

# Parasitology

3<sup>rd</sup> Stage

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## Medical helminthology

Subkingdom metazoa

**Helminth:** means worm, any creeping things or worm-like animal. Usually refers to parasitic worm.

**Medical helminthology:** Study the worms that parasitized man, It comprises:

1. Platyhelminthes (flatworms)
  - a. Cestoidea (tapeworms or ribbon-like).
  - b. Trematoda (flukes = body with holes)
2. Nematoda (true roundworms).
3. Nematomorpha (hair snakes)
4. Acanthocephala (thorny-headed worms)
5. Annelida (Hirudinea: leeches)

### Platyhelminthes

1. Flattened dorsoventrally.
2. No body cavity.
3. No digestive system or simple, no respiratory system, no circulatory sys.
4. Simple nervous system.
5. Excretory system consist of flame cells.
6. Sex organs highly developed (hermaphrodite: contain male & female org. but asexual multiplication also occurs in larval stages)

### Cestoidea (cestodes)

1. **Segmented**
  - a. scolex (for orientation and attachment).
  - b. Neck (region of growth).
  - c. proglottids (immature, mature & gravid)
2. **Integument** (surface coat) has permeability & exchange function & protection.

## **Trematoda (trematodes)**

1. Leaf like.
2. Unsegmented.
3. Head with suckers (no hooks).
4. Need more than one host.
5. Parasitic.
6. Has simple digestive system.

## **Nematoda (nematodes)**

1. Cylindrical or spindle shaped.
2. Have cuticle (highly resistant).
3. Bilaterally symmetrical.
4. Unsegmented.
5. Has body cavity (filled with fluid).
6. Has digestive system, no resp. or circulatory system.
7. Sexes separated.
8. Has direct life cycle.

## **Notes**

1. No. of the worms not exceed No. of infective eggs & larvae that entered (no internal autoinfection but few exceptions).
2. No. of mature worms is limited to levels that are tolerable to both host and parasite.
3. Most infections are asymptomatic carriers.
4. But those with heaviest worm burdens have symptoms & signs (light, moderate & heavy applied to worm burdens).
5. No. of eggs or larvae (which varies from spp. to spp.) in feces or urine or other sites is proportional to No. of worms.
6. No. of worms & size not always correlated with symptoms & signs.
7. Persistent hypereosinophilia is most widely recognized general sign of a helminthic infections.
8. Helminthic infections frequently are occult or cryptic either because they are prepatent or nonpatent.

## Cestodes or tapeworm infections

### Class Cyclophyllidea and class Pseudophyllidea

#### Larval type of cestodes

1. **Proceroid:** Solid, elongated or oval, body with caudal appendages (centromere).
2. **Plerocercoid:** Solid elongated worm —like larva with head (scolex) invaginated onto the neck e.g. *D. latum*.
3. **Cysticercus:** Bladder like structure (bladder worm). It is fluid filled vesicle with single scolex invaginated in to the bladder. (e.g. *Taenia saginata*).
4. **Cysticercoid:** Has two portions with one scolex invaginated in anterior portion. It is small solid larva (e.g. *Hymenolepis nana*).
5. **Coenurus:** Fluid filled bladder like larva with multiple invaginated scolices (e.g. *Taenia multiceps*).
6. **Hydatid:** Large bladder filled with fluid and contain multiple scolices (protoscolices), brood capsule and daughter cyst contain many scolices inside. (e.g. *Echinococcus granulosus*).

#### Cestodes

##### Adult tapeworm infections

**Human tapeworms:** *T. saginata*; *T. solium*; *H. nana*; *D. latum*

**Non-human cestodes:** *D. caninum* & *H. diminuta*

#### *Taenia saginata* (Beef tapeworm)

- ❖ Taeniasis saginata or beef tapeworm infection
- ❖ Adult: 5-12 m. long, has 4 suckers, no hooks, 1000-2000 proglottids
- ❖ mature prog. has one set of male & female reproductive systems, genital opening mid-lateral in position
- ❖ gravid prog. has 15-20 main lateral uterine branches, single gravid prog. expel and crawl out of anus.

## Pathogenesis & symptomatology

- One worm per host.
- No & mild symptoms e.g.: Diarrhea, abdominal pain, hunger pain, loss of weigh, neural disorder, rarely pruritus ani. Most common complaint is discomfort & embarrassment caused by proglottids
- crawling from anus (during the active time).
- Rarely: acute intestinal obstruction, appendicitis and hypereosinophilia.

## Diagnosis

- ✓ Recovery of egg in stool examination.
- ✓ Recovery of egg in perianal fold by Scotch tape technique (adhesive cellophane).
- ✓ Identification of gravid prog. in feces, skin, under garments by injection of the uterine branches with India ink & pressing between two slides (15-20 main uterine lateral branches).
- ✓ The egg has hexacanth embryo with thin transparent outer envelope and thick brown striated inner shell.

## Control

- ✚ Treatment.
- ✚ Sanitary disposal of human feces.
- ✚ Inspection of beef for *C. bovis*.
- ✚ Refrigeration of beef (-20 centi. for 12-24 hr. Kill the larvae).
- ✚ Thorough cooking (66 centi. Lethal for larvae).
- ✚ Prevention of cattle from grazing on contaminated pasture with human feces.

## Treatment

Praziquantel, niclosamide

## Epidemiology

worldwide distribution.

## *Taenia solium* (Pork tapeworm)

- ☒ (Taeniasis solium or pork tapeworm infection)
- ☒ Armed scolex with double rows of hooks. 1000 prog.
- ☒ 2-7 meters long, gravid prog. with 7-13 main lateral uterine branches.
- ☒ Infection usually single.
- ☒ Adult infection cause same clinical manifestations as in *T. saginata*
- ☒ Diagnosis, treatment and control as in *T. saginata*.

### Epidemiology

Found in many parts of the world where raw or poorly cooked pork is eaten.

### Notes

1. Specimens (proglottids) should be handled with extreme care because of the possible danger of ingestion and cysticercosis if proglottid is of *T. solium*.
2. The eggs look identical to those of *T. saginata* so identification to species level cannot be performed with egg alone.
3. Any patient with *Taenia* eggs should be cautioned to use good hygiene. These patients should be treated as soon as possible to avoid the potential danger of accidental infection with eggs and cysticercosis (if these patients infected with *T. solium*).

