and it is the ingestion of these eggs that lead to infection in the intermediate host.



Larval/hydatid cyst stage:

- The embryo released from an egg



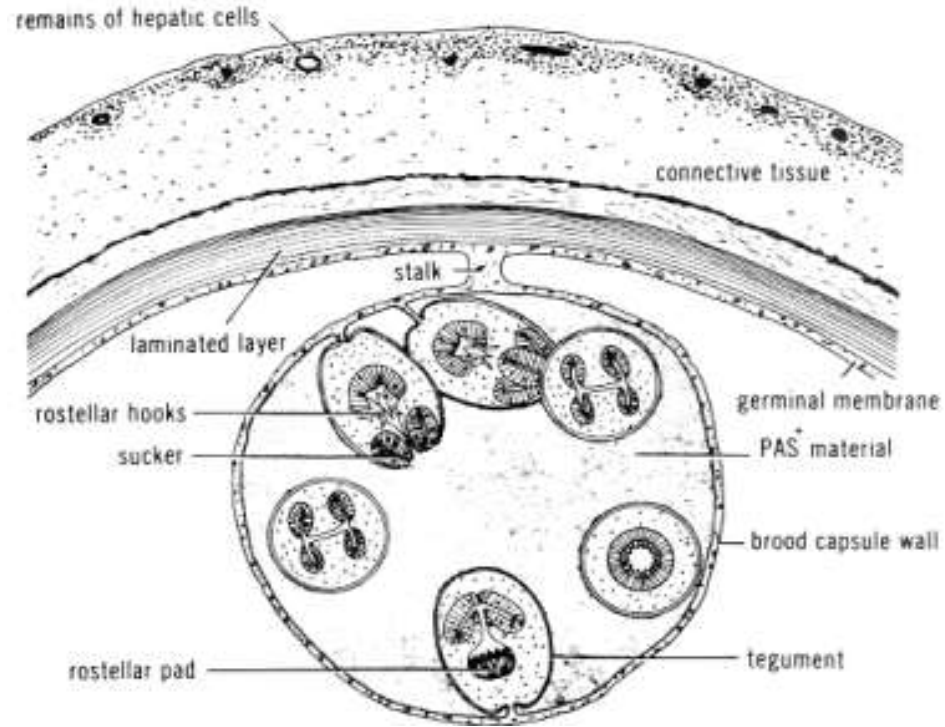
- Develops a **hydatid cyst**,



- Which grows to about **5-10 cm** within the first year and is able to survive within organs for years.



- Cysts grow to be so large that by the end of several years or even decades, they can contain several liters of fluid.



- Once a cyst has reached a diameter of 1 cm,



- differentiates into a thick outer, non-cellular membrane, which covers the thin germinal epithelium.



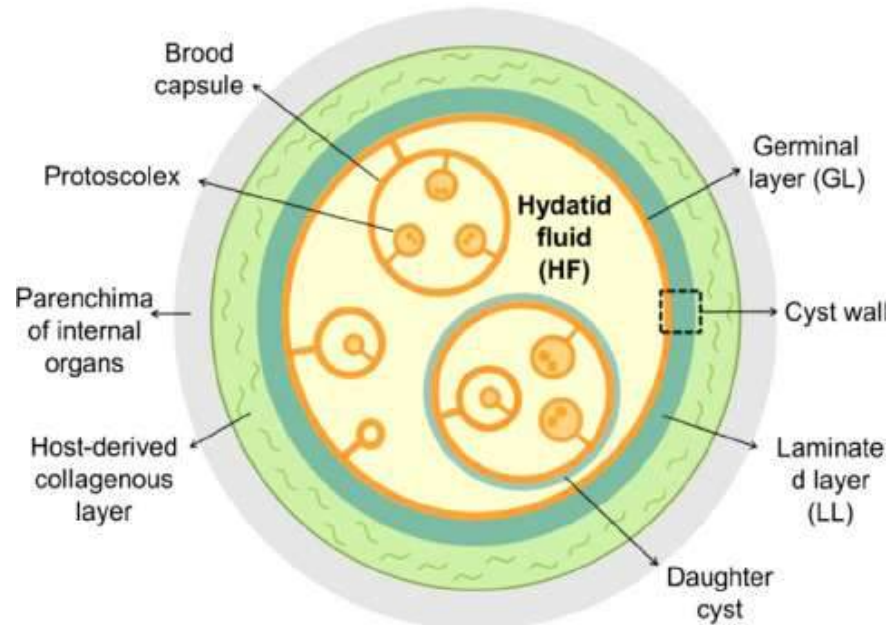
- From epithelium cells begin to grow within the cyst



- These cells then become vacuolated and are known as **brood capsules**, which are the parts of the parasite from which protoscolices bud.



- Often times, daughter cysts will also form within cysts.



Adult worms

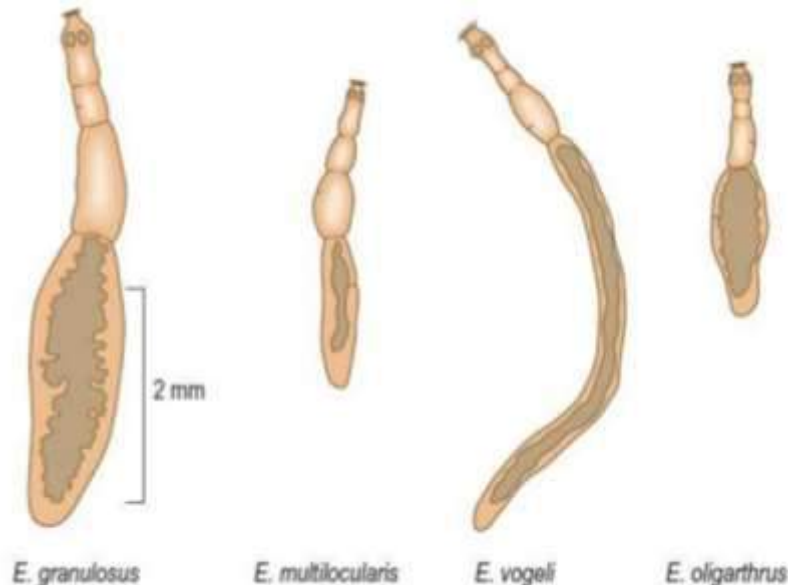
- ***Echinococcus* adult worms develop from protoscolices and are typically 6mm or less in length and have:**
 - i. Scolex: adult worm contains four suckers and a rostellum that has about 25-50 hooks.
 - ii. Neck .
 - iii. **Typically three proglottids:**
 1. One of which is immature
 2. Another of which is mature
 3. Third of which is gravid (or containing eggs).



Morphological differences among different species

i. Difference in length of the tapeworm:

1. *E. granulosus* is approximately (2 - 7) mm.
2. *E. multilocularis* is often smaller and is 4 mm or less.
3. *E. vogeli* is found to be up to 5.6 mm long.
4. *E. oligarthus* is found to be up to 2.9 mm long.



ii. Differences in the hydatid cysts of the different species.

1. *E. multilocularis*: the cysts have an **ultra thin limiting membrane** and the germinal epithelium may bud externally.
2. *E. granulosus*: cysts are **unilocular** and full of fluid
3. *E. multilocularis*: cysts contain little fluid and are **multilocular**.
4. *E. vogeli*: its hydatid cysts are large and are actually **polycystic** since the germinal membrane of the hydatid cyst actually proliferates both inward, to create septa that divide the hydatid into sections, and outward, to create new cysts and are filled with fluid.



Transmission

- All disease-causing species of *Echinococcus* are transmitted to intermediate hosts via the ingestion of eggs and are transmitted to definitive hosts by means of **eating infected cyst-containing organs.**
- Humans are accidental intermediate hosts that become infected by
 1. Handling soil.
 2. Dirt or animal hair that contains eggs.



Mechanical vectors of *Echinococcus* eggs

- Mechanical vectors for the eggs *Echinococcus* species,

1. Coprophagie flies.

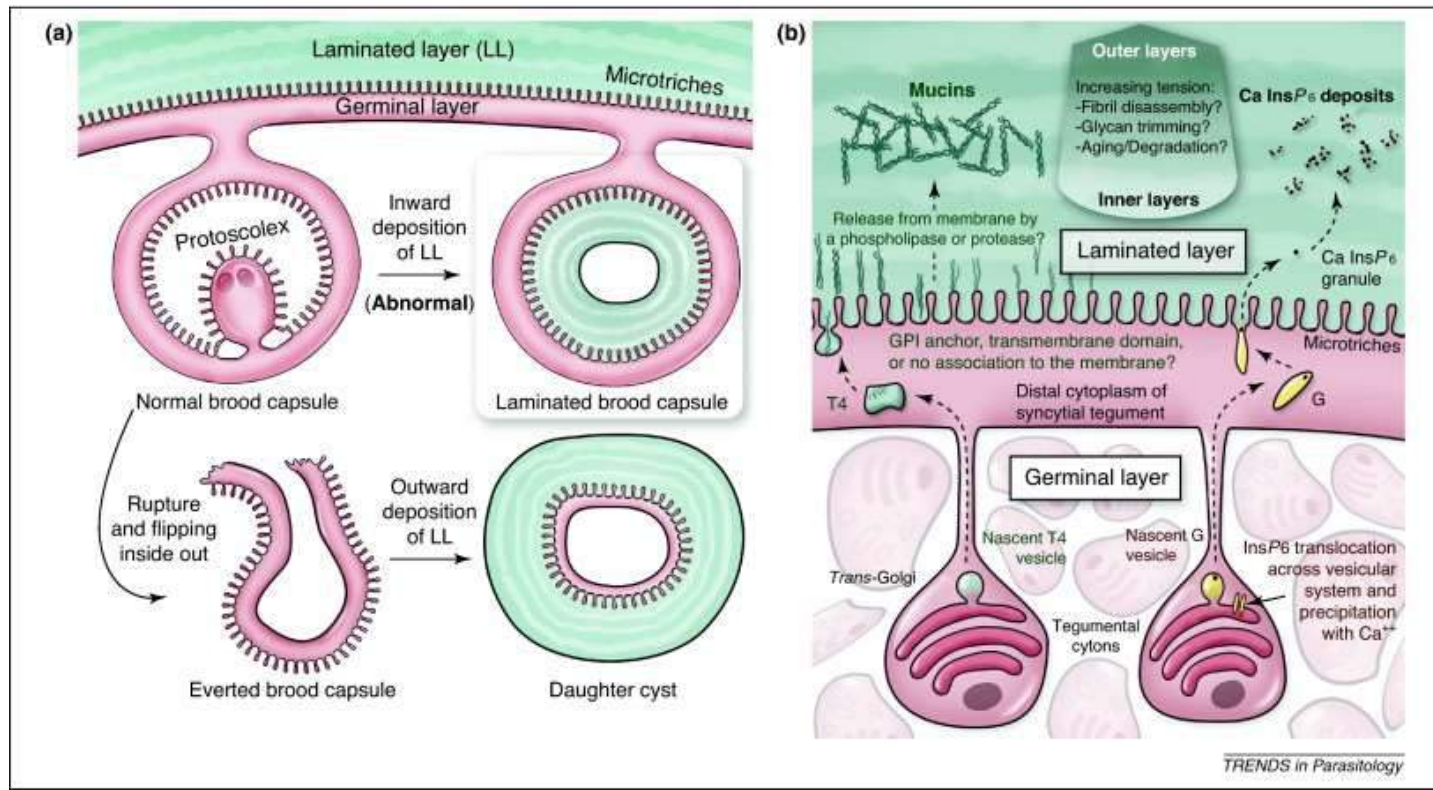
2. Carrion birds.

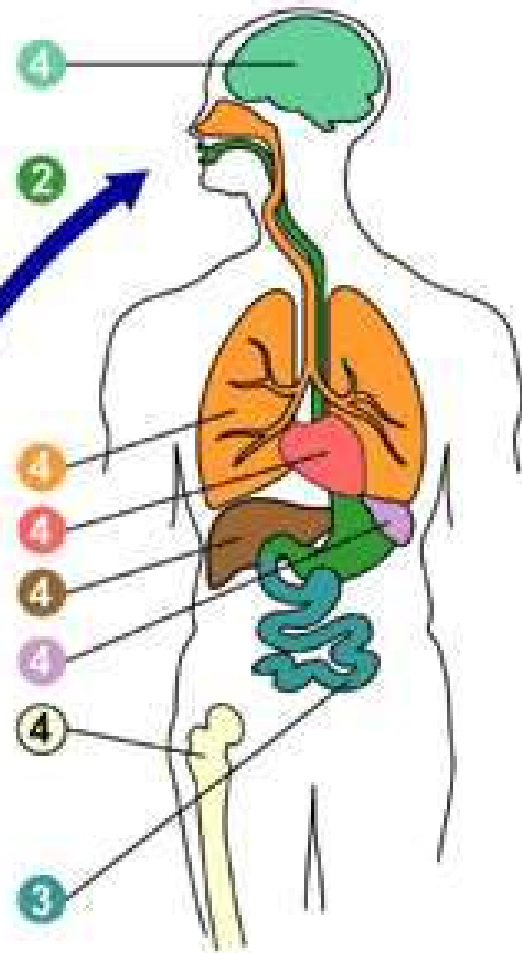
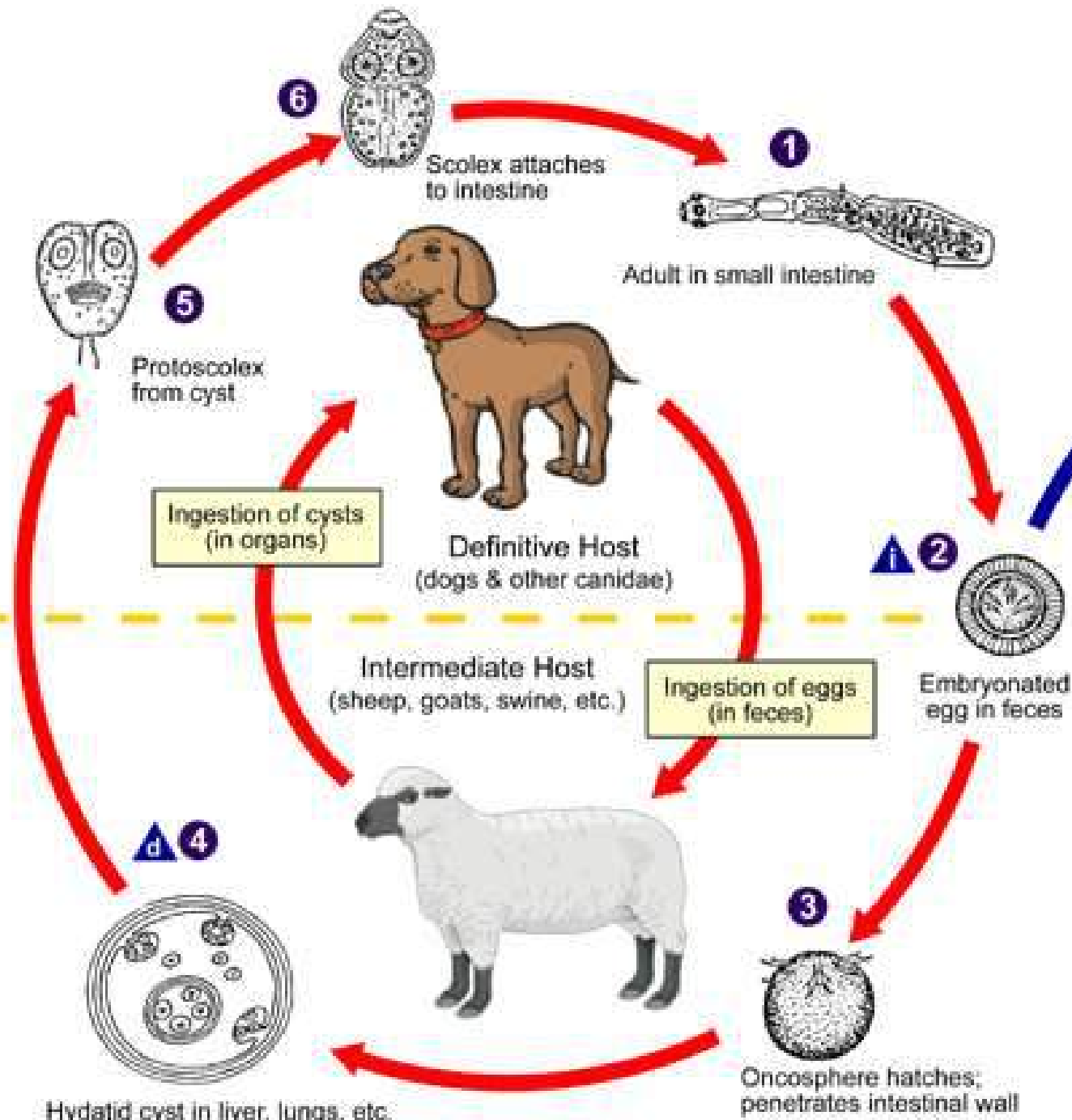
3. Arthropods.



Incubation period

- The incubation period for all species of *Echinococcus* can be months to years or even decades.
- It largely depends on:
 1. The location of the cyst in the body
 2. How fast the cyst is growing.



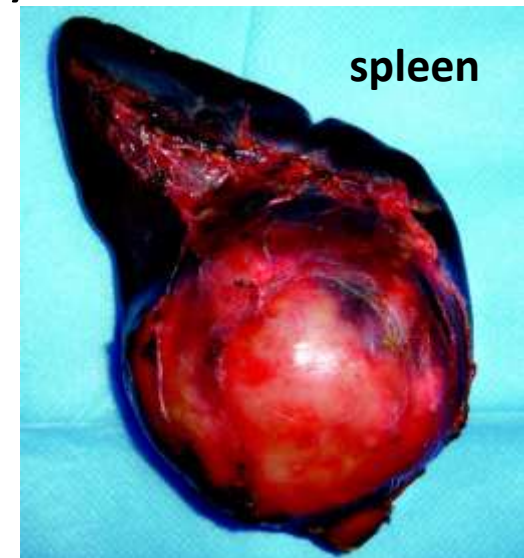
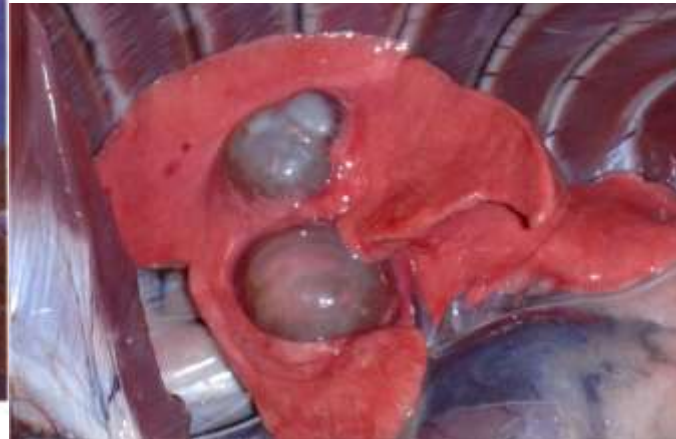
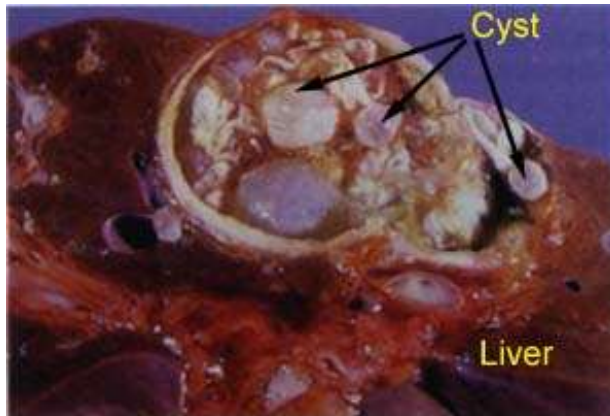
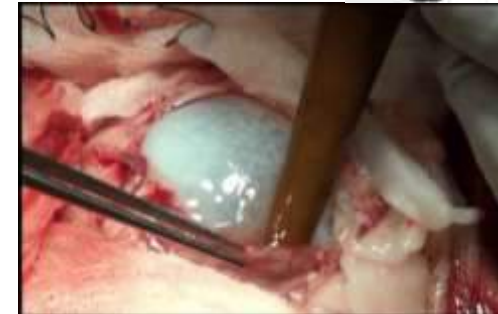


i = Infective Stage
d = Diagnostic Stage

Clinical presentation of disease

- In the human manifestation of the disease, *E. granulosus*, *E. multilocularis*, *E. oligarthns* and *E. vogeli* are localized in:

- The liver** (in 75% of cases),
- The lungs** (in 5-15% of cases)
- Other organs** in the body such as the spleen, brain, heart and kidneys (in 10-20% of cases).



Gross appearance of hydatid cysts

Development of disease

- In the patients who are infected with *E. granulosus*



- Have cystic echinococcosis.



- The disease develops as a slow-growing mass in the body.



- These slow-growing masses, often called cysts, are also found in patients that are infected with **alveolar and polycystic echinococcosis**



- Usually filled with a clear fluid called hydatid fluid.



- Are spherical and typically consist of one compartment and are usually only found in one area of the body.



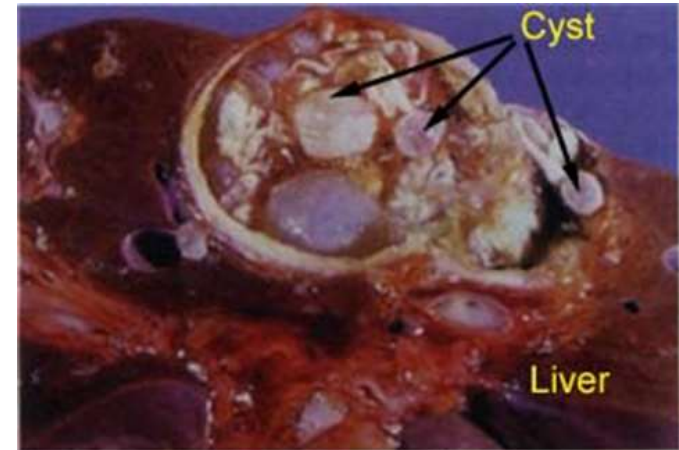
Symptoms that depending on the location of the cyst in the body

- The patient could be asymptomatic even though the cysts have grown to be very large
- Symptomatic even if the cysts are absolutely tiny:
 1. If the patient has cysts in the lungs and is symptomatic:

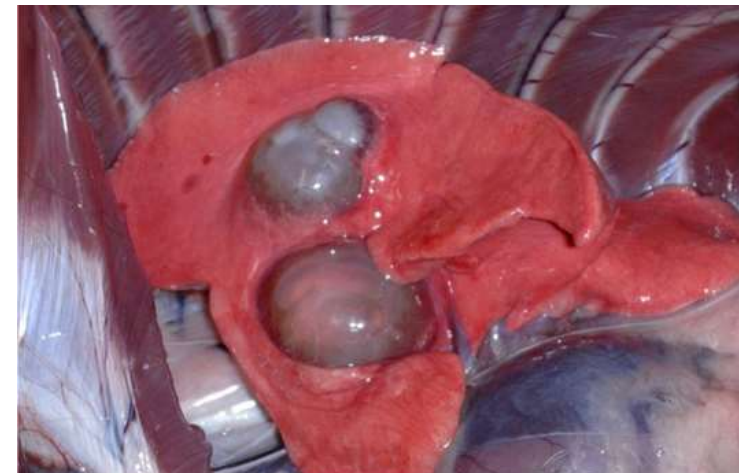
They will have a cough, shortness of breath and pain in the chest.

