T.Y. B.Sc. Zoology

Paper V, SEM-III

PARASITOLOGY

By

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Chapter 5

Life cycle, Pathogenicity and Control Measures Parasites

CONTENTS:

5.1 Plasmodium vivax

- ✓ Malaria is one of the most widely known diseases since time immemorial. It is caused by a pathogenic protozoan of blood, Plasmodium.

- ✓ Four species of Plasmodium, viz., *P. vivax*, *P. falciparum*, *P. malariae* and *P. ovale* are so far known to infect human beings causing different types of malaria.

Systemic Position :

Kingdom	**Protista**
Subkingdom	**Protozoa**
Phylum	**Apicomplexa**
Class	**Sporozoa**
Subclass	**Coccidia**
Order	**Haemosporida**
Suborder	**Aconidina**
Family	**Haemosporidae**
Genus	**Plasmodium**
Species	**falciparum, malariae, ovale, vivax**

Geographical Distribution:

- Plasmodium is widely distributed in tropical and temperate countries the world over.
- *P. malariae* is a parasite of subtropical countries.
- *P. ovale* is distributed in East Africa, West Africa, especially, Nigeria and Phillippines.

Habits and Habitat:

- Plasmodium vivax lives as an intracellular parasite in the red blood corpuscles (R.B.Cs) of man in the form of its mature adult condition, called trophozoite.
- The species of Plasmodium are reported from reptiles, birds and various mammals.

Hosts of Plasmodium Vivax:

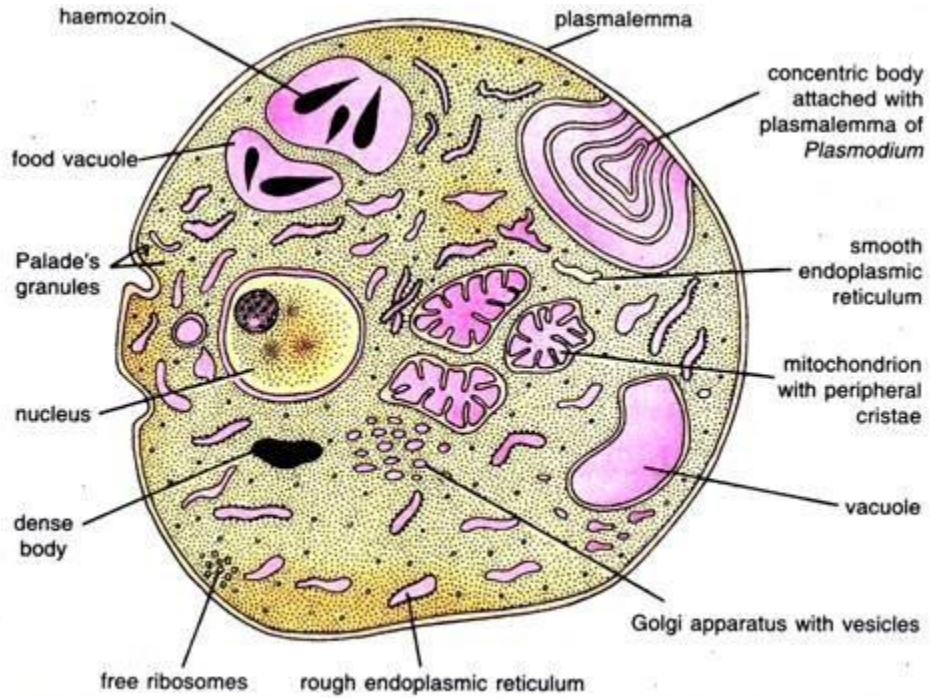
- Plasmodium vivax has two hosts; man and female Anopheles mosquito.
- Man is considered to be the primary host and female Anopheles mosquito, the secondary or intermediate host.
- The common species of Anopheles, which transmit malaria parasite in India, are *A. maculatus*, *A. stephensi*, *A. fluvialitis* and *A. culicifacies*.

Structure of Plasmodium Vivax:

- The parasite, in its mature adult condition, is called trophozoite, which lives in the red blood corpuscles of man.
- The trophozoite is amoeboid, uninucleated having vacuolated and granular cytoplasm.
- The granules are chiefly of haemozoin pigments.

Ultra structure of trophozoite:

- **According to electron microscopic studies, the Plasmodium in a red blood corpuscle possesses a double membrane, the plasma lemma closely applied to the cytoplasm.**
- **The cytoplasm of Plasmodium Vivax contains small dense particles probably containing ribo nucleoproteins.**
- **The mitochondria possess double membrane and show peripheral cristae and a structure less central region.**



Plasmodium. Ultrastructure of trophozoite in R.B.C. as seen in electron microscope.

Ultra structure of trophozoite:

- The number of mitochondria varies with the age, the merozoite has only one mitochondrion, while the trophozoite has several mitochondria.

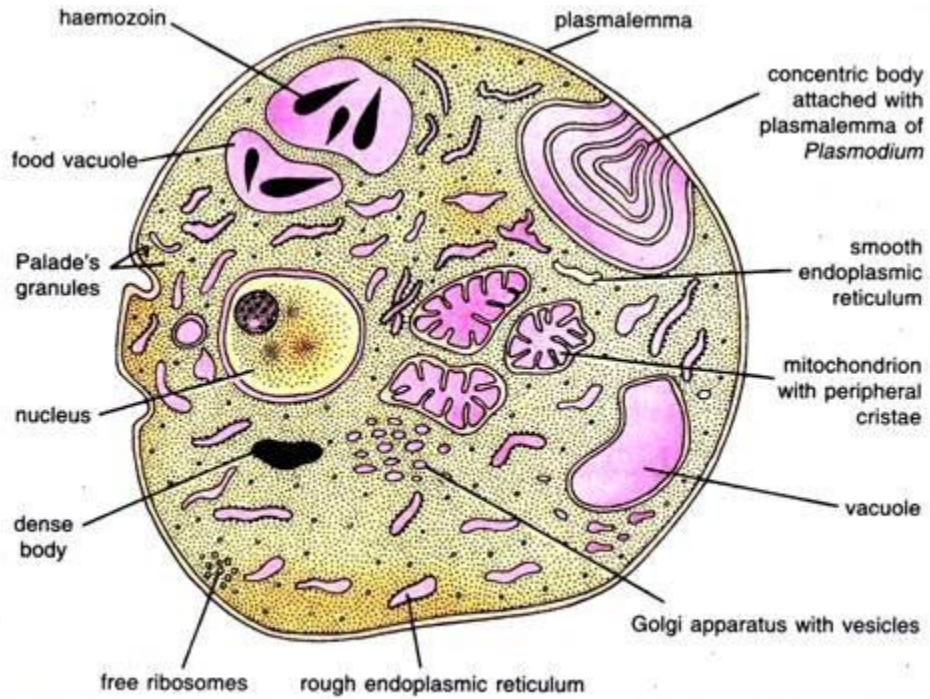
- The Golgi apparatus is composed of small vesicles arranged in rows. A double layered concentric body is also found in the cytoplasm attached with the plasma lemma of Plasmodium Vivax.

- It appears that the concentric body originates from plasma lemma. the concentric bodies serve the function of mitochondria. One or two double membrane vacuoles with structure less matrix, also occur in the cytoplasm. The function of these vacuoles is unknown.

- The nucleus is large and its nucleoplasm is composed of granular and fine fibrillar material. The nuclear membrane is double, to which RNA particles are attached. The nucleolus lies centrally in the nucleus.

- Pinocytosis vacuoles are common in the cytoplasm and serve as food vacuoles. The food vaculoes may also contain hemozoin depending upon the species of Plasmodium.

- The mode of nutrition is saprozoic, occurs by osmotrophy. Organ of locomotion, contractile vacuole, etc., are not found. Respiration takes place anaerobically. Reproduction occurs both by sexual and asexual methods.



Plasmodium. Ultrastructure of trophozoite in R.B.C. as seen in electron microscope.