## *Hymenolepis nana* (Dwarf tapeworm)

Hymenolepiasis nana or dwarf tapeworm infection

- ☆ Most common tapeworm throughout the world.
- ☆ Smallest tapeworm of man.
- ☆ Most commonly seen in children.
- ☆ Has direct & indirect life cycle.
- ☆ Man act as definitive and intermediate host.
- ☆ Autoinfection usually occur.
- ☆ Immunosuppression cause disseminated infection.
- ☆ In closer communities and constitutions, large number of people get affected.
- ☆ Person to person transmission.

## **Morphology and life cycle**

- ❖ 2.5 cm. long by 1 mm wide, scolex with 4 suckers & rostellum crown of hooklets.
- ❖ 200 segments (broader than long). Terminal proglottids usually disintegrated before separating from strobila.

## **Symptoms & signs**

no or: Anorexia, abdominal pain, diarrhea, urticaria, dizziness, weight loss, epileptoid convulsions.

## **Pathology**

Due to mechanical irritation & metabolic products which responsible for allergic manifestation.

## **Diagnosis**

Recovery & identification of egg in stool examination. The egg is oval or round with a thin shell, has six-hooked oncosphere (embryo of tapeworm), this embryo has two polar thickening from which arise polar filaments that lie between the oncosphere & the shell. The eggs are infectious and unpreserved stools should be handled with caution.

## **Treatment**

as in other tapeworms.

## **Epidemiology**

- Worldwide distribution. *H. nana* is the only human tapeworm in which the intermediate host is not necessary & transmission is from person to person.
- Infection from rats & mice is always a possibility, as is the accidental ingestion of infective insect intermediate host (containing cysticercoid)

## Control

- ✓ Good personal hygiene.
- ✓ Treatment & mass treatment.
- ✓ Good sanitation.
- ✓ Proper water supply and proper washing of green vegetable.

### *Diphyllobothrium latum* (fish tapeworm)

Diphyllobothriasis or fish tapeworm infection

### Pseudophyllidean tapeworm

- ✚ 10 meters or long, 4000 segments, scolex elongated & spoon-shaped with two long sucking grooves (bothria).
- ✚ Mature & gravid segments much wider than long. Uterus in the middle of segment, rosette in shape.
- ✚ Both egg & chain of segment (0.5 meter) found in stool.
- ✚ Eggs continuously discharged through uterine pore.
- ✚ Egg operculated & unembryonated.
- ✚ Genital pore in the ventral surface of the segment

## Pathogenesis & symptomatology

Depend on

- ☒ Number of worm,
- ☒ Amount and type of by-product of worm,
- ☒ Patient's reaction to by-product
- ☒ absorption of metabolites by the worm.

There may be intestinal obstruction, diarrhea, abdominal pain.

Vitamin B12 deficiency which resembles pernicious anemia (in Finland) due to failure to assimilate of vitamin B12 by the host and or absorption of large amount of vit. B12 by the worm.

## Diagnosis

Recovery and identification of egg and gravid segment in stool examination.

## Epidemiology

Infection by ingestion of raw or undercooked infected freshwater fish. not recorded in Iraq.

## Control

Thorough cooking or freezing for 24-48 hr. of all freshwater fish.

### Non-human cestodes infections

#### *Hymenolepis diminuta* (Rat tapeworm)

##### Rat tapeworm infection

- ☆ Man accidentally infected.
- ☆ 20-60 cm. long.
- ☆ Scolex with 4 suckers, no hooks, 1000 segments.
- ☆ Egg with two membranes and has hexacanth embryo with two polar thickening but without polar filaments, mature & gravid segments broader than long.

#### *Dipylidium caninum* (Dog tapeworm)

- ❖ Man accidentally infected
- ❖ single infection (one worm per host)
- ❖ adult 10-70 cm. long,
- ❖ scolex with 4 suckers and armed rostellum.
- ❖ Mature segment with two sets of male and female sex organs. Single segments look like cucumber seeds when moist and like rice grains when dry.
- ❖ Gravid proglottids contain egg capsules (1-20 eggs each).
- ❖ Stool may contain egg capsule or gravid segment.
- ❖ Gravid segment may actively migrate out of anus.

## Diagnosis

Recovery & identification of egg capsules or proglotiids in stool examination.



## Epidemiology

Most human cases in children, (children more likely to accidentally swallow infected fleas). Periodic treatment of dog and cat and use of flea powder reduce infection in man

## Larval tapeworm infection in man

1. Hydatid cyst of *Echinococcus granulosus*.
2. Alveolar hydatid cyst of *E. multilocularis*.
3. *Cysticercus cellulosae* of *Taenia solium*.
4. *Sparganum* (plerocercoid) of *Spirometra* spp.
5. *Coenurus* of *Multiceps* tapeworm.

### Hydatid cyst (larval stage of *E. granulosus*)

#### Hydatid disease, Echinococcosis

Adult 3-6 mm. long, has armed scolex, 3-4 segments only.

It is tapeworm of dog (D.H) and the hydatid cyst (larval stage) in man & herbivorous animals (intermediate host).

1. Unilocular hydatid cyst.
2. Osseous hydatid cyst.

## Morphology of unilocular H.C.

- Embryo in blood → tissue (liver, lung...) → spheroid bud → cyst with fluid → 5 months later → reach 1 cm.
- the wall consist of
  1. Outer non nucleated laminated layer.
  2. Inner nucleated germinal layer.
  3. Fibrous layer from the host.
- **The cyst contain**
  1. Brood capsules which contain 5-20 invaginated protoscolices each.
  2. Hydatid sand (detached brood capsules, protoscolices & free hooks which lie free in cyst fluid).
  3. Daughter cyst (has the same structure of the mother cyst but without fibrous layer).
  4. Hydatid fluid.

