

## Helminths

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

## Beef Wellington



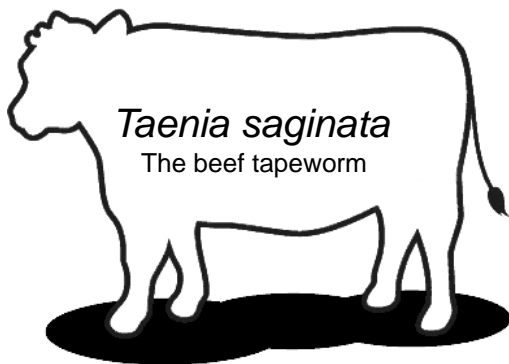
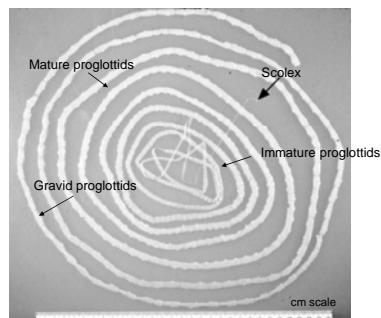
## Cestodes

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

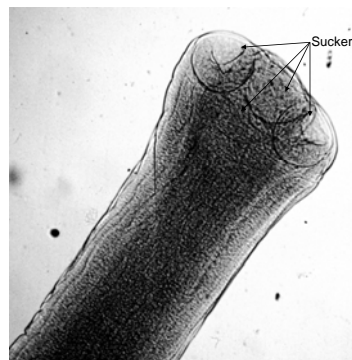
### The tapeworms:

- Taenia saginata* (beef tapeworm)
- Taenia solium* (pork tapeworm)
  - > Cysticercosis
- Echinococcus granulosus* (dog tapeworm)
  - > Hydatid Disease

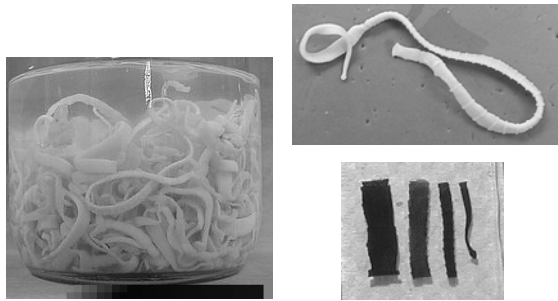
## Adult *Taenia saginata*



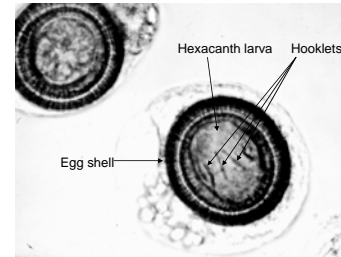
## *Taenia saginata* scolex



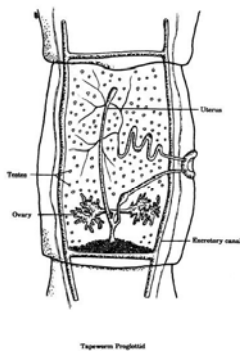
### Taenia Adult



### Embryonated, infectious taeniid eggs



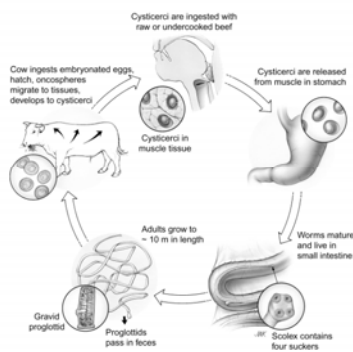
Cannot distinguish species of *Taenia* tapeworms based on morphology of eggs



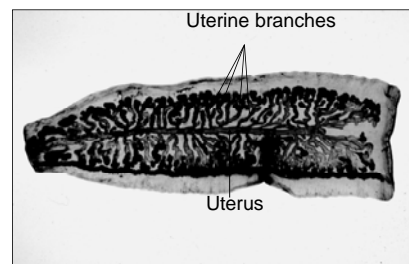
### Pathogenesis:

None

### *Taenia saginata*



### Gravid Proglottid of *Taenia saginata*



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

**Clinical Disease:**

None in humans

**Prevention and Control:**

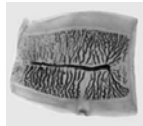
1. Sanitary disposal of feces

**Diagnosis:**

1. Find eggs on sticky tape test or in stool



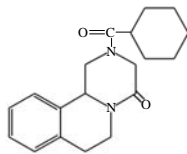
2. Identify species based on proglottid morphology



**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.

**Drug of Choice:**  
Praziquantel



Mode of Action:  
Interferes with invertebrate Ca<sup>2+</sup> ion channels

***Taenia solium***  
The Pork Tapeworm

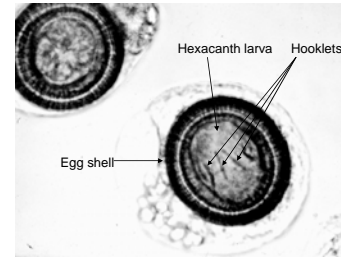


Adult *Taenia solium*



Scolex

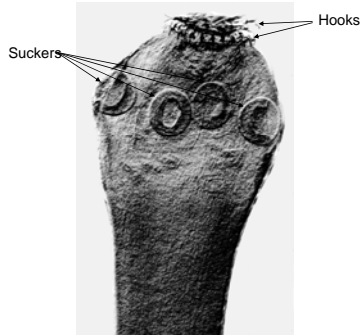
Embryonated, infectious taeniid eggs



Hexacanth larva  
Hooklets  
Egg shell

Cannot determine the species of *Taenia* based on egg morphology

*Taenia solium* scolex

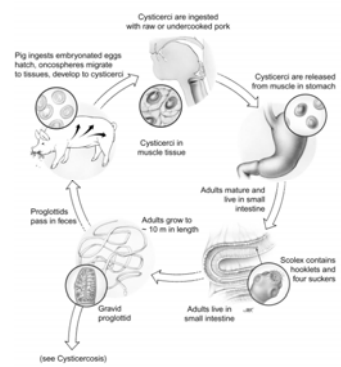


Suckers

Hooks

Photo: E. Grave

*Taenia solium*

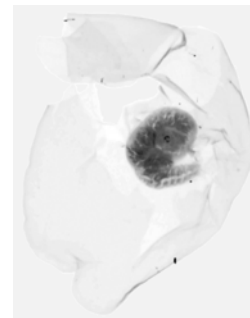


Gravid proglottid *Taenia solium*



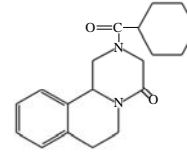
Uterine branches number less than 10 per side

Whole cysticercus of *Taenia solium*



**Pathogenesis:**

None

**Drug of Choice:**  
Praziquantel

Mode of Action:  
Interferes with invertebrate Ca<sup>2+</sup> ion channels

**Clinical Disease:**

None

**Prevention and Control:**

1. Sanitary disposal of feces

**Diagnosis:**

1. Find eggs on sticky tape test or in stool



2. Identify species based on proglottid morphology

**Prevention and Control (cont'd):**

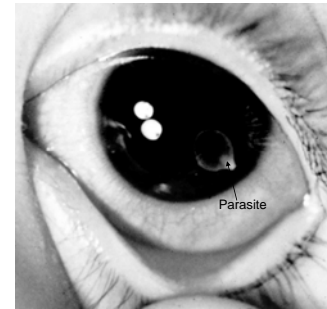
2. Good sanitary practices on the pig farm.
3. Cook and/or freeze pork products thoroughly.
4. Federal meat inspection is effective.