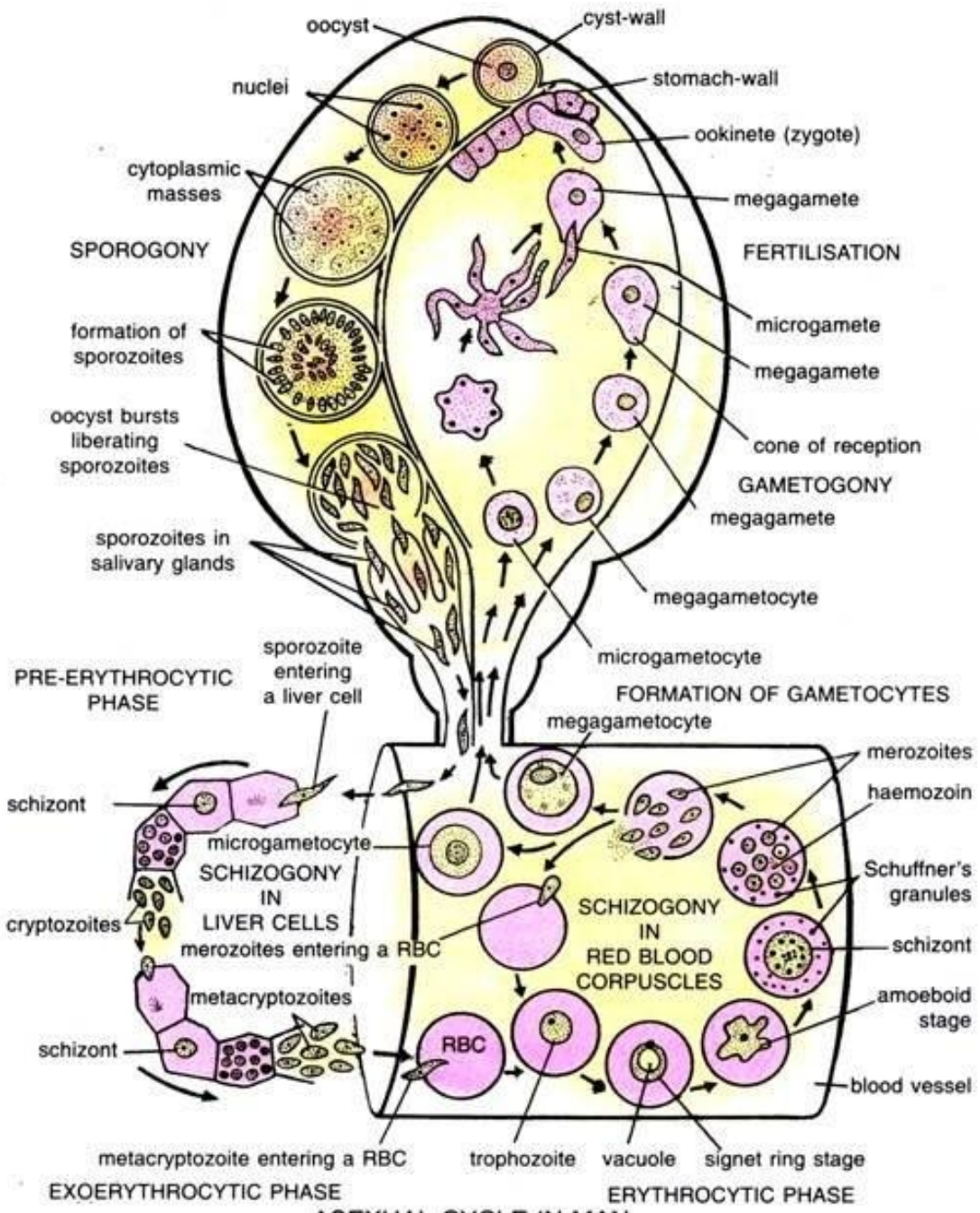
Life Cycle and Plasmodium Vivax:

- The life cycle of Plasmodium vivax is digenetic involving two hosts as mentioned earlier. Its life cycle is completed both by asexual and sexual phases.
- Asexual phase of its life cycle is completed in man by schizogony (differentiated into exoerythrocytic schizogony involving pre- and post-erythrocytic schizogonic cycles, and erythrocytic schizogony).
- sexual phase of its life cycle is completed in female Anopheles mosquito by gametogony, syngamy and sporogony.

Part of Life-Cycle of P. Vivax in Man (Asexual Cycle):

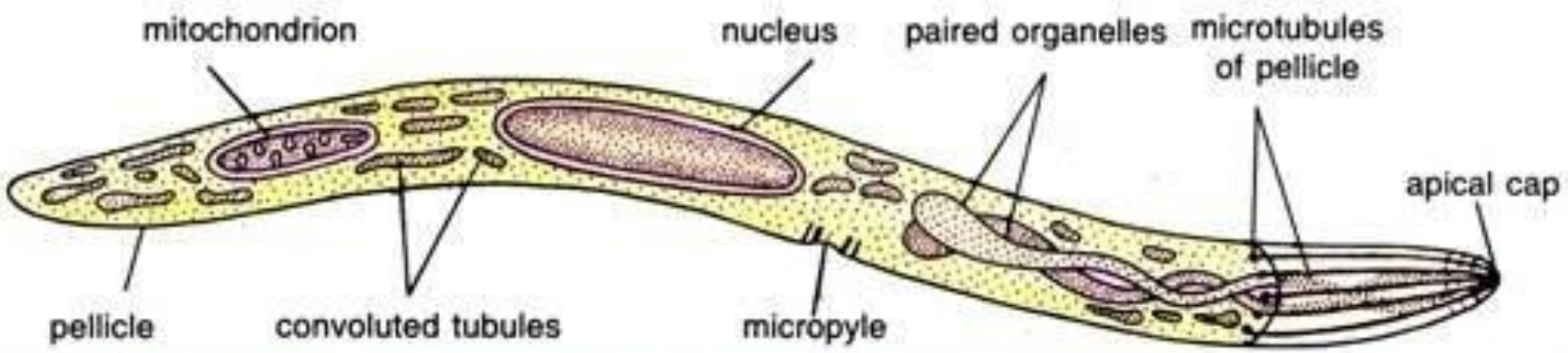
- When an infected female Anopheles bites a man to suck his blood, then along with its saliva it injects the sporozoite stage of Plasmodium into the human blood. This is called **Inoculation.** The parasite remains always in the body of one of the two hosts, hence, the sporozoites do not possess any protective covering.
- The sporozoite, infective stage, is minute measuring about 11 to 12 microns in length and 0.5 to 1 micron in width, sickle-shaped cell with an oval nucleus; mosquito inoculates sporozoites in thousands.
- The sporozoites are capable of slight gliding movement. In about half an hour the sporozoites disappear from the blood stream, and they enter the parenchymatous cells of the liver where they undergo at least two schizogonic cycles.

Life Cycle and Plasmodium Vivax:



Plasmodum vivax. Life cycle.

Ultra Structure of Sporozoite:



Plasmodium. Ultrastructure of sporozoite as seen under electron microscope.

- ✓ The sickle-shaped body of the sporozoite is covered externally by an elastic, firm pellicle having longitudinally arranged contractile microtubules. These microtubules help in the gliding movements shown by the sporozoite. Its anterior end bears an apical cup being made of three or more concentric rings.
- ✓ A pair of elongated reservoir like secretory organelles, comparable to roptries of the sporozoite of Monocystis, open into the apical cup.
- ✓ These organelles are supposed to secrete some secretion which facilitates its penetration into the liver cells. Nucleus is single and vesicular having a nucleolus in its centre. There is a single mitochondrion and a large number of convoluted tubules of unknown function. However, the micropyle represents the cytostome of other protozoans.