- **Sterile cyst:** has no brood capsule or protoscolices.
- **Fertile cyst:** has brood capsule and protoscolices (infective to dog).
- The cyst develop very slowly and may require 5-20 years to be diagnosed and may reach 20 cm. in diameter and may contain 2 liters of fluid.

### **Morphology of osseous hydatid cyst**

The embryo filtered into bony tissues → develop to cyst but without laminated layer, It migrate along bony canal as protoplasmic stream → erode the bone → multiple fracture & crumbling of bony structures.

### **Pathogenesis of unilocular Hydatid disease**

1. Mechanical damage due to pressure (depend on size & location). → interfere with **organ function**. There is usual inflammatory & fibrous tissue reaction around cyst.

Examples of organ dysfunctions are:

1. Biliary obstruction
  2. Cirrhosis
  3. Bronchial obstruction
  4. Renal outflow obstruction
  5. Increased intracranial pressure secondary to mass
  6. Hydrocephalus secondary to cerebrospinal fluid outflow obstruction.
2. Small fluid leaks continuously into blood → sensitization → when cyst rupture → large amount of fluid leaks → serious allergic reaction (anaphylactic shock) → death.
  3. Release of cyst tissues will cause:
    - abscess formation.
    - emboli.
    - development of additional cyst at secondary sites.
  4. Eosinophilia.

## Symptoms and signs

- ✓ may remain asymptomatic even in advanced age.
- ✓ S & S depend on number, site and size of the cyst
- ✓ S & S produce by mass effect or cyst complications.
- ✓ Mass effect takes along time to manifest except in brain or eyes.
- ✓ Symptomatic cyst → larger than 5 cm.
- ✓ Cyst may develop in liver 63%, lungs 25%, muscles 5%, bones 3%, kidneys 2%, brain 1%, and spleen 1%.
- ✓ **In liver**
  - pressure effect → produce symptoms of obstructive jaundice and abdominal pain.
  - Biliary rupture → biliary colic, jaundice and urticaria.
  - Hydatid emesia (passage of hydatid memb. in the emesis.)
  - Hydatid enterica (passage of hydatid memb. in the stool.)
  - Hepatomegaly or mass may be felt.
  - Tender hepatomegaly when cyst infected.
  - Splenomegaly due to hypertension or cyst in spleen.
  - Hypertention due to biliary cirrhosis or obstruction of inferior vena cava.
- ✓ **In lung**

Chronic cough, dyspnea, pleuritic chest pain, hemoptysis. expectoration of cyst memb. and fluid when cyst rupture into bronchus.
- ✓ **In brain**

Headache, dizziness, decreased level of consciousness and other neurologic deficits (depend on location).

## Complications

- ✚ Due to infection of the cyst or leakage of the cyst
- ✚ Minor leaks → increased pain and mild allergic reaction (flushing and urticaria).
- ✚ Major rupture → full-blown anaphylactic reaction → fatal.
- ✚ Rupture into biliary tree → obstruction by daughter cyst → cholangitis
- ✚ Rupture into bronchi → expectoration of cyst fluid.
- ✚ Release of cyst tissues lead to:
  1. abscess formation.
  2. emboli.
  3. development of additional cysts at secondary sites.

## Infection of cyst

Range from mild fever to full-blown sepsis.

## Bone and Muscle cyst

- ☒ Extremity pain with or without neurologic deficit palpable mass (in muscle involvement).
- ☒ Osseous hydatid cyst cause erosion of bone, multiple fracture and crumbling of bony structure.
- ☒ Death due to:
  1. Anaphylaxis
  2. Systemic complications of the cyst (e.g. sepsis, cirrhosis, respiratory failure.)
  3. Operative complications.

## Diagnosis

### A. Lab. Diagnosis

1. Increased level of bilirubin or alkaline phosphatase.
2. leukocytosis (if cyst infected).
3. eosinophilia (25% of persons).
4. hypogammaglobinemia (30%)
5. Serological tests:
  - a. ELISA
  - b. Indirect hemagglutination test
  - c. Immunodiffusion an immunoelectrophoresis.
6. Casoni test (Intradermal skin test).

### B. Imaging studies

1. plain films.
2. ultrasound
3. CT scan. (is the best test for the differentiation of the hydatid from amebic or pyogenic cysts in liver.)
4. MRI

## Treatment

1. chemotherapy: Albendazole or mebendazole 3-6 months.
2. surgical

## Control

Because human infection with *Echinococcus* results from fecal (of dog) – oral (man) contamination, prevention requires the following steps:

1. Education on proper hygiene
2. Proper cleaning of uncooked food and avoidance when possible
3. Dietary regulation of pet dogs (stop the habit of feeding viscera of intermediate hosts, such as sheep, to pet dogs)
4. Regulate pet dog activity to prevent ingestion of sheep material
5. Avoidance of unregulated dogs
6. Treatment of pet dogs in endemic areas for intestinal echinococcosis with praziquantel
7. Control of the dog population (killing)
8. Regulation of livestock butchering ( proper disposal of infected organs of slaughtered animals)

## Fate of hydatid cyst:

1. Spontaneous cure.
2. May die off and fluid is absorbed.
3. It may get calcified following injury to its wall.
4. Spontaneous evacuation following inflammatory changes
5. Liver cyst may rupture into pleural cavity or lung..
6. May rupture in body cavity giving rise to wide spread growth of hydatid cysts.

## Epidemiology

- ☆ Dogs and other canidas are the def. H., sheep is the most common int. H.
- ☆ Sheep, cattle, camel, swine, other herbivores and human serve as intermediate hosts.
- ☆ Most prevalent in sheep-raising areas.
- ☆ Transmission to humans may occur whenever infected dogs live in close proximity to them.
- ☆ Exposure commonly occurs in childhood, particularly among boys who play with infected dogs.

## Alveolar hydatid cyst of *Echinococcus multilocularis*

### Alveolar hydatid disease

- ❖ Definitive hosts are wild canine and dog, wild mice and man and herbivorous mammals are inter. h.
- ❖ Liver is most common site in man. The cyst develops minute irregular cavities within a hyaline memb. without fibrous capsule, grow as exogenous budding resemble carcinoma lead to distraction of the tissue.
- ❖ Man acquires infection by eating raw fruits and vegetables picked off the ground and contaminated with feces of foxes and other canidae infected with *E. multilocularis*.
- ❖ The cyst in man is sterile.

