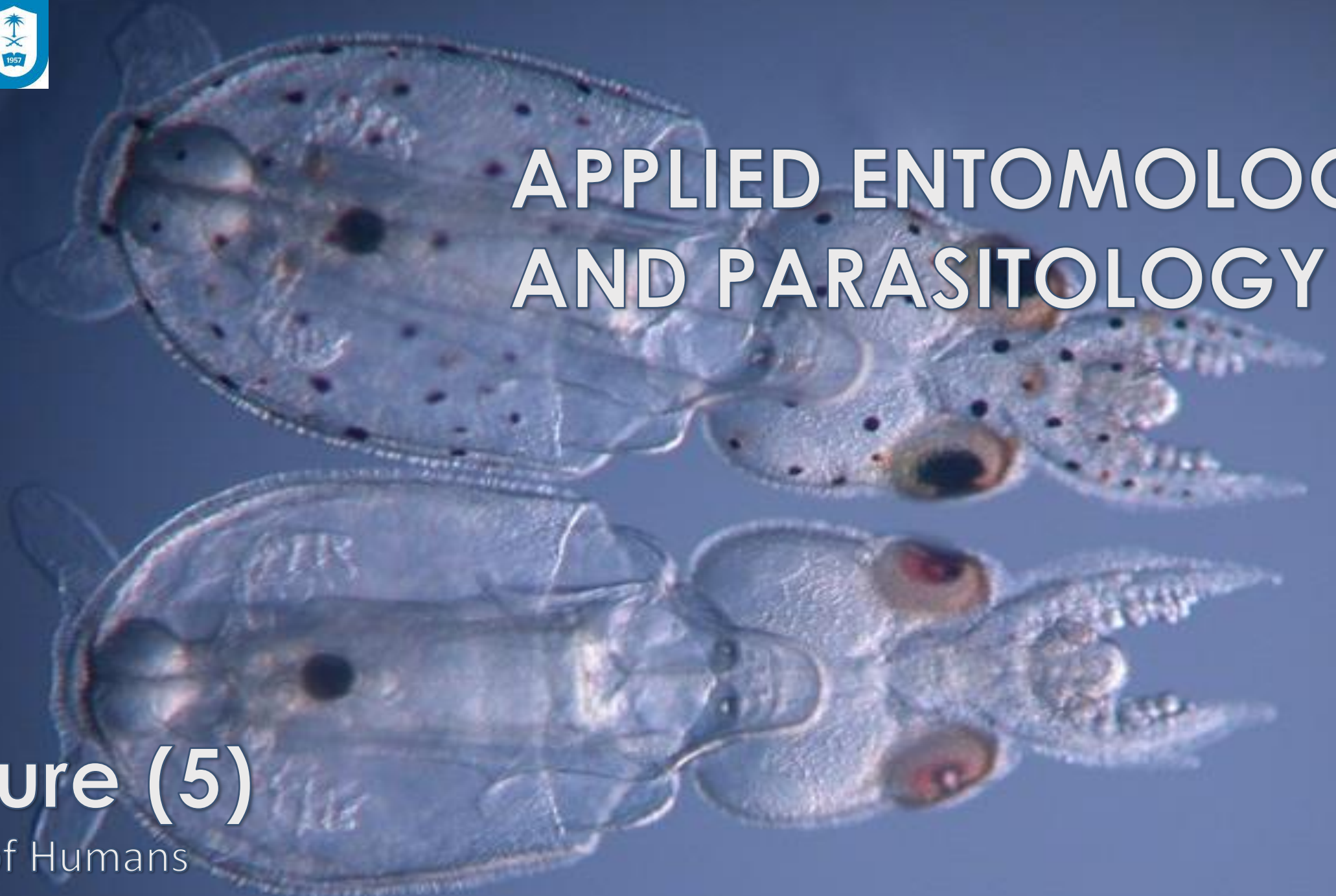


# APPLIED ENTOMOLOGY AND PARASITOLOGY

Z  
O  
O  
6  
1  
1

## Lecture (5)

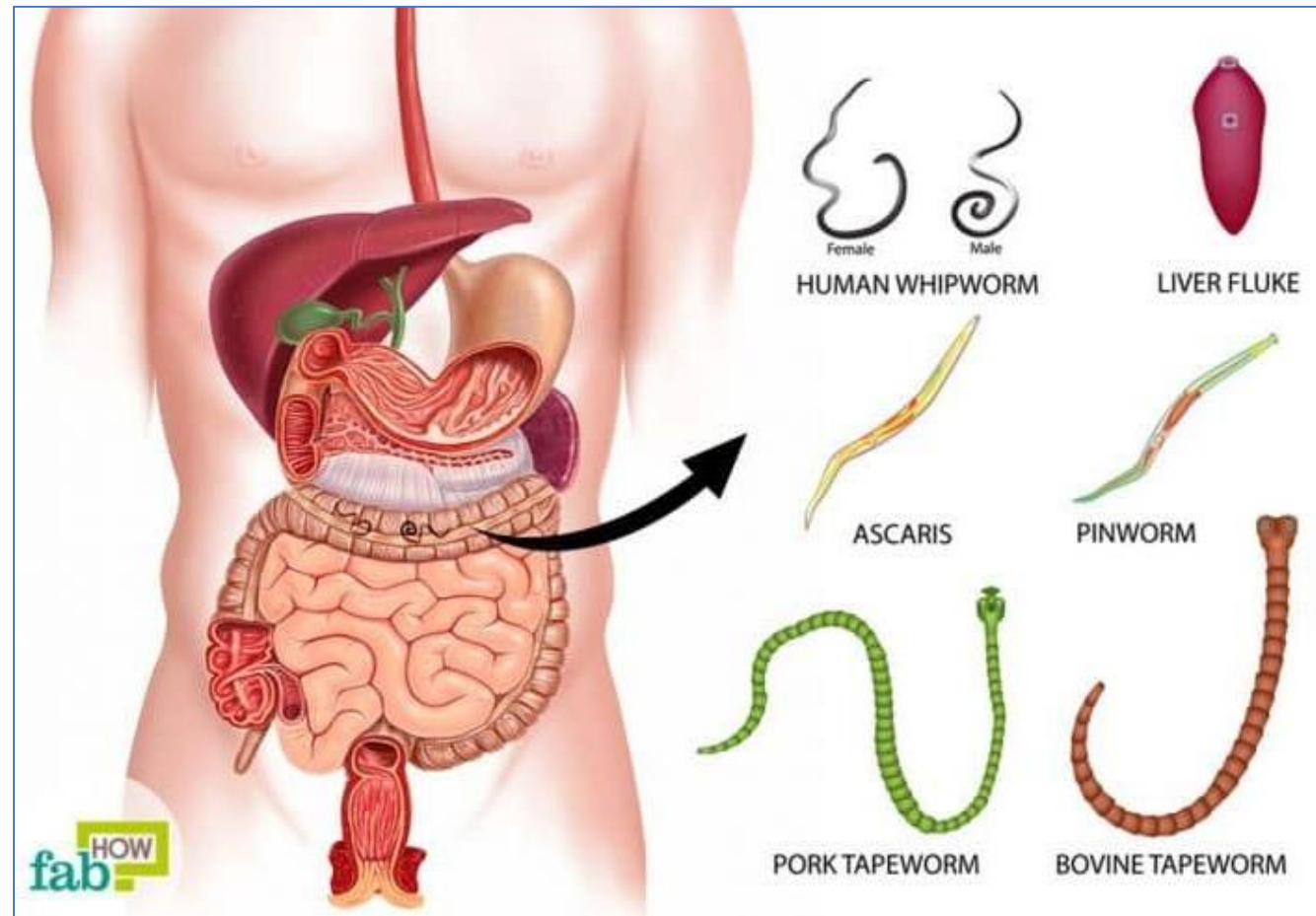
Worms of Humans



## Worms = Helminthes

Worms and its life cycles are different from those of the Protozoa, because most of them do not multiply immediately in their final hosts. There are many stages developed to adults as larvae or eggs have reached the host (e.g. by contaminated food). Proliferation may take place in the intermediate hosts (e.g. in the case of Trematodes).

