

# **Medical helminthology.**

## **Cestodes**

## **CESTODES (TAPEWORMS)**

The tapeworms are hermaphroditic and require an intermediate host. The adult tapeworms found in humans have flat body, white or grayish in color.

They consist of an anterior attachment organ or scolex and a chain of segments (proglottids) also called strobilla. The strobilla is the entire body except the scolex. The scolex has suckers or grooves. It has rosetellum, which has 1 or 2 rows of hooks situated on the center of the scolex.

Adult tapeworms inhabit the small intestine, where they live attached to the mucosa. Tapeworms do not have a digestive system. Their food is absorbed from the host's intestine.

# *Hymenolepis nana* (dwarf tapeworm)

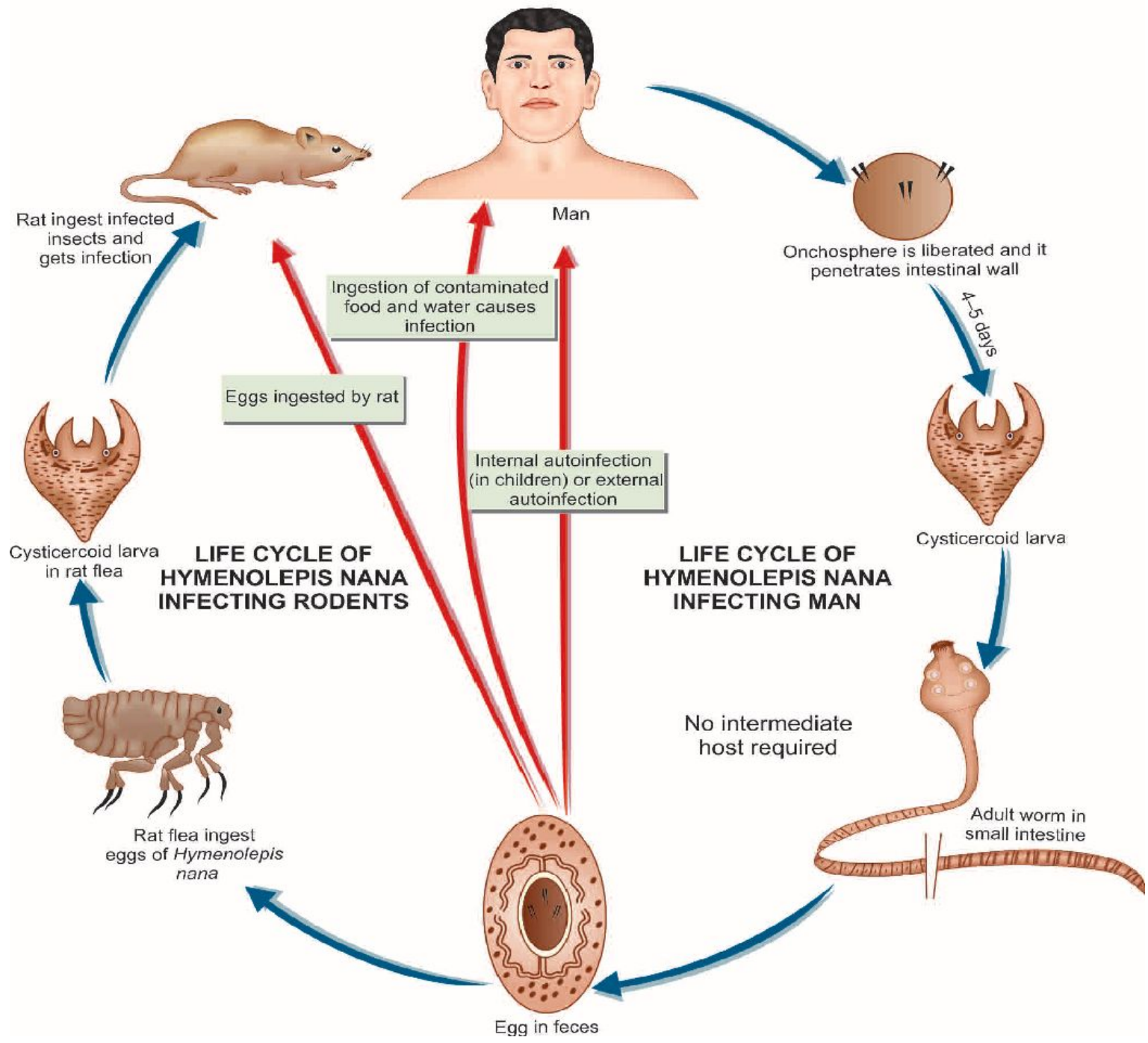
## **Morphology**

Adult worm measures 1-3 cm in length. It is made up of head (scolex), neck and segmented body. The head carries four suckers and a rostellum armed with one row of hooks. The segments of the body are divided into mature and gravid segments. In the mature segment, there are three testes in the middle.



## **Infective stage and mode of infection**

The egg, which is immediately infective when passed by the patient, is rounded, about 40 microns in diameter. It contains a six-hooked oncosphere within a rigid membrane (the embryosphere). This embryosphere has two polar thickening or knobs from which project 4-8 long, thin filaments called polar filaments.



## **Infection takes place by:**

1. Ingestion of egg with contaminated raw vegetables.
2. Direct infection from a patient
3. Auto infection: the eggs of *H. nana* are infective as soon as they are passed with feces by the patient. If the hands of the patient are contaminated by these eggs, she/he infects herself/himself again and again.

## **Symptoms**

Light infections produce no symptoms. In fairly heavy infections, children may show lack of appetite, abdominal pain and diarrhea.

## **Treatment**

Niclosamide: 4 tablets chewed in a single dose daily for 5 days.

# *Hymenolepis diminuta* (rat tapeworm)

*Hymenolepis diminuta* differs from *Hymenolepis nana* in that:

- ◆ The adult worm measures about 10-60 cm
- ◆ The rosetellum on the head has no hooks
- ◆ In the mature segment, there are two testes at one side and another testis on the other side.



