Helminths

- Phylum Nematoda (Roundworms) - "Nematodes"
- Phylum Platyhelminthes (Flatworms)
  - Class Cestoidea (segmented flatworms) - "Cestodes"
  - Class Trematoda (non-segmented flatworms) - "Trematodes"

Cestodes

All members are flat, segmented worms and are obligate parasites of the intestinal tract.

The tapeworms:

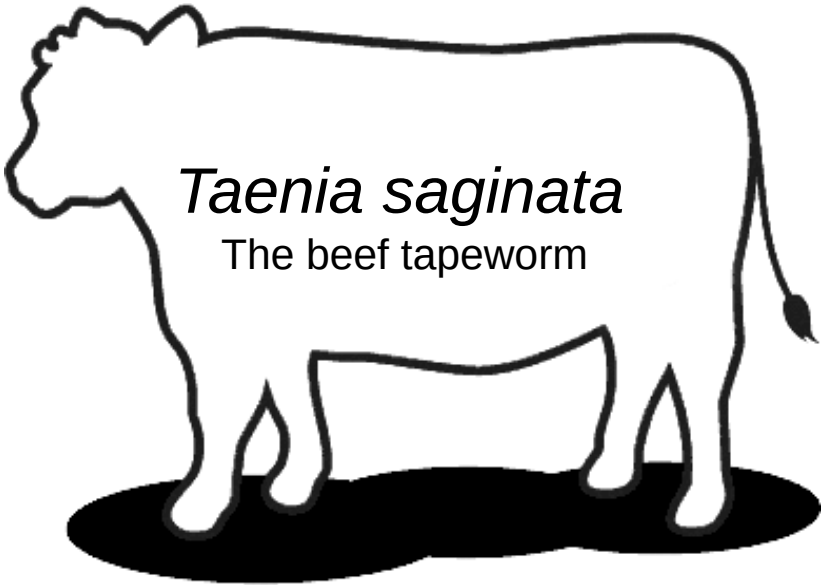
Taenia saginata (beef tapeworm)

Taenia solium (pork tapeworm)

---> Cysticercosis

Echinococcus granulosus (dog tapeworm)

