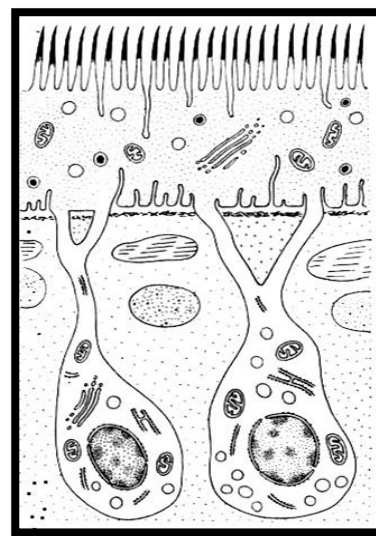
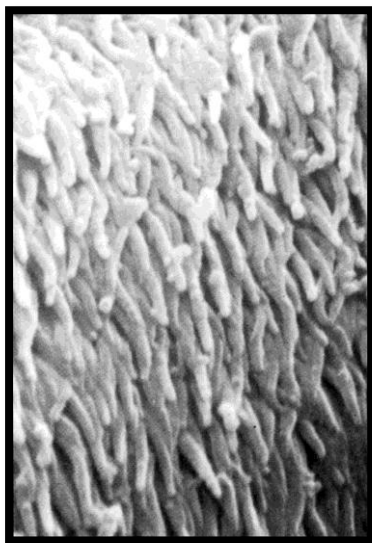


## Cestodes (Tape worms)

Cestodes (ribbon) are tape-like worms whose size vary from a few millimeters to several meters. The adult worm consists of three parts, the head, neck and trunk. The head (scolex) carries grooved or cup-like suckers which are organs of attachment to the intestinal mucosa of the definitive host, human or animals. The neck, immediately behind the scolex is the region of growth, where the segments of the body are being continuously generated. The trunk (called strobila) is composed of a chain of proglottides or segments. The segments near the neck are the young immature segments, behind them are the mature segments and at the hind end are the gravid segments.

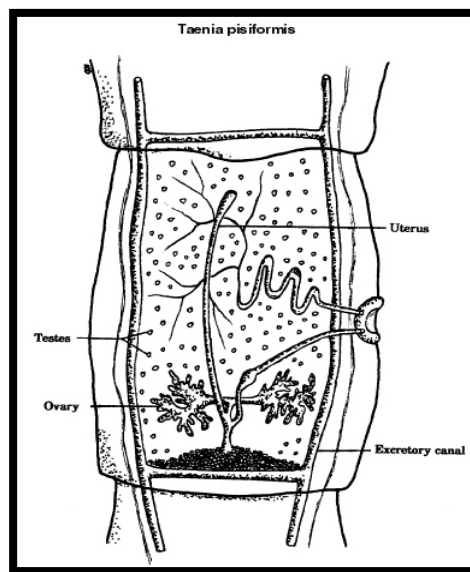
The body is surrounded by many layers the outer is cuticle (tegument), and there is a muscular layers, hypodermis and parenchyma tissues filled the cavity in which the internal organs are impeded. The reproductive system is well-developed and the proglottides are practically filled with reproductive organs. Tapeworms are hermaphroditic (monoecious) and every mature segment contains both male and female sex organs.



Cestodes do not have a mouth or any form of intestine (no alimentary canal). The entire uptake of nutrients occurs through the tegument. Cestodes are facultative anaerobes and take up glucose as main source of energy. Glucose is taken down to pyruvate through glycolysis (NAD is recycled by reduction of pyruvate to lactate, succinate and acetate). The adult cestode stores large amounts of glycogen to provide energy between host meals

In reflection of this important role in uptake the absorptive surface is highly enlarged by small microvilli or microtriches. Microfilaments (actin polymers are the molecular backbone of microtriches).

