

Class: Cestoda (Tapeworms)

General characters:

- Adults are flat, ribbon like and segmented, their length varies from few millimetres to several meters.
- The body is divided into scolex, neck and several proglottids or segments.
- The **scolex** is provided with organs for attachment.
- The **neck** is the region of growth.
- The **proglottids strobila or segments** are differentiated into immature, mature and gravid segments (according to the degree of maturity of the genital organs).
- They have neither a body cavity nor an alimentary tract. Nutrients are absorbed through their cuticle or integument which has also a protective function by secreting substances that inactivate the host digestive enzymes.
- Each mature segment is hermaphrodite having male and female genital systems.

-Reproductive system:

The **male genital organs** consist of multiple scattered testes except *Hymenolepis* where only three testes are found in each segment.

The **female genital organs** consist of a single bilobed ovary with an oviduct which unites with the common vitelline duct at the ootype.

- Reproduction is by self fertilization in the same segment or by cross fertilization between different segments.

-Excretory system: this is like that of trematodes, with flame cells and collecting tubules.

-Nervous system: in the scolex, there are nerve ganglia connected with commissures.

*Class Cestoda is divided into:

1 - Order Pseudophyllidea

e.g. *Diphyllobothrium latum* and *Diphyllobothrium mansoni*.

2- Order Cyclophyllidea

e.g. *Taenia solium*, *Taenia saginata*, *Hymenolepis nana*, *Hymenolepis diminuta*, *Dipylidium caninum* and *Echinococcus granulosus*.

Life cycle of cestodes:

Adults are parasites of the small intestine of man or animals. They usually require one or two intermediate hosts with the exception of *Hymenolepis nana* which has one host only acting as both intermediate and definitive. Gravid segments or eggs of cestodes are passed in the faeces of their definitive hosts.

Order: Pseudophyllidea
Diphyllobothrium latum
(The broad fish tapeworm)

Geographical distribution: lake regions in Europe, Baltic countries, some foci in America and Russia.

Morphology:

1-Adult: -Size: 3-10 meters, 3000 segments.

-Scolex: elongated almond-shaped, 2.5x1 mm, with 2 elongated dorsal and ventral grooves (bothria).

-Mature segments: broader than long (3x15 mm) and are hermaphrodite.

- Male system: comprises numerous testes distributed in the dorsal part of the segment.

- Female system: comprises a bilobed ovary lying posteriorly in the segment.

-No gravid segments due to the presence of separate uterine pore.

2-Egg:

Size: 80 x 40 μ.

Shape: oval, operculated with thick-shell.

Colour: yellowish-brown.

Contents: immature ovum.

3-Coracidium: spherical six-hooked embryo (onchosphere) enclosed in a ciliated embryophore.

4-Procercoid: solid elongated organism about 0.5 mm, with a spherical caudal end having 6 hooks.

5-Plerocercoid: solid elongated organism about 1-2 cm, with invaginated anterior end. The body is striated but not segmented.

Life cycle:

Habitat	adult worms live in the small intestine of definitive and reservoir hosts, attached to the mucosa by bothria
Definitive host	Man
Reservoir hosts	dogs, cats, bears, pigs, fox, sea lion and fish eating animals
Intermediate hosts	1st I.H.: <i>Cyclops</i> . 2nd I.H.: fresh water fish e.g. salmon, trout.
Infective stage	plerocercoid larva (sparganum) in salmon or trout

-Stages in the life cycle: eggs → coracidium → proceroid larva → plerocercoid larva in I. H. → adult in D. H. and R.H.

-Immature eggs (laid in the intestine of definitive and reservoir hosts), pass in faeces (a full worm lays about one million eggs daily).

-In fresh water, the embryo (coracidium) develops in about 2 weeks, hatches and swims in water.

-The coracidium is swallowed by the first intermediate host (*Cyclops*), loses its ciliated embryophore and penetrates the intestinal wall reaching its the body cavity to become a proceroid larva in about 2 weeks.

-When the infected *Cyclops* is swallowed by the second intermediate host; fresh water fish (salmon, trout), the proceroid larva liberated, penetrates the intestinal wall reaching different tissues and muscles where it becomes a plerocercoid larva (sparganum) in about 2 weeks.

Mode of infection: ingestion of undercooked or smoked fish containing the plerocercoid larva. This attaches to the intestinal wall and grows to maturity within 6 weeks and laying eggs.

Pathogenicity and clinical picture:

1. Intestinal disturbances as hunger pain, dyspepsia, colic and diarrhea.
2. Intestinal obstruction by large number of worms.
3. Worms attached high in the duodenum or jejunum lead to **pernicious macrocytic anaemia** due to competition with the host and absorption of vitamin B12, also due to toxins secreted by the parasite.
4. Neurological manifestations due to absorption of toxic secretions or by-products of the degenerating segments.

Diagnosis: 1. By finding characteristic immature eggs in stool.

2. Blood picture for anaemia.

Treatment:

1. Niclosamide (Yomesan).
2. Atebrine (Quinacrine hydrochloride).
3. Mebendazole (Vermox).
4. Praziquantel (Biltricide, Distocide).
5. Paromomycin (Humatin).
6. If macrocytic anaemia occurs, vitamin B12 should be given parenterally.

Prevention and control:

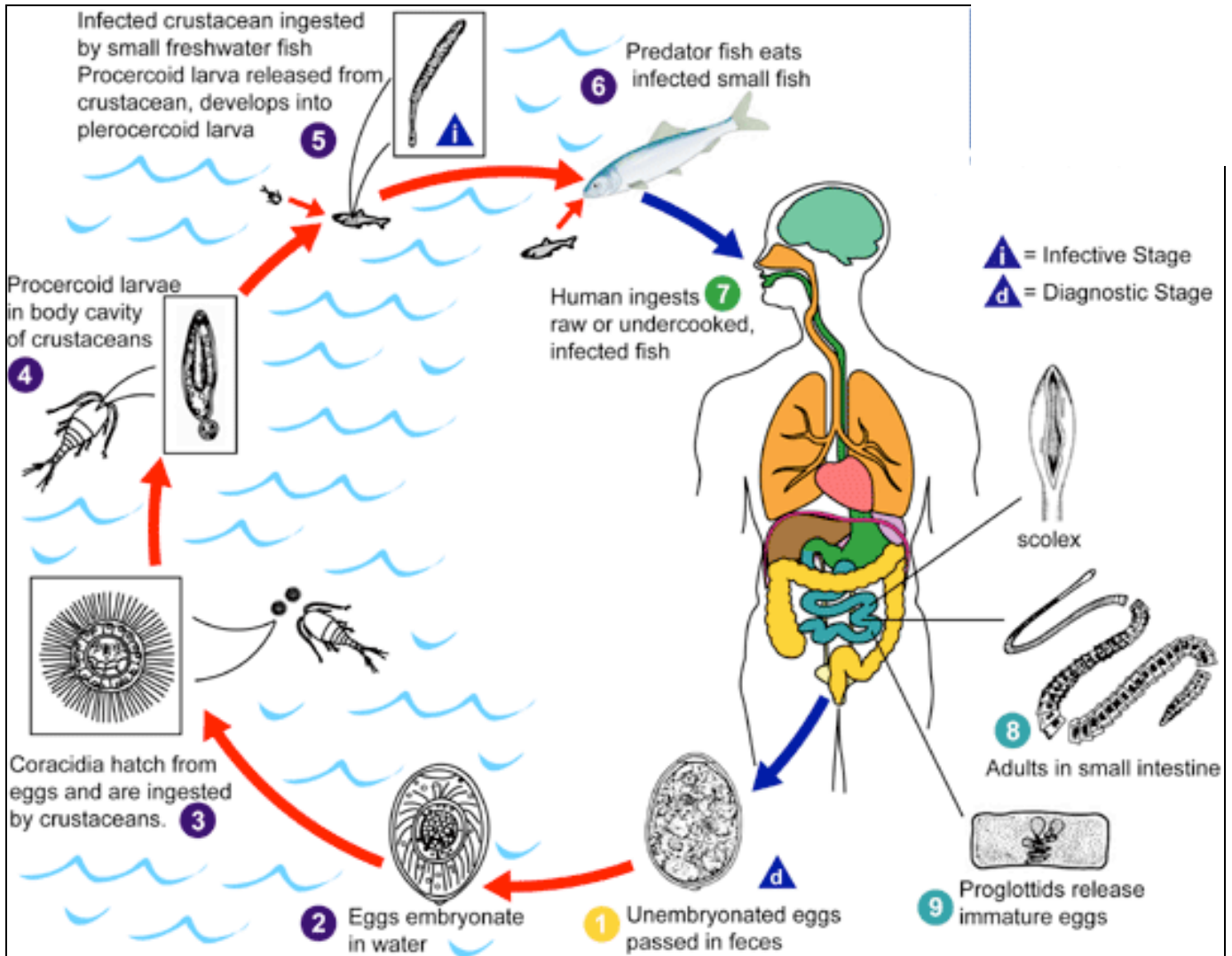
1. Proper cooking of fish (at 56°C for 5 minutes), freezing at -18°C for 72 hours or