2. If the patient has cysts in the liver:

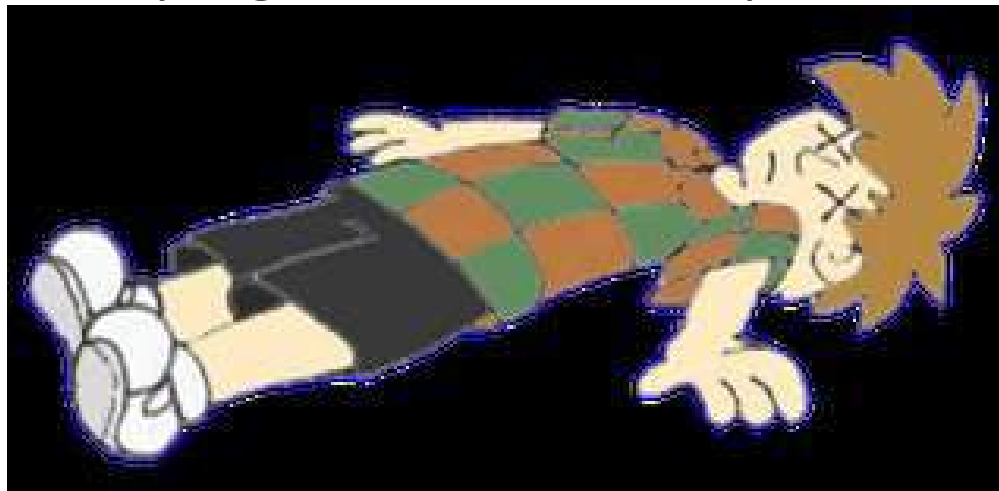
They will suffer from abdominal pain, abnormal abdominal tenderness, hepatomegaly with an abdominal mass, jaundice, fever and anaphylactic reaction.



Gross appearance of hydatid cysts



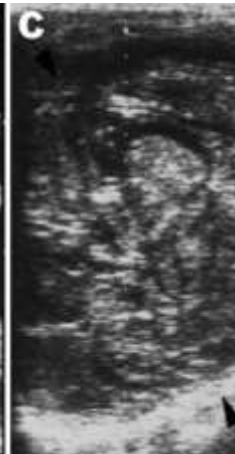
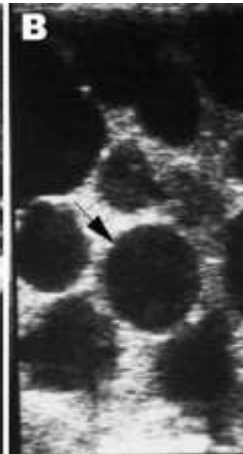
- **If the cysts were rupture in the body, during surgical extraction of the cysts or by some kind of trauma to the body:**
 1. The patient would most likely go into anaphylactic shock
 2. Suffer from high fever
 3. Pruritus (itching)
 4. Edema (swelling) of the lips and eyelids,
 5. Dyspnea, stridor and rhinorrhea.
- **Unlike intermediate hosts, definitive hosts are usually not hurt very much by the infection.**
- Lack of certain vitamins and minerals can be caused in the host by the very high demand of the parasite.



Diagnosis

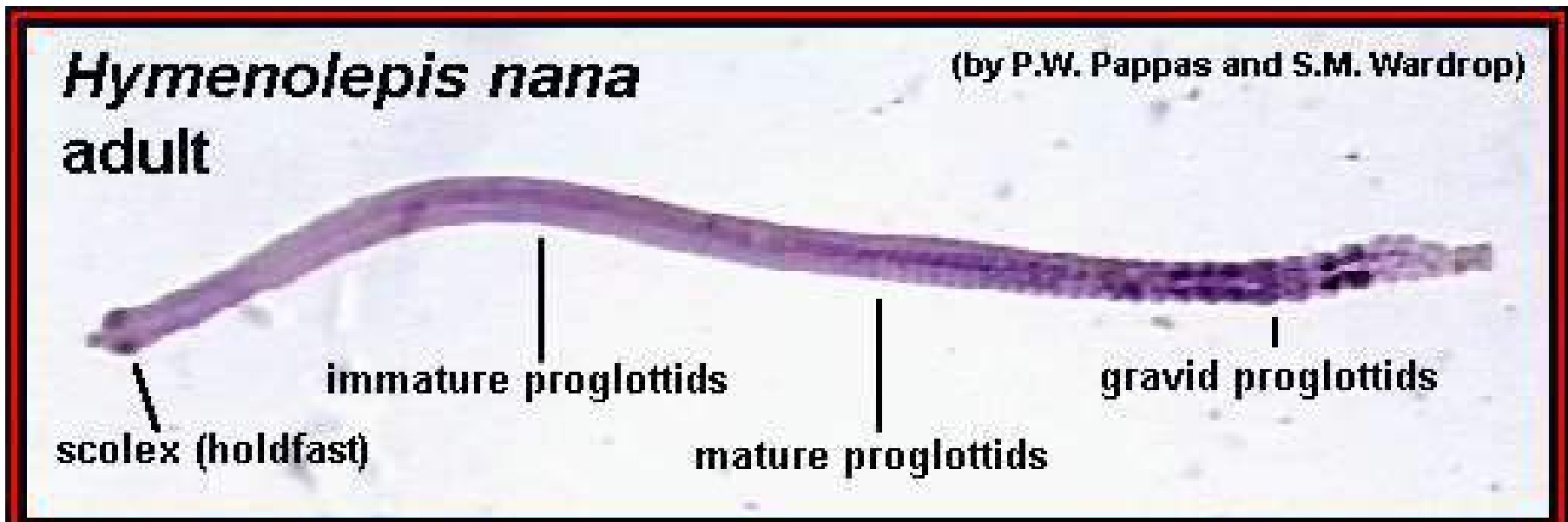
- Cystic Echinococcosis

1. Serology tests (such as indirect hemagglutination, ELISA), immunoblots or latex agglutination) that use antigens specific for *E. granulosus* are used to verify the imaging results.
2. The imaging technique of choice for cystic echinococcosis is ultrasonography
3. Both MRI and CT scans can and are often used although an MRI is often preferred to CT scans when diagnosing cystic echinococcosis since it gives better visualization of liquid areas within the tissue.



Hymenolepis nana

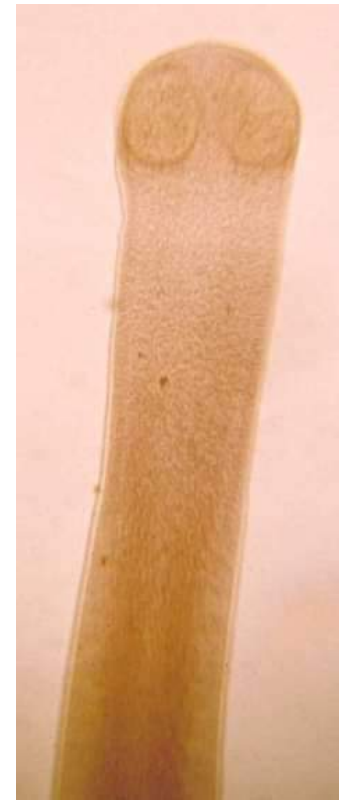
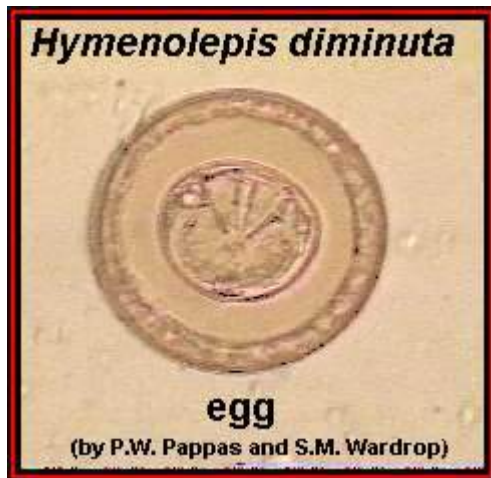
- Dwarf tapeworm (*Hymenolepis nana*, previously known as *Vampirolepis nana*, *Hymenolepis fraterna*, and *Taenia nana*) is a cosmopolitan species though most common in temperate zones, and is one of the most common [cestodes](#) (a type of intestinal worm or [helminth](#)) infecting humans, especially children.
- Intermediate host: insects



Hymenolepis diminuta

***Hymenolepis diminuta*, also known as rat tapeworm:**

is a species of *Hymenolepis* tapeworm that causes hymenolepiasis. It has slightly bigger eggs and proglottids than *H. nana* and infects mammals using insects as intermediate hosts



Adult of *Hymenolepis diminuta*

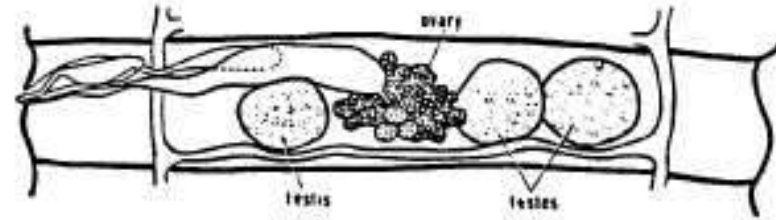
Scolex with 4 acetabula and
rostellum lacking hooks

3 testes/proglottid

Strobila reaches lengths of
1 to 3 feet.



Scolex



Mature Proglottid

Kingdom: Animalia

Phylum: Platyhelminthes

Class: Cestoda

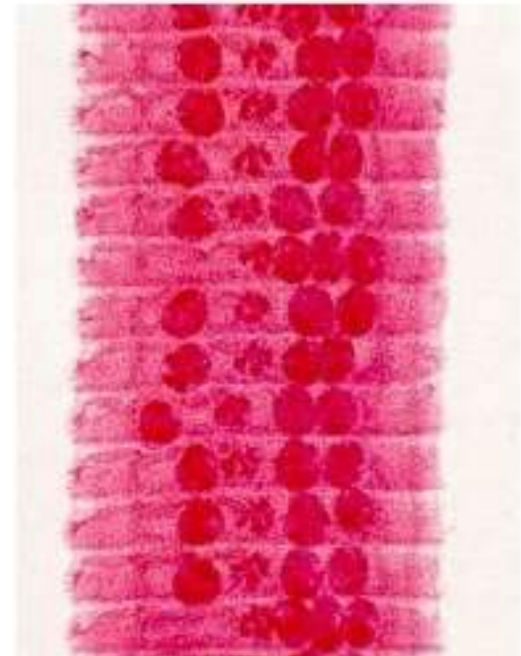
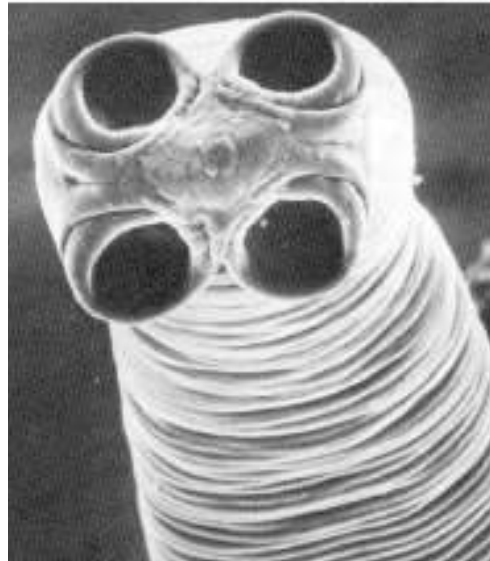
Order: Cyclophyllidea

Family: Hymenolepididae

Genus: Hymenolepis

Species: H. diminuta

H.nana



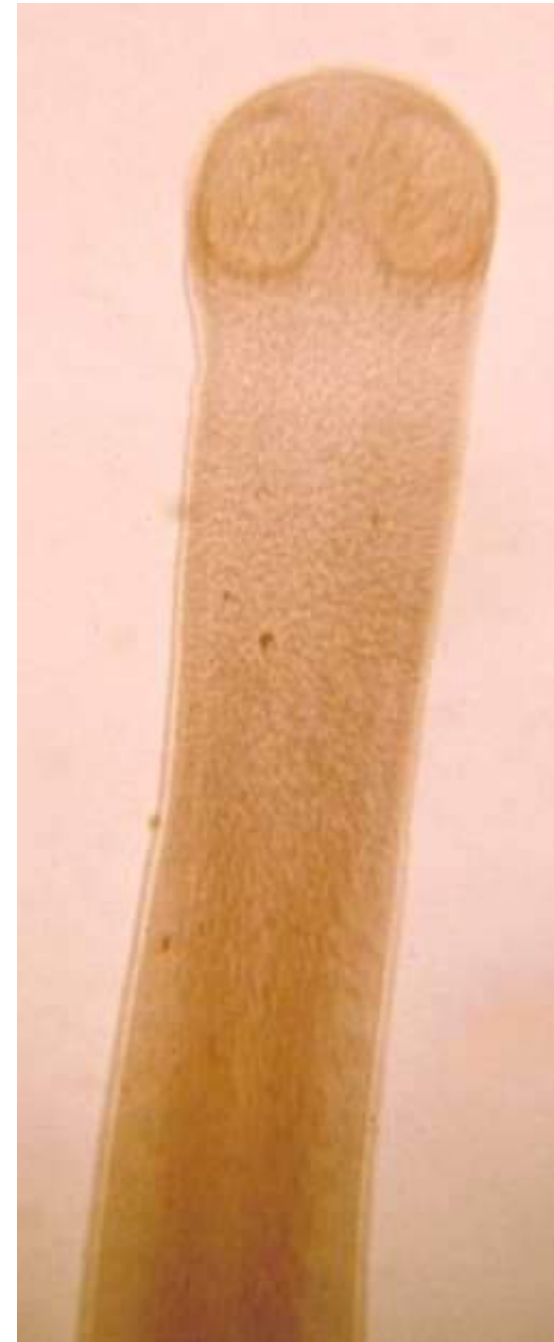
Morphology:

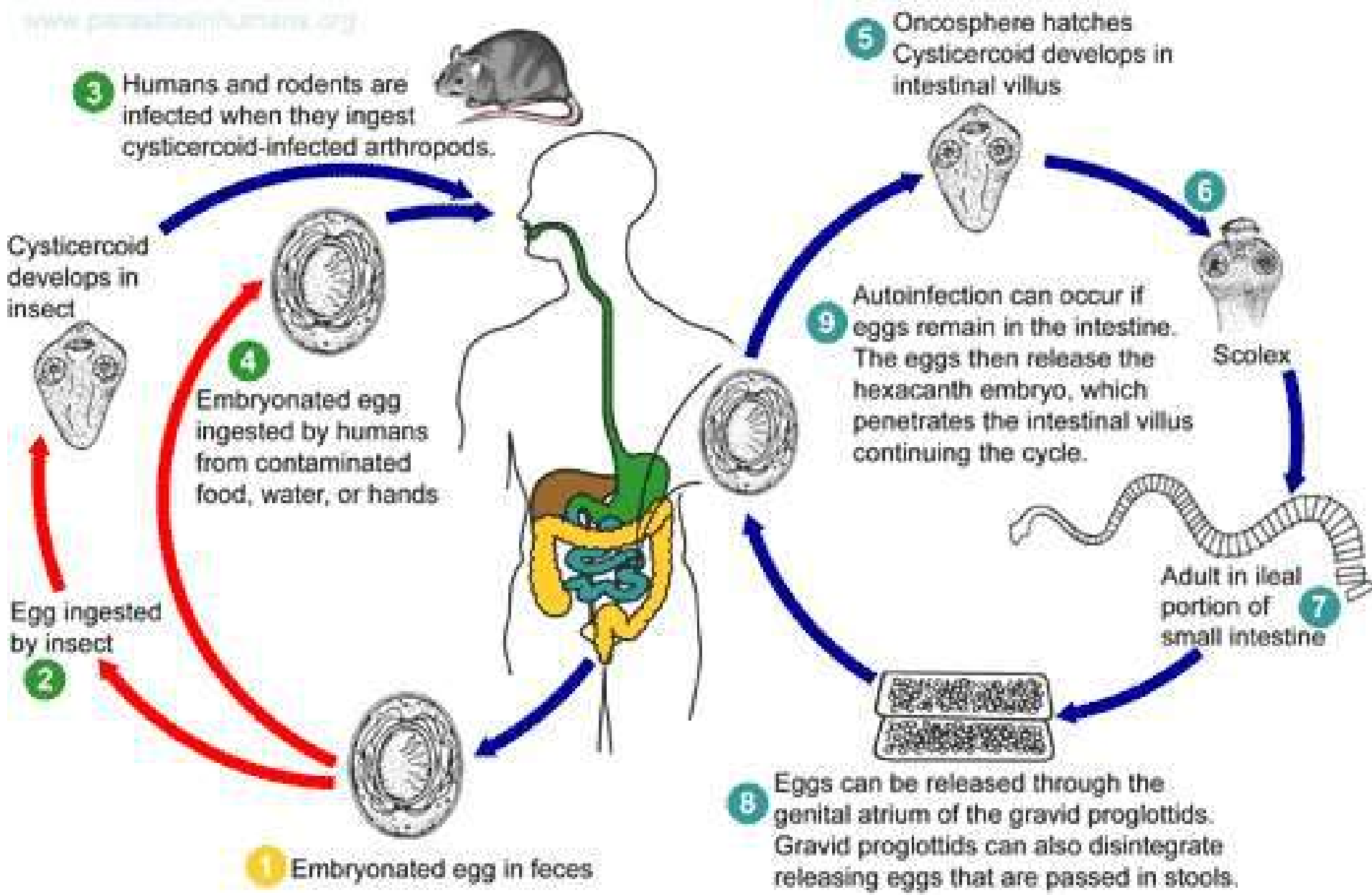
- *H. nana*:
- *H. nana* **worms** are flat and segmented with skinny necks.
- They vary in length from approximately 15 to 40 mm and are 1 mm wide.
- Each worm has a **scolex**, which is an anterior 'head segment with a single row of 20-30 retractable hooks (rostellum).
- Each worm has **proglottids**, which are wider segments of the tapeworm that contains both male and female reproductive organs.
- Each **mature segment** has unilateral genital pores and 3 testes. When the eggs have been fertilized the segments are referred to as gravid. These break off from the main portion, the strobila, and deteriorate releasing eggs.
- The **oncospheres**, or embryos, can be from 30-47 nm in diameter and are covered with a thin hyaline outer membrane and a thicker inner membrane. Embedded in the inner membrane on polar sides of the oncosphere are a number of hair-like filaments.



H. diminuta:

- *H. diminuta* **worms** are the same shape as *H. nana* but are **much larger**, up to 90 cm long and 44 mm wide.
- Their **scolex does not have hooked rostellum** like the *H. nana* species but they do have similar unilateral genital pores and 3 testes per proglottid.
- **The oncospheres of *H. diminuta* are similar to *H. nana*'s except they lack hair like filaments embedded in their inner membrane and are two times their size.**





Life cycle of *Hymenolepis nana*

Clinical manifestations of Hymenolepiasis

- *H. nano* live in the intestines



- Absorbs nutrients from the intestinal lumen.



- In human adults, the tapeworm is more of a nuisance than a health problem,



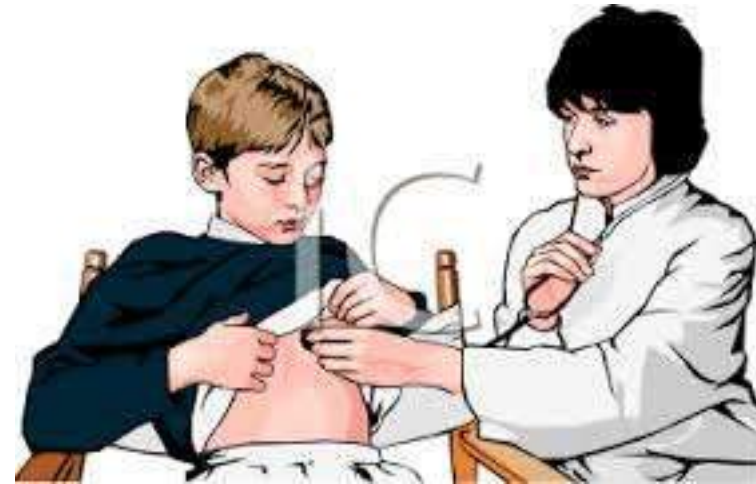
- In small children, many *H. nana* can be dangerous.



- the larva of this tapeworm that causes the most problem in children will burrow into the walls of the intestine.



- Severe damage can be inflicted. (by absorbing all the nutrition from the food the child eats)



Symptoms are due to:

- Allergic responses or systematic toxemia caused by **waste products of the tapeworm.**
- ❖ Light infections are usually symptom less.
- ✓ **Infection with more than 2000 worms can cause enteritis:**
 1. Abdominal pain.
 2. Diarrhea.
 3. Loss of appetite.
 4. Restlessness, irritability, restless sleep.
 5. Anal and nasal pruritus.



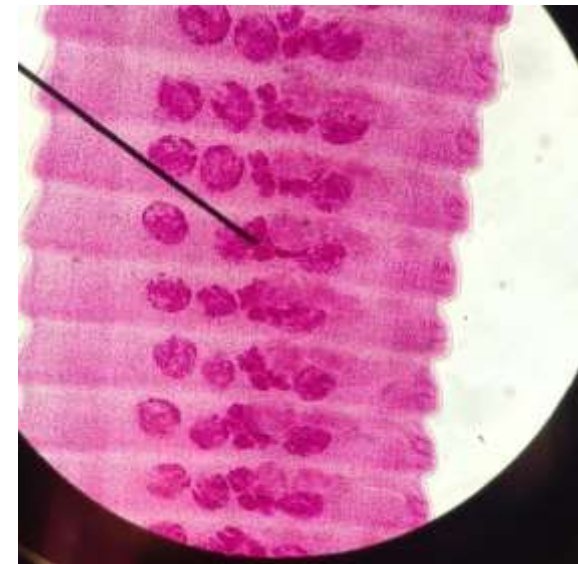
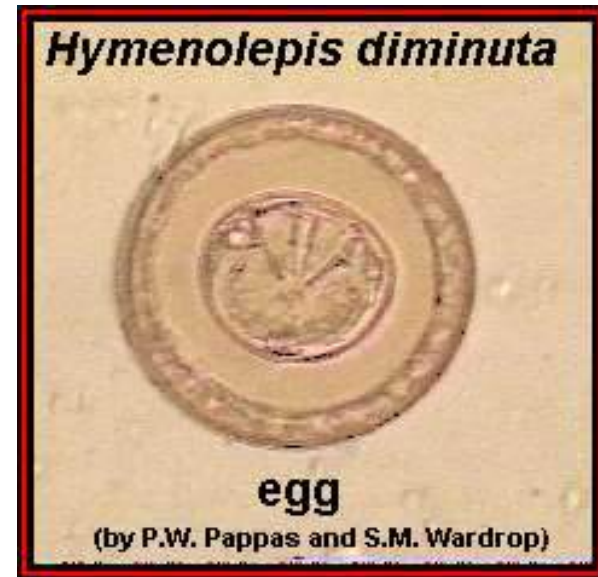
H. diminuta infection is often asymptomatic

1. Abdominal pain.
2. Irritability.
3. Itching.
4. Eosinophilia are among the existing symptoms in a few of the reported cases.



Diagnosis:

- Diagnosis for Hymenolepiasis is done by examining **stool for eggs**.
- The proglottids that are disintegrated in the intestine cannot be detected.
- Egg output could be sporadic so a couple stool tests a few days apart may need to be done to diagnose the infection.

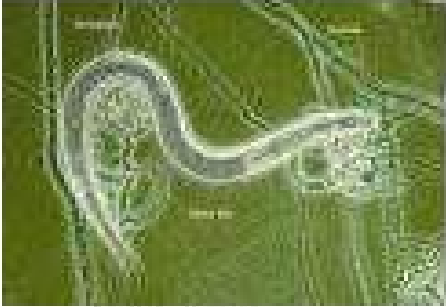


Treatment:

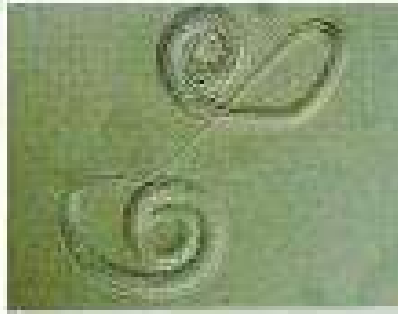
- The 2 drugs that have been described for the treatment of hymenolepiasis are **praziquantel** and **niclosamide**. Praziquantel, in a single dose for all the stages of the parasite, is the drug of choice because it acts very rapidly against *H. nana*. Although structurally unrelated to other anthelmintics, it kills both adult worms and larvae.
- Preventing fecal contamination of food and water in institutions and crowded areas is of primary importance.
- General sanitation and rodent and insect control (especially control of fleas and grain insects) are also essential for prevention of *H. nana* infection.

