

Medical Parasitology

Assistant Prof. Dr. Ahmed A. Mohammed

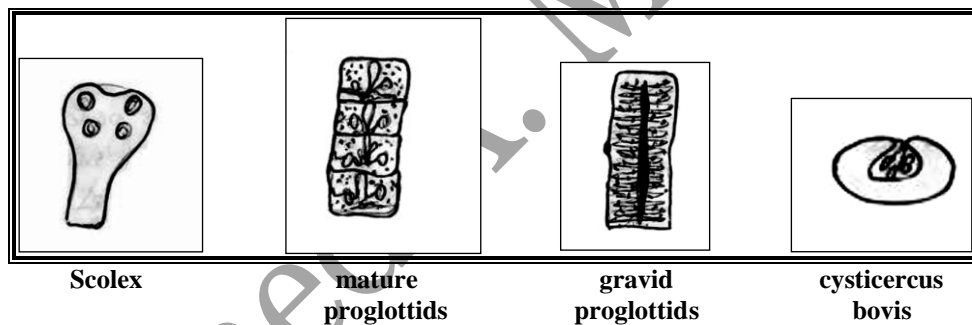
Lec. 7 Helminths

2. Class: Cestoda (Tapeworms)

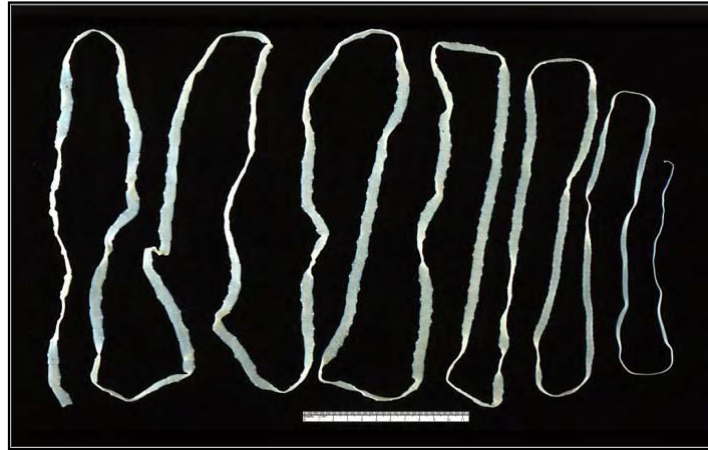
A- Adult Tapeworm Infection

1. *Taenia saginata*

This parasite causes a disease called beef tapeworm infection. The adult worm typically develops in the middle third of the small intestine. The average length of the relaxed worm is approximately 5 meters, although there are records of specimens of far greater length. It has 1000 to 2000 proglottids of which from one third to one half are nearly gravid. Usually, only a single specimen occurs in an infection, but there may be more.

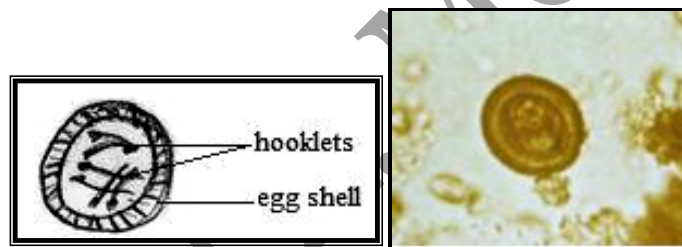


The fully developed worm is delicate anteriorly and more robust posteriorly. The **scolex** bears four suckers and a slight apical depression. Immediately behind the delicate unsegmented (**neck**) there is a region of **immature proglottids** in which the genital organs are not yet developed. Gradually the more distal of these proglottids increase in breadth and width until they reach a maximum width of 12mm, these are the **mature proglottids**, each of which contains a full set of functioning male and female reproductive organs. More distally, the mature unite have transformed into more elongated, narrower, **gravid** ones as a result of the development of a large number of branched lateral arms of a uterus (12 to 30).



“*Taenia saginata* adult worm”

The terminal gravid proglottids become separated from the **strobila** and actively migrate out of the bowel or evacuated in the stool with only partial loss of eggs. The eggs are essentially spherical, measure 31-43µm in diameter and have a thin, transparent outer embryonal envelope and a thick brown shell composed of many slender rods cemented together. Within this shell is a **hexacanth embryo** which has three pairs of delicate lancet-shaped hooklets.