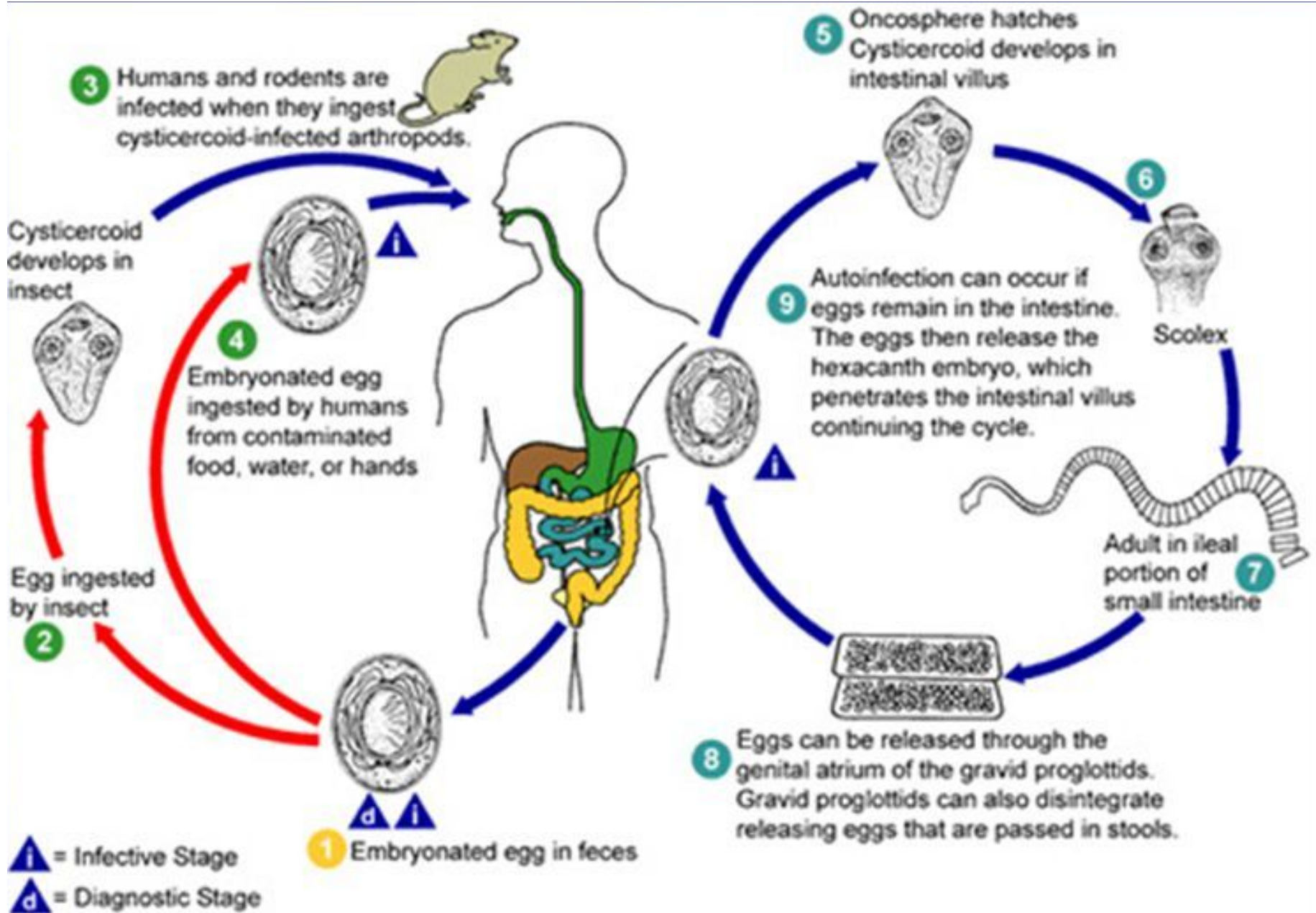
## **Symptoms**

Most infections are asymptomatic, but occasionally, patients may present with nausea, anorexia and diarrhea.

## **Treatment**

same as *Hymenolepis nana*.





# *Echinococcus granulosus* (dog tape worm)

Responsible for most cases of echinococcosis. Echinococcosis is caused by larval tapeworms. The disease is common in East Africa (the highest prevalence is seen in Kenya: 10-15%).

