

Platyhelminthes (Flatworms)

The phylum Platyhelminthes consists of two classes, the Trematoda (flukes) and the Cestodea (tapeworms). They are evolutionarily more primitive than the nematodes. The following characteristics are noteworthy.

- Most species are flattened dorsoventrally (hence flat worms)
- Trematodes are usually leaf shaped
- Size: microscopic to 100 ft long
- Covered by a cytoplasmic tegument (vs cuticle of nematodes)
- No body cavity
- Digestive system either absent or rudimentary.
- Excretory system containing ciliated cells extending into excretory tubules; in living state, motion of cilia reminiscent of flames and when seen under microscope indicates viability.
- Reproduction: Most species are hermaphroditic; schistosomes are an exception. Adult worms reproduce sexually. Subsequently, larvae can reproduce asexually (polyembryony)

Cestodes (tapeworms)

Diphyllobothrium spp. (fish tapeworm)

- transmission: consumption of raw infected fish
- adults live in human intestinal lumen
- clinical: rare B¹² deficiency, vague abdominal pains

Taenia saginata (beef tapeworm)

- transmission: consumption of infected raw beef meat .
- biology: adult lives in human intestine lumen
- clinical: vague abdominal pains

Taenia solium (pork tapeworm)

- transmission: consumption of infected raw pork
- biology: adult lives in human intestine
- clinical: vague abdominal pains

Taenia solium (cysticercosis)

- transmission: eating *T. solium* eggs in human stool contaminated garden produce
- biology: cyst like larvae live in human tissue
- clinical: subcutaneous tissue nodules, space occupying lesions (1.5 cm) in brain (epilepsy, hydrocephalus); basilar meningitis

***Echinococcus granulosus* (hydatid cyst)**

- **transmission:** ingestion of dog stool contaminated food
- **biology:** cyst like larvae live in human tissue (usually lung or liver); adult is small dog tapeworm
- **clinical:** large space occupy lesion (1-15 cm) in liver or lung with pain and at times rupture

Cestode diagnosis

- **Stool examination** for eggs of adult forms
- **Ultrasound/CT scan/MRI** for tissue larval forms
- **Serology**

Treatment: praziquantel, albendazole, surgery

Flukes - Paragonimiasis

Epidemiology: Prevalent in the Far East; also areas in Central America and Africa. Transmission is related to the consumption of raw fresh water crabs and crayfish which contain the larvae (metacercaria) of *Paragonimus*

Biology: Many different species of *Paragonimus* all with some different levels of human host adaptability. Eggs expectorated in sputum into fresh water hatch as ciliated miracidia which penetrate specific snails and multiply within. Free-swimming cercaria leave the snail and penetrate fresh water crabs and crayfish, infecting any that consume them. The consumed metacercaria penetrate the human small intestine wall and migrate to the lungs where they mate and live for a number of years laying eggs which are expectorated or swallowed.



adult *Paragonimus* 7-12 mm long *Paragonimus* egg 80-120 μ m long

Clinical

Lung abscesses, chronic cough, rusty coloured sputum
At times (~10%) aberrant worms end up in brain or in subcutaneous tissues