Schizogony in Liver Cells:

- ✓ In the liver cells, the sporozoite grows to form a large, round schizont. The schizont divides by multiple fission to form about one thousand to several thousand small spindle-shaped cells called merozoites; this multiple fission is called schizogony. The schizont ruptures and merozoites are liberated into the sinusoids or venous passages of the liver.
- ✓ This phase of asexual multiplication is pre-erythrocytic schizogony and the merozoites produced by it are also called cryptozoites or cyptomerozoites; these cryptozoites are immune to medicines and the resistance of the host.
- ✓ A second phase of asexual multiplication known as an exo-erythrocytic schizogony occurs in the liver cells in which the cryptozoites enter into new liver cells and grow into schizonts, the schizont divides to form merozoites; the merozoites of the second generation are termed metacryptozoites or phanerozoites.
- ✓ The exo-erythrocytic schizogony may continue in more liver cells to form a reservoir of merozoites, or some merozoites after at least two cycles of schizogony may re-enter the blood stream when they invade erythrocytes.
- ✓ It is supposed that the merozoites of second generation, i.e., metacryptozoites are of two types; the more numerous and smaller are micro-metacryptozoites, while larger and less in number are macro-metacryptozoites.
- ✓ In fact, the micro-metacryptozoites invade the R.B.Cs and start erythrocytic schizogony, while the macro-metacryptozoites enter fresh liver cells to continue the exo-erythrocytic schizogony. The merozoites attack only the young and immature corpuscles, (the merozoites of P. malariae attack only old corpuscles, while those of P. falciparum attack all kinds of corpuscles indiscriminately).

Pre-patent and Incubation Periods:

- The pre-patent period is the duration between the initial sporozoite infection and the first appearance of parasite in the blood. In case of P. vivax, it is about 8 days on an average. The incubation period is the time taken from the infection of man by sporozoites till the appearance of first malarial symptom.
- In case of P. vivax, it is about 14 days on an average ranging from 10 to 17 days. Of course, during the incubation period the host shows no symptoms of malaria.

Erythrocytic Schizogony :

- In the erythrocytes, a third multiplication phase of schizogony occurs which is known as erythrocytic schizogony. The micro-metacryptozoite feeds on erythrocytes, a vacuole appears in it, the nucleus is pushed to one side, and the micro-metacryptozoite is changed into what is called as the ring-shaped trophozoite, the signet ring stage, which is 1/3 to 1/2 the size of the erythrocyte.
- The signet ring stage is not found in P. falciparum. The trophozoite grows to become rounded and amoeboid, this is the full grown trophozoite and is known as a schizont. The large schizont makes the erythrocyte to become very large. The schizont shows yellowish-brown pigment granules of haemozoin derived from the iron of haemoglobin of erythrocyte; the enlarged erythrocyte acquires granules called Schuffner's dots.
- The schizont now undergoes multiple fission to form 12 to 24 oval-shaped merozoites; this phase of asexual multiplication is erythrocytic schizogony. The much weakened erythrocyte bursts and the merozoites are liberated into the plasma from where they enter new erythrocytes, then they repeat the erythrocytic schizogony once every 48 hours.

Post-erythrocytic Schizogony :

- The merozoites may again go from the blood to the liver cells and invade them to undergo another phase of asexual multiplication which is called post-erythrocytic schizogony.

Formation of Gametocytes:

- After many generations of schizogony in the blood, some of the merozoites slowly grow large producing much haemozoin, these are inside erythrocytes and do not change in schizonts but they grow and are transformed into two types of gametocytes called macro gametocytes and microgametocytes.
- The condition which brings about the formation of gametocytes is not known. Gametocytes appear in the peripheral blood at various intervals after the onset of fever, they remain inactive while in the human blood. The macro gametocytes are female, they are round with the food laden cytoplasm and a small eccentric nucleus.
- The microgametocytes are male, they have a clear cytoplasm and a large central nucleus. Both gametocytes contain large amounts of haemozoin; they enlarge the erythrocytes. Gametocytes remain in the human blood for several weeks, but are unable to develop any further, it is necessary for them to be taken into the body of an Anopheles', if this does not happen they degenerate and die.

Part of Life-Cycle of P. Vivax in Mosquito (Sexual Cycle):

- Many species of Anopheles, but not all species, act as intermediate hosts. If the gametocytes are sucked up along with human blood by a female Anopheles then they reach the stomach where corpuscles are dissolved and the gametocytes are set free.

Gametogony:

- ✓ The microgametocytes, after release in the stomach of mosquito, undergo the process of ex-flagellation. The cold-bloodedness of the mosquito is said to stimulate this process. However, the nucleus of microgametocytes divides into 6-8 haploid daughter nuclei.
- ✓ These nuclei migrate towards the periphery of microgametocyte. The cytoplasm pushes out forming long flagellum like structures having one daughter nuclei in each. Thus, 6-8 flagellum like male gametes or microgametes measuring from 20-25 microns in length are formed. Soon these gametes separate and start moving actively in the stomach of mosquito.
- ✓ On the other hand, the macro gametocytes undergo maturation process, thereby two polar bodies are pushed out and a female gamete or macrogamete is formed. The female gamete is non-motile and develops a cytoplasmic or receptive cone.

Fertilisation:

- ➢ If microgamete happens to reach the macrogamete, then it enters into the female gamete at the point of cytoplasmic cone and finally complete fusion of nucleus and cytoplasm of the two gametes occurs. This results in the formation of rounded zygote.
- ➢ Several microgametes may approach a macrogamete but only one of them enters the macrogamete and others shed off. The fusion of male and female gametes is called syngamy. Here, the gametes are dissimilar (anisogametes), hence, their fusion is called anisogamy.

Ookinete and Encystment:

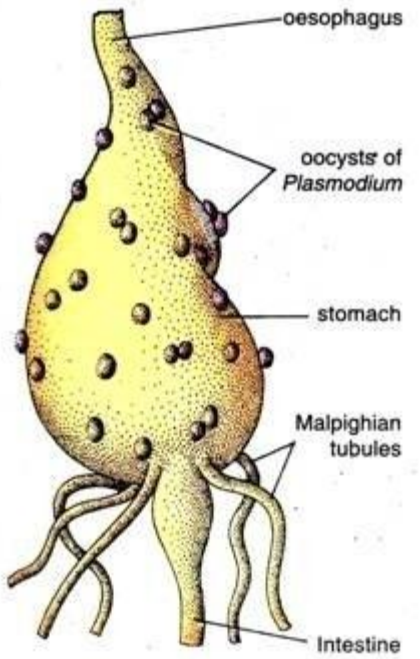
- The zygotes, thus, formed remain rounded and motionless for 24 hours but soon they elongate to become worm-like having pointed ends and motile. The zygotes are now called ookinetes or vermicules. An ookinete measures about 15 to 22 microns in length and 3 microns in width.

- The ookinete moves and bores through the wall of the stomach of mosquito and comes to lie beneath the outer epithelial layer. (The ultrastructure of ookinete shows the presence of a central, irregular nucleus, dense cytoplasm, brown pigment granules, many mitochondria and ribosomes in it. It also shows the presence of contractile fibrils, the microtubules).

- However, here they become spherical and secrete a thin elastic membranous cyst. The cyst is also partly secreted by the surrounding tissues of the stomach. Thus, the ookinetes become encysted and in this condition it is referred to as the oocyst. The oocyst grows in size and sometimes called sporont.

- As many as 50 such oocysts can be seen on the stomach of the host mosquito. Howard (1906) has observed that the ookinetes which do not succeed in boring the stomach wall pass out from mosquito's body with faecal matter.

Sporogony:



Stomach of an infected female *Anopheles* with oocysts of *Plasmodium*.

