Biology Department
Science College

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Laboratory Notes

Practical Parasitology

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1st lab

Parasitology

Parasitology:

It's the area of biology concerned with the phenomenon of dependence of one living organism on another.

Medical parasitology: Deals with the parasites which infect human.

Parasite:

Is an organism that is entirely dependent on another organism, referred to as its host, for all or part of its life cycle and metabolic requirements.

Parasites is of two types:

a. Microparasite.

b. Macroparasite.

Microparasite:

It is small, unicellular and multiplies within its vertebrate host, often inside cells protozoa are microparasite.

Macroparasite:

It is large, multicellular and has no direct reproduction within its vertebrate host, this category includes helminthes, parasites may also be divided into two types on the basis of their location:

1. Ectoparasites.
2. Endoparasites.

Ectoparasites: Organisms which live. On the surface of the body, e.g., human louse *Pediculus humanus.* The infection by these parasites is known as infestation.

Endoparaiste: Organisms that live within the body of the host are known as endoparaties. All protozoa and helminthic parasite of man are endoparasites. The invasion by endoparasites is known as infection.

Subkingdom protozoa

Phylum: Sarcomastigophora.

Sub phylum: Sarcodina.

Class: Lobosea

Order: Amoebida.

Suborder: Tubulina

Entamoeba histolytica

Definitive host: Man

Habitat: Reside in mucosa and submucosa of large intestin of man.

Disease: amoebic dysentery or Amoebic liver abscess:

Infection: By contamination of food and water with mature cyst.

The parasite exist in three morphological forms:

a. Trophozoite.
b. Precyst.
c. Cyst.

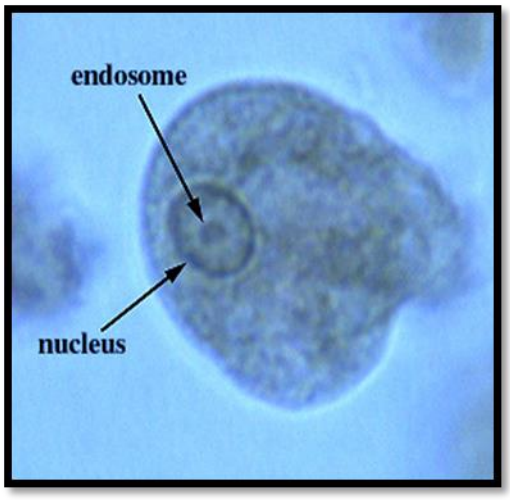
Trophozoite:

1. The trophozoite or the vegetative form is the growing or feeding stage of the parasite.
2. It is irregular in shape and varies in size from 12-60 µ.m.

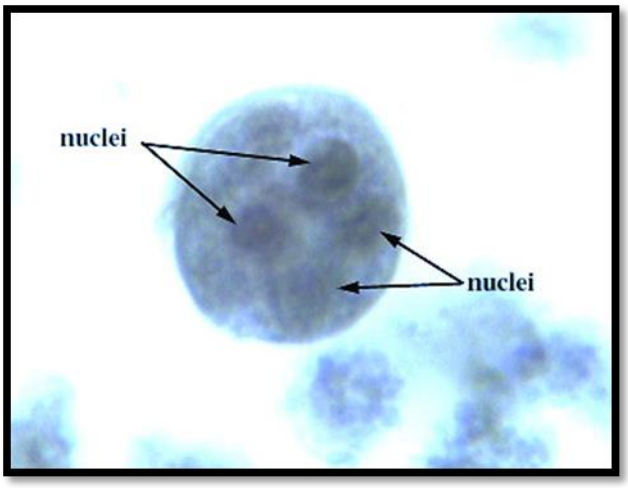
3. It is large and actively motile in freshly dysenteric stool.
4. The cytoplasm of trophozaite can be divided into a clear outer ectoplasm and an inner finely granular endoplasm in which red blood cells, leucocytes and tissue debris are found within the food vacuole it move by long finger-like pseudopodia.
5. The endoplasm contain food vacuoles, granules and nucleus which is spherical in shape. In stained preparation shows a central dot-like karyosome which is surrounded by a clear halo.

Cyst:

1. The cyst is spherical, about 10-20µm in size.
2. The early cyst contains a single nucleus and two other structures, a mass of glycogen and one to four chromatoid bodies (or bars which are cigar-shaped) refractile rods with rounded ends.
3. As the cyst mature, the glycogen mass and chromaoid bars disappear.
4. The mature cyct is quadrinucleate in formed faeces. Stools may contain cysts with (1-4) nuclei depending on their degree of maturation.



Entamoeba histolytica **trophozoit**



Entamoeba histolytica **cyst**

Phylum: sarcomastigophora.

Subphylum: sarcodina

Class: lobosea

Order: Amoebida.

Suborder: tubulina

e.g. Entamoeba coli

Endolimax nana

Iodamoeba butchlii

Entamoeba coli

Definitive host: man

Habitat: It lives freely in the large intestine of man.

Disease: Non-pathogenic

Infection: By contamination of food and water with mature cyst.

It exists in three stages: Trophozoite, precyst and cyst.

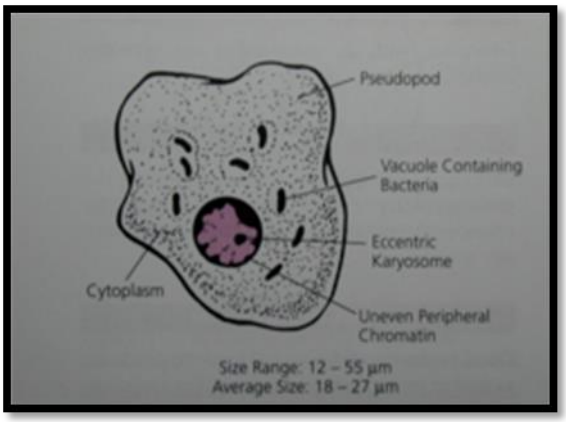
Trophozoite:

Is larger than the trophozoite of *E. histolytica*.

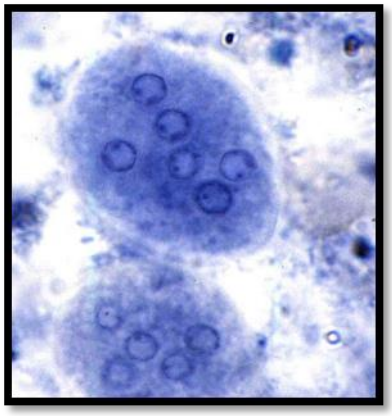
Motility is sluggish and the endoplasm contain ingested bacteria but not red blood cells. The nucleus is clearly visible in unstained films and has a large enteric karyosome and thick nuclear membrane line with coarse granules of chromatin.

Cyst:

Are large spherical with a prominent glycogen mass in the early stage. The chroumatioid bodies are filamentouse. The mature cyst has eight nuclei.



***Entamoeba coli* trohpozoit**



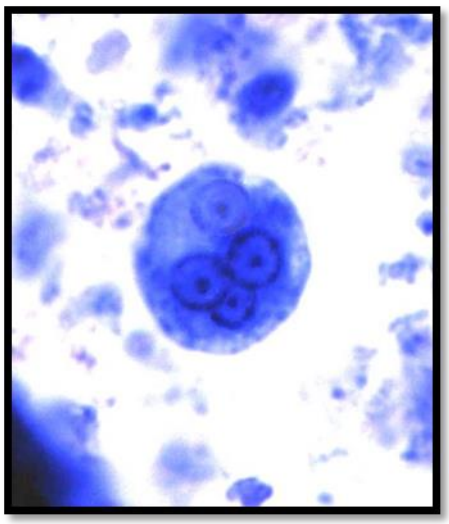
***Entamoeba coli* cyst**

Endolimax nana:

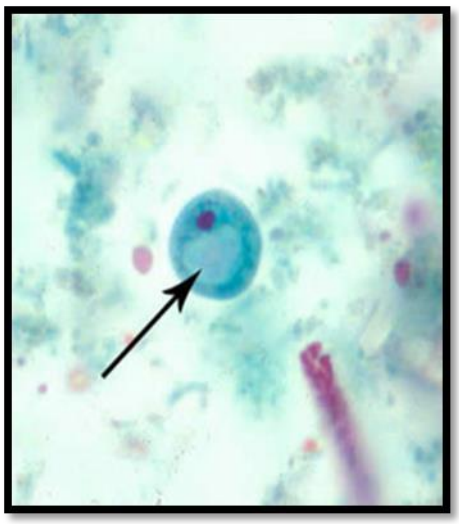
1. It is small amoeba found in the lumen of the large intestine of humans.
2. The trophozoite is small with a slow slug like motility by mean of blunt ,hyaline pseudopodia.
3. The cytoplasm contain bacteria, small vegetable cells, never red blood cells.
4. Nucleus is minute spherical with a large irregular karyosome lying eccentrically.
5. The cyst is oval. The number of nuclei varies from (1-4) but mature cyst is quadrinucleate, chromatoid bodies and glycogen vacuole are absent.
6. *E. nana* transmitted from man to man by the ingestion of viable cyst in polluted water or food.
7. It is non-pathognic.

Iodamoeba butschlii:

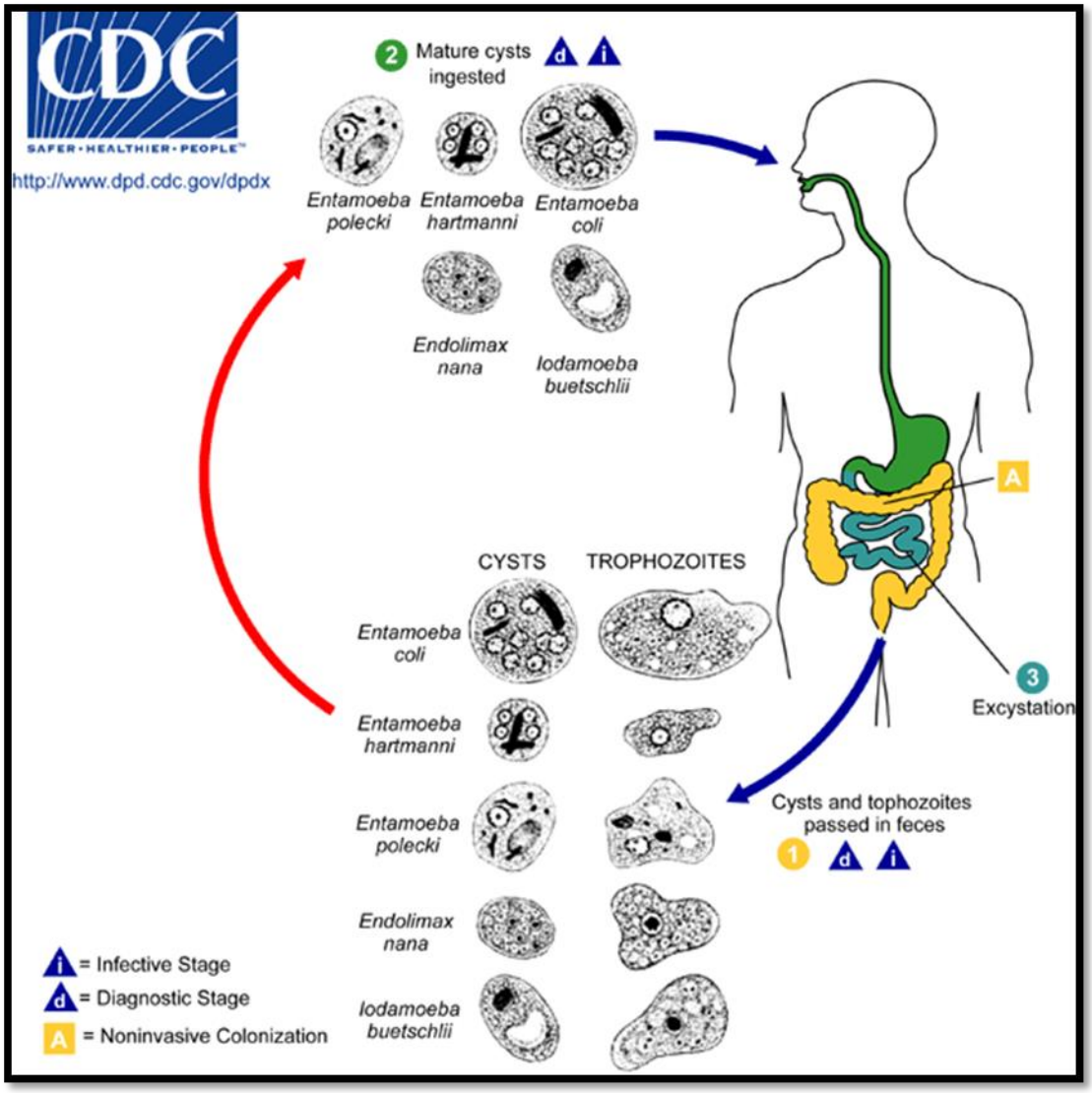
1. It live in the lumen of large intestine of man.
2. The trophozoite is small with a conspicuous nucleus.
3. The prominent karyosome is half the size of nucleus and surrounded by retractile globules.
4. The cyst is oval, uninucleate and has a prominent iodine-staining glycogen mass or vacuole. It is non pathogenic.
5. It is transmitted from man-to-man when the viable cysts are ingested in polluted water or food.



***Endolimax nana* cyst**



***Iodomeba butschlii* cyst**



Life cycle of amoebiases

2nd lab

Phylum:Ciliophora

Phylum: Ciliophora

Class: Ciliata

Order: Trichomastida

e.g.: *Balantidium coli*

1. It is the only pathogenic ciliate and is the largest protozoan parasite inhabiting the large intestine of man.
2. It has a trophozoite and a cyst stage. Throphozoite is found in dysenteric stool, but cyst was found in chronic cases it is the resistant form and the infective stage.

Trophozoite:

1. It is an oval organism. The anterior end is somewhat pointed and has a groove (peristome) leading to a mouth (cytostome) terminating in a short funnel-shaped gullet (cytopharynx) extending up to anterior one-third of the body. There is no intestine.
2. The posterior end is broadly rounded and has an excretory opening known as cytopyge through which the residual contents of food vacuoles empty periodically.
3. The body is overed with a delicate pellicle showing longitudinal striations. Embedded in the pellicle are short cilia of uniform length.

The cilia that line the mouth part are longer and called dorsal cilia. These are used for propelling food into the cytopharynx.

4. The cytoplasm contain two nuclei the macronucleus is large, kidney-shaped, spherical, curved or elongate. The micronucleus is small, round and lies in close proximity to the macronucleus. Two contractile vacuoles and numerous food vacuoles.
5. It reproduce asexually by binary fission and sexually by conjugation.