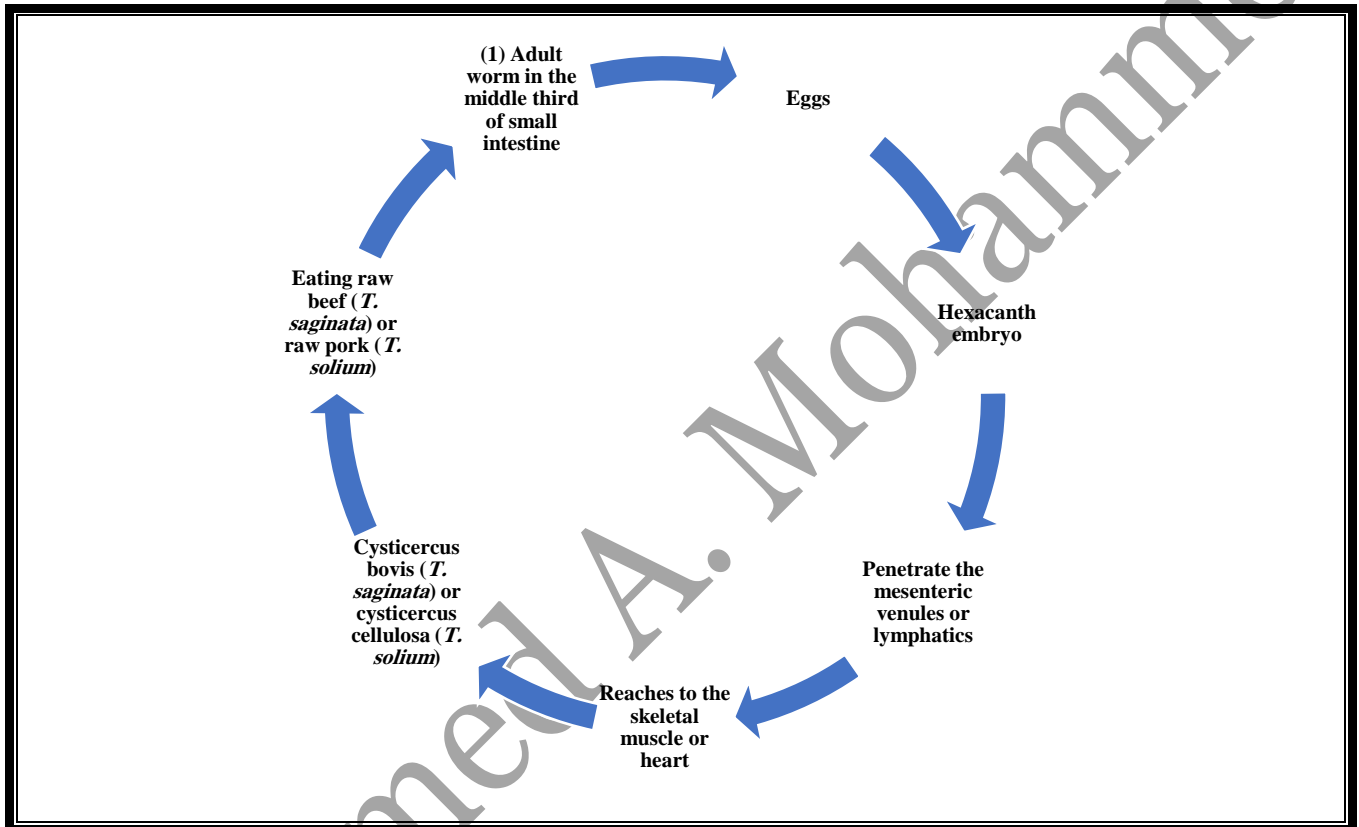
Egg of *Taenia sp.*

Life cycle

The evacuated gravid segments extrude the eggs while crawling on the ground, vegetation, or other surfaces. Eggs extruded from the proglottid contaminate and persist on vegetation for several days and when consumed by cattle they hatch and form cysticerci. Cattle grazing on the infested ground pick up the eggs, which hatch in the duodenum. The emerging embryos penetrate the mesenteric venules or lymphatics and reach the skeletal muscles or the heart where in about **2 months** they transform into a typical **cysticercus** stage (**cysticercus bovis**) which measures roughly 5-10mm and has a head like that of the adult worm, invaginated into a fluid-filled bladder. Thereafter, for a period of more than a year, a person who eats a raw or poorly cooked infected meat (beef) is subject to infection, the prepatent period usually is 10-12 weeks. When larva escapes the cyst and passes to the small intestine, it attaches to the mucosa by the scolex suckers. The proglottids start in development and the worm matures in 3 to 4 months. The adult worm may live in the small intestine as long as 25 years. During this period, the gravid proglottids pass with the feces.

Pathogenesis and Symptoms

Infection with *Taenia saginata* is ordinarily asymptomatic. Only mild abdominal symptoms of discomfort, inconvenience or embarrassment resulting from the gravid proglottids crawling out of the anus (in this respect the infection resembles that of *Enterobius vermicularis*). However, toward the end of the prepatent period, diarrhea and abdominal cramps may occur. Rarely, a mass of tangled worms may cause acute intestinal obstruction. Occasionally, appendicitis or cholangitis can result from migrating proglottids.



“Scheme for the life cycle of *T. saginata* & *T. solium*”.

Diagnosis

1. The detection of the eggs in feces.
2. The detection of the gravid proglottids evacuated in feces.

This is not possible **during the first 3 months** following infection, prior to the development of adult tapeworms. Repeated examination and concentration techniques will increase the likelihood of detecting light infections.

3. The detection of the gravid proglottids migrates from the rectum onto the skin or clothing. For this reason, the diagnosis may be made by using **adhesive cellophane tape technique**, as for Enterobiasis.

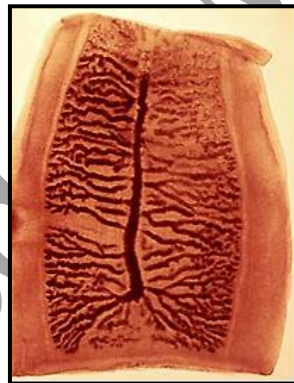
The eggs of *Taenia saginata* and *T. solium* are indistinguishable morphologically (morphologic species identification will have to rely on the proglottids or scolices).

Pollen artifact could be mistaken for a taeniid egg; however, the shell is thinner, non-uniform thickness and no hooks are visible.