الديدان الزقية

Lec 8: Phylum Ashelminthes



Rhabditis



Dracuculus



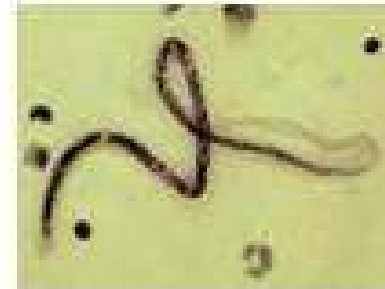
Ascaris



Enterobium



Trichiuris



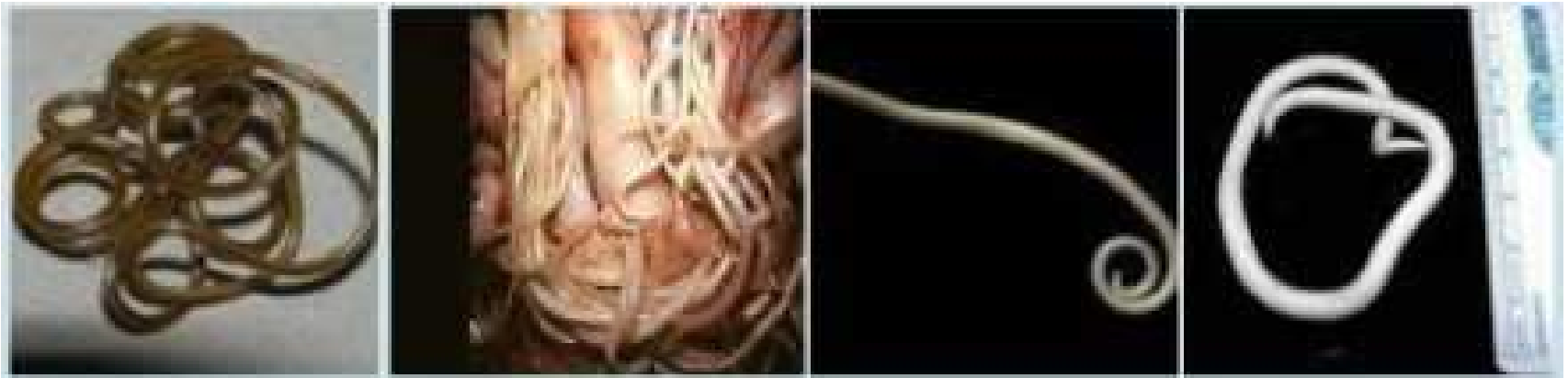
Loa loa

Lec.Dr.Ruwaidah F. Khaleel

Distinguishing Characters:

دودي الشكل

1. Body is vermiform, triploblastic with bilateral symmetry.
2. Body is un segmented.
3. Digestive system complete. Anus present.
4. They are pseudo coelomate forms.
5. There is no mesodermal living over the inner side of the body cavity.
6. Circulatory and respiratory organs absent.
7. Nervous system with cerebral ganglia and nerves.
8. Sexes separate. Male usually smaller than female.
9. Life cycle with or without larval stage.
10. Mostly parasitic, some are free living forms in the soil.

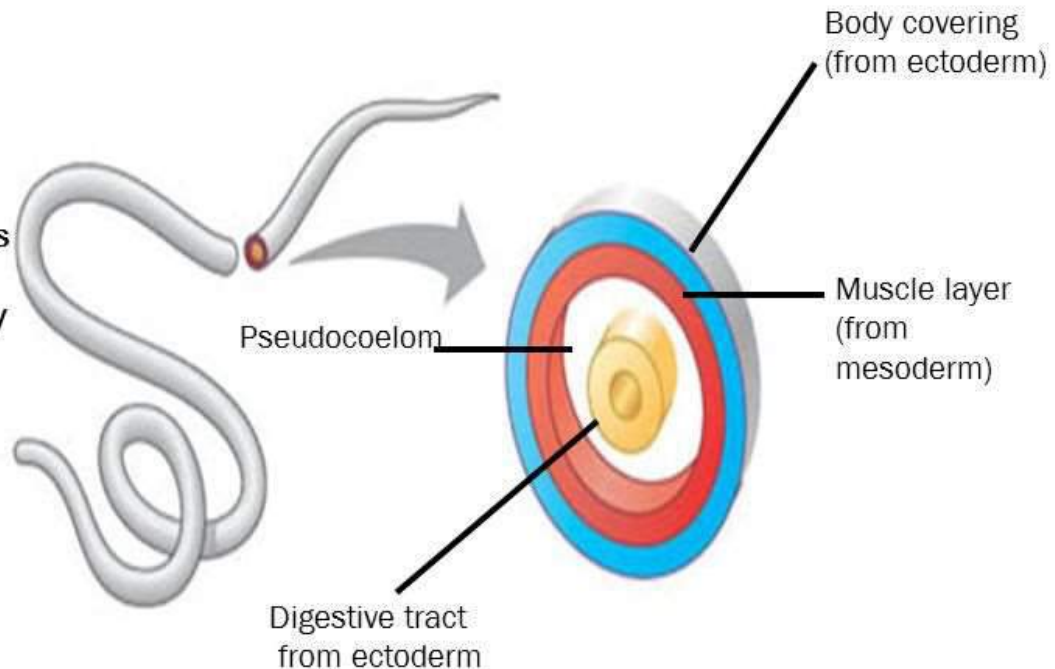


- The coelom in these forms is not a true coelom. Hence the coelom of Aschelminthes is called a false coelom (Pseudo-coelom).

- A **pseudocoelom**

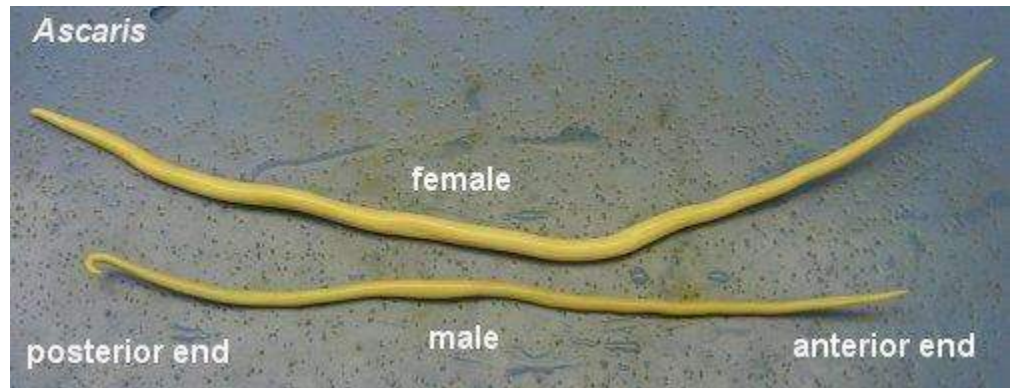
- Is a body cavity derived from the blastocoel, rather than from mesoderm

Pseudocoelomates such as nematodes have a body cavity only partially lined by tissue derived from mesoderm.



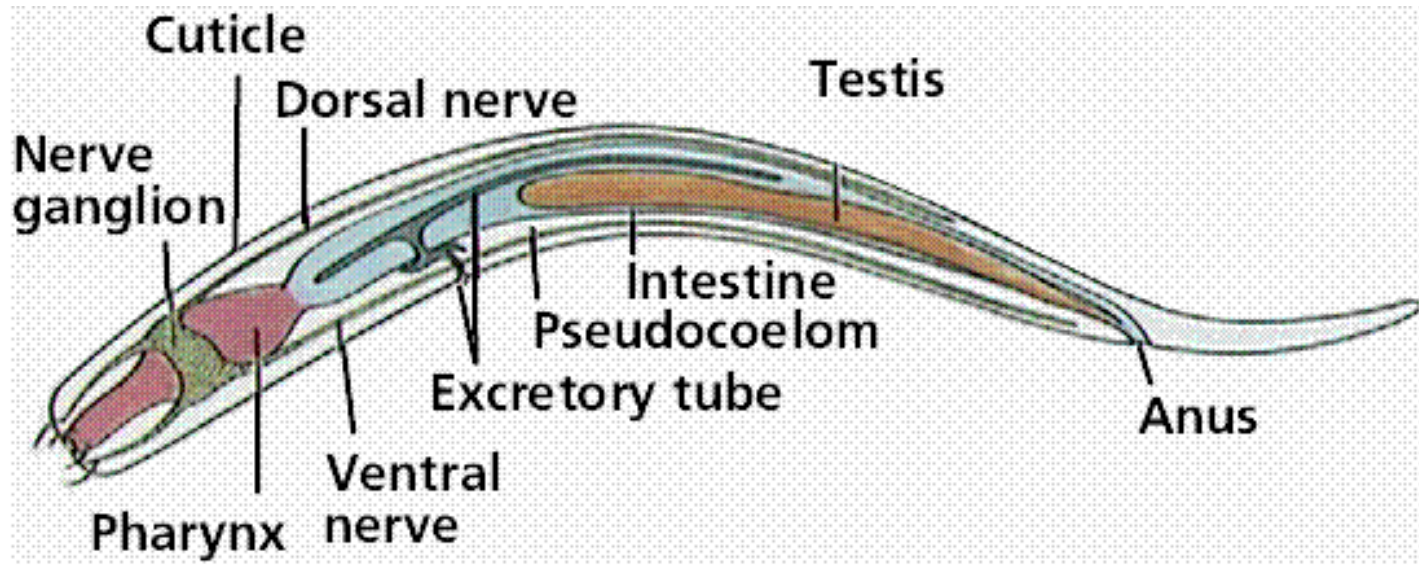
Habits and habitat

- Phylum Aschelminthes includes many forms and have both free living and parasitic representatives.
 - Class Nematoda are the most diverse **Class** of **pseudocoelomates**.
1. Free-living nematodes are extremely abundant in soils and sediments, where they feed on bacteria and detritus. فتات.
 2. plant parasites nematodes and may cause disease in economically important crops. المحاصيل.
 3. parasitize animals nematoda and humans; well-known parasitic nematodes include hookworms, pinworms, Guinea worm (genus *Dracunculus*^{التنينه}), and intestinal roundworms (genus *Ascaris*).

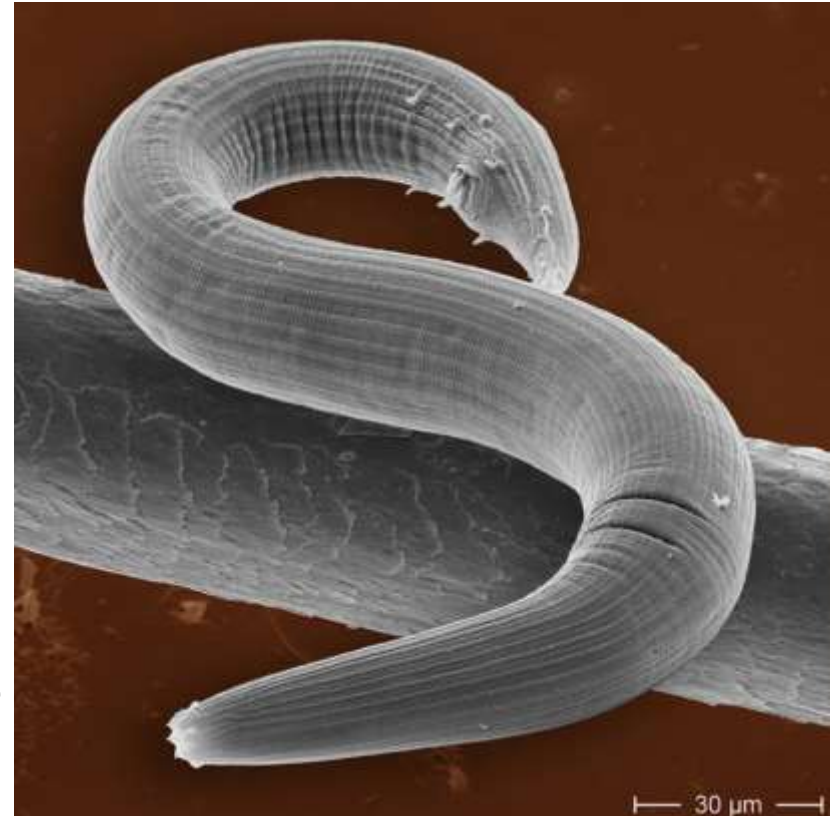


Class Nematoda:

- Are commonly termed round worms because of their cylindrical bodies.
- They have both terrestrial and aquatic representatives.
- Many have taken to parasitic life.
- Body is unsegmented.
- Body has a false coelom and well developed muscles.



- Nematode **species** are very difficult to distinguish; over **28,000** have been described, of which over **16,000** are **parasitic**.
- It has been estimated that the total number of nematode species might be approximately **1,000,000**



Anatomy

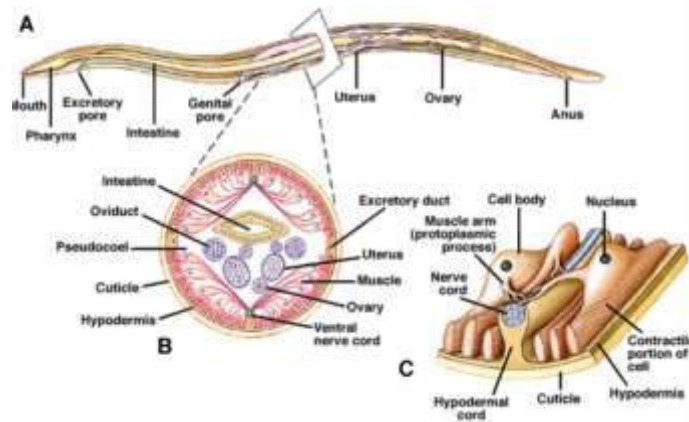
- Nematodes are slender worm-like animals, typically less than 2.5 millimeters in long.
- The smallest nematodes are microscopic, while free-living species can reach as much as 5 centimeters and some parasitic species are larger still.
- The body is often ornamented with ridges, rings, warts, bristles or other distinctive structures.
- The head is radially symmetrical, with sensory bristles

مزخرف

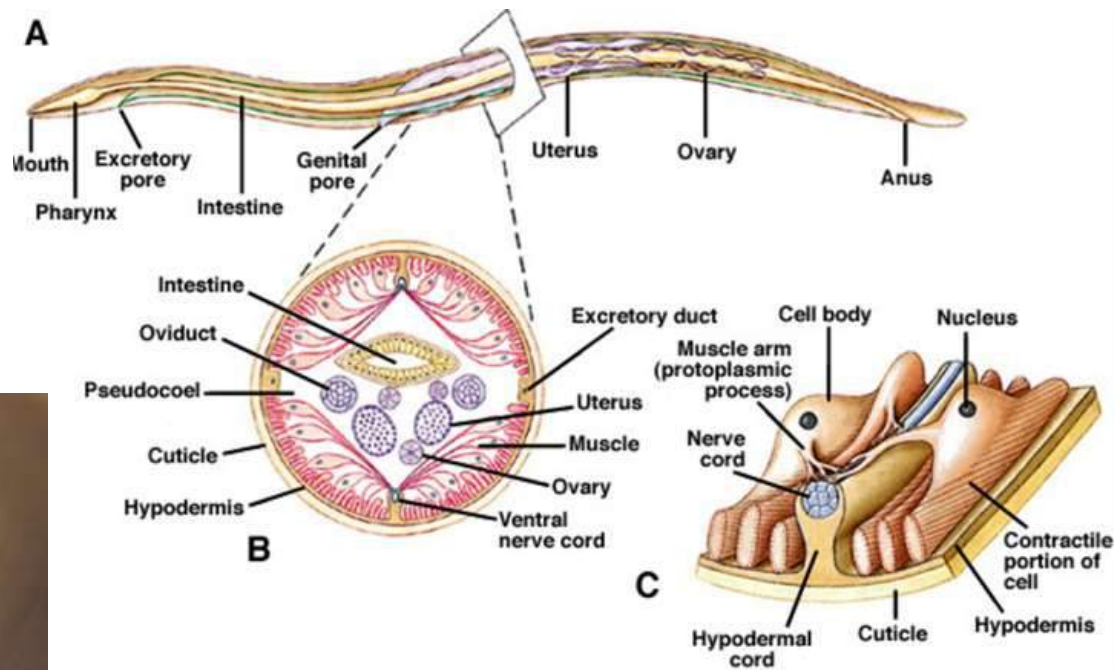
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شعيرات

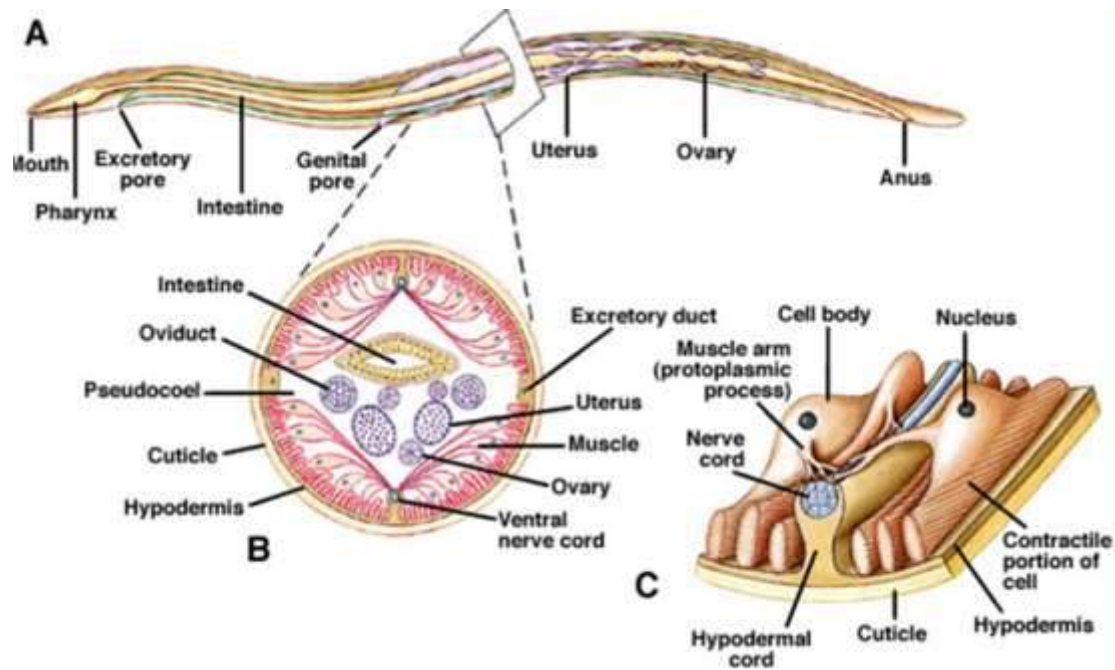
Structures of a nematode



- The mouth has either three or six lips, which often bear a series of teeth on their inner edge.
- An **adhesive caudal gland** is often found at the tip of the tail.
- The **epidermis** is either a **syncytium** or a single layer of cells, and is covered by a thick **collagenous cuticle**.
- The muscle layer surrounds the body cavity, which is filled with a fluid that lacks any form of blood cells.



- The gut runs down the center of the cavity.
- The cuticle consists of up to **9 layers of proteinaceous fibers**, with **3 layers being easily discerned**, from the outside in, **the cortex, the matrix layer and the fiber layer**.
- Despite its complexity the Nematode cuticle is permeable to both water and gases, so **respiration occurs through it**.
- Beneath the **cuticle** is a **hypodermis** and a layer of **longitudinal muscle**.



Digestive system

- The oral cavity is lined with cuticle, in carnivorous species, may bear a number of teeth.
- The oral cavity opens into a muscular sucking **pharynx**, also lined with cuticle
- The pharynx of Nematodes is an efficient pump and forces food into the intestines.
- Digestion is rapid and faeces are expelled under pressure. This pressure is so great that the parasitic nematode *Ascaris lumbricoides* which is about 12cm to 18cm long (5 to 7 inches) may shoot its faeces 60cm or 2 feet into the air.

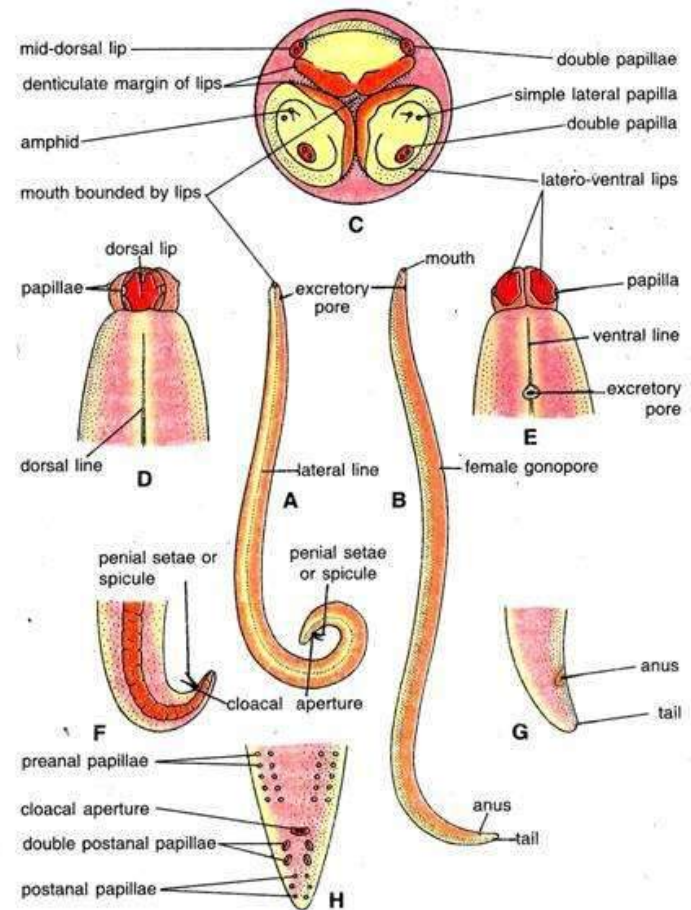


Fig. 46.1. *Ascaris lumbricoides*. A—Male; B—Female; C—Entire view of mouth and lips; D—Anterior end in dorsal view; E—Anterior end in ventral view; F—Posterior end of male; G—Posterior end of female; H—Posterior end of male in ventral view showing

- Digestive glands are found in this region of the gut, producing **enzymes** that start to break down the food.
- There is no stomach, with the pharynx connecting directly to the **intestine** that forms the main length of the gut.
- The last portion of the intestine is lined by cuticle, forming a **rectum** which expels waste through the **anus** just below and in front of the tip of the tail.