---> Hydatid Disease

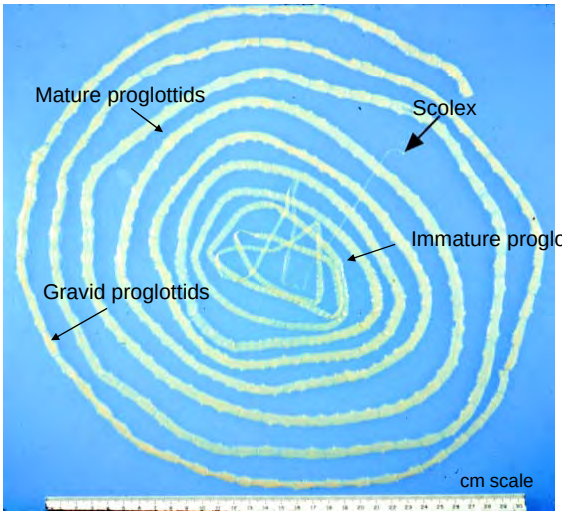


Taenia saginata

The beef tapeworm

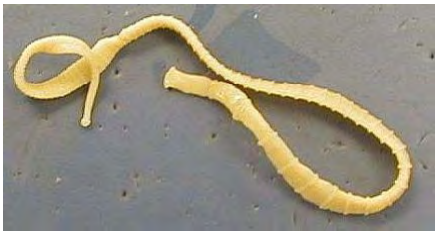
Beef Wellington

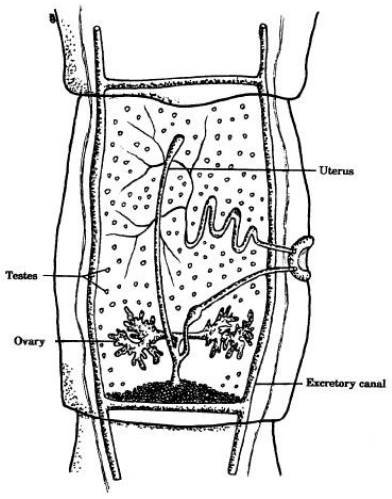
Adult *Taenia saginata*



Taenia saginata scolex

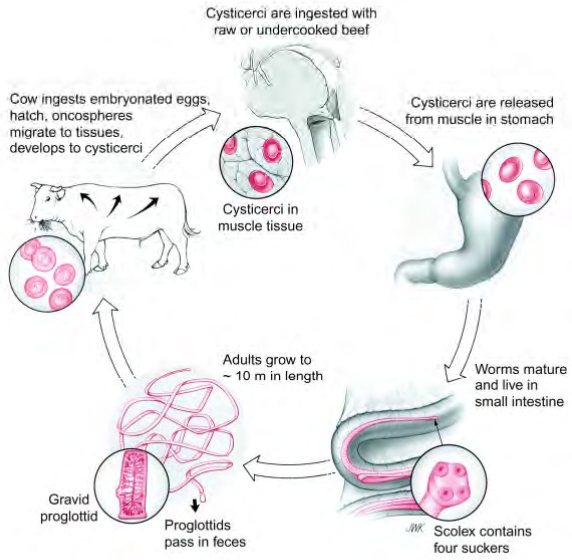
Taenia Adult



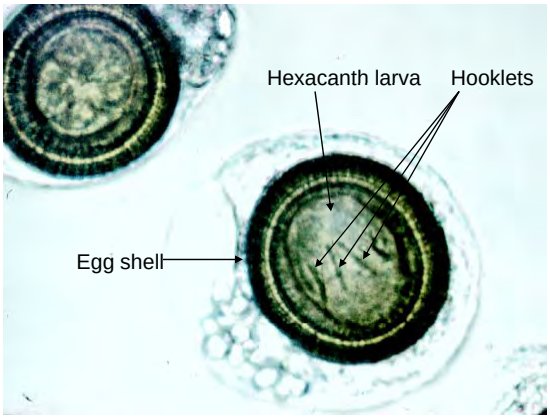


Tapeworm Proglottid

Taenia saginata



Embryonated, infectious taeniid eggs

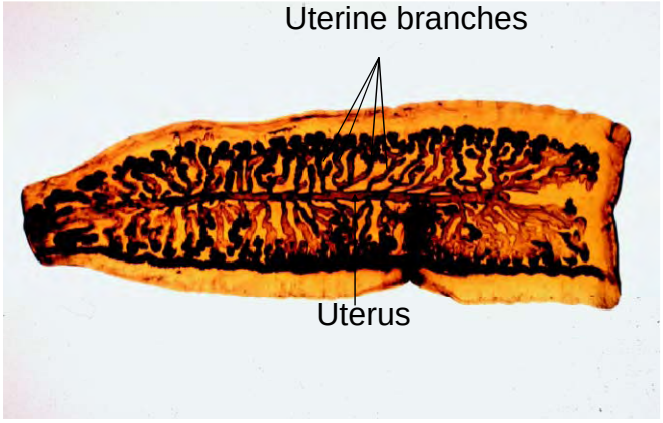


Cannot distinguish species of Taenia tapeworms based on morphology of eggs

Pathogenesis:

None

Gravid Proglottid of *Taenia saginata*

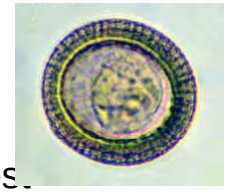


The central uterus of T. saginata has more than 12 branches on a side

Clinical Disease:

None in humans

Diagnosis:

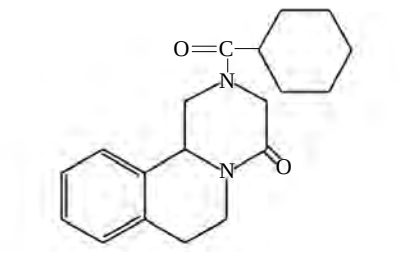


1. Find eggs on sticky tape test
   or in stool

2. Identify species based on proglottid morphology

Drug of Choice:

Praziquantel



Mode of Action:
Interferes with invertebrate Ca^{2+} ion channels

Prevention and Control:

1. Sanitary disposal of feces

Prevention and Control (cont'd):

2. Prevent cows from coming into contact with human feces - maintain good sanitary practices.

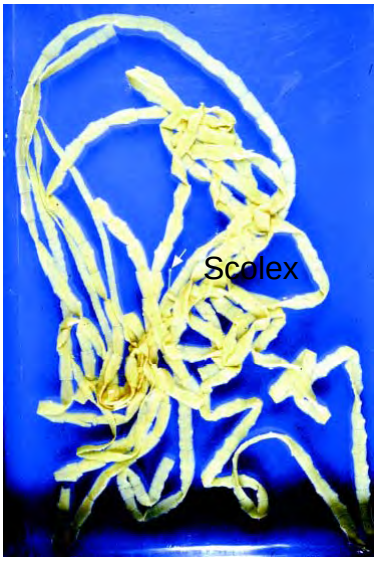
3. Freeze and/or cook all beef until well-done (Good luck, NY!!).

4. Federal meat inspection programs work.

Taenia solium

The Pork Tapeworm

Adult *Taenia solium*



Taenia solium scolex

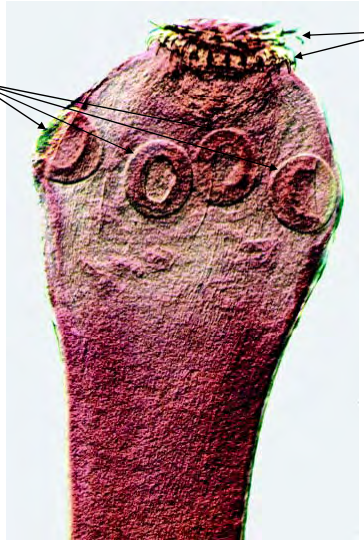
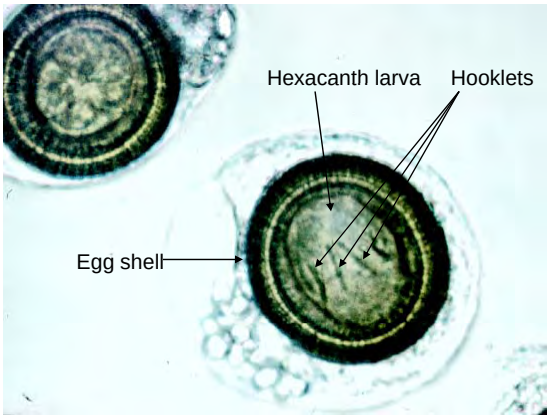