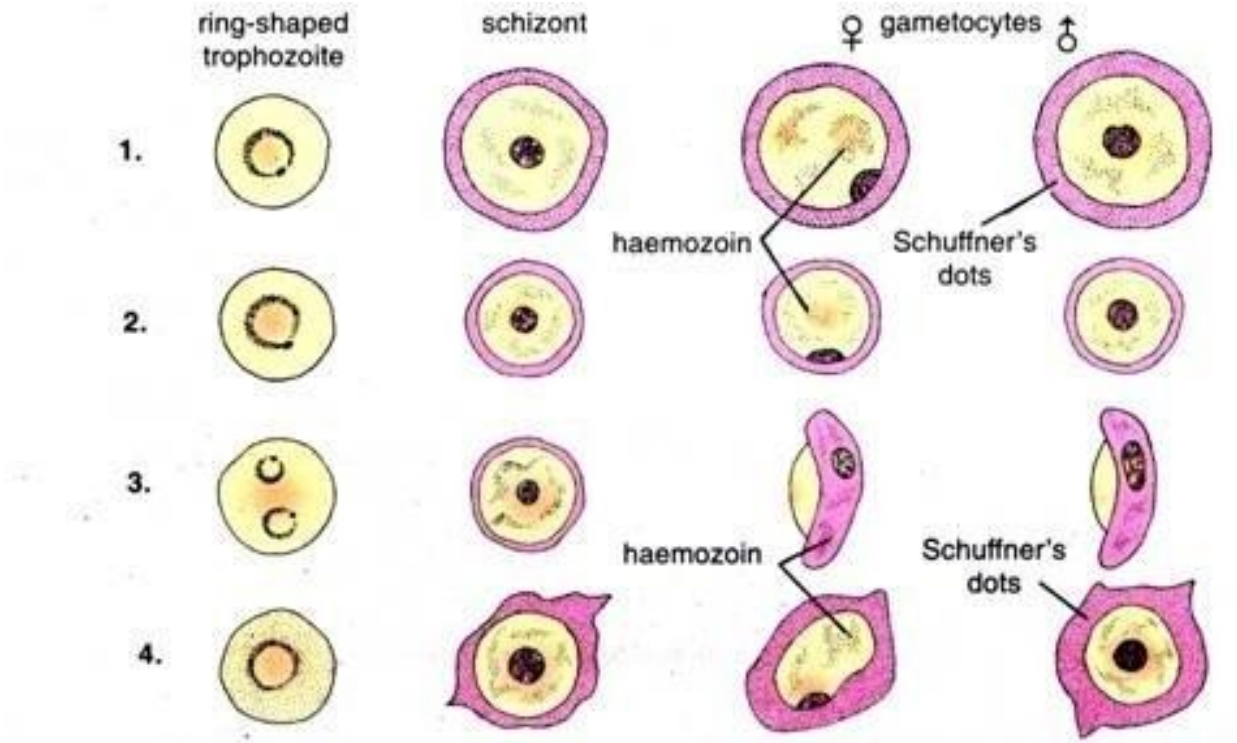
- The nucleus of oocyst first divides by meiosis and then by mitosis several times (Bano, 1959) and its cytoplasm develops vacuoles forming faintly-outlined cells called sporoblasts. Particles of chromatin arrange themselves around the periphery of each sporoblast. Then the cytoplasm forms slender spindle-shaped haploid cells known as sporozoites.
- Each oocyst may have ten thousand sporozoites, and group of sporozoites gets arranged around the vacuoles. This phase of asexual multiplication in which sporozoites are formed is called sporogony which is completed in 10-20 days from the time the gametocytes are taken in by the mosquito, the time depending on the temperature.
- The oocyst bursts and sporozoites are liberated into the haemolymph of the mosquito, from where they reach its salivary glands and enter the duct of the hypopharynx. The sporozoites will infect a human host when the mosquito bites and the life cycle is repeated again.

Types of Malaria And Malaria Parasites of Man:

- ✓ The name malaria (Gr., mala = bad; aria = air) to this fever was given by Macculoch (1827).
- ✓ Sir Ronald Ross (1897), an Indian army doctor, succeeded in establishing that malaria parasites are sucked up by female Anopheles mosquito and later on injected in the human blood. *(for which Sir Ronald Ross earned Nobel Prize in medicine, 1902)*.
- ✓ Malaria is caused by four species of Plasmodium, but their morphology and life cycles are almost alike, yet they show some distinguishing characters.
- ✓ The malaria fever is of three types (According to period of recurrence of the fever) :
  - Tertian fever – Benign tertian and Malignant tertian.
  - Quartan fever
  - Mixed fever

1. Plasmodium Vivax:

- Plasmodium vivax has a wide distribution in tropical and temperate zones; incubation period is 10 days; ring-shaped trophozoite is 1/2 to 1/3 the size of the erythrocyte; schizont fills the enlarged erythrocyte and has yellowish-brown haemozoin; enlarged erythrocyte has Schuffner's dots; in blood the schizont forms 12 to 24 merozoites; gametocytes fill the enlarged erythrocytes.
- **It causes vivax malaria or tertian malaria fever every 48 hours.**



Plasmodium. Species. 1. *P. vivax;* 2. *P. malariae;* 3. *P. falciparum;* 4. *P. ovale.*

2. Plasmodium Malariae:

- Plasmodium malariae is found in tropical and temperate zones; incubation period is 27 to 37 days; ring-shaped trophozoite is 1/3 to 1/2 the size of the erythrocyte; schizont fills the erythrocyte which is not enlarged; haemozoin is dark brown; erythrocyte has no Schuffner's dots; in blood the schizont forms 6 to 12 merozoites; gametocytes are round, they fill the erythrocyte which is not enlarged.
- It causes quartan malaria fever every 72 hours.

3. Plasmodium Falciparum:

- Plasmodium falciparum is very common in tropics; incubation period is 10 days; ring- shaped trophozoite is 1/6 to 1/5 of the erythrocyte, often there are two trophozoites in one corpuscle; schizont is 2/3 to 3/4 of erythrocyte which is not enlarged; haemozoin is black; erythrocytes not enlarged, they may even shrink and become greenish, they have no Schuffner's dots; in blood the schizont forms 8 to 36 merozoites which are not seen in peripheral circulation; gametocytes are crescentic occupying one side of erythrocyte.
- It causes pernicious malaria or malignant tertian malaria fever almost continuously or from 24 to 48 hours. A very serious result of falciparum infection is backwater fever, a condition when wholesale destruction of patient's erythrocyte occurs and the liberated haemoglobin is excreted in urine.

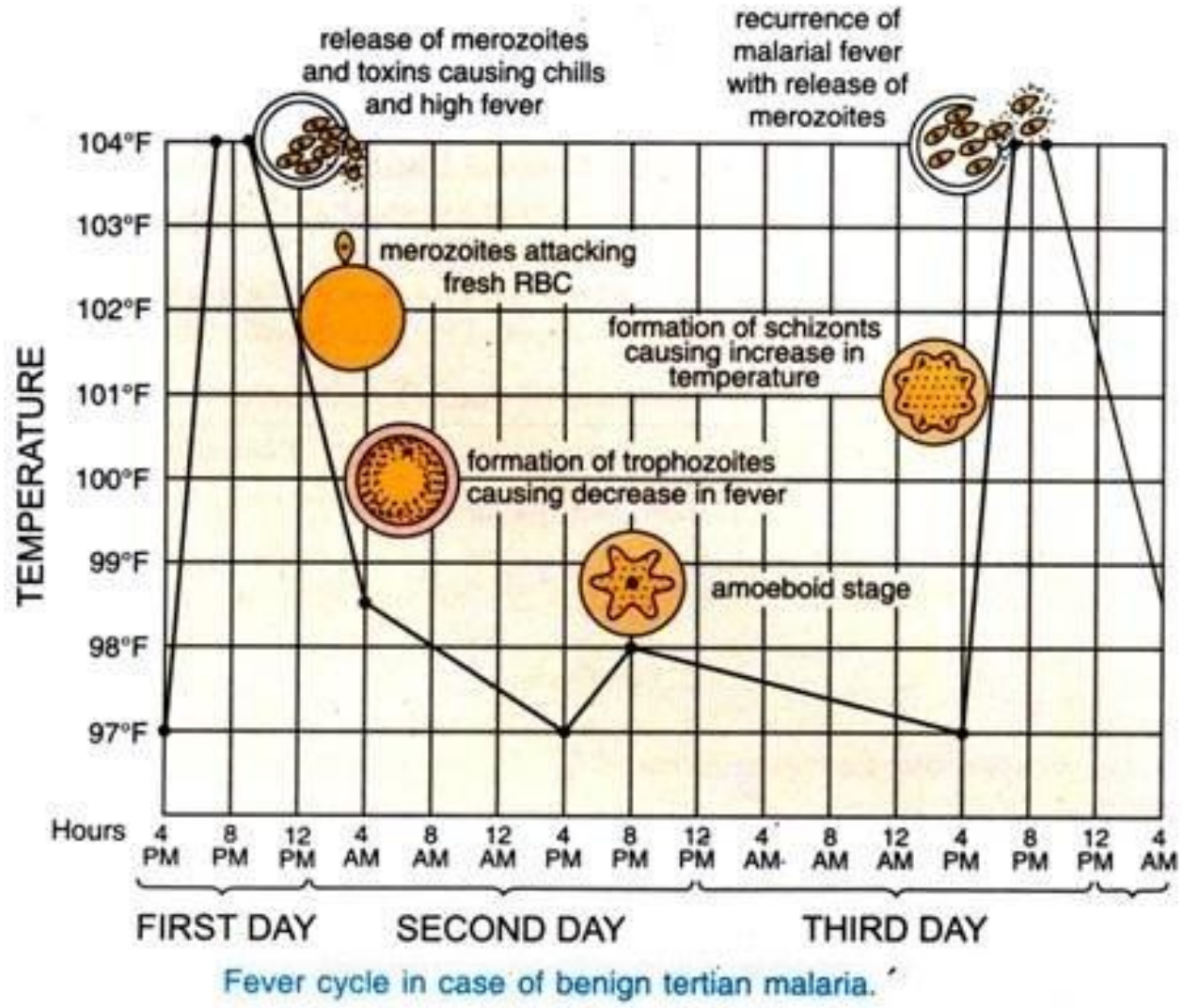
4. Plasmodium Ovale:

- ✓ Plasmodium ovale is sporadic in tropical and subtropical zones; incubation period is 14 days; ring-shaped trophozoite is 1/3 to 1/2 of the erythrocyte; schizont fills 3/4 of the erythrocyte which becomes enlarged and irregular in shape; haemozoin is dark brown; the enlarged erythrocytes have Schuffner's dots; in blood the schizont forms 6 to 12 merozoites; gametocytes are round almost filling, the enlarged and irregular-shaped erythrocytes.
- ✓ It causes ovale or mild tertian malaria fever every 48 hours.

Symptoms:

- ➢ The symptoms of malaria, in case of P. vivax infection, appear on an average after about 14 days of initial infection. In fact, it starts when the merozoites along with toxins are liberated into the blood, they are then deposited in the spleen, liver and under the skin, so that the host gets a sallow colour.
- ➢ The accumulated toxins cause malaria fever in which the patient suffers from chills, shivering and high temperature with convulsions followed by profuse sweating. The fever lasts from six to ten hours, then it comes on again after every 48 hours coinciding with the liberation of new generation of merozoites. The malaria caused by P. vivax is known as benign tertian malaria.
- ➢ After repeated and simultaneous schizogony, large numbers of erythrocytes are destroyed at intervals of 48 hours setting free increasing amounts of toxins into the blood, this causes the characteristic paroxysm of malaria on every third day. The paroxysm is divisible into three stages, *chill or rigour stage, febrile or high temperature stage* with fever over 104° F., and *defervescent or sweating stage*.

Fever Stages in Vivax Malaria:



Fever cycle in case of benign tertian malaria.

i. Cold stage:

At the beginning of malaria fever the patient suffers from a severe shaking chill.

ii. Hot stage:

As the chill subsides, the body temperature rises as high as 41° C or 106° F.

iii. Sweating stage:

As the temperature lowers down, the patient sweats profusely. Malaria fever takes place when schizonts in RBC burst, liberating the merozoites and haemozoin (malarial pigment) in the blood plasma. This haemozoin is said to be toxic and so induces high fever with shivering. It is important to note that bursting of schizonts tends to be synchronous as they all burst at the same time.

Anaemia:

Since erythrocytes are damaged in Plasmodium infection, hence, anaemia becomes inevitable. Anaemia develops because of the destruction of erythrocytes in large number; the infected erythocytes become fragile, hence, easily ruptured and damaged.

Splenomegaly:

The enlarged, spleen is said to release lysolecithin, a lytic substance, which damages erythrocytes and the parasite is believed to produce an antibody, the haemolysin, which haemolyse the normal erythrocytes.

Diagnosis of Malaria:

Chills, shivering, muscular pain, high temperature and profuse sweating are the most apparent symptoms to diagnose the infection of P. vivax. In acute conditions the development of anaemia with enlargement of spleen is sufficient to diagnose its infection. However, the diagnosis must be confirmed by blood test.

Control of Malaria:

Malaria is one of the most important human diseases, since it not only kills millions of people annually, but it renders the most fertile regions of the earth unsafe for human habitation. Hence for the control of these disease, following measures are used:

1. Control of mosquitoes.
2. Prophylaxis or prevention of infection.
3. Treatment of disease.

1. Destruction of the secondary host (mosquito):
Control of mosquitoes for prevention of malaria is very important; this may be done by:

(i) killing the mosquitoes in human dwellings by spraying them with D.D.T., which remains toxic to mosquito for several months

(ii) by filling up ditches and ponds where mosquitoes breed, and by draining swampy places to prevent breeding. In India, five wet days followed by 2 to 3 dry days were found very effective in the control of mosquitoes

(iii) by spraying surface of ponds with kerosene oil or with insecticides which kill larvae and pupae of mosquitoes; it is easier and more effective to kill larvae than the adults; they can also be destroyed by introducing certain fish (minnow, Gambusia, Lebistes) which are the natural enemies of mosquitoes because they feed on larvae and pupae.

2. Prevention of infection:

- The preventive measures are essential to adopt to avoid the infection. These usually involve the defence against mosquito bites and use of preventive drugs.

- Use of insect repellents, nets, screening of windows of the house, etc., prevent mosquito bite, similarly, use of anti-malarial drugs like Quinine, Paludrine, Daraprim, etc., in definite dose periodically are effective in checking malaria infection.

3. Treatment of the infected person:

- Various drugs are used for the treatment of malaria. Physicians usually recommend drugs like Quinine, Atebrin, Camoquin, Chloroquine, Plasmoquine, Resochin, Pentaquine, Pamaquine, Mepacrine, Paludrine, etc., for the treatment of malaria.

Anti-Malarial Campaign:

- ✓ Since, malaria is a global problem to some extent but certain countries like India face a widespread infection of this disease. However, with the assistance of World Health Organization (WHO), the Ministry of Health of Government of India started a National Malaria Control Programme (NMCP) in the year 1953.
- ✓ Under this programme effective measures were taken and malaria was almost controlled because DDT and other insecticides used were very much effective in eradicating the mosquitoes. But in recent years the cases of malaria are frequently witnessed and the frequency is rapidly increasing again.
- ✓ It appears that the insects have developed resistance and immunity to DDT and other similar insecticides; they have also changed their behaviour.
- ✓ However, various research laboratories in our country like Vector Control Research Centre at Pondicherry, Postgraduate Medical Institute at Chandigarh, National Institute of Communicable Diseases at Delhi and others are engaged in finding out the measures to check malaria infection and also the way to eradicate the mosquitoes.

5.2 Entamoeba Histolytica

Systemic Position :

Phylum	**Protozoa**
Super Class	**Sarcodina**
Subclass	**Rhizopoda**
Order	**Amoebida**
Family	**Endamoebidae**
Genus	**Entamoeba**
Species	**histolytica**

Geographical distribution:

E. histolytica is cosmopolitan in distribution, but is more common in tropical and sub-tropical countries. In India it occasionally takes an epidemic form. It is estimated that about seven to eleven per cent of the population in India suffers from its infection.

Habitat:

It lives in lower portion of small intestine and entire large intestine of ma and other primates. Topozoits of E. histolytica are the tissue invading forms live in the mucosa and submucosa layer of the large intestine of man . Frome here , some of them are carried by the blood stream of the liver , lungs, kidney and brain.

Habits:

E. Histolytica creeps with a single pseudopodium. It is myxotropic in nutrition. It respires anarobicaly, reproduces by asexual means only.

