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)
- *Echinococcus granulosus* (dog tapeworm)

--- Cysticercosis
--- Hydatid Disease

**Taenia saginata**
The beef tapeworm

**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

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

Drugs 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!).

Taenia solium
The Pork Tapeworm
**Adult *Taenia solium***

- Scolex
- Suckers
- Hooks

**Embryonated, infectious taeniid eggs**

- Hexacanth larva
- Hooklets
- Egg shell

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

***Taenia solium* scolex**

- Suckers
- Hooks

**Gravid proglottid *Taenia solium***

- Uterine branches number less than 10 per side
- Embryonated, infectious taeniid eggs

**Whole cysticercus of *Taenia solium***
Pathogenesis:

None

Drug of Choice:
Praziquantel

Mode of Action:
Interferes with invertebrate Ca\(^{2+}\) 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

<table>
<thead>
<tr>
<th>Definitive Host</th>
<th>Intermediate Host</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>T. saginata</em></td>
<td>Cow</td>
</tr>
<tr>
<td><em>T. solium</em></td>
<td>Pig</td>
</tr>
<tr>
<td>Definitive Host</td>
<td>Human</td>
</tr>
<tr>
<td></td>
<td>Pig</td>
</tr>
<tr>
<td></td>
<td>Human</td>
</tr>
</tbody>
</table>

Cysticercosis and Neurocysticercosis

Multiple Intracerebral Cysts

Cysticercus floating freely in anterior chamber

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

Radiogram of lower leg with numerous calcified cysterceri of *T. solium*
Subcutaneous Cysts

Neurocysticercosis of the spine
This may cause hydrocephalus

Cysticercus in brain, on post-mortem pathology
Asymptomatic cyst; cause of death, mesothelioma

Neurocysticercosis

Cerebello-pontine angle cysticercus

MRI sagittal and axial views with flare

T1 weighted T1 with contrast T2 weighted

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

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

<table>
<thead>
<tr>
<th>Echinococcus granulosus</th>
<th>T. saginata</th>
<th>T. solium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definitive Host:</td>
<td>Human</td>
<td>Human</td>
</tr>
<tr>
<td>Intermediate Host:</td>
<td>Cow</td>
<td>Pig</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Human</td>
</tr>
</tbody>
</table>

Traditional farming practices help to maintain the cycle in animals and humans.
Adult of *Echinococcus granulosus*

- Mature proglottid
- Gravid proglottid
- Scolex with suckers and hooks

**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

Pathogenesis and 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 occurs.

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

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

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.

Drug of Choice: Albendazole

Mode of Action:
De-polymerizes invertebrate microtubules, only