Cyst:

Is spherical or oval in shape, it is surrounded by a thick and transparent double-layered wall, newely formed cyst shows movement, but as the cyst matures the cilia are absorbed and the movement ceases, the micro macronucleus and vauoles are present in the cyst also. Unlike encystations in amoebae, in *B. coli* this is not preceded by complete dischange of undiagested foods.

Balantidium coli **trophozoite**

Balantidium coli **cyst**

Flagellates

Flagellates are protozae that bear one to several long, delicate, thread-like extension of the cytoplasm, which known as flagella and those were from blepharoblasts and used as organelles of locomotion.

According to their habitat the flagellates are classified into two broad groups:

i. Intestinal and atrial flagellates.

ii. Blood and tissue flagellates.

Intestinal and atrial flagellates

Phylum: Sarcomastigophora

Subphylum: Mastigophora

Calss: Zoomastigophora

Order: Diplomonadida

e.g. :*Giardia lamblia*

Habitat: Duodenum and the upper part of jejunum of man.

Disease: Steatorrhea in children (with excess mucus and fat, but no blood).It exist in two forms:

a. Trophozoite.

b. Cyst

Trophozoite of *Giardia lamblia:*

1- It is pear – shaped with rounded anterior end and tapering posterior end.

2- The dorsal surface is convex while the ventral surface has a shallow posteriorly notched concavity (sucking disc) they occupy anterior half of the organism. It acts as organelle of attachment.

3- It is bilaterally symmetrical and has one pair of nuclei each nucleus contain central karyosome, one pair of axostyles, one pair of parabasal bodies, present on the axostyle, four pairs of flagella and probably four pairs of blephraroplasts from which the flagella arise.

Cyst:

1. The mature cyst is oval in shape, has two pairs of nuclei which may remain clustered at one end or lie in pairs at opposite ends.

2. The remains of the flagella and margins of the sucking disk may be seen the cytoplasm of the cyst.

3. Cysts are passed in stool and remain viable in soil and water for several weeks.

4. Infection caused by the ingestion of cysts in contaminated food and water.

Life cycle:

1- It passes its life cycle in one host, (It has direct life cycle).

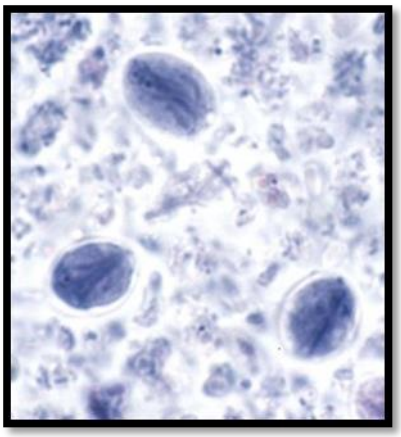
2- Mature cyst is the infective stage of the parasite. Infection caused by the ingestion of cysts with the contaminated water and food.

Within 30 minutes of ingestion excystation occur in the duodenum, each cyst hatches out into two trophozoites which multiply to form enormous numbers and colonize in the duodenum and upper part of jejunum to avoid acidity of duodenum it may localize in biliary tract.

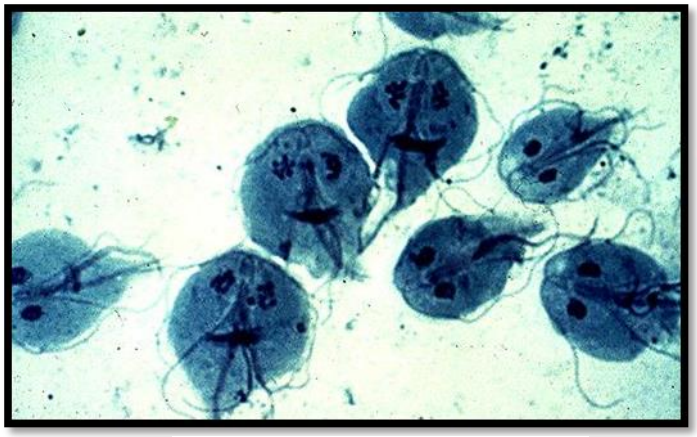
3- By means of concavity on its ventral surface the trophozoite attaches to the mucosal surface of duodenum and jejunum. It is usually to find only the trophozoites, in frankly.

4- Encystations occurs commonly in transit down the colon where the intestinal content lose moisture and patient starts passing formed stools.

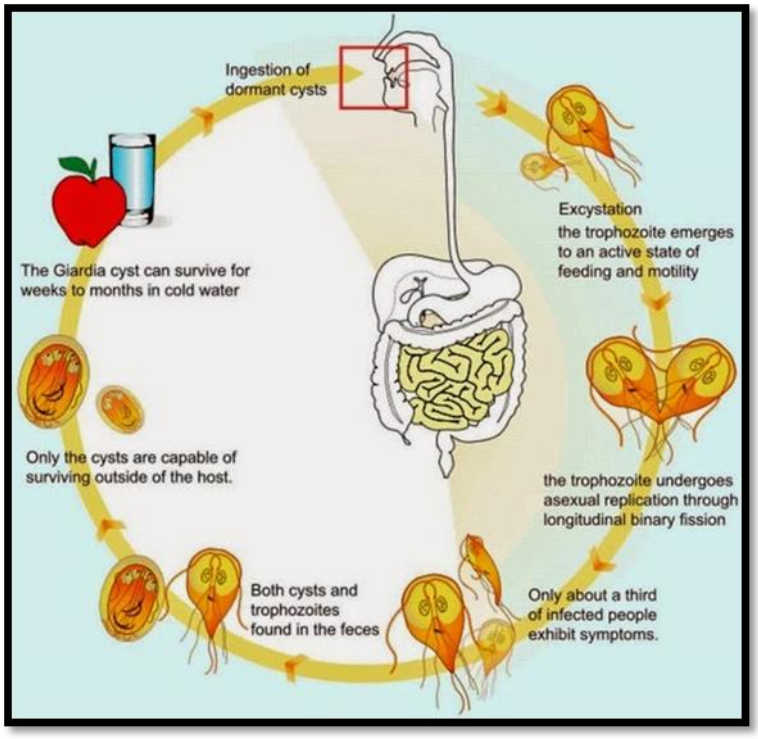
5- Trophozoite react the flagella into the axonemes. The cytoplasm becomes condensed. As the cyst mature, the internal structures are doubled, so that when excystation occurs, the sytoplasm divides, thus producing two trophozoites.



G. lamblia **cyst**



G. lamblia **trophozoi**t



Life cycle of *Giaridia lamlia*

Phylum: sarocomastingophora

Subphylum: Mastigophora

Class: Zoomastigophora

Order: Retrotamonadida

e.g.: *Chilomastix mesnili*

Trophozoites:

1- It is a common flagellate living as a harmles commensal in caecum and colon of man.

2- It has a well-defined trophozoite and cystic stages.

3- It is pear-shaped. The posterior end of trophozoite is drawn out into a long cone.

4- It has spherical nucleus situated anteriorly and has a small distinct central karyosome, few achromatic fibrils extending to the nuclear membrane, and chromatin plaques lining this membrane.

5- A large cytostome (mouth) located on one side of the nucleus. It has three free anterior flagella, a delicate flagellum lying with the cytostome and, two often that encompass the lateral margins of the cytostome. The cytoplasm is finely granular containing numerous food vacuoles.

6- Trophozoites feed on enteric bacteria and multiply by binnary fission.

Cyst:

1. Cyst is lemon-shaped with a small projection at the anterior-end as, and surrounded by a thick tough cyst wall.

2. The cytoplasm of cyst is densely granular and separated from the cyst wall at the narrow end of the cyst.

3. It has a single nucleus with central karyosome lies near the center.
4. The transmission of the parasite, from one person to another, take place by ingestion of food and water contaminated with cysts of *C. mesnili* found in the stools of an infected man.

Phylum: Sarcomastigophora.

Subphylum: Mastigophora.

Class: Zoomastigophora.

Order: Trichomonadida

e.g. *Trichomonas vaginalis*.

1. *Trichomanas vaginalis* has trophozoit, there is no cyst stage.
2. Trophozoite is ovoid or pear-shape with a short undulating membrane reaching up to the middle of the body.
3. It has 4 anterior flagella and a fifth one running along the outer margin of the undulating membrane.
4. There is also the axostyle runs throughout the length of the body and projects posteriorly.
5. It lives in the vagina and urethra of female. In male it occur in urethra and seminal vesicle.
6. It is motile, with a jerky rapid movement, and reproduce by binnary fission. The throphozoite itself, is the infective stage.

Chilomastic mesnili

Trichomonas vaginalis

3 Lab

Blood and tissue flagellates

Phylum: Sarcomastigophora.

Sub phylum: Mastigophora.

Class: Kinetoplastidea.

Order: Trypanosomatida.

e.g. *Trypanosoma spp*.

Leishmania spp.

Medically important Haemoflagellates require two hosts to complete their life cycle.They live in the blood and tissues of human and other vertebrate hosts, and in the gut of insect vectors.

Heamoflagellates infecting human belong to two genera: *Trypanosoma* and *Leishmania*.

They possess a single nucleus, a single kinetoplast and single flagellum.The kinetoplast consist of parabasal body and an adjacent dot-like blepharoplast. The blepharoplast and parabasal body are connected by one or more delicate fibrils.

Flagellum arise from the blepharoplast. The portion of the flagellum which in inside the body of the parasite is called the axoneme or axial filament.

1. Genus *Leishmania:*

It has a number of species that are nearly identical morphologically.

It infect man other mammals like Dog and also infect the reptile and causes a disease called Leishmaniasis, they are transmitted to man by the bite of female sandflies of genus *phlebotomus.*

Leishmania has two hosts in their life cycle, invertebrate hosts are the sand files and verterbrate hosts are mammals in which the parasites reside within the phagolysosomal system of mononuclear phagoycytic cells, typically macrophages. There are three species of *Leishmania* infect human:

1. *Leishmania donovani*: Cause visceral Leishmaniasis or Kala-azar. disease.
2. *Leishmania tropica*: Cause cutaneous Leishmaniasis or oriental sore.
3. *Leishmania braziliense*: Cause Muco-cutaneous Leishmaniasis.

Morphology:

The three types of *Leishmania* have the same shape and same life cycle and occurs in two stages:

1. *Leishmania* (Amastigote) stage:

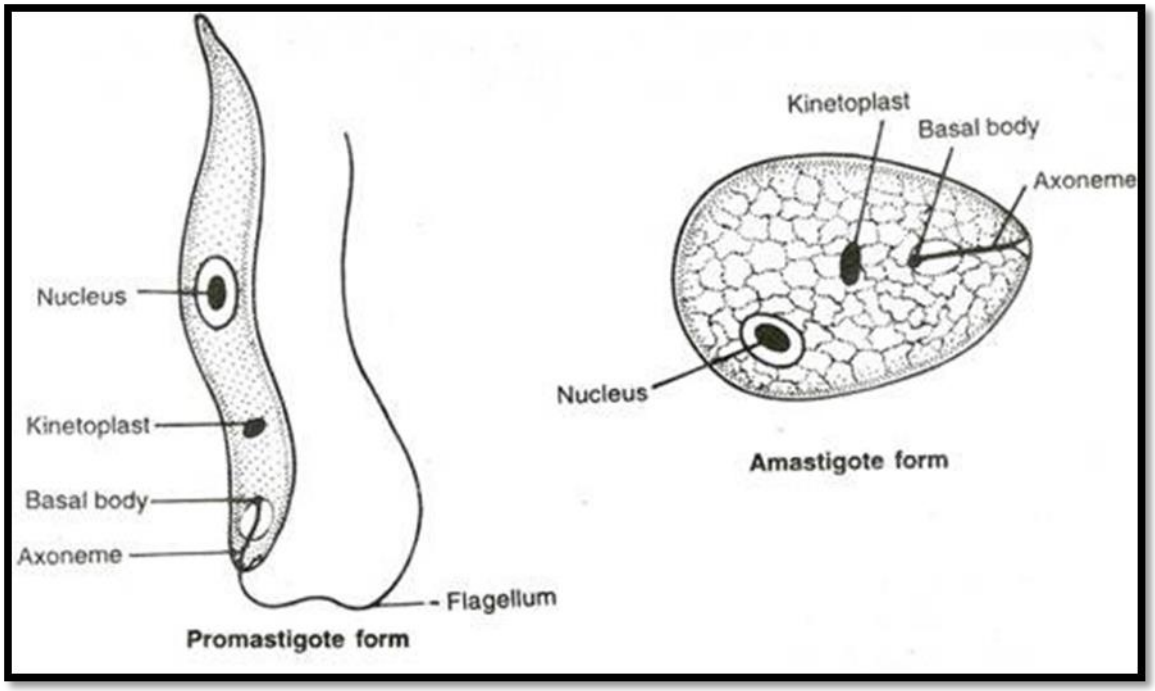
The amastigote resides in the cells of reticulo endothelial system (macrophage, monocyte, bone marrow, liver, spleen and lymph nodes of man). It is non-motile round or oval body measuring 2-4 μm in length, with round or oval one nucleus situated in the middle of the cell or along the side of the cell wall. Kinetoplast consist of parabasal body and blepharoplast which are connected by one or more delicate fibrils.

The axoneme arise from the blepharoplast and extens to the margin of the body. It represents the intracellcular portion of the flagellum.

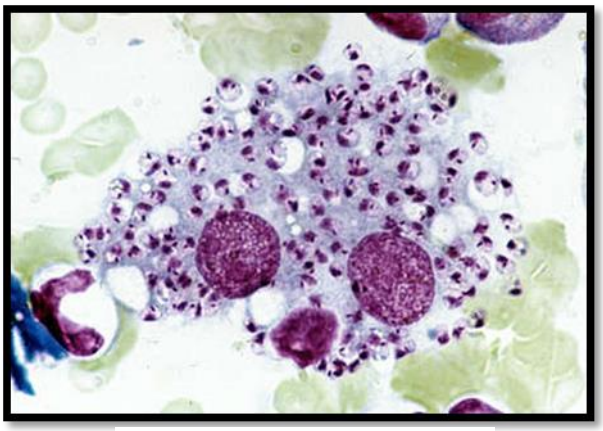
2. Leptomonas (Promastigote) stage:

Promastigote are found in the digestive tract of insect vector (sand flies) and in culture media.

