

Cestodes (Tapeworms)

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PAMB 650/720 Medical Microbiology
Adapted from Dr. Abdul Ghaffar

Lecture: 30

- Objective:
1. Epidemiology, morbidity and mortality.
 2. Morphology of the organism
 3. Life cycle hosts and vectors.
 4. Disease, symptoms, pathogenesis and site
 5. Diagnosis
 6. Prevention and control

Reading: Murray *et al.* (6th ed), pp 881-891

Recommended References:

World Health Organization	http://www.who.int/en/ http://www.who.int/wormcontrol/documents/bench aids/training_manual/en/
Center For Disease Control	http://www.cdc.gov/ http://www.dpd.cdc.gov/dpdx/
Kansas State University	http://www.k-state.edu/parasitology/
Atlas of Medical Parasitology	http://www.cdfound.to.it/html/atlas.htm
United States Military	http://www.phsource.us/PH/TM/index.htm http://www.phsource.us/PH/PARA/index.htm
Parasitology Autotutorial	http://workforce.cup.edu/buckelew/

Clinically important cestodes pathogenic to man are *Taenia solium* (pork tapeworm), *T. saginata* (beef tapeworm), *Diphyllobothrium latum* (fish or broad tapeworm), *Hymenolepis nana* (dwarf tapeworm) and *Echinococcus granulosus* and *E. multilocularis* (hydatid).

***Taenia solium* or *T. saginata* (Taeniasis):**

Epidemiology: Taeniasis has a worldwide distribution, higher in developing countries: as low as 1/1000 in most of North America and as high as 10% in the 3rd world. Pork tapeworm is related to dietary habits.

Morphology: *T. saginata* is 6-10 meters long and 12 mm broad. It has a pear-shaped (head) **scolex** with four suckers but no hooks, a neck, and long flat body with several hundred segments (**proglottids**), 18 x 6 mm each with branched uterus (15-30 branches). It produces roundish (35 x 45 μ) yellow-brown eggs that have peripheral radial striations and contains an embryo with 3 hooklets.

T. solium is slightly smaller than *T. saginata*. It has a globular scolex with four suckers and a circular row of hooks (rostellum) that gives it a solar appearance, neck and long flat body (4-5 meter) consisting of proglottids (5 x 10 mm) with 7-12 branched uterus. Its eggs are not distinguishable from *T. saginata*.

Life cycle: The tapeworm larval cyst (cysticercus) is ingested with poorly cooked infected meat. The larva escapes the cyst as it traverses the small intestine where it attaches to the mucosa by the scolex suckers. The proglottids develop as the worm matures in 3-4 months. The adult may live in the small intestine of a patient as long as 25 years and pass gravid proglottids with feces. Eggs extruded from the proglottid contaminate the vegetation where they persist and remain infective for several days. When the contaminated material is ingested by the cattle (*T. saginata*) or pig (*T. solium*), the embryonated eggs pass through the stomach, and hatch into cysticerci that penetrate the gut mucosa and lodge in various tissues (Figure 1).

Symptoms: Light infections remain asymptomatic, but heavier infections may produce abdominal discomfort, epigastric pain, vomiting and diarrhea.