Nevertheless, speciation of *Taenia* is impossible if solely based on microscopic examination of eggs, because all *Taenia* species produce eggs that are morphologically identical. Eggs of *Taenia* sp. are also indistinguishable from those produced by cestodes of the genus *Echinococcus* (tapeworms of dogs and other canid hosts). Microscopic identification of gravid proglottids (or more rarely the examination of the scolex) allows species determination.

Gravid proglottids are longer than wide and the two species, *T. solium* and *T. saginata*, differ in the number of primary lateral uterine branches: *T. solium* contains 7-13 lateral branches and *T. saginata* 12-30 lateral branches.

Note: Take extreme care in processing the fresh samples! Ingestion of eggs can result in Cysticercosis!



T. saginata Gravid proglottid

Other diagnostic techniques used in cysticercosis depends upon **serology**. **MRI** scans may reveal the presence of lesions in the brain. Calcified cysticerci are less often seen in the brain. Occasionally, the diagnosis is made histologically on surgical specimens. Calcification in muscles usually appears three to five years after initial infection, and are most typically seen as spindle-shaped calcifications, most numerous in the thighs. Western Blots also used in the diagnosis.

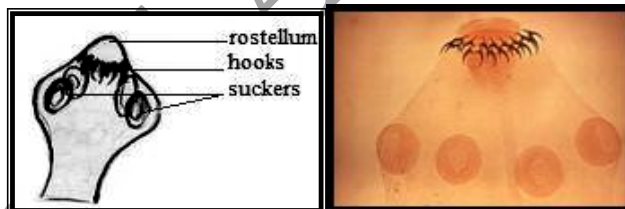
“Comparison between the two species of *Taenia*”

Characteristic	<i>Taenia saginata</i>	<i>Taenia solium</i>
Intermediate Host	Cattle, reindeer	Pig, wild boar
Scolex in adult worm	No hooks	Hooks
Scolex in cysticercus	No rostellum	Rostellum & hooks
Mature proglottid Ovary	Two lobes	Three lobes
Gravid proglottids: uterine branches	12-30	7-13
Passing of proglottids	Single, spontaneous	In groups, passively

Treatment: Niclosamide (Yomesan), Praziquantel, Quinacrine hydrochloride.

2. *Taenia solium*

This parasite causes a disease called pork tapeworm infection. In most respects, *Taenia solium* resembles *T. saginata*, but it is shorter, usually having a length of fewer than 3 meters due to a smaller number of proglottids (fewer than 1000) and smaller gravid proglottids. The scolex has rostellum with double circles of alternating large and small hooks (22 to 36 hooks) measuring 140- 200µm and 100- 150µm respectively and also has 4 suckers anteriorly.



“Scolex of *Taenia solium*”.

The mature proglottid of *T. solium* closely resembles that of *T. saginata* but is usually readily differentiated because it contains approximately one half the number of the main lateral uterine arms on each side of the longitudinal uterine stem (usually 9 or 10). Eggs of *T. solium* are indistinguishable from those of *T. saginata*.

Gravid proglottids actively migrate from the anus or are passed in the feces. Eggs discharged by migrating proglottids or are become free when they disintegrate on the ground. To develop, the eggs must be ingested by the pig or by the man himself. The hexacanth embryo hatch in the duodenum, migrate through the intestinal wall and reach the blood and lymphatic channels which carry them to the skeletal muscle and myocardium. At that time embryos transform in 2-3 months into cysticerci (cysticercus cellulosae), glistening pearly white and measuring about 5-8 or 10mm. The scolex is deeply invaginated into the fluid-filled bladder and is provided with 4 suckers and a

rostellum, as in the adult scolex. When people eat pork containing viable cysticerci, the larvae are digested out of the meat and the heads evaginate from the bladder, become attached to the wall of the intestine, and mature in 5-12 weeks (direct infection).

Pathogenesis and Symptoms

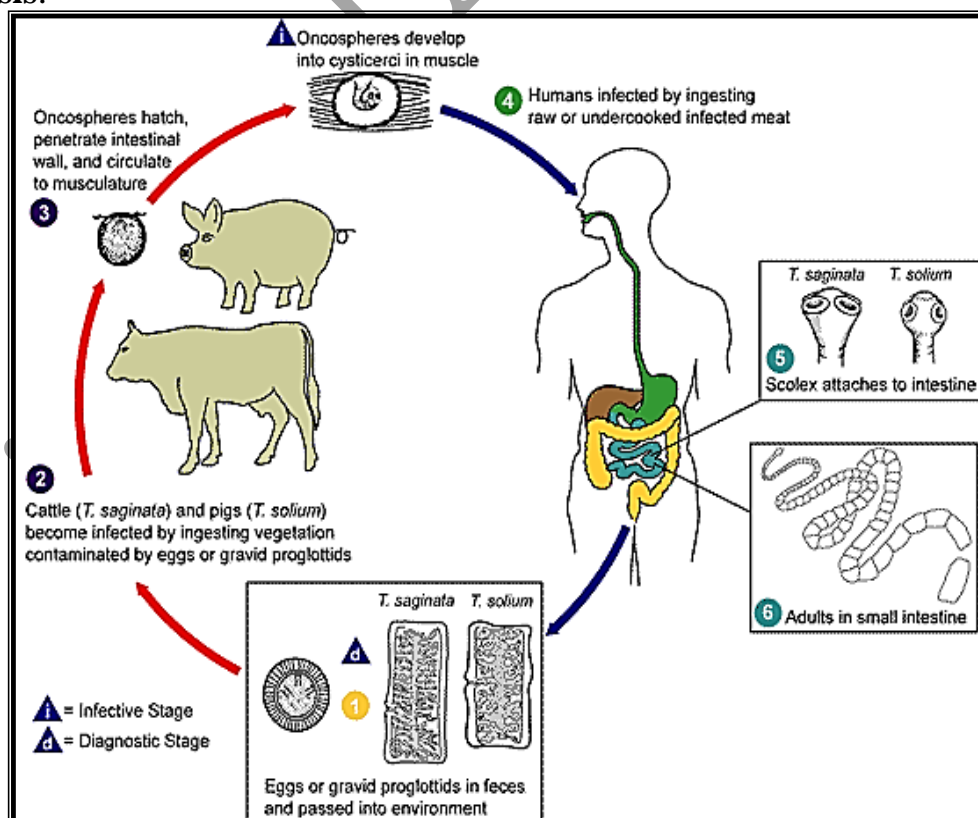
Taenia solium taeniasis is less frequently symptomatic than *Taenia saginata* taeniasis. The main symptom is often the passage of proglottids. The most important feature of *Taenia solium* taeniasis is the risk of development of Cysticercosis. The infection with the adult worm produces the same clinical manifestations as in the infection with *T. saginata*. However, because of its shorter length, there is less likelihood of developing intestinal obstruction.

