Cestodes

P & S, 2008

Joshua Stillman MD, MPH
Department of Emergency Medicine
Assistant Professor, Columbia University

Helminths

- Phylum Nematoda (Roundworms) - "Nematodes"
  - Pinworm, Whipworm, Ascaris + VLM, Hookworm + CLM
  - Elephantiasis, River Blindness, Dracunculiasis, etc.

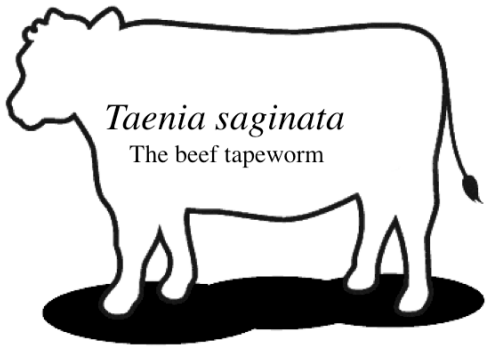


- Phylum Platyhelminthes (Flatworms)
  - Class Cestoidea (segmented flatworms) - "Cestodes"
  - Class Trematoda (non-segmented flatworms) - "Trematodes"

The tapeworms

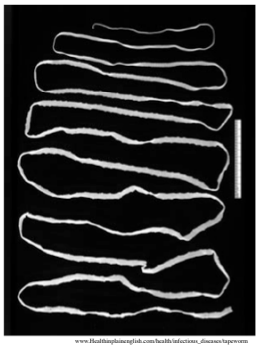
(Cestodes ==> Non-segmented flatworms)

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



Taenia *saginata* adult

"Bowl o' Worms"

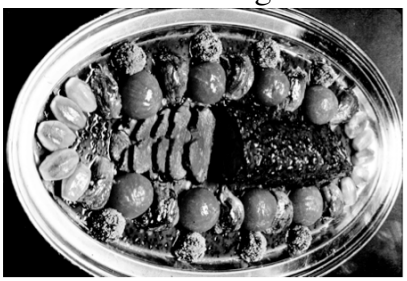


www.Healthinplainenglish.com/health/infections_diseases/tapeworm

"Fields o' beeves"

D. Desjeommier, master photographer and fly-fisherman

"Plate o' Beef" a la "Wellington"



D. Despommier, expert chef

Cysticercosis - heart of cow

Veterinary Pathology Laboratory, Univ. Penn

Cysticercus cysticerc

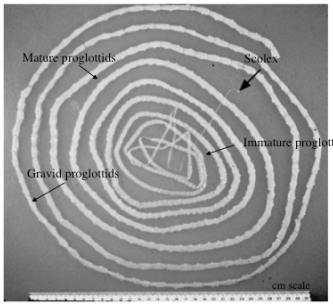
Cestode hosts

T. saginata

Definitive Host: Human

Intermediate Host: Cow

Adult *Taenia saginata*

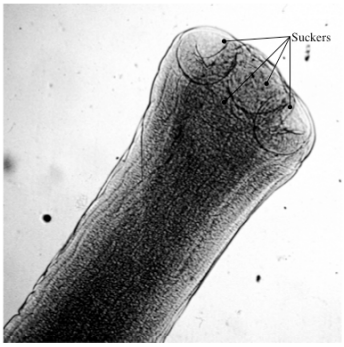


Scolex (head)

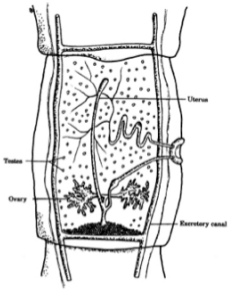
Proglottids (segments)

Strobila (body and head)