Diagnosis

Examination of sputum and stool for eggs
CT/MRI of head

Treatment: Praziquantel

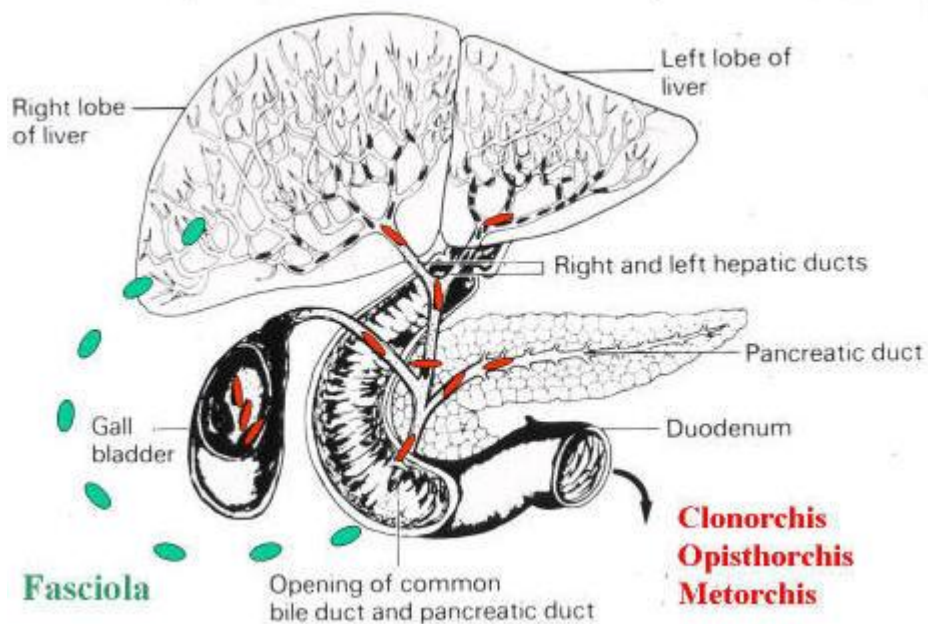