### Cestode hosts

***T. saginata***      ***T. solium***

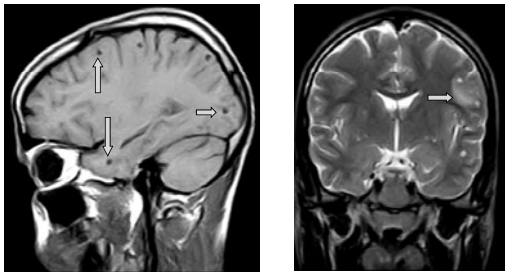
Definitive Host:	Human	Human
Intermediate Host:	Cow	Pig Human

Cysticercus floating freely in anterior chamber

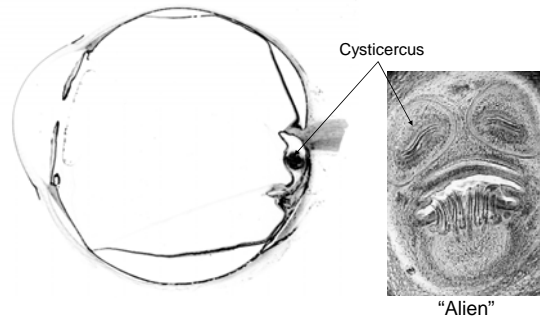


### Cysticercosis and Neurocysticercosis

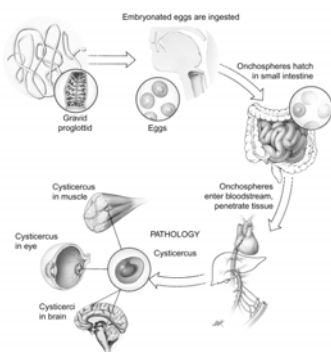
Multiple Intracerebral Cysts



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



### Cysticercosis (*Taenia solium*)



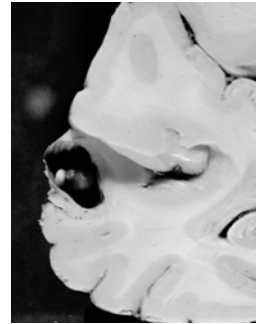
Radiogram of lower leg with numerous calcified cystercerci of *T. solium*