prolonged salting.

2. Treatment of patients.

3. Periodic deworming of reservoir hosts (dogs, cats).

4. Abstinance from defecation or sewage disposal in water.



Life cycle of *Diphyllobothrium latum*

Main differences between Cyclophyllidea & Pseudophyllidea.

	Cyclophyllidea	Pseudophyllidea
Scolex:	Globular	Elongated
- Organs of attachment	Suckers	Bothria (grooves) No suckers
- Hooks	May be present	Absent (unarmed scolex)
Mature segment:		
- Genital opening	On the lateral side	On the ventral surface
- Uterus:	Blind (No uterine pore)	Uterine pore on the ventral surface.
- Vitelline glands:	In mass	Dispersed in the segment
Gravid segment:	Present	Absent
Eggs:	- Non operculated - Mature containing onchosphere	- Operculated - Fertilized & immature
Intermediate hosts	- One I.H.	- Two I.H.
Larval stages: One of the following:	-Cysticercus - Cysticercoid -Hydatid cyst -Coenurus cyst	-Proceroid - Plerocercoid

Diphyllobothrium mansonii (*Spirometra mansonii*)

Geographical distribution: mostly in the Far East, East Africa and U.S.A.

Life cycle:

-Habitat: adult worms live in the small intestine.

-Definitive host: dogs, cats.

-Intermediate hosts: 1st I.H.: *Cyclops*.

2nd I.H.: frogs, snakes, birds, lizards, birds and also man.

Human sparganosis

Infection of human tissues by the plerocercoid larva of *Diphyllbothrium mansonii* (*Sparganum mansonii*), or another plerocercoid larva (*Sparganum proliferum*).

Types of spargana:

1. ***Sparganum mansonii***: plerocercoid larva of *D. mansonii* is elongated solid larva, few mms to several cm in length with invaginated scolex at one end.
2. ***Sparganum proliferum***: plerocercoid larva of *D. proliferum* which multiplies and proliferates by producing lateral branches that separate forming new larvae, thus greatly increases in number and may be disseminated to other tissues.

Method of human infection:

1. Swallowing *Cyclops* (in water) containing the proceroid larva.
2. Eating raw or undercooked flesh of the second intermediate host containing the plerocercoid larva.
3. Applying infected flesh of such animals as a foment or poultice to wounds or inflamed tissues specially the eye, the sparganum migrates to the tissues.

Pathogenicity:

- 1- Subcutaneous Sparganosis: cyst like, itchy, migratory swellings about 2 cm. It is slowly growing, may or may be not tender. Peripheral eosinophilia may be present.
- 2- Ocular sparganosis : irritation, oedema of eye lids, lacrimation, sub-conjunctival nodules, and retrobulbar larvae may lead to exophthalmoses and corneal ulcer with intensive pain (painful oedematous conjunctivitis).
- 3- Budding and splitting of ***Sparganum proliferum*** results in thousands of plerocercoid with honey-combed appearance of the infected organ.
- 4- Patient may suffer from urticaria, oedema, fever, pain and eosinophilia.
- 5- Death of the larva causes intense local reaction.

Diagnosis: -It is made after surgical removal of nodules and finding the larva.
-Serodiagnosis.

Treatment:

1. Surgical removal of the nodule.
2. In ocular sparganosis: injection of 2- 4 ml of 40% ethyl alcohol with procaine, to kill larva in situ.

Prevention and control:

- In endemic areas water is boiled or filtered.
- Thorough cooking of the flesh of suspected intermediate hosts.
- Avoid using the flesh of intermediate hosts as poultices.

Order: Cyclophyllidea

Taenia saginata (Beef tapeworm)

Geographical distribution: Cosmopolitan.

Morphology:

1-Adult:

- Size: 10 meters, 2000 segments.
- Scolex: globular, 2 mm in diameter, with 4 suckers without rostellum or hooks.
 - Mature segments: squarish or slightly broader than long (about 1 x 1 cm) containing irregularly alternating lateral genital pores.
 - Male system: numerous testes (300).
 - Female system: bilobed ovary lying posteriorly in the segment with a compact vitelline gland behind it.
- Gravid segments: longer than broad (about 20x7mm) with the uterus having 15-20 lateral branches on each side.

2-Egg:

Size	30-40 μ
Shape	spheroid.
Shell	thick radially striated embryophore
Colour	yellowish-brown.
Contents	hexacanth embryo (onchosphere)

3- *Cysticercus bovis*: a bladder-like structure lined with a germinal layer enclosing a cavity containing fluid. It has an invaginated scolex with 4 suckers. It measures about 1-2 cm.

Life cycle:

Habitat	adult worm lives in the small intestine.
Definitive host	man.
Intermediate host	cattle.
Reservoir host	no
Infective stage	<i>cysticercus bovis</i> .

-Stages in the life cycle: egg \rightarrow onchosphere (Hexacanth embryo) \rightarrow *cysticercus bovis* in (I. H.) \rightarrow adult in (D. H.).

- Mature eggs and gravid segments pass in the human faeces.
- Gravid segments are detached separately and disintegrate liberating eggs. Sometimes these segments creep out of the anus by their own activity.

- The eggs or gravid segments are ingested by the intermediate host →the onchosphere hatches→penetrates through the intestinal wall into the lymphatic or blood vessels to the right side of the heart to the lung to the systemic circulation where it is distributed everywhere specially in active muscles, brain, bones, etc... There, it develops into *Cysticercus bovis* in about 12 weeks and remains viable for about one year. In muscles, cysticerci become surrounded by fibrous capsules formed by the host, which may be calcified later on.

Mode of infection: -Ingestion of undercooked beef containing viable *Cysticercus bovis*.

- In the intestine, the scolex is evaginated, attaches to the mucosa and the worm develops to maturity in about 10 weeks.

Pathogenicity and clinical picture:

- 1- Intestinal disturbances as hunger pain, indigestion, abdominal discomfort, diarrhea or constipation.
- 2- Loss of weight and appetite.
- 3- Intestinal obstruction.
- 4- Segments of *T. saginata* migrating out of the anus, cause irritation, itching, insomnia and anxiety.

Diagnosis:

1. Searching mainly for gravid proglottids in faeces to differentiate *T. saginata* from *T. solium*. If not found, give a saline purge (segments pressed between 2 slides and examined for the number of lateral uterine branches on each side).
2. Finding eggs in faeces is rare, may be in peri-anal scraping using a swab. Can be stained by **Zeihl-Neelsen stain** to be differentiated from *T. solium* eggs.