Photo: E. Grave

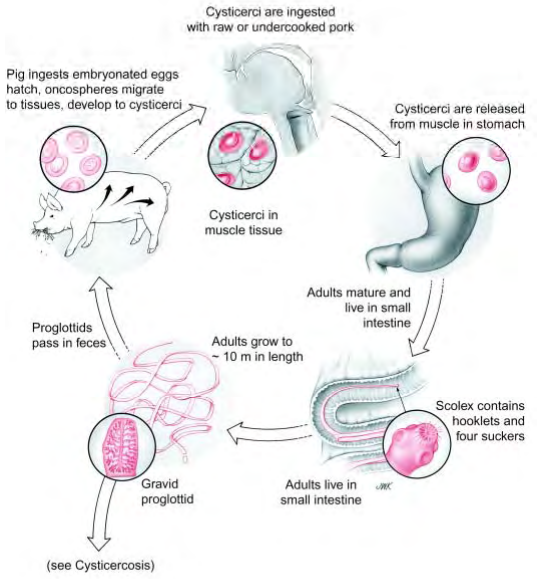
Gravid proglottid *Taenia solium*

Embryonated, infectious taeniid eggs



Cannot determine the species of Taenia based on egg morphology

Taenia solium



Whole cysticercus of *Taenia solium*

Pathogenesis:

None

Clinical Disease:

None

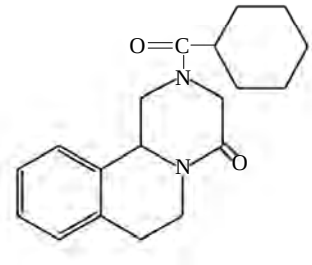
Diagnosis:

1. Find eggs on sticky tape test or in stool

2. Identify species based on proglottid morphology

Drug of Choice:

Praziquantel



Mode of Action:
Interferes with invertebrate Ca^{2+} ion channels

Prevention and Control:

1. Sanitary disposal of feces

Prevention and Control (cont'd):

2. Good sanitary practices on the pig farm.

3. Cook and/or freeze pork products thoroughly.

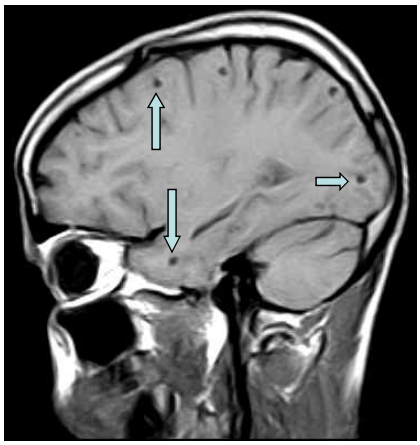
4. Federal meat inspection is effective.