## *Cysticercus cellulosae* of *Taenia solium*

Cause human cysticercosis.

### Mode of infections

1. Ingestion of eggs of *T. solium* in contaminated food and water.
  2. Internal autoinfection (eggs hatch in small intestine in patient infected with adult T.s.
  3. External autoinfection. the eggs of T.s. contaminate the hands of patient then ingested.
- 
- The larvae may develop in brain, eye (ocular cysticercosis), subcutaneous tissue, muscle, liver, heart lungs,.
  - Cysticerci have been recovered from all over the body.
  - Neurocysticercosis is the development of *T. solium* cysts in the brain. When the larvae are in the brain, symptoms can result from the actual larval invasion or the death of the organism. In either case, the tissue surrounding the larvae becomes stimulated and can cause seizures, behavioral disturbances, obstructive hydrocephalus, and a host reaction to the dying cysts that is like symptoms of meningitis.
  - Neurocysticercosis is the most frequent cause of adult-onset epilepsy in the world.
  - Cysts in the spinal cord can cause gait disturbances, pain, and transverse myelitis.

- Subcutaneous cysts can produce visible palpable nodules and calcified cysts.
- Skeletal muscle encystments is usually asymptomatic but can lead to heavy parasitic burden with muscular pseudohypertrophy.
- Ocular involvement can cause visual impairment and even blindness,
- Cardiac cysts may cause abnormal conduction of heart nerves.

## Diagnosis

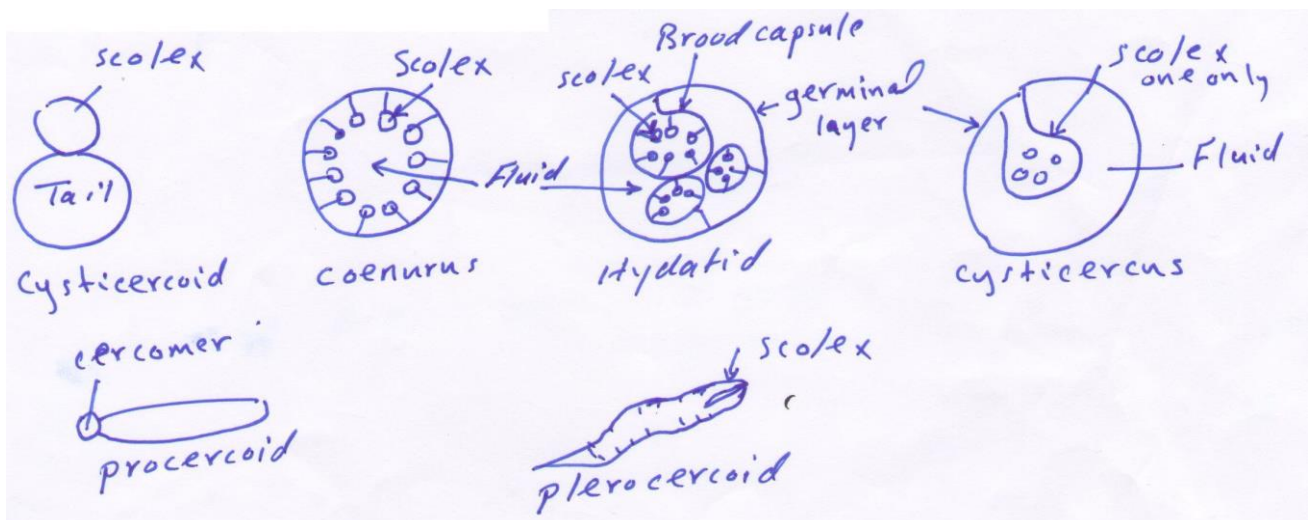
- ✓ The most effective means of diagnosis is the CT scan or MRI for neurocysticercosis.
- ✓ Serology testing
- ✓ Demonstration of larva in biopsy samples.
- ✓ Detection of eggs and proglottides on stool samples. Study of the proglottid or head of the tapeworms are require for species identification.

## Some Treatment/Therapy

- ✚ Neurocysticercosis treatment is based on whether the cysts are viable or not. MRI and CT scans are able to show this.
- ✚ For patients with non-viable cysts (shows calcification only on CT scans), anticonvulsants are given and treated on a symptom by symptom basis.
- ✚ Antiparasitic treatment will be deferred until the cerebral edema is controlled.
- ✚ Ocular cysticercosis is treated by surgical excision of the cyst.
- ✚ Two drugs: praziquantel and albendazole are effective against cysticerci.

## Tape worm (Cestode)

	pseudophyllidea	cyclophyllidea
<b>Egg</b>	Unembryonated, operculated Discharged from uterine pore	Embryonated, no operculum Discharged after disintegration of proglottids.
<b>scolex</b>	Spatulate with two sucking grooves (Bothria)	Globular with a cup-shaped sucker, may be armed
<b>oncosphere</b>	Ciliated (coracidium)	Not ciliated, has 6 hooks
<b>uterus</b>	In the middle, coiled or rose in shape, open by uterine pore in middle line of ventral surface	Sac-like or branched or contain egg capsule. Blind (no uterine pore)
<b>Genital pore</b>	In the ventral surface	In the margin(s) of segment
<b>Gravid segment</b>	Contain all reproductive organs	Only uterus filled with eggs
<b>Larval stage</b>	Two (proceroid and plerocercoid) in the life cycle	Only one (either cysticercus, or cysticercoid, or hydatid cyst, or coenurus)
<b>Life cycle</b>	Requires two intermediate hosts	One intermediate host
<b>e.g.</b>	<i>Diphyllobothrium latum</i>	<i>Taenia saginata</i> , <i>T. solium</i> , <i>Hymenolepis nann</i> , <i>H. diminuta</i>





Cysticercus in brain (neurocysticercosis) represent the most frequent parasitic infections of human C.N.S.

The larvae may remain viable up to 4-5 years.

### **Control**

1. treatment of adult (T.s) infections.
2. Sanitary disposal of human feces.
3. Personal hygiene.