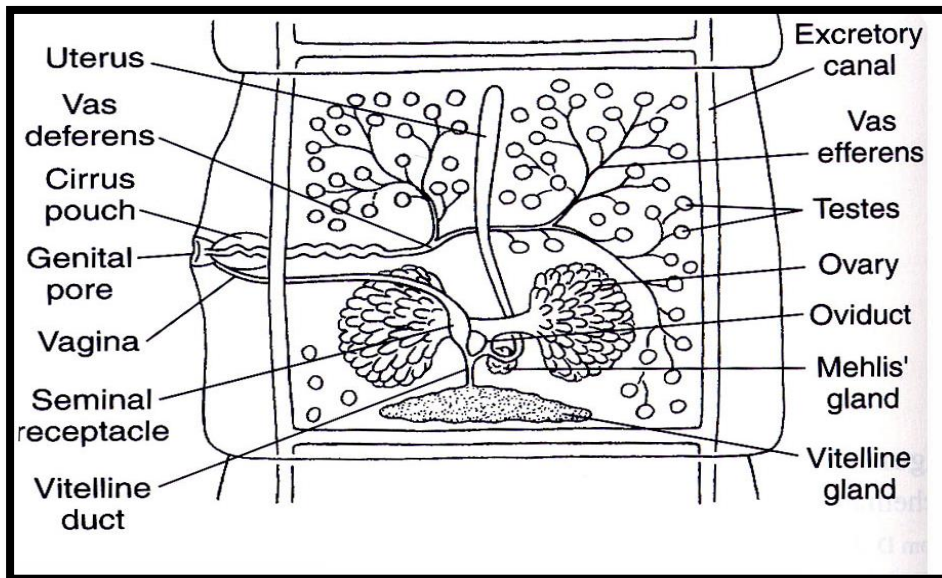
Rudimentary excretory and nervous systems are present. Pair of dorsal and ventral excretory or osmoregulatory canals traverse the entire strobila from scolex to the last proglottid. The dorsal one is often smaller than the ventral. Transverse canals can be seen. The dorsal and ventral canals unite in the scolex. Posteriorly, the two pair of canals merge into an excretory bladder with a single pore to the outside. When the terminal proglottid detaches, the canals empty independently at the end of the strobila.



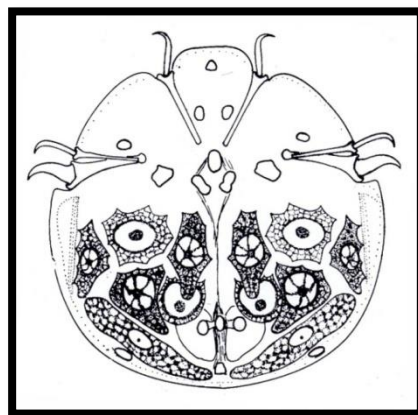
Male sex organs consist of testis located in medullary parenchyma and in some species located in cortical parenchyma , each testis opens to vas efferent which united to form vas deferens then expands to form seminal vesical also there is a cirrus and cirral sac in the cestodes.

Female reproductive organs consist of a single ovary which vary in shape , size and location. Which opens in to small oviduct this leads to ootype in which the fertilization will takes place. There are two types of glands in the female reproductive system of cestodes (vitelline and mehli's glands) , the first present as a single solid structure or many follicles distributed through paranchymal cells which opens in the ootype by the vitelline duct whereas the second surrounds the ootype .

In the immature segments the sex organs are not well- developed, they are well differentiated in the mature segments,the gravid segments are completely occupied by the uterusfilled with the eggs.



The embryo inside the egg is called the oncosphere (meaning hooked ball) because its spherical and has hook lets also this named as hexacanth embryo because typically have three pairs of hooks.

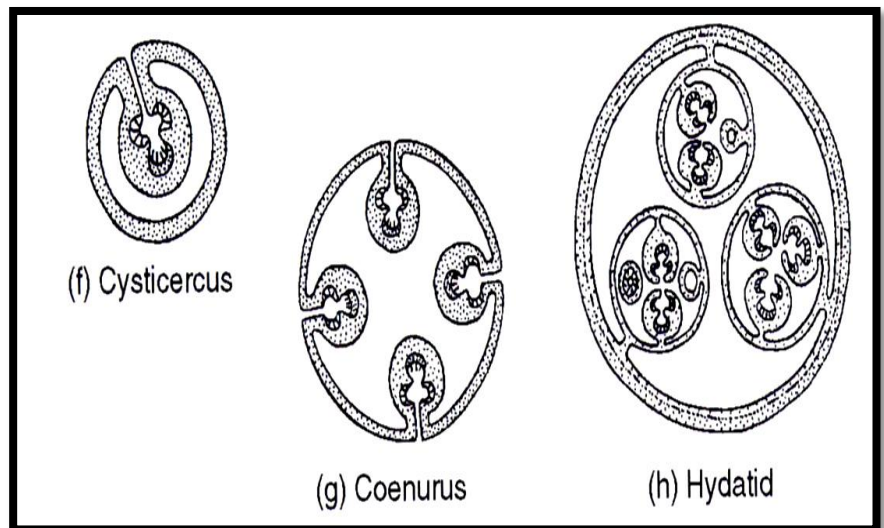
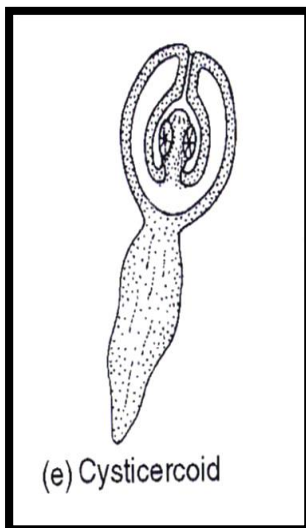
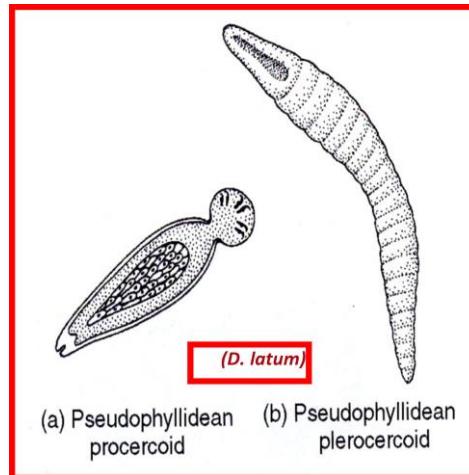


