# Helminths (Parasitic worms)

**Kingdom Animalia**

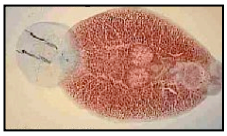
**Phylum Platyhelminths** | Phylum Nematoda

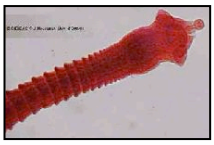
Tubellarians → Free-living worms

Monogenea → Monogenetic Flukes

Trematodes → Digenetic Flukes

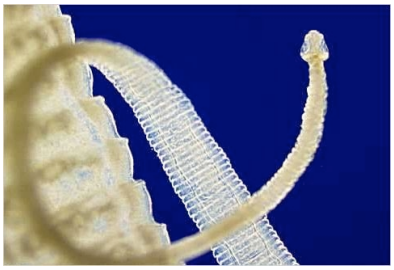
Cestodes → Tapeworms



# 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 |
|---|---|
| *Diphyllobothrium latum* | 16 million |
| *Taenia solium* | 5 million |
| *Taenia saginata* | 76 million |
| *Hymenolepis nana* | 36 million |
| *Hymenolepis diminuta* | Rare |
| *Dipylidium caninum* | Rare |

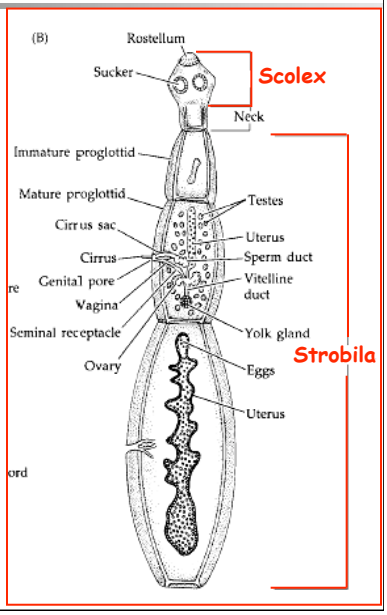
**Worldwide distribution**

## Extra-intestinal

| Tissue cestodes (extra-intestinal) | Disease |
|---|---|
| *Echinococcus granulosa* | Hydatid disease (6k) |
| *Echinococcus multilocularis* | Hydatid disease (rare) |
| *Diphyllobothrium spp* | Sparganosis (?) |
| *Taenia solium* | Cysticercosis (?) |