### Subcutaneous Cysts



### Cysticercus in brain, on post-mortem pathology

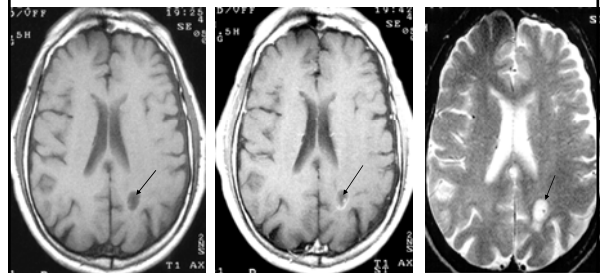


Asymptomatic cyst; cause of death, mesothelioma



Neurocysticercosis of the spine

### Neurocysticercosis



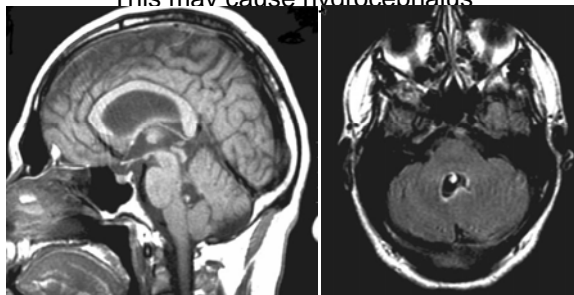
T1 weighted

T1 with contrast

T2 weighted

### Cerebello-pontine angle cysticercus

This may cause hydrocephalus

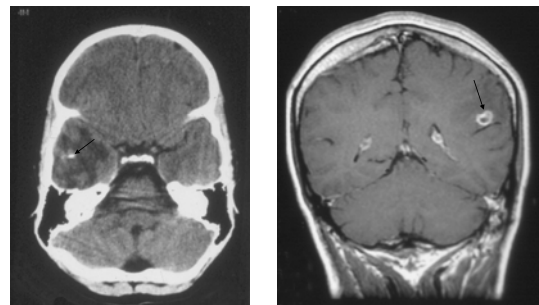


MRI sagittal and axial views with flare

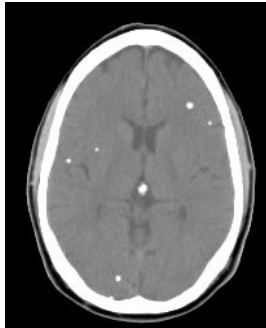
### Neurocysticercosis

CT Scan

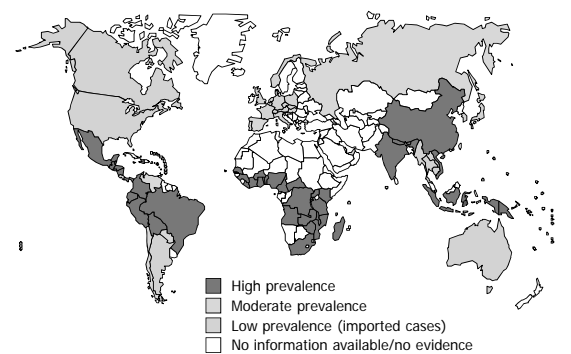
MRI



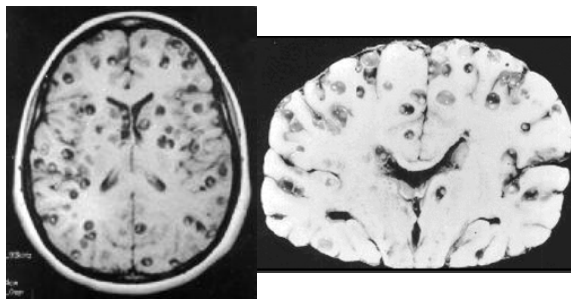
### Intracerebral Calcifications



Global distribution of *Taenia solium* cysticercosis/taeniosis



### How bad can things get?



### Clinical Epidemiology of Cysticercosis

- Mexico, South America, Sub-saharan Africa, India, and Southeast Asia
- Est. 50 million people with Intestinal Taeniasis, worldwide
- 2% - 7 % have neurocysticercosis
- Leading cause of adult-onset seizures worldwide (~40%)
  - Remaining 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

### Immunomodulation

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

### 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

### *Echinococcus granulosus*

The Dog tapeworm  
Hydatid Disease in Humans

### 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

### Cestode hosts

	<i>T. saginata</i>	<i>T. solium</i>	<i>Echinococcus granulosus</i>
Definitive Host:	Human	Human	Dog
Intermediate Host:	Cow	Pig Human	Sheep Human

### 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)

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

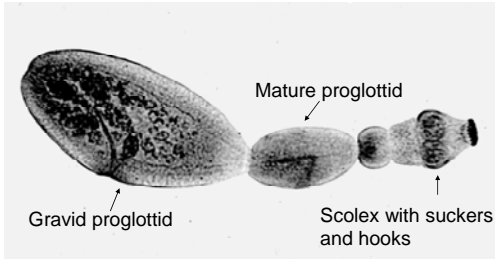


Navaho, Arizona

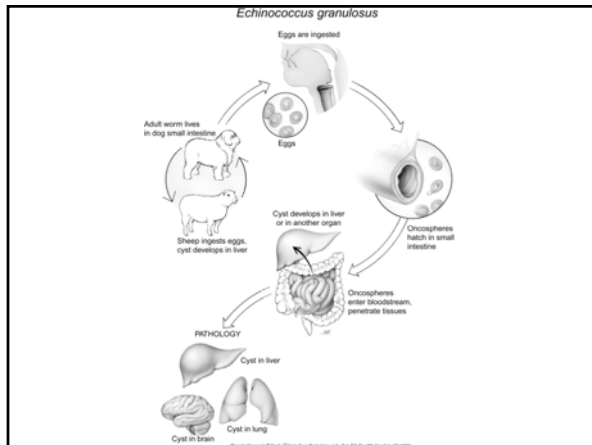
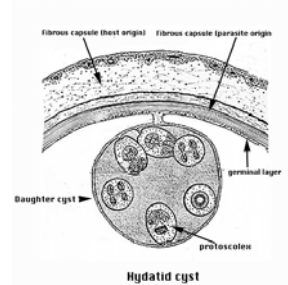