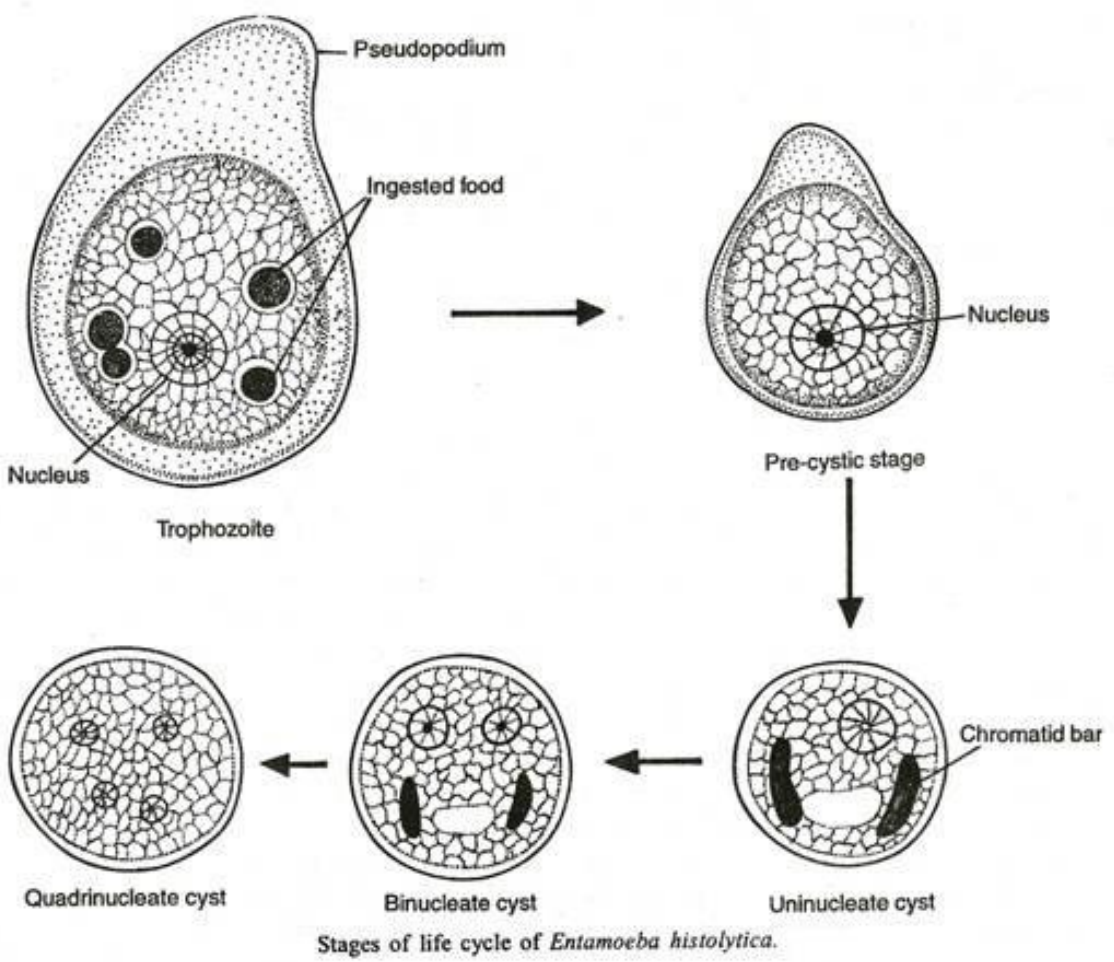
Life cycle:

E. histolytica is a monogenetic parasite as its life cycle is completed in a single host i.e., man. Three distinct **morphological forms** exist in its life cycle. – Trophozoite, Pre-cystic stage and Cystic stage.

Trophozoite:

- It is the growing or feeding stage of the parasite. During this stage the parasite resides in the mucosa and sub-mucosa layers of the large intestine of man. Trophozoites are unicellular organisms, with a size ranging from 18 to 40 mm in diameter (average being 20 to 30 um) During the optimal living condition the parasite exhibit slow gliding movement by forming pseudopodia, hence the body shape is not fixed because of constantly changing position.

- The cytoplasm inside the body of trophozoite is divisible into clear, transparent ectoplasm and inner granular endoplasm. The endoplasm contains nucleus, ingested red blood cells and tissue debris. A single spherical nucleus lies inside the endoplasm.

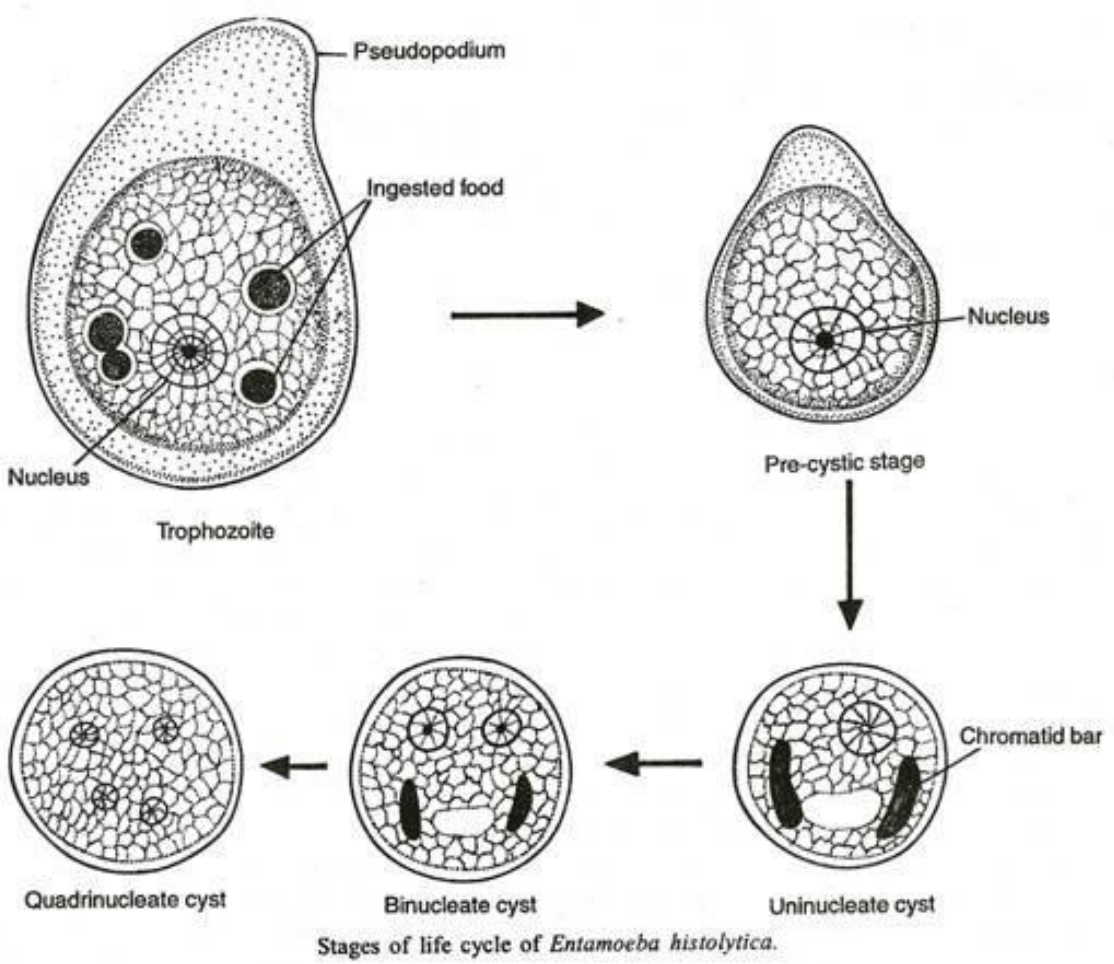


Stages of life cycle of *Entamoeba histolytica*.

Trophozoite:

- The size of the nucleus ranges from 4 to 6 um. Nucleus contains a central dot like Karyosome and a delicate single layered nuclear membrane containing fine chromatin granules. The space between Karyosome and the nuclear membrane is traversed by radially arranged fine threads of limn network.

- Trophozoite secretes a proteolytic ferment around itself. This ferment is of the nature of histolysin which brings about destruction and necrosis of the surrounding host tissues to be absorbed later by the parasite as food. Trophozoite reproduces by binary fission and increases their number. They are exclusively parasitic in nature, growing at the expense of living tissues and multiplying rapidly to maintain their presence in good number.



Stages of life cycle of *Entamoeba histolytica*.

Pre- Cystic stage:

- It is an intermediate stage between the trophozoite and cystic forms. During this stage the parasite reduces in size (10 — 20 um), becomes avoid in shape and bears a single blunt pseudopodia. The endoplasm does not contain ingested R.B.C's and other tissue debris, indicating that during this stage the parasite stop feeding. A single nucleus remains present.