Treatment:

1. Niclosamide (Yomesan): the tablets should be taken in the morning on an empty stomach and well chewed. The strobila is often evacuated within a few hours, if not a purgative is recommended.
- 2- Praziquantel.

Prevention and control:

1. Proper sanitary disposal of human faeces to prevent cattle infection.
2. Proper inspection of beef for cysticerci at slaughter houses.
3. Proper cooking of beef products to kill any cysticerci present (cysticerci are killed at -56°C). Freezing at -10°C for 5-10 days are sufficient to kill the cysticerci.
4. Mass treatment of infected patients.
5. Health education.

***Taenia solium* (Pork tapeworm)**

Geographical distribution: cosmopolitan wherever raw or insufficiently cooked pork is ingested. Thus it is very rare in Islamic countries.

Morphology: similar to *Taenia saginata* but with the following differences:

1. Shorter in length, 4 meters with 1000 segments.
2. Scolex: globular with a rostellum armed with double rows of taenoid hooks.
3. Mature segments contain a less number of testes about 150.
4. The ovary is trilobed.
5. The gravid segment: the uterus possesses 9-11 lateral branches on each side.

Life cycle:

Habitat	small intestine
Definitive host	man
Intermediate host	pig
Reservoir host	No
Infective stage	<i>cysticercus cellulosa</i>

Stages in the life cycle: egg → hexacanth embryo → *cysticercus cellulosa*.

- 1- Gravid segments pass with defecation.
- 2- They dry in the soil, rupture and release the eggs which are morphologically indistinguishable from those of *T. saginata* but not stained with Zeihl-Neelsen stain.
- 3- Pigs and hogs feed on human faeces. The eggs are swallowed pass to the duodenum or jejunum where the shells disintegrate. The onchospheres, liberated by the aid of their lytic secretions and hooks penetrate through the intestinal wall into the mesenteric venules and are carried throughout the body, they are then filtered between the muscles and metamorphose into cysticerci.
- 4- Cysticerci are spherical or ovoid cysts with the head invaginated appearing as a milky spot. Microscopically the rostellum, suckers and hooks are apparent; this larval stage is known as *cysticercus cellulosa*.

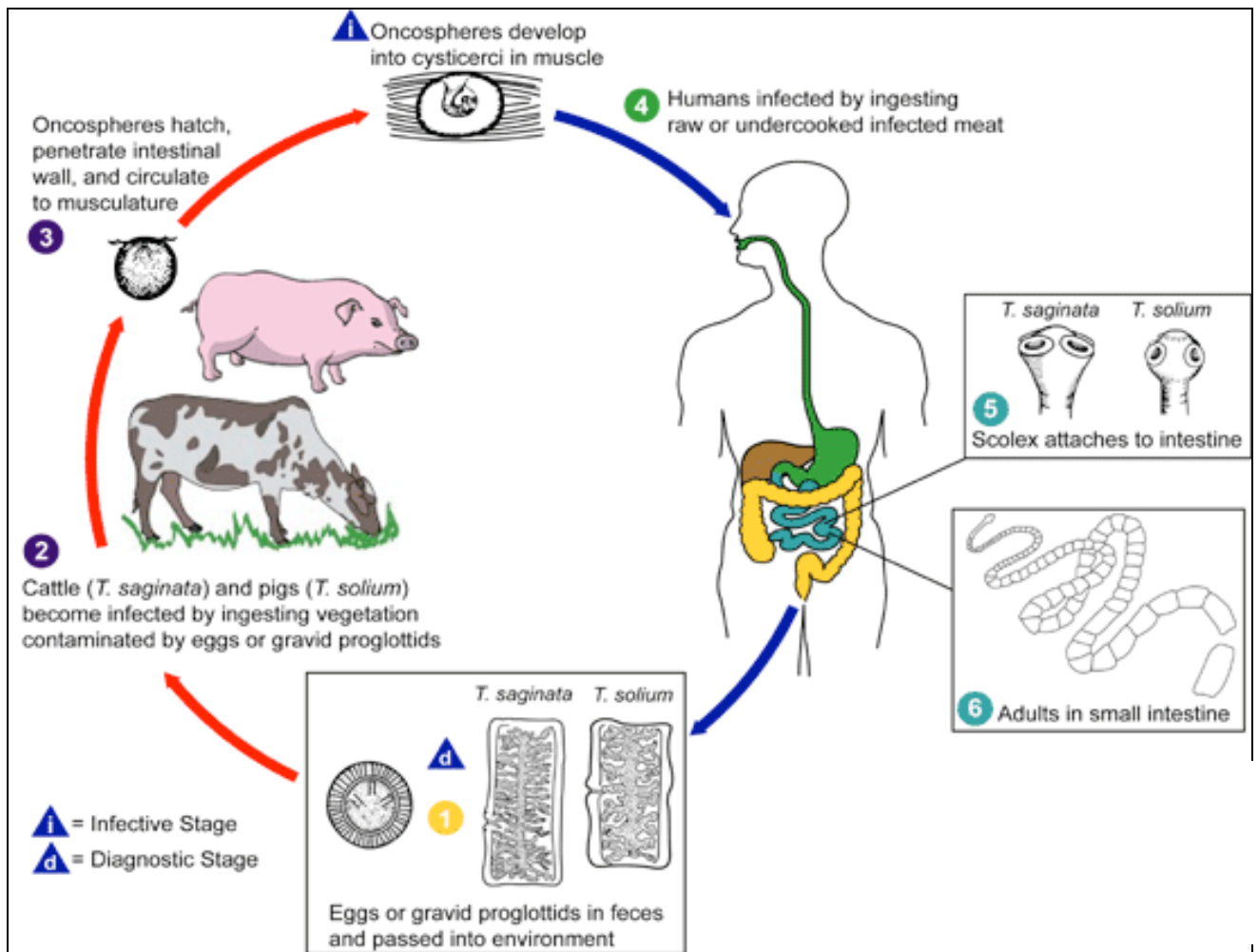
Mode of infection:

-Human beings are infected with *T. solium* following consumption of imperfectly cooked pig's meat containing the *cysticercus cellulosa*.

-In the stomach the cyst wall is digested out, the head evaginates in the upper level of the small intestine, attaches by its suckers to the wall of the small intestines and develops into a mature adult worm in 5-12 weeks.

Pathogenicity :

1-Taeniasis solium	Man ingests <i>cysticercus cellulosa</i> in pig's muscles, and the adult parasite develops. The disease is similar to taeniasis saginata.
2- Cysticercosis	Man ingests eggs of <i>T. solium</i> , and develops <i>cysticercus cellulosa</i> in the extra-intestinal tissues



Life cycle of *Taenia* species

Diagnosis:

- Stool examination reveals the presence of the gravid segments, rarely eggs.
- Eggs cannot be differentiated from those of *T. saginata* morphologically, but they do not take the Zeihl-Neelsen stain.

Treatment: Similar to *T. saginata* but:

-Atebrine is preferable as it leads to expulsion of the parasite but causes nausea and vomiting. So, anti-emetic must be given one hour before Atebrine to avoid anti-peristalsis and subsequently internal autoinfection.

Niclosamide and Paromomycin **should be avoided as they disintegrate the worm releasing large number of eggs in the lumen of intestine which increase possibility of cysticercosis due to internal autoinfection.

Prevention and control: 1. Similar to *T. saginata*, but mainly directed towards pigs.

2. Prompt treatment of infected persons to eliminate the danger of auto infection.

3. Infected persons should not take emetics or nauseating drugs.

Differences between *T. saginata* and *T. solium*.