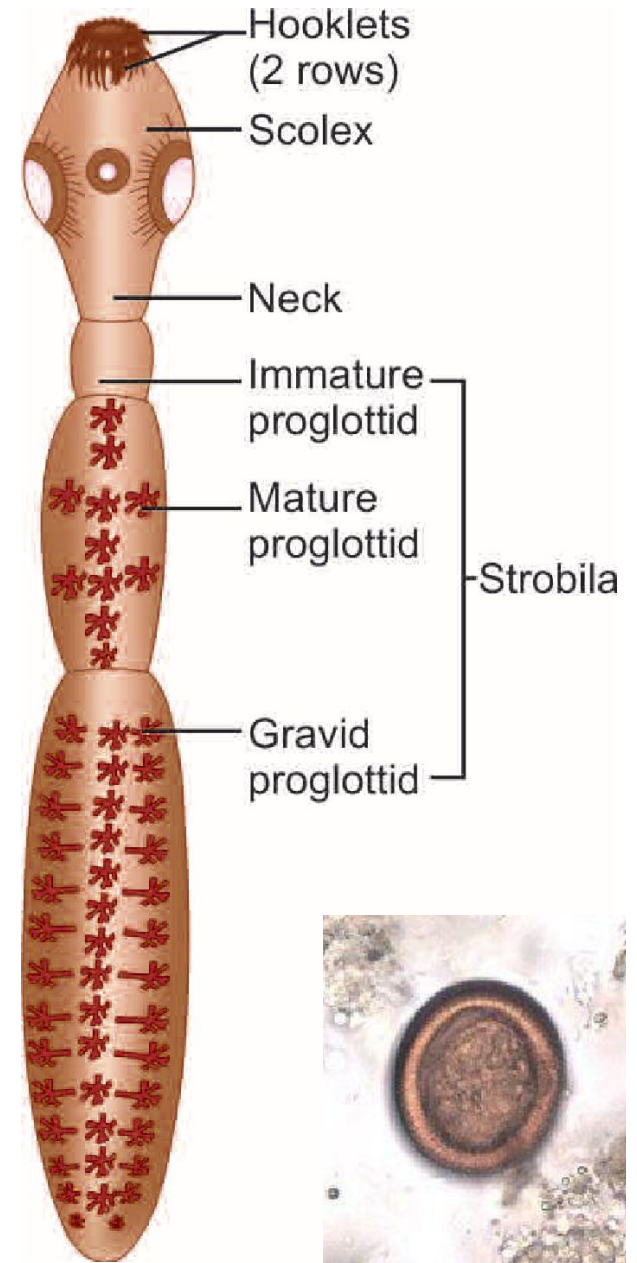
## **Morphology**

The adult worm measures 3-6 mm in length (up to 1 cm). It has scolex, neck and strobilla. The scolex is **pyriform**, with 4 suckers and a prominent rostellum bearing 2 circular rows of hooklets. Adult worms live in small intestine of definitive host (dog). Man is an intermediate host - carrying the hydatid cyst (larva). Man contracts infection by swallowing eggs in excreta of definitive host. The neck is shorter than the rest of the worm (3 - 6 mm). The strobila is composed of only 3 proglottids, the anterior immature, the middle mature, and the posterior gravid segment. The terminal proglottid is longer and wider than the rest of the worm and contains a branched uterus filled with eggs. The adult worm lives for 6-30 months.



*Egg.* The eggs of *Echinococcus* are indistinguishable from those of *Taenia* species. It is ovoid in shape and brown in color. It contains an embryo with 3 pairs of hooklets.

*Larval Form.* The larval form is found within the hydatid cyst developing inside various organs of the intermediate host. It represents the structure of the scolex of adult worm and remains **invaginated** within a vesicular body. After entering the definitive host, the scolex with suckers and rostellar hooklets, becomes **exvaginated** and develops into adult worm.



## **Life cycle**

**Definitive hosts:** Dog (optimal host), wolf, jackal, and fox. **Intermediate host:** Sheep and Cattle. Sheep is the ideal intermediate host. Man acts as an accidental intermediate host (dead end). The larval stage of the parasite is passed in intermediate hosts, including man, giving rise to hydatid cyst. The adult worm lives in the small intestine of dogs and other canine animals. These animals discharge numerous eggs in the feces. Intermediate hosts (sheep and cattle) ingest them while grazing. Oncosphere hatch in duodenum or small intestine into embryos (oncosphere) which:

- ◆ Penetrate wall
- ◆ Enter portal veins

## **Mode of human infection:**

Ingestion of eggs by the following ways:

- i) Ingestion of water or vegetables polluted by infected dog feces.
- ii) Handling or caressing infected dogs where the hairs are usually contaminated with eggs.