### **Treatment**

Albendazole, praziquantel, surgical.

*Coenurus* of canine *Taenia* (*T. multiceps*, *T. brauni*, *T. serialis*)

Cause Coenurosis.

D. hosts are dogs and their relatives and the larvae (Coenurus) occurs in animals preyed upon by them and man.

Sparganum (plerocercoid) of *Spirometra* tapeworms

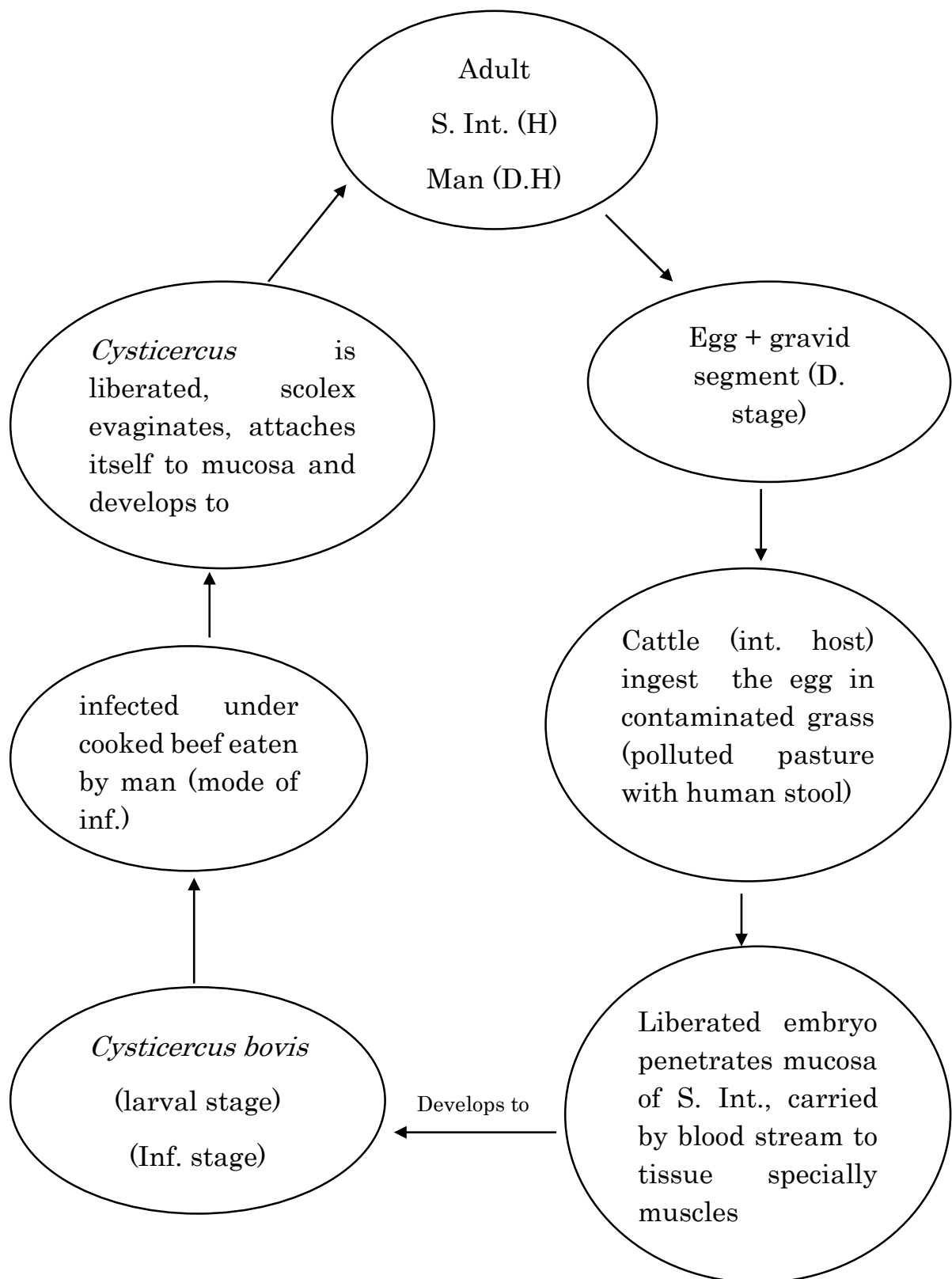
D. Hosts: canine and feline. the int. hosts are fish, frogs, snakes, birds, pigs, mammals, man.