	<i>T. saginata</i> (Beef tape worm)	<i>Taenia solium</i> (Pork tape worm)
Disease:	Taeniasis saginata.	Taeniasis solium
Distribution:	Cosmopolitan where beef is eaten	Cosmopolitan where pork is eaten.
Adult: Size:	10 meters	5 meters
Scolex:	Quadrangle, about 1-2 mm in diameter with no rostellum or hooks	Globular about 1 mm in diameter. There is a rostellum with 2 rows of large and small hooks
Number of segments:	2000	1000
Mature segment:	Testes are numerous (300-400), ovary bilobed, vaginal opening with sphincter.	Testes are fewer (150) ovary trilobed, no vaginal sphincter.
Gravid segment:	Longer than broad uterus with 15-20 (18) lateral branches, segments detach singly (creeping out without defecation).	Longer than broad. With 9-11 lateral branches, segments detach in groups of about five with stool.
Egg	not infective to man and stained with Zeihl-Neelsen stain.	infective to man →cysticercosis) - not stained
Definitive host	Man	Man
Intermediate host:	Cattle	Pigs and man
Larval stage	<i>Cysticercus bovis</i> (scolex without hooks)	<i>Cysticercus cellulosa</i> (scolex with hooks)
Stage in man	Adult	Adult and larva (cysticercus cellulosa).
Mode of infection	Ingestion of undercooked beef → taeniasis	-Ingestion of undercooked pork → taeniasis -Ingestion of eggs → cysticercosis.

CYSTICERCOSIS

Definition: invasion of the human tissues by the larval stage of *Taenia solium* (*Cysticercus cellulosa*). In this case man acts as an intermediate host.

Mode of infection: it can develop in different ways:

- Ingestion of food or water contaminated by the eggs of *Taenia solium*.
- **Auto- infection** either
 - a- **External autoinfection (Exogenous):** the patient harbouring the adult parasite contaminates his fingers with *Taenia solium* eggs from his own stool.
 - b- **Internal autoinfection (Endogenous):** antiperistaltic movements of the intestine (in case of vomiting or taking emetic drugs) leads to regurgitation of the gravid segments to the stomach. The gravid segments become broken up and liberate the eggs. On returning to the intestine, the eggs hatch.

Eggs hatch in the intestine → oncospheres penetrate the intestinal wall → venous circulation → right side of the heart → the lung → left side of the heart → the systemic circulation where they settle in different tissues and develop into cysticerci. Subcutaneous tissues, muscles, viscera, brain and orbit are commonly affected.

Pathogenicity and clinical picture:

- The cyst produces local cellular reaction and infiltration with neutrophils, eosinophils and lymphocytes. Presented by mild fever and eosinophilia.
- Clinical picture depends upon the organs affected and the number of cysticerci.
- In vital organs (heart or brain) serious manifestations may lead to death.
- In skeletal muscles, myositis and muscle pain are present.
- Cerebral cysticercosis results in severe headache, convulsions and paralysis.

Diagnosis:

1. Biopsy for histopathological examination.
2. X-ray for calcified cyst.
3. Ultrasound, C.T. (computerized tomography) and MRI (magnetic resonance).
4. Serological tests may be helpful in diagnosis as I.H.A.T and ELISA.

Treatment:

1. Surgical removal when possible.
2. Praziquantel combined with corticosteroids as anti-inflammatory in case of meningitis or cerebral oedema.
3. Albendazole is also effective.

Prevention and control:

1. Early treatment of persons harbouring the adult worms to avoid autoinfection.

2. In patients harbouring the adult parasite, no nauseating drugs should be given.
3. Avoid the use of human excreta as manure.
4. Personal cleanliness, fly control and proper washing of raw vegetables.

Taenia multiceps
(*Multiceps multiceps*)

Geographical distribution: sheep raising regions of Europe and Asia, Tropical and South Africa.

Morphology: the adult resembles *Taenia solium* but it is 40-60 cm in length.

Life cycle:

- Habitat: small intestine.
- Definitive host: dog.
- Intermediate host: sheep (man is an accidental intermediate host).
- Infective stage to dog: *coenurus cerebralis*.
- Infective stage to man: eggs.

COENUROSIS

Definition: Human infection with *coenurus cerebralis*, the larval stage of *Taenia multiceps* (*Multiceps multiceps*).

Mode of infection:

-Man is accidentally infected by the *coenurus cerebralis* cyst through intimate association with dogs or through working in the manufactures of fox furs, where he ingests the eggs of *T. multiceps*.

-The eggs when ingested, hatch in the intestine. The liberated onchospheres penetrate the intestinal wall; pass in the circulation to the **brain** where they develop into *coenurus cerebralis* cyst.

-This is a clear, translucent cystic larva. It may reach the size of hen's egg. It contains hundreds of scolices arising from the germinal layer of the cyst wall.

Pathogenicity and clinical picture: symptoms of increased intracranial pressure as headache, convulsions, epilepsy and diplopia.

Diagnosis: difficult, diagnosed as brain tumour (X-ray and C.T.).

Treatment: surgical removal.

Prevention and control:

1. *Coenurus* cysts found in slaughtered animals should be destroyed.
2. Stray dogs should be destroyed.
3. Avoid close contact and playing with dogs.
4. Avoid contamination of hands, food and drink with dog's faeces.

Case study :

A 29-year-old woman presented to the physician complaining of diarrhea, mild indigestion, hunger pains, loss of weight and frequent abdominal pain. She passed white segments, each about 2 cm long, with or without defecation causing perineal irritation and pruritus. She is fond of eating roasted meat.

The patient was instructed to submit three stool specimens, on alternate days that were examined for ova and parasites. Also, blood sample was drawn for complete blood count.

The blood count revealed eosinophilia (16% eosinophils). On examination of the concentrated stool sediments, several yellow-brown, spherical, 40 μ in diameter, thick-shelled eggs were detected. The eggs were characterized by radial striations. Gravid segments were also detected in the stool specimens; each contained 15-20 lateral uterine branches, on either side, when stained with an Indian ink.

Questions:

1. Which parasite is causing the patient's illness?
2. Name the 2 species of this genus which cause human disease.
3. Can they be differentiated by the morphological appearance of their eggs?
Explain.
4. Can these 2 species be differentiated by the appearance of their proglottids?
Explain.
5. Compare the morphological characteristics of the scolices of these 2 species.
6. What is the infective stage? What is the mode of infection?
7. Why is it important to differentiate between these 2 species?
8. How is this infection treated?
9. What is the sure sign of complete cure?

Hymenolepis nana (Dwarf tapeworm)

Geographical distribution: cosmopolitan. It is the commonest tapeworm in children.

Morphology:

1- Adult:

- Size: 0.5-5 cm (the smallest tapeworm of man).
- Scolex: globular, 0.2 mm in diameter, with 4 suckers. A retractile rostellum with a crown of hooks (long handle, short blade and a guard).
- Strobila: 200 segments.
- Mature segments: broader than long (0.5 x 0.15 mm).
 - Male system: 3 globular testes, in the middle of the segment.
 - Female system: as in *Taenia* but the ovary is small and central.
 - Genital pores are unilateral and always open to one side.
- Gravid segments: broader than long (0.2x 0.9 mm) and are occupied by a sac-like uterus full of eggs.

2-Egg:

Size	30-50 μ .
Shape	spheroid with 2 envelopes; outer egg shell, inner embryophore with two polar thickenings from each arises 4-8 filaments.
Colour	translucent.
Contents	mature hexacanth embryo.

3- Cysticercoid: a bladder-like structure, 0.5-1 mm in diameter, having double wall, similar to cysticercus but the head is withdrawn in upright position (**invaginated everted**), and it has a tail-like appendage (*Cercocystic cysticercoid*).

Life cycle:

Habitat	the small intestine
Definitive host	Man
Reservoir hosts	rodents (rats and mice).
Intermediate host	man, may be insects like flea larva or grain beetles.
Infective stage	mature eggs and <i>cercocystic cysticercoid</i> .