In dog

In cattle, sheep, hogs, humans



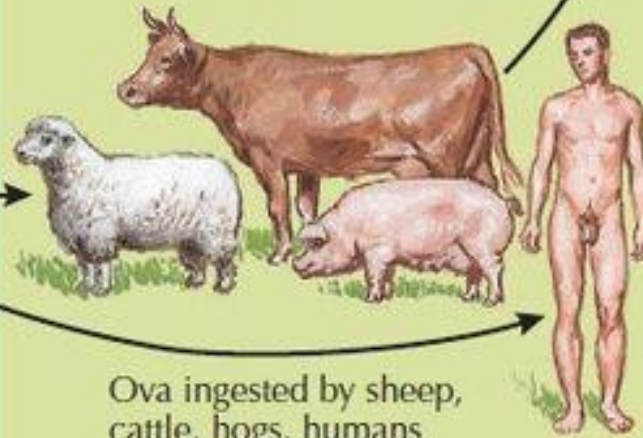
Infested animal organs eaten by dog



Worm matures in dog's small intestine

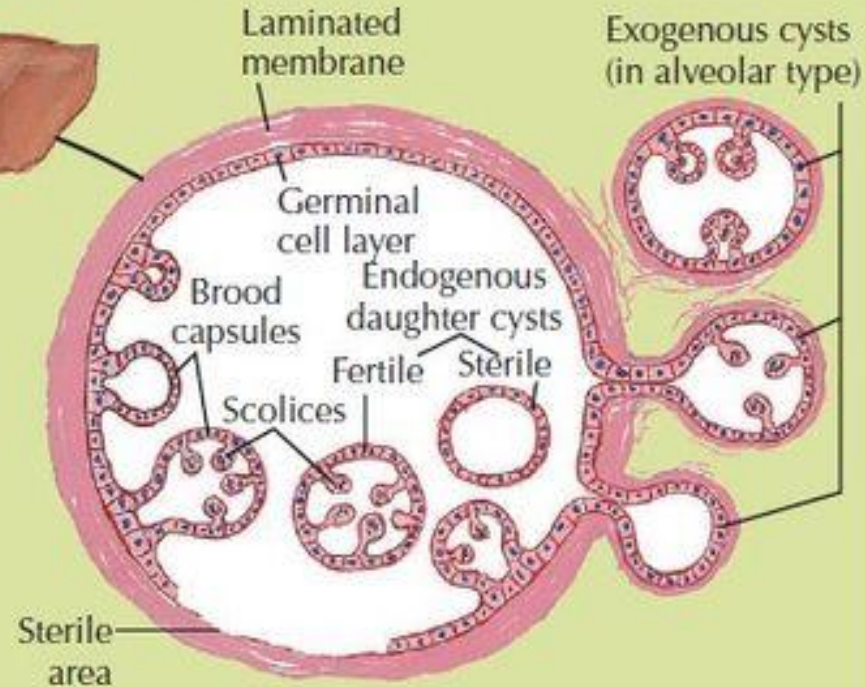
Life cycle of *Echinococcus granulosus*

Ova passed in feces

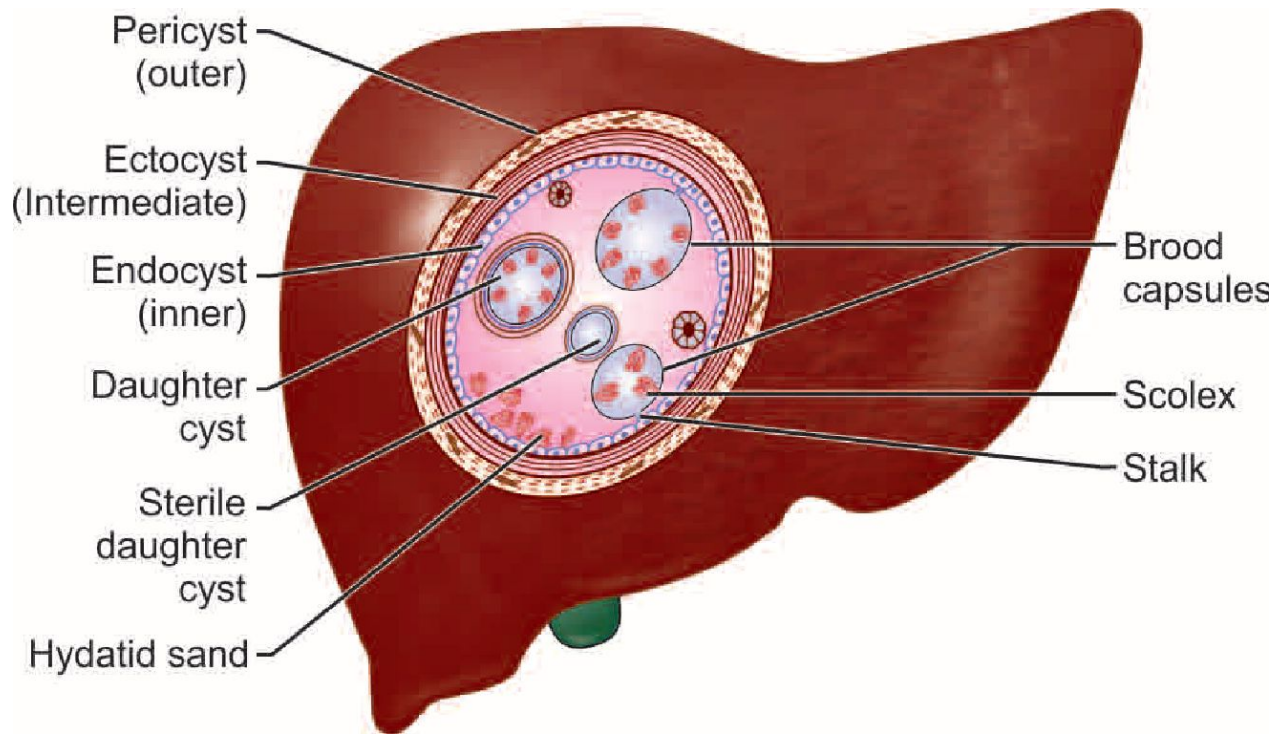


Ova ingested by sheep, cattle, hogs, humans

Hydatid cyst develops in liver (and/or lung, brain and other organs)







Migrate via portal blood supply to organs: eg: lungs, liver, brain etc., thus, causing extra intestinal infections. In these organs, larvae develop into hydatid cysts. The cysts may be large, filled with clear fluid and contain characteristic protoscolices (immature forms of the head of the parasite). These mature into developed scolices, which are infective for dogs. It enlarges slowly and reaches a diameter of 0.5–1 cm in about 6 months. The growing cyst evokes host tissue reaction leading to the deposition of fibrous capsule around it.

## Symptoms

Asymptomatic infection is common, but in symptomatic patients

It may cause cough - with hemoptysis in lung hydatid disease.

Hepatomegaly - with abdominal pain and discomfort

Pressure -from expanding cyst

Rupture of cyst - severe allergic reaction – anaphylaxis, **hypersensitivity** to the echinococcal antigen.

Clinical disease develops only when the hydatid cyst has grown big enough to cause obstructive symptoms. Disease results mainly from pressure effects caused by the enlarging cysts. In about half the cases, the primary hydatid cyst occurs in **liver** (63%), mostly in the right lobe. Hepatomegaly, pain, and obstructive jaundice are the usual manifestations.

The next common site is the **lung** (25%) (most common being the lower lobe of the right lung). Cough, hemoptysis, chest pain, pneumothorax, and dyspnea constitute the clinical picture.

In the kidney (2%), hydatid cyst causes pain and hematuria.

**Other sites** affected include spleen (1%), brain (1%), pelvic organs, orbit, and bones (3%).

## **Diagnosis**

X-ray or ultrasonography (USG), CT scan, and MRI

Demonstration of protoscolices in cyst after operation

Serology

Blood Examination (It may reveal a generalized **eosinophilia** of 20–25%).

PCR

Casoni's Intradermal Test (It is an immediate hypersensitivity skin test)

## **Treatment**

Surgery

Albendazole 400 mg twice a day for one to eight periods of 28 days each, separated by drug-free rest intervals of 14 to 28 days.

## **Prophylaxis**

Ensuring pet dogs do not eat animal carcass or offal.

Periodical deworming of pet dogs.

Destruction of stray and infected dogs.

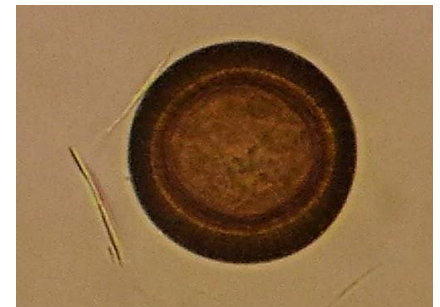
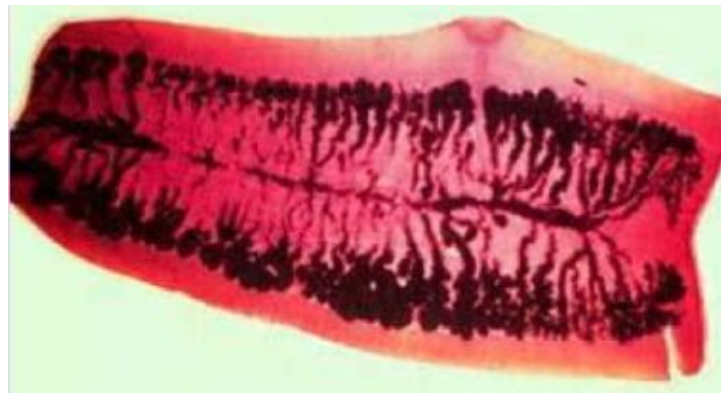
Maintaining personal hygiene such as washing of hands after touching dogs and avoidance of kissing pet dogs.

## ***Taenia saginata* (beef tapeworm)**

In adult stage, *T. saginata* inhabits the upper jejunum where it may survive for as long as 25 years. It causes intestinal infection, Taeniasis. It has worldwide distribution.