Human are the definitive host for most tape worms which cause human infection , with important exception is the dog tape worm *Echinococcus granulosus* for which dog is the definitive host and man act as intermediate host. For the pork tape worm man is the ordinarily final host but its larval stages also can develop in the human body.

Clinical disease can be caused by the adult worm or by the larval stages. In general adult cause only minimal disturbance while the larval stages can produce serious illness, particularly when they lodge in critical areas like the brain or the eyes.

**Developmental stages :-**

There are two types bladder and solid larval stages. In pseudophyllidean cestodes the larvae look fairly similar to the adult (the first host is infected by a proceroid which still carries the larval hooks. In the second host a plerocercoid forms (there is no asexual amplification). The cyclophyllidean larvae are more complex and come in a quite a variety. The medically important larvae are cysticeroid, cysticercus and hydatid cyst.



Tape worms that infect human classified according to medically importance in to two orders , Cyclophyllidean and pseudophyllidean tape worms ,the former bearing slit-like grooves (bothria)and the later cup-like suckers (acetabula) on their scolex .

A- pseudophyllidean tape worms:

1-*Diphyllobothrium latum* (fishtapeworm),the adult worm in the human intestine.

2-*Sparganum mansoni* and *S. proliferum*, the larval stages in tissues causes sparganosis.

B- Cyclophyllidean tape worms:

1-Genus-Taenia:

- *Taeniasaginata* (beef tapeworm),the adult worm in the human intestine.
- *Taeniasolium* ( pork tapeworm),the adult worm in the human intestine, the larval stages can cause disease in man.

2-Genus-Echinococcus:

- *E. granulosus* (dog tapeworm),the larval form causes unilocularhydatid disease in human.
- *E. multilocularis* , the adult worm causes multilocularhydatid disease .

3-Genus-Hymenolepis :

- *Hymenolepis nana* (dwarf tapeworm), the adult and larval stages in the human.
- *Hymenolepis diminuta* (rat tapeworm), adult worm rarely in the human intestine .

4- Genus-Dipylidium:

- *Dipylidium caninum* (double-pored tapeworm), the adult rarely in the human intestine.

5- Genus-Multiceps:

- *Multiceps multiceps* (gid worm), causes staggers ,development to the coenurus stage takes place mainly in the central nervous system and fail to complete their development in other tissues.

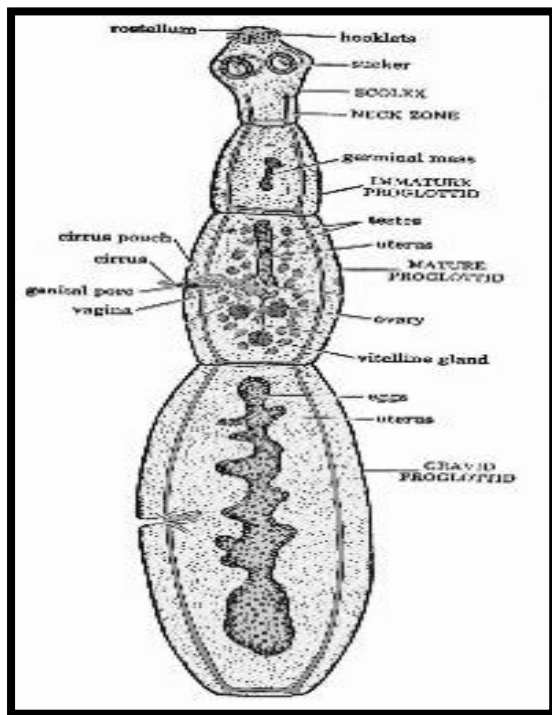
### **Echinococcus granulosus:**

Tapeworms belonging to the genus *Echinococcus* have as their definitive host a carnivorous predator that preys on the intermediate host which is usually a herbivorous mammal. The domesticated example of this is *Echinococcus granulosus* (the dog tapeworm or hydatid cyst worm (formerly called *Taenia echinococcus*) which has the dog as final host and the sheep and human as the principle intermediate host, in human cause disease named as (unilocular echinococcosis or hydatid disease).

