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Medical Parasitology

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Lec. 5 Helminths

Introduction

The term **"Helminths"** mean **"worm"**, it is broadly interpreted; it refers to any worm-like animal, in a more restricted sense it refers to a parasitic worm, those comprises two large phyla:

1. Phylum: Platyhelminths (flat worms).
2. Phylum: Nemathelminths or Nematoda (true round worms).

And two smaller ones:
1. Phylum: Nematomorpha (hair snakes).
2. Phylum: Acanthocephala (thorny-headed worms).
And one **class** group [of **phylum Annelida**] the **class Hirudinea** (Leeches).

Special adaptations for the parasitic mode of life and for species survival are more apparent in the helminths than in the protozoa. The complete or partial loss of the digestive tract in certain parasitic helminths is presumed to be because of their location in the host's intestine or tissue, where predigested nutrients are abundant; it is greatly reduced or nearly absent in many of the trematodes, and although present and complete in most nematodes, it is much reduced in some. A related adaptation in the trematodes and cestodes is evident in the tegument, which on its outer surface has a coat of microvilli morphologically not unlike that of the intestinal mucosa of vertebrates.

While most of the vital systems of the parasitic helminths have been modified toward simplification, the reproductive system has been modified toward increased capacity. However, with few exceptions, reproduction to increase the parasitic population within the same host (internal autoinfection) does not occur among helminths, as a general rule, and the number of individuals in a worm population living within a given host does not exceed the number of the infective eggs or larva that entered from the outside. Moreover, under usual condition of host and environment, the number of worms that reach maturity in any given host is limited to levels that are tolerable to both host and people infected with helminths who are asymptomatic carriers; whereas the diseased individuals among the infected group are those with the heaviest worm burdens.

In some helminths, the life cycle is direct and relatively simple, involving only one host species and a brief period of development of an infective transfer stage as in the pinworm, ***Enterobius vermicularis***. In a group referred to as soil-transmitted helminths the life cycle involves only one host, man, but the infective transfer stage requires a period of development in soil (larvae remaining in the eggs, as in ***Ascaris lumbricoides*** and ***Trichuris trichiura***, or free in the soil, as in the hookworm species), the soil acts as an intermediate host. In others, the man-to-man cycle involves essential development in one intermediate host, as in the filarial worms and most tapeworms, or two intermediate hosts, as in most trematodes. The first being a snail or other mollusc; the second an animal or plant that is eaten by people (such as larval lung flukes in crabs and certain larval liver flukes in fish or others on aquatic vegetation). In addition, certain nematodes, cestodes, and trematodes include in their life cycles a special kind of transmission known as **paratenesis**, involving **paratenic hosts**. Intermediate hosts provide the parasite with support for essential development,

protection, and availability to its final host. In a prey-predator relationship paratenic hosts acquired the larval stage after it has developed to the infective stage in soil or an intermediate host and provide for its protection, support, and availability to its final host.

Worms and larvae that migrate through or reside in tissues generally produce **eosinophilia**, focally in the tissues, in the blood, or in both. Persistent hypereosinophilia is the most widely recognized general sign of a helminthic infection. Helminthic infections frequently are occult or cryptic because they are prepatent or nonpatent. Certain helminths of animals develop in man but do not produce eggs or larvae and therefore the infections are not patent. In addition to eosinophilia, common signals of occult helminthic infections are **hepatomegaly**, **pneumonitis**, **bronchial asthma**, **urticaria**, **subcutaneous cysts** or **swellings**, **neurologic disturbances**, and **deviations in behavior**.

Groups of Helminths

I- Phylum: Platyhelminths

This phylum includes the following classes:

1 Class: Turbellaria.
2 Class: Trematoda.
3 Class: Cestoda.

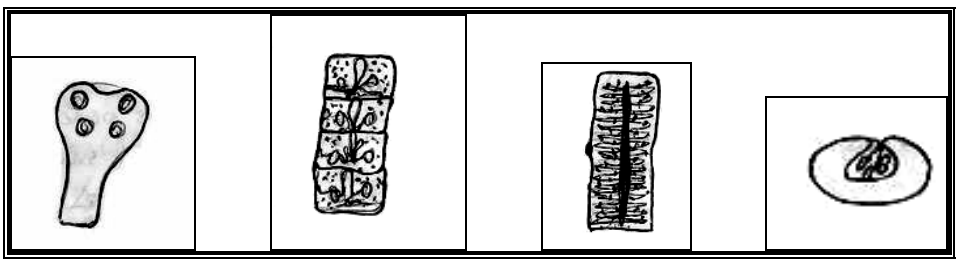
Class: Cestoda (Tapeworms)