The most important species of worms parasitizing humans belong to the so-called Platyhelminthes (with the groups **Trematoda** (= flukes) and **Cestoda** (= tapeworms) as well as the so-called **Nemathelminthes** (former: Aschelminthes), which are better known as roundworms.



# TREMATODES

**Trematoda** is a class within the **Phylum Platyhelminthes**. The class of trematodes includes only such parasites, which anchor themselves at the inner or outer surface of their hosts by the help of their **hold-fast apparatus (suckers)**.

They are internal parasites of **molluscs** and **vertebrates**. Most trematodes have a complex **LIFE CYCLE** with at least two hosts. The primary host, where the flukes sexually reproduce, is a vertebrate. The intermediate host, in which asexual reproduction occurs, is usually a snail.

## Etymology

Trematodes are commonly referred to as **flukes**. This term can be traced back to the Old English name for flounder, and refers to the flattened, rhomboidal shape of the worms.

***The flukes can be classified into two groups, on the basis of the system which they infect in the vertebrate host.***

- ❖ **Tissue flukes** infect the bile ducts, lungs, or other biological tissues. This group includes the lung fluke, *Paragonimus westermani*, and the liver flukes, *Clonorchis sinensis* and *Fasciola hepatica*.
- ❖ **Blood flukes** inhabit the blood in some stages of their life cycle. Blood flukes include species of the genus *Schistosoma*.

They may also be classified according to the environment in which they are found. For instance, **pond flukes** that infect fish in ponds.

According to the traditional system, Trematodes include the following groups:

- Aspidobothrea
- Monogenea
- Digenea

According to other systems only the following groups are included:

- Aspidobothrea
- Digenea

## Digenea

The term **Digenea** (= two generations) was created to characterize species, which have developed during their life cycle the typical alternation of generations being accompanied by an obligate change of hosts.

**[1]- Gasterostome flukes:** The intestine looks sac-like and has no branches, and the mouth has no apical but a ventral opening.

**[2]- Monostome flukes:** One of the mostly two existing suckers is reduced (in general the ventral one).

**[3]- Distome flukes:** The ventral sucker exists, but its position varies (depending on species) from a place close to apical pole until posterior pole.

**[4]- Amphistome flukes:** The second sucker occurs exactly at the posterior pole.

**[5]- Echinostome flukes:** The oral sucker is surrounded by species-specific rows of hooks.

**[6]- Holostome flukes:** These flukes have in addition to the two suckers another hold-fast system developed—the so-called *tribocytic organ*.

**[7]- Schistosomes (Greek: schizein=divide; soma=body):** In this group the leaf-like looking males surround (forming a channel) the slender long female and keeps her there lifelong (up to 25 years).

All these listed flukes [1-6] are *hermaphrodites*—they contain both male and female sexual organs. The flukes of the last—7th group, however, are dioecious: they possess male and female adult worms.

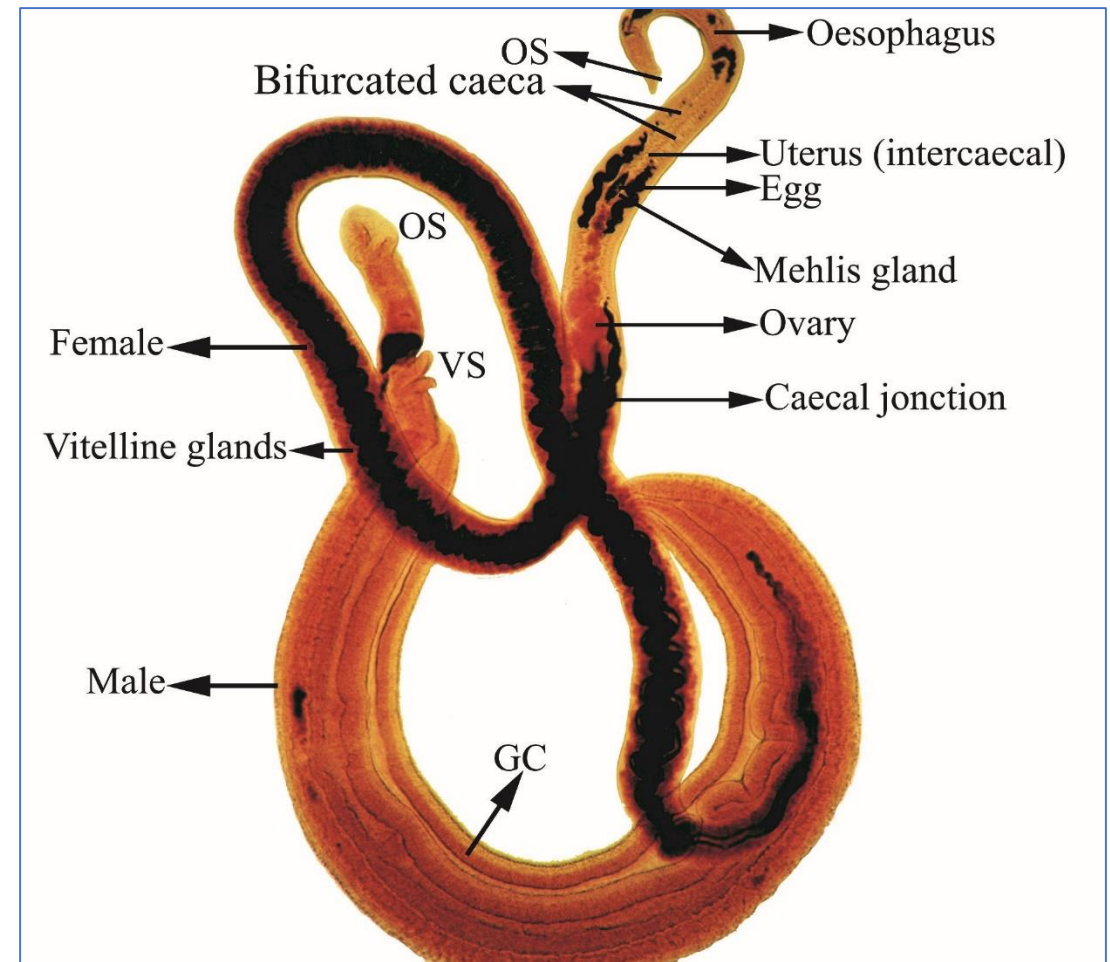
## *Schistosoma* spp.

.... Schistosomiasis “snail fever” is a water-borne trematodiasis carried by fresh water snails infected with one of the varieties of the parasite *Schistosoma*.

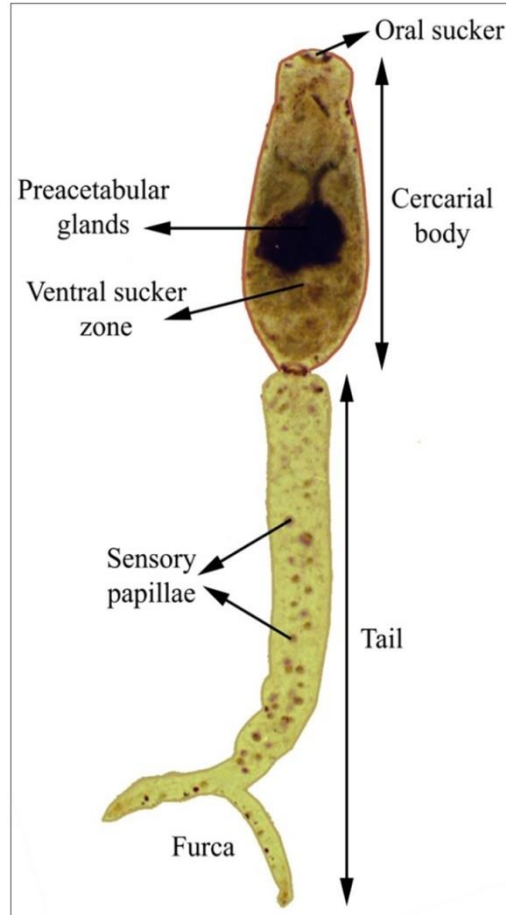
.... Three principal varieties are mainly the **causative agents for human schistosomiasis**: *Schistosoma mansoni*, *Schistosoma haematobium* and *Schistosoma japonicum*.



