

Cestodes - tapeworms

- Obligate parasites
- Considered to be degenerate (disgusting)
 - Simplified structure
 - No mouth, no digestive system
 - Live in intestines with feces
 - Reproductive structures
- The ultimate parasite!!
 - Amazing holdfast organs
 - "bag of reproductive organs bathed in a sea of predigested food"

Human Intestinal Tapeworms

■ Intestinal Cestodes	Cases
■ <i>Diphyllobothrium latum</i>	16 million
■ <i>Taenia solium</i>	5 million
■ <i>Taenia saginata</i>	76 million
■ <i>Hymenolepis nana</i>	36 million
■ <i>Hymenolepis diminuta</i>	Rare
■ <i>Dipylidium caninum</i>	Rare

Worldwide distribution

Extra-intestinal

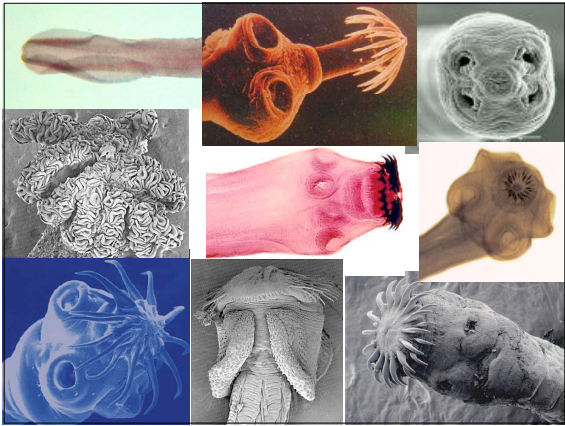
<ul style="list-style-type: none"> ■ Tissue cestodes (extra-intestinal) <ul style="list-style-type: none"> ■ <i>Echinococcus granulosus</i> ■ <i>Echinococcus multilocularis</i> ■ <i>Diphyllobothrium spp</i> ■ <i>Taenia solium</i> 	<p style="text-align: center;">Disease</p> <ul style="list-style-type: none"> ■ Hydatid disease (6k) ■ Hydatid disease (rare) ■ Sparganosis (?) ■ Cysticercosis (?)
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Cestode Morphology

- **Scolex** - small anterior hooked attachment organ
- **Strobila** - division of body into segments immediately following the scolex/neck
- **Proglottid** - each individual segment
- Most cestodes are long - can occupy the entire length of the small intestine
- How large is the small intestine?

Scolex Diversity

- Typically referred to as the head
- Holdfast organ to resist peristaltic contractions
- Includes adhesive suckers and spines



Grasp your weapon of choice

Strobilation - forming segments

A fun day at the museum!

Proglottids - segments

- Proglottids grow in series from the scolex.
- Proglottid close to the scolex are the immature segments
- Middle segments contain male and female reproductive structures
- Simultaneous hermaphrodite with cross-fertilization - also can self-fertilize
- Proglottids break free and are excreted in host feces
- Later segments are gravid
 - Filled with eggs!

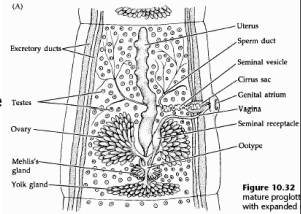
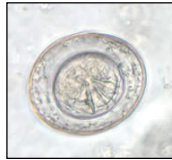
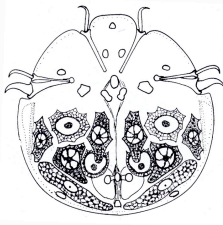


Figure 10.32 mature proglottid with expanded

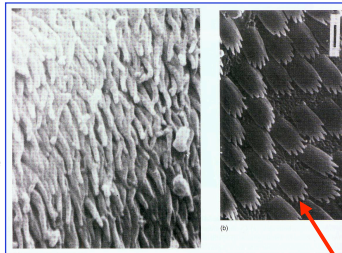
Developmental Stages

- Many invertebrates and vertebrates are parasitized as intermediate hosts
- The embryonated egg contains the **oncosphere**
- a larva that will penetrate the intestinal wall after eggs are swallowed by intermediate host
- The oncospheres of cestodes have three pairs of hooks which makes it easy to identify them



