Tapeworms

*Diphyllobothrium latum*- fish tapeworm
*Taenia saginata*- beef tapeworm
*Taenia solium*- pork tapeworm
Dipylidium caninum
Echinococcus sp.
Echinococcus sp

The genus contains some of the smallest adult cestodes.

Larval forms may be HUGE and can infect humans—hydatid cysts—very serious.

E. granulosus: canines are definitive hosts, herbivores infected by ingesting eggs from infected grass.

**Epidemiology:** The organism is common in Asia, Australia, Eastern Africa, southern Spain, southern parts of South America and northern parts of North America. The incidence of human infection about 1-2/1000 and may be higher in rural areas of affected regions.

**Morphology:** This is the smallest of all tapeworms (3-9 mm long) with only 3 proglottids.
**Echinococcus granulosus**

**Life cycle:** The adult worm lives in domestic and wild carnivores. After ingestion by a suitable intermediate host (under natural conditions: sheep, goat, swine, cattle, horses, camel), the egg hatches in the small intestine and releases an oncosphere that penetrates the intestinal wall and migrates through the circulatory system into various organs, especially the liver and lungs. In these organs, the oncosphere develops into a cyst that enlarges gradually, producing protoscolices and daughter cysts that fill the cyst interior.

When other animals consume infected organs of these animals, protoscolices escape the cyst, evaginate, attach to the intestinal mucosa, and develop into adult stages in 32 to 80 days.

In humans the oncosphere penetrate small intestine, enter circulation and form cysts in liver, lung, bones, and sometimes, brain. The cyst is round and measures 1-30 cm in diameter. The cyst consists of an outer hyaline cuticula, and an inner germinal layer containing clear yellow fluid. Attached to the germinal layer, there are daughter cysts known as brood cysts. Man is usually a dead end host. Because the scoleces in the hydatid fluid resemble sand grains, they are called hydatid sand. If a cyst bursts within the human body, it can give rise to dozens of new cysts limited, in most cases, by a strong cellular immune response of the host.
*Echinococcus granulosus* is a zoonosis; the adult is a parasite of canids. The dog-sheep cycle is the one most germane to humans. Other animal cycles, such as dog-camel, dog-horse, wolf-moose, wolf- or coyote-deer, also occur, each with a degree of specific host-parasite adaptation, as well as a distinct geographic range. Eggs passed by the dog can be ingested by sheep or other herbivores, or by humans who have close contact with feces-contaminated dog fur.

**Taeniidae (mammals swallow eggs)**
Four types of larval stages. Produce scoleces asexually.

- coenurus (single bladder with numerous scolices attached to the inside of the bladder wall)
- cysticercus (large bladder with single invaginated scolex)
- strobilocerus (small bladder with long everted strobilus with an invaginated scolex)
- hydatid cyst (large capsule containing many smaller ones called brood capsules, each being attached by a slender stalk to the germinal layer of the mother cyst)
**Echinococcus granulosus**, The Hydatid Tapeworm

**Clinical Manifestations**

Echinococcosis (hydatid disease) results from the presence of one or more massive cysts, which can develop in any tissue site, including the liver, lungs, heart, brain, kidneys, and long bones.

The clinical manifestations of this infection therefore vary greatly, depending on the site and size of the cyst, but resemble those of a slow-growing tumor that causes gradually increasing pressure.

Infections in the liver, lungs, or subcutaneous tissue sites may be asymptomatic for many years, but pressure effects eventually develop. In sensitive or vital areas, hydatids produce many symptoms, chiefly owing to mechanical compression or blocking effects but also include collapse of infected long bones, blindness, and epileptic seizures.

The rupture of a hydatid cyst may induce sudden anaphylactic shock in a previously asymptomatic individual.
**Symptoms:** The symptoms, comparable to those of a slowly growing tumor, depend upon the location of the cyst. Abdominal cysts, when large produce increasing discomfort. Liver cysts cause obstructive jaundice. Peribronchial cysts may produce pulmonary abscess. Brain cysts produce intracranial pressure and Jacksonian epilepsy. Kidney cysts cause renal dysfunction.

**Diagnosis:** Clinical symptoms of a slow-growing tumor accompanied by eosinophilia aresuggestive. Intradermal test with hydatid fluid is useful. Pulmonary cysts and calcified cysts can be visualized by x-ray. Antibodies against hydatid fluid antigens have been detected in a sizable population of infected individuals by ELISA or indirect hemagglutination test.

**Treatment and control:** Treatment involves surgical removal of cyst or inactivation of hydatid sand by injecting the cyst with 10% formalin and its removal within 5 minutes. High dose of Mebendazole have claimed some success. Preventive measure involve avoiding contact with infected dogs and cats and elimination of their infection.
The infection is transmitted to the definitive host when the hydatid cyst is eaten. As one might suspect, this species of parasite is more common in areas of the world where dogs are used to herd sheep. Under most circumstances humans are a "dead end" in the life cycle, but hydatid disease in humans remains a serious problem because the disease can cause such serious pathology.