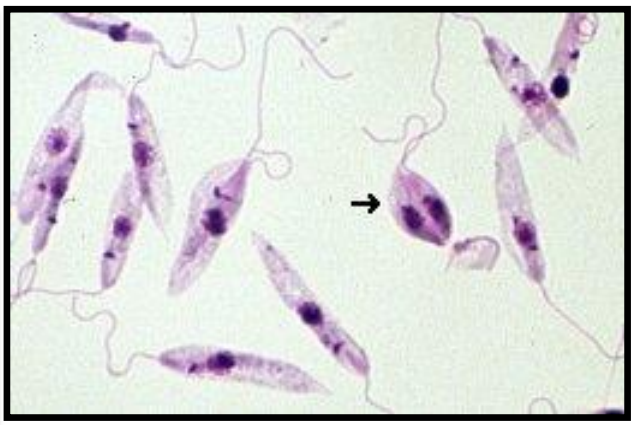
These are elongated, motile, extracellular stage of parasite. Nucleus situated centrally, kinetoplast lies transversely near the anterior end. In front of kinetoplast lies a pale staining vacuole. From the blepharoplast arise the axoneme which projects from the anterior end of the parasite as free fagellum.



Morphological forms of *Leishmania donovani*



Amastigote stage



Promastigote stage

2. Genus *Trypanosoma*:

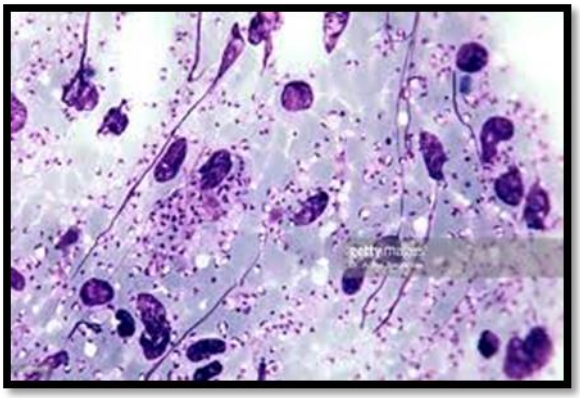
Trypanosomes are haemoflagellates that lives in the blood and tissues of their human hosts, the life cycle include two host:

Inverterbrate host and **vertebrate hosts**.

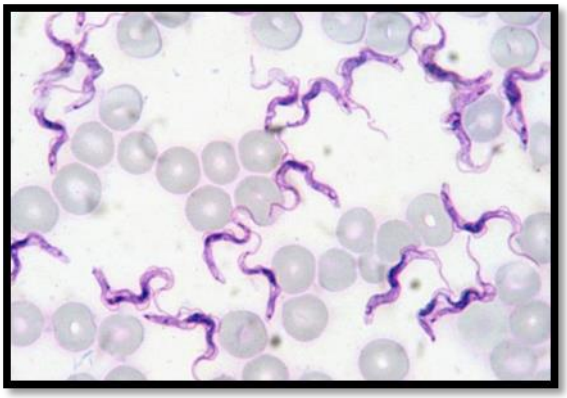
The major trypanosames are nonpathogenic but some of them are pathogenic and cause a disease called trypanosomiasis. The trypanosomes which infect human are:

1. ***Trypanosoma gambiense***: Cause West African sleeping sickness.
2. ***Trypanosoma rhodesiense***: Cause East African sleeping sickness. Both types of trypanosome have same life cycle and same insect vector which is **tsetse fly** from genus ***Glossina*** and passes in two stages:
   a. **Trypomastigote (trypanosomal) stage:** found in blood of the vertebrate host it is elongated, spindle shaped with a central nucleus and kinetoplast posterior to the nucleus. The flagellum runs alongside of the undulating membrane before emerging from the anterior end as free flagellum, this found in blood of infected vertebrate, and divide by binnary fission.

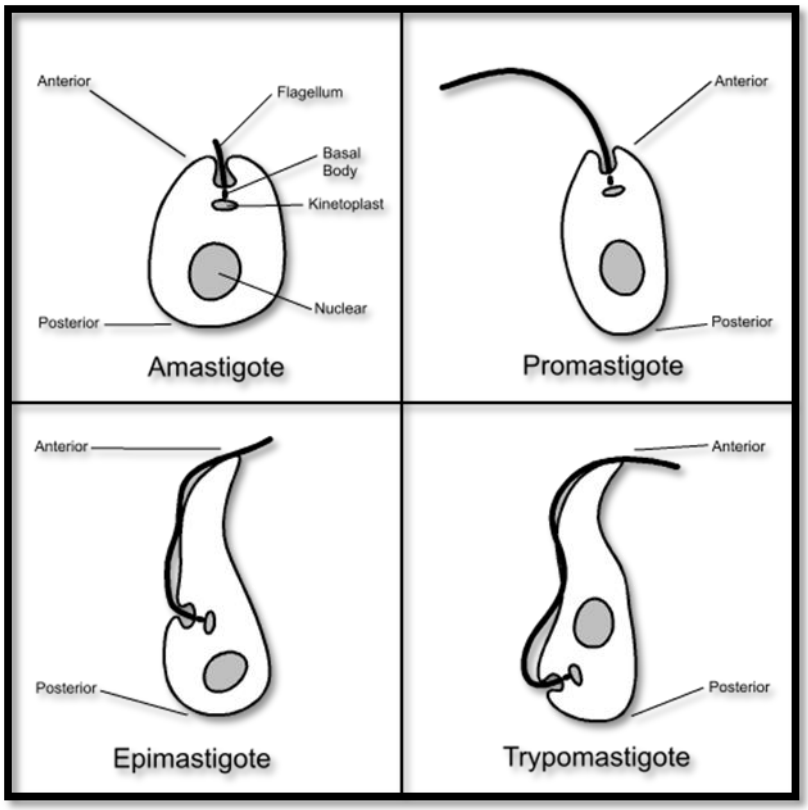
b. **Epimastigote (crithidial) stage**: is more elongated, with the kinetoplast placed more anteriorly in front of nucleus. The flagellum runs along the body as a short undulating membrane before emerging from the anterior end. This is the stage in which ***T. gambiense*** **and** ***T. rhodesiense*** **occur in the salivary glands of the vector tsetse fly (Which is consider as infective stage of this parasite).**



Crithidial stage



Trpanosomal stage



3. *Typansoma cruzi*:

It cause **chaga's disease** or **American trypanosomiasis**. The life cycle include three stages:

a. **Trypomastigote stage.**
b. **Amatigote.**
c. **Epimastigote**

A. Trypomastigote stage:

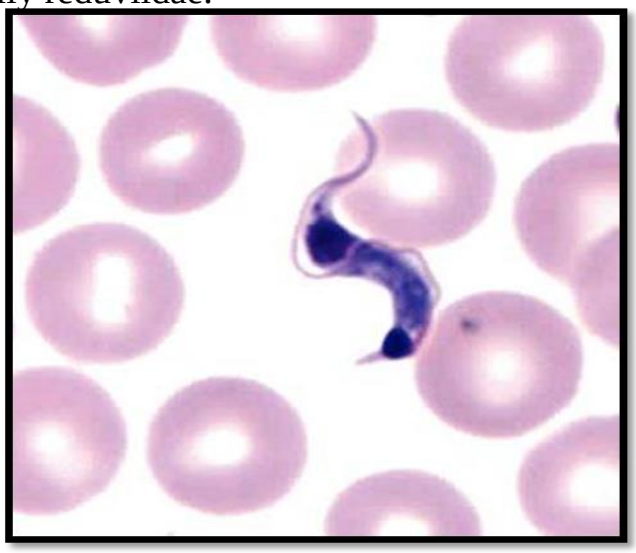
These are present in blood of the patient extracellularly, it has a central nucleus and a large kinetoplast situated at the posterior end. Two forms occur in the blood a long slender one and a short broad one. There is no binnary fission in this stage. (In this species only).

B. Amastigote:

These are round or oval in shape, have a large nucleus and a kinetoplast. It live inside the cells of patient in the reticuloendothelial system especially in spleen, liver, bone marrow, myocardium and neuroglial cells.

C. Epimastigote:

It is found in culture media and insect vector of Genus *Traitoma* from the family reduviidae.



Trypomastigote stage

4th lab

Sporozoa

Phylum: Apicomplexa

Class: Sporozoa.

Subclass: Coccidia.

Order: Eucoccidia.

Suborder: Haemosporidia.

e.g. *Plasmodium*

Genus *Plasmodium*: The malarian organism.

Plasmodium infect various species of vertebrates and cause malarian disease to humans and animals.

The vectors of malaria is the female of ***Anopheles*** **(mosquitoes).** There are four species of malarian parasites (genous *Plasmodium*) infect humans:

1. ***Plasmodium vivax***: Cause bengin tertian malaria (Tertian, because the fever recurs after intervals of 48 hours) and it is less dangerous than *P. falciparum*.
2. ***Plasmodium falciparum***: Malignant tertian malaria, because the fever recurs at irregular intervals of less than the expect 36- 48 hours.
3. ***Plasmodium malariae***: Cause quartan malaria, it has a cycle of 72 hours.
4. ***Plasmodium ovale***: Bengin tertian malaria (Because of its tertian periodicity every 48 hours and the irregular oval shape of infected RBCs).

Life cycle:

Malaria parasites exhibit a complex life cycle involving alternating cycles of asexual cycle (schizogony) occurring in man, the intermediate host and sexual cycle (sporogony) occurring in female *Anopheles* mosquito (definitive host).Therefore, malaria parasites exhibit alternation of generation and alternation of host.There are three stages in the asexual cycle (schizogony):

1. **Pre-erythrocytic stage in tissue.**
2. **Erythrocytic schizogony stage.**
3. **Formation of gamets.**

1. Pre-erythrocytic stage in tissue:

a. Infection of man occur when a minute infective stage (sporozoites) are injected into the blood stream by the female *Anopheles*.

b. Sporozoites are minute slender fusiform organisms with one or more chromatian mass near the center.

c. After half an hour of their entrance into the body. The sporozoites reach the liver where they grow rapidly to form cryptozoic in hibatic cell schizont.

The schizont divides to produce (10000- 40000) small merozoites (schizogony) and after that cell rupture to release metacryptozoite, some of them re-invade more liver cells or invade Red blood cells (RBCs) to starts the erythrocytic stage. (schizogony).

2. Erythrocytic stage (schizogony):

When the merozoites invades the blood stream each enter an erythrocyte where it rounds up and form a trophozoite, the trophozoites grows and feed on the expanse of the host cell (red blood cells).

The trophozoite has a ring shape (ring stage inside RBC), later it forms pseudopodia and takes an amoeboid form amoeboid stage in RBC. Trophozoite continue to grow.

Finally, its nucleus divides repeatedly by mitosis to produce numerous nuclei and the parasite called schizont in RBC. Inside the schizont each nucleus is surrounded by a piece of cytoplasm and cell membrane and it becomes a new merozoite, the erythrocyte membrane ruptures and release the merozoites into the blood stream. The merozoites quickly invade other erythrocytes to start a new cycle inside RBC or some of these merozoites gives rise to gametocytes (i.e. the 3^{rd} stage of schizogony). Two type of gametocytes are formed: The female gametocyte (macrogametocyte) and the male gametocyte (microgametocyte).

The macrogametocyte has small peripheral nucleus and dense cytoplasm loaded with a reserve food material.

The microgametocyte has a large loose centric dense nucleus and granulated cytoplasm.

3. The sexual cycle (Sporogony):

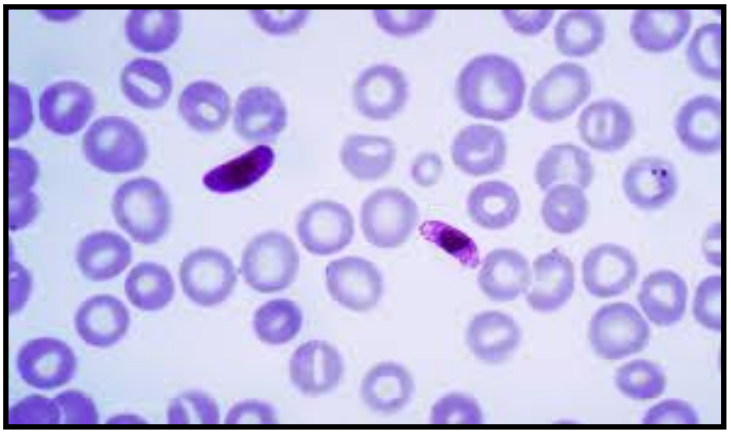
When the female mosquito sucks the blood of the infected host it also takes some R.B.Cs that contain the gametocytes of the parasite.

The gametocytes enter it's alimentary canal and undergo maturation forming male and female gametes. Microgametocytes produce 8 microgametes through 3 successive division.

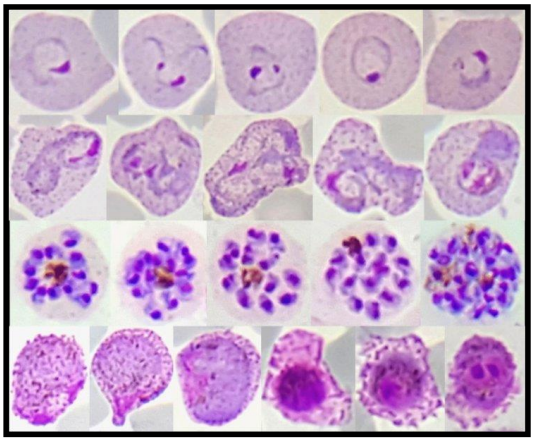
In the meantime, the macrogametocyte gives rise to single macrogamets.

The microgamete fertilized the macrogamete and form the zygote. The zygote develops into a mobile elongated ookinate which penetrates the gut walls of mosquitoe and develops into an oocyst below the outer stomach epithelium. The oocyst mature in (10 - 20) days, the nucleus divides repeatedly into hundereds of small nucleur masses.