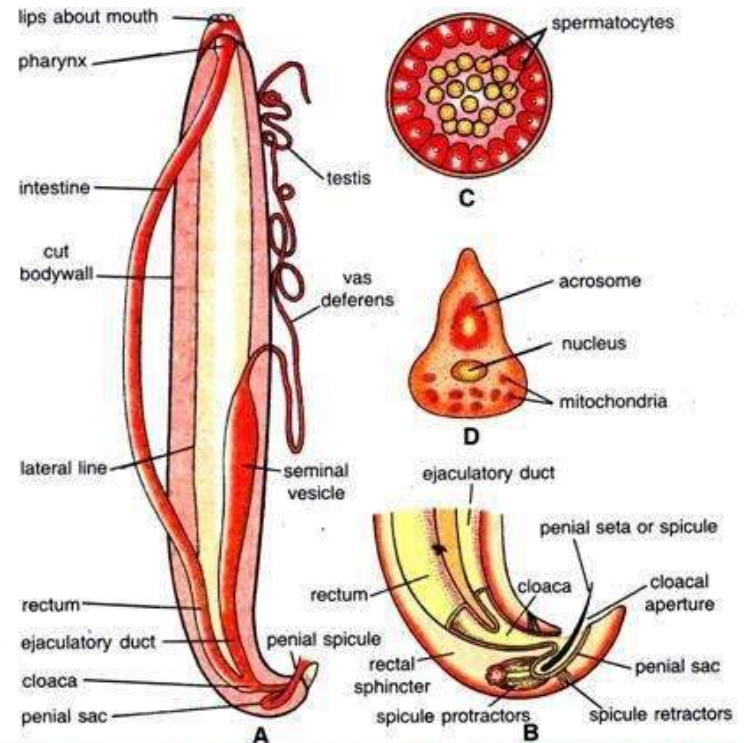


Fig. 46.11. *Ascaris lumbricoides*. A—Male reproductive system; B—Posterior end of male *Ascaris* in lateral view showing cloaca and spicule; C—T.S. vas deferens; D—A sperm.

Excretory system

- **Nitrogenous waste** is excreted in the form of **ammonia** through the body wall, and is not associated with any specific organs. However, the structures for excreting salt to maintain **osmoregulation** are typically more complex.

- In most nematodes, Excretory system consisting of:



- Two parallel ducts



- Connected by a single transverse duct.



- This transverse duct opens into a common canal that runs to the excretory pore.

- ❖ Nematodes have no circulatory or respiratory organs and the excretion of metabolic waste is via **two simple ducts** or **tubules** which have no **nephridia** or **flame cells**.

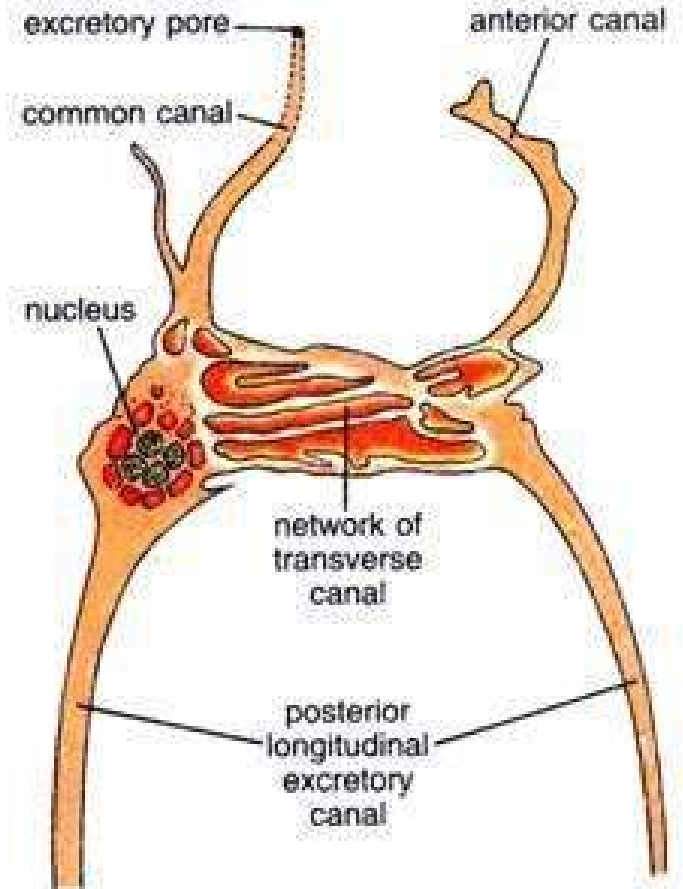


Fig. 46.7. *Ascaris lumbricoides*. Excretory system.

Nervous system

- Four **nerves** run the length of the body on the dorsal, ventral, and lateral surfaces.
 - Each nerve lies within a cord of connective tissue lying beneath the cuticle and between the muscle cells.
1. The ventral nerve is the largest and is responsible for motor and sensory control.
 2. The dorsal nerve is responsible for motor control.
 3. The lateral nerves are sensory.

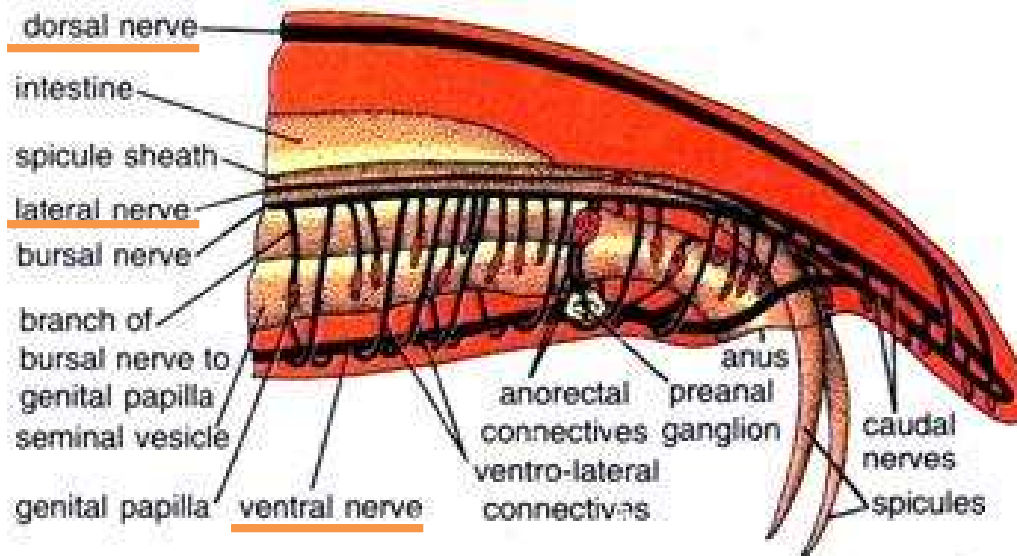
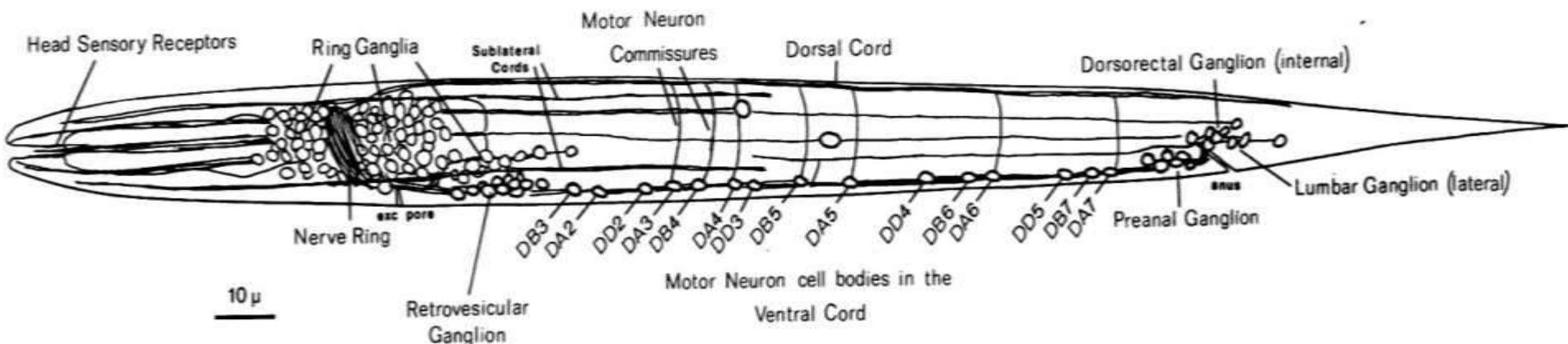
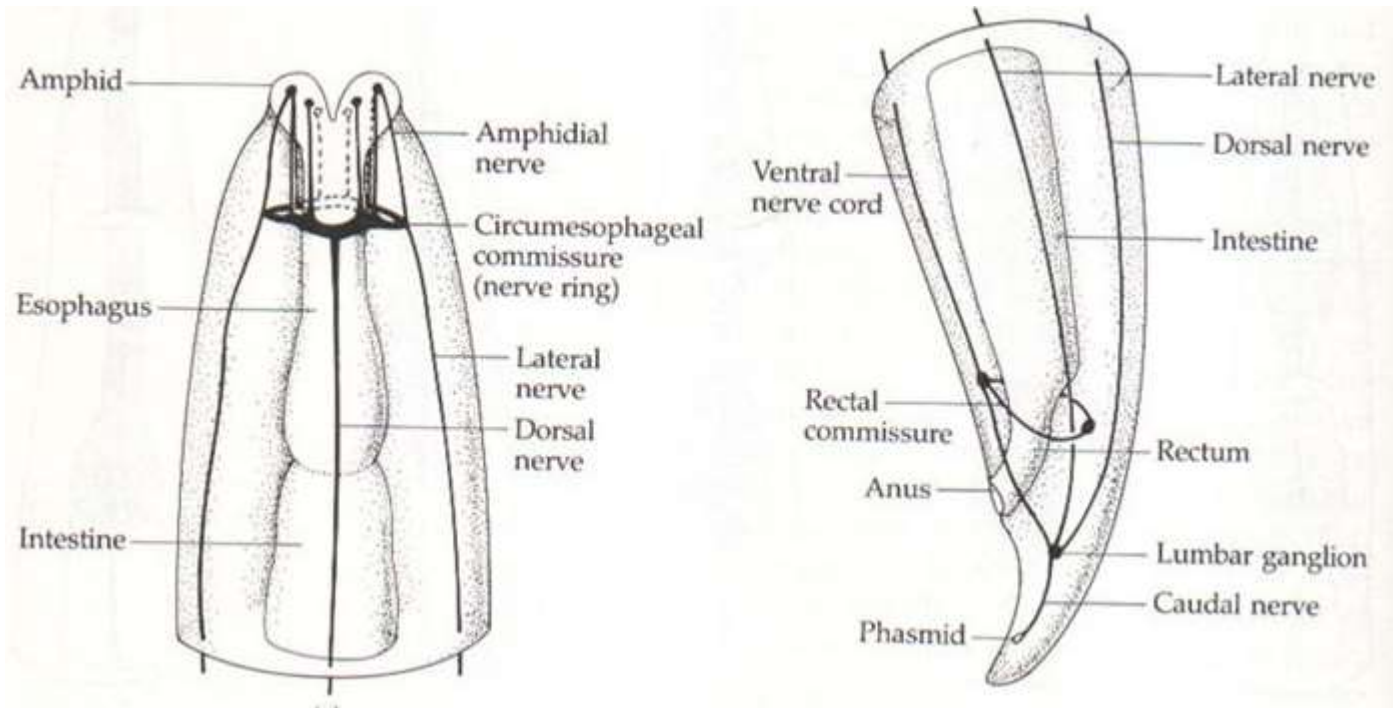


Fig. 46.9. *Ascaris lumbricoides*. Lateral view of posterior end showing nervous system.

- At the anterior end of the animal, the nerves branch from a dense circular nerve ring surrounding the pharynx, and serving as the brain.
- Smaller nerves run forward from the ring to supply the sensory organs of the head.
- The body of nematodes is covered in numerous sensory bristles and papillae that together provide a sense of touch.
- Behind the sensory bristles on the head lie two small pits, or *amphids*. These are well supplied with nerve cells, and are probably **chemoreception** organs.

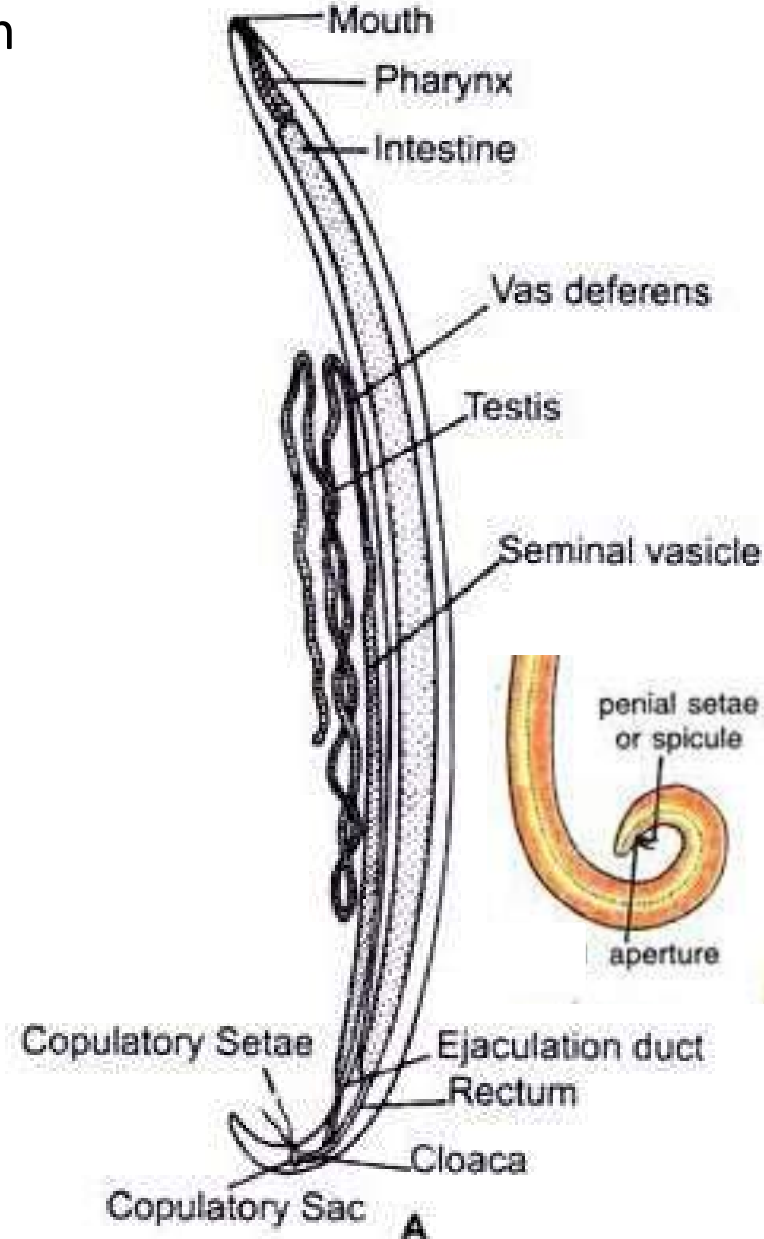


- Sense organs of importance in the nematodes are:
 - 1. The amphids:** consist of a **pair of minute, lateral bodies** at the **anterior end of the body**, each with an external chamber that may be a simple pore or a circular, spiral, helical, or elongate tubule.
 - 2. The phasmids:** Most nematodes have pair of minute organs called phasmids that are posterial in position .



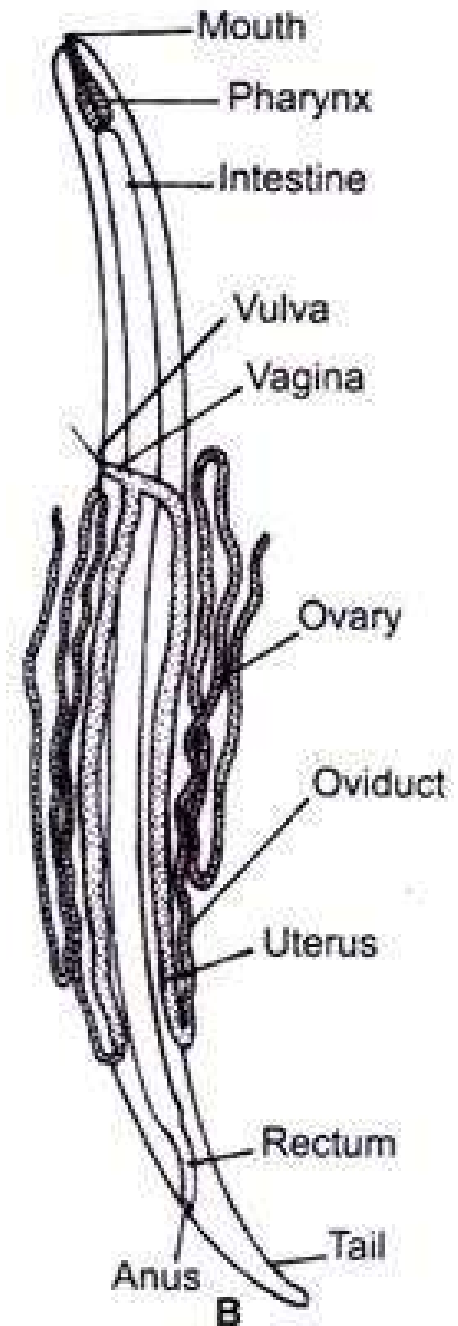
Reproduction

- Most nematode species are **dioecious**, with separate male and female individuals.
- Both sexes possess one or two tubular **gonads**.
- **In males**
 - ❖ The sperm are produced at the end of the gonad, and migrate along its length as they mature.
 - ❖ The testes each open into a relatively wide sperm duct and then into a glandular and muscular ejaculatory duct associated with the **cloaca**.
واسعة نسبيا
 - ❖ Males are usually smaller than females and often have a characteristically **bent tail** for holding the female for **copulation**.
دبيل مائل
- During copulation, one or more **chitinized spicules** move out of the cloaca and are inserted into genital pore of the female.



In females

- The ovaries each open into an **oviduct** and then a glandular **uterus**.
- The uteri both open into a common **vagina**, usually located in the middle of the ventral surface.



(B) Adult female

Eggs

- Eggs may be embryonated or unembryonated when passed by the female.
- The eggs are protected by an outer shell, secreted by the uterus.
- In free-living roundworms, the eggs hatch into larvae, which appear essentially identical to the adults, except for an underdeveloped reproductive system;
- In parasitic roundworms, the life cycle is often much more complicated.

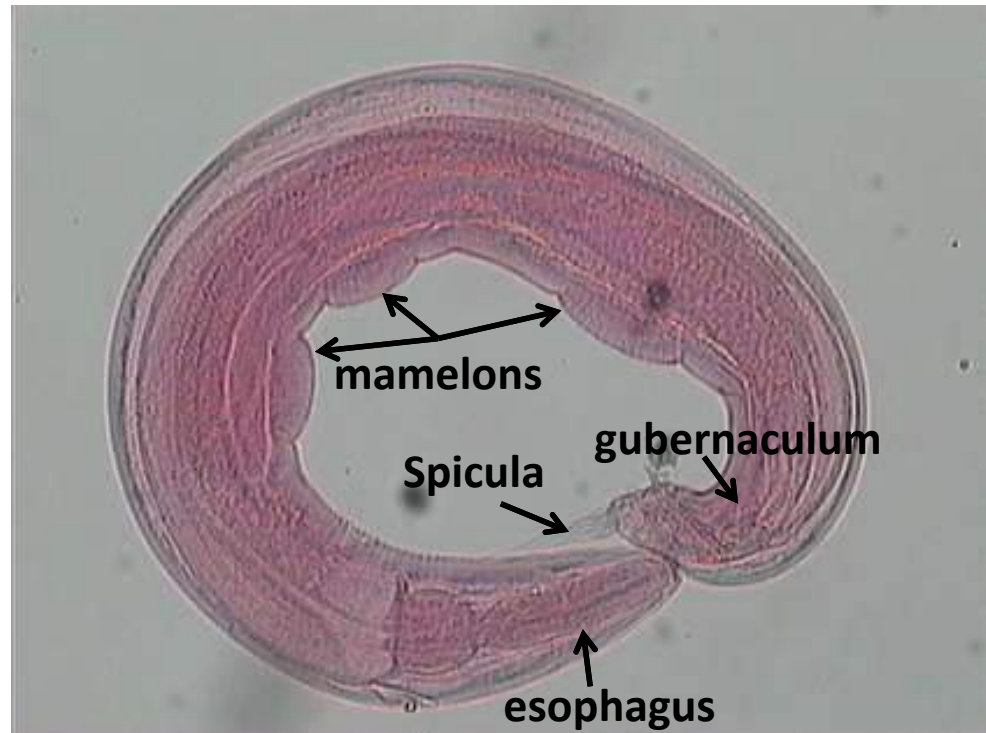


- **Nematodes as a whole possess a wide range of modes of reproduction.**
- Some nematodes, undergo a process called **endotokia** : **intrauterine birth causing maternal death.**
- Some nematodes are **hermaphroditic**, and keep their self-fertilized eggs inside the uterus until they hatch
- **The genus Mesorhabditis** exhibits an unusual form of **parthenogenesis**, in which sperm-producing males copulate with females, but the sperm do not fuse with the ovum.
- Contact with the sperm is essential for the ovum to begin dividing, but because there is no fusion of the cells, the male contributes no genetic material to the offspring, which are essentially **clones** of the female.



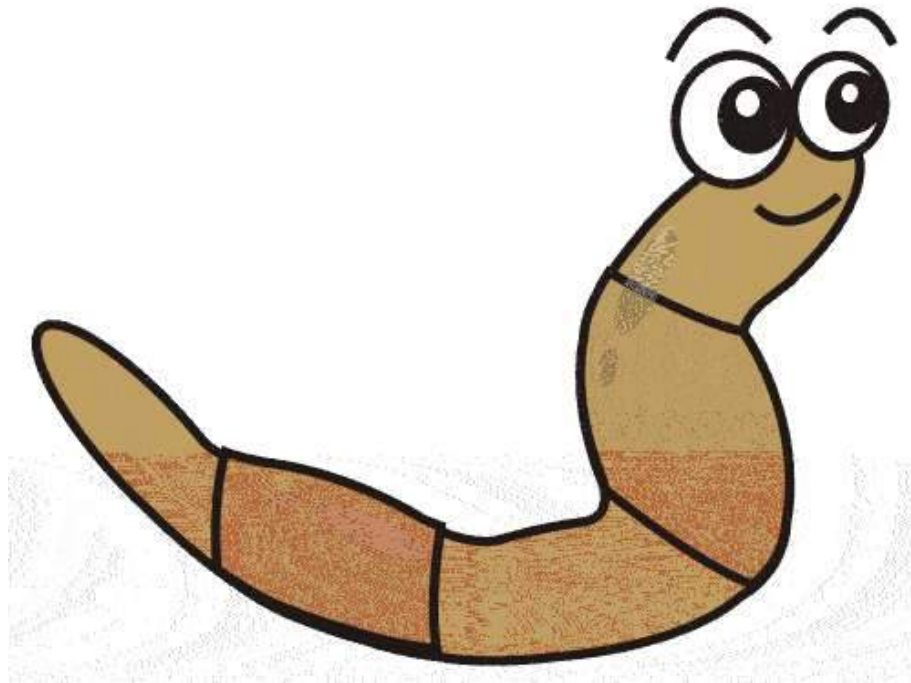
Phasmids nematodes, *Syphacia* spp.