These are one of the true and segmented tapeworms. Their body is divided into three regions;

1. Scolex: the hold fast organ
2. Neck: posterior to the scolex
3. Stobilla: the main bulk, made up of proglottids.





## Morphology

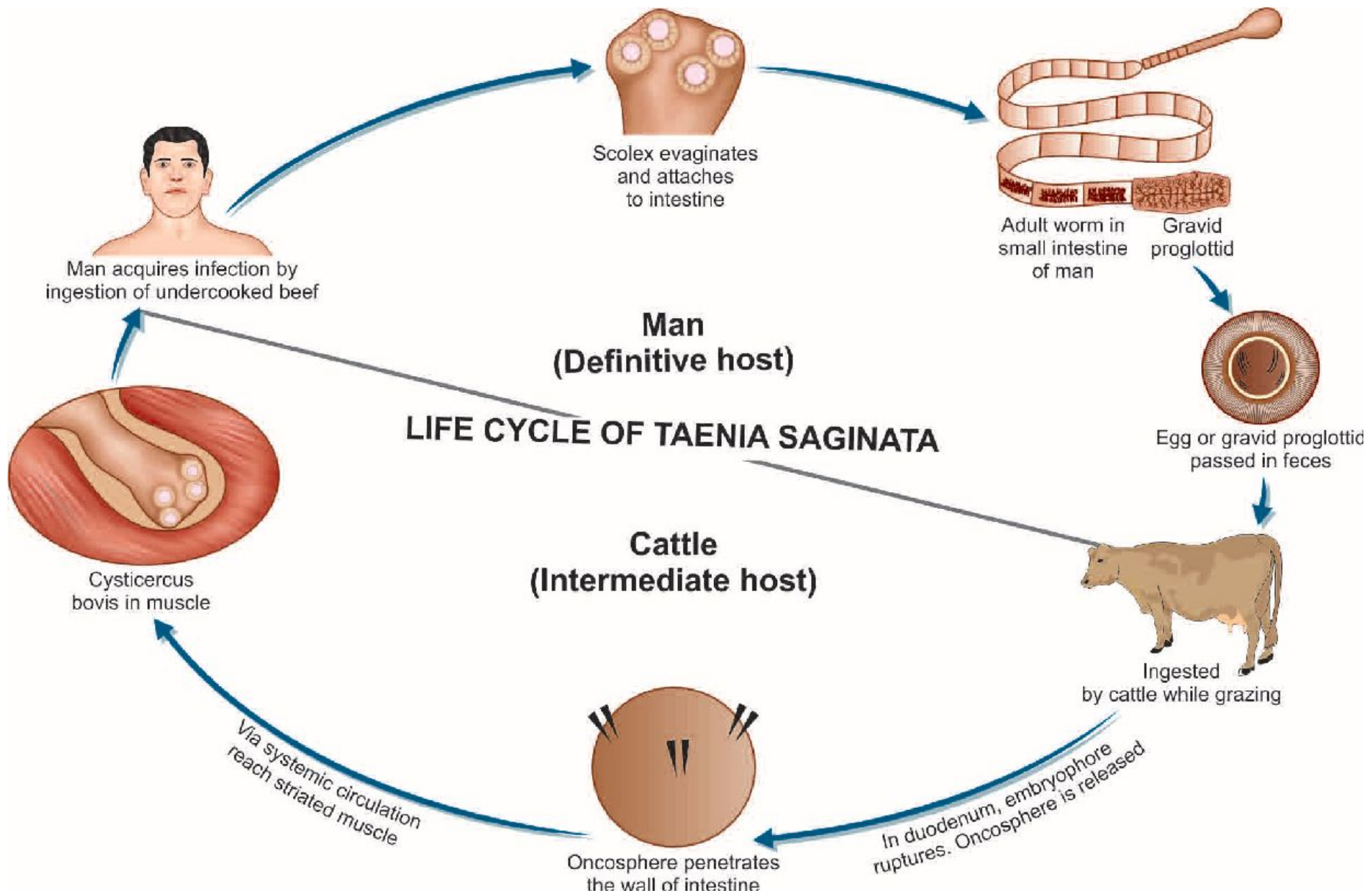
**Adult worm** is opalescent white in color, ribbon-like, dorsoventrally flattened, and segmented measures 5-10 meters in length. The scolex (head) of *T. saginata* is about 1–2 mm in diameter, quadrate in cross-section, bearing 4 hemispherical suckers situated at its four angles. They may be pigmented. The scolex has no rostellum or hooklets. The suckers serve as the sole organ for attachment. The neck is long and narrow. The strobila (trunk) consists of 1000 to 2000 proglottides or segments—immature, mature and gravid. The gravid segments are nearly four times as they are broad, about 20 mm long and 5 mm broad. The segment contains male and female reproductive structures. The mature segments have irregularly alternate lateral genital pores. Each of the terminal segments contains only a uterus made up of a median stem with 15-30 lateral branches.

**Eggs** of both species are indistinguishable. The egg is **spherical**, measuring 30–40  $\mu\text{m}$  in diameter. It has a thin hyaline embryonic membrane around it, which soon disappears after release. The **inner embryophore** is radially striated and is yellow-brown due to **bile staining**. In the center is a fully-developed embryo (**oncosphere**) with 3 pairs of hooklets (**hexacanth embryo**). The eggs do not float in saturated salt solution. The eggs of *T. saginata* are infective only to cattle and not to humans, whereas the eggs of *T. solium* are infective to pigs and humans too.

The larval stage of *Taenia* is called as **cysticercus**.

## Life cycle

The adult worm lives in the small intestine of man. Gravid segments pass out in the stool and become disintegrated and eggs come out to the soil. The gravid proglottid uterus contains about 100,000 eggs. The egg of *T. saginata* is round, about 40 microns in diameter. The 6-hooked embryo is enclosed in a radially striated embryophore. Eggs are ingested by an intermediate host, cattle. The 6-hooked embryo escapes from its shell, penetrates through the intestinal wall into the blood vessels and is carried to the muscles where it develops into a larval stage, **cysticercus bovis** (made up of an invaginated /inverted head and spherical body). Infection to man takes place by the ingestion of raw or insufficiently cooked beef. In the small intestine of man, the head of the cysticercus gets invaginated and the body becomes segmented.



## **Symptoms**

Infected persons may complain of epigastric pain, abdominal discomfort, indigestion, diarrhea, nausea, weight loss, hunger sensation, vomiting, etc. Occasional cases of acute intestinal obstruction, acute appendicitis, and pancreatitis have also been reported.