Prevention: Cooking crab meat
Sewage treatment

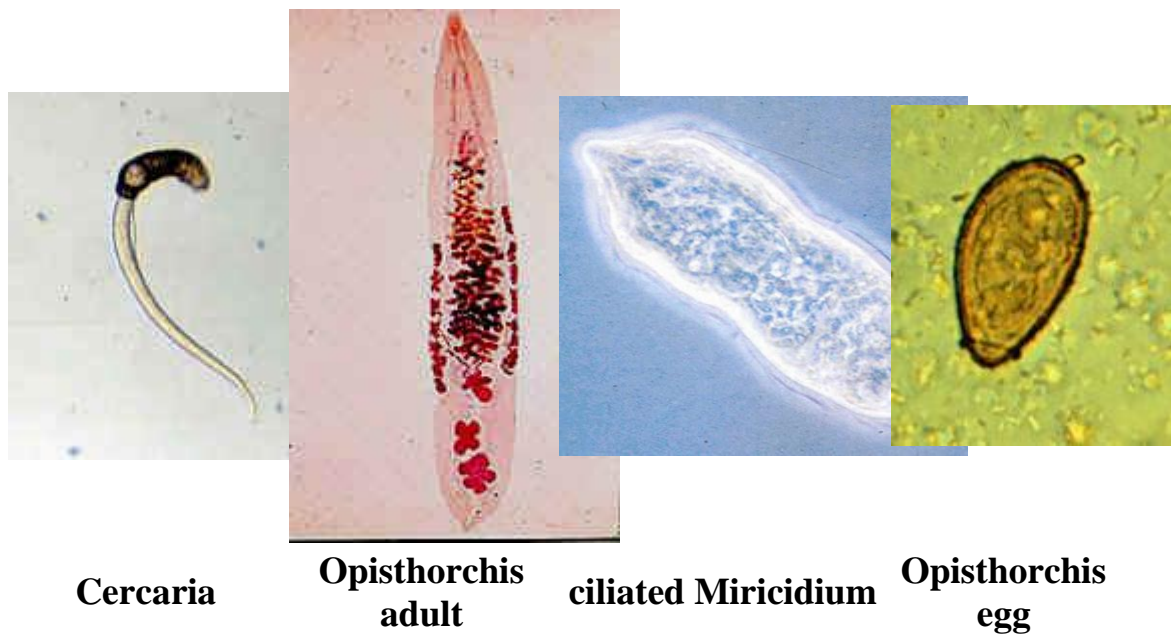
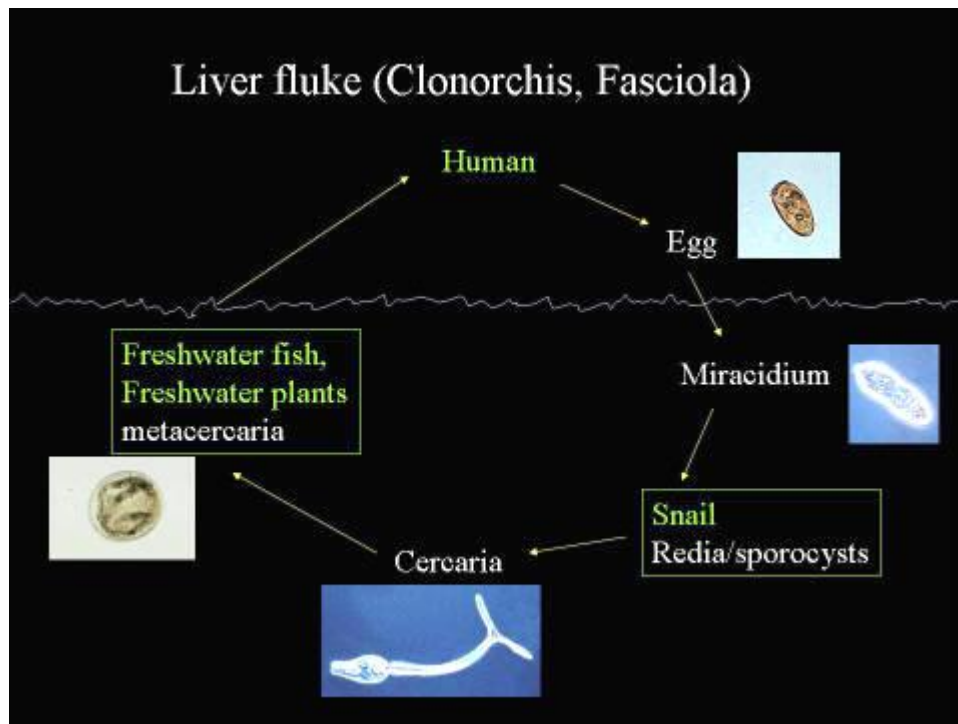
Liver Flukes