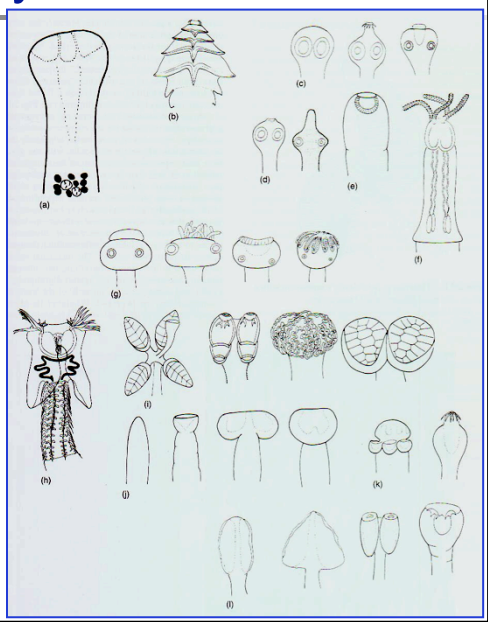
# Cestode Morphology

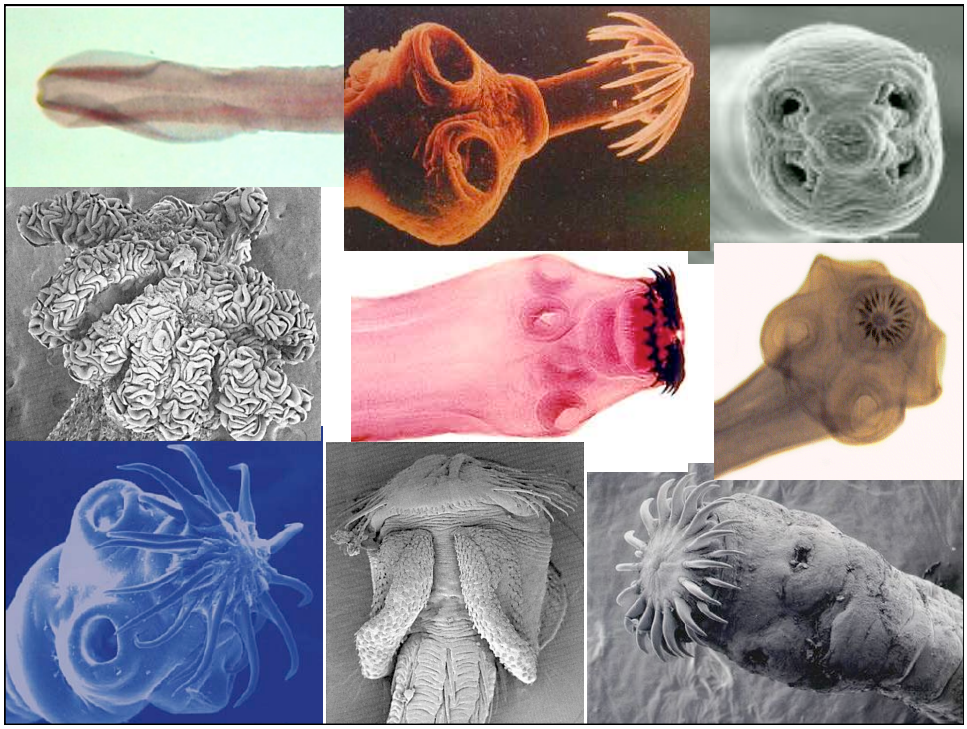
- Scolex - small anterior hooked attachment organ
- Strobila - division of body into segments immediately following the scolex/neck
- Proglottid - each individual segment
- Most cestodes are long - can occupy the entire length of the small intestine
- How large is the small intestine?



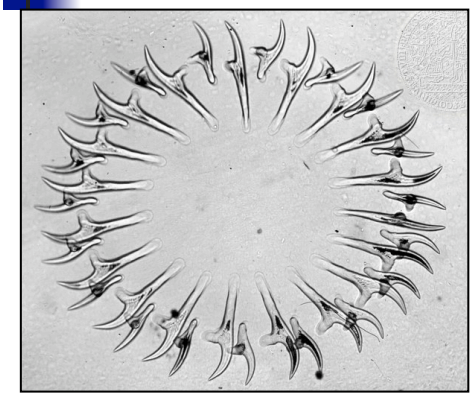

# Scolex Diversity

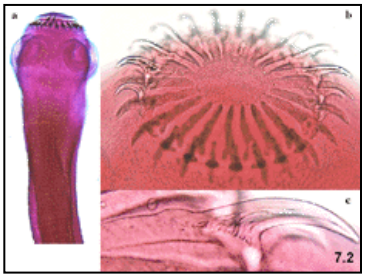
- Typically referred to as the head
- Holdfast organ to resist peristaltic contractions
- Includes adhesive suckers and spines