Cystic stage:

- Cyst formation occurs inside the lumen of the host's intestine. The precystic parasite moves into the gut lumen to be transformed into cystic form, a process called "encystations". During the process of encystations, the parasite becomes round and get surrounded by a double refractile wall, called the cyst wall.

- A cyst in the beginning is uninucleate body with size ranging from 7—15 um, in different races. I he nucleus inside the cyst soon divides by binary fission to become a binucleate form and then to quadrinucleate form. In this way, a single nucleus by mitotic division forms four daughter nuclei, undergoes reduction in size and ultimately becomes 2 in diameter.

- Inside the cytoplasm of the cyst develops certain extra nuclear bodies like chromatid bars and glycogen mass. Chromatid bars or chromatoids are dark oblong bar like structures varying in size and number (1 to 4). In addition to chromatid bars the cyst also contains mass of glycogen in the form of brown vacuolar structure.

- As the cyst transform from uninucleate to quadrinucleate stage, both chromatid bars and glycogen vacuole reduces in size and finally disappear. The whole process of encystation occurs within a few hours. The life of a matured cyst (quadrinucleate form) inside the lumen of the host's gut is only two days.

- The mature quadrinucleate cysts pass out of their host's body through faeces. Outside the body of the host, the cyst survives for ten days and their thermal death point is about 50°C.

Reproduction:

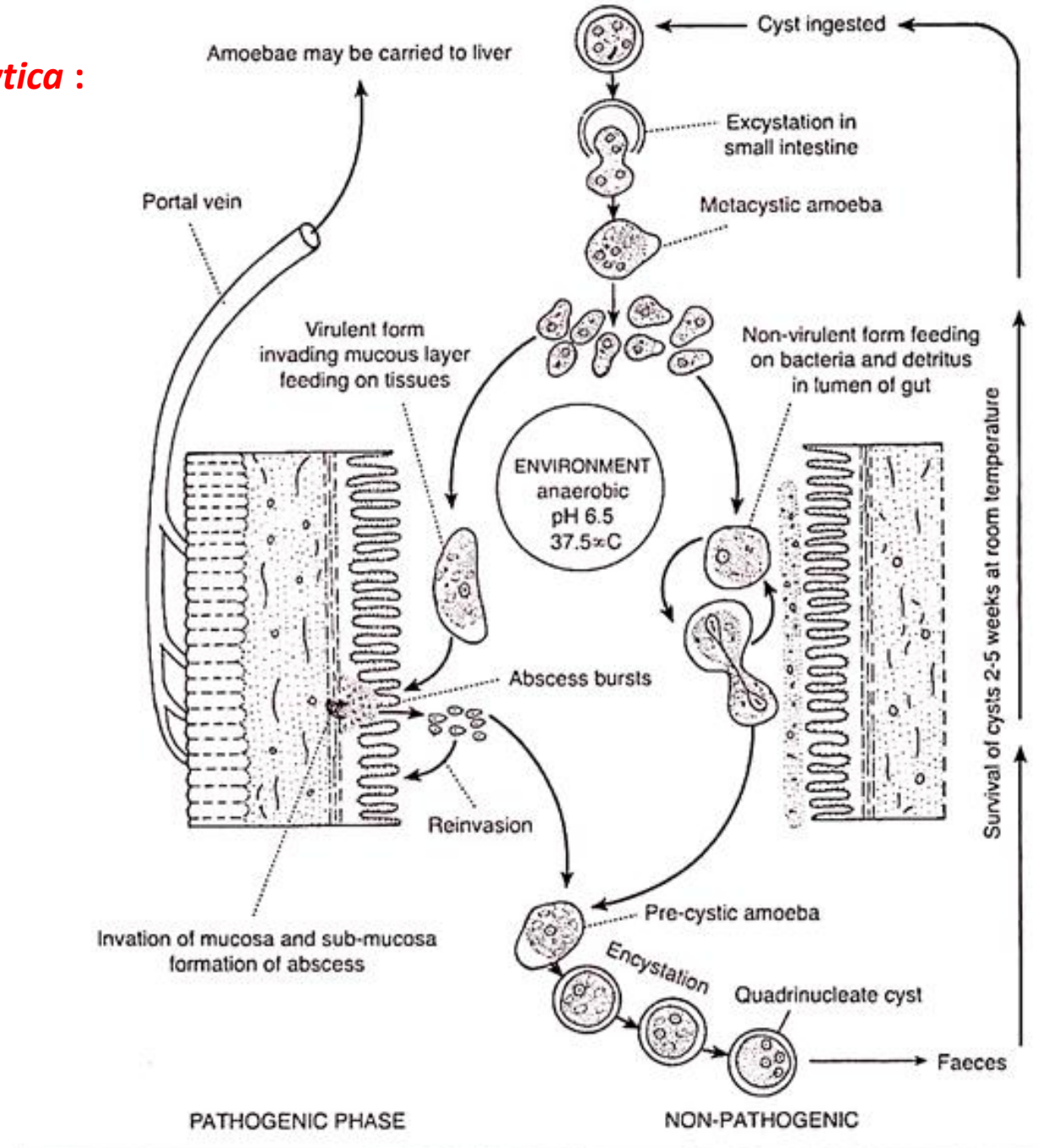
The trophozoite of Entamoeba histolytica reproduces normally by a process of simple binary fission in the intestinal wall and by a multiple fission. In reproduction following methods occurs:

1. **Excystation:**
   This is the process of transformation of cysts to trophozoite and occurs only when cysts enter into the alimentary canal of man (a susceptible host). During excystation a quadrinucleate cyst gives rise to eight *amoebulae,* each one develops into a trophozoite.

2. **Encystation:**
   This is the process of transformation of trophozoites to cysts and occurs inside the lumen of the intestine of an infected individual.

3. **Multiplication:**
   This stage occurs only in the trophozite phase and multiply by simple binary fission.

Life Cycle of *Entamoeba Histolytica* :



Life cycle of *E. histolytica* in man

5.3 Ascaris Lumbricoides (Round Worm) :

Systemic Position :

Kingdom	**Animalia**
Subkingdom	**Metazoa**
Phylum	**Nematoda**
Class	**Secernentea or Phasmidea**
Order	**Ascaridida**
Superfamily	**Ascaridoidea**
Family	**Ascarididae**
Genus	**Ascaris**
Species	**lumbricoides**

Habit and Habitat :

- Ascaris lumbricoides is an endoparasite in the small intestine of man lying freely in the lumen. It has been living in man from time immemorial. It is found more commonly in children than in adults.
- Sometimes it migrates from intestine to stomach and comes out through the mouth or nostrils of the host.
- As many as 1000 to 5000 adult worms may inhabit a single host.
- Mode of nutrition is holozoic, as it feeds on host's partly digested food by sucking action of its pharynx.
- It produces anti-enzymes to protect itself from the action of the host enzyme.
- This parasite is called *microaerophilic* because it needs very small quantity of free oxygen.