### Morphology and life cycle:

The adult worm is small, measuring about 3-6 or 2.5-9 mm in length. It consists of a scolex which is pyriform provided with 4 suckers and a prominent rostellum bearing two circular rows of hooklets, short neck, and the trunk called strobila composed only 3 proglottides, the anterior immature, the middle mature and the posterior gravid proglottid.

The mature segment contains male and female reproductive organs. The gravid segment is completely occupied by uterus filled with eggs (12-15 lateral uterine branches or pouches) and is considered the largest segment which occupies about half of the length of the adult worm. We can differentiate *E. granulosus* from *E. multilocularis* by the gravid segment because the last one does not possess lateral uterine branches.

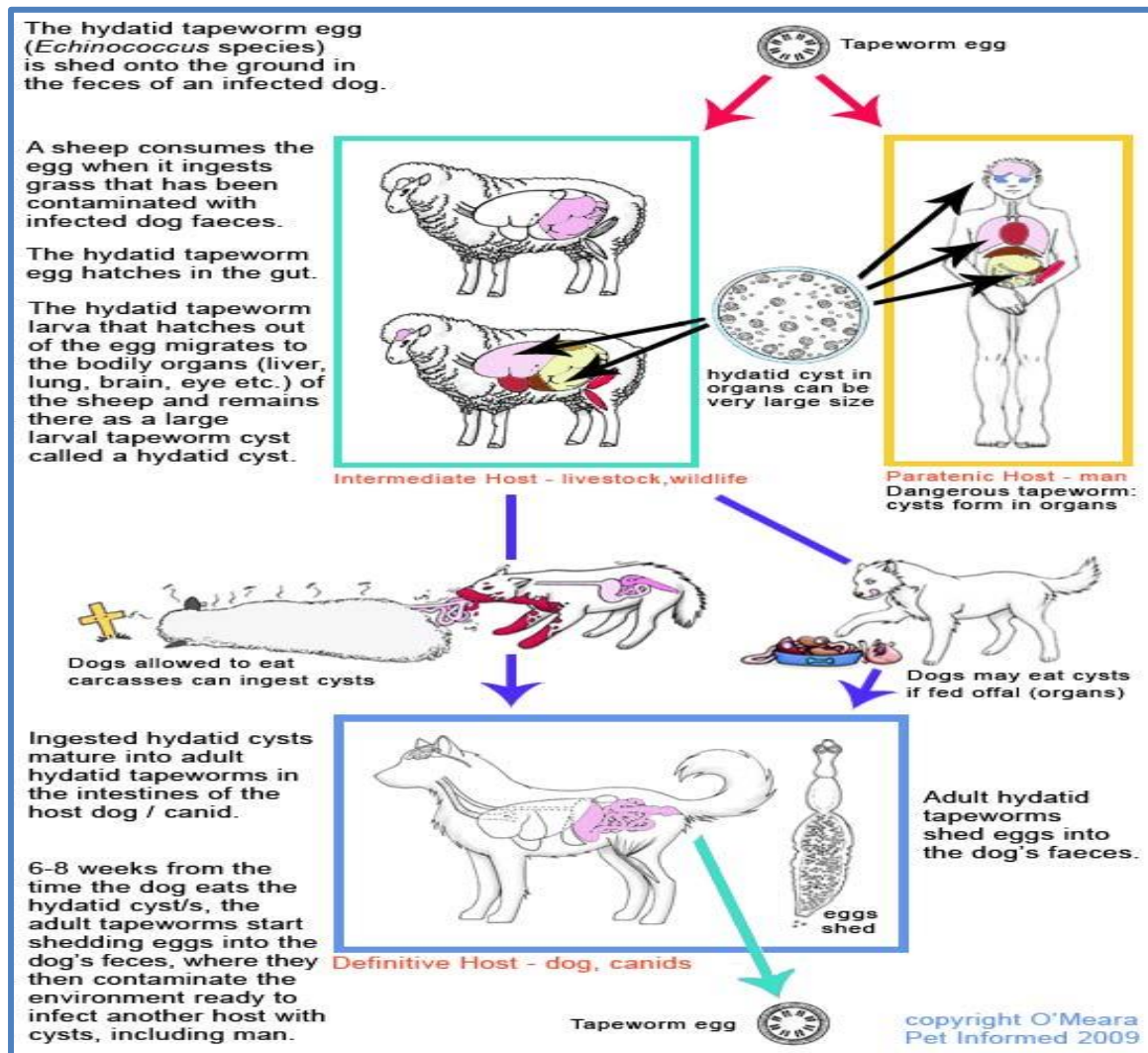


The eggs are indistinguishable from those of *Taenia spp.* They are passed in dog feces. Sheep and cattle ingest them while grazing.