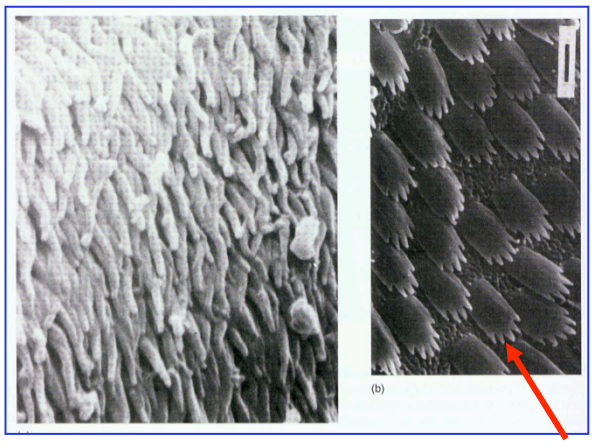
## Grap your weapon of choice





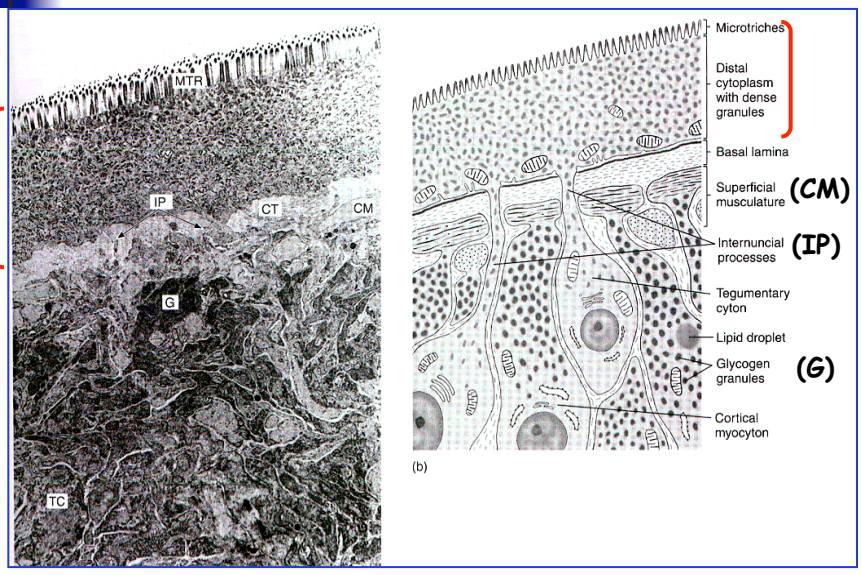

# Cestode Nutrients

- 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

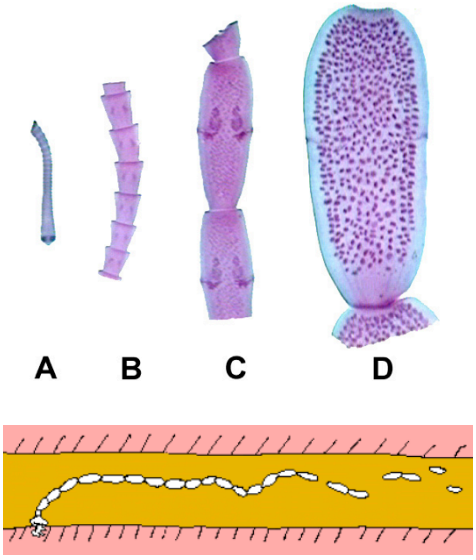



Cestode tegument structure is similar

# Tegument is a syncytium



# 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!

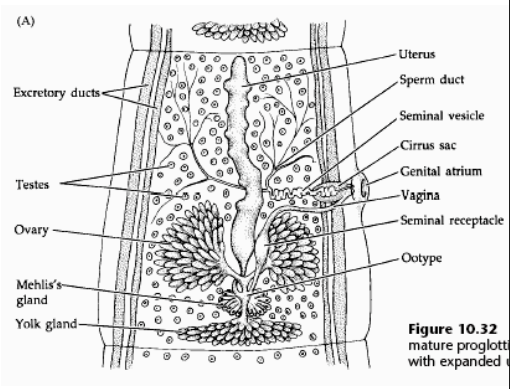
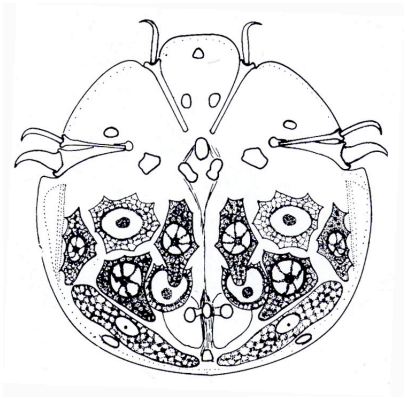



**Figure 10.32** mature proglotti with expanded

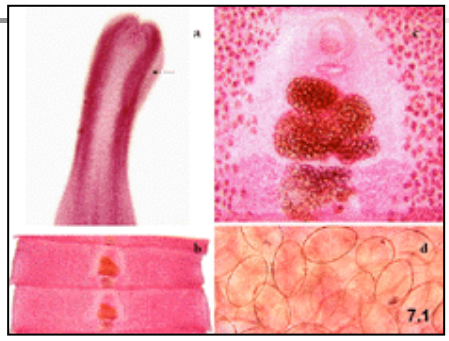
# Developmental Stages



- **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**

# *Diphyllobrothrium 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.

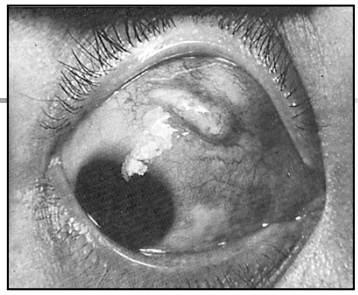


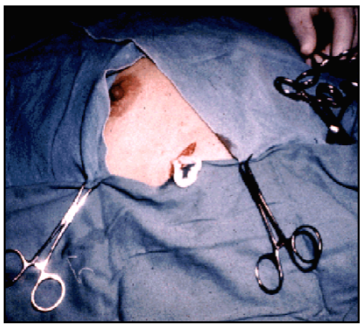
# *Diphyllobrothrium latum*

- **Transmission:** for all three hosts, the parasite is eaten.
  - Copepod eats coracidium
  - Fish eats copepod with procercoid larvae
  - D.H. eats fish with plerocercoid.
- **Symtoms 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 diphyllobothroid 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. mansonoides* 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 procercoid, it can crawl in and form plerocercoid.