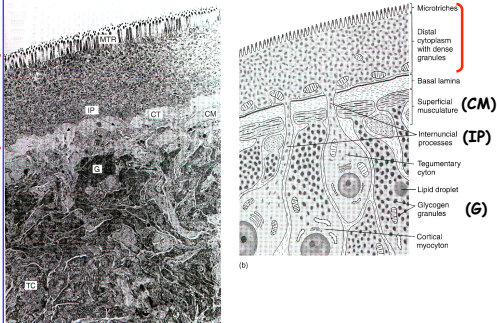
Cestode Nutrients

- No digestive tract - absorb all nutrients directly through the **tegument**
- **Microtriches** - outward projections
 - Similar to microvilli of our gut mucosal cells
 - Increase the surface area for nutrient absorption
 - Interdigitate with host microvilli



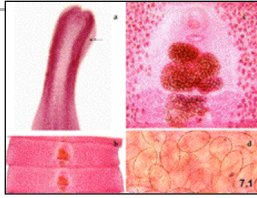
Cestode tegument structure is similar

Tegument is a syncytium



Diphyllobothrium latum

- A.K.A Broad Fish Tapeworm
- **Definitive Host:** Fish-eating carnivores, including dogs, bears, humans, weasels, seals, etc.
- **First Intermediate Host:** Crustaceans, including copepods
- **Second Intermediate Host:** Fish, particularly pike and salmonids (trout, salmon) **Geographic Distribution:** northern Europe,
 - Russia, Scandinavia, Baltic Republics.
 - May be different species in U.S.




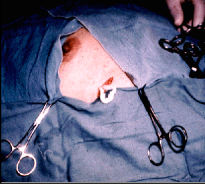
Diphyllobothrium latum

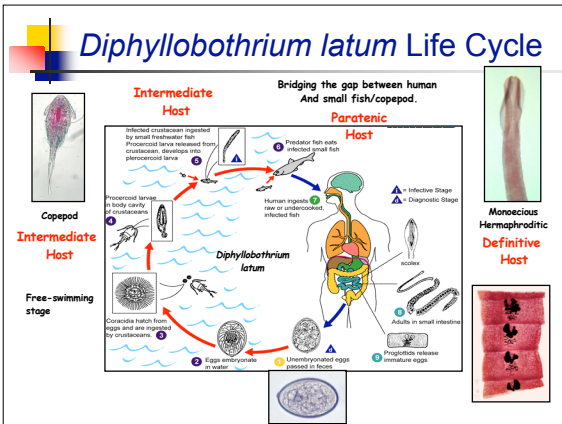
- **Transmission:** for all three hosts, the parasite is eaten.
 - Copepod eats coracidium
 - Fish eats copepod with proceroid larvae
 - D.H. eats fish with plerocercoid.
- **Symptoms and Pathology:**
 - **Diphyllobothriasis** caused by adult tapeworm.
 - Most cases are asymptomatic.
 - Symptoms include nausea, diarrhea, and weakness.
 - Also causes anemia because worm absorbs large amounts of B-12.



Sparganosis


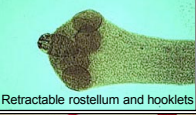
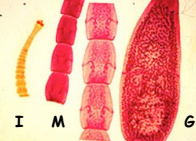
- Related disease cause by larval form of any diphylobothroid tapeworms, including *D. latum*.
- Humans cannot be the definitive host, but are accidental hosts.
- Most infections are due to copepods in drinking water or ingestion of eggs accidentally.
 - Especially *D. mansonioides* of cats
- Some are due to undercooked amphibians, reptiles, birds or mammals.
- Organisms can live up to 20 yrs.
- Other transmission: In east Asia, skin ulcers, eye or vagina inflammation are traditionally treated with poultice made of raw meat. If meat has proceroid, it can crawl in and form plerocercoid.