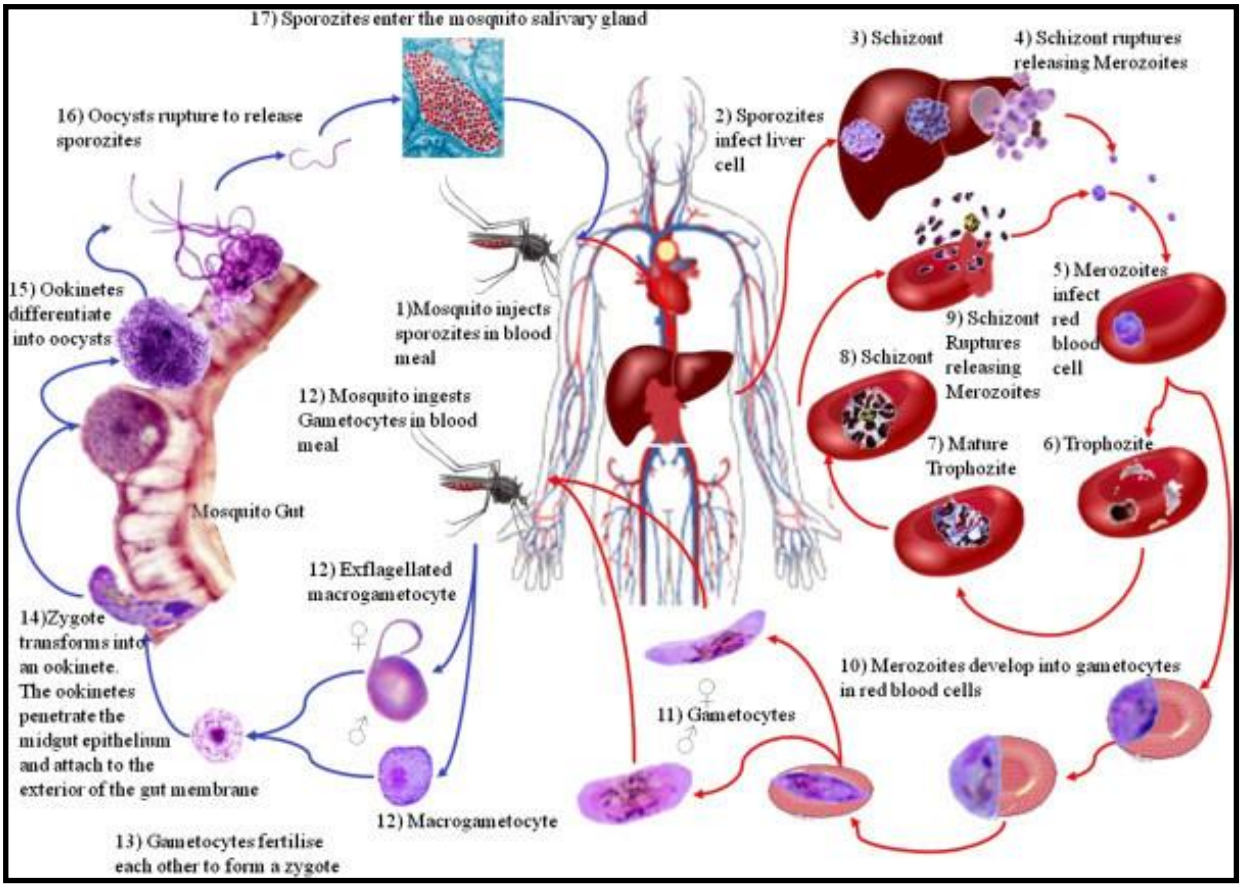
This followed by the division of the cytoplasm resulting in the formation of handred of thread-like sporozoites and at this time the oocyst converted to sporocyst then bursts out to releases the sporozoites. The sporozoites migrate to salivary glands of mosquito. Where they stay until they are injected into a new host and repeat the cycle.



***Plasmodium* gamets**



***Plasmodium* stages**


17) Sporozites enter the mosquito salivary gland
16) Oocysts rupture to release sporozites
15) Ookinetes differentiate into oocysts
Mosquito Gut
14)Zygote transforms into an ookinete. The ookinetes penetrate the midgut epithelium and attach to the exterior of the gut membrane
13) Gametocytes fertilise each other to form a zygote
12) Macrogametocyte
12) Exflagellated macrogametocyte
12) Mosquito ingests Gametocytes in blood meal
1)Mosquito injects sporozites in blood meal
2) Sporozites infect liver cell
3) Schizont
4) Schizont ruptures releasing Merozoites
5) Merozoites infect red blood cell
6) Trophozite
7) Mature Trophozite
8) Schizont
9) Schizont Ruptures releasing Merozoites
10) Merozoites develop into gametocytes in red blood cells
11) Gametocytes

Phylum: Apicomplex.

C*la*ss: Sporozoa.

Subclass: Coccidia.

Order: Eucoccidia.

Suborder: Eimeriina.

e.g.: *Toxoplasma gondii*.

1. *Toxoplasma gondii* is an obligate intracellular parasites, which is found inside the reticuloendothelial cells and many other nucleated cells.
2. *Toxoplasma* occurs in 3 forms
    - **a.** Trophozoite (Tachyzoite).
    - **b.** Tissue cyst.
    - **c.** Oocyst.

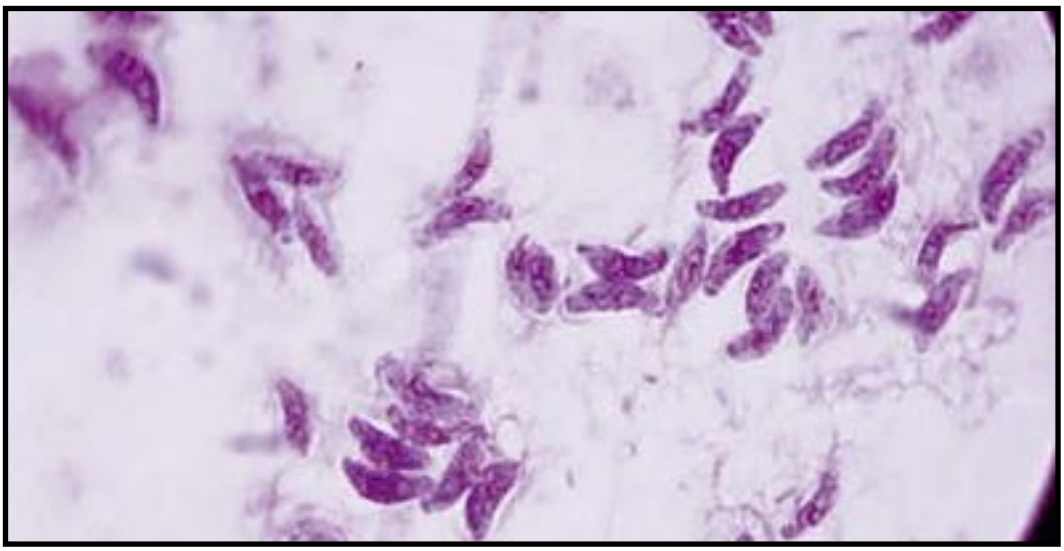
the trophozoite and tissue cyst represent stages in asexual multiplication (schizogony), while the oocyst is formed by sexual reproduction (gametogony or sporogony).

All three froms occurs in the domestis cat which are the definitive host while the humans, mice, rat, sheep and certain birds are the intermediate host.

Trophozoite (Tachyzoite):

1. It is crescent – shaped with a pointed anterior and a rounded posterior end.
2. Nucleus has spherical or rounded shape, which usually situated towards the central area of the cell (parasite).

3. Trophozoite was the active multiplying form seen during the acute stage of infection.
4. It enters the host cell by active penetration of the host cell membrane. After entering the host cell the trophozoite (tachyzoite) assume an oval shape and becomes surrounded by a parasitophorous vacuole.
5. It multiples asexually within the host cell by repeated endodyogeny or internal budding, two daughter trophozoite being formed within the parent cell.
6. Human which is the intermediate host acquire infection by ingestion of food and drinks contaminated with cat's faeces containing sporulated oocyst and also by ingestion of under cooked meat (mutton, pork and rarely beef) containg tissue cysts.



Trophozoit of *Toxoplasma gondii*

5th Lab

Phylum: Platyhelminthes

Platyhelminthes include three classes:

Class: Turbellaria (free-living).

Class: Cestoda (Parasitic).

Class: Trematoda (Parasitic).

Class: Cestoda (Tape-worm):

1- Cestodes have segmented body, dorsoventrally compressed.

2- They are vary from a few millimeters to several meters in length.

3- Adult cestodes live attached to the mucosa in the small instine and absorb food from the host intestine.

4- The adult worm consist of three parts:

- **a.** Scolex
- **b.** Neck
- **c.** Strobila (body or trunk).

5- Cestodes posses an organ of attachment like longitudinal groove (bothria), suckers, rostellum (apical protrusion on scolex) usually present, but may be absent, the rostellum may be armed with hooks or not.

6- Tape worms that infect man, belong to two order:

- **a. Order:** Pseudophyllidea bearing a pair of longitudinal grooves called bothria.
- **b. Order:** Cyclophyllidea bearing cup-like suckers on their scoleices.

Phylum: Platyhelminthes

Class: Cestodea

Order: Pseudophyllidea

e.g: *Diphyllobothrium latum*

1- **Common name: The fish tapeworm**;or the **broad tapeworm**.

2- Adult worm lives in the small intestine (ileum or jejunum) of man. Also in dog, cat and other fish-eating animals.

3- It is the longest tapeworm found in man. With as many as 3.000 or more proglottids.

4- Body consist of scolex, neck and strobila (proglottids or segments).

5- **Scolex:** has almond-shape, it bears two slit-like grooves (bothria) demarcated by lateral lip-like folds, one dorsal and the other ventral. There are no restellum and hooklets.

6- **Neck:** It is situated immediately behind the scolex. It is thin, unsegmented and several times the length of the head.

7- **Strobila** (or proglottids or segments): Consisting of immature and mature segments. The typical mature proglottid is broader than length, and is practically filled with male and female reproductive organs. A coiled uterus in the form of a compact-rosette is seen centrally within each segment, ovary bilobed, vagina,which extend from the common genital pore, uterus open through the uterine pore located in the ventral mid line at the back of common genital pore. The male reproductive organs consist of many testes and muscular male organ which open in the common genital pore.

8- **Egg:** yellowish-brown in color, oval or elliptical in shape, has thin and smooth shell. It contains an immature embryo. There is an inconspicuous operculum at one end with a small knob at the other end.

Larval stages:

Egg develops into 3 larval stages:

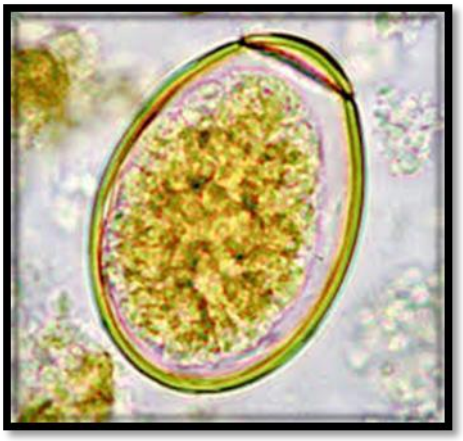
The first stage larva is known as coracidium, it develops from the egg in water as ciliated and free-living larva.

The second stage larva is known as procercoid it develops from coracidium inside small copepods mainly Cyclops (first intermediate host).

The third stage larva is known as plerocercoid. It develops from procercoid in freshwater fish, the second intermediate host.

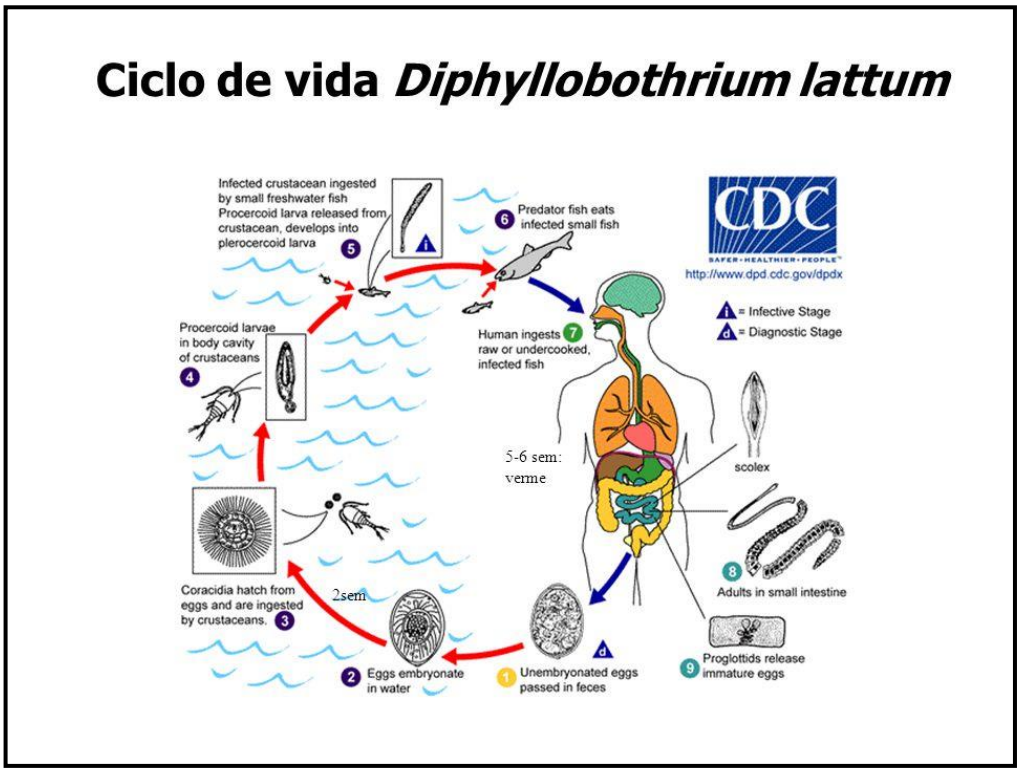
Human become infected by eating undercooked, raw or lightly salted meat or roe from infected freshwater fishes. Inside the intestine of man the plerocercoid larva develops into an adult worm.

Mature segment of *D.latum*



***Diphyllobothrium latum* egg**

***Diphyllobothrium latum* Scolex**



Life cycle of *D. latum*

hylum: Platyhelminthes

Class: Cestodea

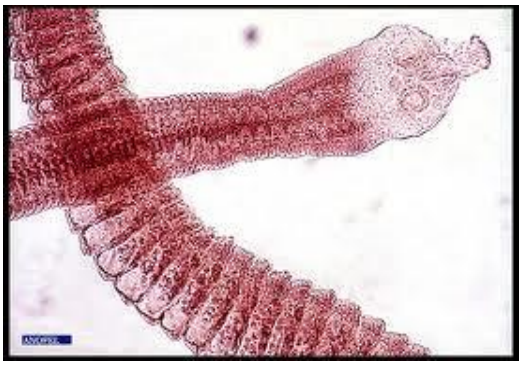
Order: Cyclophyllidea

e.g: *Hymenolepis nana*

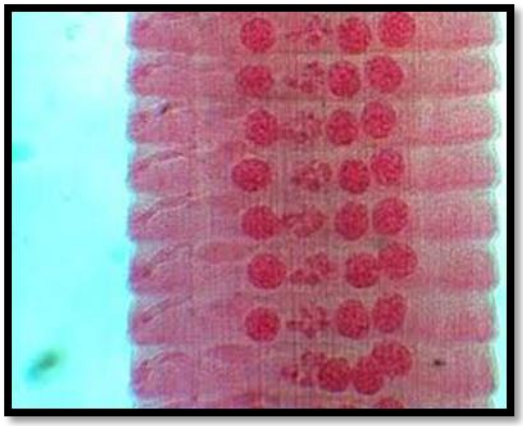
1. **The common name: Dwarf tapeworm**.
2. It is the smallest tapeworm infecting human.
3. In human the adult tapeworm are found in the upper two-third of the ileum.
4. The adult tapeworm is small reaching only 4-5cm in length and 1mm in diameter. It is made up of scolex-neck and strobila.
5. **Scolex**: It is globular, has four cup-shaped sucker and a retractile rostellum armed with a single row of 20-30 hooklets.
6. **Neck**: It is long and slender and is situated posterior to the scolex.