# *Diphyllobothrium latum* Life Cycle

Copepod

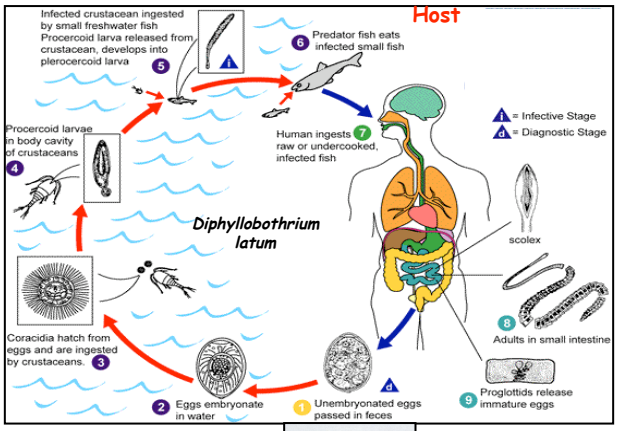
Intermediate Host

Free-swimming stage

Intermediate Host

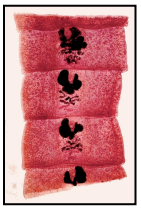
Bridging the gap between human And small fish/copepod.

Paratenic Host



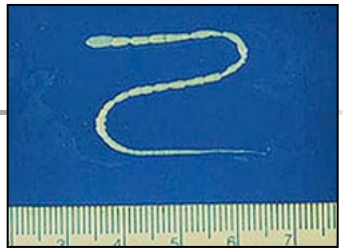

Monoecious Hermaphroditic

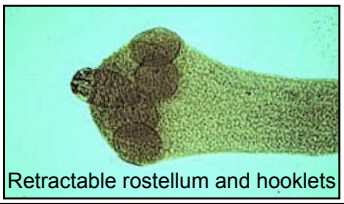
Definitive Host



# *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.

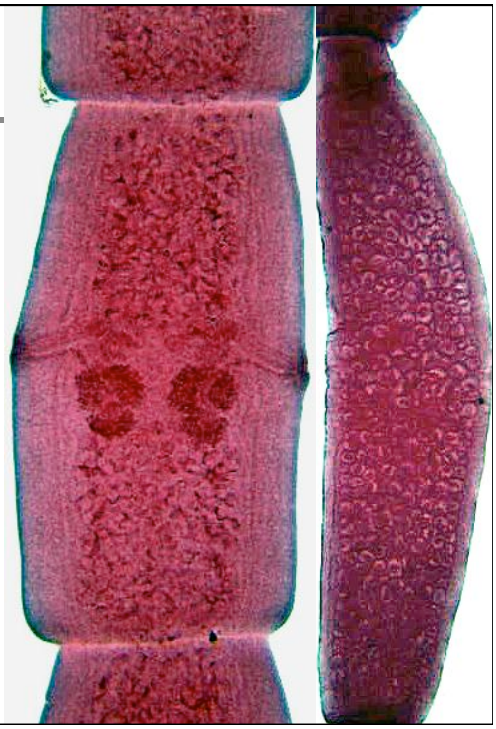




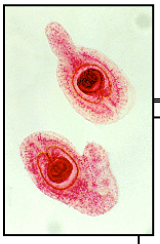
Retractable rostellum and hooklets

# *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

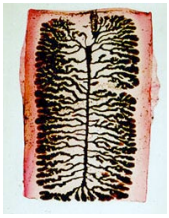


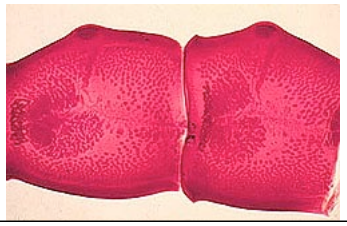
# Dipylidium caninum Life cycle




## *Taenia saginata*

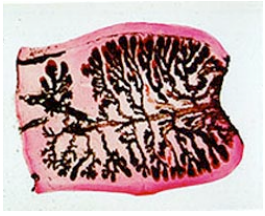
- AKA - Beef tapeworm
- **Definitive Host:** Humans
- **Intermediate Host:** Cattle
- **Geographic Distribution:** Cosmopolitan. Most common where poor sanitation and no inspection of meat combined.
  - Africa and South America
- **Transmission:** Ingestion of larval form in undercooked beef