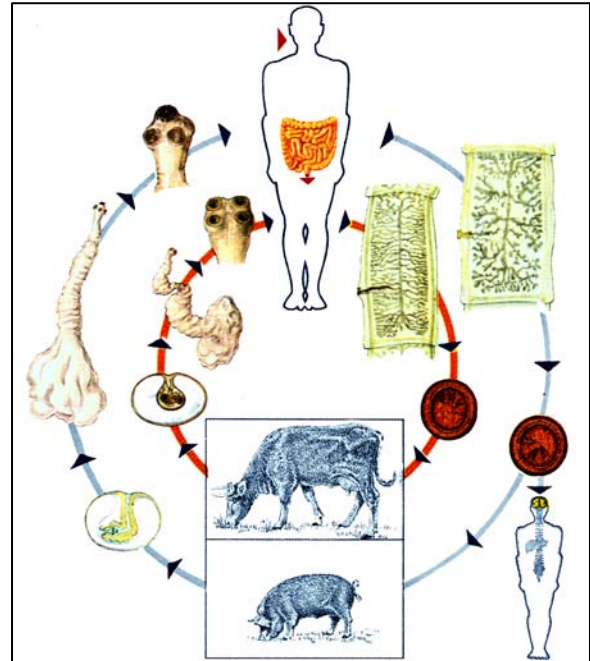


Figure 1. Life cycle of *T. saginata* and *T. solium*

Cysticercosis: *T. solium* eggs, when ingested by humans, hatch to produce cysticerci that penetrate the gut mucosa, migrate to different tissues and organs (lung, liver, eye and brain) resulting in pulmonary distress, hepatic abscesses, blindness and neurological disorders. The incidence of cerebral Cysticercosis can be as high as 1/1000 and may account for up to 20% of neurological cases in some countries (South America). The incidence of ocular cysticercosis may be as high as 2.5% and bone and muscle cysticercosis may be as high as 10%.

Pathology and Immunology: Gastrointestinal symptoms are due to the presence of the tapeworm. Cysticercosis symptoms are a result of IgE and basophil/eosinophil mediate inflammatory responses. Antibodies provide a useful epidemiological tool.

Diagnosis: Diagnosis is based on the recovery of eggs or proglottids in stool or from the perianal area (Figure 2). Cysticercosis is confirmed by the presence of antibodies.

Treatment and control: Praziquantel is the drug of choice. Expulsion of scolex must be assured to assume a satisfactory treatment. A thorough inspection of beef and pork, adequate cooking or freezing of meat are effective precautions, since

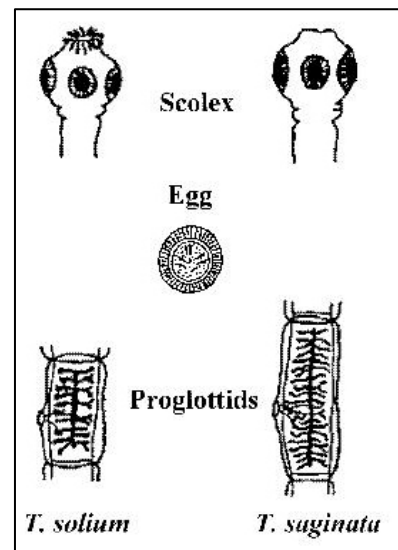


Figure 2. *Taenia* scolex, egg and proglottids

cysticerci do not survive temperatures below -10° C and above 50° C.

***Diphyllobothrium latum* (fish or broad tapeworm):**

Epidemiology: Diphyllobothriosis is distributed worldwide, both in the sub-arctic and temperate regions. It is associated with the consumption of raw or undercooked fresh water fish.

Morphology: It is the longest tapeworm of man, ranging from 3-10 meters with more than 3000 proglottids. The scolex resembles two almond-shaped leaves and the proglottids are more broad than long, a morphology reflected by the tape's name. Eggs are 30x50 µ in size and contain an embryo with 3 pairs of hooklets.

Life cycle: Man and other animals are infected by eating uncooked fish that contains plerocercoid larvae (15x2 mm) which attach to small intestinal wall and mature into adult worms in 3-5 weeks. Eggs discharged from gravid proglottids in the small intestine are passed in the feces. The egg hatches in fresh water to produce a ciliated coracidium that, for its survival needs to be ingested by a water flea (Cyclops) where it develops into a plerocercoid larva. When infected Cyclops is ingested by the freshwater fish, the proceroid larva penetrates the intestinal wall and develops into pleocercoid larva, infectious to man (Figure 3).