7. **Strobila**: It consists of about 200 proglottids. The mature proglottid has broader than length, genital pores are marginal and are situated on the same side. The 3 testes are circular or round in shape. The ovary is bilobed . the gravid proglottid contain uterus which is transverse sac with lobulated walls.
8. **Egg**: It is spherical or oval, Hyaline. It has asmooth, thin and colourless outer shell and an inner membrane (embryophore). Containing a hexacanth embryo (oncosphere). The space between two membranes is filled with yolk granules and 4-8 polar filaments arising from polar thickenings at either end of embryophore.

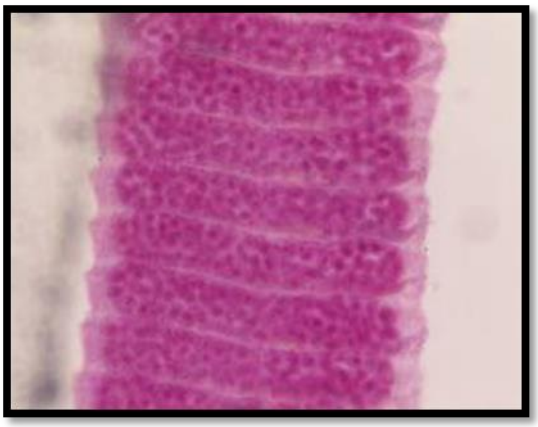
Egg of *Hymeonleps nana*



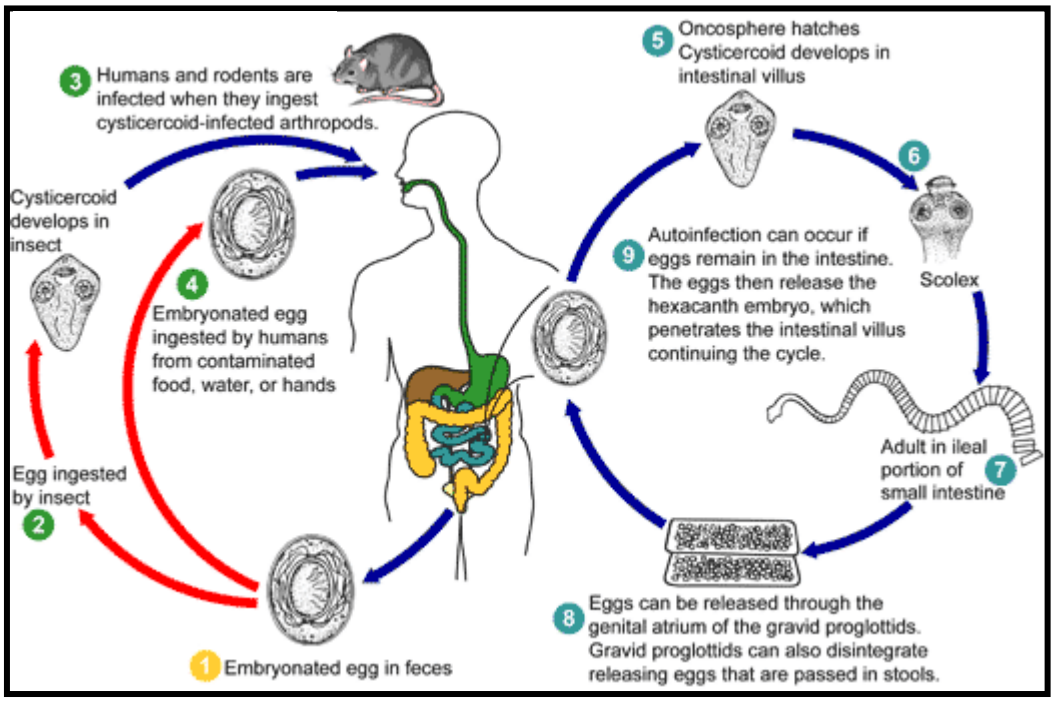
Scolex of *H.nana*



Mature proglottid



gravid proglottid



Life cycle of *Hymeonleps nana*

Life cycle:

H. nana is the only cestode which is capable of completing its life in a single host. It has two types of life cycle.

Direct cycle دورة مباشرة

Indirect cycle دورة غير مباشرة

Direct cycle:

1- Eggs and proglottids with eggs are passed in faeces of infected humans.

2- Man acquires infection by ingestion of food and water contaminated with these (faecal – oral route).

3- In the luman of small inte-sine a free oncosphere (hexacanth embryos) in testine was librated from the egg. It penetrate into a villus of the

enterior part of small intestine and develops into cysticercoid larva in about four days.

4- Thereafter, the villus ruptures and the cysticercid become free in the lumen of the small intestine.

5- Later, it attacks by its scolex to another villus further down, and in the course of weeks or more develops into an adult tapeworm.

6- Strobilation is rapid and in about 30 days after infection, the egg and proglottids with eggs begin to appear in faces the cycle is repeated.

7- In heavy infection, eggs may hatch in the intestine before passing out in the faces resulting in autoinfection.

6th Lab

Phylum: Platyhelminthes

Class: Cestodea

Order: Cyclophyllidea

Family: Taeniidae

e.g: ***Taenia saginata***

Taenia solium

Taenia saginata:

1- **Commonly called beef tapeworm**. It lives in the human small intestine, commonly in the jejunum with its head embedded in the mucosa.

2- The worm is usually 5 meters in length, but may reach 25 meters.

3- Body consist of scolex, neck and strobila.

4- **Scolex**, quadrate in cross section, bearing 4 hemispherical suckers situated at its four angles. The scolex has no rostellum, no hooklets and therefore called unarmed tapeworm. The sucker serve as organ of attachment.

5- **Neck** is long and narrow.

6- **Strobila**: consist of 1000-2000 proglottids, immature, mature and gravid respectively. Mature segment: is quadrate in shape, the genital pore opens on the lateral side of the segment. It contains numbers of testes (about twice than that of *T. solium*), ovary bilobed, uterus sac-like. Gravid segment: are nearly 4 times as long as its broad, with 15-30 lateral uterine branches.

Eggs: of both *T. solium* and *T. saginata* are indistinguishable, spherical, brown in colour. They are surrounded by thick-walled and radially striated embroyphore. Outside this may be present thin transparent shell which represent the rummant of yolk mass. Inside the embryophore is present hexacanth embryo (onchosphere) with three pairs of hooklets.

Scolex of *Taenia sagenata*

scolex of *Tenia solium*

Life cycle:

1- Life cycle passes in two host: The definitive host is man and the intermediate host is cattle.

2- Eggs or gravid segments are passed out of definitive host with the faeces on ground, these were ingested by cows.

3- When they reach the duodenum the embryophore of the eggs ruptures and librates oncospheres, with the help of their hooklets they penetrate the intestine, then reach the circulation and then are filtered out in striated muscles where, they were developed into bladder worm known as cysticercus in 10-12 weeks.

4- The mature cysticercus is ovoid in shape, milky-white apalescent, it has urarmed scolex (scolex without hooklets) invaginated in it, found in the hosts muscles as mastication, cardiac muscles diaphragm and tongue. The cysticerci can live in flesh of cattle for about 8 months but can develop only when ingested by man, its definitive host. Cysticercus is unknown in humans, man acquire infection when eating raw or undercooked beef containing cysticercus (encysted larval stage).

5- The larvae hatch out in the small intestine, the scolices evaginated and anchor to the intiestinal mucosa by mean of their suckers and develop into adult worms.

Taenia solium:

1- It is **commonly called pig tapeworm**.

2- Body consist of scolex, neck and strobila. Its length 2 - 4 metters.

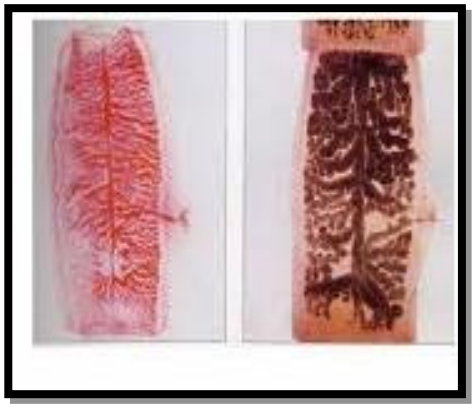
3- Scolex: small, globular, with rostellum armed with a double row of 25-30 alternating large and small hooklets. Possesses four suckers which are not pigmented.

4- Mature segment similar to that of *T. saginate* except that the ovary consist of two lobes with an accessory small lobe. The gravid segment is shorter than that of *T. saginata* and have 5-10 lateral uterine branches or (7-12).

5- Cysticercus (larval stage) is an opalescent, it has an invaginated scolex with its four suckers and a rostellum with a double row of alternating large and small hooklets.

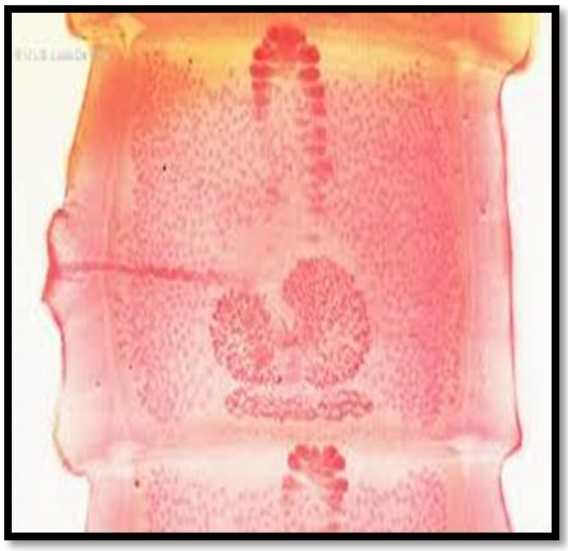
6- Man acquires infection by eating raw or undercooked pork containing cysticercus.

T.saginata ***T.solium***

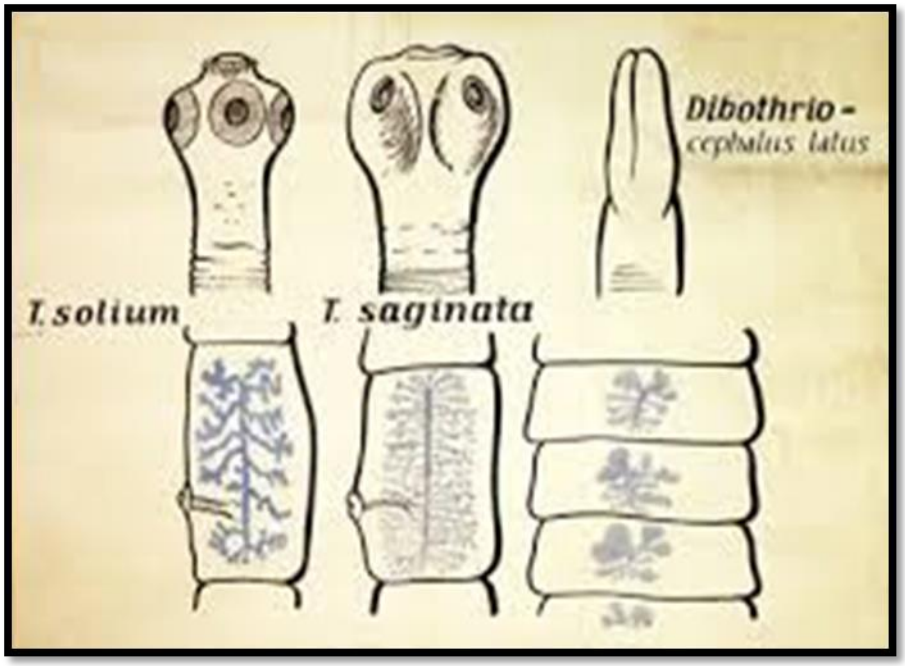


Note- 5-10major uterine branches with *T.soluim* in *T.saginata* *15-30 branches*

Stained gravid segments of *T.saginata* and *T.solium*



mature segment of *T.saginata*



Phylum Platyhelminthes

Class: Cestodea

Order: Cyclophyllidea

Family: Taeniidea

e.g: *Echinococcus granulosus*

1- **Common names: The dog tapeworm; the hydatid worm.**
2- Adult worm resides in the small intestine of dog and other canine animals (wolf – fox and jackal).
3- The larval form was seen in man and other intermediate hosts (sheep, goat, cattle, pig and horse). The dog is the definitive host.
4- The adult worm is small measuring 3-6mm in length. It consists of a scolex, neck and three strobila.
5- **Solex:** It has pyriform shape. It possesses four suckers and protrusible rostellum with two circular rows of hooklets. **Neck:** It short and thick. **Strobila:** It consists of three segments (occasionally four). The first

segment immature, the second are mature and the third (and the fourth when present) gravid.

6- **Eggs** are indistingusible from those of other *Taenia* species. And contain hexacanth embryos with three pairs of hooklets.

7- **Larval form**: this is found within the hydatid cyst which develops in the intermediate host.

Life cycle:

1- *E. granulosus* passes its life cycle in two hosts.

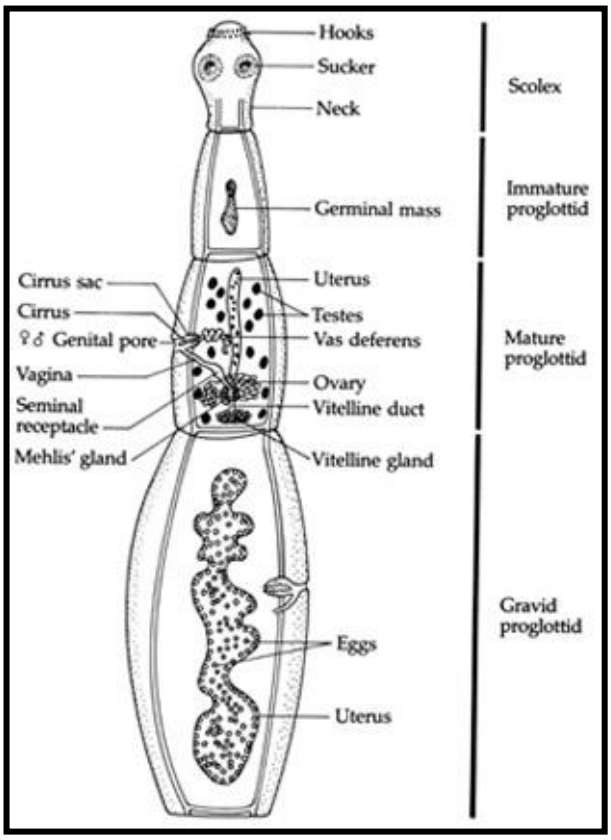
2- The adult worm lives and attached to the mucosa of small intestine of dog and other canine animals.