Life cycle as in *D. latum*

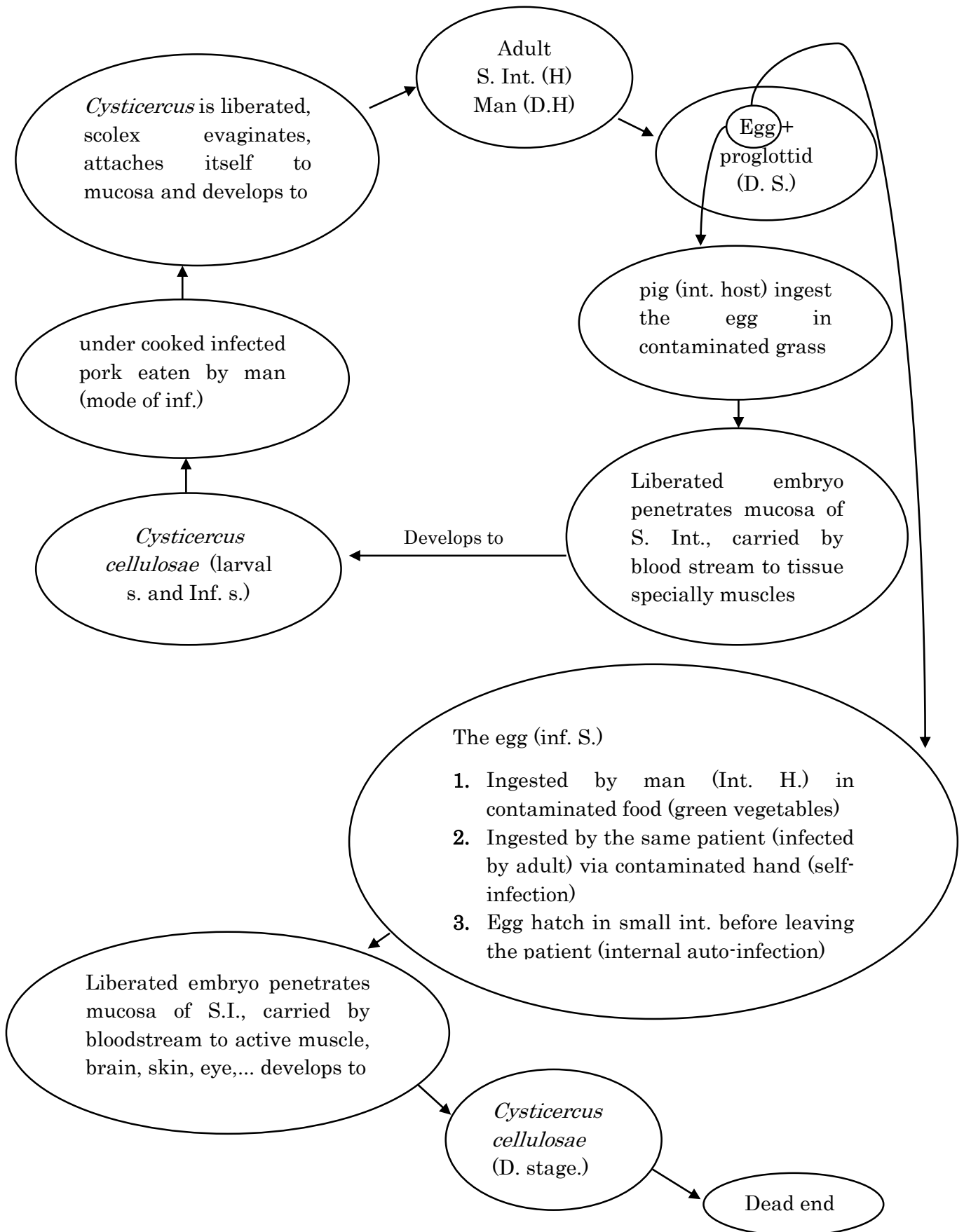
### **Mode of infections**

1. Ingestion of proceroid in a copepod or plerocercoid in a second int. host.
2. Applying plerocercoid-infected flesh of frogs, snakes as a poultice on an inflamed eye or finger.

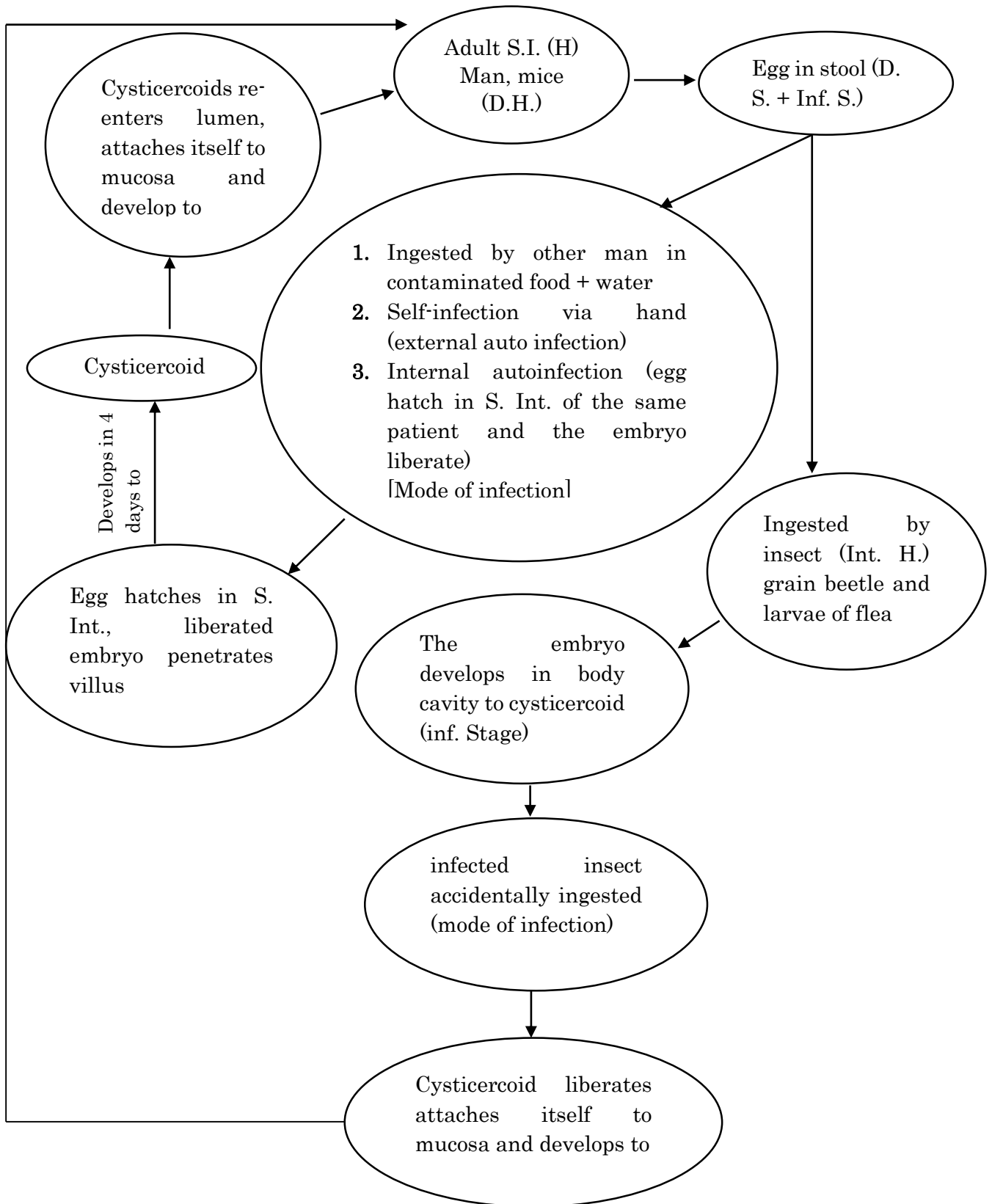
*Taenia saginata* (beef tapeworm)