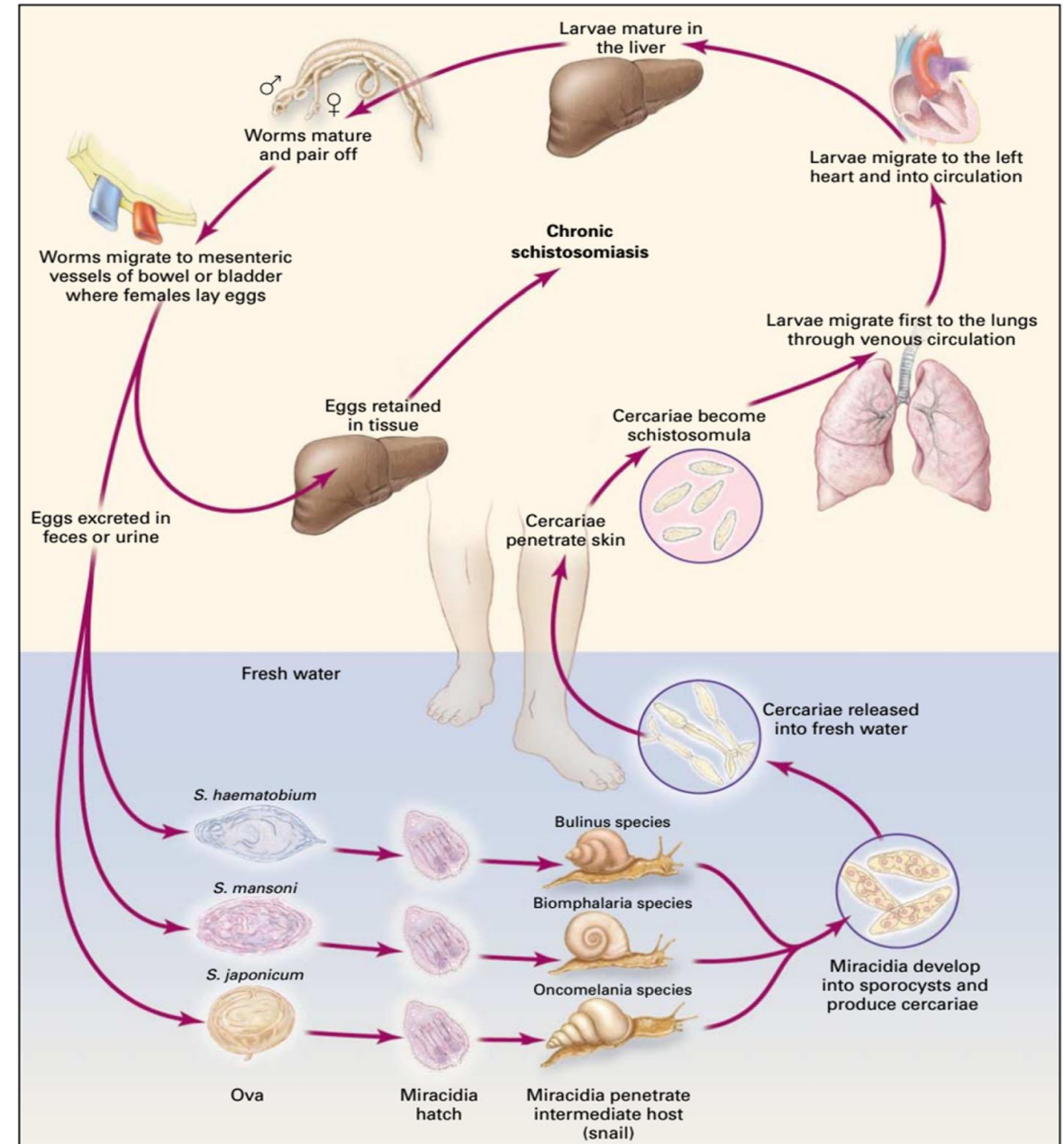
Scanning electron micrograph of a couple of the species *Schistosoma* spp. The male transports the female inside the so-called canalis gynaecophorus, which is produced by upfolding of the lateral sides of the male



**Pathway of infection:** Cutaneously; the cercariae (shed by the intermediate hosts = water snails) penetrate into the skin of humans while they have contact with contaminated “sweet water” of rivers or lakes, wherein potential intermediate hosts live.



Cercariae of *Schistosoma* spp.



## Symptoms:

### Acute (exposure to high numbers of cercariae)

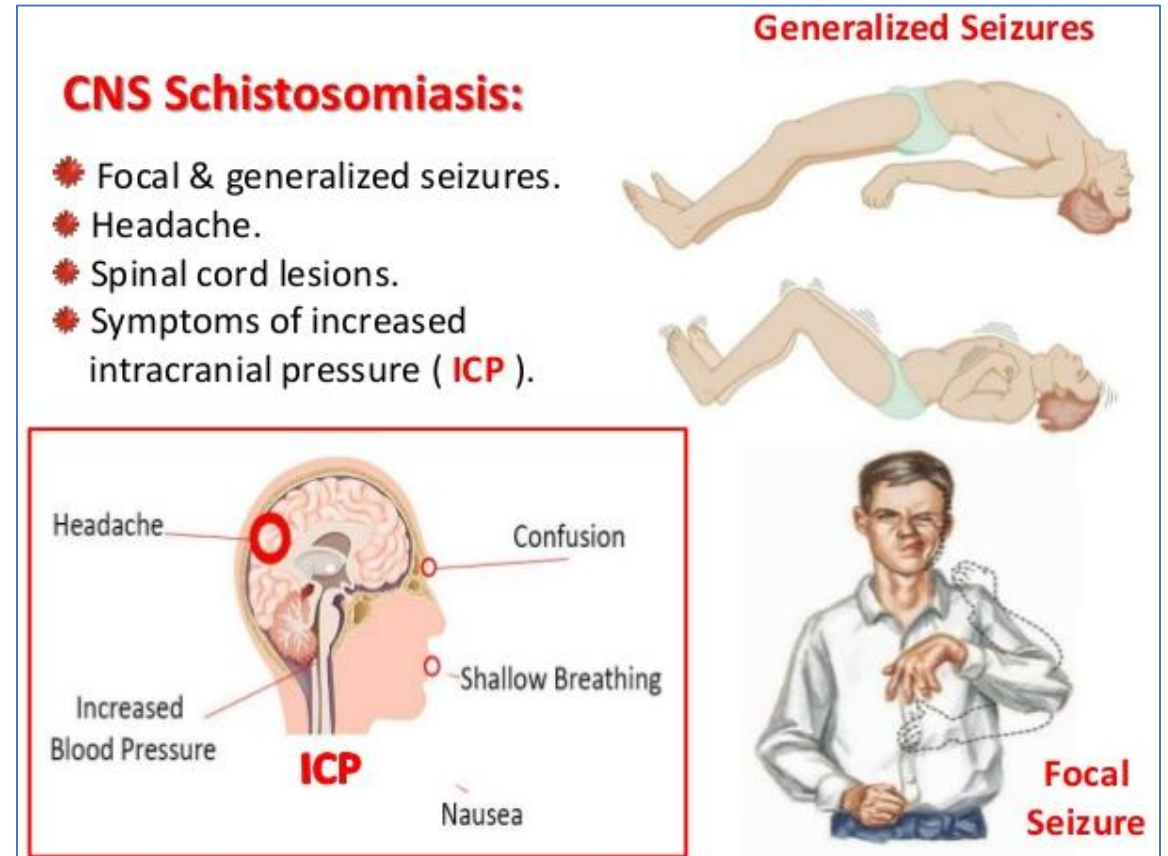
High fever  
Hepatomegaly

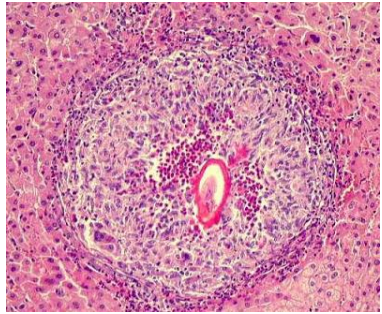
### Chronic (untreated acute infection)