Diagnosis

Although eggs of *T. solium* may be found in the feces or on anal swabs, specific diagnosis is based on demonstration of the relatively small number of lateral arms of the uterus which is 7-13 (usually about 9) in the gravid proglottids.

Treatment

Niclosamide and Praziquantel are the drugs of choice. Niclosamide may cause disintegrate and release the eggs into the bowel lumen, possibly increasing the hazard of cysticercosis.

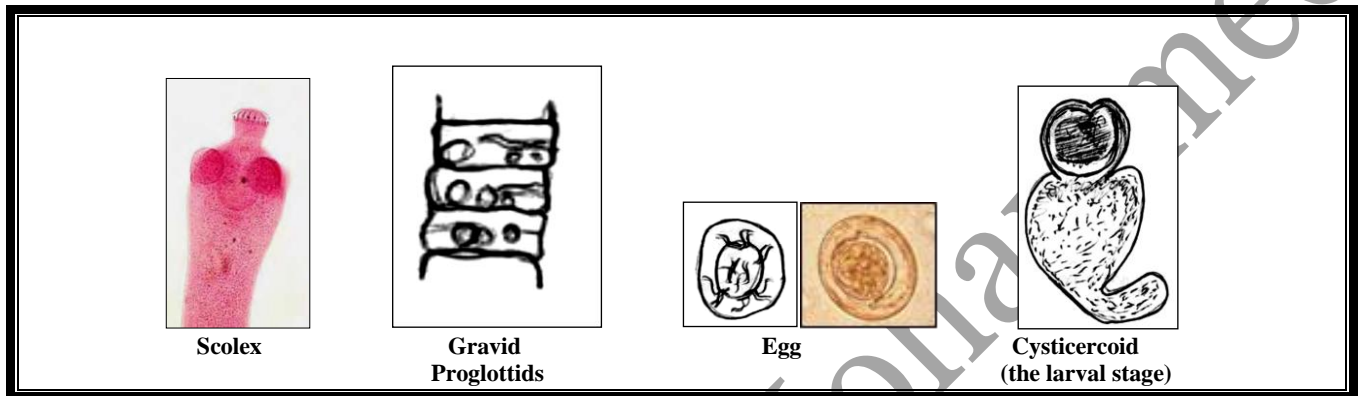


“Diagram for the life cycle of *T. saginata* & *T. solium*”.

3. *Hymenolepis nana* (The dwarf tapeworm)

Dwarf tapeworm infection in humans is primarily limited to children in warm climates. The adult worms found in the small intestine of the human and mice. It is characterized by its ability to complete its life cycle in one host.

H. nana is the smallest tapeworms of man. The entire worm has a length of only 15-40mm and 1mm in breadth. The scolex is small, provided with 4 suckers and a rostellar crown of 20-30 minute hooklets.