Taenia saginata scolex

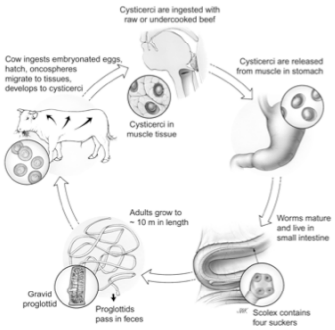


Proglottid - Sex organs

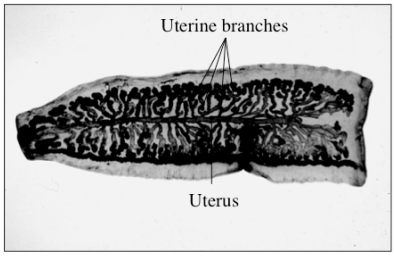


Tapeworm Proglottid

Taenia saginata

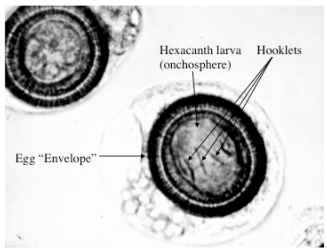


Gravid Proglottid of *Taenia saginata*



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

Embryonated, infectious taeniid eggs



Cannot distinguish species of Taenia tapeworms based on morphology of eggs

Pathogenesis:

None

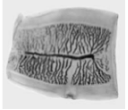
Clinical Disease:

None in humans

Diagnosis:

1. Find eggs or proglottids in stool

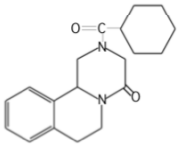
2. Identify species based on proglottid morphology, after formalin and India Ink



3. Identify scolex

Drug of Choice

Praziquantel



Mode of Action:
Increases permeability of flatworm tegument to Ca^{2+} ions,
Causing muscle tetany and worm detachment.

Prevention and Control:

1. Sanitary disposal of human feces

Prevention and Control (cont'd):

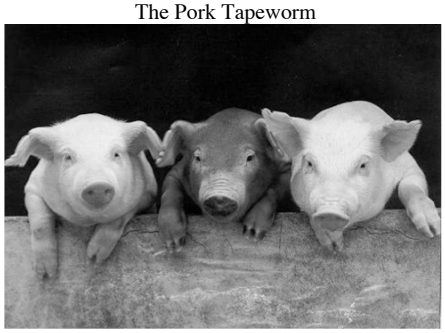
2. Prevent cows from coming into contact with human feces, ie good sanitation and physical restraints.

3. Freeze and/or cook all beef until well-done
   Good luck Paris, good luck New York!!
   (No more rare filet mignon or steak tartar)