Liver fibrosis  
Liver cirrhosis  
Splenomegaly  
Ascites  
Impaired physical and cognitive development

### Infection outside intestines, liver and spleen

Morbidity due to immune reactions to eggs trapped or dispersed in lungs, nervous system, and other organs





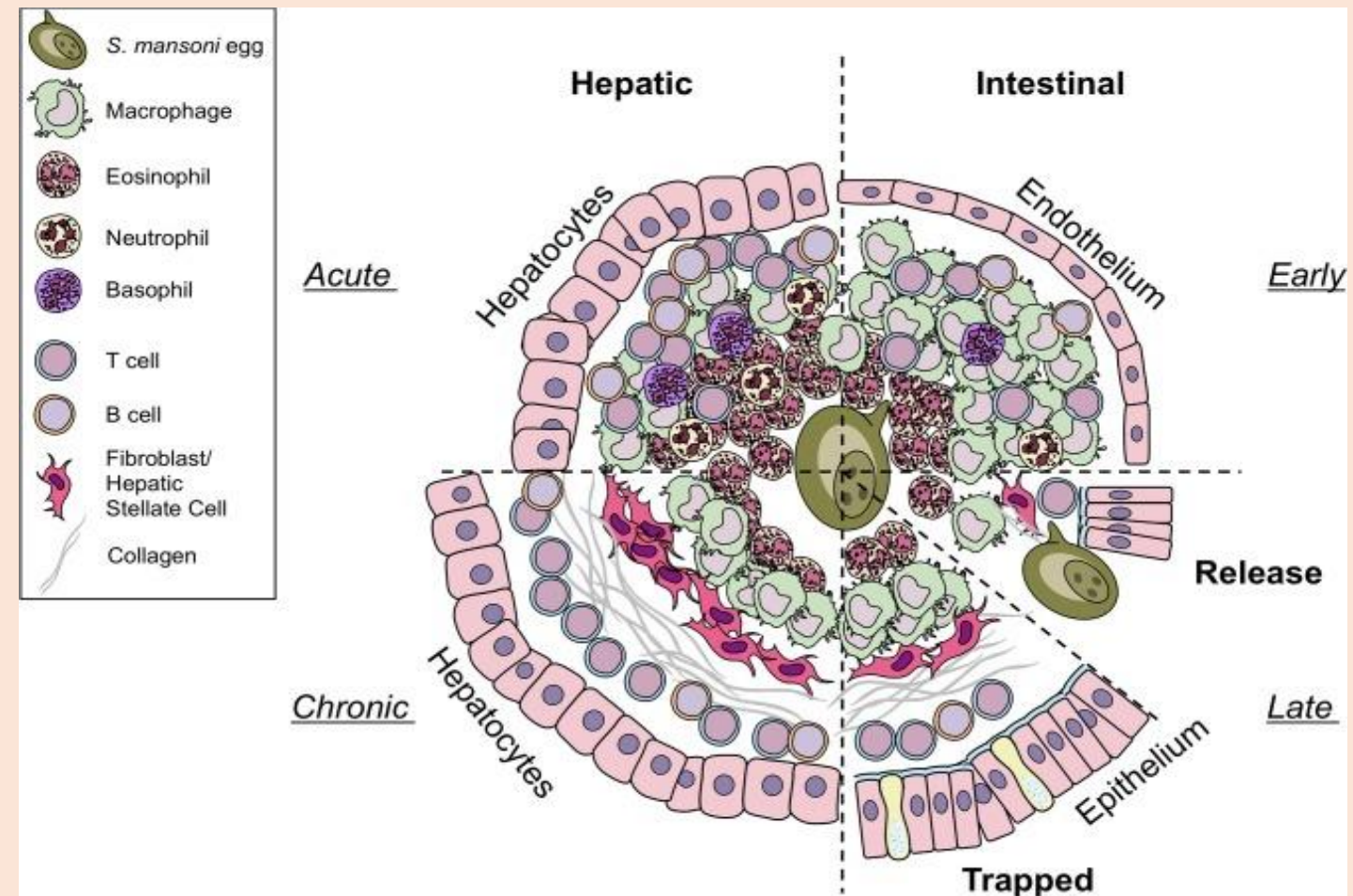
## Granuloma Formation

... Schistosomiasis is characterized by the formation of inflammatory granulomas around deposited parasite eggs.

... Granuloma formation is a cell-mediated immune response that is dependent on CD4<sup>+</sup> T cells sensitized to schistosomal egg Ags (SEA).

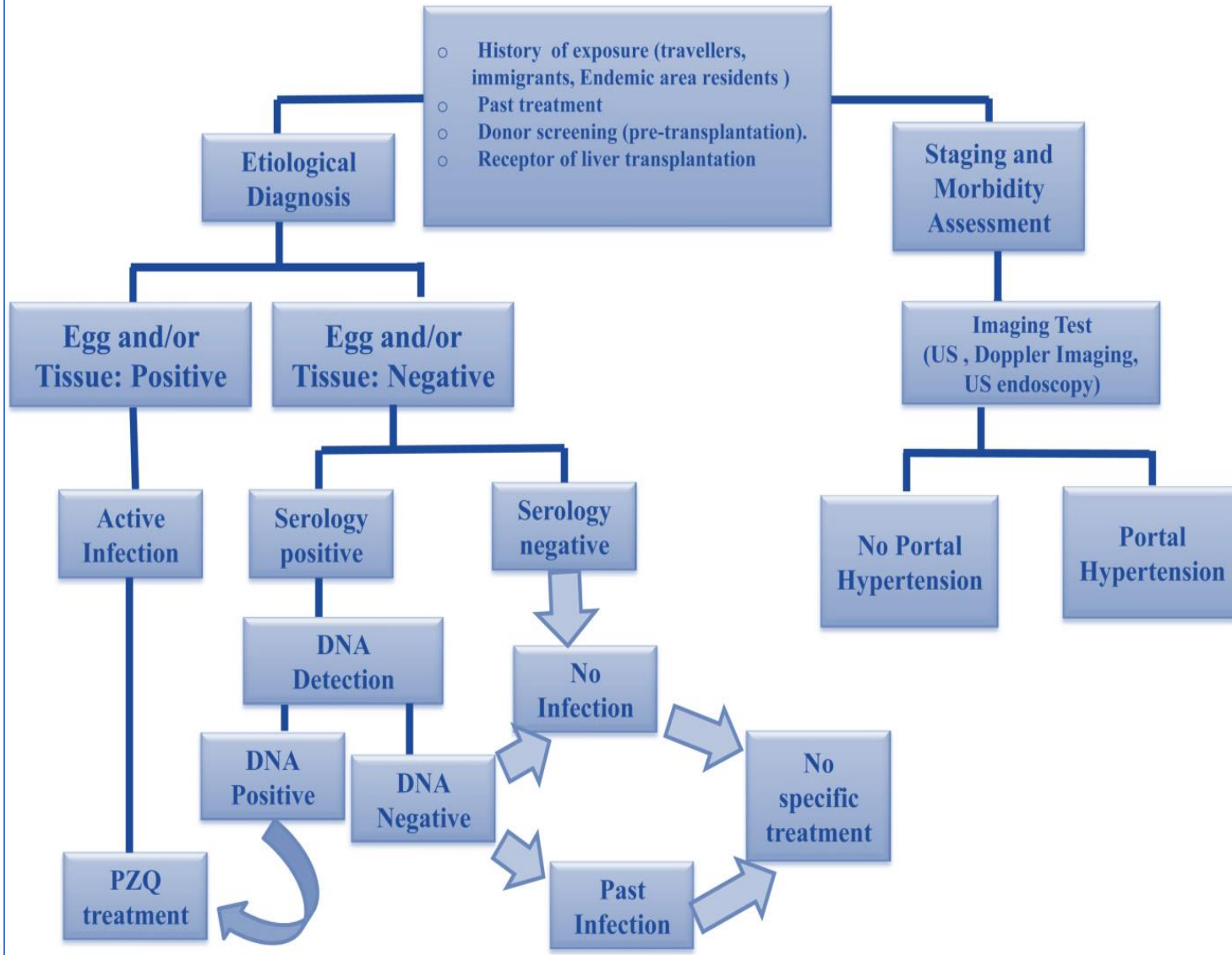
....This **acute stage** granuloma is characterized by dense cellularity and maximum cytokine production.