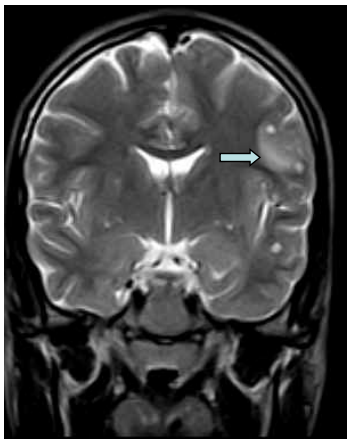
Cestode hosts

	T. saginata	*T. solium*
Definitive Host:	Human	Human
Intermediate Host:	Cow	Pig
		Human

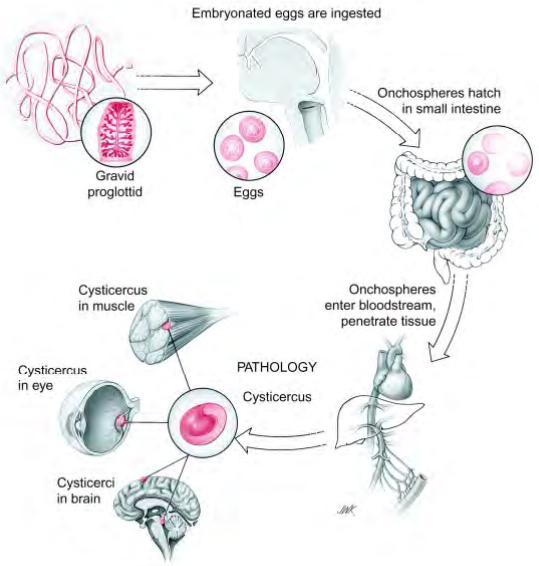
Cysticercosis and Neurocysticercosis

Multiple Intracerebral Cysts

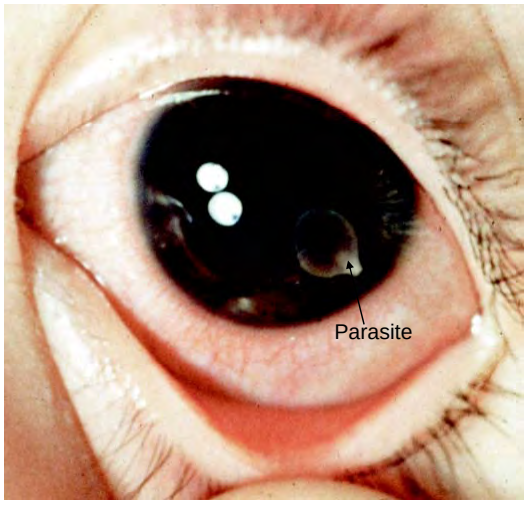




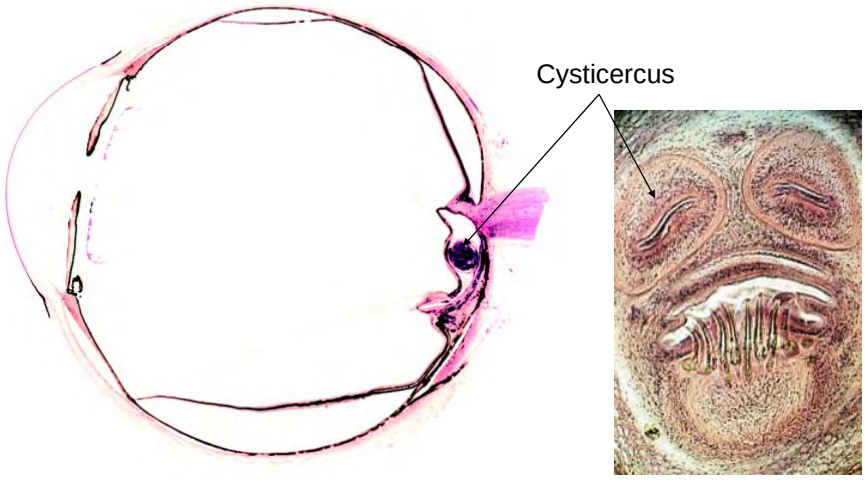
Cysticercosis
(Taenia solium)



Cysticercus floating freely in anterior chamber

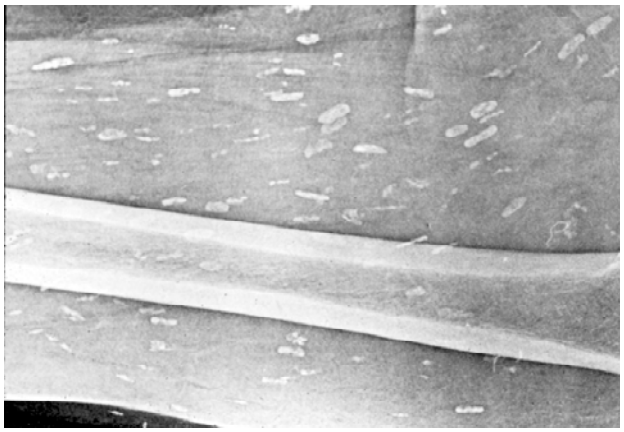


Cross section of eye with cysticercus near optic nerve. Disease was mis-diagnosed as retinoblastoma.

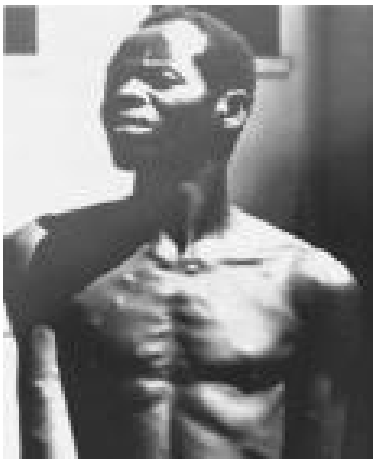


"Alien"

Radiogram of lower leg with numerous calcified cystercerci of *T. solium*

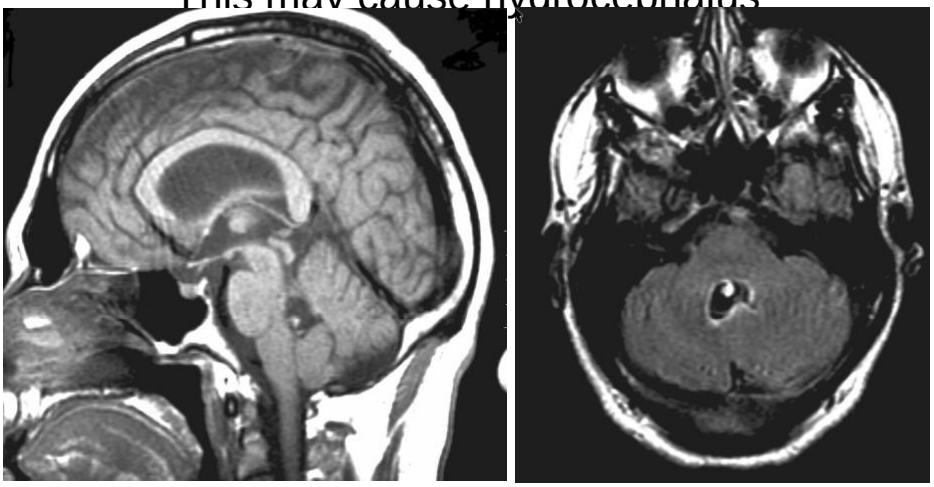


Subcutaneous Cysts



Cerebello-pontine angle cysticercus

This may cause hydrocephalus

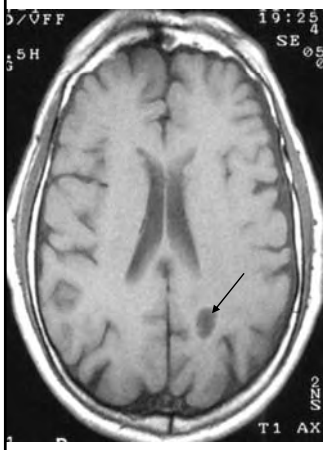


MRI sagittal and axial views with flare

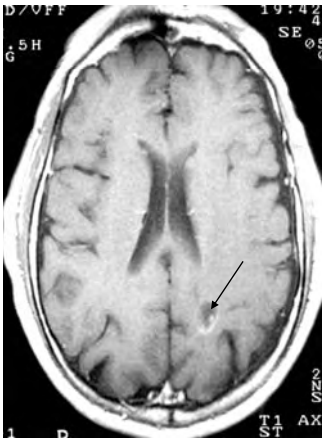
Cysticercus in brain, on post-mortem pathology