Epidemiology: *Clonorchis sinensis* (China), *Opisthorchis viverrini* (SE Asia) *Opisthorchis felinus* (Russia), *Metorchis conjunctus* (Canada). and *Fasciola spp* worldwide. Infect more than 20 million esp. in far east.

Acquired by eating infected freshwater fish.

Biology: The adult, living in the intra-hepatic bile ducts releases eggs that, in stool, if reach fresh water will hatch as ciliated swimming miracidia. These infect specific snails, multiply and are released as swimming cercaria which infect freshwater fish (or edible plants in the case of *Fasciola*). If ingested by humans the larvae climb up the biliary tree (or cross the peritoneal cavity and liver parenchyma in the case of *Fasciola*) and mature to adults in the intrahepatic biliary radicles.





Clinical

Acute: abdominal pain, eosinophilia (a couple of weeks normally except in Fasciola 2-3 months)

Chronic: Live for years in biliary tree producing obstruction and at times ascending cholangitis and abscesses and biliary endothelial metaplasia leading to cholangiocarcinoma.

Diagnosis **Acute stage** CT scan, serology

Chronic stage: serology, eggs in stool, ultra sound

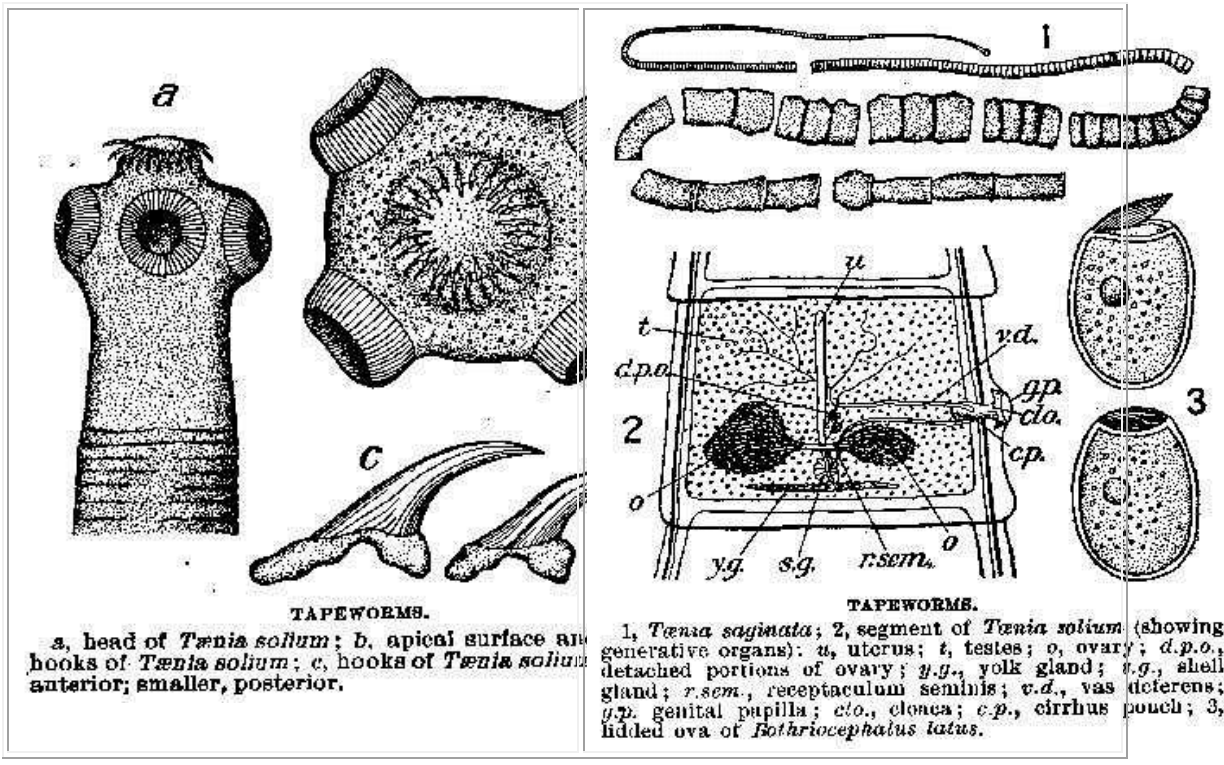
Treatment: Praziquantel (Triclabendazole for Fasciola)

Cestodes (Tapeworms)

These are long segmented worms in which each segment is independent of the other except for neurological intercommunication. The adult stage always reside in the gut of the definitive host. All except for one have an intermediate host. Humans may serve as definite host, as intermediate host, or as both, depending on the species of tapeworm.

General Characteristics of Tapeworms












Proglottids (segment): body of adult worm is subdivided into segments; a segment usually corresponds to one proglottid which has male and female reproductive organs, nervous and excretory system. There is no intestine; nutrients are absorbed through the integument. New proglottids are produced near the anterior end, and are shunted posteriorly as they mature. Mature, gravid proglottids detach from the strobila.



TAPEWORMS.
 a, head of *Taenia solium*; b, apical surface and hooks of *Taenia solium*; c, hooks of *Taenia solium*, anterior; smaller, posterior.

TAPEWORMS.
 1, *Taenia saginata*; 2, segment of *Taenia solium* (showing generative organs): u, uterus; t, testes; o, ovary; d.p.o., detached portions of ovary; y.g., yolk gland; s.g., shell gland; r.sem., receptaculum seminis; v.d., vas deferens; gp, genital papilla; clo., cloaca; cp, cirrus pouch; 3, hatched ova of *Bothriocephalus latius*.

Scolex (head): Anterior segment of the worm modified for attachment to host's digestive tract; equipped with suction apparatus and/or hooks.