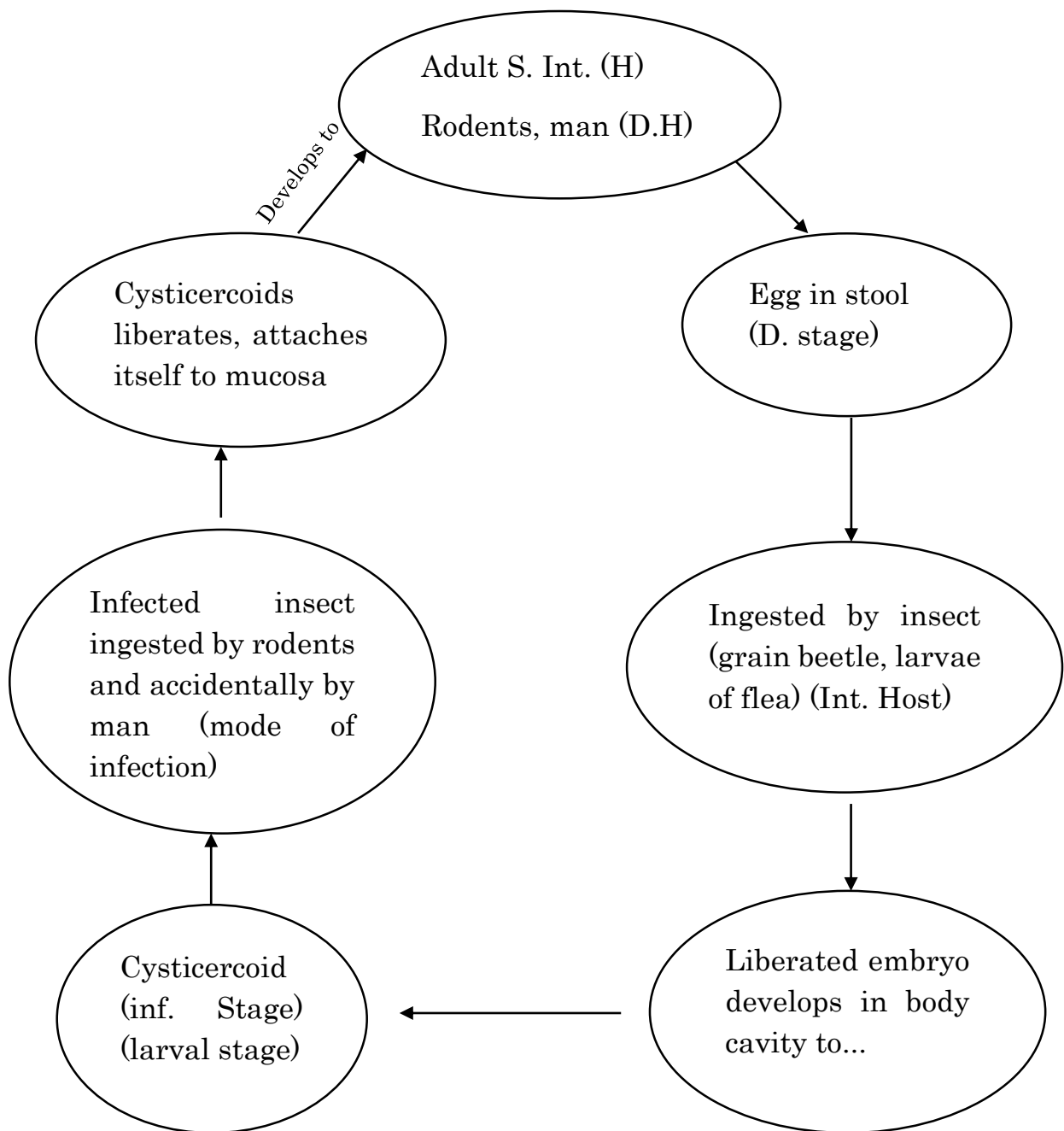
## *Taenia solium* (pork tapeworm)