A- Adult Tapeworm Infection

-Kingdom: Animalia
-Phylum : Platyhelminths
-Class : Cestoda
-Sub-class: Eucestoda
-Order : Cyclophyllidea

1 *Taenia saginata*

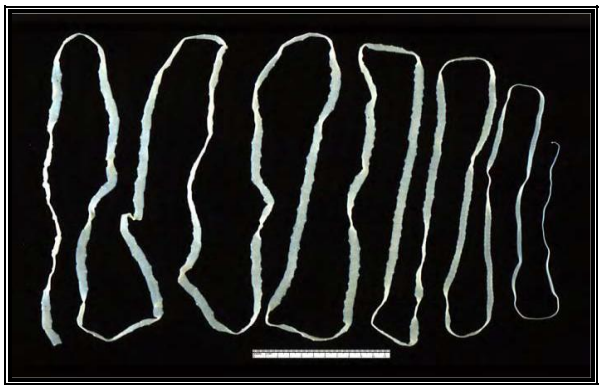
This parasite causes beef tapeworm infection. The adult worm typically develops in the middle third of the small intestine. The average length of the relaxed worm is approximately 5 meters, although there are records of specimens of far greater length. It has 1000 to 2000 proglottids of which from one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



***Taenia saginata*: scolex, mature segment, gravid segment and cysticercus bovis.**

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 are 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*.