-Stages in life cycle: egg \rightarrow onchosphere \rightarrow *cercocystic cysticercoid* in (I.H.) \rightarrow adult in (D. H. and R.H.).

-Mature eggs pass in faeces of definitive and reservoir hosts are immediately infective without requiring intermediate host.

-When the final host swallows the egg in food, drink or by autoinfection, the

onchosphere hatches in the small intestine, penetrates into **the submucosa** to become a cysticeroid. After about one week, it returns to the **lumen** and develops into an adult worm. Man acts as definitive as well as intermediate host.

- Eggs appear in faeces about two weeks after infection.
- Also development may take place in an intermediate host if the egg is swallowed by flea larva (or flour insects, beetles and cockroaches).
- The onchosphere liberates in the intestine of the insect, penetrates into the body cavity where it develops into a cysticeroid. When such flea is ingested with food the cysticeroid is liberated and develops into adult.

Mode of infection:

- 1- Swallowing of infected insects or their larvae containing cysticeroid.
- 2- Contaminated food, water with eggs.
- 3- Autoinfection: by ingestion of mature eggs, either from **person to person** or by **external autoinfection** or **internal autoinfection**.

Pathogenicity and clinical picture:

1. In light infection, usually there are no manifestations.
2. In heavy infections: ulcerations of the mucosa lead to **enteritis**. There may be abdominal discomfort, colic and diarrhea with passage of mucus.
3. Some patients specially children suffer from dizziness and may be convulsion, attributed to **neurotoxin** product of the worms.

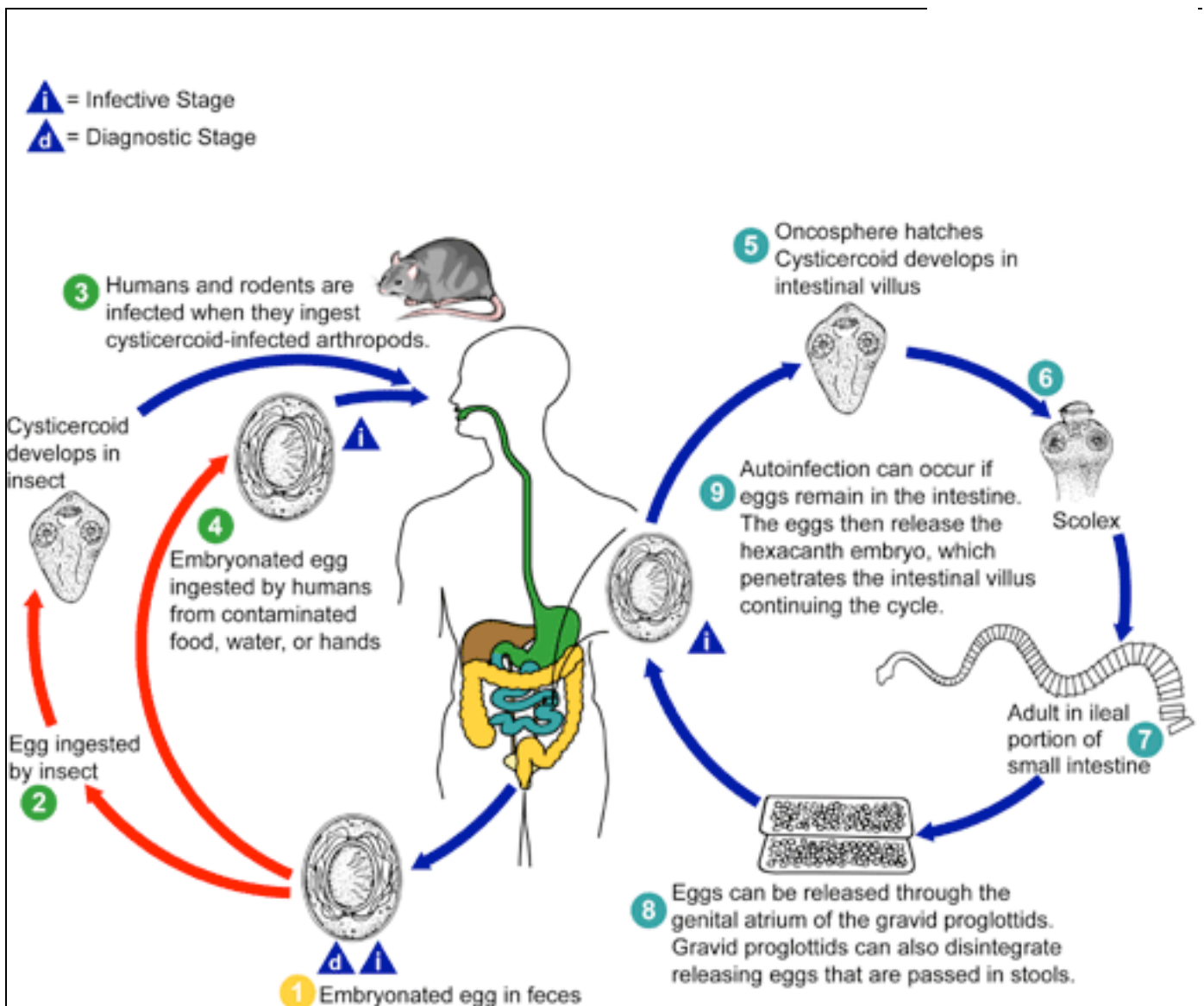
Diagnosis: finding eggs in faeces.

Treatment:

- 1-Niclosamide: treatment is prolonged or repeated in 3 weeks to kill worms that emerge from cysticeroids in the submucosa.
- 2-Praziquantel: a single oral dose after breakfast. It acts on both cysticeroid in the villi and the adult in the lumen of small intestine.
- 3-All infected members of the family should be treated at the same time.

Prevention and control:

1. Avoid contaminated food and drink.
2. Personal cleanliness and proper sanitary disposal.
3. Health education.
4. Mass treatment to prevent autoinfection and infection of others.
5. Rodents control.



Life cycle of *H. nana*

Hymenolepis diminuta (Rat tapeworm)

Geographical distribution: cosmopolitan. It is a common parasite of the small intestine of rats, mice and accidentally infects man.

Morphology:

1- Adult:

- Size: 20-60cm in length x 4 mm in width.
- Scolex: small, globular, 0.3mm in diameter, with 4 true deeply cup shaped muscular suckers and invaginated small rostellum (no hooks).
- Strobila: 800 segments.
- Mature segments: 0.75x0.25 mm, with 3 testes, one on the side of the genital

pore and two on the a-poral side with the ovary in between.

- Gravid segments: similar to *H. nana* but bigger (4x 0.8 mm).

2- Egg:

Size	60-70 μ .
Shape	- Spheroid with 2 envelopes: a. Outer egg shell is thick. b. Inner embryophore devoid of filaments. - Embryo with two polar thickenings.
Colour	yellowish.
Contents	mature hexacanth embryo.

3- Cysticercoid: similar to that of *H. nana* (*Cercocystic cysticercoid*) but the scolex without hooks.

Life cycle:

Habitat: small intestine.

Definitive host: man.

Intermediate host: rat flea (*Xenopsylla cheopis*), grain beetles and cockroaches.

Reservoir host: rats and mice.

Infective stage: *cercocystic cysticercoid*.

Stages in the life cycle: egg \rightarrow onchosphere \rightarrow *cercocystic cysticercoid* in (I. H.) \rightarrow adult in (D. H. and R.H.).

- The gravid segment passes with faeces to the soil where it disintegrate liberating eggs.
- The eggs are ingested by the larval stages of rat flea, adult beetles and cockroaches.
- The egg hatches and onchosphere develops into cysticercoid larva in the body cavity of these insects. In case of flea larva, the cysticercoid remains in its body cavity till the larva of flea becomes pupa then adult.
- In the small intestine of man the cysticercoid is set free, attaches to the mucosa and matures into adult within 3 weeks.