Infected sheep- slaughtered- entrails fed to dogs- or preyed upon by wild canids-definitive host

Dogs infected- tapeworms exit in feces- dog licks himself- licks children in the face-transfers eggs to children-infection
Traditional Cultural factors that used to be implicated in hydatid disease:

Some Kenyan tribes like roasted dog intestine- if intestine not cleaned or thoroughly cooked- infection.- these people may have the highest prevalence of infection.

Turkana people of Kenya- do not bury their dead. Predators eat bodies- here humans can act as intermediate hosts.

Lebanon: tanneries used dog feces in tanning solution- infected handlers.

In some areas dogs are used to clean up young children. Dogs infected- tapeworms exit in feces- dog licks himself- licks children in the face- transfers eggs to children-infection.

Control / elimination by interrupting the life cycle- denying access of dogs to offal, culling wild dogs and education.
Hydatid sand". Fluid aspirated from a hydatid cyst will show multiple protoscolices (size approximately 100 µm), each of which has typical hooklets. The protoscolices are normally invaginated (left), and evaginate (middle, then right) when put in saline.
Gross pathology of membrane and hydatid daughter cysts from human lung

Pathologically hydatid liver cyst has three distinct layers:

- **Ectocyst** - fibrous adventitial layer due to host response
- **Middle layer** - laminated membrane of proteinaceous material
- **Endocyst** - inner germinal layer from which the scolices may be detached
Histopathology of Echinococcus granulosus hydatid cyst in a sheep. Thick fibrous pericyst, hyaline ectocyst, and brood capsules filled with protoscolices are visible.
Hydatid cysts
Echinococcus granulosus (the small, white objects) in the small intestine of a dog. Although these tapeworms are quite small, a single dog can be infected with many of them.
The interior of a hydatid cyst is filled with "protoscolices" (singular = protoscolex), each of which has the ability to grow into an adult worm when ingested by a canine host. A small cyst might contain hundreds of protoscolices; a large cyst might contain tens of thousands! This tremendous reproductive potential poses a problem in the intermediate host (particularly in humans). If a hydatid cyst breaks open, each protoscolex could grow into a new hydatid cyst. How might this happen? A sharp blow to the abdomen might rupture a cyst in the liver. A number of cases have been reported in which cysts have been damaged during routine surgery, allowing the cyst's contents to leak into the patient's abdominal cavity.
A hydatid cyst (*) in the cranium of a child (the ruler at the top measures 6 inches long, and the child's brain is below the hydatid cyst). This infection resulted in the child's death.
E. Multilocularis

This is a tapeworm similar to E. granulosus, also causes hydatid disease in northern parts of Asia and North America. It has a very similar morphology and life cycle except that rodents are its intermediate host. Humans, when infected with this worm also develop hydatid cysts which produce symptoms like those caused by E. granulosus. However, the cysts are multilocular (many chambers). The organism is resistant to praziquantel; high doses of Albendazole has some antiparasitic effect. Surgery is the means of removing the cyst. Rodent control is the mean of prevention.

The life cycle is similar to E. granulosis, with the following differences: the definitive hosts are foxes, and to a lesser extent dogs, cats, coyotes and wolves; the intermediate host are small rodents.
Liver from healthy rodent (right) and rodent with Echinococcus multilocularis (left).
Gross pathology of cotton rat infected with Echinococcus multilocularis.
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<td>Cyst in beef</td>
<td>Epigastric pain, vomiting, diarrhea</td>
<td>Proglottids or eggs in stool or perianal area</td>
<td>Praziquantel</td>
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<td><em>T. solium</em></td>
<td>Cyst in pork</td>
<td>Epigastric pain, vomiting, diarrhea</td>
<td>Proglottids or eggs in stool or perianal area</td>
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<tr>
<td><em>T. solium</em> Cysticercosis</td>
<td>Oro-fecal</td>
<td>Muscle pain and weakness, ocular and neurologic problems</td>
<td>Roentgenography, anti-cysticercal antibody (EIA)</td>
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<tr>
<td><em>D. latum</em></td>
<td>Cyst in fish</td>
<td>Abdominal pain, loss of weight, anorexia, malnutrition and B12 deficiency problems</td>
<td>Proglottids or eggs in stool or perianal area</td>
<td>Praziquantel</td>
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<tr>
<td><em>E. granulosus</em></td>
<td>Oro-fecal</td>
<td>Large cysts produce various symptoms depending on the location of the organism.</td>
<td>Roentgenography, anti-hydatid fluid antibody (EIA), Casoni skin test</td>
<td>Surgery, formalin injection and drainage, Praziquantel</td>
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<tr>
<td><em>E. multilocularis</em></td>
<td>Oro-fecal</td>
<td>As above</td>
<td>As above</td>
<td>Surgery, Albendazole</td>
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