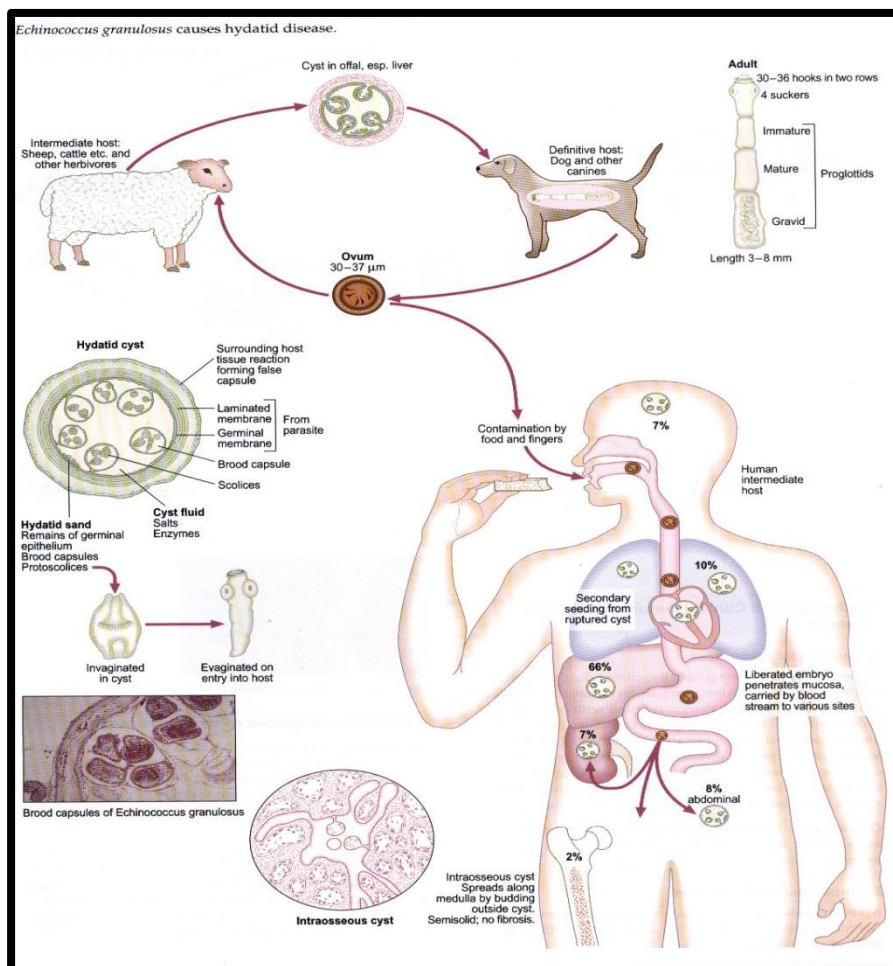
The life cycle of *E.granulosus* is indirect, the adult worm is found in the small intestine of dogs (final host). The eggs and gravid segment passed with feces, sheep and cattle and other herbivorous animals infect during grazing and the human infection occur by ingestion of raw contaminated vegetables.



The egg shell disintegrates in the duodenum , the free hexacanth embryo will penetrate the intestinal wall and enter the portal venules, to be carried to the liver along the portal circulation .The liver acts as the first filter for the embryos which get arrested in the sinusoidal capillaries, if some embryos that escape, many get filtered out in the pulmonary capillaries , so the lung act as the second filter. A few enter the systemic circulation and lodge in various organs and tissues such as the spleen, kidneys, eyes ,brain or bones.

At the site of deposition the embryo develops in to a bladder like cyst filled with fluid,this becomes the hydatid cyst (Greek hydatid means a drop of water ),it enlarge slowly and reach a diameter of 0.5-1 cm in about 6 months.