Mode of infection:

1. Insect is infected by eating grain and rice contaminated by faecal matter of infected rats and mice with eggs.
2. **Man is infected by accidental swallowing of insect vectors** (flea larva, pupa or adults) containing the infective stage, in food such as cereals, grains or dried fruits.

Pathogenicity and clinical picture: infection may be accompanied by abdominal pain, diarrhea and epileptiform convulsions.

Diagnosis: finding gravid segments and eggs in faeces.

Treatment: as *H. nana*.

Prevention and control:

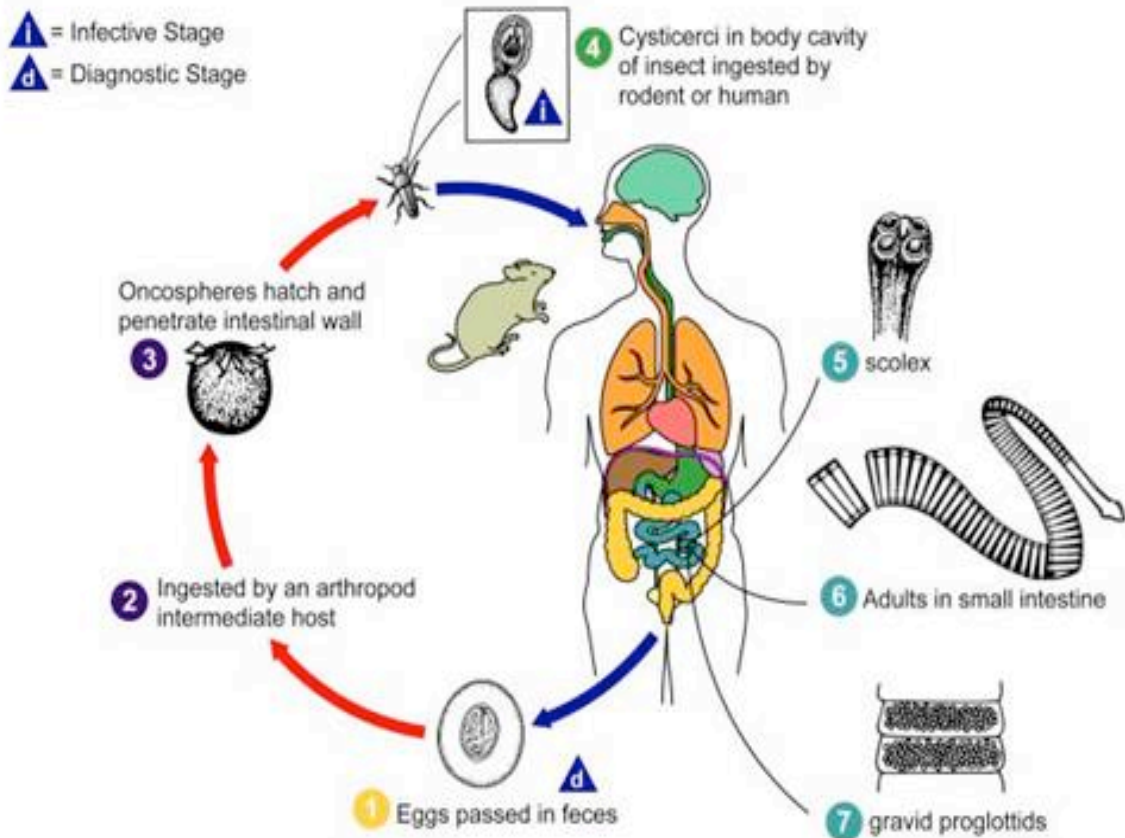
1. Care to avoid ingesting ectoparasites of rodents and other insects of flour, grains and cereals.
2. Rodents control.

The differences between *Hymenolepis nana* and *Hymenolepis diminuta* :

	<i>H. nana</i>	<i>H. diminuta</i>
Distribution	Cosmopolitan	Cosmopolitan
Adult: size	0.5-5 cm	20-60 cm
-Scolex:	Has a rostellum with one row of hooks (20-30)	Rostellum without hooks
-Mature segment:	Testes and ovary close together in the middle of the mature segment	Two a-poral testes and one poral testis with the ovary in between
-Gravid segments:	Smaller (0.5 x 0.15 mm)	Similar but bigger (4x0.8mm).
-Egg: size	30-50 μ	60-70 μ
Shape:	Spheroid with 4-8 filaments arising from the polar thickening)	Similar but without filaments
Colour:	Translucent	Yellowish
Content:	Onchosphere	Onchosphere
Definitive host:	Man (may be rats or mice)	Rats, mice and accidentally man
Intermediate host:	Man, rat flea, and other insects as beetles and	Rat flea and other insects as beetles and cockroaches.
Larval stage:	Cysticeroid (cercocystic)	Cysticeroid (cercocystic)
Mode of infection:	1- Direct (ingestion of eggs) 2- Indirect: ingestion of infected insects containing cysticeroid.	Ingestion of fleas and insects, containing cysticeroid.

Hymenolepiasis

(Hymenolepis diminuta)



Life cycle of *Hymenolepis diminuta*

Dipylidium caninum (Double-pored dog tapeworm)

Geographical distribution: cosmopolitan.

Morphology:

1- Adult:

- Size: 20-60 cm, and contains 60-175 segments.
- Scolex: pyriform in shape, 0.5 mm in diameter with 4 suckers and a retractile rostellum with several rows of rose-thorn shaped hooks (2-7).
- Mature segments: longer than broad (12 x 4mm), **cucumber-seed like** containing two sets of genital organs with a genital pore on each lateral margin.
- Gravid segments: similar to mature segments. The uterus divided into packets (egg capsules) each containing 5-15 eggs.

2- Egg:

Size	40 μ .
Shape	spheroid with 2 envelopes separated by a hyaline layer.
Colour	yellowish-brown.
Contents	onchosphere.

3- **Cysticeroid:** similar to that of *H. nana* or *H. diminuta* but **without a tail appendage** (*Cryptocystic cysticeroid*).

Life cycle:

Habitat: small intestine.

Definitive hosts: dogs, cats and occasionally man (especially children).

Intermediate hosts: insects as dog flea (*Ctenocephalus canis*), cat flea (*Ctenocephalus felis*), human flea (*Pulex irritans*) and dog louse.

Reservoir hosts: dogs and cats.

Infective stage: *cryptocystic cysticeroid* larva in dog, cat and human fleas.

-Stage in the life cycle: egg \rightarrow onchosphere \rightarrow *cryptocystic cysticeroid* in (I.H.) \rightarrow adult in (D. H. and R.H.).

- The gravid segments separated singly or in groups, pass with faeces, where they disintegrate liberating egg capsules and eggs, which appear in faeces after 3-4 weeks of infection.
- Eggs are ingested by insect intermediate host, while feeding on faecal or organic debris on dogs and on ground.
- The onchosphere penetrates the gut to the body cavity where it develops into *cryptocystic cysticeroid* larva.
- The cysticeroid remains within the body cavity till the larva of flea becomes an adult.
- In the small intestine the cysticeroid is set free, attaches to the mucosa and matures into adult.

Mode of infection: man is infected by accidental ingestion of infected fleas or dog louse containing the infective stage (*Cryptocystic cysticeroid*) in contaminated food and drink or through close association with infected dogs.