- *Syphacia. obvelata* found in **cecum and large intestine of rodents and rarely in humans**
- The males die after mating.
- Pinworms, is the possibility for retroinfection.
- Eggs deposited on perianal region Infective **5-20** hours after release



Toxocariasis (also as Roundworm)

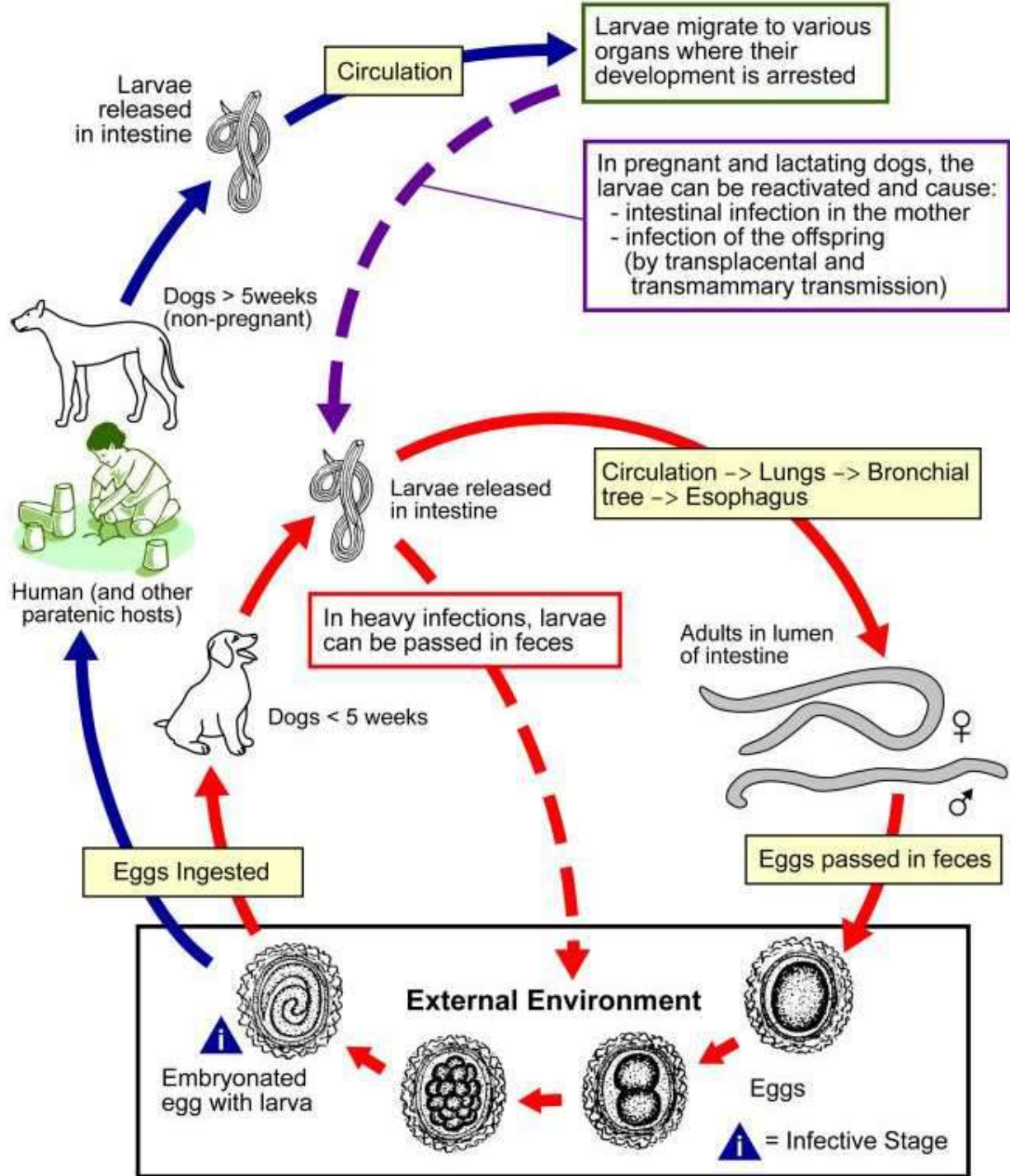
- **Roundworms** are parasites that have evolved some remarkable strategies for survival. استراتيجيات ملحوظة
Unfortunately, their success is at the expense of not only our pets, but ourselves.



Toxocariasis

- Is the parasitic disease caused by the larvae of two species of *Toxocara* roundworms:
- *Toxocara canis* from dogs.
- *Toxocara cati* from cats (less commonly).





Larvae released in intestine

Circulation

Larvae migrate to various organs where their development is arrested

In pregnant and lactating dogs, the larvae can be reactivated and cause:

- intestinal infection in the mother
- infection of the offspring (by transplacental and transmammary transmission)

Dogs > 5 weeks (non-pregnant)



Larvae released in intestine

Circulation -> Lungs -> Bronchial tree -> Esophagus

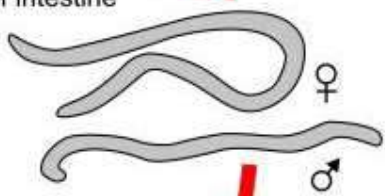
Human (and other paratenic hosts)



Dogs < 5 weeks

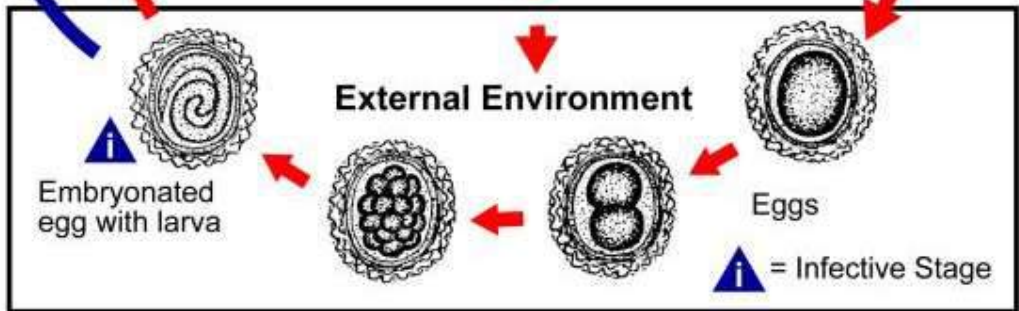
In heavy infections, larvae can be passed in feces

Adults in lumen of intestine



Eggs passed in feces

Eggs Ingested



Embryonated egg with larva

External Environment

Eggs

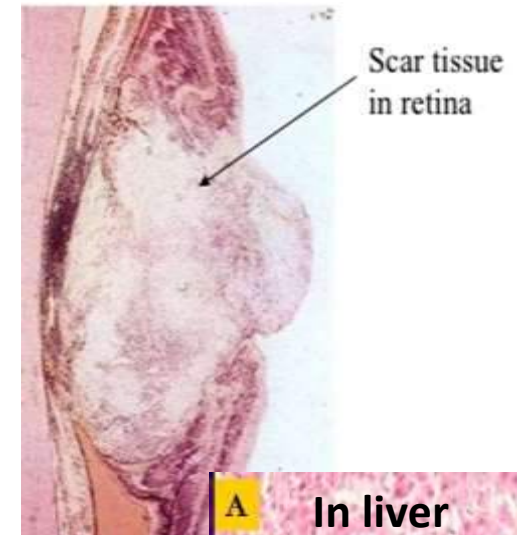
i = Infective Stage

***Posterior end of *Toxocara canis*
showing cervical alae***



Visceral larva migrans

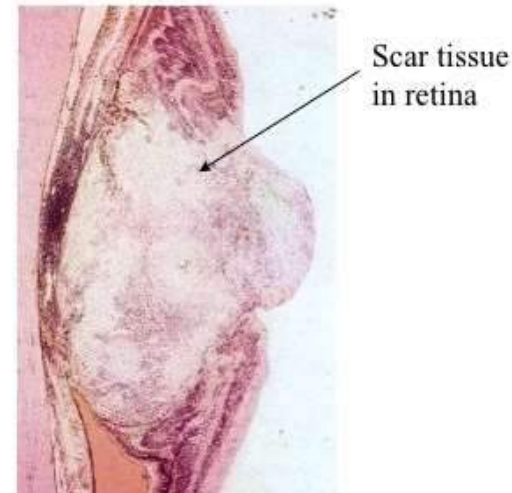
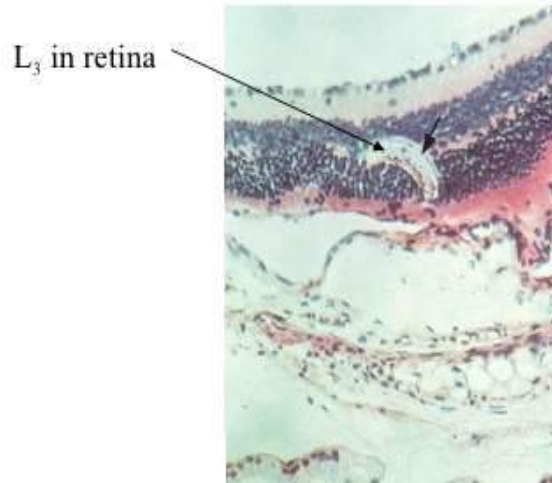
- **Visceral larva migrans** is a condition in humans caused by the migratory larvae of certain **nematode** causing such **zoonotic** infections are *Toxocara canis*, *Toxocara cati*, and *Ascaris suum*, humans being an **terminal host**.
- These nematodes can infect but not mature in humans and after migrating through the intestinal wall, travel with the blood stream to various organs where they cause inflammation and damage.
- **Affected organs can include:**
 1. The **liver**
 2. The **Heart** (causing **myocarditis**)
 3. The **CNS** (causing dysfunction, **seizures**, and coma).
 4. A special variant is **Ocular larva migrans** where usually *T. canis* larvae travel to the eye.
- Young children may also become infected by eating dirt or sticking a dirty hand or toy into their mouths. This can result in **Ocular or Visceral Larva Migrans**, in which the worm larvae migrate into the eyes, causing vision loss, or throughout the body, causing generalized disease.



Symptoms

- Mild infections may not cause symptoms.
- More serious infections may cause the following symptoms:

1. Abdominal pain
2. **Cough**
3. **Fever**
4. Irritability
5. Itchy skin (hives)
6. Shortness of breath
7. **Wheezing** تنفس بصفير



8. If the eyes are infected (called ocular larva migrans), loss of vision and crossed eyes (**strabismus**) may occur.

Treatment

- This infection usually goes away on its own and may not require treatment. However, some people may need anti-parasitic drugs such as albendazole.

Complications

1) Blindness

انخفاض حدة البصر (تدهور البصر)

2) Decreased visual acuity (worsened eyesight)

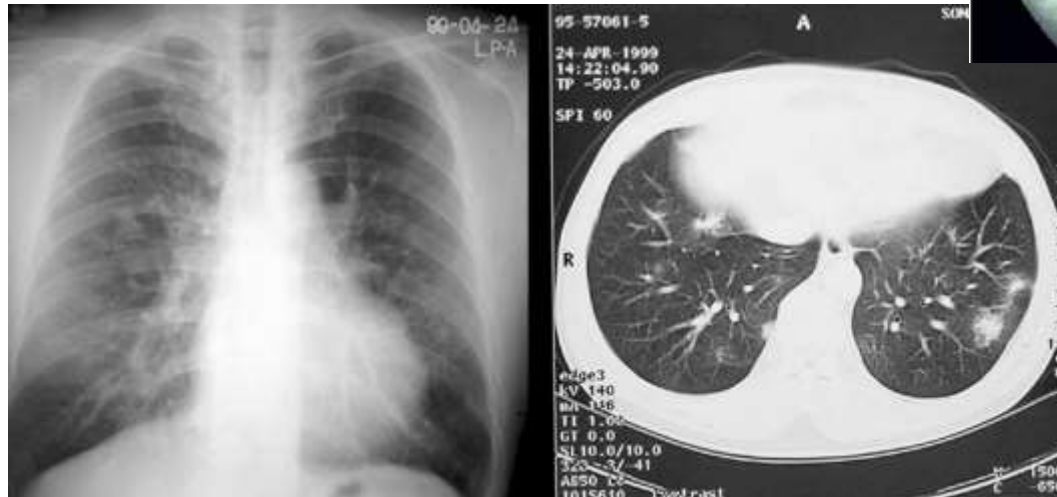
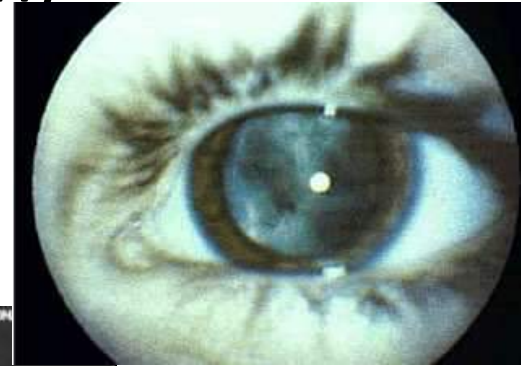
3) Encephalitis (infection of the brain)

عدم انتظام ضربات

4) Heart arrhythmias

ضيق التنفس

5) Respiratory distress

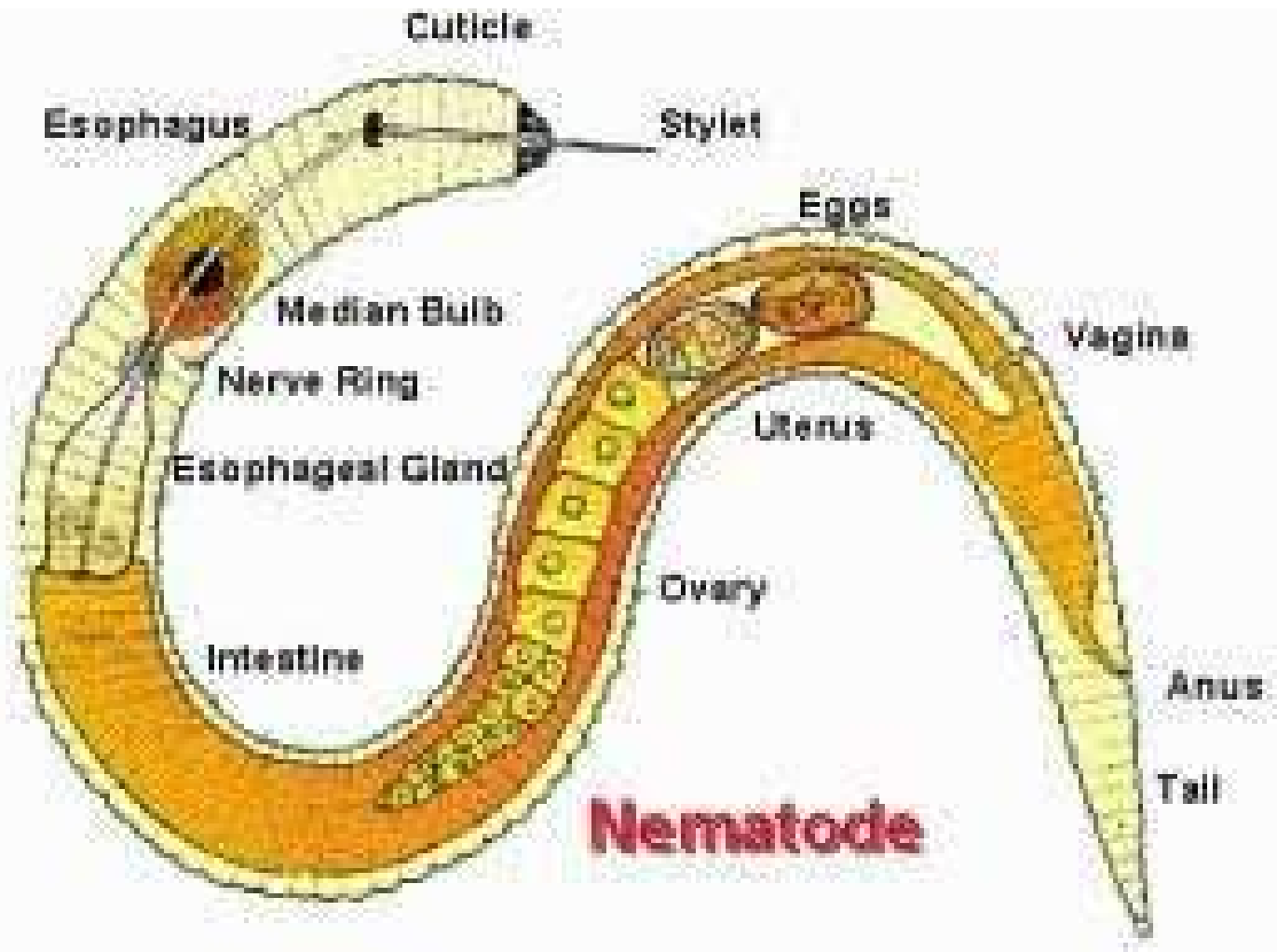


Prevention

- Prevention includes:
 1. De-worming dogs and cats.
 2. Preventing dogs and cats from defecating in ^{الاماكن العامة.} public areas.
 3. Keeping children away from areas where dogs and cats may defecate.
 4. It is very important to carefully wash your hands after touching soil.



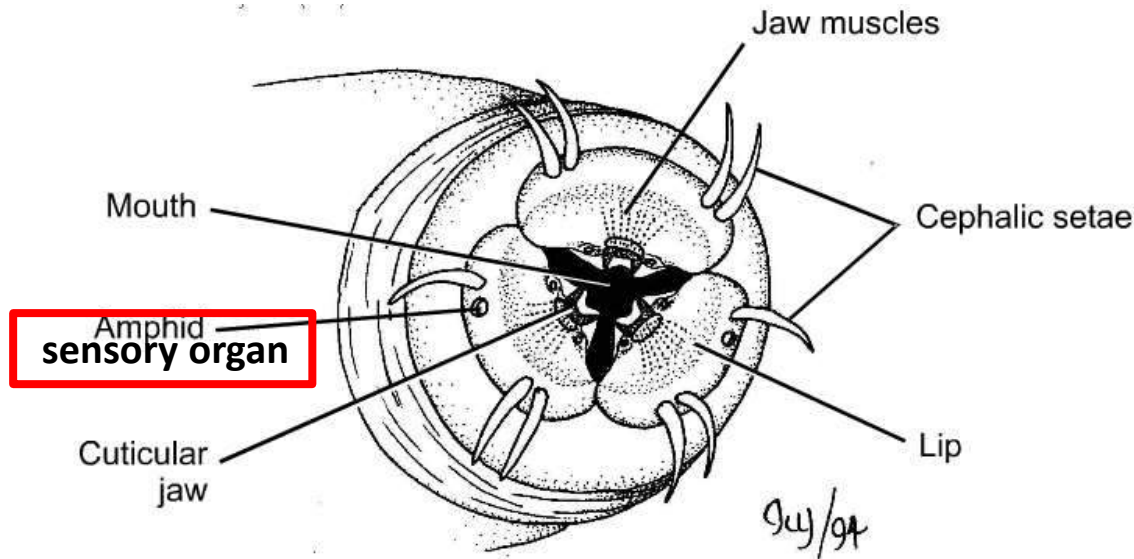
Lec. (9): Phylum Nematoda



Lec. Dr. Ruwaidah F. Khaleel

Phylum Nematoda

- Traditionally, they are divided into two classes:
- **First: Class Adenophorea or Aphasmodia Characterized by:**
 1. Amphids always post-labial, variable shape, pore-like to elaborate.
 2. Phasmids are absent.
 3. Simple non-tubular excretory system when present.
 4. Both sexes with single gonad.
 5. Male with one spicule.
 6. Caudal alae are rare.
 7. Mostly free living and some parasitic.

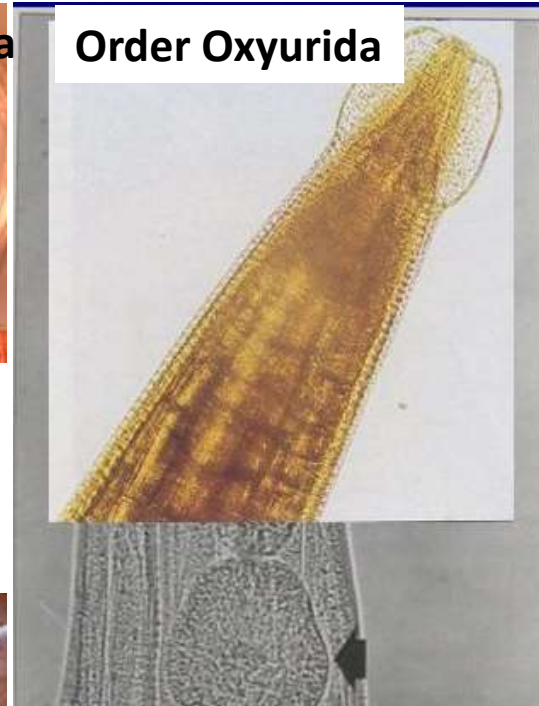
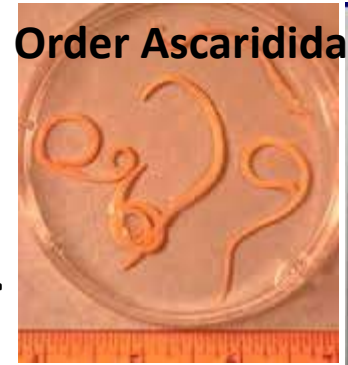


Second: Class Secernentea or phasmidia are the main class of nematodes, characterized by

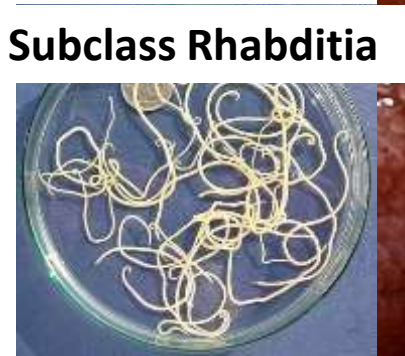
1. Amphids poorly developed.
2. Phasmid present.
3. An excretory system possessing lateral canals.
4. Female reproductive system is double.
5. Numerous caudal papillae.
6. Males with two spicules.



This class (phasmidia) contains:



1. Subclass Rhabditia
Order Rhabditida Order Strongylida
2. Subclass Spiruria
Order Ascaridida Order Oxyurida Order Spirurida



Hookworm:

- Kingdom: Animalia
- Phylum: Nematoda
- Class: Secernentea
- Order: Strongiloidae
- Family: Ancylostomatidae
- Genus: Necator/Ancylostoma
- Hookworm is a parasitic nematode that lives in the small intestine of its host, which may be a mammal such as a dog, cat, or human. Two species of hookworms commonly infect humans:

1. *Ancylostoma duodenale*.
2. *Necator americanus*.

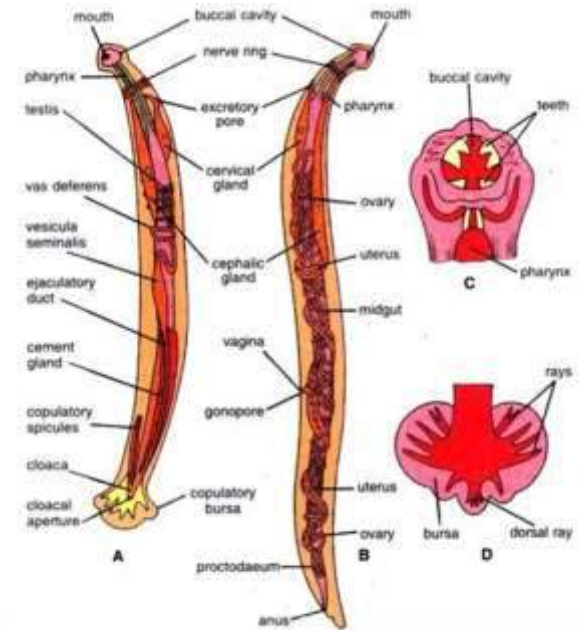


Fig. 47.1. *Ancylostoma duodenale*. A—Adult male; B—Adult female; C—Anterior end; D—Posterior end of male.



Geographic distribution:

1. Ancylostoma duodenale:

predominates in the Middle East, North Africa, India and in southern Europe.