Proglottids	<p>Scale: 0 5.5 11 mm</p>  <p><i>Taenia solium</i></p>	 <p><i>Taenia saginata</i></p>	 <p><i>Diphyllobothrium latum</i></p>	 <p><i>Dipylidium caninum</i></p>	<p>Scale: 0 1 2 3 mm</p>  <p><i>Hymenolepis nana</i></p>	 <p><i>Hymenolepis diminuta</i></p>
	Scolecex	<p>Scale: 0 1 2 mm</p>  <p><i>Taenia solium</i></p>	 <p><i>Taenia saginata</i></p>	 <p><i>Diphyllobothrium latum</i></p>	 <p><i>Dipylidium caninum</i></p>	<p>Scale: 0 1 mm</p>  <p><i>Hymenolepis nana</i></p>

ADULT LARVAE

Taenia saginata

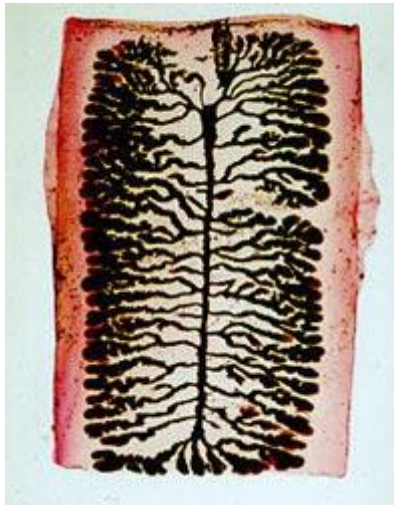
human gut cow muscle

<i>Taenia solium</i>	human gut	pig muscle
<i>Taenia solium (cysticercosis)</i>	human gut	human brain etc.
<i>Diphyllobothrium latum</i>	human gut	Fish
<i>Echinococcus granulosus</i>	dog gut	human/cow/sheep liver/lung

Taenia saginata (Beef tapeworm)

Epidemiology: Most common tapeworm found world wide. Acquired from eating uncooked beef. Humans are definitive hosts. Very common in Lebanon and Ethiopia. Occasionally found in Canadian dairy cattle herds.

Biology: Eggs are released individually in human feces or while still within tapeworm proglotids. They are ingested by cows and hatch; the resultant larvae invade the gut and are hematogenously spread, and develop as small 1 cm cysts in muscle. When humans consume these cysts in raw beef the cyst grows into an adult tapeworm in the small intestine, holding onto the small intestine mucosa with suckers on the head (scolex).



proglotid of *T. saginata* (note many uterine branches)



scolex of *T. saginata*

Clinical: Few if any symptoms; non-specific intermittent pains or indigestion. Tapeworm segments (proglotids) or segment chains are seen in the stools.

Diagnosis: Stool examination for eggs or segments. Segments differentiated from pork tapeworm by having large number of uterine branches when viewed with a trans-illuminating light source.