4. Federal meat inspection programs (muscle exam or serum ELISA specific to larval stage).

Taenia solium

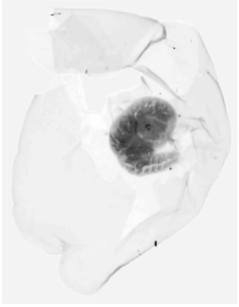
The Pork Tapeworm



Still Life With Ham. *(Or not?)*

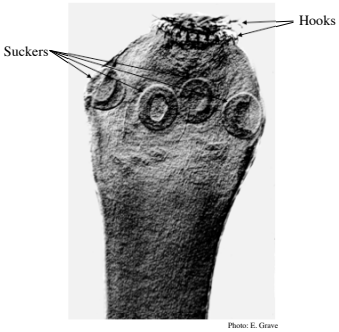
Oil on canvas, Paul Gauguin

Whole cysticercus of *Taenia solium*

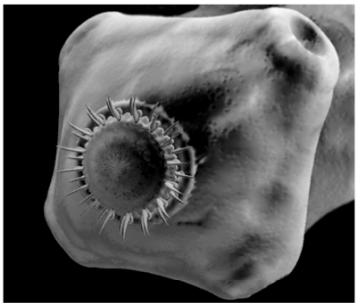


Adult *Taenia solium*

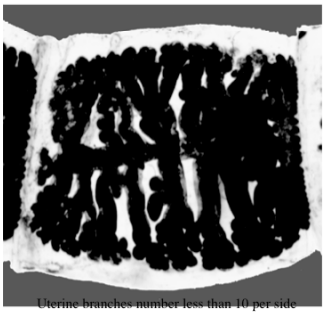
Taenia solium scolex



T. Solium Scolex

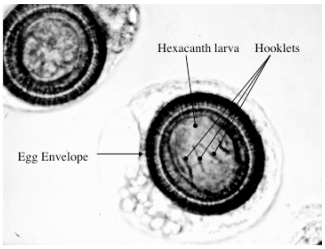


Gravid proglottid *Taenia solium*

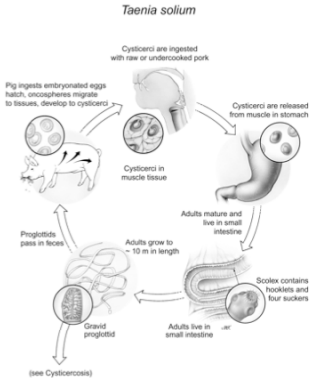


Uterine branches number less than 10 per side

Embryonated, infectious taeniid eggs



Cannot determine the species of Taenia based on egg morphology



Pathogenesis:

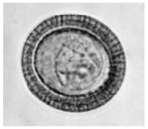
None

Clinical Disease:

None

Diagnosis:

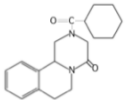
1. Find eggs or proglottids in stool



2. Identify species based on proglottid morphology
3. Identify scolex
4. Stool PCR or ELISA (not readily available)

Drug of Choice:

1. Praziquantel



2. Niclosamide
   - Not absorbed systemically
   - Uncouples cestode oxidative phophorylation, preventing ATP production.
   - Parasite is then digested by host enzymes.

Prevention and Control:

1. Sanitary disposal of feces

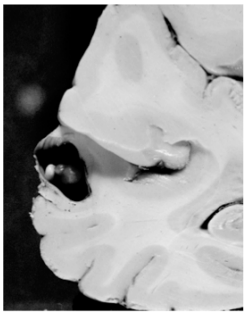
Prevention and Control (cont'd):

2. Sanitary practices on pig farms; separate human feces from pigs.
3. Cooking and/or freezing pork products thoroughly.
4. Federal meat (pork) inspection programs.
5. Treat pigs or vaccinate pigs, using new oncosphere mRNA vaccine, in eradication programs. (WHO Assembly, 2003).

Cestode hosts

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

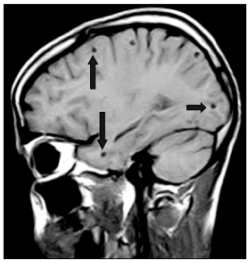
Cysticercus in brain, on post-mortem pathology

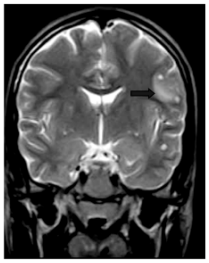


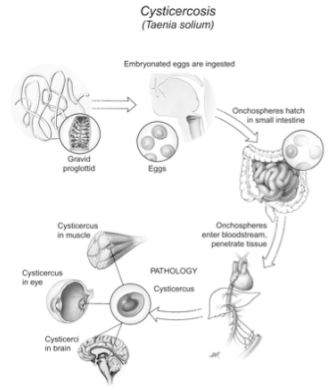
Asymptomatic cyst. Actual cause of death, mesothelioma

Cysticercosis and Neurocysticercosis

Multiple Intracerebral Cysts

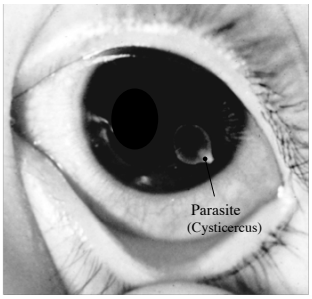




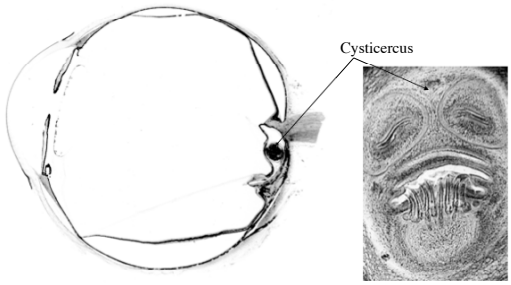


Manifestations of Cysticercosis in Humans

Cysticercus floating freely in anterior chamber



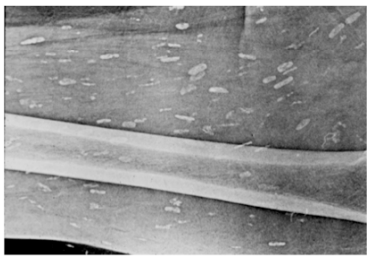
Cysticercosis of eye:
cysticercus near optic nerve,
mis-diagnosed as retinoblastoma.