... As the infection progresses into **the chronic stage** (16–20 wk postinfection (p.i.)), cytokine production and cellularity decrease while the fibrotic components of the immunopathologic process increase.



Differences in hepatic and intestinal granuloma composition. Cellular granuloma composition in the liver (left) and the intestine (right). While early (upper half) granulomas may appear similar, intestinal granulomas harbor less eosinophils, T cells, and B cells than hepatic granulomas, more macrophages are present. Only few neutrophils and basophils can be observed in both sites. During later stages (lower half) eggs in the liver become trapped and fibrosis develops. In contrast, eggs deposited in the gut must be released to the intestinal lumen.

### Schistosomiasis Clinical Management



**Incubation period:** Depending on the amount of worms inside a human body, symptoms of disease are noted about 4–8 weeks after an infection.

**Patency:** Up to 25 years.

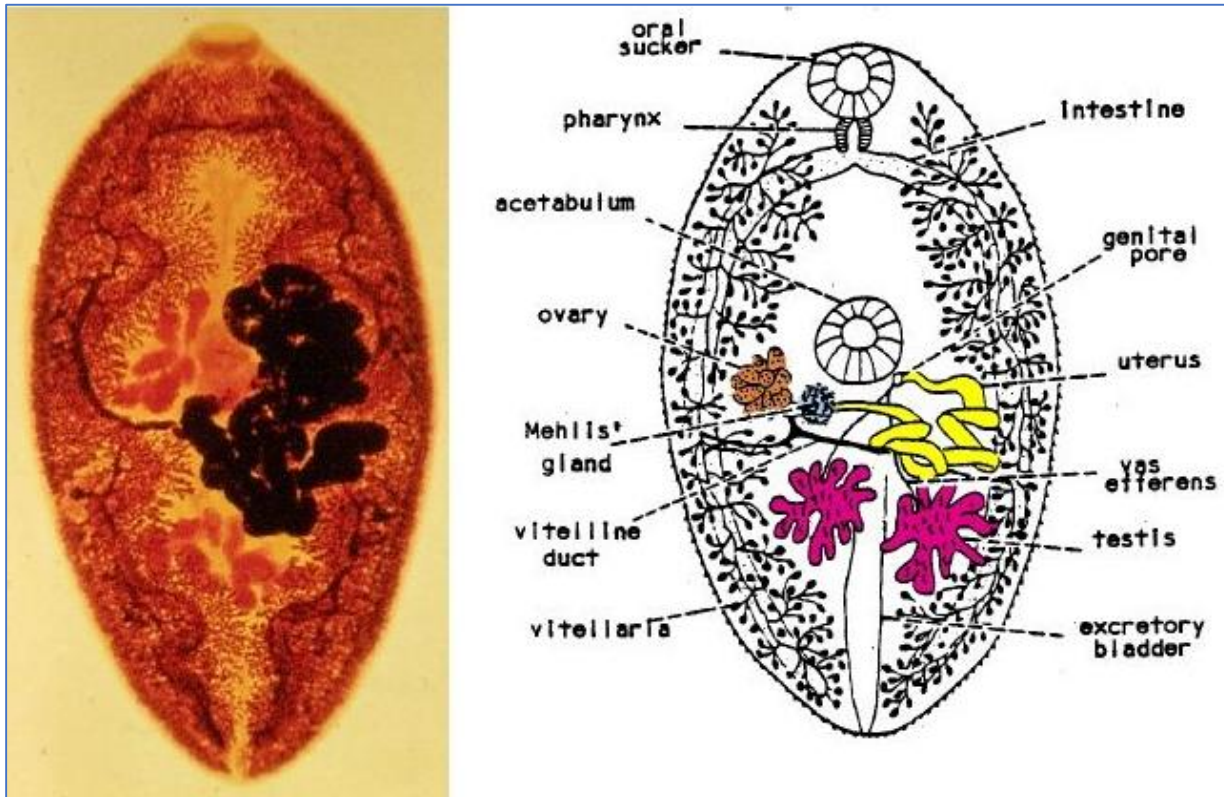
**Therapy:** Mass drug administration (MDA) in endemic areas using **Praziquantel (PZQ)** remains a major cornerstone of schistosomiasis control programs. In addition, **Oxamniquine** (115 mg/kg bodyweight) acts only against *S. mansoni*.

## Paragonimus Species (Paragonimiasis)

... It is a lung fluke found in both humans and animals.

... The adults are 12µm long and are found in capsules in the lung.

... The species sometimes is called the *Japanese lung fluke* or *Oriental lung fluke*.



# PARAGONIMIASIS

Medical Observer / Source: WebMD



**Paragonimiasis is an infection with parasitic worms. It is caused by eating undercooked crab or crayfish. Usually there are no symptoms. But paragonimiasis can cause illness resembling pneumonia or stomach flu. It can last for years.**

Once swallowed by a person, the worms mature and grow inside the body. Over months, the worms spread through the intestines and belly (abdomen). They penetrate the diaphragm muscle to enter the lungs. Once inside the lungs, the worms lay eggs and can survive for years, causing chronic (long-term) paragonimiasis.