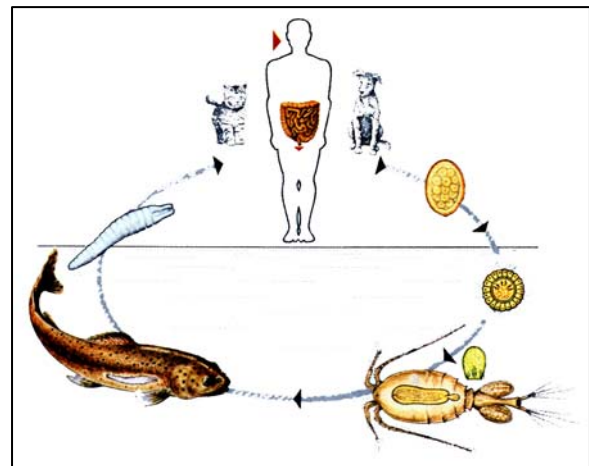


Figure 3. Life cycle of *D. latum*

Symptoms: Clinical symptoms of diphyllobothriosis may be mild to severe, depending on the number of worms. They include abdominal discomfort, loss of weight, loss of appetite and some malnutrition. Anemia and neurological problems associated with vitamin B₁₂ deficiency are seen in heavily infected individuals.

Diagnosis: Diagnosis is based on finding many typical eggs and empty proglottids in feces (Figure 4). History of raw fish consumption and residence in endemic locality is helpful.

Treatment and control: Praziquantel is the drug of choice. Freezing for 24 hours, thorough cooking or pickling of fish kills the larvae. Fish reservoirs should be kept free of raw sewage.

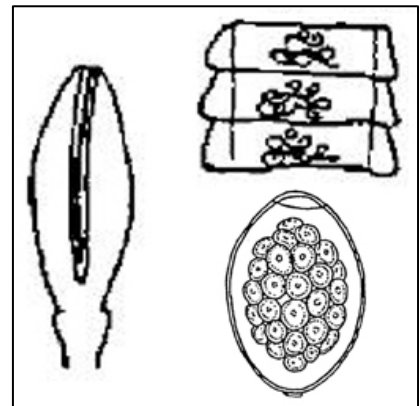


Figure 4. Scolex (left), proglottid (top right) and egg (bottom right) of *D. latum*

***Hymenolepis nana* (dwarf tapeworm):**

This is a small tapeworm (20 x 0.7 mm) that infects children. Rodents are the reservoir. Infection is by the oro-fecal route, and hence cross infection and auto infection by eggs in feces is normal. The ingested egg hatches in the intestine, matures into a tapeworm and resides there for several weeks. Light infections produce vague abdominal disturbances but heavier infections may cause enteritis. Diagnosis is based on finding eggs in the feces. Praziquantel is the drug of choice. Hygiene is the best control.

Echinococcosis (hydatid): *Echinococcus granulosus* and *E. multilocularis* are the causative agents of hydatid cysts.

***Echinococcus granulosus*:**

Epidemiology: The organism is common in Asia, Australia, Eastern Africa, southern Spain, southern parts of South America and northern parts of North America. The overall incidence of human infection is about 1-2/1000: it is higher in rural areas of affected regions.

Morphology: This is the smallest of all tapeworms (3-9 mm long) with only 3 proglottids.

Life cycle: The adult worm lives in domestics and wild carnivorous animals. Eggs, passed by infected animals, are ingested by the grazing farm animals or man, localize in different organs and develop into hydatid cysts containing many larvae (proto-scolices or hydatid sand). When carnivorous animals consume infected organs of these animals, proto-scolices escape the cyst, enter the small intestine and develop into adult worms (Figure 5). *Echinococcus* eggs in the fecal material of carnivores contaminate the vegetation and when swallowed by man, produce embryos that penetrate small intestine, enter circulation and form cysts in liver, lung, bones, and sometimes, brain. The cyst is round and usually measures 1-7 cm. in diameter, although it may grow to be as large as 30 cm. The cyst consists of an outer anuclear hyaline cuticula, an inner nucleated germinal layer containing clear yellow fluid. Attached to the germinal layer, there are daughter cysts. Some cysts, known as brood cysts, may only have hydatid sand. Man is the dead end host.