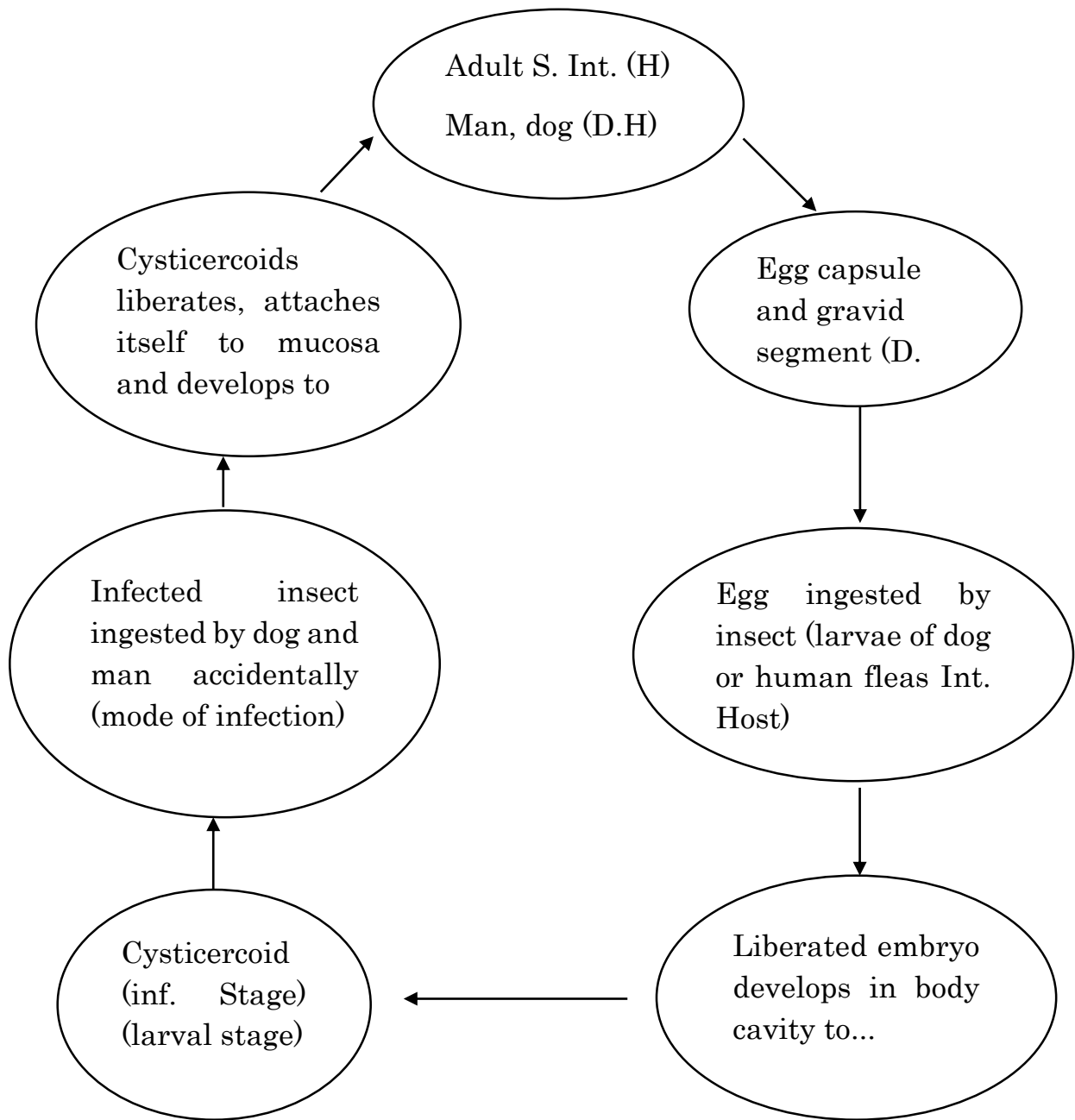
*Hymenolepis nana* (dwarf tapeworm)



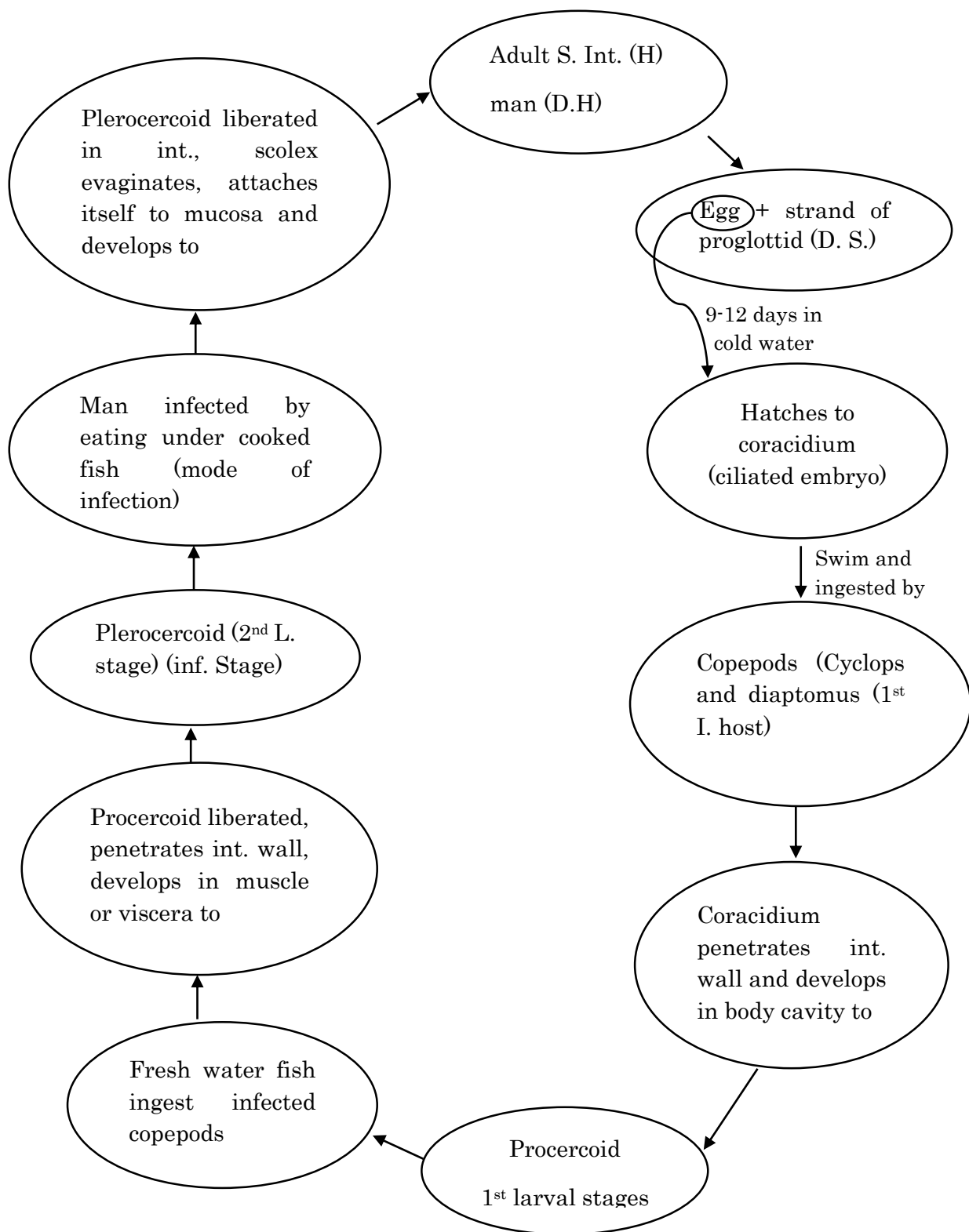
*Hymenolepis diminuta* (Rat tapeworm)



*Dipylidium caninum* (Dog tapeworm)



*Dipyllobothrium latum* (fish tapeworm)



*Echinococcus granulosus*