Dipylidium caninum

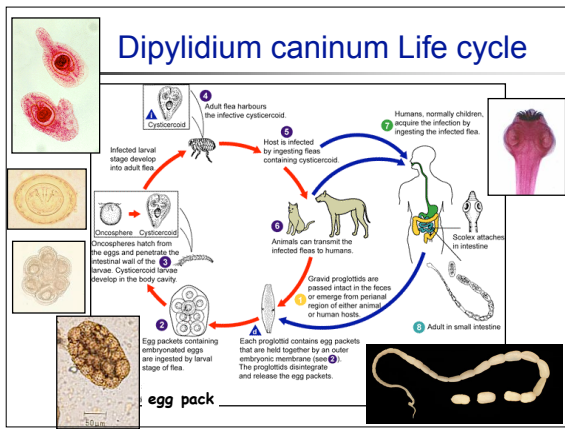
- **Definitive Host:** Humans, particularly children, dogs, and cats.
- **Intermediate Host:** Flea
- **Geographic Distribution:** Cosmopolitan
- **Transmission to D.H.:** Ingestion of infected flea. *Ctenocephalide species*
- **Pathology and Symptoms:** Usually asymptomatic. Incidence in children is higher than adults.
 - Children let dogs lick their faces.
 - Adults may develop immunity.

D. caninum


- **Diagnosis:** Proglottids in feces
 - Shaped like cucumber seed
 - Move like a fluke
 - Can crawl out of anus
 - Double-pore proglottid
- **Treatment:** Praziquantel
- **Notes:** There are hundreds of species in this family
 - Most parasitize birds and non-human mammals






Taenia saginata

- AKA - Beef tapeworm
- **Definitive Host:** Humans
- **Intermediate Host:** Cattle
- **Geographic Distribution:** Cosmopolitan. Most common where poor sanitation and no inspection of meat combined.
 - Africa and South America
- **Transmission:** Ingestion of larval form in undercooked beef



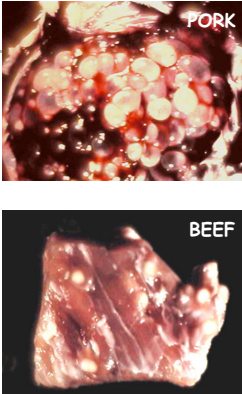
Taenia solium

- AKA: Pork tapeworm
- **Definitive Host:** Human
- **Intermediate Host:** Pigs
- **Geographic Distribution:** Cosmopolitan
- **Transmission:** Ingestion of undercooked pork
- **Location in D.H.:** Small Intestines
- **Pathology and Symptoms:** Minimal pathology from adults.
 - Larval forms cause cysticercosis
 - cysticercus develop in humans
 - More dangerous than *T. saginata*.

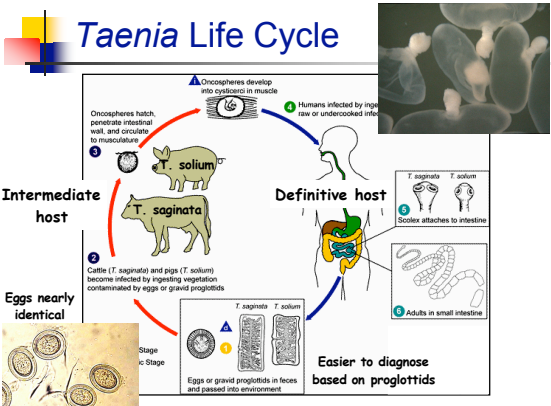


Prevention

- Avoid undercooked pork, beef
- In butcher shops, grinding machines must be cleaned between grinding beef and grinding pork.
- Washing hands before preparing food reduces incidence of cysticercosis
- Proper sanitation



Taenia Life Cycle

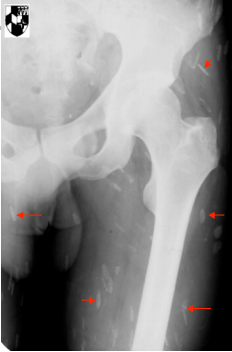


The diagram illustrates the life cycle of *Taenia* species, involving an intermediate host and a definitive host.