Enucleated globe in cross-section

"The Alien"

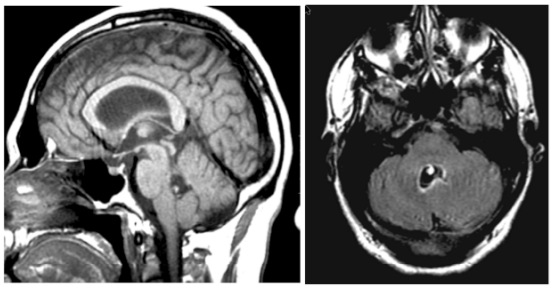
Radiogram of lower leg with numerous calcified cystercerci of *T. solium*



Subcutaneous Cysts

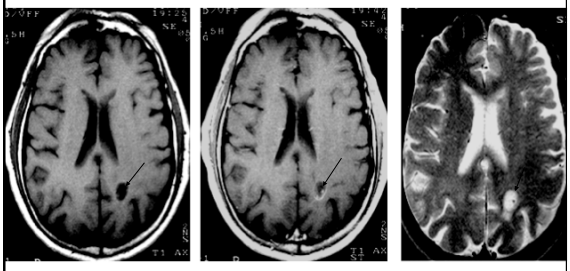
Cerebello-pontine angle cysticercus

This may cause hydrocephalus



MRI sagittal (T1) and axial views (T1 + C)

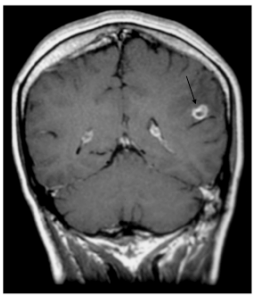
Neuro-cysticercosis



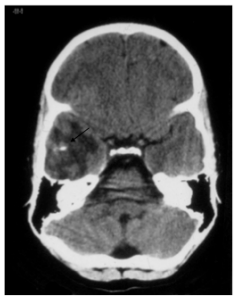
T1 weighted | T1 with contrast | T2 weighted

Neurocysticercosis

MRI

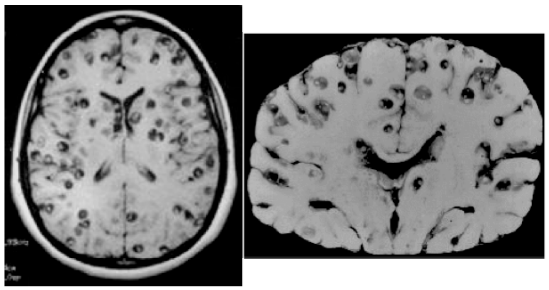


CT Scan

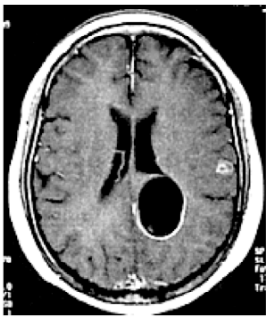


Intracerebral Calcifications

How bad can things get?



a GIANT cyst



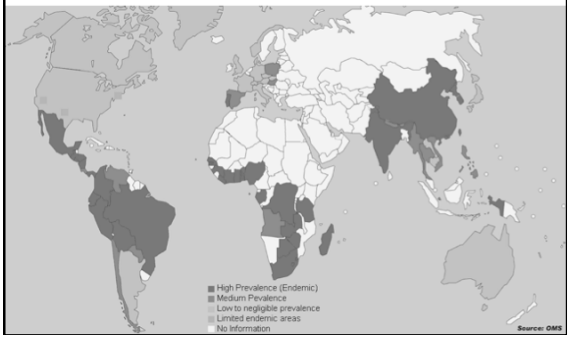
- Single vs multiple cysts
- Growing/living cysts vs
- Calcified/dead cysts
- Small vs GIANT Cysts
- Seizures,
- CSF obstruction
- Hydrocephalus,
- Arachnoiditis,
- Mass effect,
- Focal neurologic deficits…