2. Necator americanus:

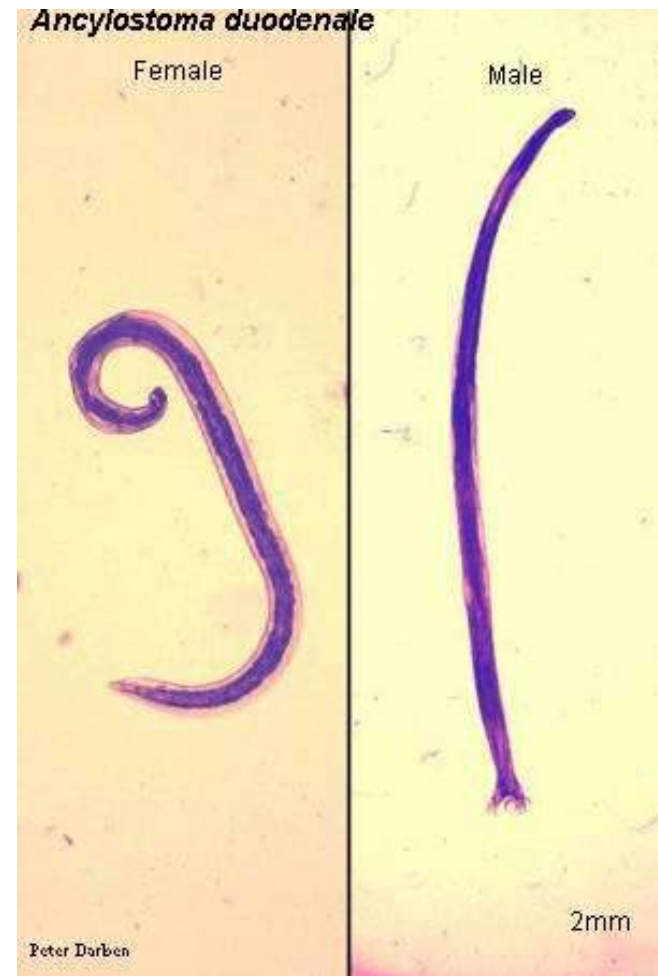
predominates in the Americas, Sub-Saharan Africa, Southeast Asia, China, and Indonesia.



Morphology

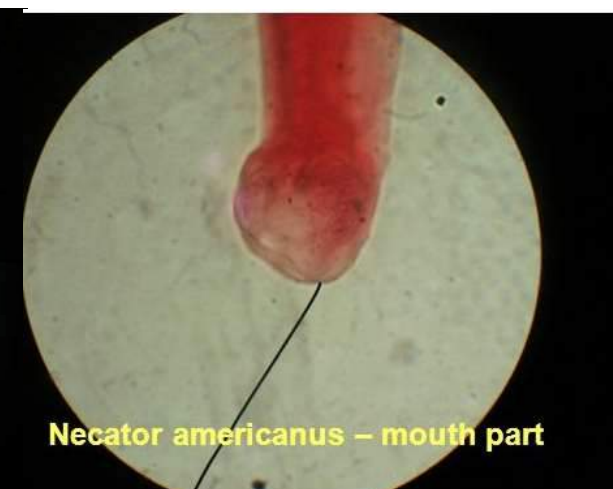
Ancylostoma duodenale worms are:

- Grayish white or pinkish with the head slightly bent in relation to the rest of the body. This bent forms a definitive hook shape at the anterior end for which hookworms are named.
- They have two ventral plates at the anterior margin of the buccal capsule. Each of them has two large teeth that are fused at their bases. A pair of small teeth can be found in the depths of the buccal capsule.
- Males are **8 - 11 mm** long with a copulatory bursa at the posterior end. It also has needlelike spicules which are not fused and have simple tips.
- Females are **10 mm to 13 mm** long with the vulva located at the posterior end and can lay **10,000 -30,000** eggs per day. Their life span is one year.



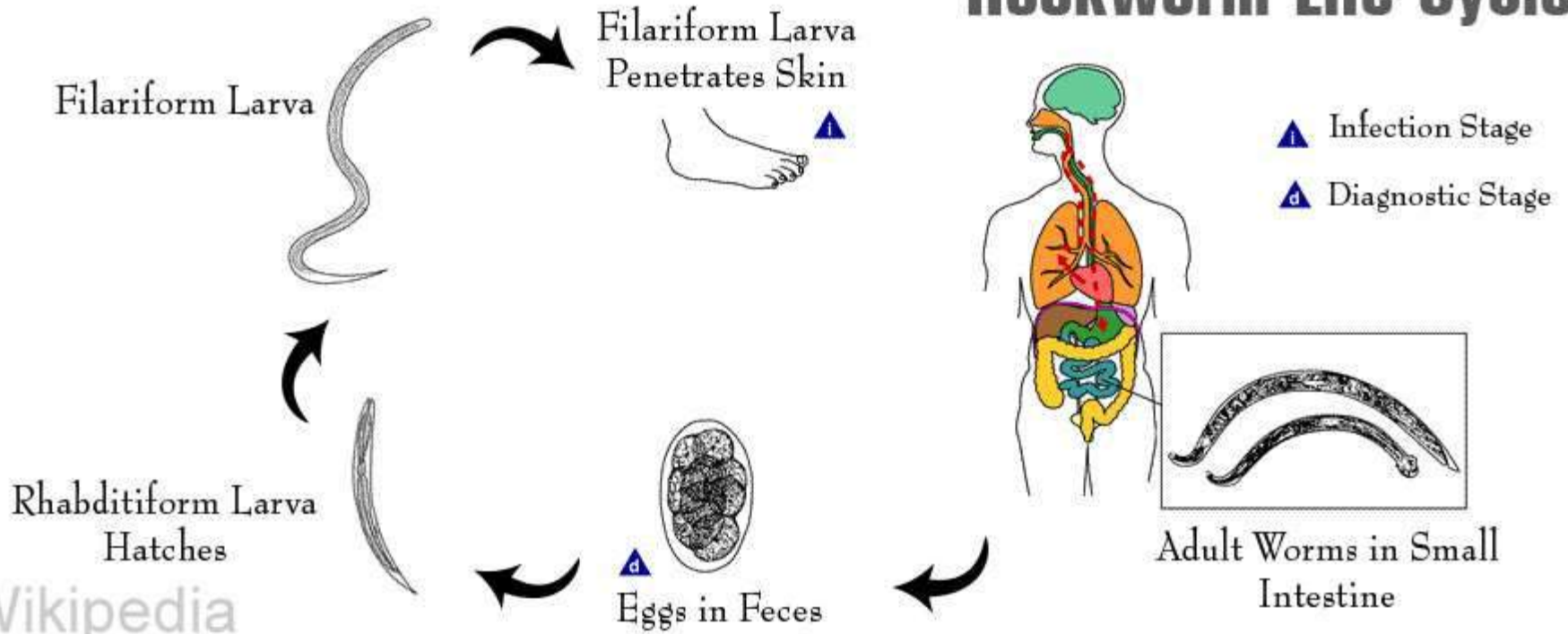
Necator americanus

- *N. americanus* is very similar in morphology to *A. duodenale* but; They are generally smaller than *A. duodenale*.
- The hook shape is much more defined in *Necator* than in *Ancylostoma*.
- They have two dorsal and two ventral cutting plates around the anterior margin of the buccal capsule.
- They also have a pair of subdorsal and a pair of subventral teeth that are located close to the rear,
- Males are usually **7-9mm long**, while females are about **9 -11mm long**,
- The typical life span of these parasites is **3-5 years**.
- They can produce between **5000 to 10,000 eggs per day**.



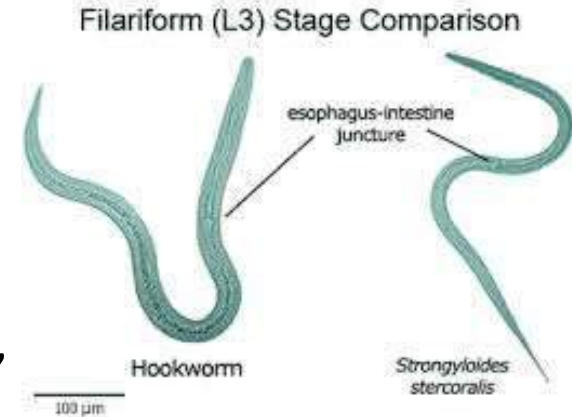
Life cycle hook worm

Hookworm Life Cycle



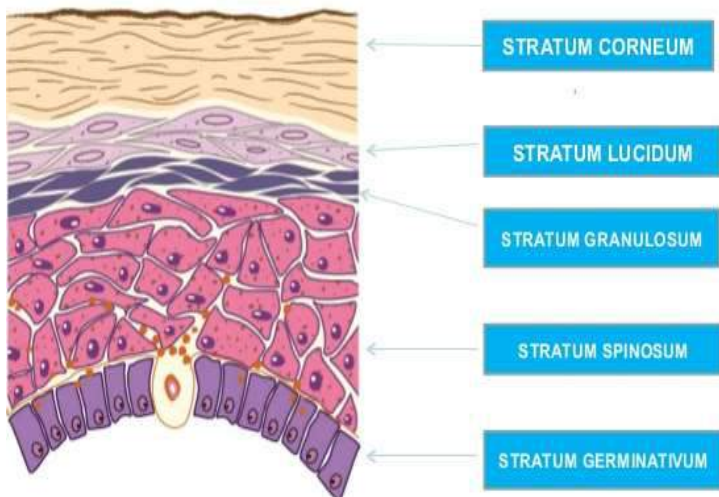
Pathology and clinical features:

- There are no specific symptoms or signs of hookworm infection; they arise from a combination of intestinal inflammation and progressive iron/protein- deficiency anemia.
- Hookworm disease can produce an itchy rash, often called ground itch, at the site of initial skin infection,
- ❖ **When the hookworm larvae are present in the lungs**, coughing with or without bloody sputum may result.
- ❖ **When present in the intestines**, hookworm infection usually does not produce any recognizable symptoms. However, some people may experience diarrhea, abdominal pain, intestinal cramps, and nausea.
- Chronic or persistent hookworm disease can cause anemia due to blood loss, especially in people with poor health or in pregnant women.



- ***Animal hookworm larvae (Ancylostoma braziliense) when penetrating humans skin may produce a skin disease called cutaneous larva migrans (CLM) Sometimes referred to as "creeping eruption" or "ground itch" .***
- **The larvae migrate in tortuous tunnels in between **stratum germinativum** and **stratum corneum** of the skin, causing **serpiginous vesicular lesions**. With advancing movement of the larvae, the rear portions of the lesions become **dry** and **crusty**.**

Layers of the epidermis

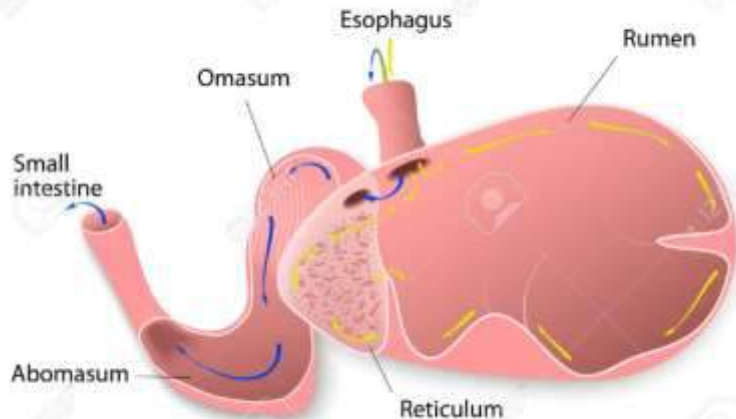


Species	<i>Necator americanus</i>	<i>Ancylostoma duodenale</i>
Common Name	New world hookworm	Old world hookworm
Disease	Necatoriasis, Uncinariasis	Ancylostomiasis, Wakana disease
Infective stage	Filariform larva (L3)	
Definitive Host	Human	
Mode of Transmission	Skin > Mouth	Mouth > Skin
Habitat	Small Intestine (jejunum, ileum)	Small Intestine (duodenum, jejunum)
Mode of Attachment	Oral attachment to mucosa by sucking	
Mode of Nutrition	Sucking and Ingesting of blood	
Laboratory diagnosis	finding worm eggs on microscopic examination of the stools, usually segmented ovum, with 4 to 8 blastomeres.	
Treatment	Albendazole, Mebendazole, or Pyrantel Pamoate	
Shape	Head curved opposite to curvature of body, giving a hooked appearance to anterior end	Head continuous in same direction as the body
copulatory bursa	Bipartite dorsal ray	Tripartite dorsal ray
Egg output / female / day	5,000-10,000 0.03 ml	10,000-30,000 0.15-0.23 ml
Blood loss / worm /day		

Haemonchus contortus

- *Haemonchus contortus*, also known as **red stomach worm**, **wire worm** or **Barber's pole worm**: is very common parasite and one the most pathogenic nematode of ruminants.
- Adult worms are attached to **abomasal mucosa** and feed on the **blood**. This parasite is responsible for **anemia**, **bottle jaw**, and **death of infected sheep and goats**, mainly during summer months in warm, humid climates.
- The infection, called **Haemonchosis**, causes large economic losses for farmers around the world, especially for those living in the warmer climates.

RUMINANT STOMACH



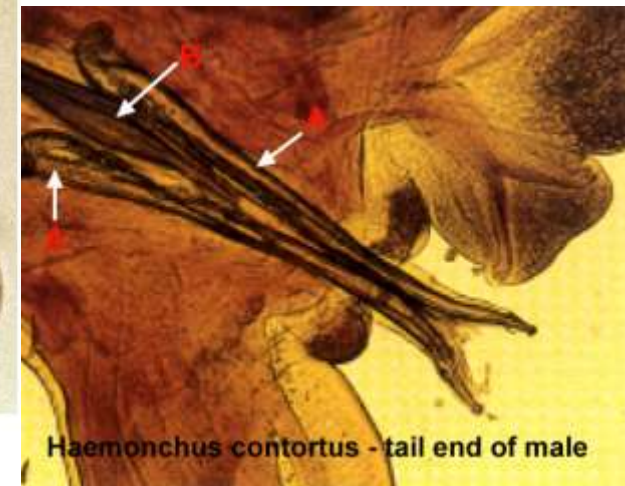
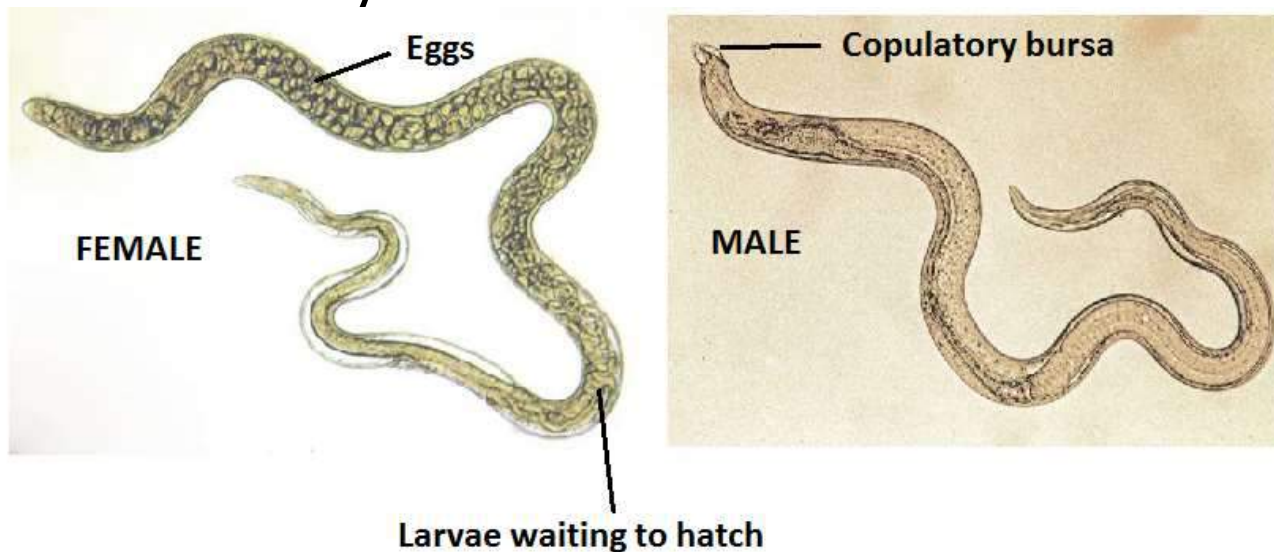
Scientific classification

- Kingdom : Animalia
- Phylum: Nematoda
- Class: Cesternentea
- Order: Strongylida
- Genus: Haemonchus
- Species: contortus

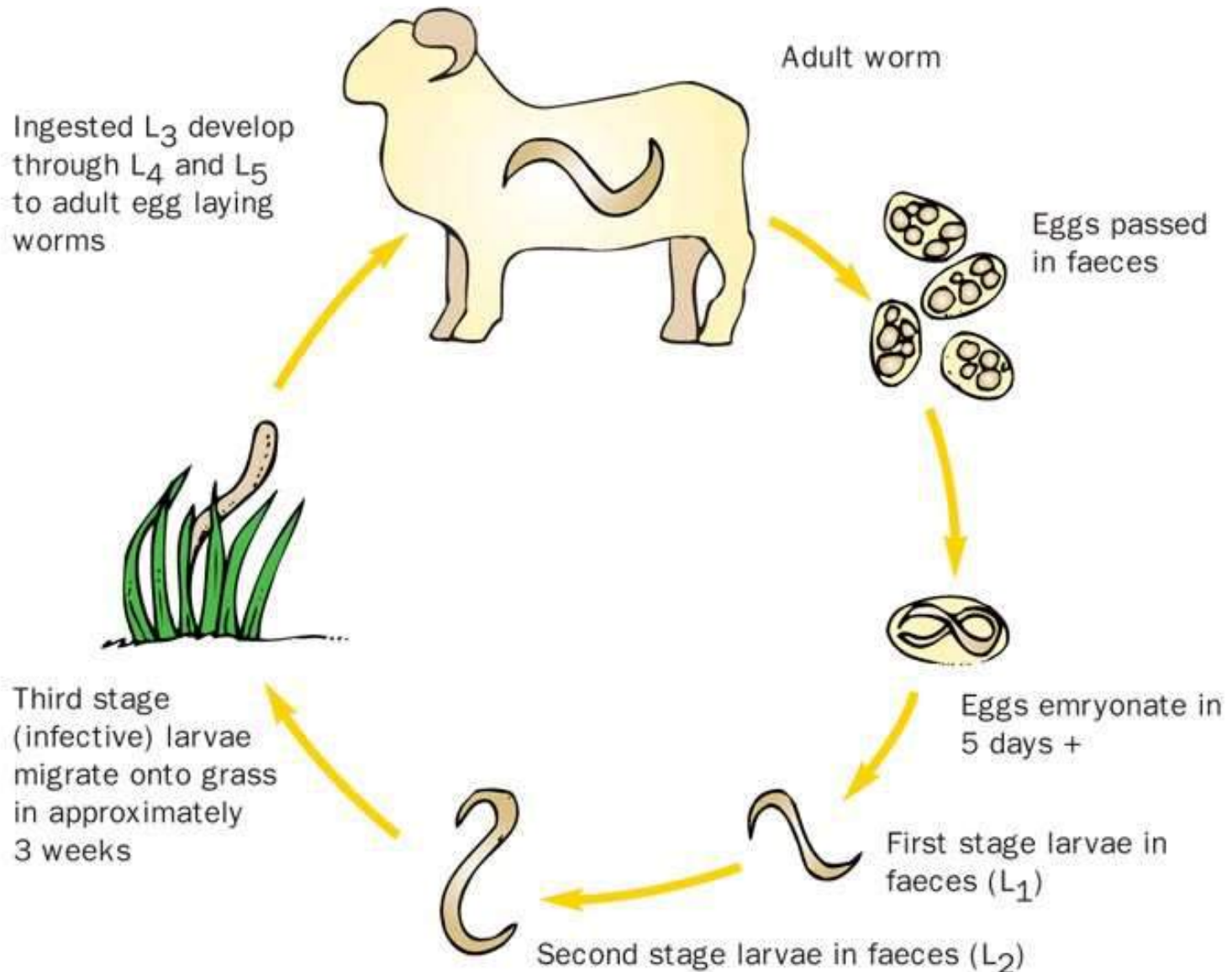


Morphology:

- **The adult female worm:** is **18-30 mm** long and is easily recognized by its trademark “**barber pole**” coloration.
- The red and white appearance is due to the fact the *Haemonchus contortus* is a blood feeder and is due to the white ovaries that coil around the intestines which are filled with blood.
- **The male adult worm:** is much smaller at **10—20 mm** long and displays the distinct feature of a well-developed copulatory bursa, containing an asymmetrical dorsal lobe and a **Y shaped** dorsal ray.



Life cycle of *Haemonchus contortus*



Pathogenicity:

- The nematode piercing the **abomasum** causes a number of significant complications in the **infected ruminants** that can lead to death.
- The infected animals can display **severe dehydration, diarrhea, unthrifty appearance, lethargy, depressed low energy behavior, rough hair coat and uncoordinated movements.** Furthermore, **significantly reduced growth and poor reproductive performance** has been observed.
- **The accumulation of fluid in the abdomen, gut wall, thoracic cavity and submandibular tissue - a phenomenon commonly called "bottle jaw",** also is a common association with this infection. **Severe blood loss, white mucous membranes, and anemia** are common complications of the infection.



Dioctophyme renale

- ***Dioctophyme renale*** is commonly referred to as “giant kidney worm” because it is the largest helminthes to parasitize humans and has the propensity to affect the kidneys.

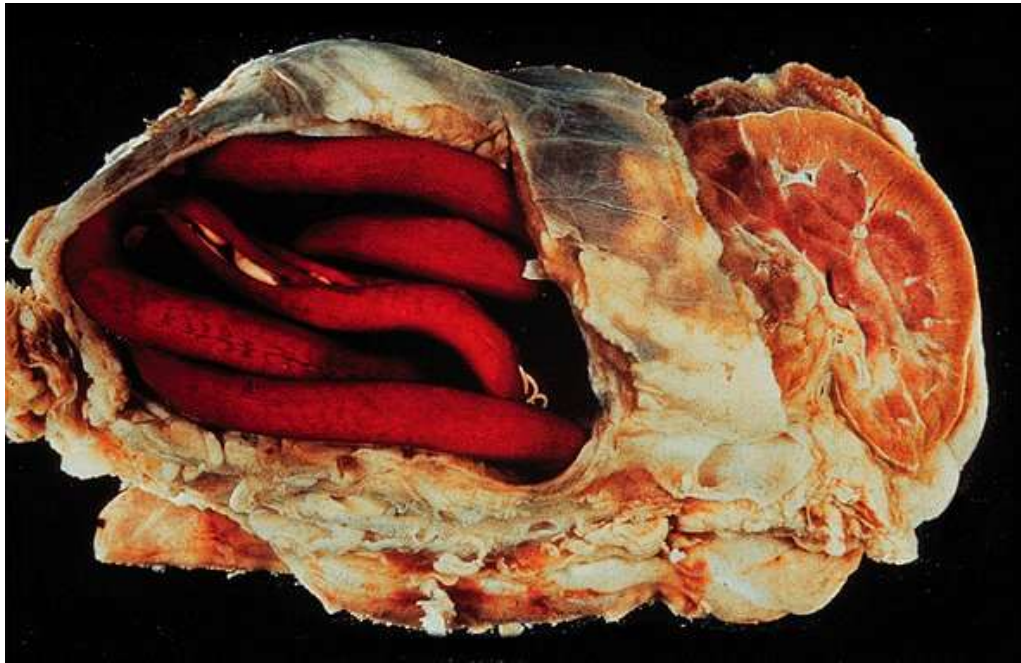


Adult *Dioctophyme renale*, aptly called the giant kidney worm, removed from the kidney of a dog



Dioctophyme renale

- *D. renale* is distributed worldwide, but is less common in Africa and Oceania.
- It affects **fish eating mammals**, particularly **mink and dogs**.
- **Human infestation is rare**, but results in **destruction of the kidneys**.
- Upon diagnosis through **tissue sampling**, the only treatment is **surgical excision**.



- **Kingdom:** Animalia
- **Phylum:** Nematoda
- **Class:** Secernentea
- **Order:** Ascaridida
- **Family:** Dioctophymatidae
- **Genus:** Dioctophyme
- **Species:** *D. renale*



Morphology:

- *D. renale* is the largest helminth to parasitize humans.
- **Adult male worms** are 20-40 cm long and 5-6 mm wide.
- **Females** can grow to 103 cm in length with a width of 10-12 mm.
- Both sexes appear bright red in color and taper at both the anterior and posterior ends.
- **Male *D. renale* worms** have a bursa, which is used to attach to facilitate mating.
- **Eggs** are (60-80) x (39-47) micrometers, contain an embryo, and have characteristic sculpturing of the shell.
- They have an oval-shape and brownish-yellow hue.
- Eggs have a thick shell, and the surface appears to be pitted except at the poles.