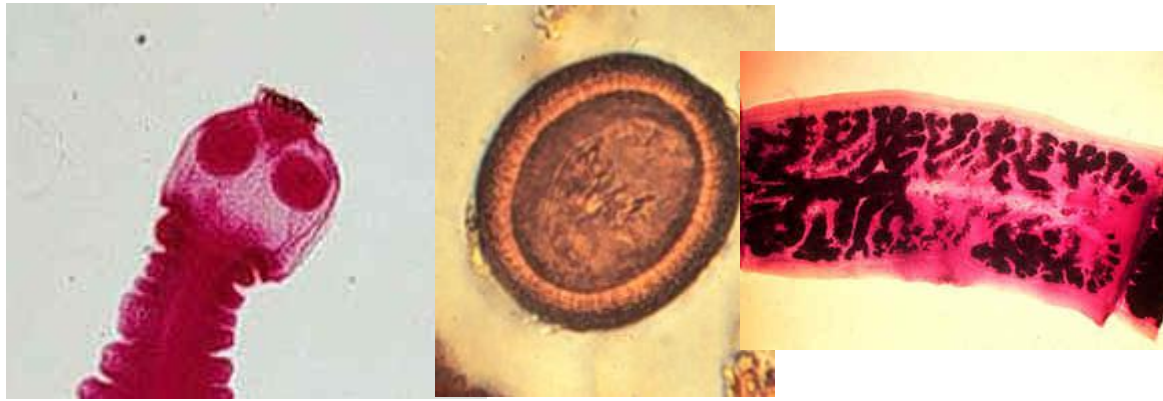
Treatment: Praziquantel

Prevention: Sewage treatment; cook or freeze beef

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

Epidemiology: Not as widely disseminated as *T. saginata*. As with beef tapeworm humans are definitive hosts and pig the intermediate host.. Acquired by eating uncooked pork.

Biology: same as for the beef tapeworm (above) except for the intermediate host (pig). However humans can be infected with the larval cysts like in the pig (see cysticercosis below)



Scolex of *T. solium*

Taenia egg

T. solium proglotid

Clinical: The same as beef tapeworm (above)

Treatment: Praziquantel

Prevention: Sewage disposal; cook or freeze pork

Taenia solium (cysticercosis)

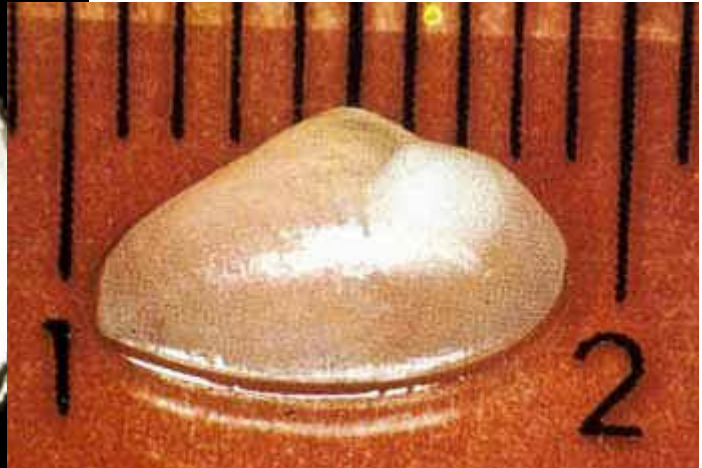
Epidemiology: The larval form of *T. solium* infects humans who ingest the eggs of this tapeworm passed in human stool. This occurs most frequently where human stool is used as fertilizer. This occurs most frequently in developing countries where pigs are bred.

Biology: *T. solium* eggs, on ingestion, hatch into larvae which penetrate small intestine mucosa and are carried throughout the body where they are deposited and grow in many different tissues (muscle, subcutaneous, brain, eye, heart). They form small (1-3 cm cysts with an invaginated scolex) and live for ~7 years.

Clinical: Pathology is produced by the cysts as space occupying lesions (especially brain) and as foci of host inflammatory response when the cyst eventually dies or is killed with anti-helminthics. Frequent Presentations are seizures or hydrocephalus.