Immuno-modulation

- Taeniastatin
  - protease inhibitor
- Paramyocin
  - Inhibits complement
- Other proteases:
  - Degrade Interleukin-12, immunoglobulins and interferon

Neurocysticercosis and Taeniasis:

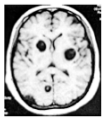
Global Prevalence Map



Clinical Epidemiology of Cysticercosis

- Est. 50 million people with Intestinal Taeniasis, world-wide
- 20% have cysticercosis; at least half will be symptomatic (Sz)
- Leading cause of adult-onset seizures worldwide (~40%)
  - Other causes are trauma, TB, tumors, toxins, other.
- In US: Est. 1000 new cases per year (no mandatory reporting)
  - Immigrants account for > 95% annually
  - Travelers account for ~3%
  - Autochthonous transmission: rare

Pathogenesis:



Space-Occupying lesion

Local Immunologic Reaction

Clinical Disease:

- Vision impairment / Blindness
- Seizures/Death
- Hydrocephalus/Coma/Death
- Focal Neurologic deficits that depend upon location of mass and area affected.

Diagnosis:

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

1. Biopsy whenever possible
2. Physical (palpation) and X-ray evidence
3. Enzyme-linked immunoblot serological test, can be as high as 98% sensitive, 100% specific.
4. MRI

Treatments:

1. Surgical removal of cysticercus when appropriate
2. Steroids (e.g., dexamethazone) during time of neurological symptoms
3. Anticonvulsants (e.g. Dilantin - Phenytoin)
4. Antiparasitic antibiotics: Praziquantel or albendazole + steroids + anticonvulsants for multiple or symptomatic cysticerci, or for inoperable cysts - under study)

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

Navaho, Arizona

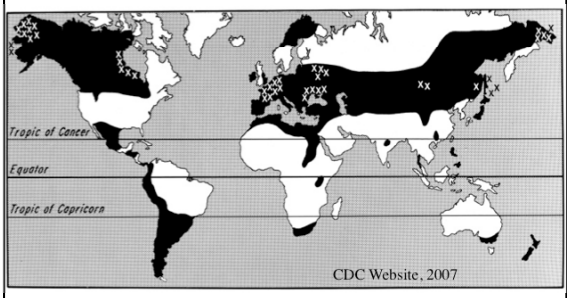
Tibet

Scotland

Abattoir, Ecuador

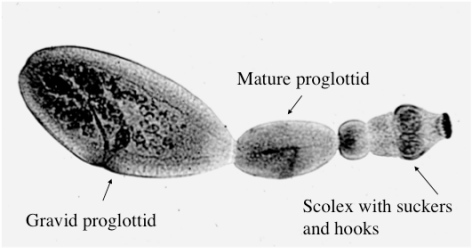
Echinoccocus Granulosus

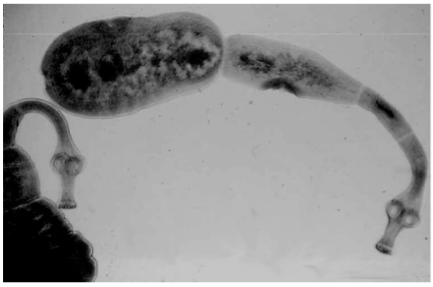
Global Prevalence Map



Distribution map of *Echinococcus granulosus* (black) and *E. multilocularis* (marked by 'X;). The latter is now also found in Hokkaido (Japan), Alaska and also in the whole of Germany.