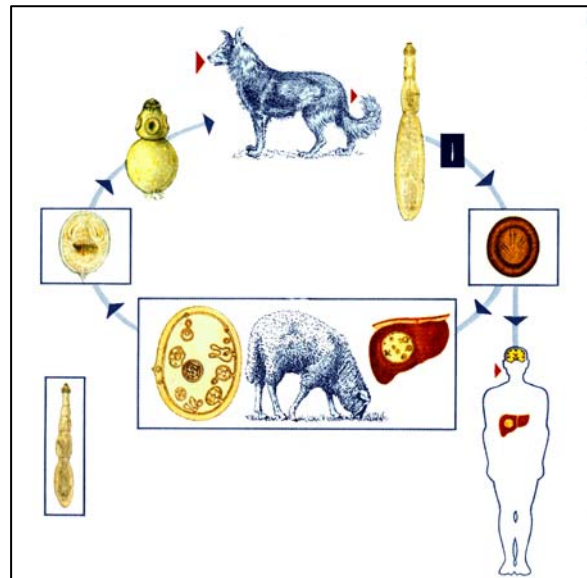


Figure 5. Life cycle of *E. granulosus*

Symptoms: The symptoms are comparable to those produced by a slowly growing tumor, depend upon the location of the cyst. Abdominal cysts, when large, produce increasing discomfort. Liver cysts cause obstructive jaundice. Peribronchial cysts may produce pulmonary abscess. Brain cysts produce intracranial pressure and Jacksonian epilepsy. Kidney cysts cause renal dysfunction. Contents of cyst produce anaphylactic reaction.

Diagnosis: Clinical symptoms of a slow-growing tumor accompanied by eosinophilia are suggestive. Intradermal (Casoni) test (type-I hypersensitivity) with hydatid fluid is useful. Pulmonary cysts and calcified cysts can be visualized by x-ray. Antibodies against hydatid fluid antigens have been detected, in a sizable population of infected individuals, by ELISA or indirect hemagglutination test.

Treatment and Control: Treatment involves surgical removal of cyst or inactivation of hydatid sand by injecting the cyst with 10% formalin and its removal within few (4-5) minutes. Praziquantel has been shown to be effective in many cases. Albendazole, in high doses, is an alternative. Preventive measures involve avoiding contact with infected dogs and cats and elimination of their infection.

E. multilocularis:

This tapeworm is prevalent in northern parts of Asia and North America. It is a tapeworm similar to *E. granulosus* in morphology and life cycle except that rodents (instead of grazing animals) are its intermediate host. Humans, when infected with this worm also develop hydatid cysts that produce symptoms like those caused by *E. granulosus*. However, the cysts are routinely multilocular (many chambers). The organism is resistant to Praziquantel; high doses of Albendazole have some antiparasitic effect. Surgery is the means of removing the cyst. Rodent control is the mean of prevention.

Summary:

Organism	Transmission	Symptoms	Diagnosis	Treatment
<i>Taenia saginata</i>	Cyst in beef	Epigastric pain, vomiting, diarrhea	Proglottids or eggs in stool or perianal area	Praziquantel
<i>Taenia solium</i>	Cyst in pork	Epigastric pain, vomiting, diarrhea	Proglottids or eggs in stool or perianal area	Praziquantel
<i>T. solium:</i> cysticercosis	Oro-fecal	Muscle pain and weakness, ocular and neurologic problems	Roentgenography, anti-cysticercal antibody (EIA)	Praziquantel
<i>D. latum</i>	Cyst in fish	Abdominal pain, loss of weight, anorexia, malnutrition and B12 deficiency problems	Proglottids or eggs in stool or perianal area	Praziquantel
<i>H. nana</i>	Oro-fecal (rat)	Enteritis	Eggs in the stool	Praziquantel
<i>E. granulosus</i>	Oro-fecal	Large cysts produce various symptoms depending on the location of the organism.	Roentgenography, anti-hydatid fluid antibody (EIA), Casoni skin test	Surgery, formalin injection and drainage, Praziquantel
<i>E. multilocularis</i>	Oro-fecal	As above	As above	Surgery, Albendazole