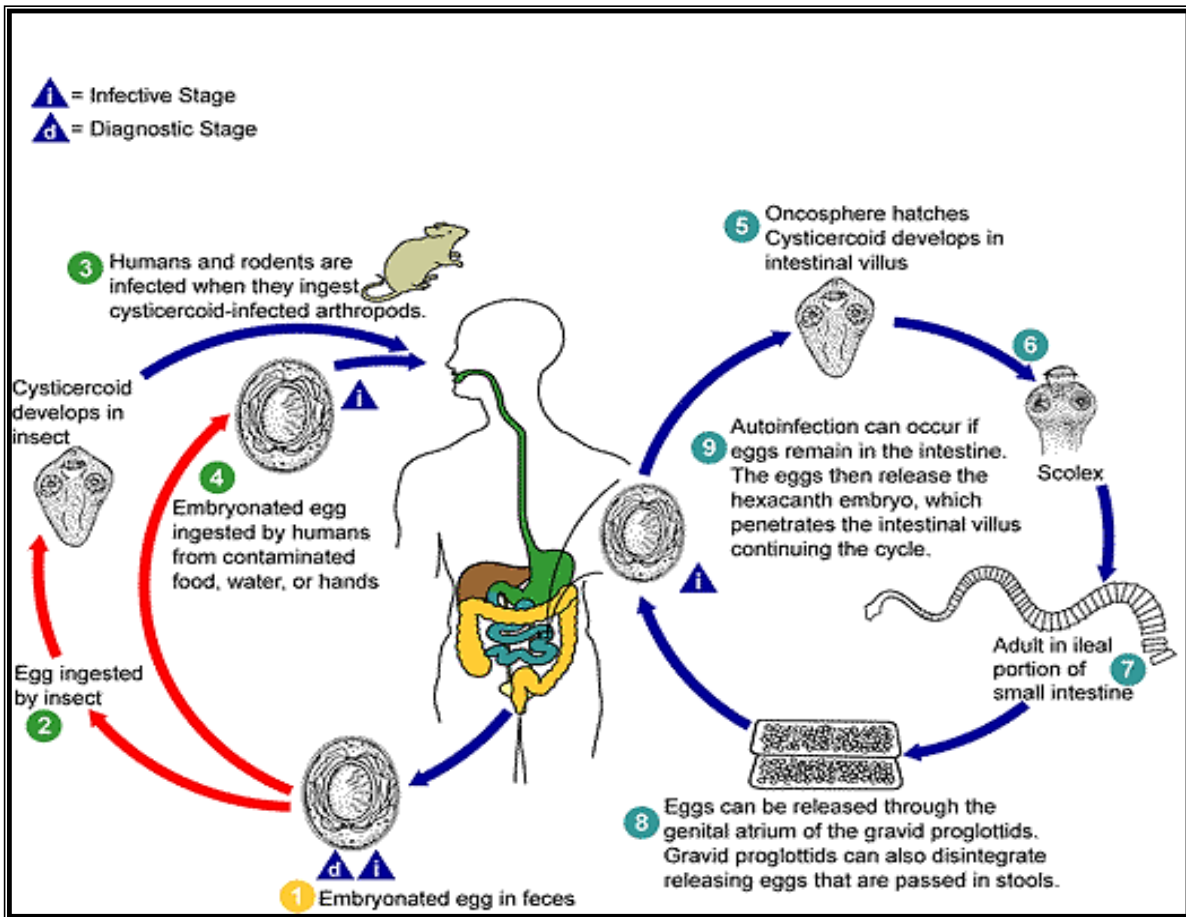
Hymenolepis nana: scolex, gravid proglottids, egg and Cysticercoid.

The neck is long and slender, followed by approximately 200 proglottids which are broader than they long, and the terminal gravid proglottids usually disintegrate before separating from the strobila, so that the eggs are randomly mixed with the feces. The average infection consists of few to several worms, but thousands have been reported from some patients. The eggs are nearly spherical 30 to 55 μ m in diameter; there are two membranous shells, the inner one of which has **polar thickenings**, each provided with 4-8 long threadlike filaments extending into the space between the inner and outer shells.

Life cycle

This worm is different from the other tapeworms by its ability to complete its life cycle without a need to intermediate host, although it could grow in the fleas and the grain beetles as an intermediate host.

When eggs are swallowed, they hatch in the duodenum and the liberated embryos (Hexacanth embryo) penetrate into the stroma of the villi where in 5-6 days they transform into **cysticercoid larvae**. These cysticercoids then attach to the mucosa, and in about 2 weeks they develop into complete worms. Thus, both the larval and adult stages develop in the same individual. Moreover, in the heavy infections, it seems entirely probable that internal autoinfection may have occurred as a result of hatching of eggs in the upper levels of the small intestine **following regurgitation into the stomach**. The stage which may develop in the fleas and beetles is cysticercoid larva.



“Diagram for the life cycle of *Hymenolepis nana*”.

Pathology & Symptoms

The infection may produce no detectable symptoms or it may be responsible for diarrhea, anorexia, vomiting, insomnia, loss of appetite and weight, irritability, pruritus of the nose and anus and urticaria. Heavy infection invariably is pathogenic, causing diarrhea, abdominal pain, anorexia and nervous disorders.

Diagnosis

It is based on the demonstration of the characteristic eggs in the stools. Concentration techniques and repeated examinations will increase the likelihood of detecting light infections.

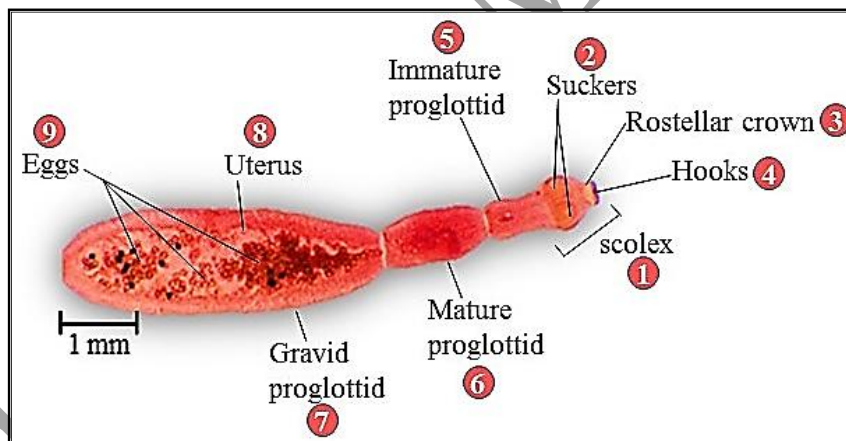
Treatment: Niclosamide / in course of (5-7) days. [also, Praziquantel].