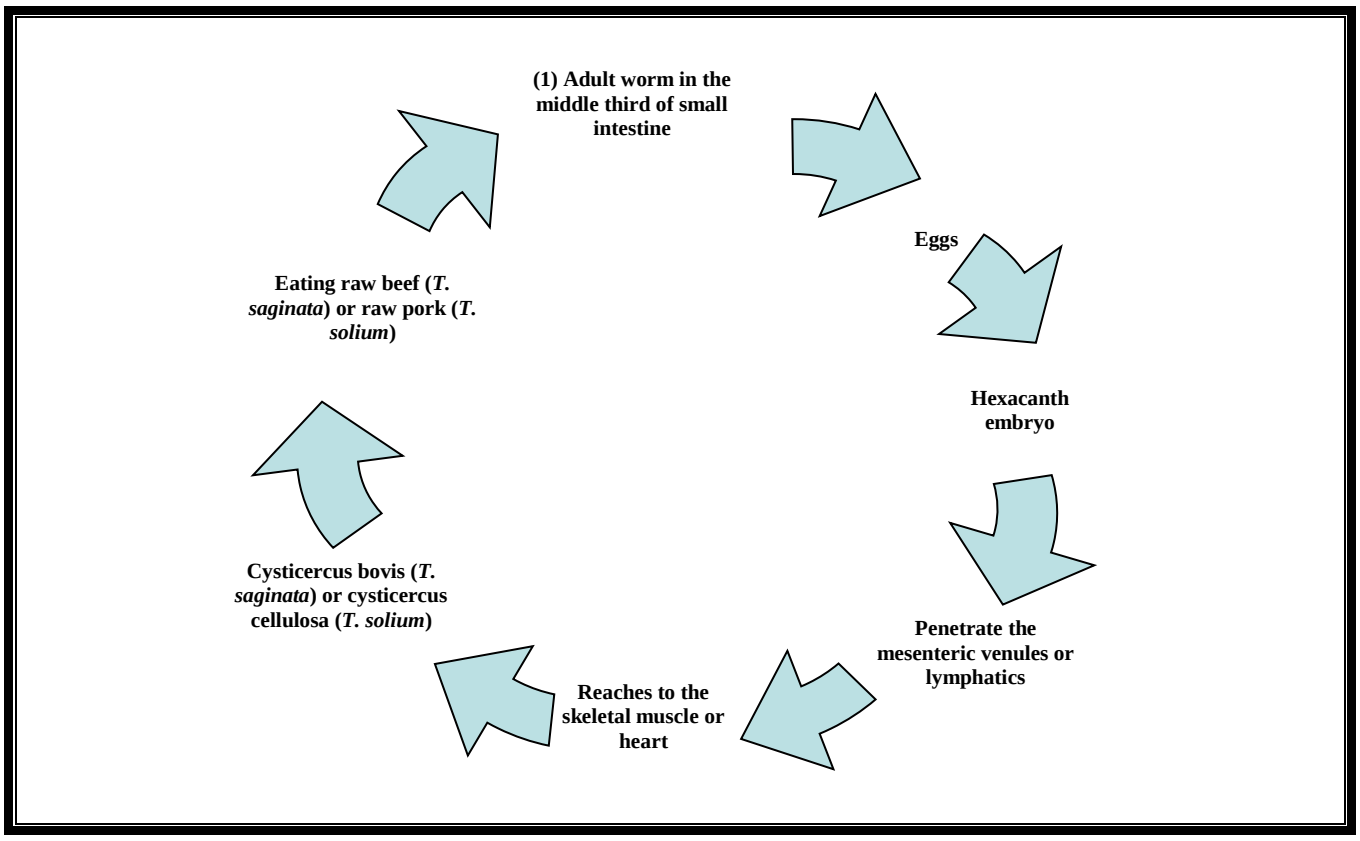
Life cycle

The evacuated gravid segments extrude the eggs while crawling on the ground, vegetation, or other surfaces. 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 the raw infected beef is subject to infection, the prepatent period usually is 10-12 weeks.

The human host become infected when the larval cyst (cysticercus) is ingested with poorly cooked infected meat. Whenever the larva escapes the cyst and passes to the small intestine where 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. Eggs extruded from the proglottid contaminate and persist on vegetation for several days and when consumed by cattle they hatch and form cysticerci.

Pathogenesis & Symptomatology

Infection with ***Taenia saginata*** is ordinarily asymptomatic. Only mild abdominal symptoms for the 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, of 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.

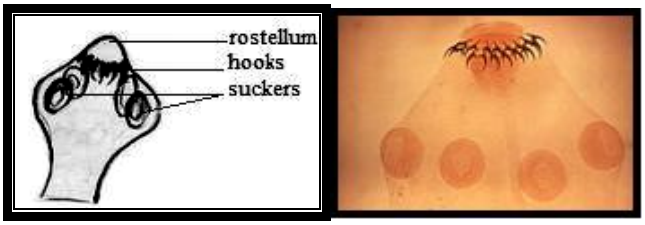
"Comparison between the two species of *Taenia*"

Characteristic	***Taenia saginata***	***Taenia solium***
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 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 (usually 9 or 10) of main lateral uterine arms on each side of the longitudinal uterine stem. 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 & Symptomatology