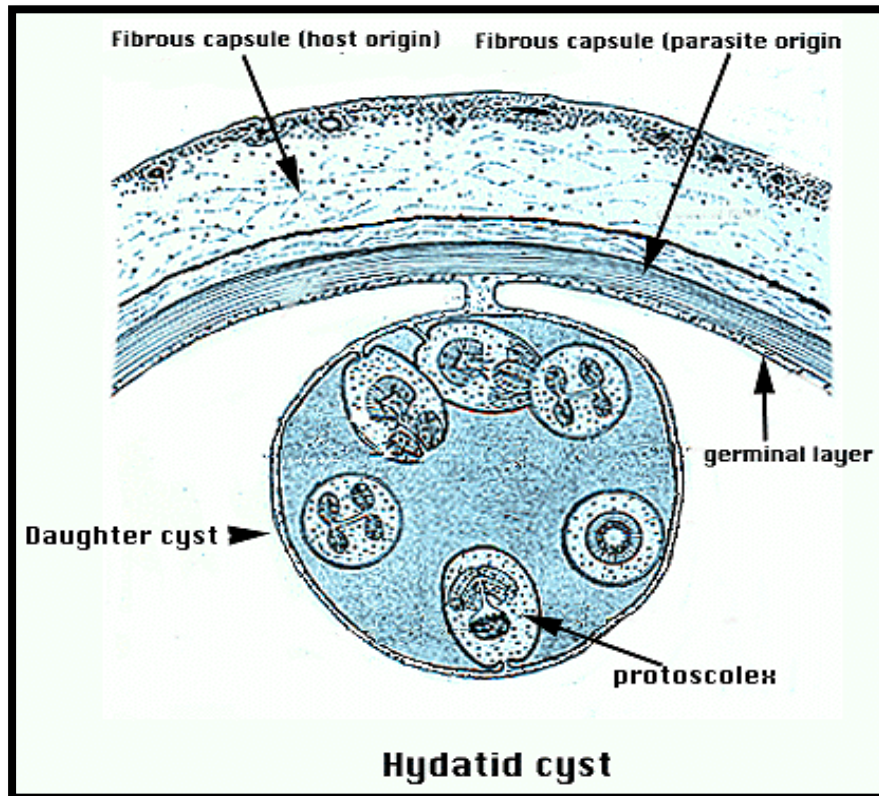
The growing cyst evokes host tissue reaction leading to the formation of a fibrous capsule around it. The cyst has a thick, opaque, white outer laminated layer measuring about 22-25 $\mu$ m in thickness, and inner germinated layer containing nucleated cells. The germinated layer is very important structure in the cyst. The fluid is clear, colorless or pale yellow with a pH about 6.7, containing salts and protein it is a good antigen which sensitizes the host (so it used as antigen for many diagnostic serological methods).



From the germinal layer a small knob-like excrescences or gemmules protrude into the lumen of the cyst. These enlarge, become vacuolated and filled with the fluid, these are called broad capsules, they are initially attached to the germinal layer by a stalk (pedicel), but later escape free in the fluid filled cyst cavity. From the inner wall of the broad capsule, the protoscolex develops, which represents the head of potential adult worm, bearing suckers and hooklets. Several thousands of protoscolices develop in the mature hydatid cyst, so that this represents an asexual reproduction of great magnitude. Many scolices float free in the cyst fluid, these together with free broad capsules are called the hydatid sand.



Inside the mature hydatid cysts , further generation of cyst may develop daughter and granddaughter cysts. The cyst grows slowly , often lurking 20 years or more to become big enough to cause clinical illness.

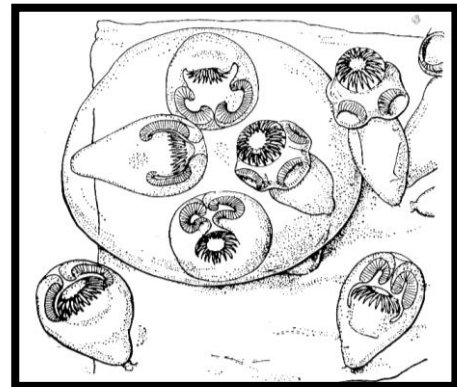


### Types of hydatid cyst :

- 1) **Unilocular hydatid cyst:** This type usually less than 5 cm in diameter, but occasionally may grow to 20 cm or more in size with about 2 liters of fluid inside it. *E. granulosus* typically forms unilocular hydatid cyst which composed of single cavity, surrounded by two layers ( laminated and germinal), inner germinal layer is considered as the region of growth, nucleated whereas the outer laminated layer is non-nucleated formed by the inner germinated layer and act as supporting mechanism for it. This type of cyst surrounded by thick fibrous capsule which secreted by host as a defense mechanism. Some of protoscolices are invaginated and the others are evaginated , the evaginated are very dangerous because when the dog ingests an infected sheep (infected organ) each evaginated scolex will develop to an adult worm. All the above was fertile hydatid cyst but there is a sterile hydatid cyst without broad capsules and without protoscolices .
- 2) **Osseous hydatid cysts:** form insides bones, because of the confinement by dense osseous tissues, its composed of germinal layer and no laminated layer

and no fibrous capsule. It grows inside the bone cavity and takes its shape. Its contain few hydatid fluid and it is sterile (i.e. no protoscolex and no broad capsule present).The common sites of the formation of this type is the upper end of the long bones, ribs and vertebra. The osseous hydatid cyst causes erosion of bone and leads to necrosis and bone fracture. So must be differentiated from osteomyelitis and T.B. and sarcoma.

**3) Alveolar hydatid cyst (multilocular hydatid cyst):** it is larval stage of *Echinococcus multilocularis*, it occurs in cold climate (Alaska, Sebria, Australia ) because the definitive host is the fox which lives in these areas.It is composed of numerous small irregular cavities or spaces which is filled with jelly like matrix and each space is separated from other by connective tissue. It is less common type of hydatid cyst and has marked connective tissue reaction and no fibrous tissue reaction.