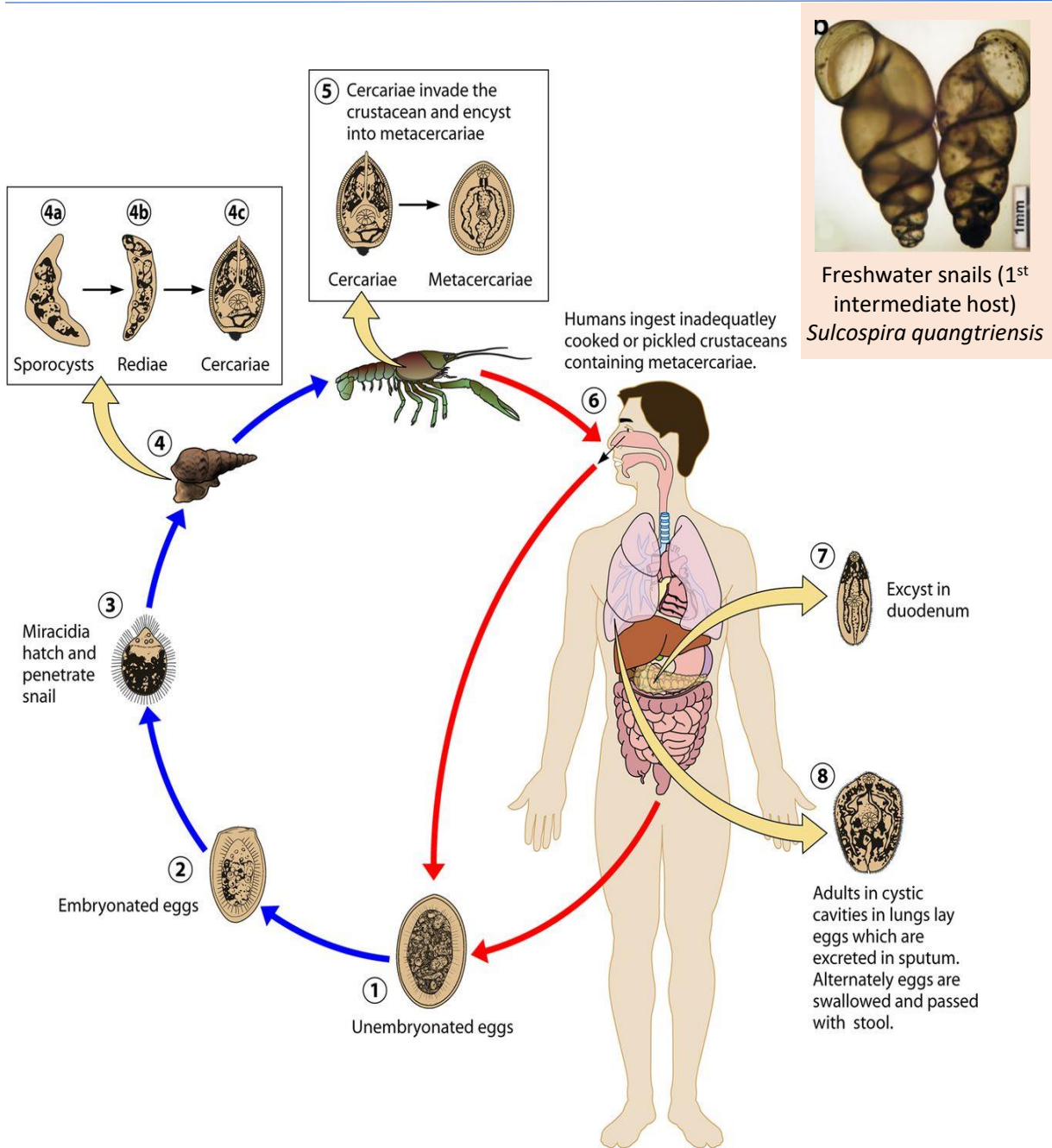
**In the first month or so after someone is infected, paragonimiasis worms spread through the abdomen, sometimes causing symptoms that can include:**

- Fever
- ill-feeling (malaise)
- Belly pain
- Itching and hives
- Diarrhea

**Worms then travel from the belly into the chest. There they can cause respiratory symptoms, such as:**

- Chest pain
- Shortness of breath
- Cough

**Without treatment, it becomes chronic and can continue for decades.**



### Pathway of infection:

Oral uptake of infected raw or undercooked meat crabs (second intermediate host) that contained infective metacercariae, e.g., of the genus *Eriocheir* (in case of *Paragonimus westermani*) or *Cambarus* (in the case of *P. kellicotti*).



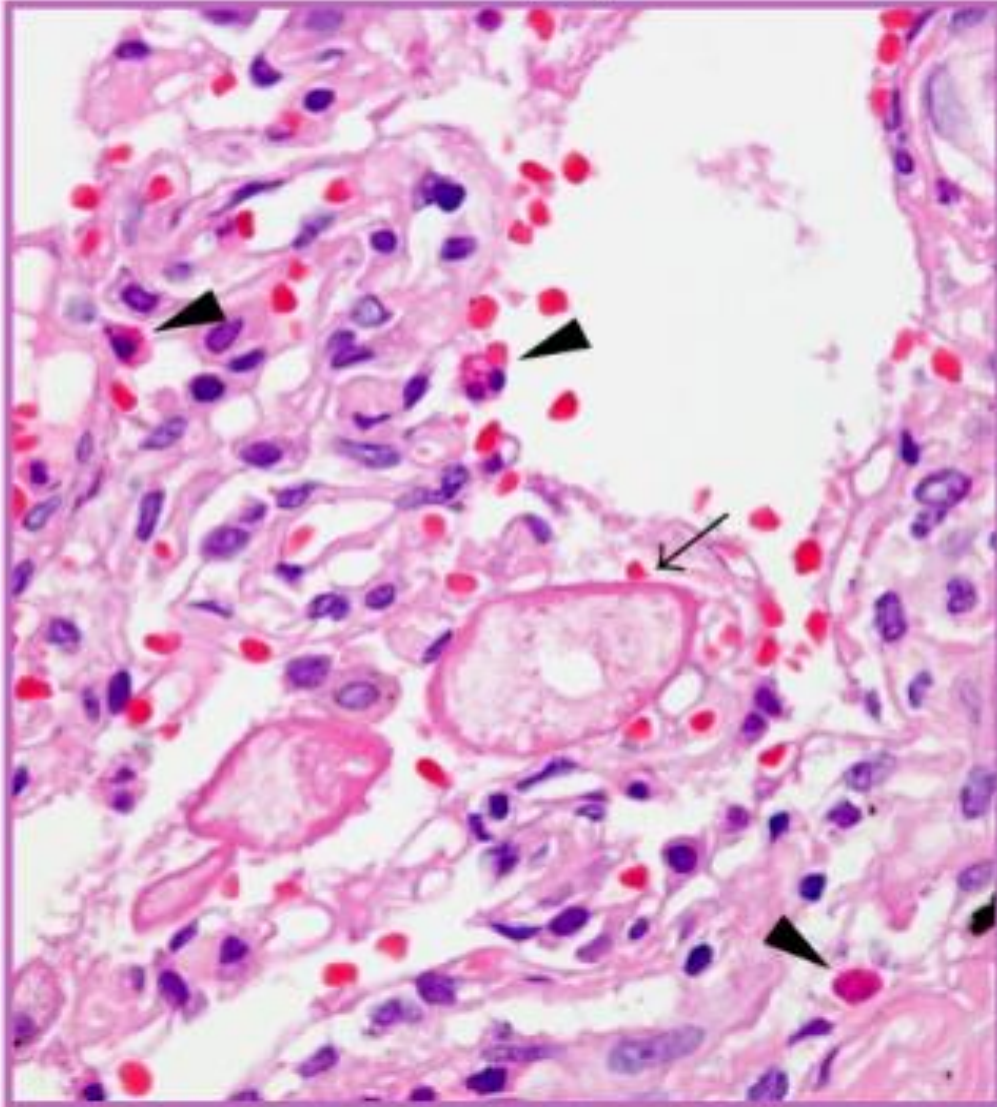
**Incubation period:** 9–12 weeks.

**Patency:** Up to 20 years.

### Treatment

**Praziquantel** is the drug of choice to treat paragonimiasis. The recommended dosage of 75 mg/kg per day, divided into 3 doses over 3 days has proven to eliminate *Paragonimus* species.

# Pathology of Paragonimiasis



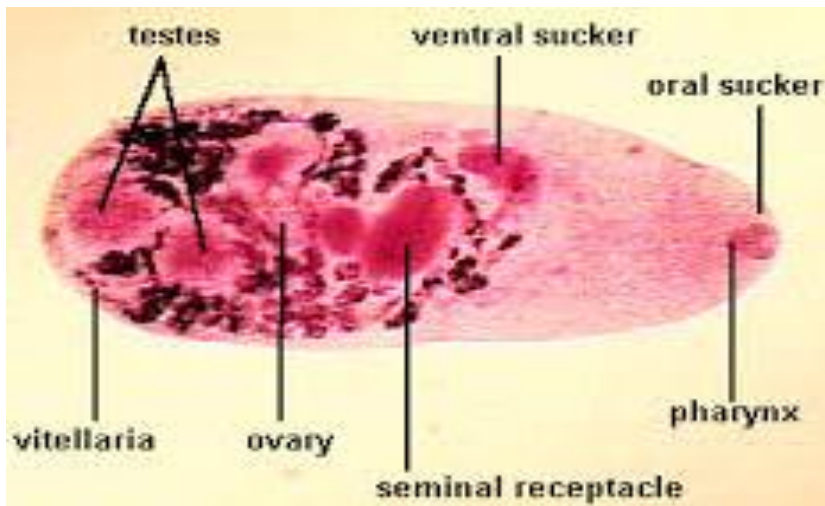
Scattered degenerated parasitic eggs (arrows) morphologically consistent with ova of *Paragonimus westermani*, intra-alveolar macrophages, and some infiltrating eosinophils (arrowhead) are noted in organizing pneumonia area.