Asymptomatic cyst; cause of death, mesothelioma

Neurocysticercosis



T1 weighted

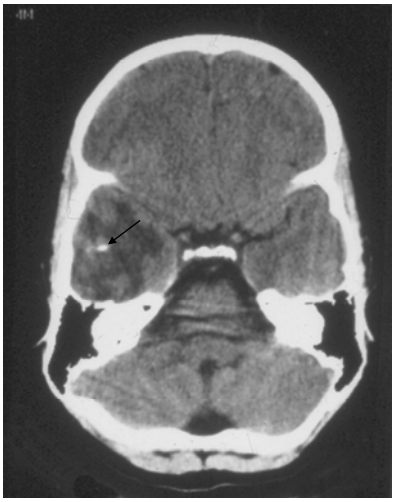


T1 with contrast

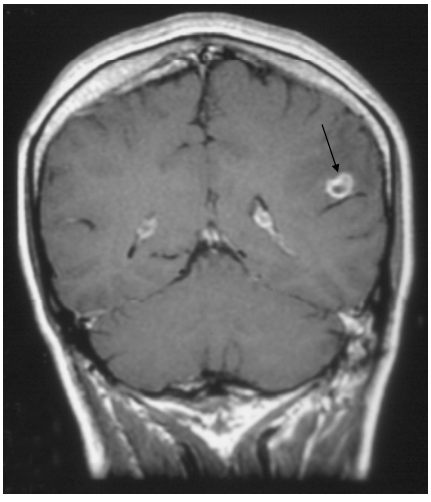
T2 weighted

Neurocysticercosis

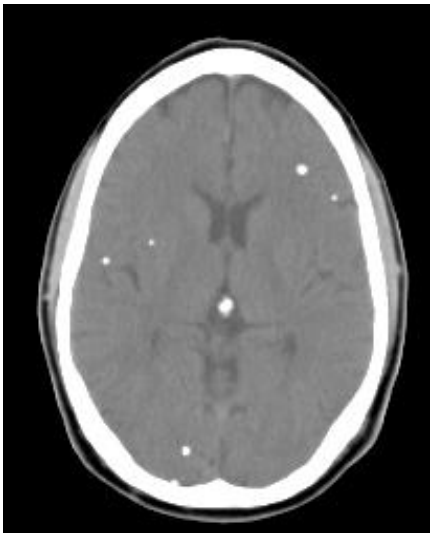
CT Scan



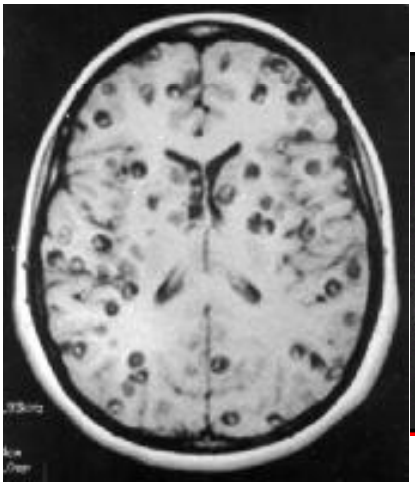
MRI

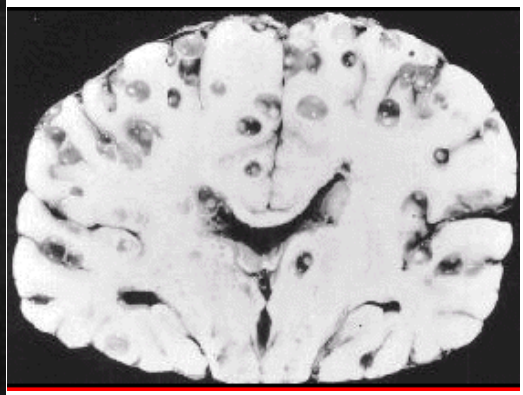


Intracerebral Calcifications



How bad can things get?

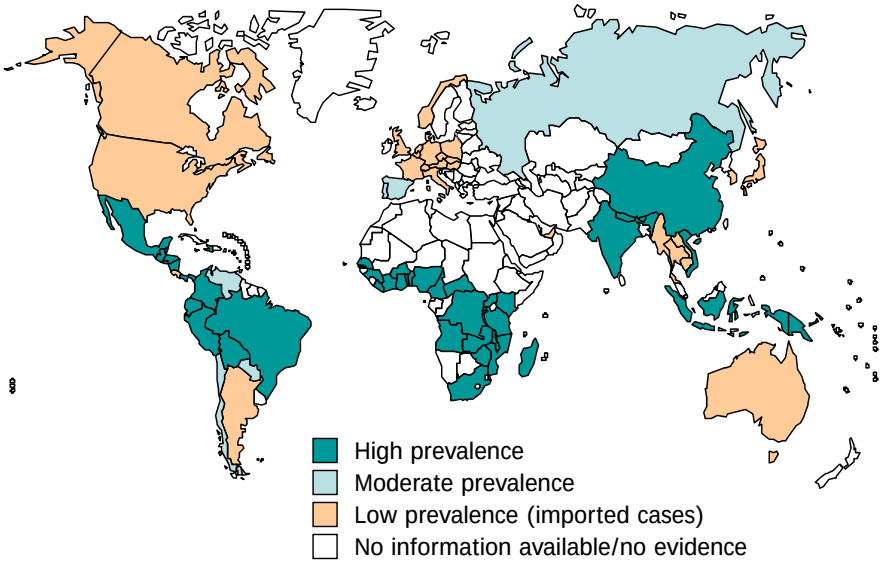




Immunomodulation

- Taeniastatin: protease inhibitor
- Paromycin
  - Inhibits complement
- Other proteases:
  - Degrade IL-2, immunoglobulins and interferon