## **Diagnosis**

Microscopy of stool

Eggs can also be detected by **cellophane swab method** (NIH Swab) in 85–95% patients.

**Detection of *Taenia* Antigen in feces:** Antigen capture enzyme-linked immunosorbent assay (ELISA)

Serodiagnosis (Specific antibodies in serum can be demonstrated by ELISA, indirect immunofluorescence test and indirect hemagglutination (IHA) test

Polymerase chain reaction (PCR)

## **Treatment**

Praziquantel (10–20 mg/kg)

Niclosamide: Four tablets chewed in a single dose.

Mebendazole 100mg twice daily for three days

## **Prevention**

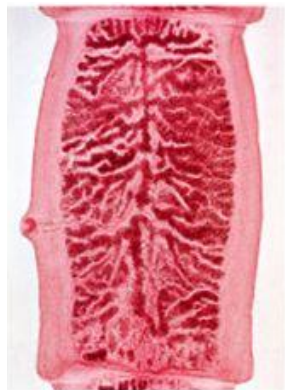
- ◆ Thorough cooking of meat (above 570C).
- ◆ Proper disposal of human excret
- ◆ Maintenance of clean personal habits and general sanitary measures.

## ***Taenia solium* (pork tapeworm)**

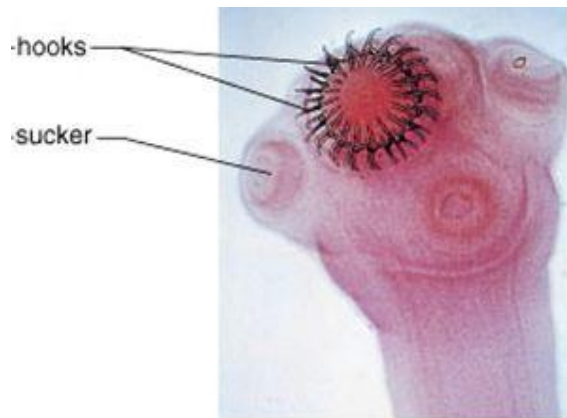
The adult worms of *T. solium* reside or inhabit the upper jejunum. Infection has worldwide distribution.

### **Morphology**

Adult worm measures about 2-3 meters in length. The globular scolex is small and globular about 1 mm in diameter, with 4 large cup-like suckers (0.5 mm in diameter), and has rostellum with 2 rows of hooklets. There are <1000 proglottids. The neck is short and half as thick as the head. Gravid proglottid liberates about 30,000-50,000 eggs. The gravid segments are twice as long as broad, 12 mm by 6 mm. The testes are composed of 150 to 200 follicles. There is an accessory lobe for the ovary. The vaginal sphincter is absent. The uterus has only 5 to 10 (under 13) thick lateral branches. A lateral thick-lipped genital pore is present, alternating between the right and left sides of adjacent segments.



1.0 mm



250  $\mu$ m



## **Life cycle**

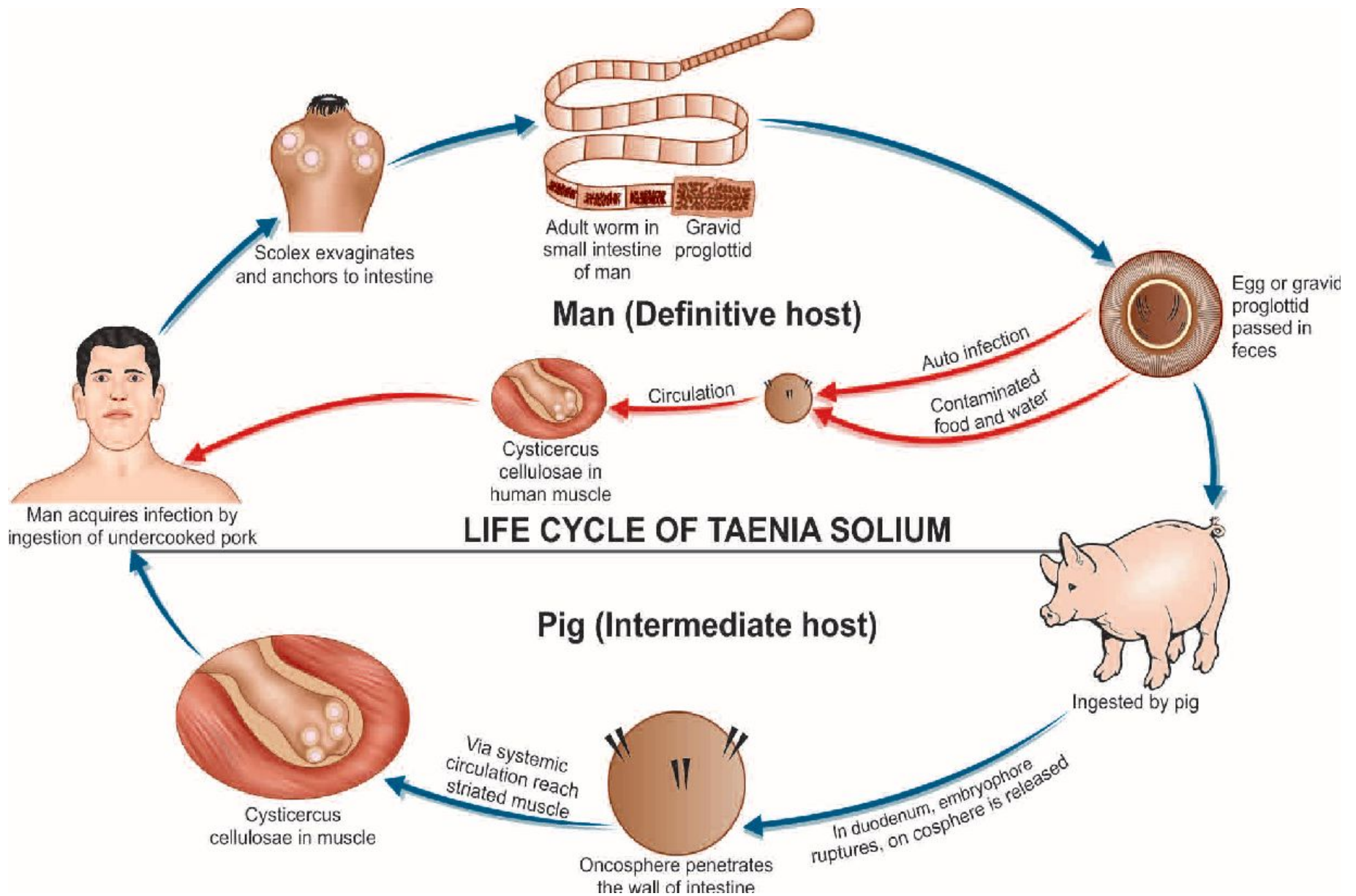
**Definitive host:** Man

**Intermediate host:** Pig, occasionally man (in case of cysticercosis).

**Mode of infection:** Undercooked (measly) pork containing *cysticercus cellulosae*; autoinfection and egg in contaminated vegetable, food, and water. Eggs are infective to human.