## *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. sagniata*.

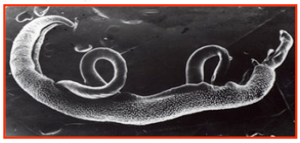


## Maximum survival of selected platyhelminths in human host

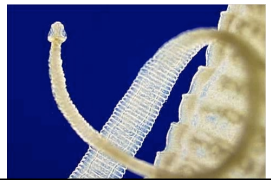
- Liver fluke >>20 yrs

- Lung fluke >> 20 yrs

- Schistosoma >>40 yrs



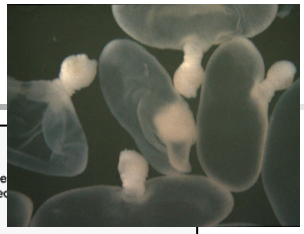
- Taenia >>35 yrs

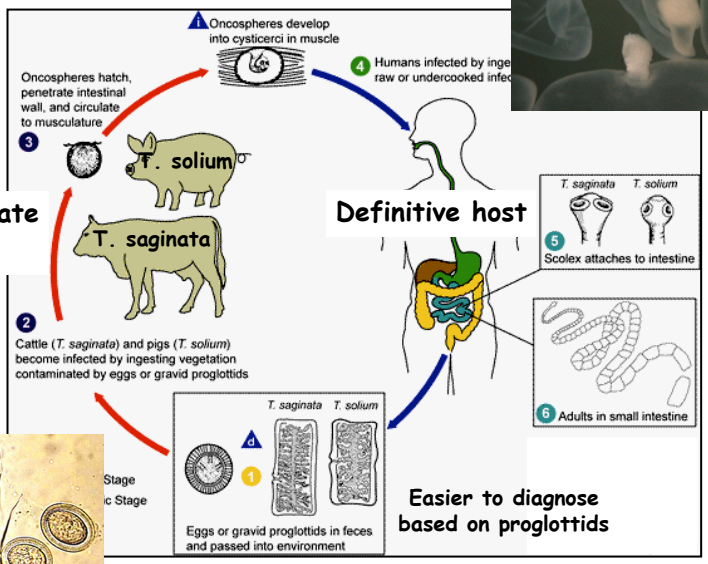


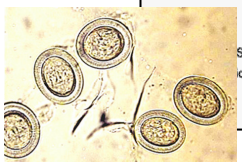
## Prevention

- 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

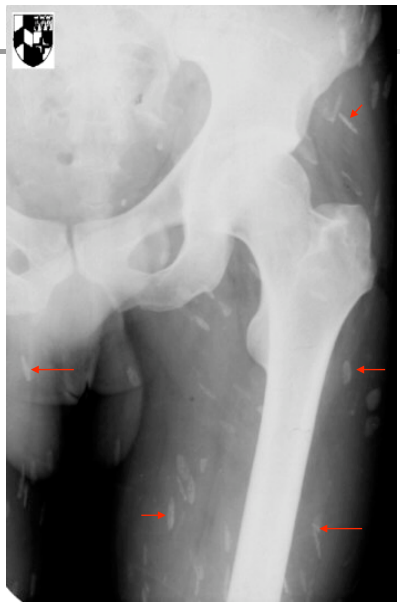




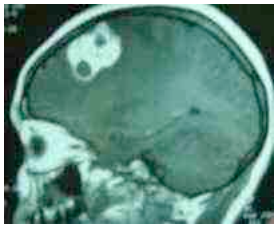
# Cysticercosis

- 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

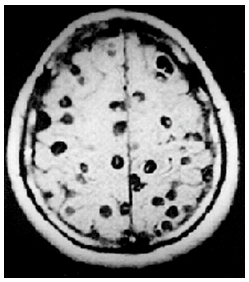


## Human cysticercosis: When humans plays the role of the Intermediate Host

- 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 ophtalmic cysticercosis serious



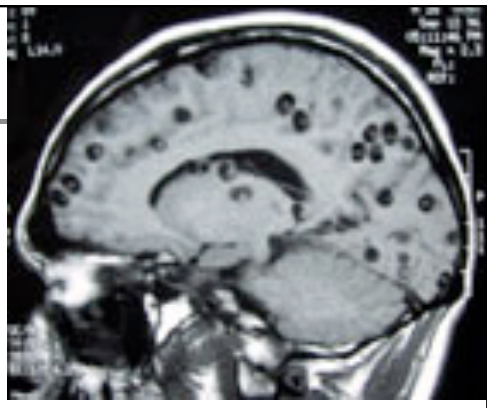
Racemose Cysticercosis-MRI



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.