*Paragonimus* egg

## *Metagonimus yokogawai* and Related Species (Metagonimiasis)

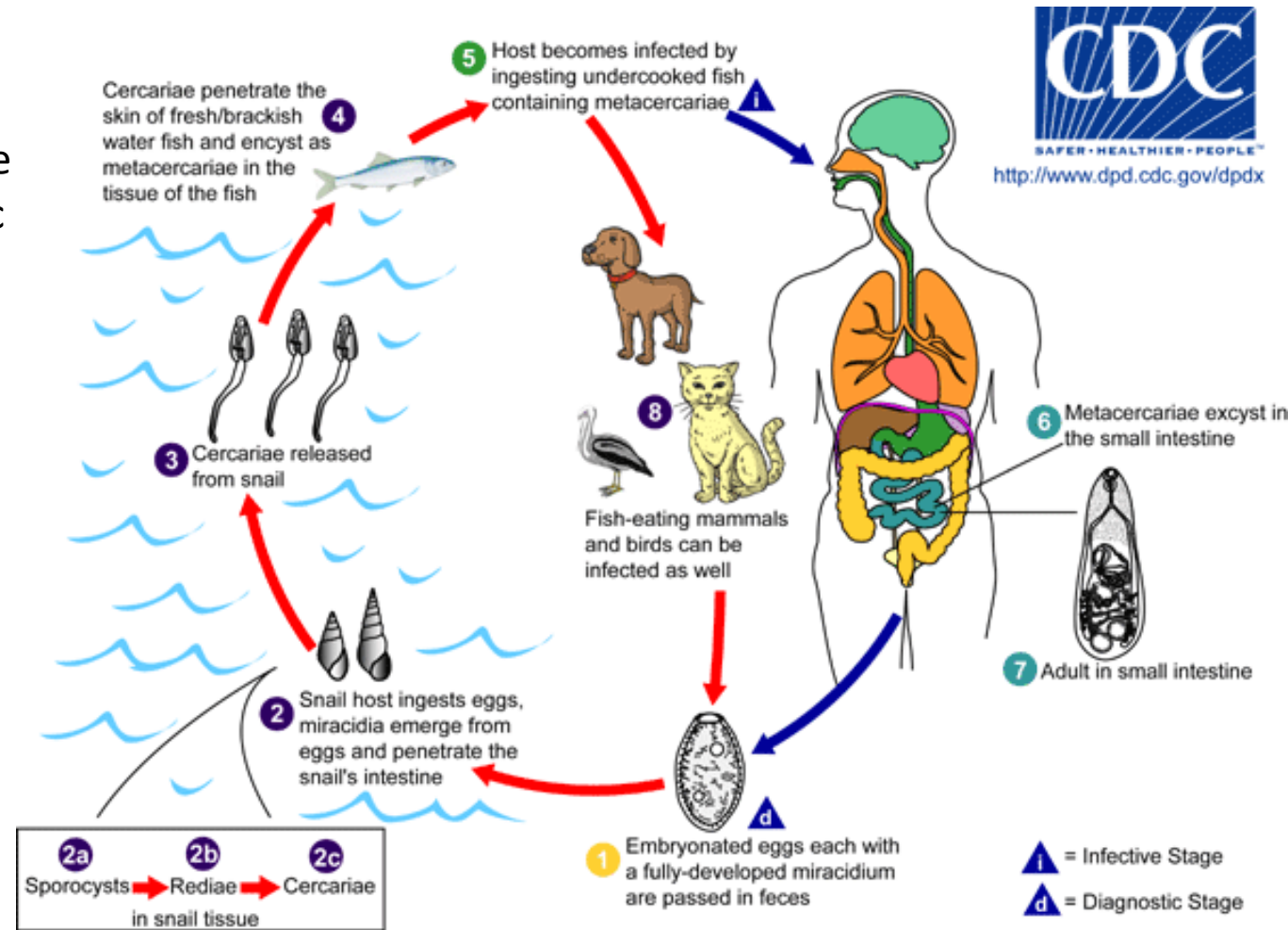
The intestinal fluke, *Metagonimus yokogawai*, is one of the important heterophyid flukes causing fishborne helminthic zoonoses (metagonimiasis) in Eastern Asia, including the Republic of Korea, China, Taiwan, Japan, and Russia