Embryonated eggs passed with stool are ingested by pig and the embryo is released. It penetrates the intestinal wall and is carried by vascular channels to all parts of the body. After a period of 2-3 months of development the encysted larval stage called cysticerci or bladder worm occurs in the striated muscles of the tongue, neck, trunk brain, eye, and the nervous system. The cysticercus survives for 5 years. Humans become infected by eating pork containing larvae, *cysticercus cellulosae*. When improperly cooked cysticercus infected meat is eaten by man, the scolex remains undigested and attaches itself to the intestinal wall and chain of proglottids begin to grow to adult worm.







## Symptoms

Infected persons may complain of epigastric pain, abdominal discomfort, indigestion, diarrhea, nausea, weight loss, hunger sensation, vomiting, etc.

*Cysticercosis*. It is caused by larval stage (cysticercus cellulosae) of *T. solium*. *Cysticercus cellulosae* may be solitary or more often multiple. Any organ or tissue may be involved, the most common being subcutaneous tissues and muscles. It may also affect the eyes, brain, and less often the heart, liver, lungs, abdominal cavity, and spinal cord. The cysticercus is surrounded by a fibrous capsule except in the eye and ventricles of the brain. The larvae evoke a cellular reaction starting with infiltration of neutrophils, eosinophils, lymphocytes, plasma cells, and at times, giant cells. This is followed by fibrosis and death of the larva with eventual calcification. The clinical features depend on the site affected: **Subcutaneous nodules** are mostly asymptomatic, **Muscular cysticercosis** may cause acute myositis, **Neurocysticercosis** (cysticercosis of brain) is the most common and most serious form of cysticercosis. About 70% of adult-onset epilepsy is due to neurocysticercosis.

## **Diagnosis**

Stool Examination: Microscopy of stool specimen, **cellophane swab method** (NIH Swab), **Detection of Taenia Antigen in feces:** Antigen capture enzyme-linked immunosorbent assay (ELISA),

Serodiagnosis

Polymerase chain reaction (PCR)

Biopsy of the lesion and its microscopic examination

Imaging (X-ray, CT-scan, MRI scan)

## **Treatment**

Praziquantel 50 mg/kg in 3 divided doses for 20–30 days

Niclosamide: 2 gm PO stat

Albendazole 400 mg twice daily for 30 days

## **Prevention**

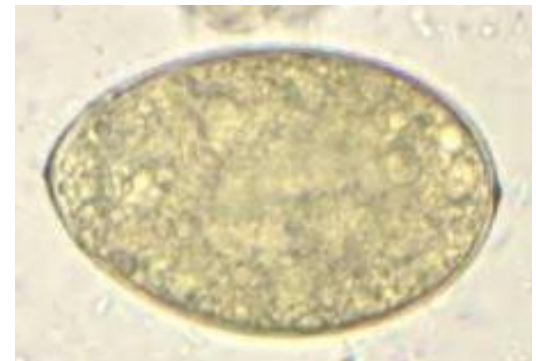
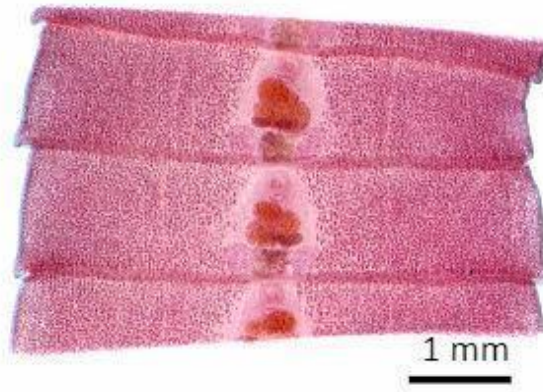
- ◆ Treatment of infected persons.
- ◆ Thorough cooking of pork and proper processing, avoidance of eating undercooked pork and raw vegetables
- ◆ Proper disposal of human excreta (good hygiene/sanitation).

## ***Diphyllobotrium latum* (fish tapeworm or broad tapeworm)**

The broad tapeworm infecting man has worldwide distribution, occurring in areas where improperly cooked or raw fresh water fish is prominent in diet.

### **Morphology**

*Diphyllobotrium latum* is the broadest and longest tapeworm. It is **ivory-colored** and very long, measuring upto 10 meters or more with 3000-4000 proglottids. It is the **largest tape worm** inhabiting the small intestine of man. The adult worm has 3 parts: scolex, neck, and strobila. **Scolex** (head) is **spatulate** or **spoon-shaped**, about 2–3 mm long and 1 mm broad. It carries 2 slit-like longitudinal sucking grooves (**bothria**), one dorsal and the other ventral. The scolex lacks suckers and hooks. Neck is thin, unsegmented and is much more longer than the head. **Strobila** consists of 3,000–4,000 proglottids, consisting of immature, mature, and gravid segments in that order from front to backwards.