- Intermediate Host:** Cattle (*T. saginata*) and pigs (*T. solium*) become infected by ingesting vegetation contaminated by eggs or gravid proglottids.
- Definitive Host:** Humans become infected by ingesting raw or undercooked meat.
- Development:** Oncospheres hatch, penetrate the intestinal wall, and circulate to muscle tissue, where they develop into cysticerci.
- Reproduction:** In the definitive host, the scolex attaches to the intestine, and adults develop in the small intestine.
- Diagnosis:** Easier to diagnose based on proglottids.
- Eggs:** Eggs or gravid proglottids in feces are passed into the environment.

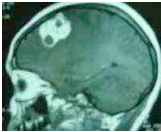
Cysticercosis

- Larval infection - *T. solium*
- Two ways to get it
 - Eat eggs in contaminated food
 - Autoinfection
 - Eggs hatch before leaving D.H. (rare!)
- Any organ and tissue can have cysticerci
 - Muscle most common
- Many cases are asymptomatic
- Severity depends on larval migration

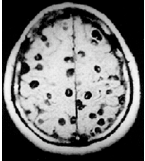


Human cysticercosis: When humans plays the role of the Intermediate Host

- Larval stages develop in the human host
- Humans acquire cysticercosis through faecal-oral contamination with *T. solium* **EGGS**
- The **oncosphere** in the eggs is released by the action of gastric acid and intestinal fluids
- Cross the gut wall and enter the bloodstream
- They are carried to the muscles and other tissues
- They encyst as **cysticerci**
- Neurocysticercosis and ophthalmic cysticercosis serious



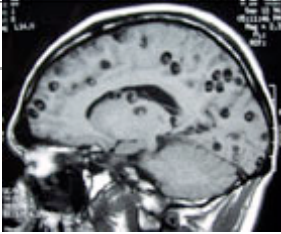
Racemose Cysticercosis-MRI

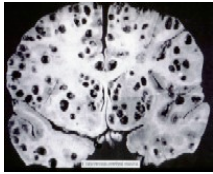


MRI of multiple cysts. Image courtesy of the Centers for Disease Control and Prevention.

Cysticercosis

- Symptoms depend on where larvae develop and number of larvae
 - Skeletal Muscle – little pathology
 - Eye – cause blindness
 - Heart – may cause heart failure
 - Brain – leading cause of adult onset epilepsy
- Killing adults reduces risk of cysticercosis.
- Killing larval forms may cause more damage than leaving them alive.
 - Dead larvae cause inflammatory response
 - Need to provide steroids to keep inflammation down
- Surgery can be used to remove larvae







Cysticercosis pathology

- Cysts are rounded or oval vesicles from a few mm to 1-2 cm
- Most common location is in the cerebral hemispheres, mainly at the junction of grey and white matter.
- Cysts can be found in the cerebellum, ventricles, brainstem, basal cisterns, and spine.
- Viable cysts have a translucent membrane through which the scolex is visible.
- Cysts degenerate: the fluid becomes opaque and dense and edges irregular and shrink.
- Calcification starts in the cephalic portion and leaves a whitish calcified nodule
- **Racemose form:** high mortality. Large translucent vesicle lobulated without scolex which develops in the basis of the brain or in the ventricles. Sometimes several small vesicles surround a pedicle like a bunch of grapes.