### Formation of daughter cyst hypothesis:

1. Detachment of the fragment from germinal layer.
2. Vesiculization of the protoscolex , filled with fluid and develop to the daughter cyst.
3. Regressive change of the broad capsule and secrete outer laminated layer.

The daughter hydatid cyst may be formed either inside, these are hypothesis mention previously; or outside, this type formed as result of high cystic pressure which causes herniation or rupture of both germinated and laminated layers.

## **Rupture of hydatid cyst:**

There are different types :

1. Spontaneous rupture.
2. During coughing in case of pulmonary hydatid cyst.
3. Aspiration of fluid from the cyst for the diagnosis .
4. Surgical interference.

The rupture of hydatid cyst causes release of cyst components which leading to :

1. Allergic manifestation which may lead to urticarial rash and pruritis.
2. Fever, gastrointestinal disturbance and abdominal pain.
3. Formation of secondary hydatid cyst.
4. Severe anaphylactic shock and sudden death may result if hydatid fluid enter the blood. A sudden, life-threatening allergic reaction, characterized by dilation of blood vessels with a sharp drop in blood pressure and bronchial spasm with shortness of breath. Anaphylactic shock is caused by exposure to a foreign substance.

## **Epidemiology and risk factors:**

The disease is prevalent in most parts of the world (cosmopolitans) through it is most extensive in the sheep and cattle-raising areas in Australia, parts of Africa and south America. It is common in Europe, China and Middle East, many parts of India, it seen more often in temperate than in tropical regions.

Human infection follows ingestion of eggs passed by infected dogs this may occur by eating raw vegetable contaminated with dog feces , finger contaminated with eggs while fondling pet dogs may carry them to the mouth , kissing pet dogs may cause the eggs to be transferred directly to the mouth so the infection is acquired during childhood while the clinical disease develop after several years.

Many factors play an important role in the epidemiology of the disease :

1. The nature of life cycle:
  - When the sheep or cattle harboring the hydatid cyst die or slaughtered dogs may feed on the carcass or offal, inside the intestine of dog the scolex develops into adult worm that mature in about 6-7 weeks, this is the natural cycle of the parasite but when the infection occur in human the cycle comes to dead end .
  - Large number of stray dog are infected with parasites.

- Some local traditions.
- Man is not infected by the adult worms.
  - 2- The nature of eggs:  
Eggs are not affected by washing , chemical , or detergents they are only killed by direct sunlight , it can remain viable for several months in moist shady areas.
  - 3-the presence of different strains so preparation of vaccine is difficult .
  - 4-the occupation , the incidence of infection increase in case of butchers ,veterinarians because the direct contact with infected animals.

### **Pathogenesis of hydatid cyst:**

Host reaction : wherever the hexacanthembryo settle , it will evoke the typical cellular reaction which include infiltration of cellular components of immune system (eosinophil, lymphocyte, giant cells, plasma cells, etc.) by the action of these cells phagocytosis will take place, but some of embryos may escape from immune system and develop to hydatid cyst and gradually the cellular reaction will disappear then the fibroblast come and form the fibrous capsule surrounding the cyst.

(pre-encystment phase) and ( postencystment phase). Both cellular and humoral immunity are induced during each phase; however, neither response is sufficient to eliminate the parasite.

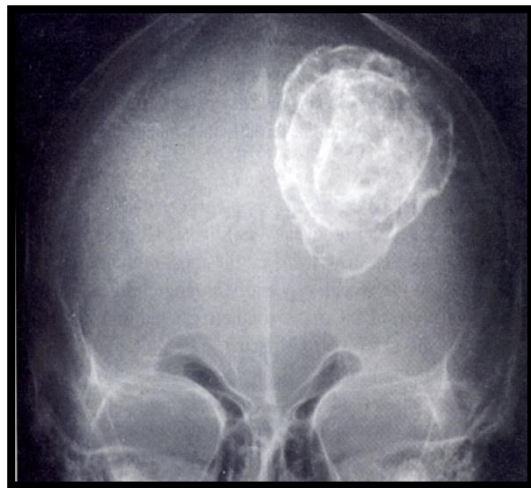
The old hydatid cyst may be sclerosed or calcified and the parasite will die due to lack of nourishment.

The clinical picture , it is depend on the local signs that appear in the host.

1. in the liver mostly in the right lobe, hepatomegaly, pain , obstructive jaundice due to the congestion of the bile duct are the usual manifestations.
2. The next common site it is the lung usually in the lower lobe of the right lung, cough , haemoptysis,chest pain , dyspnoea constitute the clinical pictures.
3. In the kidney , paranchymial tissue of the cortex, pain and haematuria.
4. In the spinal cord and brain (right and left hemisphere), headache, vomiting and epilepsy.
5. In the bone may lead to erosion, necrosis and pathological fracture.
6. Hypersensitivity to the Echinococcal antigen.