3- The eggs are discharged in the faeces of dog. These are swallowed by the intermediate hosts while grazing in the fields.

4- Man acquires infection by direct contact with infected dog or by allowing the dog to feed from same dish or by ingesting water and food contaminated with dog's faeces containing eggs of *E.granulosus*.

5- When the eggs ingested by sheep or man, the hexcanth embryo hatch out and penetrate intestine, and by circulation reach target organs and develop into hydatid cyst.

6- When the hydatid cyst with it protoscolecies (hydatid sand) ingested by dog the ingested protoscolecies evaginates in the intestine and develop into adult worm.



Echinococcus granulosus

Hydatid sand (protoscolecies)

Egg of *E. granulosus*

7th Lab

Class: Trematoda

1- Trematodes or flukes are leaf-like unsegment flat worms.

2- They vary in size, the most characteristic external structures are possession of two sucker's oral through which the digestive tract opens and ventral (acetabulum) for attachment.

3- All trematodes are hermaphrodite except the schistosomes which are unisexual.

4- Body is covered with integument, which often bears spines.

5- Body cavity is absent.

6- Alimentary canal was incomplete. It consists of a mouth surrounded by oral sucker, muscular pharynx and the eosophagus which bifurcate in front of ventral suckers into a pair of blind intestinal caeca, anus was absent.

7- The excretory system consists of flame cells.

8- The nervous system consists of a group of paired ganglion cells and nerve trunks.

9- Reproductive system is well developed.

10- Life cycle passed in to two hosts:

Man, harbours the adult worm, the definitive host. And fresh water sail or mollusk, the intermediate host.

A second intermediate host may be present in the life cycle as crab which required for encysment in some trematodes.

Phylum: Platyhelminthes

Calss: Trematoda

Order: Digenea

Family: Fasciolidae

e.g: *Fasciola hepatica*

1- **Common names: The sheep liver fluke**, or **common liver fluke**.
2- **It causes the liver rot of sheep**.
3- Adult worms found in the biliary passages of liver of sheep, goat, cattle and man.
4- It is a large leaf-shaped fluke, brown to pale grey in color.
5- Bilaterally symmetrical with three body wall layers.
6- The anterior end width shoulders. It has a distinct conical projection the cephalic cone, the posterior end is broadly pointed.
7- Oral sucker was situated in the conical projection at the anterior end.
8- Ventral sucker was situated nearby in a line with two shoulders, suckers have same size.
9- The intestinal caeca, testes and vitelline follicles of the parasite are extensively branched.
10- **Eggs**: large, elliptical to oval, operculated, light yellowish-brown in color. It has thin shell with smooth surface. Egg contains an immature larva the miracidium which extends to the shell margins without leaving space.

Infective form:

Metacercariae encysted on water plants that are ingested by definitive host.

Life cycle:

F. hepatica passes its life cycle in one definitive and two intermediate hosts.

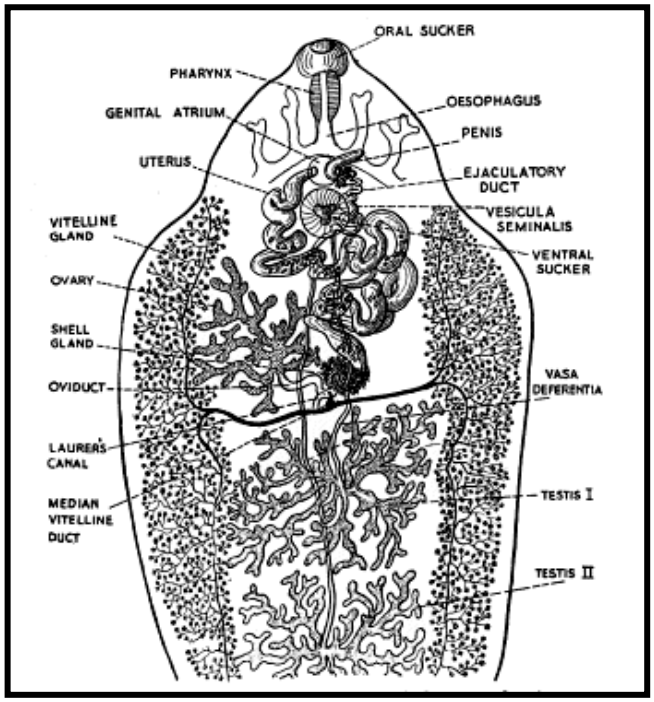
Definitive hosts: sheep-goat, cattle and man. The first three are the reservoir hosts of *F. hepatica*.

Intermediate hosts: First intermediate hosts: snails of genus *Lymnaea.*

Second intermediate host: Aquatic vegetation e.g watergrass.

Digestive system:

1. The alimentary canal begins with the mouth opening.
2. Mouth leads into a short muscular pharynx which leads into an extremely short and thin eosophagus.
3. Oesophagus is followed by the intestine which divides into (2) right and left, branches called intestinal caeca.
4. Each branch extends to the posterior parts of the body giving rise to some short inner branches and numerous and much longer outer lateral branches, called diverticulae which end blindly. There is no anus.



Excretory system:

1- It consist of a great number of small canals which collect into a main excretory canal.

2- This main canal extends along the middle line in the posterior three quarters of the body and opens to the outside by the excretory pore.

3- The small canals are branching and end with flame cells or solenocytes.

Reproductive system:

1- **Male reproductive system** consist of two testes lying in the centre of the body, the left one anterior to the right, they are tubular, branched organs and each one give off a vas deferens. The two vasa efferentia run to the region of ventral sucker where they unite to form sminal vesicle followed by ejaculatory duct which terminates with cirrus enclosed in a cirrus sac and open into the genital atrium.

2- **Female reproductive systems**: consist of a single branched ovary which lies to the right side of the anterior third of the body, infront of the testes. It leads to viduct. A great number of minute rounded follicles the vetilline or yolk glands on either side of the body between the diverticula of intestinal caeca. Ootype. Small chamber found at the point where the oviduct and median vitelline duct meet and surrounded by a cluster of unicellular glands called mehlis gland. From the ootype a long and wide convoluted tube, the uterus runs forwards to open in the genital atrium.

Life cycle:

Egg → miracidium→ sporocyst→ Redia I and II→ cercaria → metacercaria→ Adult worm (in definitive host).

Miracidia:

Is a minute free-living larva with an elongated conical body covered by cilia.

It has an apical gland and penetrating papillae, two pairs of penetration gland, two eyespots, two flame cells and some germ cells.

Sporocyst:

Is a sac-like, covered by epidermis and thin cuticle, and filled with parenchyma and germ cells which develop into redia.

Redia:

Has an elongated body with an anterior projecting collar and two posterior processes. It has a mouth, a suctorial pharynx, a simple sac-like intestine, paired flame cells, and germ cells. The germ cells develop either into a second generation of redia (daughter redia) or into cercaria according to the temperature . All of which escape through a birth pore situated anteriorly behind the collar.

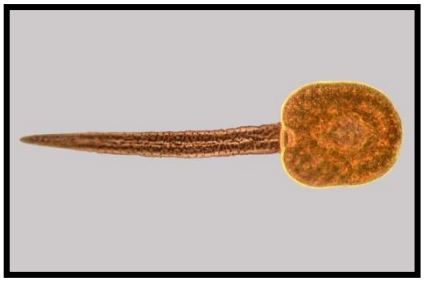
Cercaria:

Has a heat-shaped body with long unforked tail and rudiments of most of the adult organ: two suckers, pharynx and a bifid intestine, paired flame cells and excretory canals.

Metacercaria:

Or encysted cercaria has lost the tail and enclosed with a thick cyst secreted by the cystogenous cells.


Egg of *F.hepatica* →→ **miracidium** →→→ **sporocyst** →


→→redia →→→ **cercaria** →→ ***Fasciola hepatica***

Phylum: Plathyhelminthes

Class: Trematoda

Order: Digenea

Family: *Fasciolidae*

Fasciolopsis buski

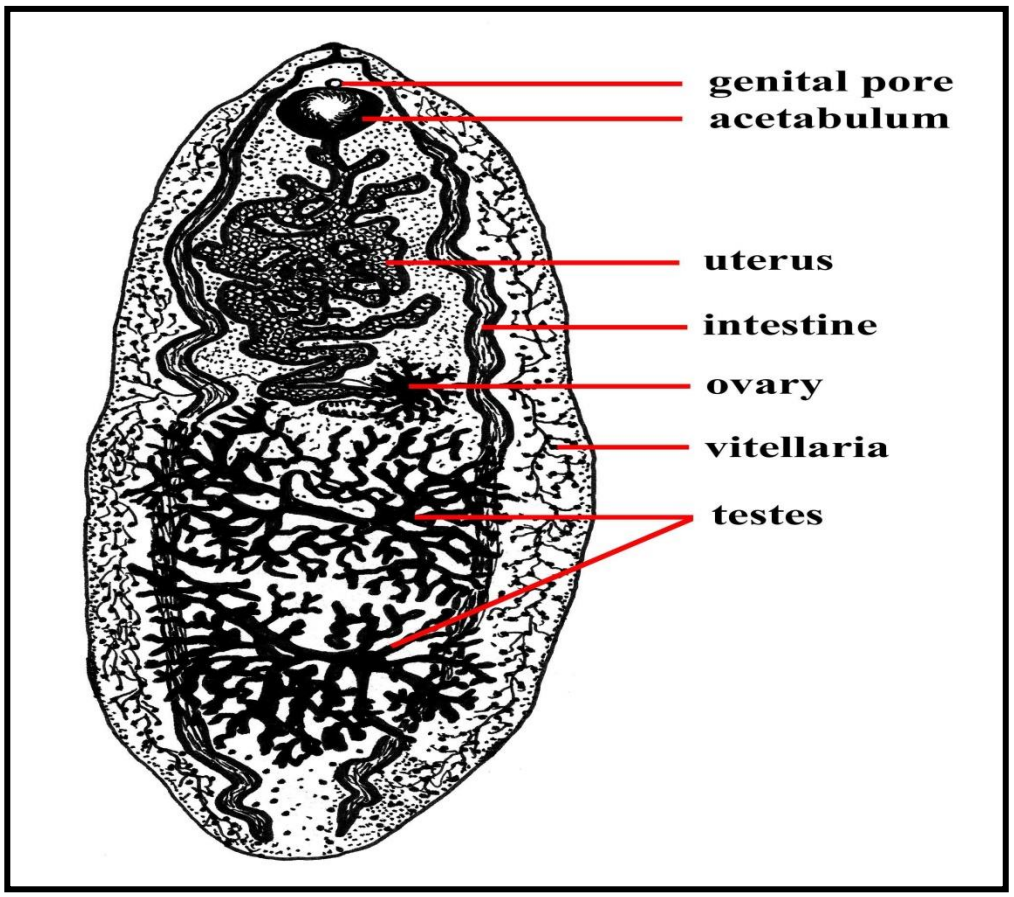
1. **Common name: The large or giant intestinal fluke**. It is the largest fluke that infect humans.
2. The adult worm lives attached to the mucosa of the duodenum and jejunum of man and pig. Pig serves as reservoir of infection for man.
3. Adult worm consider as the largest trematode parasitising man. It is fleshy dark red, and elongate, ovoid in shape, the anterior end narrower than the posterior one.
4. There is no cephalic cone, the ventral sucker lies close to oral sucker. The ventral sucker larger than oral one.
5. The two intestinal caeca have no branches.
6. The male genital system consist of two testes lies in the posterior half of the body.
7. The female genital system consist of single branched ovary lies on the right half of the body.
8. The vitelline glands lies lateral to intestinal caeca and extend from the region of ventral sucker to the end of the body.
9. The convoluted uterus extend or arise from ootype and open in the common genital atrium which lies on the anterior edge of the ventral sucker.
10. **Eggs** are almost identical with those of *F. hepatica*.
11. The infective stage: Metacercariae with encysted on aquatic vegetation that are ingested by humans.

Life cycle:

Definitive hosts: Man and Pig there were two intermediated hosts:

The first intermediate hosts: snails from the genera *Segmentina* and *Hippeutis*. The second intermediate host: Aquatic vegetations especially the seed pods of water caltrop, and roots of the lotus and water bamboo.

The life cycle of *Fasciolopsis buski* is closely parallels that of *F.hepatica*, but is differ in the intermediate host.



8th lab

Phylum: Platyhelminthes

Class: Trematode

Family: Opisthorchiidae

e.g*: Clonorchis sinensis*

1- Common nane: Chinese liver fluke; **oriental liver fluke**.

2- The adult worms habitat the biliary tract and occasionally in the pancreatic duct of man.

3- The fluke is narrow, oblong, flat worm with pointed anterior and somewhat rounded posterior end.

4- The oral sucker is slightly larger than the ventral sucker, which is situated at the junction of the anterior and the middle third of the body.

5- The blind intestinal caeca are simple and extend to the end of worm.

6- It has two large deeply lobulated or branched testes. These are situated one behind the other in the posterior third of the body.

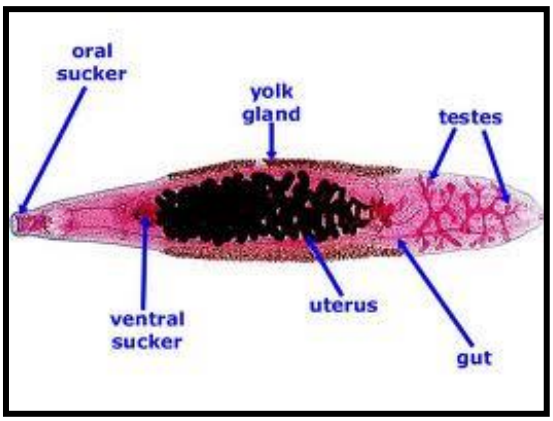
7- Uterus was convoluted, end with common genital opening. It has lobulated ovary.

8- Vitelline glands are in the form of small follicles and occupy the mid-lateral part of the body.

9- The eggs are broadly ovid have thick, light yellowish-brown shell and provided with a distinct convex operculum resting on a shoulders. Egg has a small knob at it's posterior end. They hatch only after ingestion by suitable molluscan hosts.

10- The infective form is metacercariae encysted in the flesh of freshwater fish.