Global distribution of *Taenia solium* cysticercosis/taeniosis



Clinical Epidemiology of Cysticercosis

- Mexico, South America, Sub-saharan Africa, India, and Southeast Asia
- Est. 50 million people with Intestinal Taeniasis, world-wide
- 2% - 7 % have neurocysticercosis
- Leading cause of adult-onset seizures worldwide (~40%)
  - Remainding causes are trauma, TB, tumors, toxins, other.
- In US: Est. 1000 new cases per year (no mandatory report)
  - Immigrants account for ~ 95% annually
  - Travelers account for 3%-5%
  - Autochthonous transmission: rare

Pathogenesis:

Space-Occupying lesion

Local Immunologic Reaction

Clinical Disease:

1. Vision impairment / Blindness
2. Seizures / Death
3. Hydrocephalus / Coma / Death
4. Neurological deficits, dependent upon location

Diagnosis:

Must differentiate between cysticercosis and other possible lesions (benign cysts, solid tumors, etc.)

1. Biopsy whenever possible
2. Physical (palpation) and radiological evidence
3. ELISA-based serological tests
4. MRI

Treatments:

1. Surgical removal of cysticercus whenever possible

2. Steroids (e.g., dexamethazone) during time of neurological symptoms

3. Anticonvulsants (Dilantin)

4. Praziquantel or albendazole plus steroids if multiple symptomatic cysticerci are inoperable (still being studied)

Echinococcus granulosus

The Dog tapeworm

Hydatid Disease in Humans

Cestode hosts

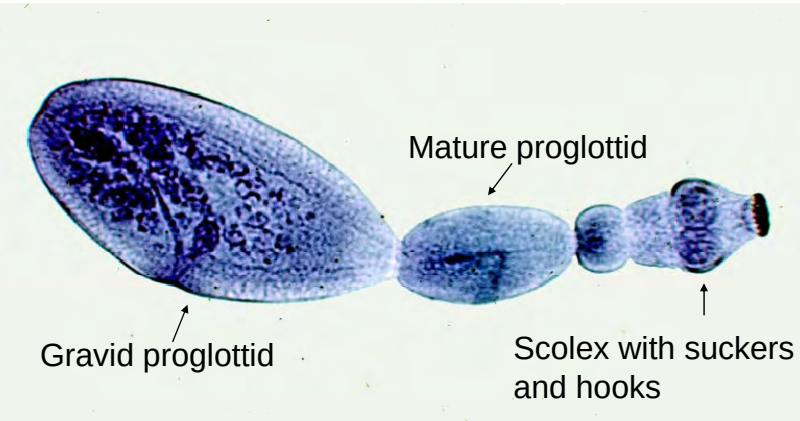
	T. saginata	*T. solium*	*Echinococcus granulosus*
Definitive Host:	Human	Human	Dog
Intermediate Host:	Cow	Pig	Sheep
		Human	Human

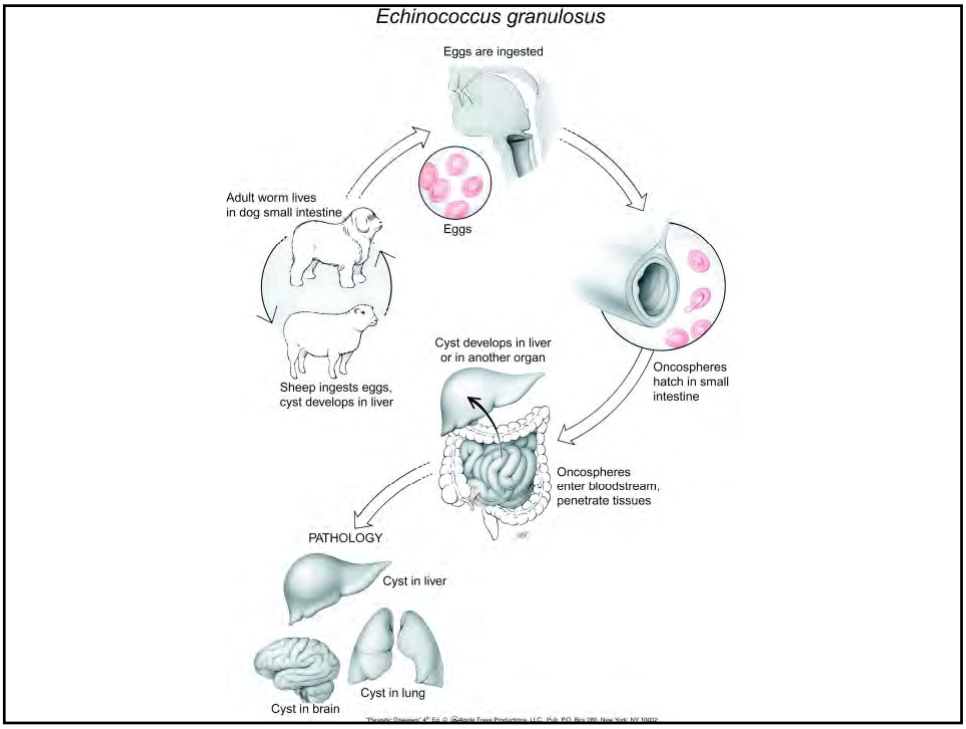
Traditional farming practices help to maintain the cycle in animals and humans.