B- Larval Tapeworm infection

1. *Echinococcus granulosus*

This parasite causes a disease called unilocular or cystic (hydatid disease, or echinococcosis, or hydatidosis). It is widely distributed throughout temperate and subtropical regions where sheep are extensively raised. The adult worm lives in the small intestine of the canine host (dog, fox, wolf, ...), whereas the larval stage lives in the herbivorous animals (sheep, cattle, goats, cows, horses, camels) and man; the human is an accidental intermediate host. It infects all the body organs except the nails and hair, especially the liver and the lungs.

The adult worm is small in size, it measures 2-9mm length and characterized by its limited number of proglottids, it has a pyriform scolex provided with 4 suckers and a rostellar crown of 28-50 hooks. After the scolex, there are three proglottids, immature, mature, and the gravid proglottids. The mature one has (45-65) testes (pyriform) and pair of ovaries and a single vitelline gland (vitellaria) behind the two ovaries; the genital pore is lateral in position. The gravid proglottid has a uterus filled with eggs and it measures more than the half of the body long.



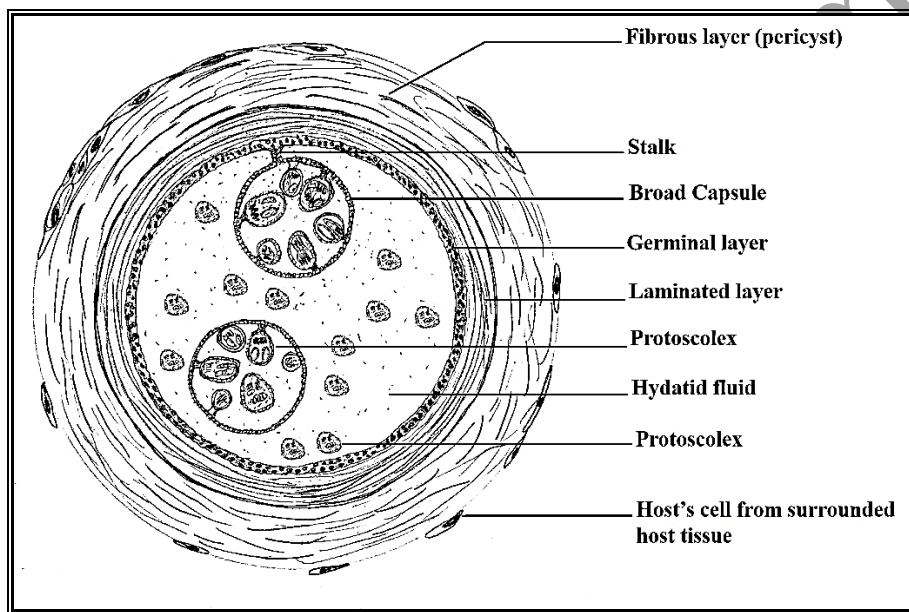
Echinococcus granulosus: adult worm.

Life cycle

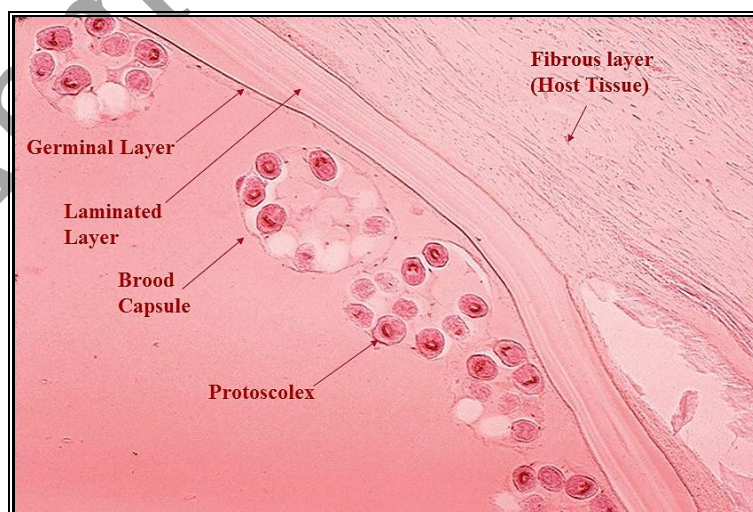
1. The intermediate host:

It is infected by the ingestion of the worm eggs which are hatching in the duodenum into hexacanth embryos and penetrate the intestinal wall and enter the mesenteric venules or lymph vessels then reach to different tissues in the body where 70% of these larvae will stay in the liver and the others will reach mostly to the lungs and other body organs. The oncosphere develop rather slowly into unilocular hydatid cysts, which grow and reach to a large size depending on the position of the cyst. The cyst surrounded by a fibrous capsule externally, which consist of a host connective tissue constructed by the

infected organ (as a mechanical immune response). The cyst also surrounded with 2 different layers, the outer one lay directly under the fibrous capsule; it is milky white, striated and consists of many layers, called the laminated layer. The inner layer consists of a thin layer of (germinative epithelium) and called the germinative layer; it appears as a granular membrane with much nuclei. This layer producing numerous protoscolices and daughter cysts within the parent cyst. The germ layer also produces vesicles or capsules contain 30-40 protoscolices called brood capsules, which become free in the cyst fluid. If the cyst has no protoscolices it is called sterile cyst. The cyst filled with a transparent or white-yellowish liquid called hydatid cyst fluid, it is toxic and responsible for the symptoms which appear if the cyst ruptured.