**Pathway of infection:** Oral uptake of uncooked fish meat containing metacercariae.

**Symptoms:** diarrhea and abdominal pain.

**Incubation period:** 1–3 weeks depending on the amount of ingested metacercariae.



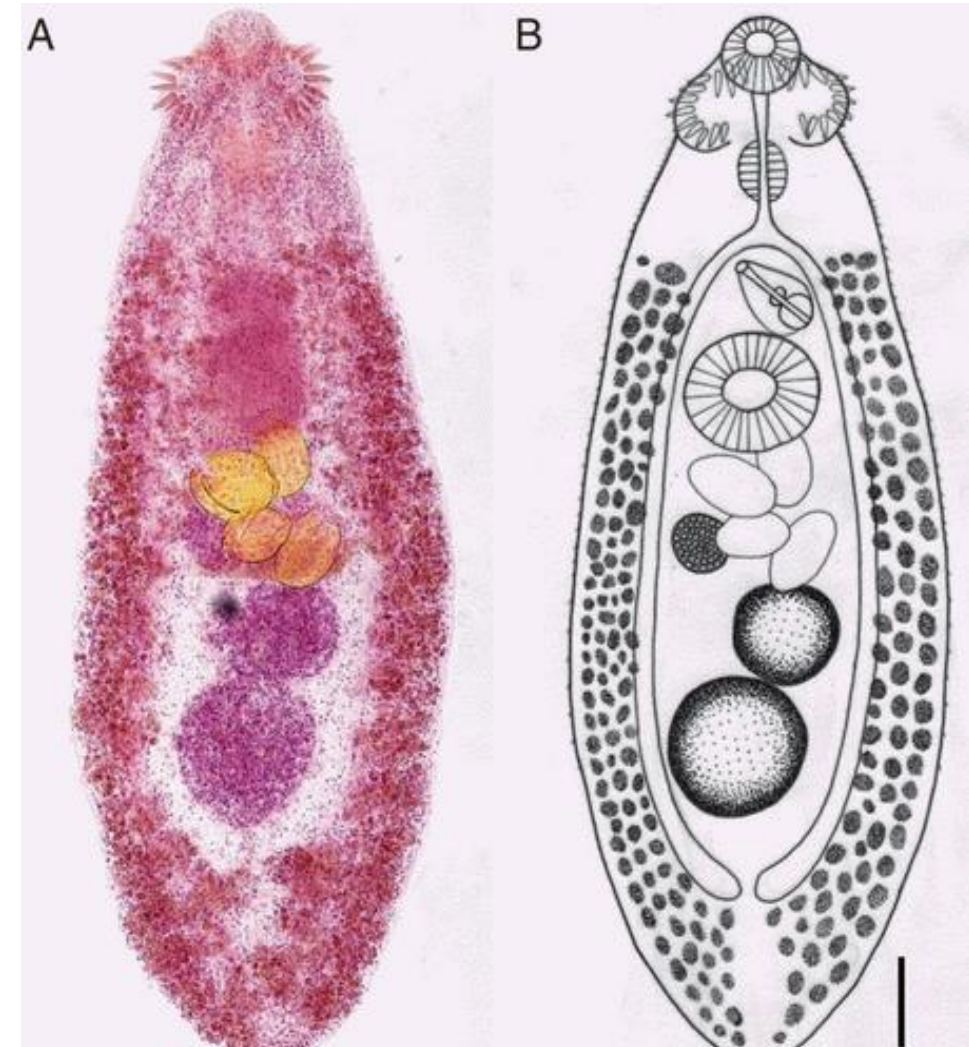
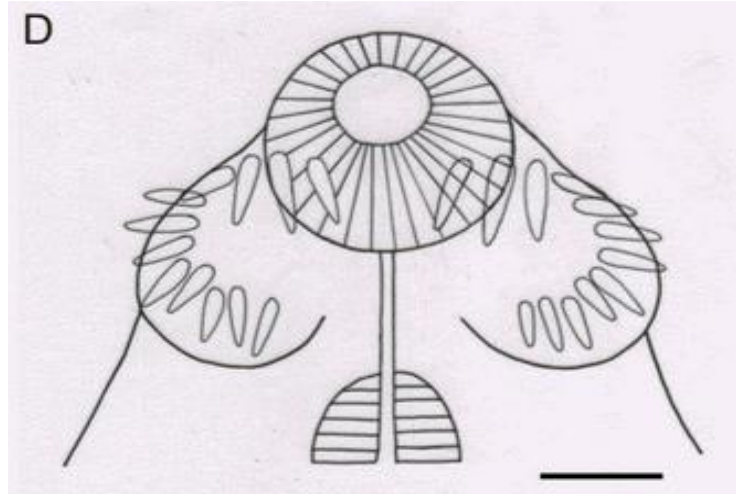
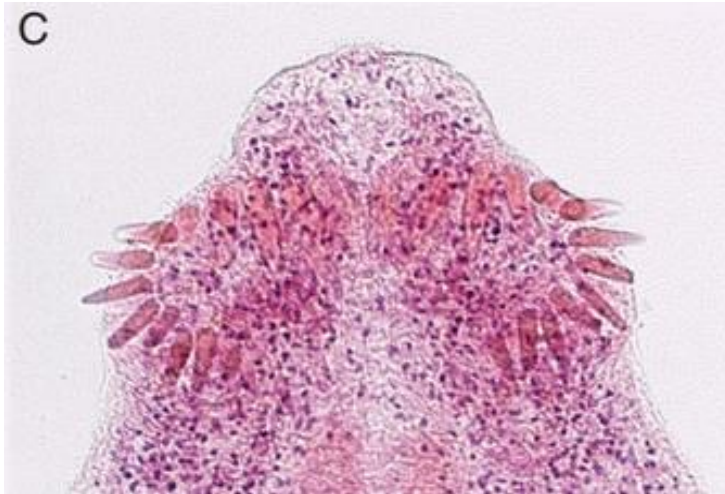
**Patency:** 6–10 months.

**Therapy:** Drug of choice is praziquantel, which should be used by application of a single dose of 20 mg/kg body weight. Niclosamide and tetrachloroethylene are also efficient.

## *Echinostoma* Species (Echinostomiasis)

... *Echinostoma* is a genus of trematodes, which can infect both humans and other animals.

... These species have a characteristic head collar with spines surrounding their oral sucker. The number of collar spines varies between *Echinostoma* species, but there are usually between 27 and 51. These spines can be arranged in one or two circles around the sucker, and their arrangement may be a characteristic feature of an *Echinostoma* species.



... These intestinal flukes have a **three-host life cycle** with snails or aquatic organisms as intermediate hosts, and a variety of animals, including humans, as their definitive hosts.

**Pathway of infection:** Humans and other hosts become infected when ingesting raw mussels or snails being contaminated with **metacercariae**

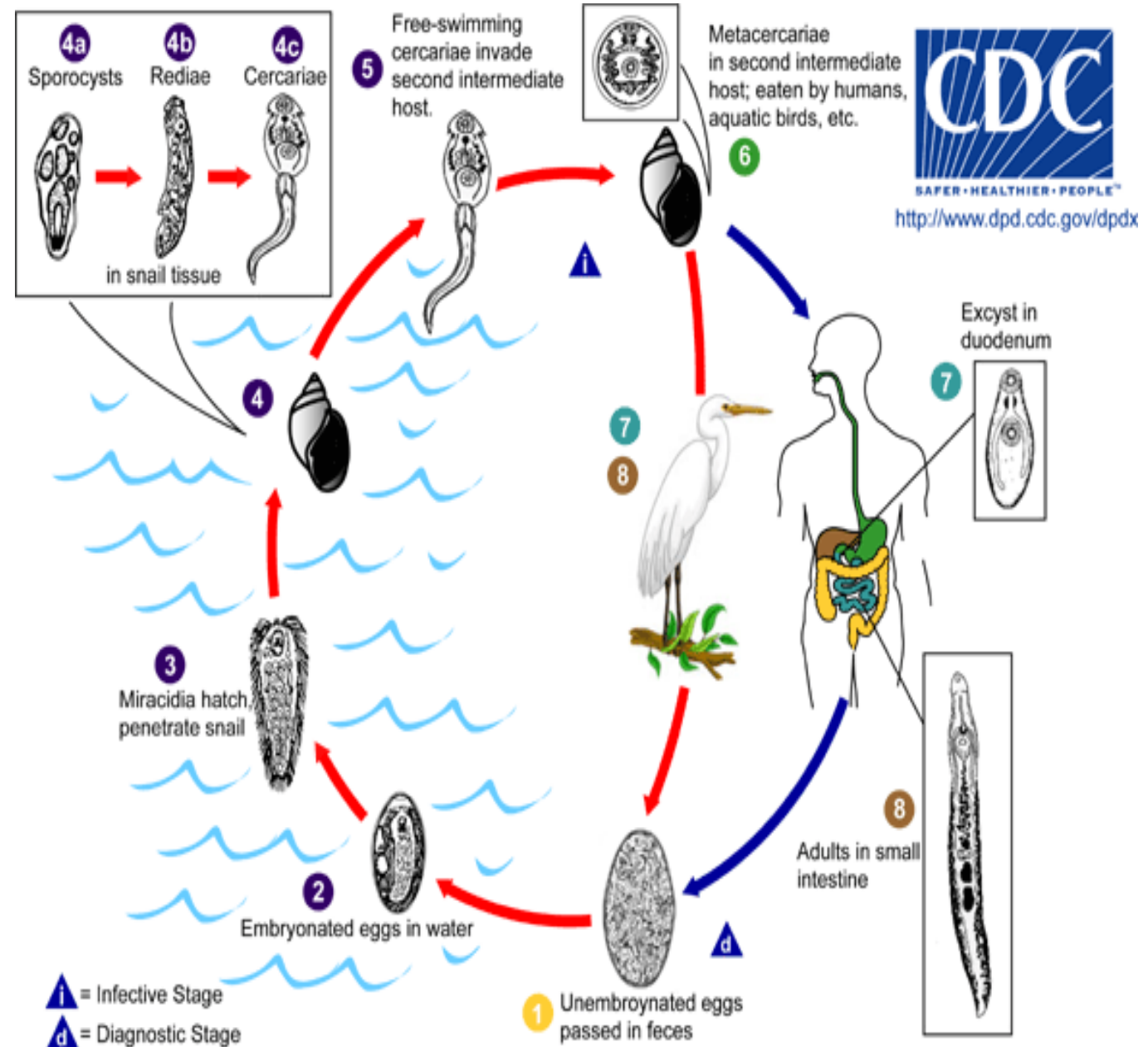
**Symptoms:** Intestinal wall severely damaged by the numerous hooks at the apical pole of these flukes, initiates severe diarrhea leading to significant dehydration and body pain.

**Incubation period:** 1–3 weeks.

**Patency:** 6–12 months.

### Treatment

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



**Any  
questions**