Navaho, Arizona

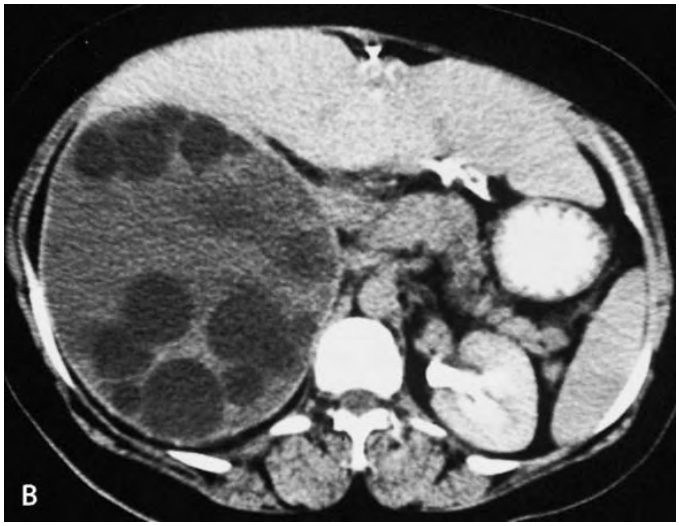
Abattoir, Ecuador

Adult of *Echinococcus granulosus*



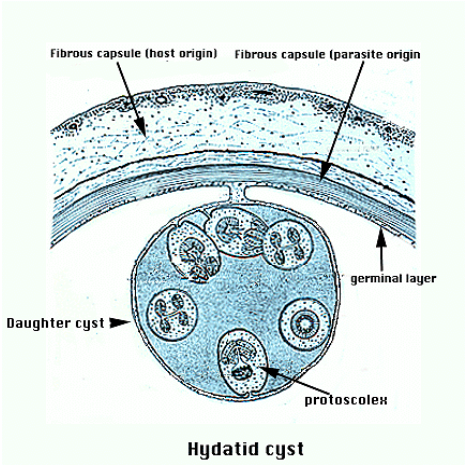


Hydatid cyst of Liver

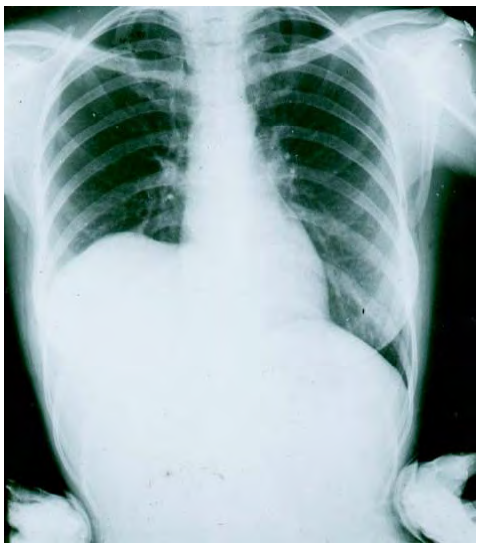


Visualize: Hydatid cyst, daughter cysts, hydatid fluid

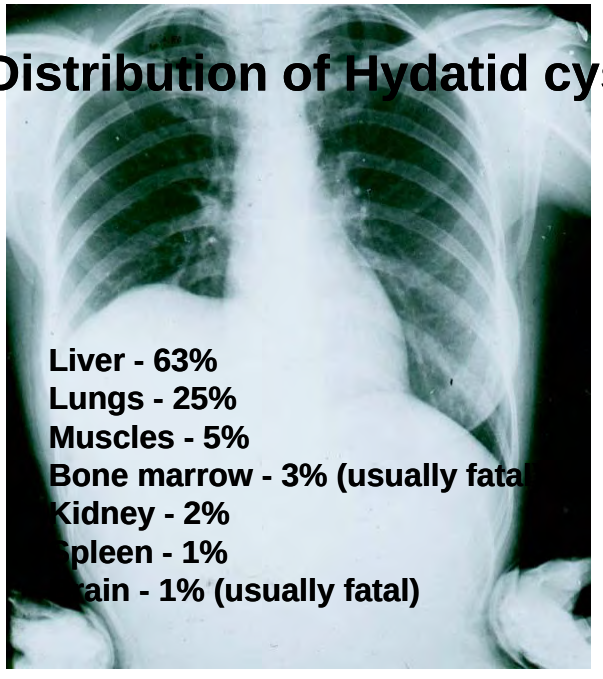
Hydatid Cyst diagram



Radiogram of upper body showing elevation in right lobe of liver due to large hydatid cyst



Distribution of Hydatid cysts



Hydatid cyst of Parietal Lobe

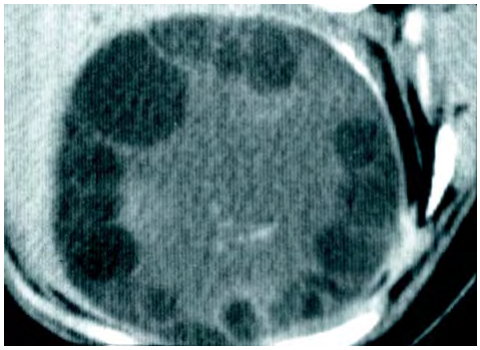
Pathogenesis and Clinical disease:

1. Hydatid cyst *per se* is not a problem as a single cyst in liver, while it is immunologically silent.

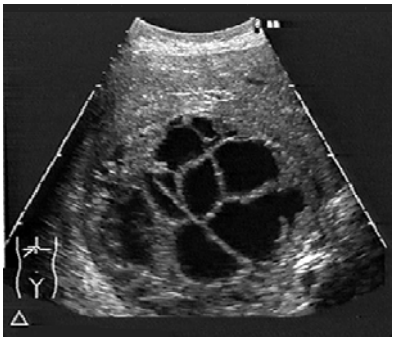
2. In other organs (e.g., brain, lung, bone marrow), an hydatid cyst may range from asymptomatic to fatal, depending on its effect as a space-occupying lesion or if ruptures.