Abattoir, Ecuador

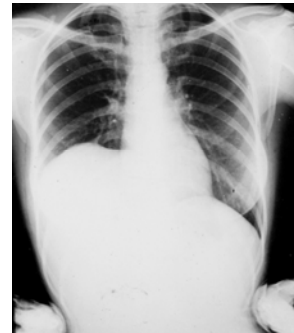
Adult of *Echinococcus granulosus*



Hydatid Cyst diagram



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

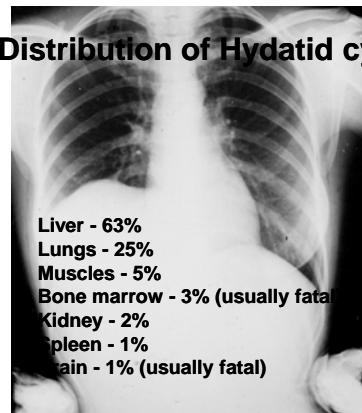


Hydatid cyst of Liver



Visualize: Hydatid cyst, daughter cysts, hydatid fluid

Distribution of Hydatid cysts

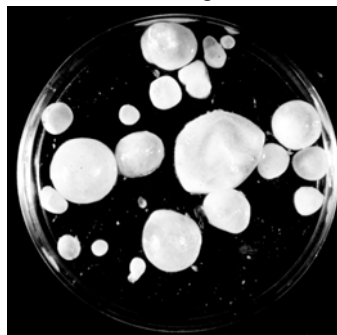


- Liver - 63%
- Lungs - 25%
- Muscles - 5%
- Bone marrow - 3% (usually fatal)
- Kidney - 2%
- Spleen - 1%
- Brain - 1% (usually fatal)

### Hydatid cyst of Parietal Lobe



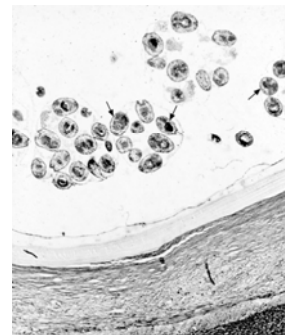
### Petri dish filled with daughter cysts of *Echinococcus granulosus*



### 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 occurs, anaphylaxis usually

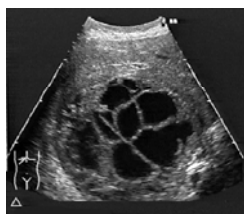
### Histological section through brood capsules in hydatid cyst of *Echinococcus granulosus*



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

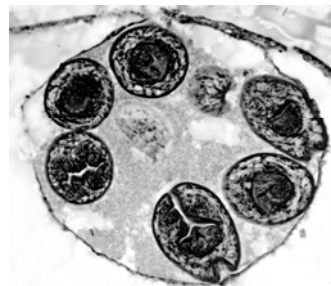


CT Scan

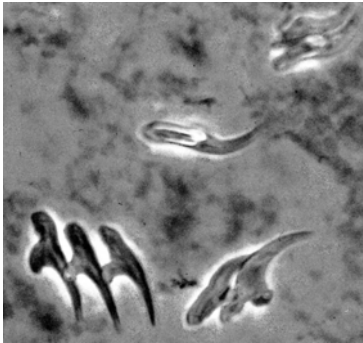


Ultrasound

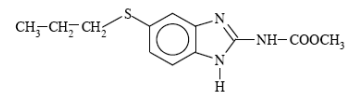
### Brood capsule with protoscolices of *Echinococcus granulosus*



### “Hydatid sand”



### Drug of Choice: Albendazole



Mode of Action:

De-polymerizes invertebrate microtubules, only

### 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.)

### 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.

### Treatment:

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