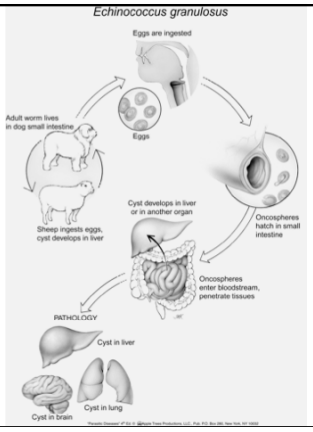
Adult of *Echinococcus granulosus*



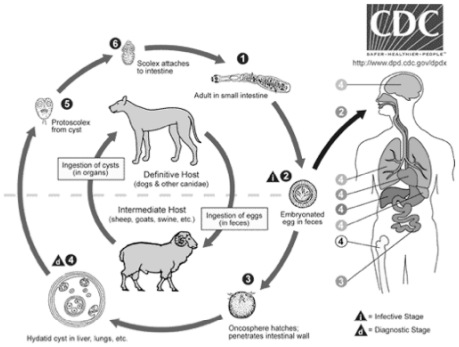


Echinococcus Granulosus Adult

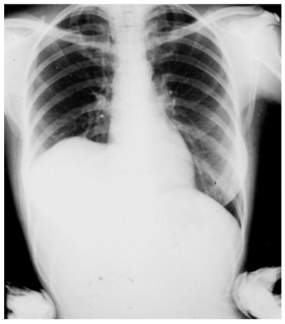
cute, n'est-ce pas?



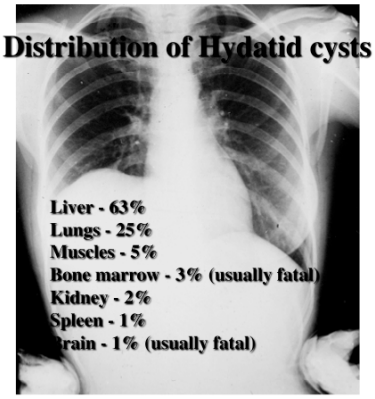
Echinococcus Lifecycle



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



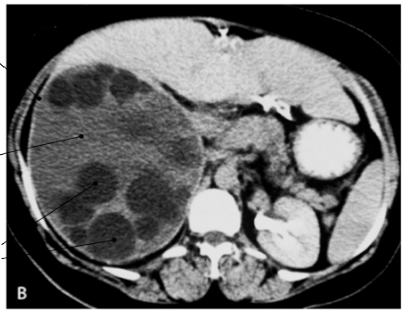
Distribution of Hydatid cysts



Hydatid cyst of Liver

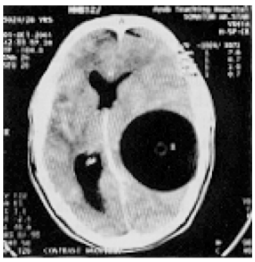
Visualize:

1. Hydatid Cyst
2. Hydatid Fluid
3. Daughter Cysts

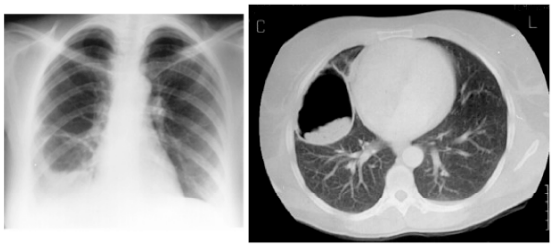


Hydatid cysts removed from human liver

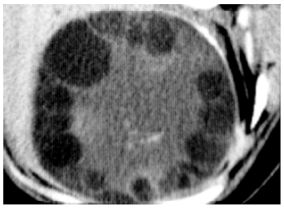
Hydatid cyst of Parietal Lobe



Pulmonary Echinococcus



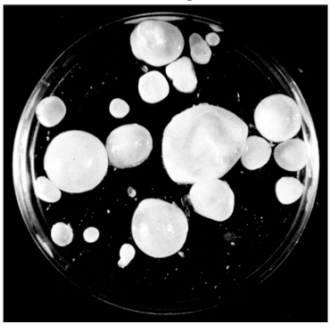
Liver infected with **hydatid cyst** of *Echinococcus granulosus*