cerebral cysticercosis



cysticercus containing inverted scolex

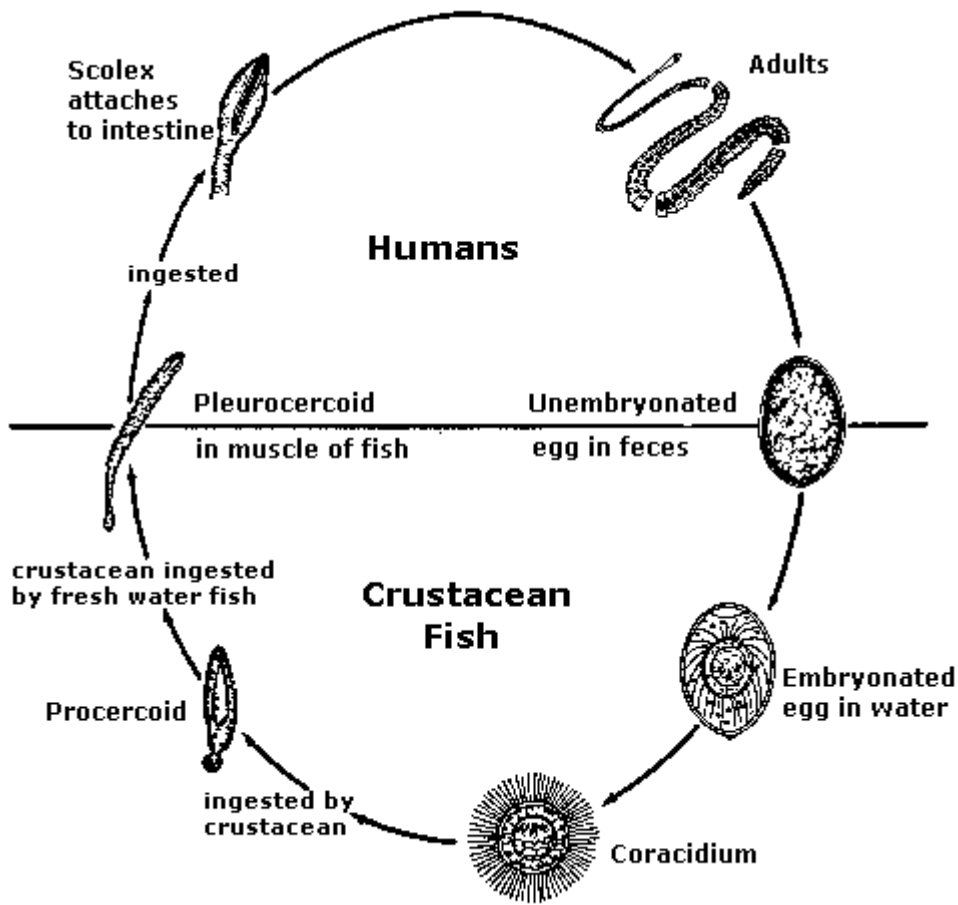
Treatment: Praziquantel, albendazole

Diphyllobothrium latum (fish tapeworm)

Epidemiology: World wide - particularly frequent in Scandinavia and northern Canada where raw freshwater fish are consumed.

Biology: Human is the definitive host with adult residing in the small intestine lumen. Eggs or proglotids containing eggs are passed in stool and if reaching freshwater hatch (as coracidium) and are consumed by copepods which are then ingested by fish. The resulting larva (plerocercoid) in fish flesh, following human consumption, grow into a tapeworms several meters long that attach to small intestine mucosa by sucking grooves on the head (scolex).

There are several other species of *Diphyllobothrium* in Canada especially in the North (*D. dendriticum*, *D. ursi* etc.) with the same life cycle.



life cycle of *Diphyllbothrium*



proglotids (segments) of *Diphyllbothrium*



egg of *Diphyllbothrium*

Clinical: As with the *Taenia* the *Diphyllbothrium* species have few if any symptoms. In Finland B¹² deficiency occurs due to consumption by the tapeworm. This is not seen in the Americas

Diagnosis: Stool examination for eggs (typical) and proglotids with characteristic uteri.

Treatment: Praziquantel

Prevention: Freezing or cooking fish. Sewage treatment.

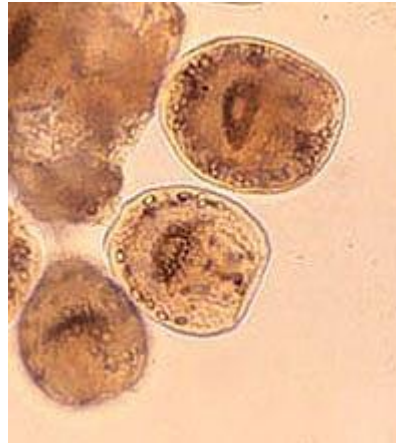
Echinococcus granulosus: (Hydatid disease)

Epidemiology: This is a dog tapeworm, the larval (cyst) stage of which infects humans who eat food contaminated with dog feces containing tapeworm eggs. The infection occurs most frequently in geographic regions where dogs and the usual non-human intermediate host live together (eg cattle raising Argentina, sheep raising Australia, sheep and goat raising Mediterranean, caribou sled dog Arctic North America).