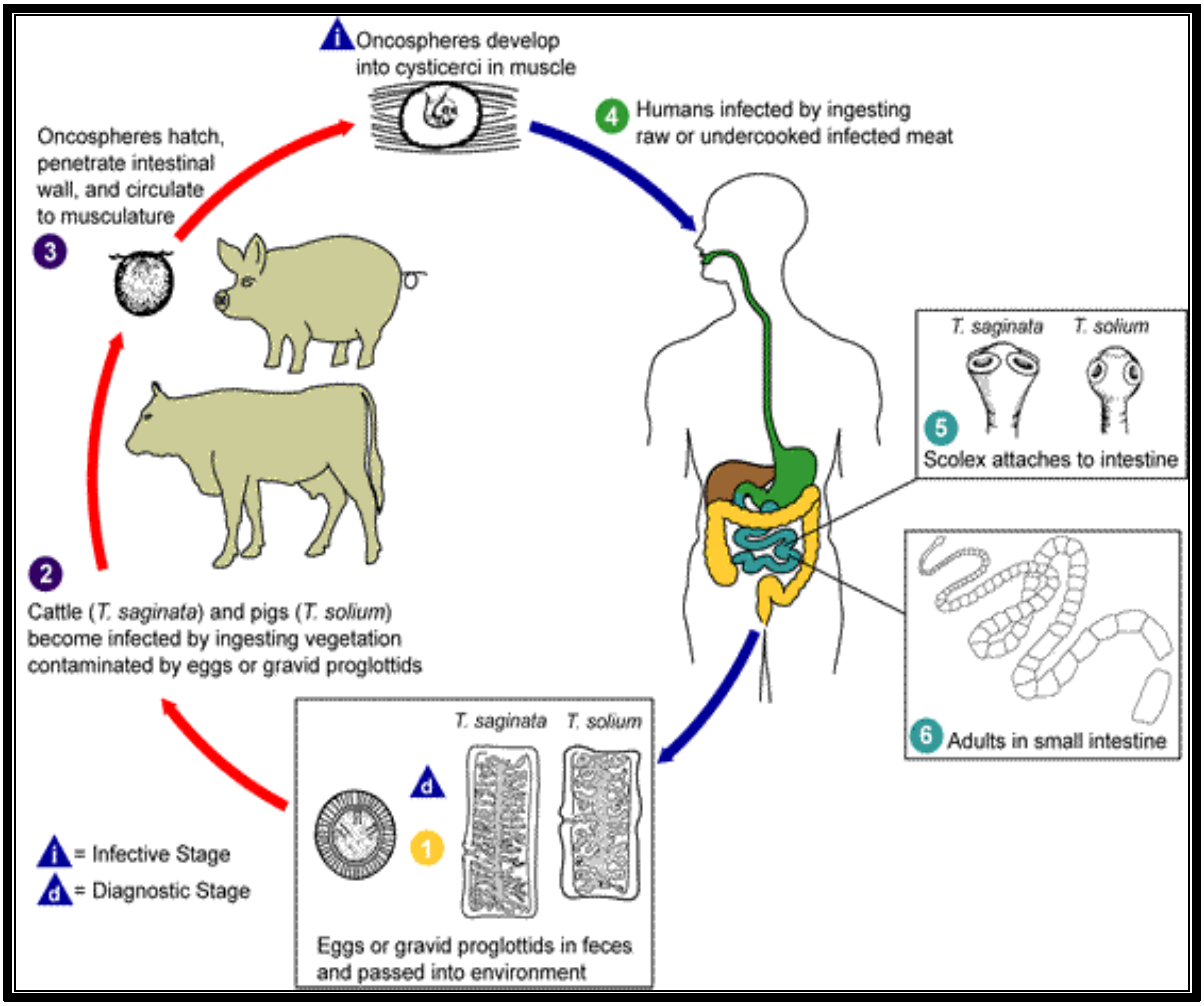
Taenia solium taeniasis is less frequently symptomatic than ***Taenia saginata*** taeniasis. The main symptom is often the passage of proglottids. The most important feature of ***Taenia solium*** taeniasis is the risk of development of Cysticercosis. The infection with the adult worm produces the same 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 be causes disintegrate and release the eggs into the bowel lumen, possibly increasing the hazard of **cysticercosis**.

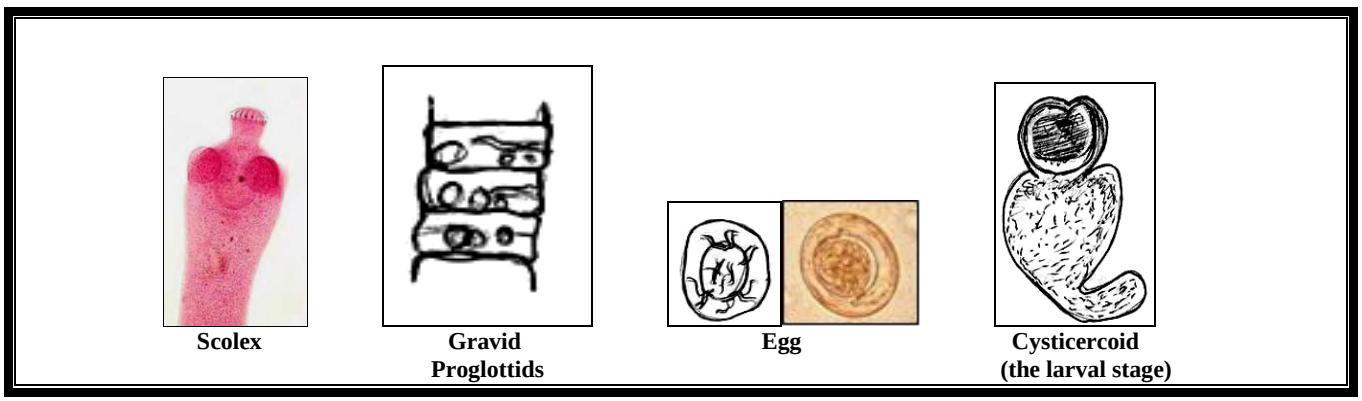


"Diagram for the life cycle of *T. saginata* & *T. solium*".