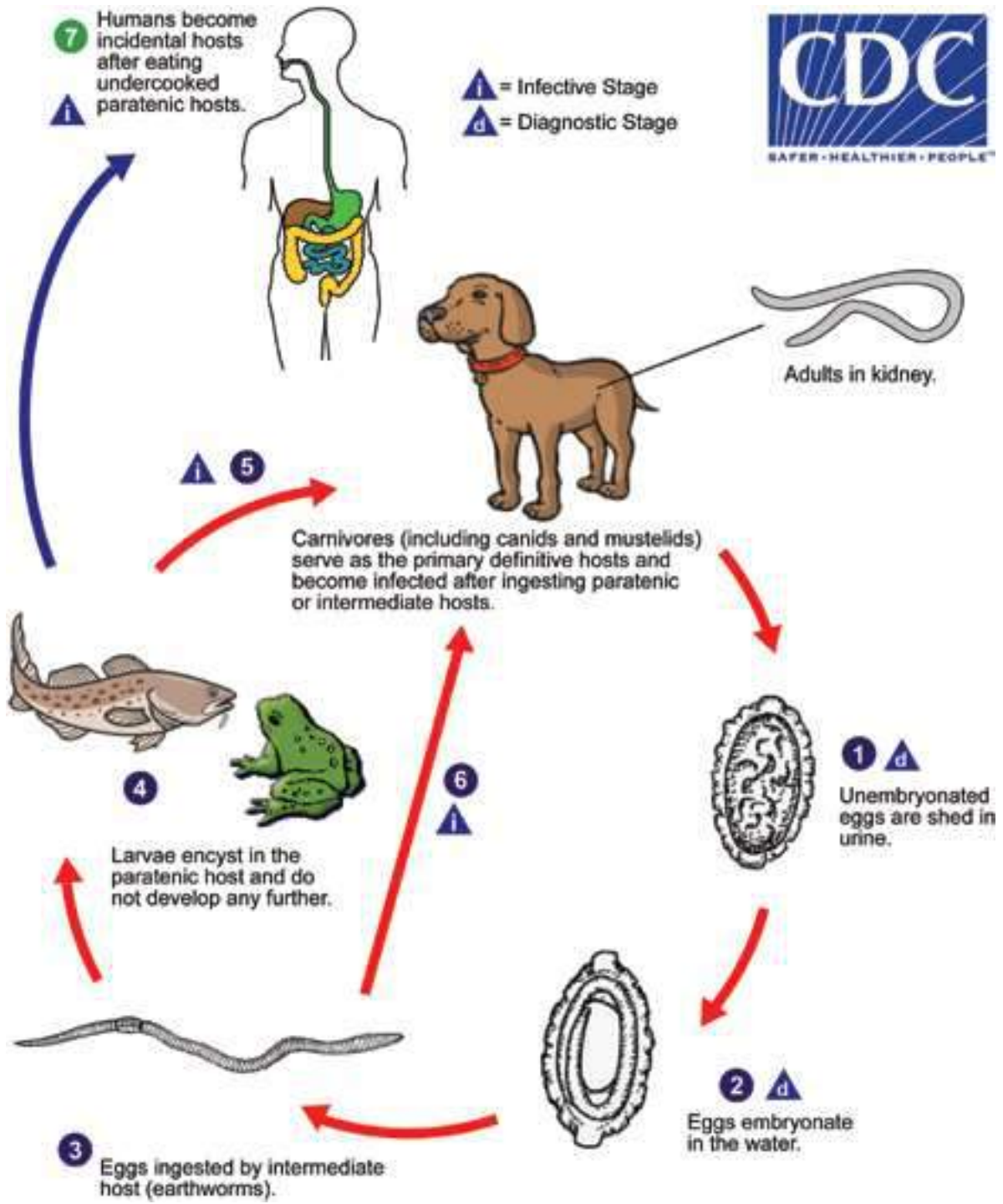


Barrel-shaped egg of *Diocotophyme renale* with the characteristic indistinct bipolar plugs and heavily pitted surface



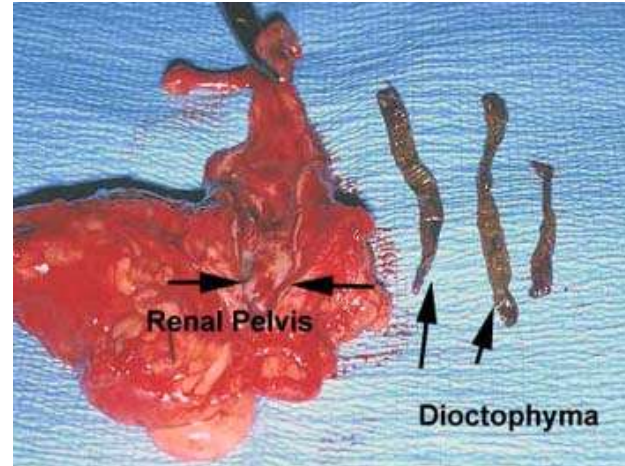
7 Humans become incidental hosts after eating undercooked paratenic hosts.

i = Infective Stage
d = Diagnostic Stage



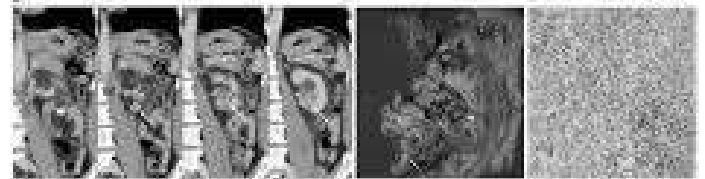
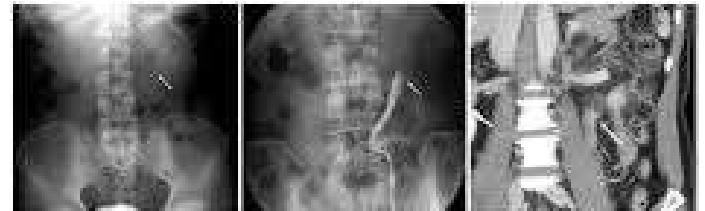
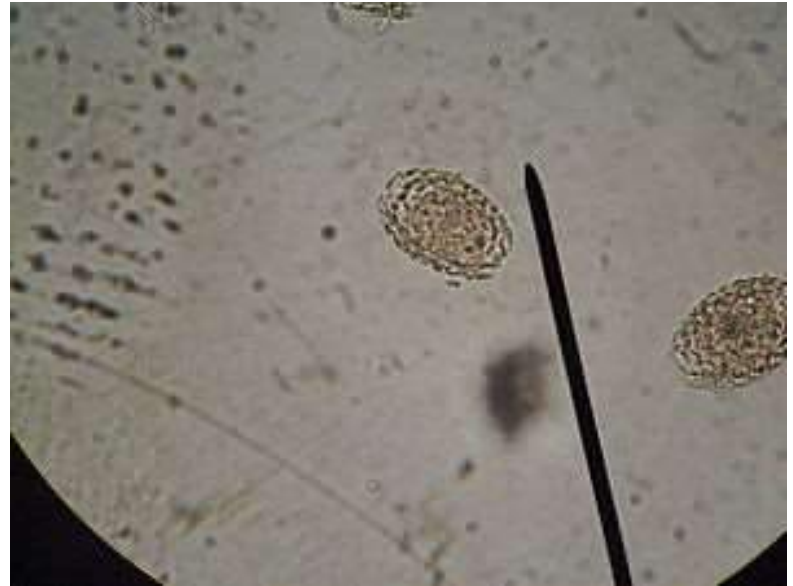
Clinical presentation in humans:

- Individuals with *D. renalis* infection typically present with unspecific
- **Symptoms including:**
- Hematuria (blood in urine).
- Nephritis.
- Loin pain.
- Renal enlargement.
- Renal colic (intermittent pain in the kidney area), which may result from the rare migration of worms through ureters.
- Adult worms typically only infect one kidney. The kidney is destroyed because of fibrosis, the development of excess fibrous connective tissue.
- Renal function is typically limited because the non-infected kidney is usually capable of assuming the increased work. However, parenchymal inflammation can lead to death in extreme circumstances.



Diagnosis:

- The only means of obtaining a definitive diagnosis is through: identification of *D. renale* eggs in a patient's urine.
- **Radiological test** to search for enlarged or calcified kidneys.
- **Urinalysis** will likely show hematuria.
- **Blood tests** may reveal eosinophilia.



Treatment

- For *D. renale* infection in humans the only means of known means is
- surgical excision of either adult worms or the infected kidney.
- Nephrectomy is generally considered extreme for human cases.
- The use of anti-helminth drugs has not yet been evaluated as the proper
- course of action to treat this infection

Trichinella spiralis

- Kingdom: Animalia
- Phylum: Nematoda
- Class: Adenophorea
- Order: Trichurida
- Family: Trichinellidae
- Genus: Trichinella
- Species: *Trichinella spiralis*
- **Trichinella spiralis** is a nematode parasite, occurring in rats, pigs, and humans, and is responsible for the disease trichinosis. It is sometimes referred to as the "pork worm" due to it being found commonly in pork or rat products that are undercooked



- Trichinella species are the **smallest nematode parasite of humans**, which has an unusual life cycle and one of the most widespread and clinically important parasites in the world.
- The small adult worms **mature in the intestine of an intermediate host** such as a **pig**.
- Humans can be infected by eating **infected pork or wild carnivores such as fox, cat or bear**.



Trichinosis:

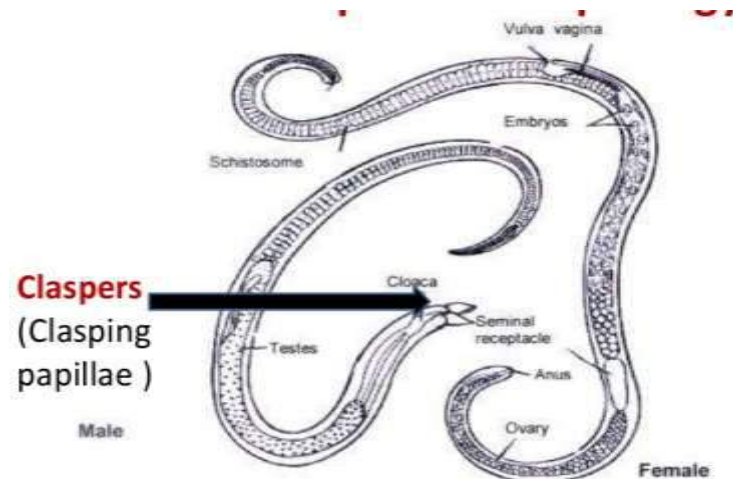
- Trichinosis, also called trichinellosis, or trichiniasis, is a parasitic disease caused by eating raw or undercooked pork or wild game infected with the larvae of a species of roundworm *Trichinella spiralis*, commonly called the trichina worm.
- There are eight *Trichinella* species', five species are **encapsulated** and three are **non-encapsulated**.
- Only three *Trichinella* species are known to cause trichinosis:

1. *T. spiralis.*
2. *T. nativa.*
3. *T. britovi.*



Morphology:

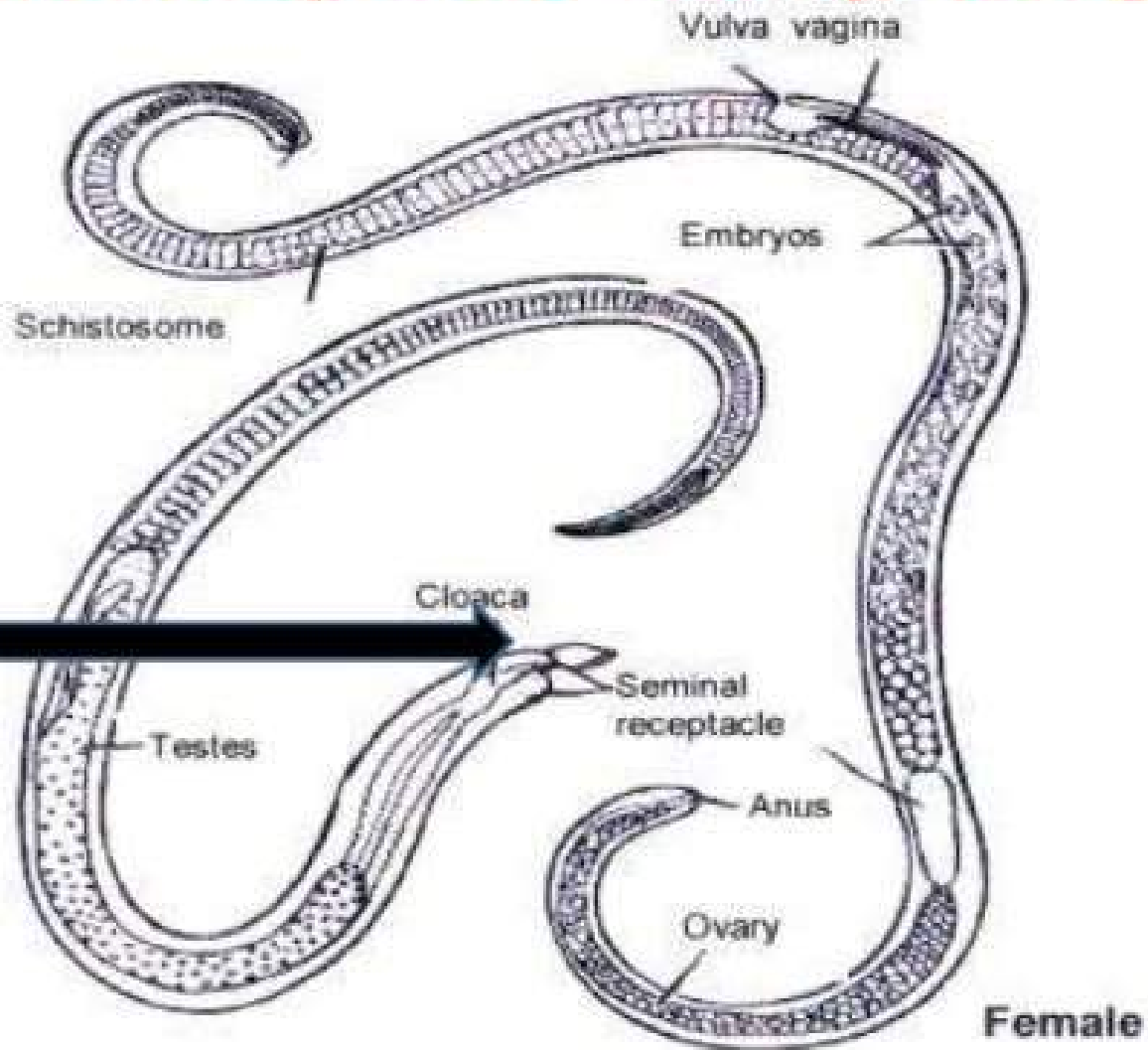
- **Males of T. spiralis** measure between 1.4 mm to 1.6 mm long and are flat anteriorly than posteriorly.
- The anus can be found in the terminal (side) and they have a large copulatory pseudobursa on each side.
- **Females of T. spiralis** are about twice the size of the males and have an anus found terminally.
- The vulva is located near the esophagus.
- The single uterus of the female is filled with developing eggs in the posterior portion, while the anterior portion contained the fully developed juveniles.
- Female trichinella worms live for about six weeks and in that time can produce up to 1,500 larvae; where eventually a spent female dies and passes out of the host

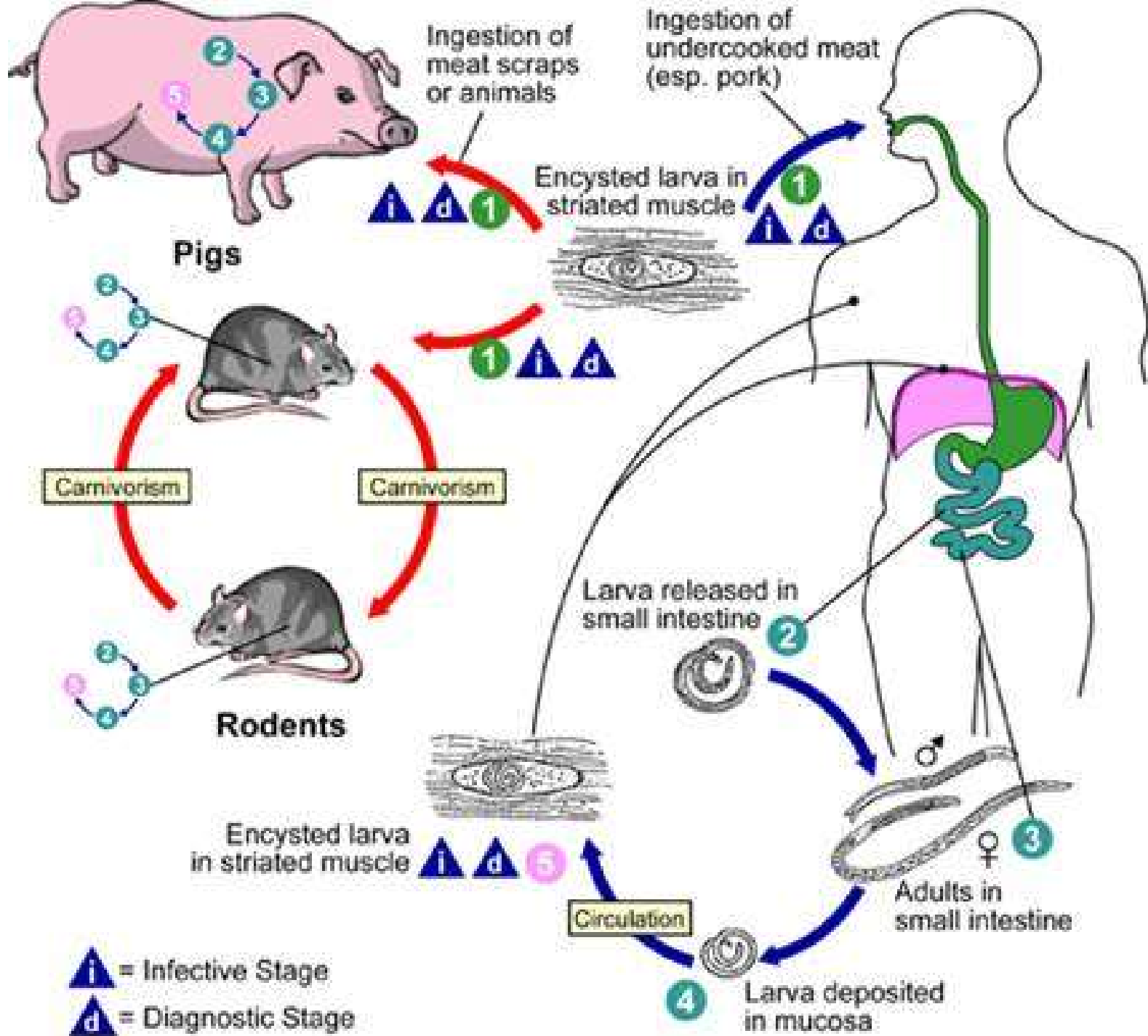


Trichinella spiralis- Morphology

Claspers
(Clasping papillae)

Male





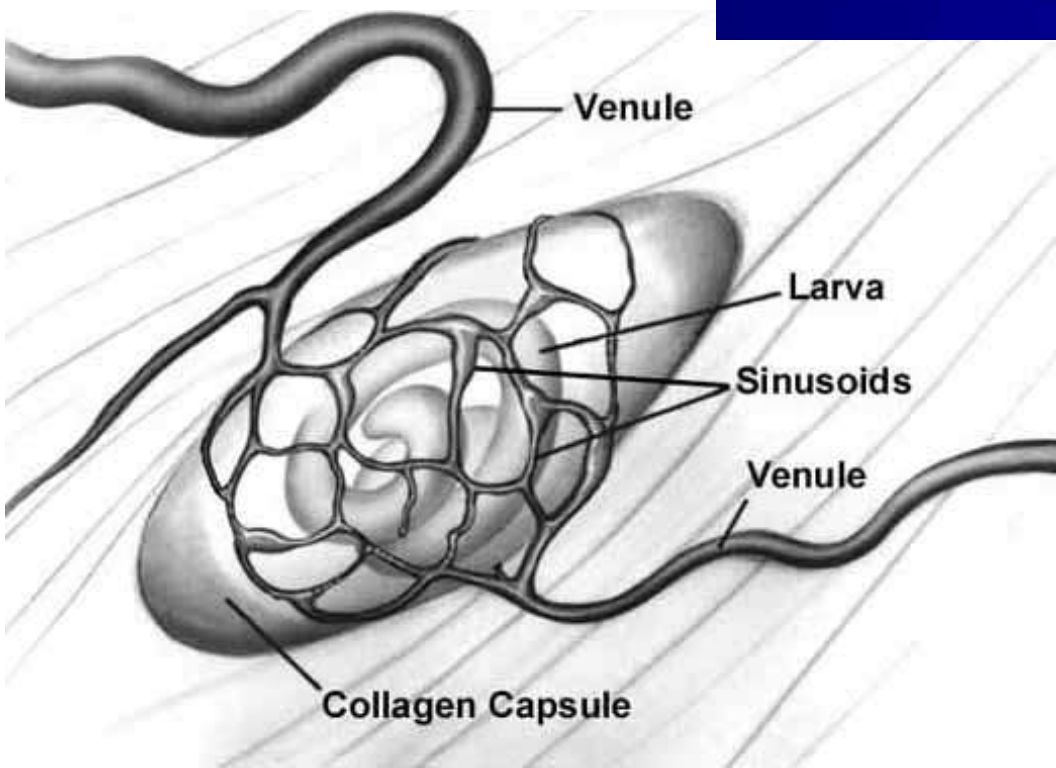
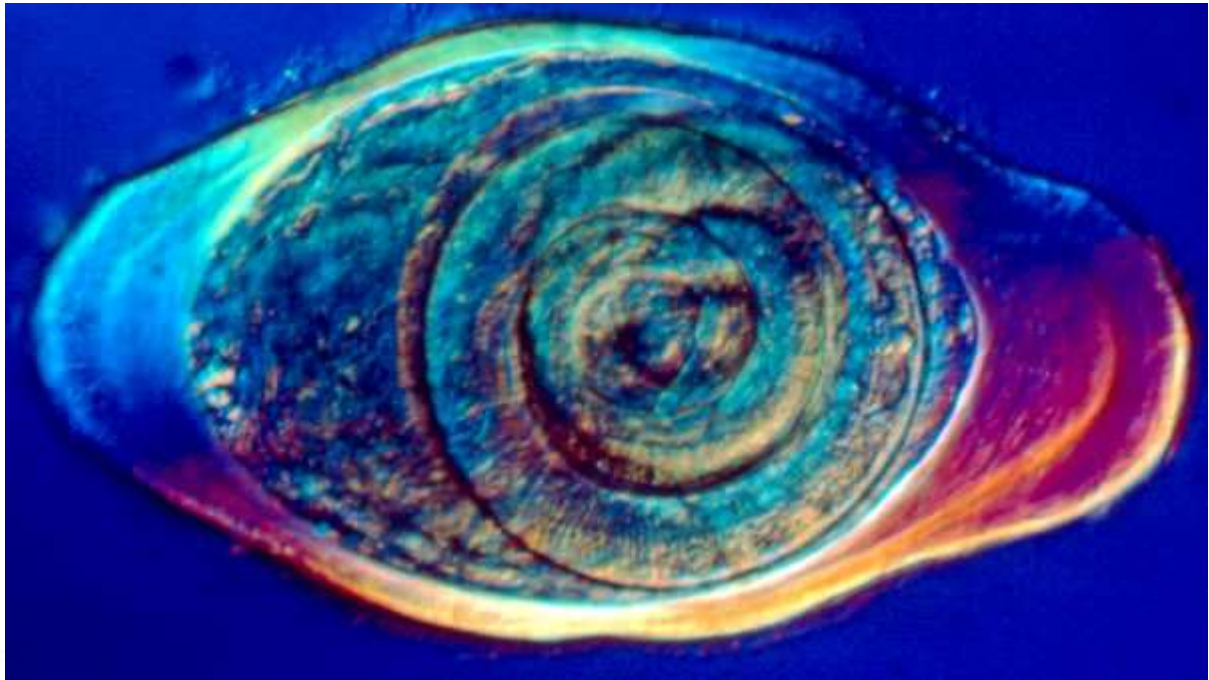
Nurse Cell Formation:

- **The Nurse cell** is a unique consequence of the host cell's association with the infectious L1 larva of *T. spiralis*. It presumably functions to nourish it as well as protect it from host immune responses.
- **The mature Nurse cell** is morphologically distinct from any other mammalian cell type; no other pathological condition induces such a radically different, and yet functional cell.
- **The Nurse cell-parasite complex** can survive in the human host for up to 30 years, and in most other species of mammal for the life span of the animal. For this to occur, the worm must immuno-suppress the host.