## **Life cycle**

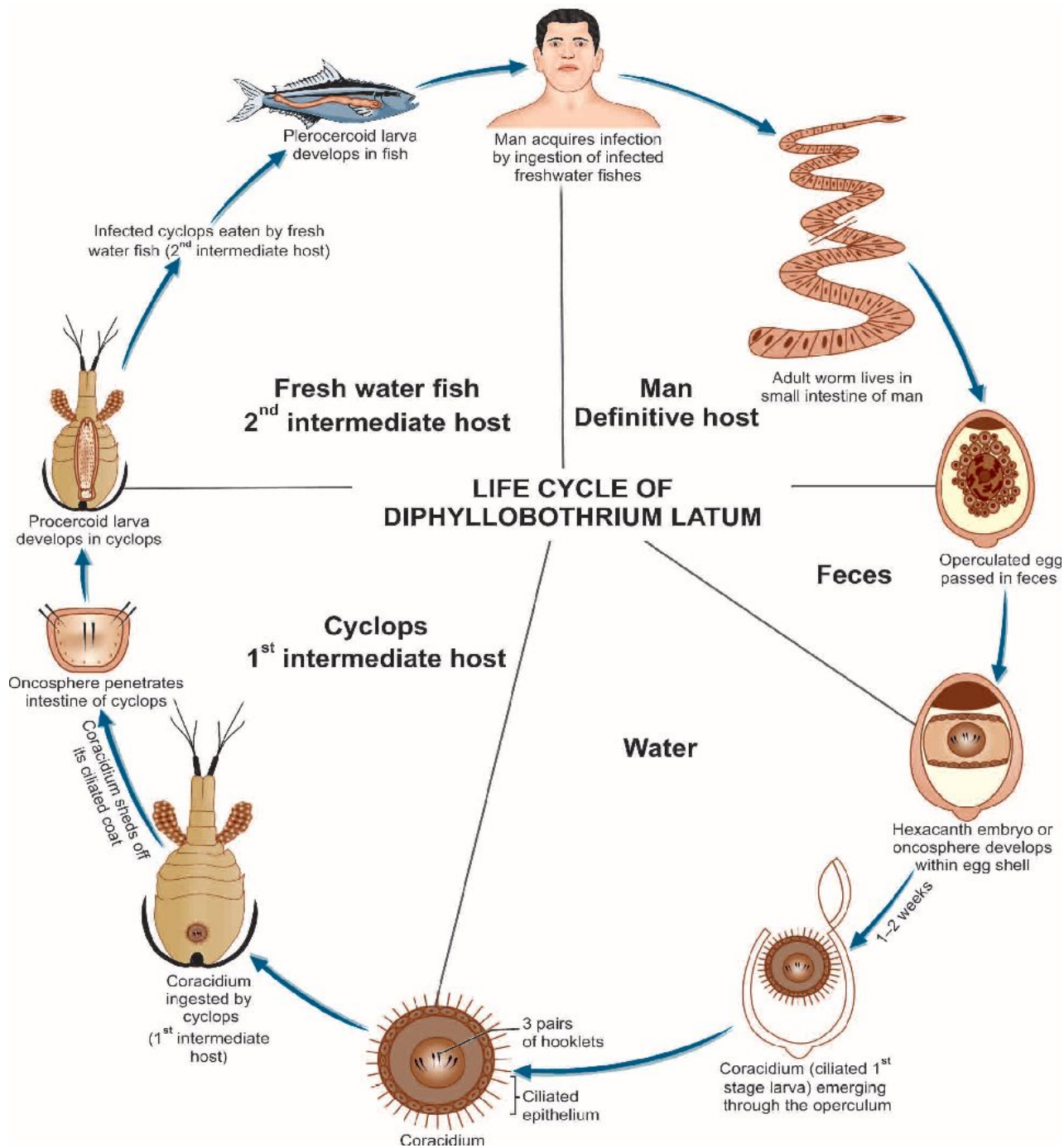
**Definitive hosts:** Man, dog, and cat. Man is the optimal host.

**First intermediate host:** Fresh water copepod, mainly of genera Cyclops or Diaptomus.

**Second intermediate host:** Fresh water fish (salmon, trout, etc.).

**Infective form to human:** Third stage plerocercoid larva.

Unlike Taenia, the gravid segments are retained by the worm. Operculated eggs passed in feces hatch into small ciliated coracidium larvae which swim about freely. These are eaten by crustaceans -Cyclops or Diaptomus - in which the larvae develop into second stage larvae- the proceroid. When the crustaceans are swallowed by fresh water fish, the larvae migrate into the flesh of the muscle fish and develop to pleurocercoid or sparganum larvae. Humans are infected by ingesting raw or improperly cooked fish. The tapeworm matures in the intestine and after 3 weeks, the adult worm discharges eggs. The life cycle requires two intermediate hosts.



**LIFE CYCLE OF  
DIPHYLLOBOTHRIUM LATUM**

Man acquires infection by ingestion of infected freshwater fishes

Adult worm lives in small intestine of man

**Fresh water fish  
2<sup>nd</sup> intermediate host**

**Man  
Definitive host**

**Cyclops  
1<sup>st</sup> intermediate host**

**Feces**

**Water**

Proceroid larva develops in cyclops

Infected cyclops eaten by fresh water fish (2<sup>nd</sup> intermediate host)

Plerocercoid larva develops in fish

Operculated egg passed in feces

Hexacanth embryo or oncosphere develops within egg shell

1-2 weeks

Coracidium (ciliated 1<sup>st</sup> stage larva) emerging through the operculum

Coracidium ingested by cyclops (1<sup>st</sup> intermediate host)

Oncosphere penetrates intestine of cyclops

Coracidium sheds off its ciliated coat

3 pairs of hooklets  
Ciliated epithelium

Coracidium

## **Symptoms**

Most infections are asymptomatic. Rarely, it causes severe cramping, mechanical Obstruction, abdominal discomfort, vomiting, diarrhea, nausea, anemia, weakness and weight loss. Pernicious anemia can also result, due to interference of vitamin B12 absorption in jejunum.

## **Diagnosis**

Eggs in stool: Single shell with operculum at one end and a knob on the other.

## **Treatment**

Praziquantel in a single dose of 10 mg/kg is effective.

Parenteral vit B12 should be given, if B12 deficiency is present.

Niclosamide: 2 mg after light breakfast.

## **Prevention**

Proper cooking of fish

Deep freezing ( $-10^{\circ}\text{C}$  for 24–48 hours ) of fish, if it is to be consumed raw

Prevention of fecal pollution of natural waters

Periodical deworming of pet dogs and cats.

# HOME work. Cestodes

Latin name of parasite	Dyphilobothrium latum	Echinococcus granulosus	Taenia solium	Taenia saginatum
Forms of parasites				
Definitive host				
Intermediate host				
Infective stage				
Transmission Way of infection				
Symptoms				
Diagnosis				
Treatment				
Prevention				