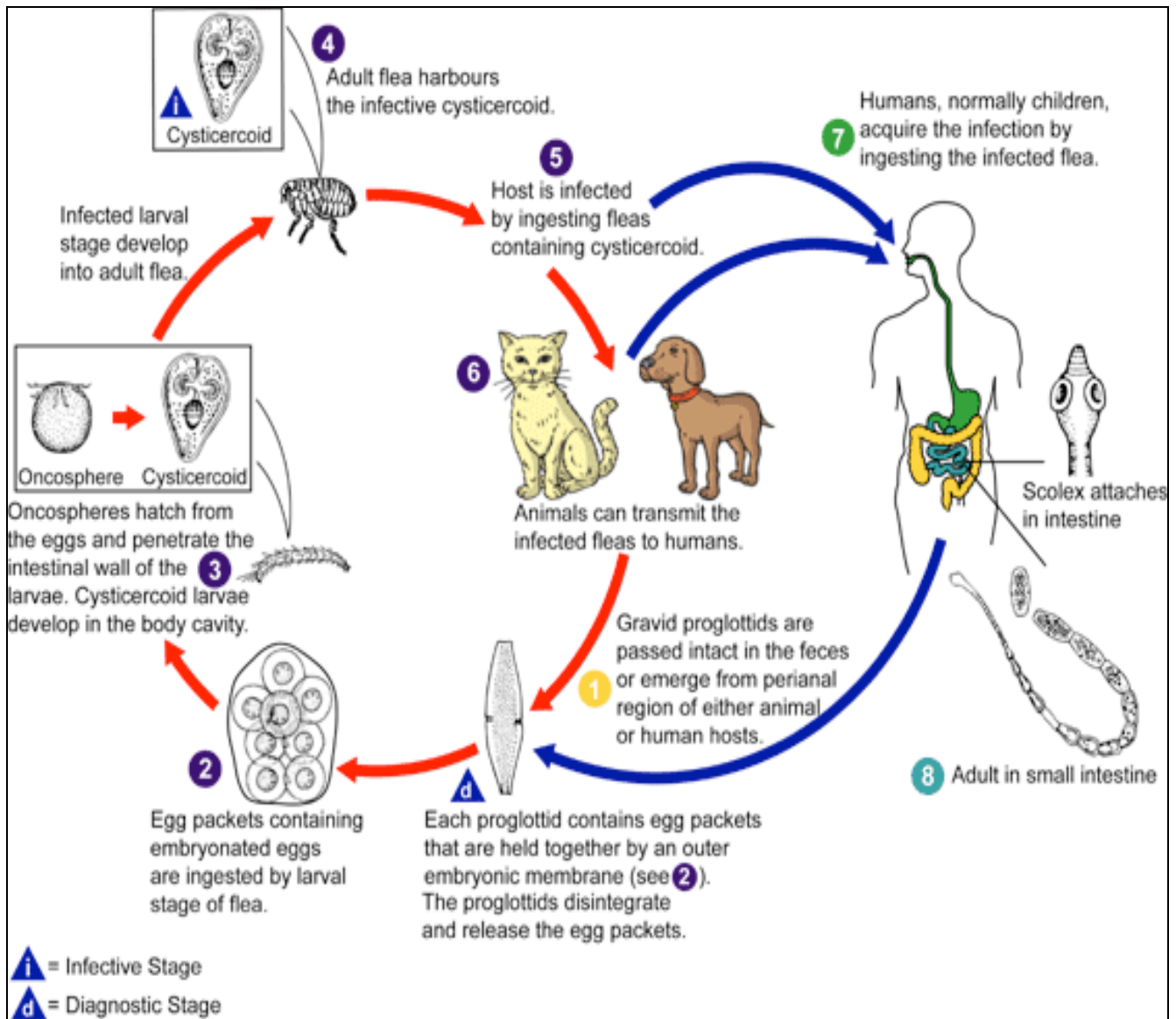
Pathogenicity and clinical picture: usually symptomless, however mild symptoms in the form of intestinal disturbance, indigestion and loss of appetite may occur.

Diagnosis: detection of gravid segments, egg capsules, rarely eggs in stool.

Treatment: Niclosamide as in *T. saginata*.

Prevention and control:

1. Household pets should periodically be given anti-helminthic treatment and insecticidal dusting to kill fleas.
2. Avoid handling dogs and cats.



Dipylidium caninum life cycle

***Echinococcus granulosus* (Dog tapeworm)**

Geographical distribution: cosmopolitan, more in cattle raising countries.

Morphology:

Adult:

Size: about 5 mm.

Scolex: globular with 4 suckers and double crown of hooks (similar to *T. solium*).

Strobila: composed of 3 segments, one immature, one mature and one gravid.

Mature segment: longer than broad. Reproductive organs as *Taenia*.

Gravid segment: is $\frac{1}{2}$ length of the worm, longer than broad. The uterus develops lateral pouches which are full of eggs.

Egg: similar to *Taenia*.

Hydatid cyst: a complex cyst composed of daughter daughter inside and may be outside the mother cyst and contains several scolices.

Life cycle:

Habitat	small intestine
Definitive hosts	dogs or other carnivorous animals
Intermediate hosts	herbivorous animals and occasionally man
Infective stage to dog	hydatid cyst
Infective stage to man	Eggs

-Stages of life cycle: egg → onchosphere → hydatid cyst in (I. H.) → adult in (D. H.).

-Gravid segments and mature eggs pass in the faeces of definitive host.

-When the egg is ingested by the intermediate host, the liberated onchosphere penetrates the intestinal wall into the blood stream to various parts of the body where it develops into a hydatid cyst, causing hydatid disease.

Echinococcus multilocularis

Geographical distribution: Central Europe and Siberia.

Life cycle:

-Habitat: small intestine.

-Definitive host: fox

-Intermediate host: field rodents and man.

-Infective stage to fox: hydatid cyst.

-Infective stage to man: eggs.

Morphology and life cycle:

Adults resemble *Echinococcus granulosus*, but are smaller. Eggs passed in fox's faeces are taken by the intermediate host in which they develop into *alveolar* or *multilocular* hydatid cysts.

Hydatid disease

(Hydatidosis, Echinococcosis)

Definition: it is the presence of hydatid cyst, larval stage of *E. granulosus* and *E. multilocularis* in the human tissues. The liver is the commonest organ affected (70%) followed by the lungs (20%), then the brain and other organs (10%).

Mode of human infection: ingestion of eggs of *Echinococcus* species by the following ways:

- 1- Ingestion of water or vegetable polluted by infected dog's faeces.
- 2- Handling infected dogs where hair is usually contaminated with eggs.
- 3- Man is infected with the alveolar cyst during the skinning of foxes to make furs or from collecting strawberries polluted with fox's faeces.

Morphology and types of hydatid cyst:

I. Unilocular hydatid cyst: it is the larval stage of *E. granulosus*.

Size: 1-10 cm.

Shape: spherical enclosed in a fibrous capsule produced by the host.

The wall of the cyst has 2 layers:

(1) Outer laminated non-cellular layer.

(2) Inner cellular germinal layer which secretes the laminated layer and produces scolices, brood capsules and daughter cysts.

Contents:

(a) Individual scolices (microscopic).

(b) Brood capsules: invagination of the germinal layer from which scolices develop.

(c) Daughter cysts: cysts formed of the 2 layers of the mother cyst, giving rise to scolices, brood capsules and even grand daughter cysts.

(d) Hydatid fluid.

(e) Hydatid sand: detached scolices, brood capsules and daughter cysts that fall in the hydatid fluid are called hydatid sand.

(f) Exogenous daughter cysts: a daughter cyst is produced outside the mother cyst by herniation through the fibrous capsule, and may separate from it.

II. Sterile cyst or acephalocyst: the germinal layer fails to produce scolices, brood capsules or daughter cysts.

III. Osseous cyst: growth of hydatid cyst in bones is along the medullary cavity with erosion of osseous tissue.

IV. Alveolar or multilocular hydatid cyst: it is the larval stage of another species *Echinococcus multilocularis* or *Alveococcus multilocularis*.