Nurse cell formation

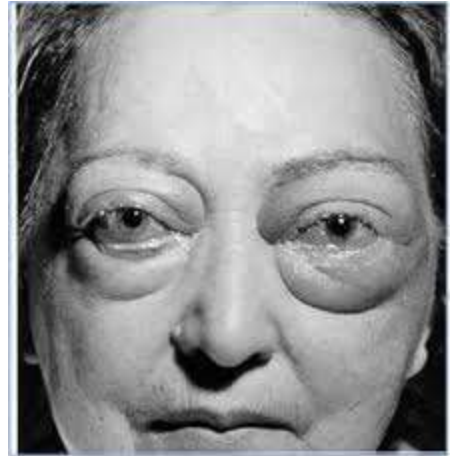
- Nurse cell formation in skeletal muscle tissue is mediated by the hypoxic environment surrounding the new vessel formation.
- ↓
- The hypoxic environment stimulates cells in the surrounding tissue to up-regulate and secrete **angiogenic cytokines**.
- ↓
- These cytokines allow for the newborn *T. spinalis* larva to enter and form the nurse cell.
-
- ❖ Previous studies have shown that cytokines can stimulate proliferation of synthesis of **collagen type 1** in activated myofibroblast like cells.





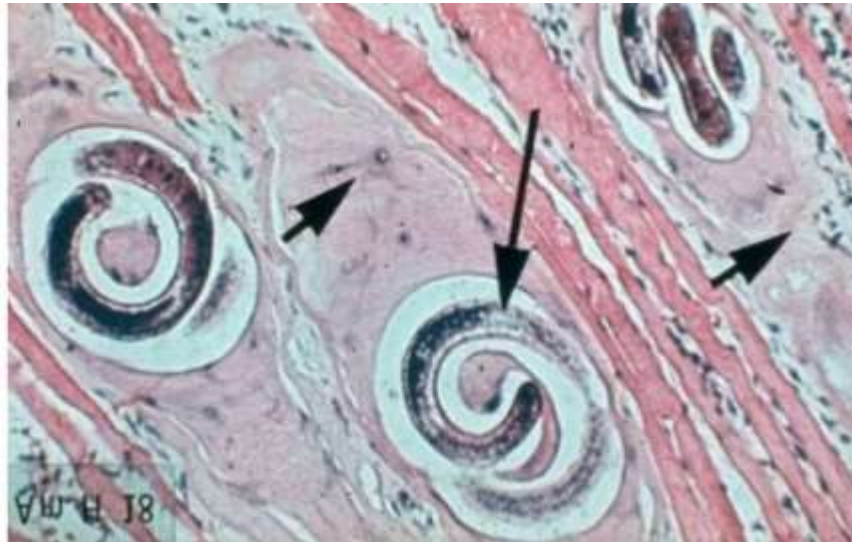
Symptoms:

- The first symptoms may appear between 12 hours and two days after ingestion of infected meat.
- **The migration of worms in the intestinal epithelium** can cause traumatic damage to the host tissue and the waste products they excrete can provoke an immunological reaction.
- The resulting inflammation can cause symptoms such as nausea, vomiting, sweating and diarrhea.
- Five to seven days after the appearance of symptoms facial edema and fever may occur.
- After 10 days intense muscular pain, difficulty breathing, weakening of pulse and blood pressure, heart damage and various nervous disorders may occur, eventually leading to death due to heart failure, respiratory complications or kidney malfunction.



Diagnosis:

- Muscle biopsy is used for trichinosis detection.
- Serological tests and microscopy can be used to confirm a diagnosis of trichinosis. Serological tests include a blood test for eosinophilia, increased levels of creatine phosphokinase, and antibodies against newborn larvae.
- Immunoassays such as ELISA can also be used

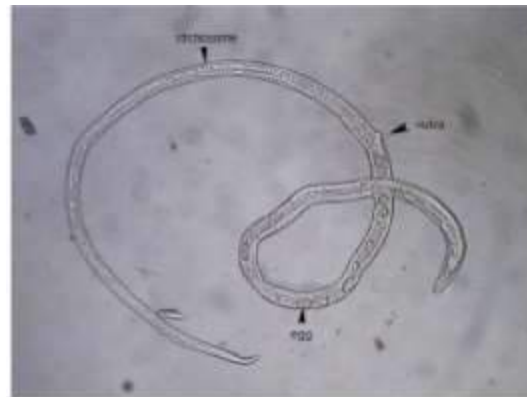
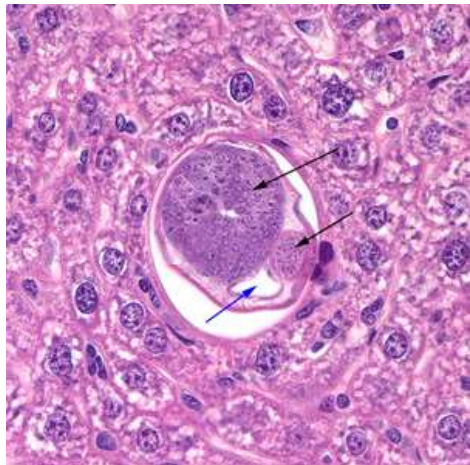


Treatment:

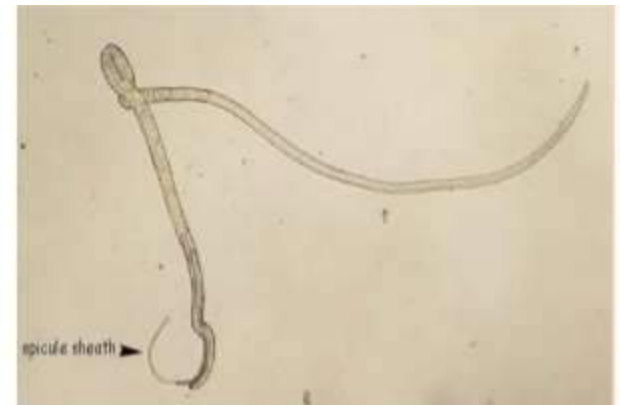
- Typically patients are treated with either Mebendazole or Albendazole but efficiency of such products is uncertain. Symptoms can be relieved by use of analgesics and corticosteroids.

Capillaria spp. - Tiny Worms

- Capillaria spp. are nematodes, or roundworms. There are many different species infecting a wide range of vertebrate hosts—a few occasionally infect human hosts causing serious parasitic disease.
- Capillariasis is a disease caused nematodes in the Capillaria genus. The two principal forms of the disease are:
 - 1- **Hepatic capillariasis, caused by C.hepatica.**
 - 2- **Intestinal capillariasis, caused by C. philippinensis.**



Female

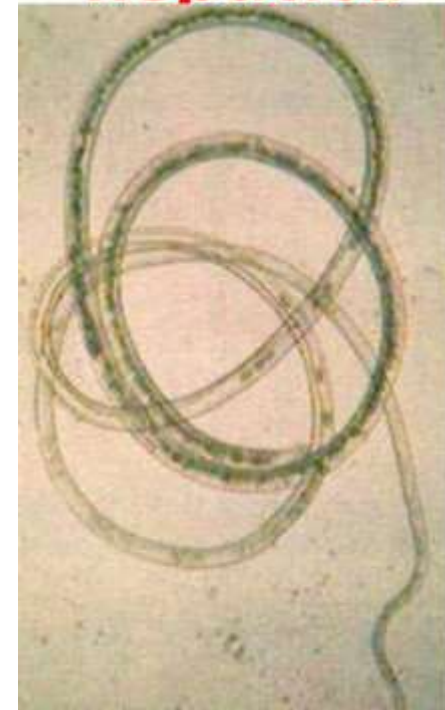


Male

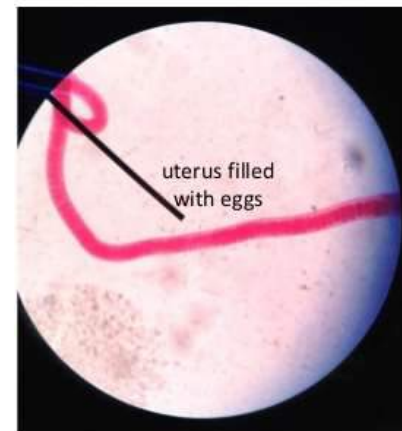
Scientific classification

- Kingdom: Animalia
- Phylum: Nematoda
- Class: Adenophorea
- Subclass: Enoplia
- Order: Trichurida
- Family: Trichinellidae
- Genus: *Capillaria*
- Species: *Capillaria hepatica phillippinensis*

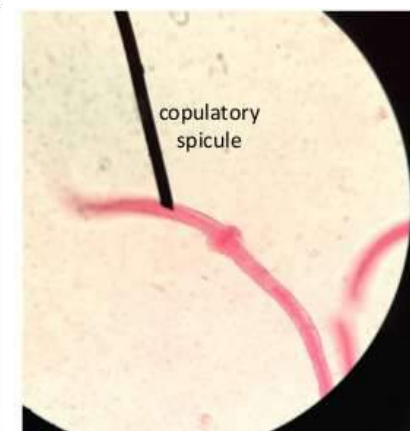
*Capillaria
hepatica*



Female

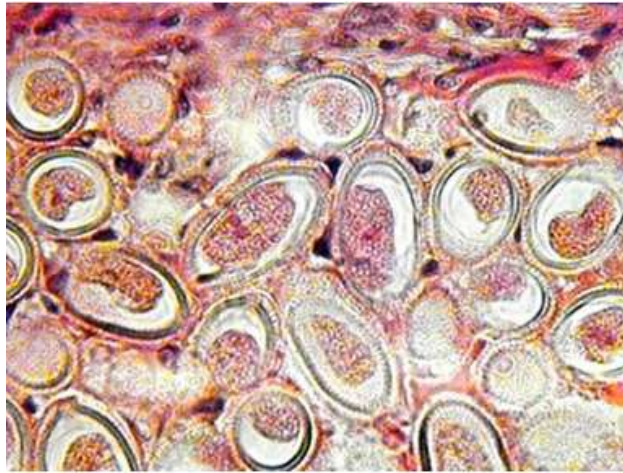


Male



Capillaria hepatica

- *Capillaria hepatica* is a parasitic nematode which causes hepatic capillariasis **in rodents** and numerous other mammal species, including man.
- The life cycle of *C. hepatica* may be completed in a **single host species**. However, the eggs, which are laid in the liver, must mature outside of the host body (in the environment) prior to infecting a new host. So the death of the host in which the adults reach sexual maturity, either by **being eaten or dying and decomposing**, is necessary for completion of the life cycle.



The life cycle of *C. hepatica*

- As the adult *C. hepatica* begin to die in the liver tissue.



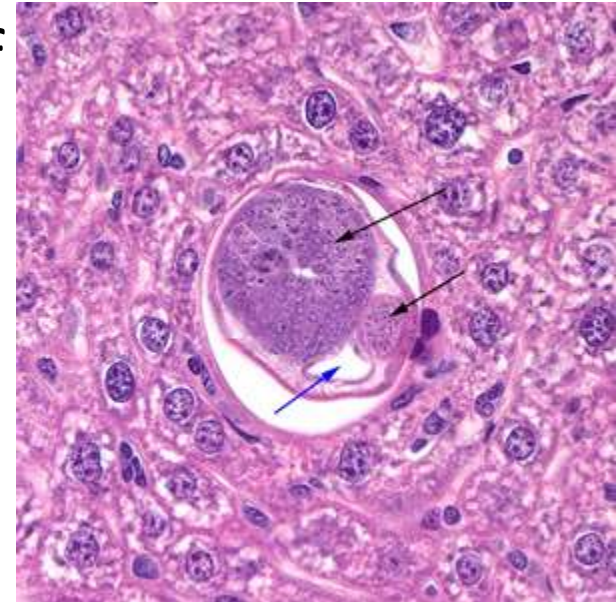
- Accelerates the immune response of the host.



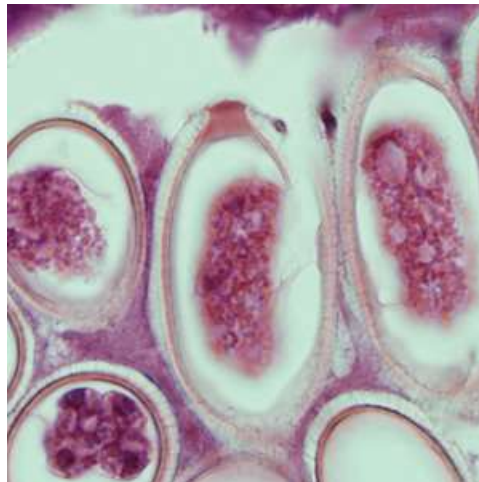
- This response leads to chronic inflammation and encapsulation of the dead worms in collagen fibers



- Septal fibrosis (abnormal connective tissue growth) and cirrhosis of the liver.



- The eggs in the liver exist in a state of arrested development; they are unable to develop into larvae until they spend some time outside of the host, in the environment.
- Escaping from the liver tissue may be accomplished by :
 1. The death and decomposition of the host's body.
 2. The consumption and digestion of the host by a predator or scavenger.



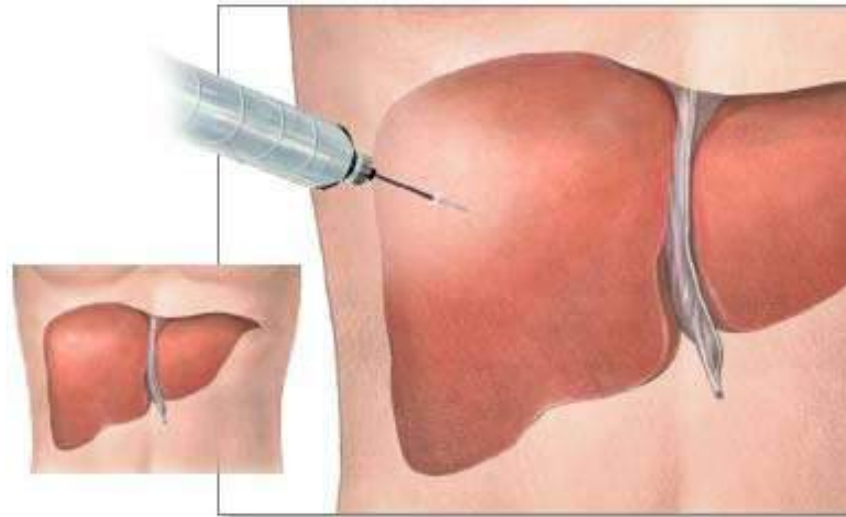
Symptoms:

- In human cases, symptoms of hepatic capillariasis include:
 1. Abdominal pain with fever and chills.
 2. Hepatitis (liver inflammation).
 3. Ascites (excess fluid in the peritoneal cavity).
 4. Hepatolithiasis (gallstones in the bile ducts).
 5. Hepatomegaly (enlarged liver).



Diagnosis:

- Diagnosis is made by finding eggs or adults of *C. hepatica* in liver biopsy samples.
- The encapsulated eggs and adults may appear as white nodules which measure 2-3 mm in diameter on the surface and interior of the liver at autopsy.



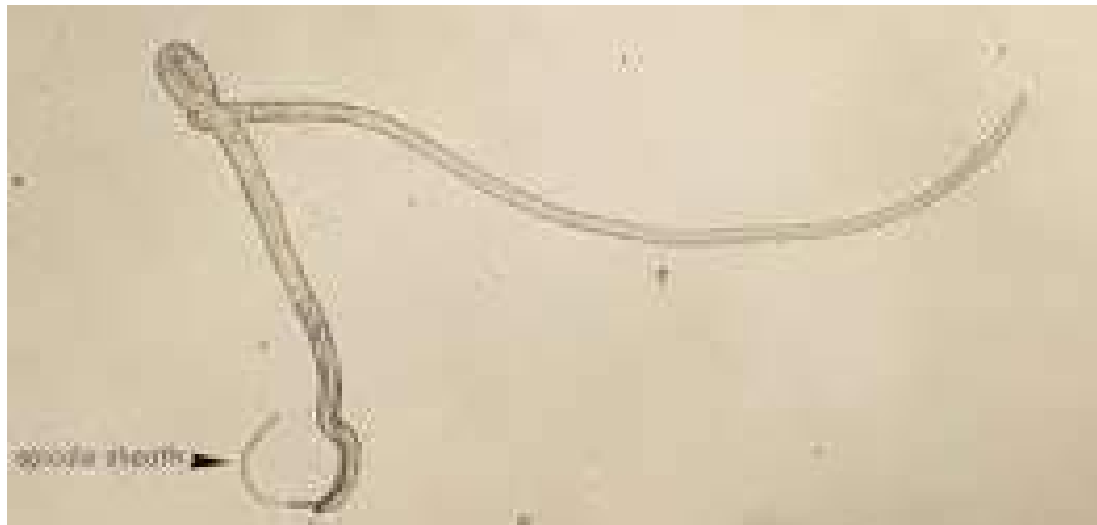
Biopsy needle is inserted and a sample of the liver is removed

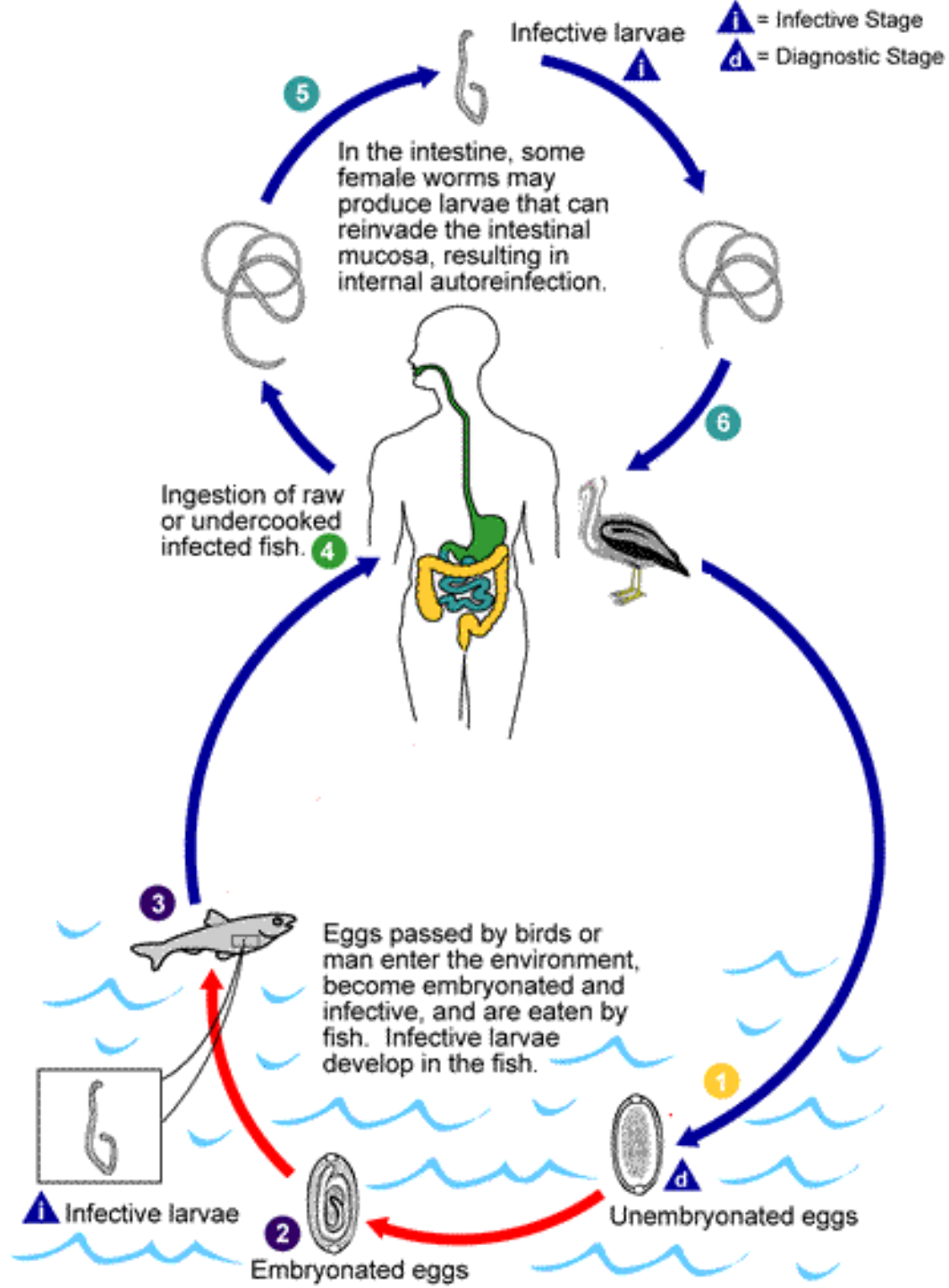
Treatment:

- Successful treatment of human cases with thiabendazole¹ or albendazole (with or without corticosteroids) have been reported

Capillaria philippinensis

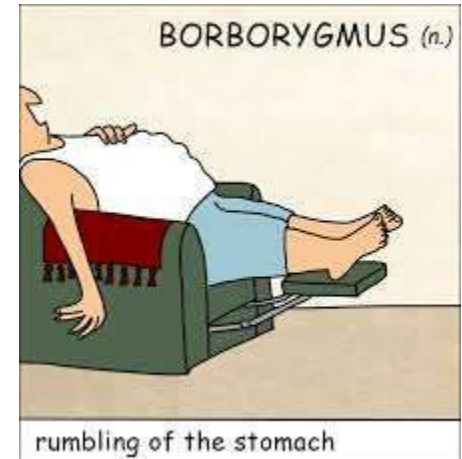
- *Capillaria philippinensis* is a parasitic nematode which causes intestinal capillariasis. This sometimes fatal disease.
- The natural life cycle of *C. philippinensis* is believed to involve **fish as intermediate hosts**, and **fish eating birds as definitive hosts**.
- Humans acquire *C. philippinensis* by **eating small species of infested fish whole and raw**.





Symptoms in infected humans include

- Watery diarrhea.
- Abdominal pain.
- Edema.
- Weight loss.
- **Borborygmus (stomach growling),**
- Depressed levels of potassium and albumin in the blood.
- ❖ In humans, the parasites damage the cells of the intestinal wall. This damage interferes with the absorption of nutrients and the maintenance of a proper electrolyte balance.
- ❖ Untreated *C. philippinensis* infestations are often fatal.



Diagnosis:

- Diagnosis usually involves finding the eggs and/or adults of *C. philippinensis* in stool samples.



- **Treatment:**
- Anthelmintics such as mebendazole and albendazole have been reported to eliminate infestation of humans more effectively than thiabendazole.

Prevention:

- Prevention is as simple as avoiding eating small, whole, uncooked fish. However, in *C. philippinensis* endemic areas, such dietary habits are common and have been practiced for many generations.