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.



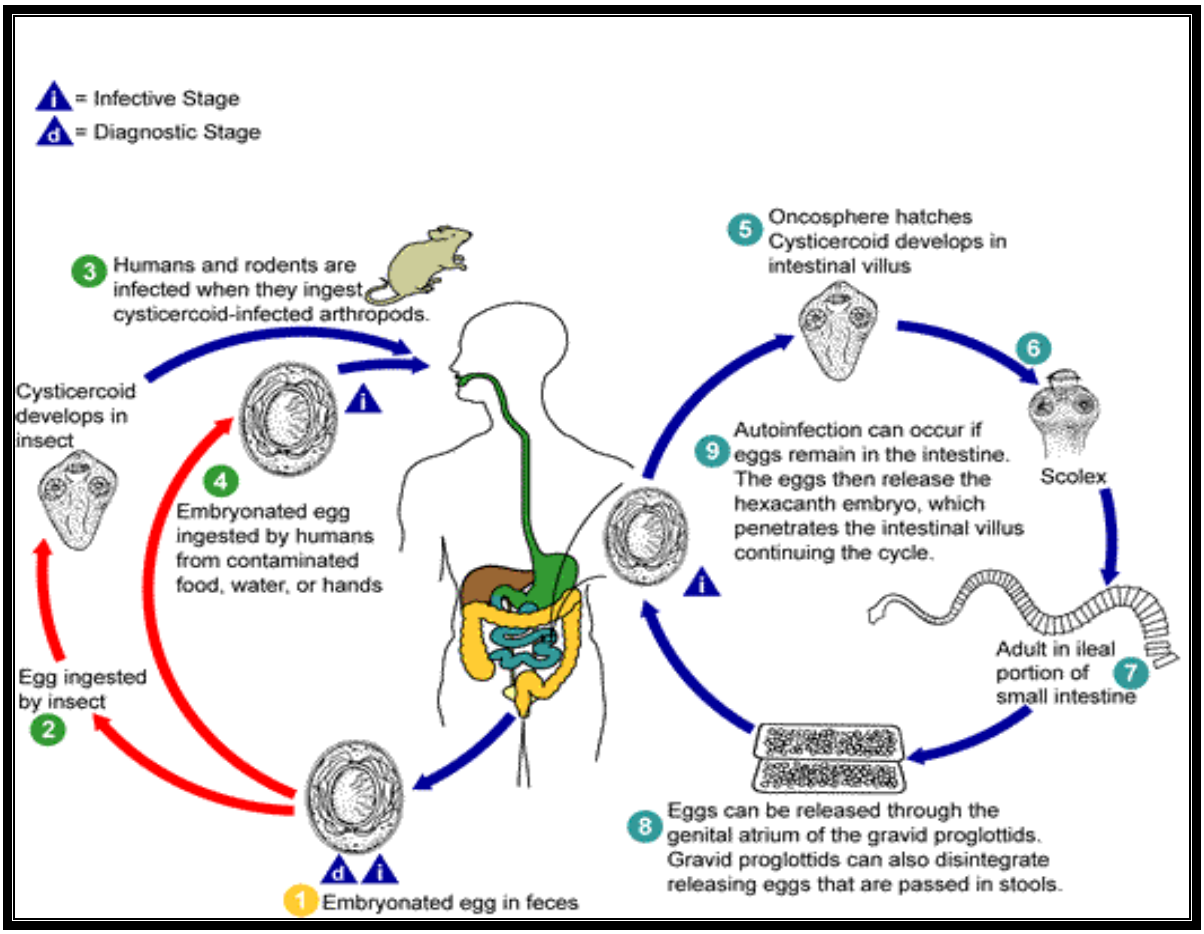
***Hymenolepis nana*: scolex, gravid proglottids, egg and Cysticercoid.**

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 55µm 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 & Symptomatology

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, urticaria. Heavy infection invariably is pathogenic, causing diarrhea, abdominal pain, anorexia and nervous disorders.

Diagnosis

It is based on 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].