A scheme for a cross section in the hydatid cyst of *Echinococcus granulosus*.

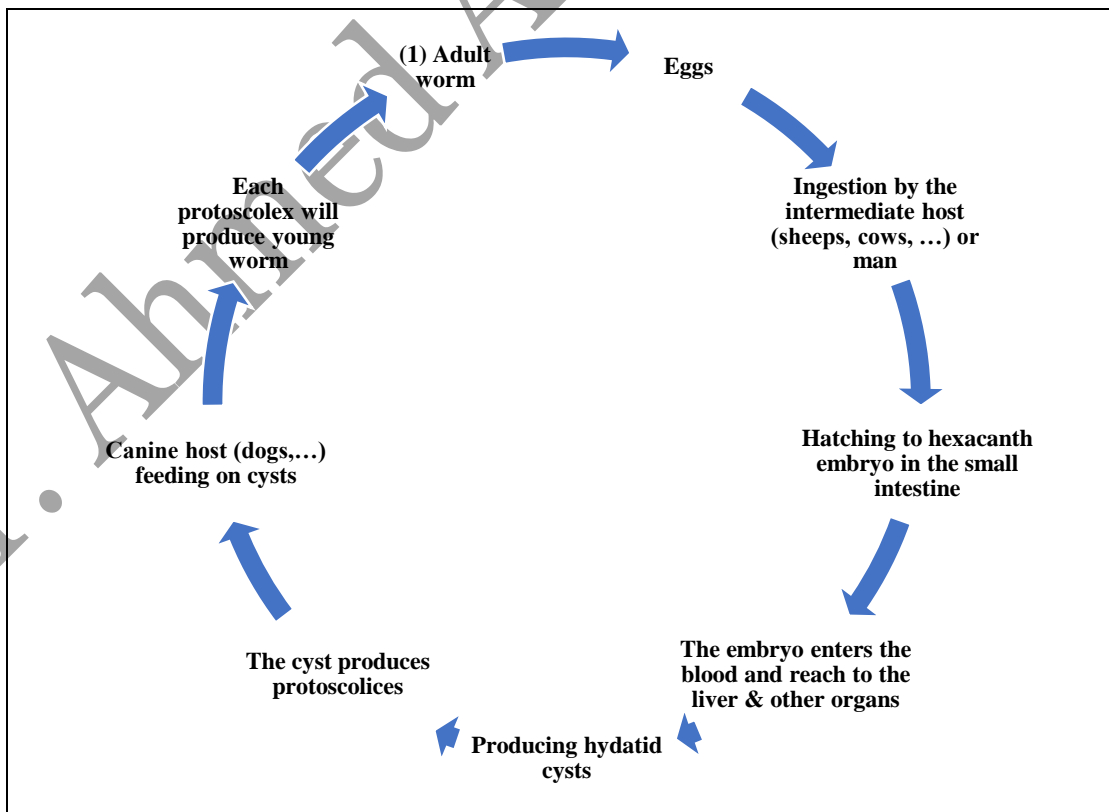


Section in the hydatid cyst of *Echinococcus granulosus*.