Egg of *C.sinensis*



Clonorchis sinensis

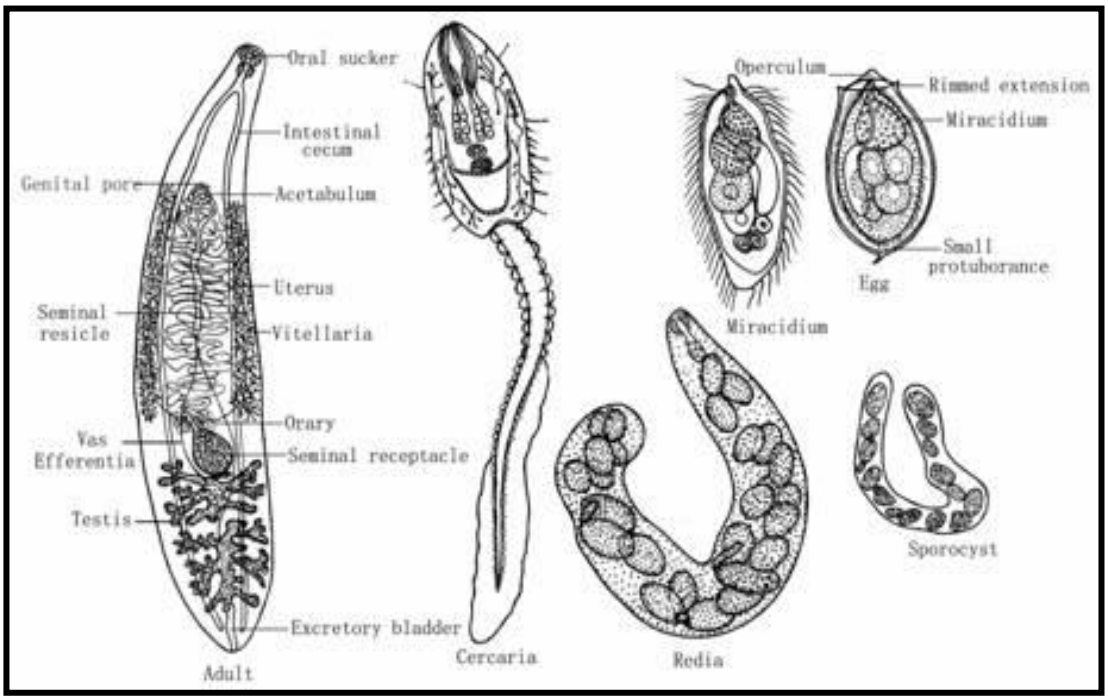
Life cycle:

C. sinensis passes its life cycle in three hosts, one definitive host and two intermediate hosts.

Definitive hosts: are Man, pig, dog, cat and rat.

First intermediate host: mollusc from genera: *Bulimus, Melanoides,*

Second intermediate hosts: Freshwater fish of the family cyprinidae.



Phylum: Platyhelminthes

Class: Trematode

Order: Digenea

Family: Troglotrematidae

e.g: *Paragonimus westermani*

1- It causes paragonimiasis.

2- Common name: is oriental lung fluke.

3- The adult worms found usually in pairs, in the fibrous capsules in the lungs of man and other definitive hosts.

4- It is thick, fleshy, oval-shaped and reddish-brown in colour with an integument covered with scale – like spines.

5- Its anterior end is slightly broader than the posterior end.

6- The ventral sucker is located toward the middle of the body and is of similar size to the oral sucker on the anterior end.

7- The fluke possesses an large excretory bladder.

8- The two blind intestinal caeca are zig-zag in shape and unbranched extending to the end of the body.

9- Tow testes are irregularly lobulated, one in front of the other located in the posterior third of the body.

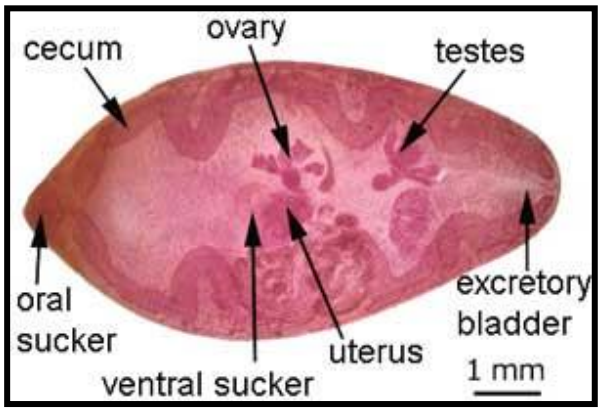
10- Ovary also lobulated and found infront of the testes in the right side, but the convoluted uterus lies in the left side.

11- The vitelline glands lies laterally and continuous to end of the body.

12- The eggs are oval, yellowish-brown, with a flattened operculum resting on shoulder. Shell is smooth and thick. They are unembryonated when laid.

13- The infective form is metacercariae, which encysted in flesh of various crustaceans (crayfish, crab).

Egg of *P. westermani*



P. westermani

Life cycle:

Life cycle is passed in three hosts, one definitive host (Man, wolf, fox, tiger) and two intermediate hosts: First one is a freshwater snail of genera: *Tiara*, *Brotia*, *Hua* and *Syncera*.

The second one is a freshwater crayfish or a crab (crustacean).

Phylum: Platyhelminthes

Class: Trematode

Order: Digenea

Family: Schistosomatidae

e.g: There were three species of genus: *Schistosoma* infect man:

1- *Schistosoma haematobium*

2- *Schistosoma mansoni*

3- *Schistosoma japonicum*

Schistosomes or blood flukes:

1- Schistosomes are the causative agents of the disease schistosomiasis.

2- Schistosomes are unisexual trematodes i.e. the sexes are separate.

3- Males are shorter and stouter than females.

4- Males possess a gynaecophoric canal, for holding the females continuously and during copulation.

5- Suckers were armed with delicate spines.

6- Muscular pharynx was absent and intestinal caeca reunite behind the ventral sucker to form single canal.

7- In males, the number of testes varies from (4-8).

8- **Eggs** are non-operculated and are fully embryonated when laid.

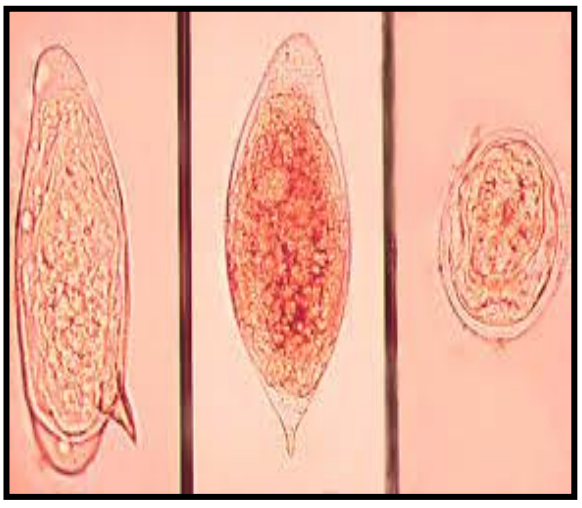
9- Cercariae have bifid tails, they can penetrate the unbroken skin of the definitive host.

10- Encysted metacercaial stage is absent the three species infect man, habitate circulatory system of mas:

a. ***Schistosoma haematobium*.** The adult worms live in the vesical veins.

b. ***S. mansoni***. The adult worm live in the venules of the inferior mesenteric group in the sigmoidorectal area.

c. ***S. japonicum***. The adult worm are seen typically in the venules of superior mesenteric vein



S.mansoni ***S.haematobium*** ***S.japonicum***

Eggs of Schistosomiasis

Differentiating features of *S. haematobium, S. mansoni* and *S. japonicum*

	S. haematobium	*S. mansoni*	*S. japonicum*
Geographical distribution	51 eastern Mediterranean and African countries, India and Turkey.	36 countries in Africa, 9 in the Americas and 7 in the East Mediterranean.	China, Indonesia, Philippines and Thailand.
Morphology male			
Size	10-15mm in length and 0.8mm in breadth.	6.4-12mm in length and 1mm in breadth.	12-20mm in length and 0.5mm in breadth.
Integument	Covered with minute tuberculation	Covered with more conspicuous tuberculation.	Covered with minute acuminate spines.
Number of testes	4-5	6-9	7
Female			
Size	20mm in length and 0.25mm in breadth.	7.2-17mm in length and 0.25mm in breadth.	26mm in length and 0.3mm in breadth.
Ovary	In the posterior one-third of the body.	In the anterior half of the body.	In the middle of the body.
uterus	Contains 20-200 eggs.	Contains 1-3 eggs	Contains 50 or more eggs
Egg	**Elongated, 110-170um long and 40-70um wide. Has a thin, smooth shell, a rounded anterior end and characteristic terminal spine from the tapered posterior end.**	**Elongated, 115-180um long and 40-70um wide. Has a thin, smooth shell with a prominent lateral spine near the more rounded posterior end. Anterior end tends to be somewhat pointed and curved.**	**Oval or subsherical, 70-100um long and 55-65um wide. Has a smooth, relatively thick shell. A small lateral knob may be seen. Because it is often located in a depressions in the shell, this is often difficult to see.**
Egg dis.			
Charged in	**Urine**	**Faeces**	**Faeces**
Infective form	**Fork-tailed cercariae that penetrate skin of humans wading in freshwater canals**	**As in case of *S. haematobium***	**As in case of *S. haematobium***
Cephalic gelnds	Two pairs oxyphilic and three pairs basophilic	Two pairs oxyphilic and four pairs basophilic.	Five pairs oxyphilic (no basophilic)
In cercariae			
Habitat	Veins of the vesical and pelvic plexuses, less commonly in portal vein and its mesenteric branches.	Mesenteric veins draining sigmoido-rectal region (interior mesenteric vein and its branches.	Mesenteric veins draning ileo-caecal region (superior mesenteric vein and its branches)
Definitive host	**Man**	**Man**	**Man and domestic animals**
Intermediate snail host	***Bulinus spp.***	***Biomphalaria spp.***	***Oncomelania spp.***

9 Lab

Nemathelminthes

General characters:

1- Nematodes are the most abundant and widespread animal group.

2- Many species of nematodes are free-living in fresh water marine, mud soil and others are parasites of both animals and plants.

3- They are elongated, cylindrical, bilaterally symmetrical unsegmented worms with tapering ends.

4- Body was covered with a tough cuticle which may be smooth, striated, or spiny.

5- Adults vary greatly in size from less than 5mm (*Trichinella Spiralis*) to more than one metre (*Dracunculus Medinensis*).

6- Males were generally smaller than females and there posterior end curved or coiled ventrally.

7- They have a straight digestive tract with an anteriorly terminal mouth and posteriorly subterminal anus.

8- Excretory and nervous system are rudimentary.

9- Circulatory system was absent and the body wall consist of an outer layer of cuticle and an inner layer of longitudinal muscles.

10- Sexes are separate.

11- The male reproductive system consists of a long convoluted tube which can be differentiated into testis, vas deferens, seminal vesicle and ejaculatory duct which opens into the cloaca.

12- The female reproductive system consists of the ovary, oviduct, seminal receptacle, uterus and vagina.

Phylum: Nemathelminthes

Class: Nematoda

Subclass: Phasmidia

Order: Oxyurida

e.g: *Enterobuis vermicularis*

(Phasmid: is a caudal chemoreceptors), according to the presents of which mematodes divides into two groups phasmedia and a phasmedia.

1- *Common name: Threadworm, pinworm, seat worm.*

2- Adult worms inhabit the caecum, appendix and adjacent portions of ascending colon.

3- The adult worms are white, spindle-shaped and resemble short pieces of thread.

4- At the anterior end of both male and female worms possess a pair of wing-like cuticular expansions, known as cervical alae which are transversely striated.

5- Male measures 2-4mm in length and 0.1-0.2mm in breadth and the posterior one – third of the body is curved.

6- The female is longer, 8-12mm in length and 0.3 - 0.5mm in width, its posterior extremity is straight and drawn out into a thin pointed pin-like tail.

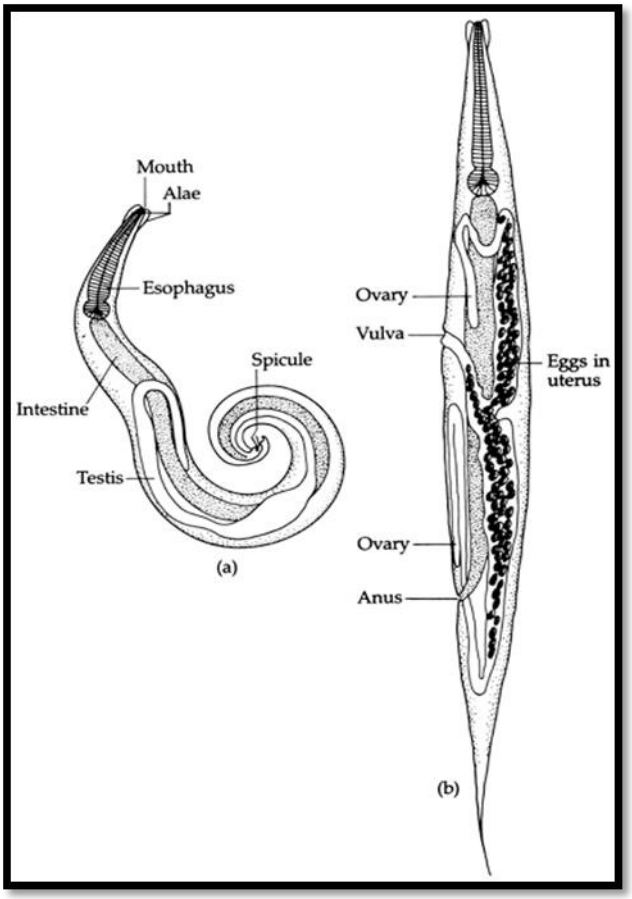
7- Male live for about 7 weeks and female live for 5-13 weeks.

8- *Enterobuis* cause enterobiasis or pin-worm infection which was most frequently found in school age children, but can occur in any age group.

9- **Eggs** are colorless, and flattened on one side (planoconvex) or like D-shape. They are surrounded by a thin, smooth, transparent shell and usually contain fully developed larvae.

10- The definitive host was the man and the infection takes place by the contamination of hands with the eggs. Infection may also be acquired from contaminated object like door knobs.

11- The life cycle was simple and completed in a single host.



a-male of *E.vermicularis*

b-female of *E.vermicularis*

Eggs of *Enterobuis vermicularis*

Phylum: Nemathelminthes

Class: Nematoda

Subclass: Phasmidia

Order: Ascaridida

e.g: *Ascaris lumbricoides*

1- The common name: is common roundworm.

2- The adult worm inhabit the small intestine particularly the jejunum of man.