## Diagnosis:

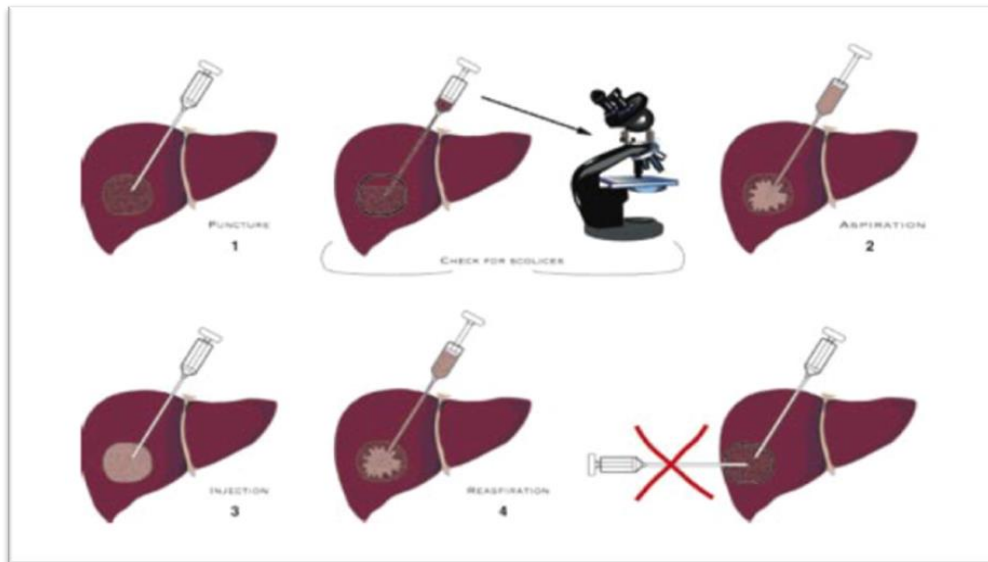
1. Clinical diagnosis: by hydatid thrill this is very indicating sign.
2. Radiological diagnosis : by x-ray examination, C.T. scan and ultrasonography reveal the diagnosis in the most cases.
3. Laboratory diagnosis: by
  - A. Direct method, by finding the protoscolices, broad capsule in the hydatid fluid by aspiration but it is dangerous and not recommended because this will lead to rupture and consequent anaphylaxis.
  - B. Indirect methods, such as Casoni's intradermal test , this done by injection of two ml of bacteriologically sterile hydatid fluid intradermally in one arm and equal volume of saline in the other arm as control.
    7. 20-30 minutes immediate reaction.
    8. 6-8 hours intermediate reaction.
    9. 24-48 hours delayed hypersensitivity reaction.
    10. False positive result due to other parasitic infection, after surgical removing the cyst and suppuration or calcification of the cyst.
  - C. Serological test: such as (Complement fixation test), Indirect haemaagglutination test), (Immunofluorescence antibody test) and (Enzyme linked immunosorbent assay), (latex agglutination test).





**Treatment:**

- ❖ Surgical removing offers the best mode of treatment .
- ❖ Drug treatment include mebendazole, albendazole and praziquantel have been used.
- ❖ **Percutaneous Aspiration, Injection, Re-aspiration( PAIR):** Percutaneous aspiration, injection, re-aspiration, a third option for the treatment of hydatid cysts in the liver and some other locations consists of:
  - (1) percutaneous puncture using sonographic guidance, (2) aspiration of substantial amounts of the liquid contents, (3) injection of a protoscolicidal agent for at least 15 minutes, and (4) re-aspiration.
 PAIR is indicated for patients who cannot undergo surgery and for those who refuse surgery who have single or multiple cysts in the liver, abdominal cavity, spleen, kidney, and bones.

**Prophylaxis:**

- Health education.
- Destruction of stray dogs.
- Washing the hands after touching the dogs and prevent some traditions in infected areas.
- Prevent the slaughtering outside the slaughter houses.

❖ *Echinococcus multilocularis*:

- Intermediate host, mice.
- Final host, fox and wolf (in the small intestine).
- Length 1.2-3.7 mm.
- Composed of 4-5 proglottids.
- Gravid segment without lateral uterine branches.
- The larval stage is alveolar hydatid cyst in human.
- Sylvatic zoonosis in Europe and northern America.
- Humans get infected by eating contaminated berries and mushrooms collected in forests populated by foxes.
- Life Cycle: (A) Adult parasite. (B) Foxes (left, red fox; right, Arctic fox) as principal definitive hosts; dogs, other canids, and cats can be involved in the cycle. (C) Proglottid with eggs. (D) Egg with oncosphere. (E) Infection of humans. (F) Rodent infected with metacestodes. (G) Rodent liver with metacestodes. (H) single metacestode cyst with protoscolexes.