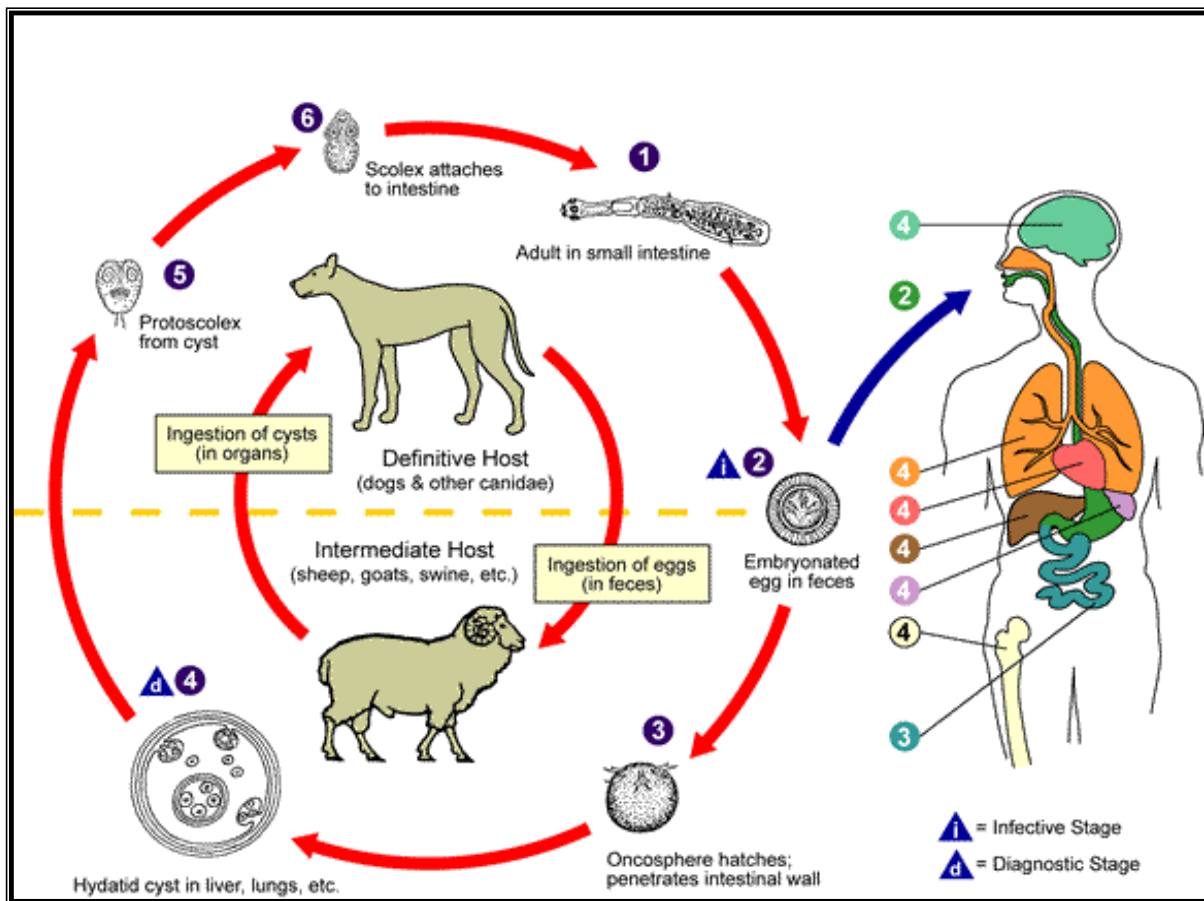


2. The definitive (or final) host:

When the carnivores feed on the infected organs of the intermediate host, the protoscolices become free in the intestine. They grow into adult worms in about one month. The adult worms live 5-20 months in dogs.



“Scheme for the life cycle of *Echinococcus granulosus*”.



“Diagram for the life cycle of *Echinococcus granulosus*”.



Invaginated protoscolex.



Evaginated protoscolex.

Pathology and Symptomatology

The infections remain silent for years before the enlarging cysts cause symptoms in the affected organs. The signs depend primarily on the size of the cyst which depends on the cyst age. The infection can result in abdominal pain, a mass in the hepatic area and biliary duct obstruction. Pulmonary involvement can produce chest pain, cough and hemoptysis.

If a large abdominal cyst ruptured either spontaneously or following a blow on the abdomen, it can produce fever, urticaria, eosinophilia, and anaphylactic shock, as well as cyst dissemination; anaphylaxis may be precipitated by the sudden liberation of hydatid fluid into the peritoneal cavity. Moreover, protoscolices spilled out of cyst cavity will become implanted in the peritoneum and produce multiple secondary cysts. Rupture of a pulmonary cyst into a bronchus results in patient’s coughing up the contents, with possible spontaneous clearance of the infection. In addition, other organs (brain, bone,

heart) can also be involved. Hydatid cysts of the brain produces increasing symptomatic evidence of an intracranial tumor. Osseous hydatid cysts are insidious, gradually eroding the bone to a stage at which fracture or crumbling suddenly occurs.

Random signs: Coughing, dizziness, vomiting, nausea, enlargements of the infected organs depend on the size, age and position of the cyst, and also necrosis in the tissue of the organ. In the liver, the cyst may cause an obstructive jaundice because of the bile duct obstruction.

Diagnosis

In the patient (the intermediate host):

1. Immunologic tests: the intradermal test (or **Casoni test**), immunoelectrophoresis (IEP), indirect fluorescent antibody (IFA) tests. ELISA and enzyme immunoassays (EIA) are sensitive tests for detecting the antibodies in the patient's serum.

False-positive reactions may occur in persons with other helminthic infections, cancer, and chronic immune disorders. Negative test results do not rule out echinococcosis because some cyst carriers do not have detectable antibodies. Whether the patient has detectable antibodies depends on the physical location, integrity, and vitality of the larval cyst. Rupture of a cyst is followed by a high stimulation of antibodies. A patient with aging, calcified, or dead cysts is generally found to be seronegative.

2. by X-ray: it is useful in the cysts of the lung, bones, liver capsule.

3. Hydatid thrill.

Treatment

The surgery is the most common form of treatment for echinococcosis, although removal of the parasite mass is not usually 100% effective. After surgery, medication may be necessary to keep the cyst from recurring. The drug of choice for treatment in echinococcosis is albendazole (or Mebendazole) and sometimes the Biotherapy. The PAIR technique used in the diagnosis and the treatment of Hydatid cysts.

2 *Echinococcus multilocularis*

This parasite causes a disease called alveolar or multilocular hydatid disease or echinococcosis. The adult worm is smaller than *E. granulosus*, the definitive host is mainly foxes.

The hydatid cyst is different from the above sample. The wall of the cyst is thin, it is grow and produce a minute irregular cavities or processes in the host tissues as similar as the cancer. The processes may be having many small pockets filled with a liquid and few protoscolices, so that, this type of hydatid cyst called multilocular or alveolar cyst. In the man and other unnatural hosts, the pockets are without protoscolices. These cysts found always in the liver where 90% of the infection are in the liver, and rarely they infect the lungs. The infection with this type of hydatid cysts is dangerous because they are spread as in malignant tumors.

Pathology

Echinococcus multilocularis affects the liver as a slow growing, destructive tumor, with abdominal pain, biliary obstruction, and occasionally metastatic lesions in the lungs and the brain.

Diagnosis

Specific diagnosis is likely to be missed in the living patient because of the general unfamiliarity of pathologists with this type of hydatid infection.

Treatment: Albendazole or Mebendazole, the surgical removal is not amenable.

Dr. Ahmed A. Mohammed