3- Adult worms: Body was cylindrical tapering gradually at the anterior end and somewhat less at the posterior end, white longitudinal streaks can usually be seen along the entire length of the pinkish cream body of the parasite. Mouth open at the anterior end. It possesses three finally lips. One dorsal and two ventrolateral.

The male measures 15-30cm in length and 3-4mm in diameter. The posterior end is curved ventrally, the ejaculatory duct along with the anus open into the cloaca from which arises a pair of copulatory spicules of equal size.

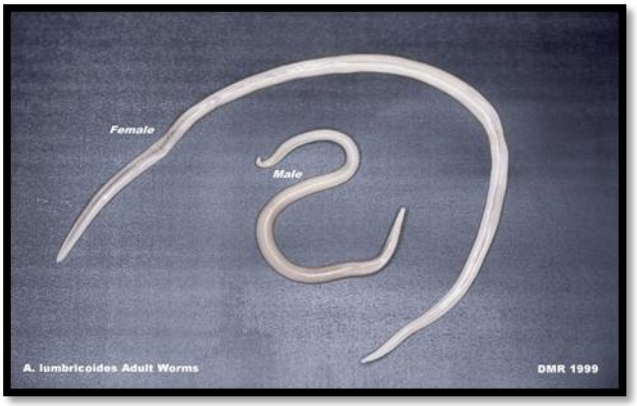
The female is longer and stouter than the male worm and measures 25-40cm in length and 5mm in diameter, with straight and conical tail. Anus was sub terminal and opens on the ventral surface in the form of a transverse slit. The valva open at the junction of the anterior and middle third of the body on the midventral aspect of the worm.

4- The fertilized eggs are round or oval in shape. They are surrounded by a thick, transparent shell, consisting of a relatively nonpermeable innermost lipoidal vitelline membrance, thick transparent middle layer and an outermost coarsely mammillated albuminiod layer.

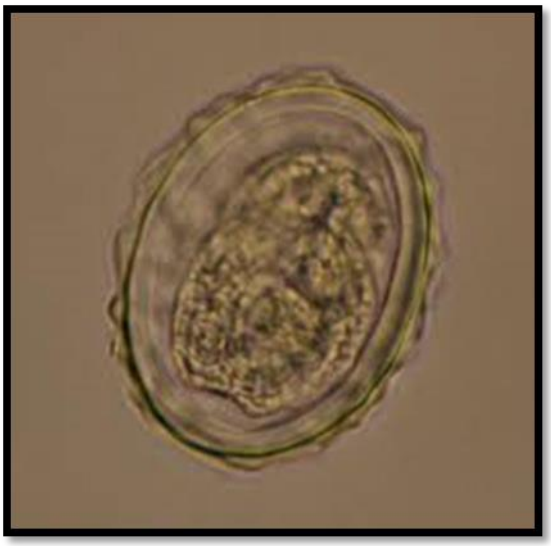
5- According to the huge number of eggs produce d by female some of them were unfertilized egg in the absence of male worm, female produces unfertilized (infertile) eggs also.

These are narrow and longer, measure 90µm in length and 55µm in width. They have a small atrophied ovum and a thin shell within an irregular coating of albumin. The innermost lipoidal vitelline membrane of the shell is absent.

6- Man acquires infection by ingestion of food, water or raw vegetables contaminated with embryonated eggs.



Adult male and female



Fertilized egg of *Ascaris lumbricoides*

Phylum: Nemathelminthes

Class: Nematoda

Subclass: Aphasmidia

Order: Enoplida

e.g: *Trichuris trichiura*

1. **The common name is whipworm**.
2. It live in the large intestine, particularly in the caecum and less commonly in vermiform appendix and colon of man.
3. Adult worms are whip-shaped, body consist of two portions. The anterior three-fifth is very thin and hair-like; the posterior two-fifth is thick and stout, resembling the handle of the whip.
4. The worm lives in the large intestine with the long, thin anterior end buried in the mucosa while the thicker posterior end, which contains the reproductive tract, extends into the intestinal lumen.
5. The worms are white in color. The male worm measure 30-45mm in length and have coiled posterior end.
   The female worms are longer measure 35-50mm in length and their posterior end was comma or arc-shaped.
6. The eggs are barrel-shaped with mucous plug at each pole. Shell is yellow to brown and plugs are colourless.
7. Man acquires infection by ingesting embryonated eggs. With contaminated food or water.

Egg of *Trichuris trichiura*

Male and female worms

10 Lab

Phylum: Nemathelminthes

Class: Nematoda

Subclass: Aphasmidia

Order: Enoplida

e.g: *Trichinella spiralis*

1- The common name (trichina worm). It is the causative agent of trichinosis.

2- It occurs in humans both as an adult in the intestine and as a larval stage in the tissues, usually muscles (i.e. it is both definitive and intermediate host in the same time).

3- Adult worms lived buried in the duodenal or jejunal mucosa of pig, rat or man. The encysted larvae are present in the striated muscles of these hosts.

4- It is one of the smallest nematodes infecting man. The female measure 3-4mm in length by 0.06mm in diameter. They are viriparous and release first stage larvae into the intestinal mucosa.

The male measures 1.4-1.6mm in length by 0.04mm in diameter. At its tail end, it bears a pair of papillae, termed clasper, that was used to hold on the female worm during mating.

5- The larvae measure 80mm in length by 7-8mm in diameter. The infective larvae becomes encysted in the striated muscle fiber and measures 10mm in length by 6mm in diameter called as capsulated larva which has coiled - shape inside the capsule.

The life span of the adult worm is very short. The male after fertilizing the female, dies and the female dies after about 16 weeks, the period required for discharging larvae.

Life cycle:

1- The whole life cycle was passed in one host. (Pig, rat or man) only Man was the dead end of the parasite and represent the alternative host.

2- Infection normally passes from pig-to-pig, pig-to-rat and rat-to-rat.

3- Infection of the new host is acquired by ingestion of raw flesh of the animal containing viable encysted larvae (capsulated larvae).

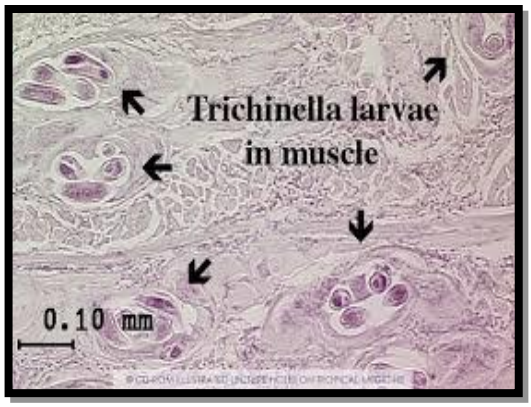
4- Man acquires infection by ingestion of raw or inadequately cooked park containing the viable larvae.

5- The larvae are released in the stomach by the action of digestive enzymes and the freed larvae are transported to the duodenum and jejunum. They penetrate into the epithelium and after 30 hours, mature to adult. Within 5 days they become sexually mature. Males, after fertilizing the female were died.

6- The fertilized female (Five days after infection) discharges a large number of first-stage larvae into the intestinal mucosa. These larvae enter the lumina propria of intestine and from there, penetrate the mesenteric lymphatics and finally blood stream. The larvae ultimately find the general circulation and become distributed to various tissue including striated skeletal muscles.

They were killed in all cells they enter except striated skeletal muscle cells which alone provide the proper conditions, to support the growth and development of the parasites. Whit in 20 days after entering the muscle cells, the larvae undergo encystment in a coiled form.

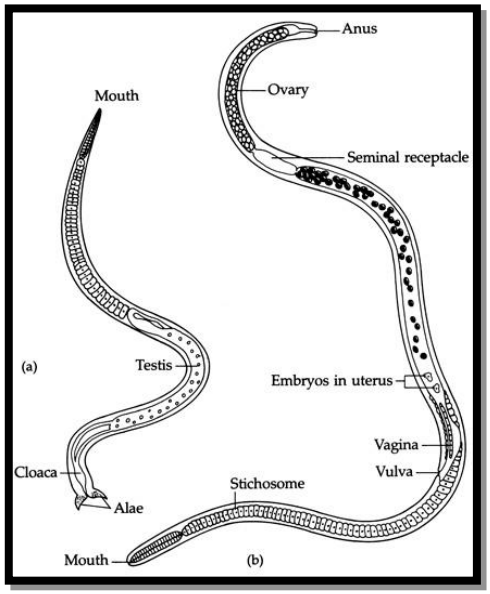
7- The muscle cell carrying larva of *T. spiralis* is known as a Nurse cell encysted larvae can survive for months to years, but eventually most become calcified and die-in man the cycle end here.



Capsulated larva

free living larva (isolated larva)

Egg



a-male **b-female**

Filarial Nematodes

1- The filarial nematodes are a group of arthropod-borne worms that reside in the subcutaneous tissues, deep connective tissues, lymphatic system, or body cavities of humans.

2- Adult worms measure 80-100mm × 0.25-0.30mm.

3- Females were much longer than males.

4- The worm has a simple lipless mouth, small buccal cavity, a cylindrical oesophagus without a bulb, and simple intestine which may be atrophied posteriorly.

5- Tail of the male worm has no caudal bursa, but carries perianal papillae and unequal spicules.

6- The female worms are viviparous, giving birth to larvae known as microfilariae-embryos which develop within thin (shells) that, in *wuchereria bancrofti*, the *Brugia* spp. And *loa loa*, are retained as (sheaths) after the microfilariae are released.

Once released by the female worm, microfilariae can be detected in the peripheral blood or cutaneous tissues, depending on the species.

7- The life cycle of filarial nematodes is passed in two hosts: Man and blood-sucking arthropods.

The microfilariae complete their development in the arthropod host to produce the infective larval stages. These are then transmitted when the vectors next feed. There were to important characteristic features, the present or absence of sheath and the periodicity of microfilariae.

Phylum: Nemathelminthes
Class: Nematoda

Subclass: phasmidia

Order: spirudida

e.g: ***Wuchereria bancrofti***

Onchocerca volvulus

1- It causes Bancrofts filariasis or Elephantiasis.

2- Adult male and female worms reside in the lymph nodes and lymphatic vessels of man. The microfilariae are found in blood. Humans are the only known reservoir hosts.

3- The adult worms are transparent, creamy white, long, hair-like structures. They are filiform in shape with both ends tapering.

4- Male and female worms measure 2.5-4cm × 0.1mm and 8-10cm × 0.2-0.3mm respectively.

5- The posterior end of the female worm is straight, while that of the male is curved ventrally and contains two spicules of unequal length.

6- Both male and female worms remain coiled together and it is difficult to separate them in the lymph node.

7- The female is viviparous and liberates sheathed embryos (microfilariae) into lymph from where they find their way into blood.

Microfilaria:

It is transparent and colorless with blunt head and pointed tail and was covered by a hyaline sheath which is much longer than the microfilaria from the two ends. It can move forwards and backwards within the sheath. The somatic cells or nuclei appear as granules in the central axis of the microfilaria.

These granules are absent in both anterior and posterior ends and also nerve ring. These form the landmarks for recognition of various microfilariae. Microfilaria of *W.bancrofti* has a right periodicity.

Life cycle:

1- *W. bancrofti* passes it life cycle in two hosts. Man is the definitive host and the female mosquitoes belonging to the genera *Culex, Aedes* and *Anopheles* act as intermediate hosts, which are the most important vector of *w. bancrofti*.

2- Adult worms reside in lymph nodes and lymphatics (usually inguinal, scrotal and abdominal) of man.

3- The lymph provides nutrition to the adult worms.

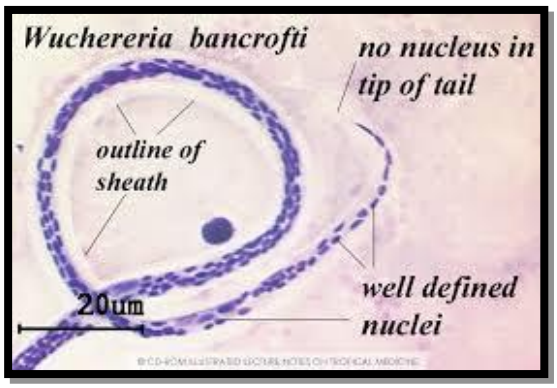
4- Male fertilizes female and the gravid female gives birth to microfilariae, which they found their way into general circulation through lymphtics. Sheathed microfilariae are ingested by the mosquito during its blood meal and reach the stomach of the mosquito.

They cast off their sheaths in 2-6 hours, penetrate the stomach wall and then reach thoracic muscles.

5- These larvae then migrate from thoracic muscles to the proboscis sheath of the mosquito.

6- When the infected mosquito bites a human the larvae, in its proboscis, are deposited on the skin near the site of puncture. They then either enter through the puncture wound.

7- Thereafter, they enter into lymphatics and settle down usually in abdominal lymph nodes, where they develop into adult worms. On one year or more they become sexually mature.



Phylum: Nemathelminthes

Class: Nematoda

Subclass: phasmidia

Order: spirudida

***e. g: Onchocerca volvulus*:**

1- The adult worms habitat nodules in the subcutaneous tissue of man and cause **onchocerciasis** or **river blindness**.

2- The adult worms white, opalescent and transparent with transverse striation on the cuticule.

3- Male measures 1.9-4.2cm in length by 0.13-0.21mm in diameter and has a coiled tail.

4- Female was much longer, measuring 33.5-50cm in length by 0.27-0.40mm in diameter.

5- Adult worms are long-lived; the average life span of female worms is 8 years, but can be as long as 15 years.

***Microfilariae*:**

Microfilariae are unsheathed, non-periodic (has no periodicity). The column of nuclei does not extend to the tail-tip. Microfilariae are normally found in dermis and rarely, in the blood, sputum or urine.

Life – cycle:

1- *O. volvulus* completes its life cycle in two hosts. man is the definitive host and day-biting female black fly of genus *Simulium* is the intermediate host.

2- The fly has its main habitat in the underbrush lining the banks of fast-moving stream.

3- Humans become infected by the bite of black fly, which contain in its mouth parts the infective third-stage larvae.

4- The larvae enter the skin through the punctured wound and migrate to the subcutaneous tissue in which they moult twice and develop into male and female adult worms.

5- The adult worms live singly, in pairs, or in coiled entangled masses in the deep subcutaneous tissue.

6- The female release actively motile, unsheathed microfilariae which migrate to the skin and eyes of infected subjects. They can survive in the body for 1-2 years.

7- When a black fly again bites an infected human at one of the infected sites, the microfilariae are taken up with the blood meal.

8- They migrate from the gut of the vector into the thoracic muscles. Here they moult twice and develop into infective larvae over a period of 6-8 days.

9- The larvae then migrate to the mouth parts of the black fly where they may be transmitted to humans at the next blood meal. The cycle is thus repeated.