3. If it ruptures however, no matter which organ it occupies, anaphylaxis usually

Liver infected with **hydatid cyst** of *Echinococcus granulosus*

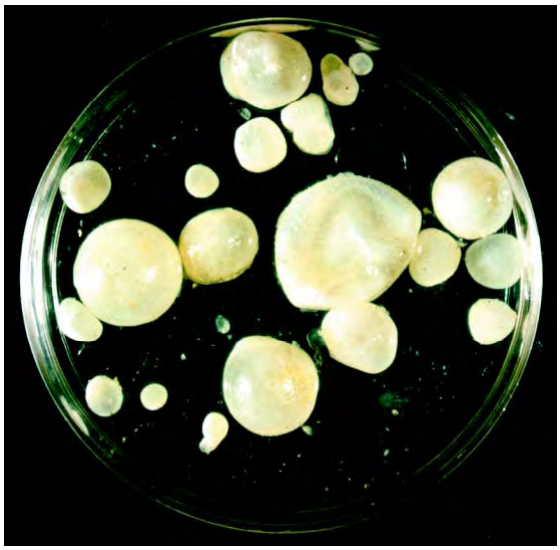


CT Scan

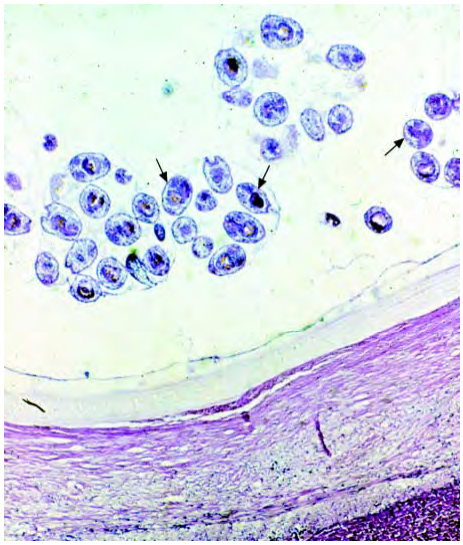


Ultrasound

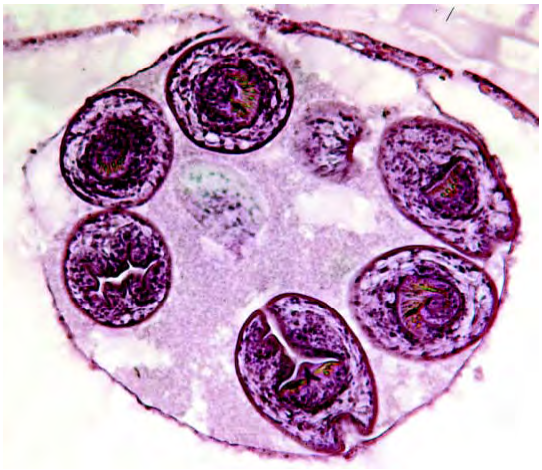
Petri dish filled with daughter cysts of *Echinococcus granulosus*



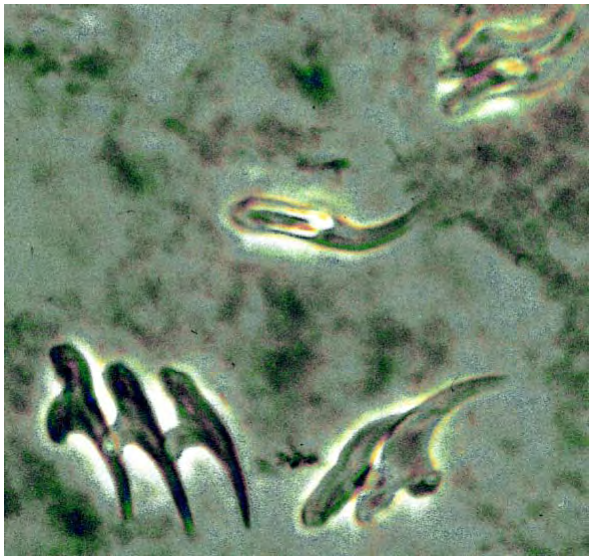
Histological section through brood capsules in hydatid cyst of *Echinococcus granulosus*



Brood capsule with protoscolices of *Echinococcus granulosus*



“Hydatid sand”



Diagnosis:

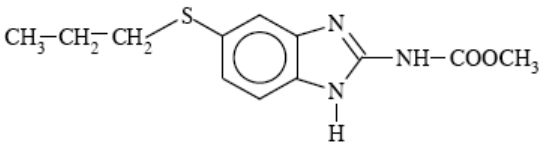
A. Direct
1. DO NOT BIOPSY!
2. Detect circulating antigens
3. Microscopic examination of fluid from hydatid cyst after surgical removal, see “hydatid sand”

B. Indirect
1. ELISA-based serology
2. MRI, CAT, x-ray
3. Accurate case history (ownership of dogs, living on a farm, etc.)

Treatment:

- Surgical, whenever possible
- Pharmacologic has less than 50% success

Drug of Choice: Albendazole



Mode of Action:

De-polymerizes invertebrate microtubules, only

Prevention and Control:

1. Regularly treat all dogs with niclosamide that have contact with sheep. This drug kills the adult parasites.

2. Avoid feeding hydatid cyst material to dogs.

3. Public health education of sheep farmers.