Biology: Eggs are passed in dog feces and when consumed by humans (or bovines) hatch and penetrate the small intestine mucosa where they enter the portal venous system to eventually lodge in liver or lungs. There they slowly grow over years to large size (2-15 cm diameter). Within each cyst the germinal epithelium at the periphery of the cyst buds off, within the host cyst, new protoscolices and daughter cysts which themselves produce protoscolices. These hydatid cysts if consumed by dogs will produce a new tapeworm from each scolex.

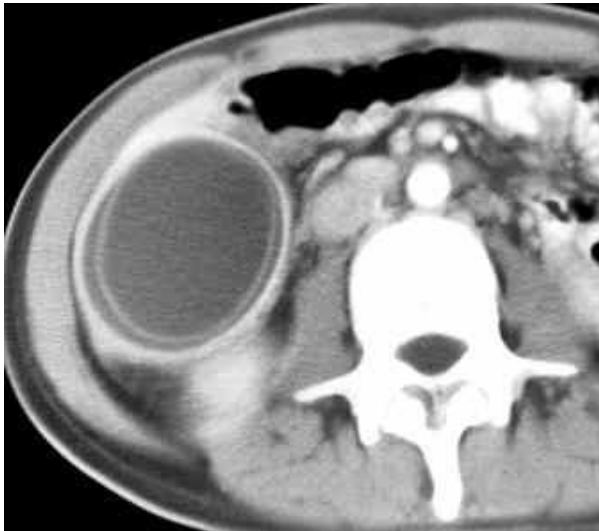


adult of Echinococcus granulosus from dog intestine

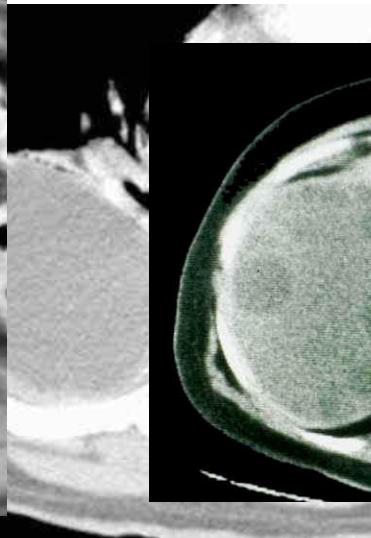


protoscolices from human hydatid cyst

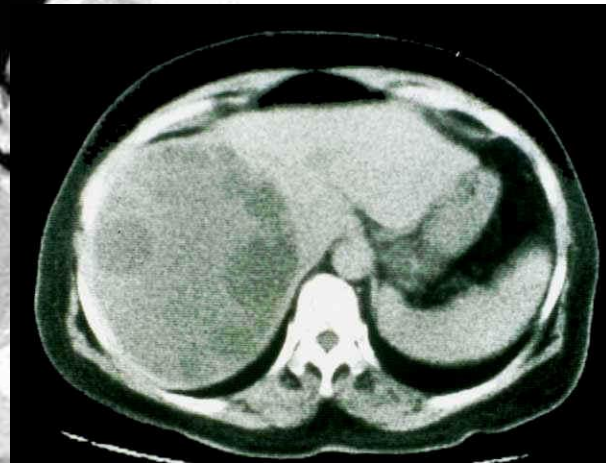
Clinical: The enlarging cysts can produce symptoms and signs related to their space occupation or can rupture with resultant anaphylactic shock. Leakage of daughter cysts produce hydatid cysts in new locations.



Hydatid cyst in left lobe of liver; note the laminar membrane split off the outer wall.



Hydatid cyst in lung



Hydatid cyst of liver containing daughter cysts

Treatment: surgical removal; albendazole; PAIR (percutaneous aspiration, instillation of scolicide, reaspiration)