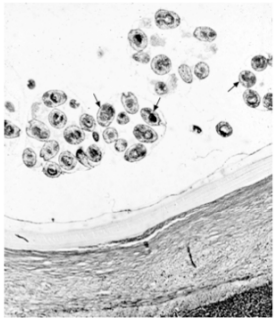
CT Scan

Ultrasound

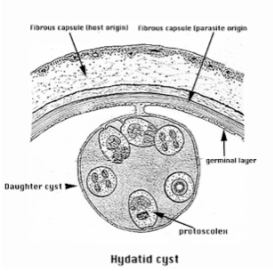
Petri dish filled with daughter cysts of *Echinococcus granulosus*



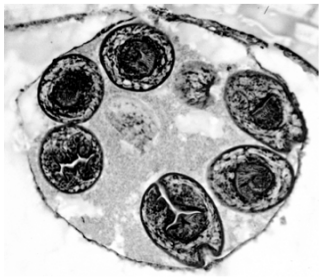
Histological section through brood capsules in hydatid cyst of *Echinococcus granulosus*



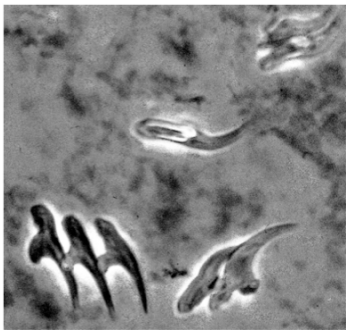
Hydatid Cyst diagram



Brood capsule with protoscolices of *Echinococcus granulosus*



"Hydatid sand"



Pathogenesis and Clinical disease:

- When intact, hydatid cysts are immunologically and often clinically silent, especially in the liver.
- In other organs (e.g., brain, lung, bone marrow), hydatid cyst is a space-occupying lesion.
- It may leak or rupture, seeding/metastasizing adjacent areas.
- When hydatid cyst ruptures, allergic reactivity and anaphylaxis often ensue. This may be fatal.

Diagnosis:

A. Direct
   1. NO BIOPSY!
   2. CAN remove surgically. Find "hydatid sand" on microscopic examination of fluid from hydatid cyst

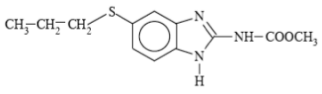
B. Indirect
   1. ELISA-based serology
   2. Imaging: MRI, CAT scan, X-ray, Ultrasound
   3. Accurate case history (ownership of dogs, living on a sheep farm, etc.)

Treatment:

- Surgical, whenever possible
- PAIR Technique for liver lesions
  - (puncture, aspirate, Inject, re-aspirate)
- Pharmacologic has less than 50% success

Drug of Choice:

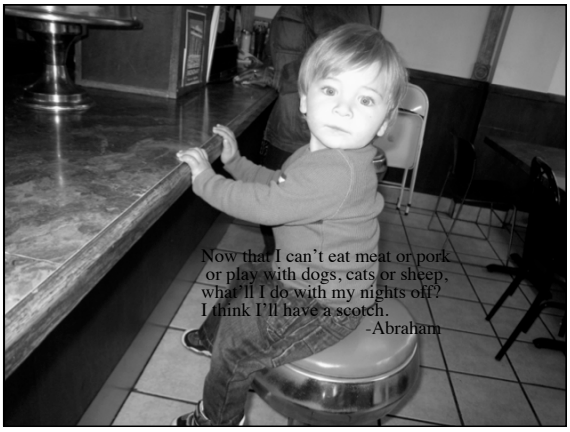
Albendazole (for 1-6 months)



Mode of Action:
Prevents microtubule polymerization, blocking glucose absorption, starving worm

Prevention and Control:

- Regularly treat all shepherding dogs with niclosamide. This drug kills the adult parasites (by inhibing ATPase).
- Avoid feeding hydatid cyst material (sheep offal) to dogs.
- Public health education of sheep farmers.


Now that I can't eat meat or pork
or play with dogs, cats or sheep,
what'll I do with my nights off?
I think I'll have a scotch.
-Abraham