It differs from the common unilocular variety in the following:

- There is no laminated layer, hence the cyst has no regular shape and not defined from the surrounding tissue. The germinal layer infiltrates the tissue.
- There is no free fluid, but a jelly-like substance in irregular cavities separated by fibrous strands.
- The central area of the cyst undergoes necrosis while growth continues at the periphery.
- Growth is neoplastic and metastasis occurs.
- In man the cyst is usually sterile or produces only few scolices and brood capsules.

Pathogenicity and clinical picture: depend on the size of the cyst and the organ affected.

- 1- Hepatic hydatid cyst: indigestion, jaundice and discomfort in the right hypochondrium.
- 2- Pulmonary hydatid cyst: dyspnea, cough, chest pain and haemoptysis.
- 3- Cerebral hydatid cyst: symptoms of increased intracranial tension and epilepsy.
- 4- Osseous hydatid cyst: erosion and spontaneous pathological fracture of long bones.
- 5- Rupture of the cyst results in anaphylactic shock and transplantation of the germinal layer in other tissues producing secondary cysts.

Diagnosis:

I. Clinical diagnosis: slowly growing cyst (space occupying and pressure effects) with hydatid thrill in case of large abdominal cyst. History of contact with dogs.

II. Laboratory diagnosis:

A- Direct:

- Puncture and aspiration to demonstrate hydatid cyst (may lead to leakage of fluid and the risk of anaphylactic shock).
- Radiological: X-ray, ultrasonography (U.S.), C.T. scans.
- Blood examination reveals eosinophilia in 20-25% of cases.

B- Indirect:

-Intradermal allergic test (Casoni test): 0.2 ml of sterile hydatid fluid is injected intradermally. In positive cases an erythematous wheel is formed within 20 min and a delayed reaction appears after 24 hours.

-Serological methods: using hydatid fluid antigen for detection of antibodies by:

1. Precipitin reaction: equal parts of hydatid fluid and patient's serum incubated at

37°C for 1 hour show flocculation in 36 hours.

2. ELISA and IHA.
3. Complement fixation test (CFT).
4. Latex agglutination test (LA).
5. Indirect fluorescent antibody test (IFA).
6. Immuno-electrophoresis test (IEP).

Treatment:

- 1- Surgical treatment: is recommended for unilocular cysts in accessible sites with pre-operative administration of Mebendazole.
- 2- Sterilization: some of hydatid fluid is replaced by 10% formalin for 5 minutes then the content is aspirated and repeatedly washed with saline or ethanol to kill the germinal layer and scolices causing cyst collapse.
- 3- Medical treatment: when surgical interference is impossible or contra-indicated, Mebendazole can be used in high dose and for a long period (about 3 months up to one year), as the drug stop proliferation and spread of the cysts.

Prevention and control:

1. Hydatid cysts found in slaughtered animals should be destroyed and not fed to dogs.
2. Stray dogs should be destroyed.
3. Pet dogs should be examined and dewormed periodically.
4. Avoid close contact and playing with dogs.
5. Avoid contamination of hands, food and drink with dog's faeces.

Case study

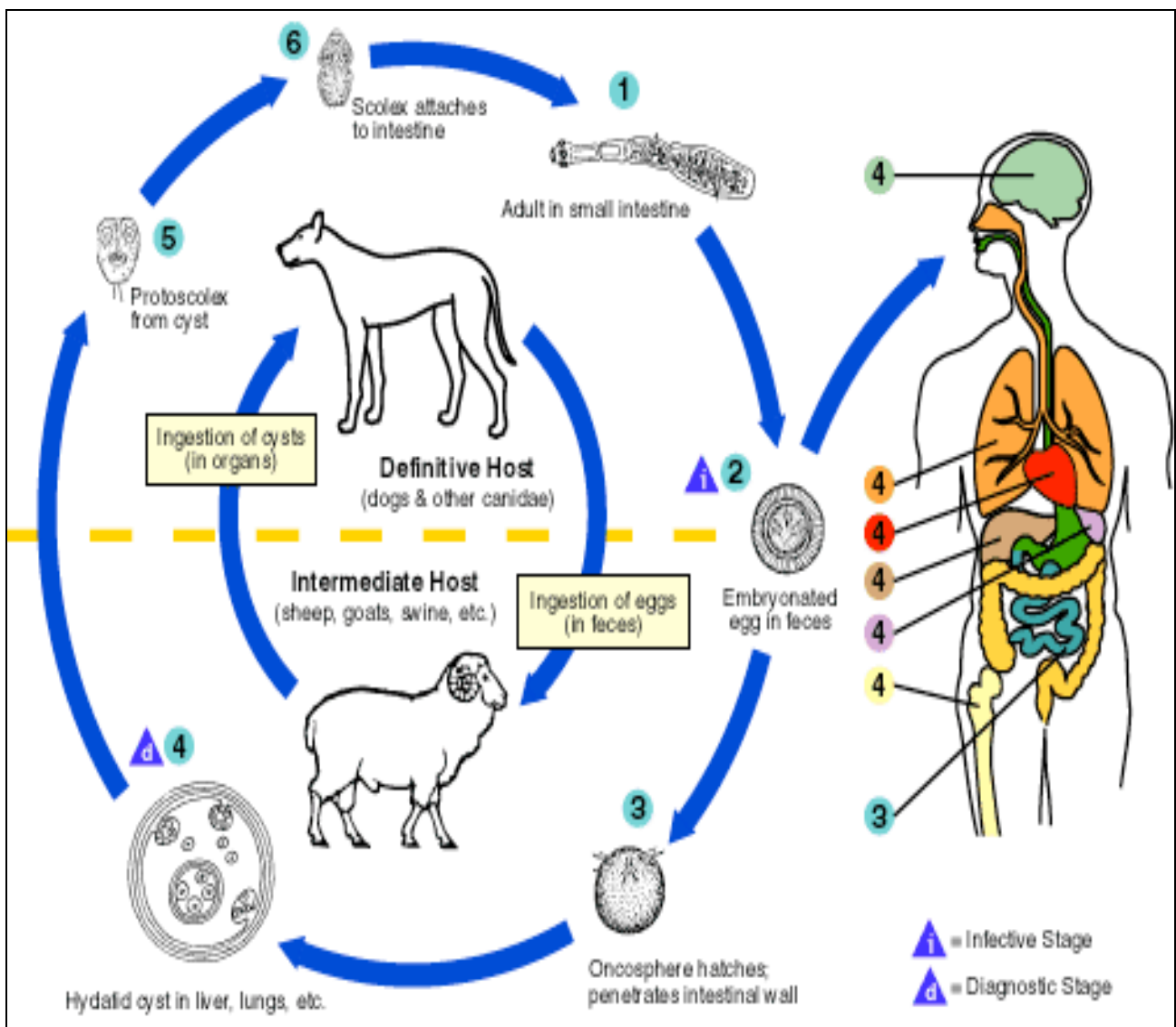
A 45-year-old man was presented with pain in the upper quadrant of the abdomen. He had a history of contact with dogs many years ago. On examination, the physician noted an enlarged liver with a palpable mass in the right hypochondrium. The patient was submitted for stool, blood and radiological (plain x-ray, CT and MRI) examinations.

Stool examination is negative for ova or parasites. The blood count revealed eosinophilia (24 % eosinophils). Radiological studies revealed a rounded space-occupying lesion, 12 cm in diameter in the liver. Microscopic examination of a biopsy specimen confirmed the diagnosis of the parasitic infection. During surgical removal of the hepatic cyst, aspiration of the cyst contents was performed and the contents were also examined microscopically.

Questions:

1. Based on the patient's symptoms, which parasitic infection do he has?

2. What aspect of the patient's history is a clue to his infection?
3. Describe the morphology of this cyst.
4. What danger to the patient exists during surgical removal and aspiration of the cyst?
5. Can sputum examination help in the diagnosis?
6. What is the parasitological diagnostic value of Ziehl-Neelsen stain?
7. How would you treat this patient?



Echinococcus granulosus life cycle