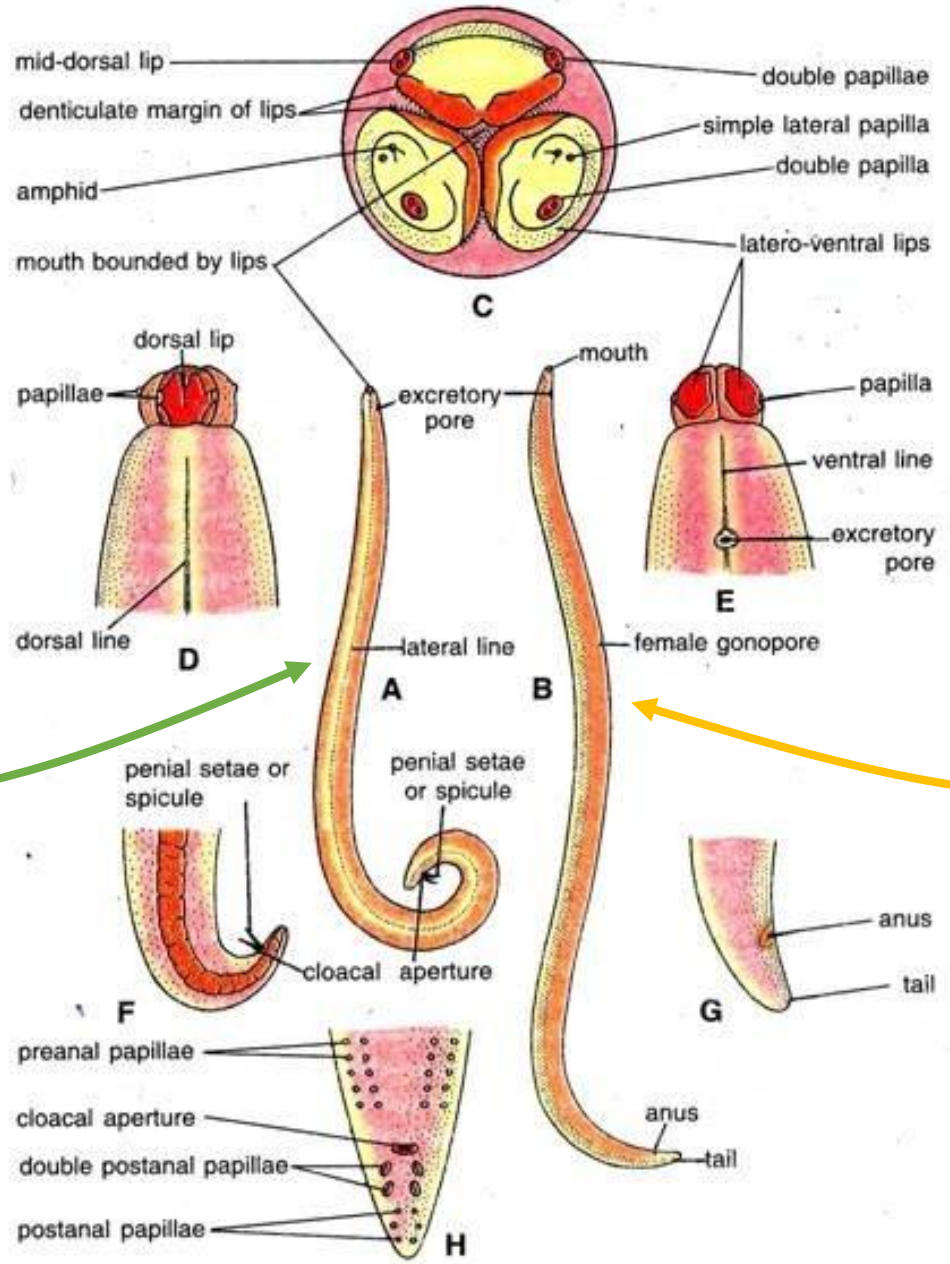
Geographical Distribution:

- **It is a cosmopolitan, having a world wide distribution being specially prevalent in tropics, such as China, India and South-East Asia.**
- **The parasite is most common in agricultural areas.**

External Morphology of *Ascaris Lumbricoides* :

Male

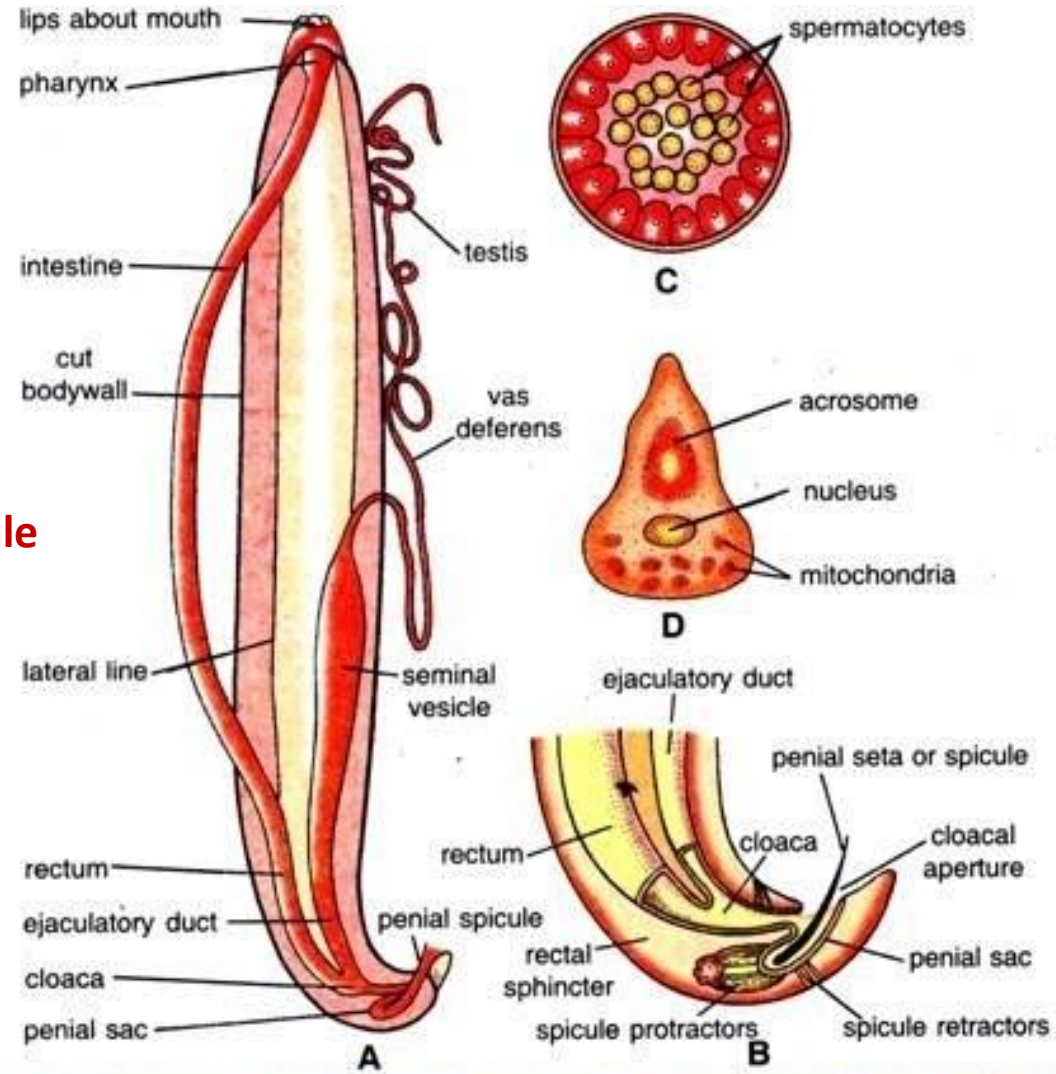
Female



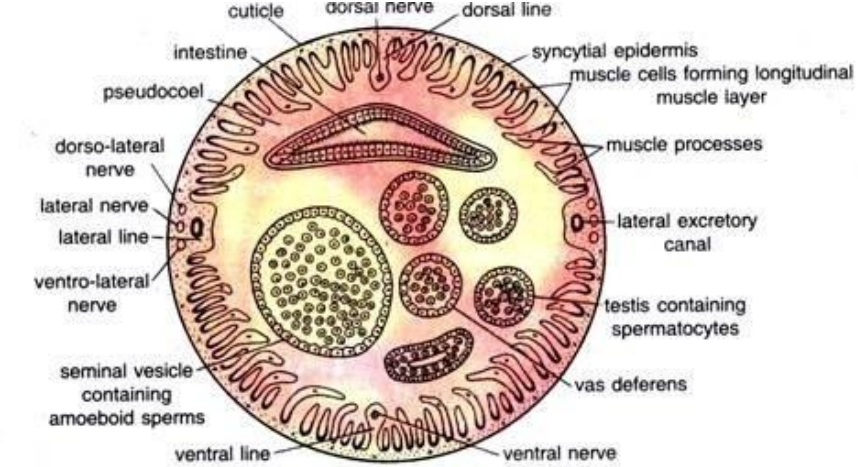
Ascaris lumbricoides. A—Male; B—Female; C—Entire view of mouth and lips; D—Anterior end in dorsal view ; E—Anterior end in ventral view ; F—Posterior end of male ; G—Posterior end of female , H—Posterior end of male in ventral view showing

Reproductive system of *Ascaris Lumbricoides* :

Male

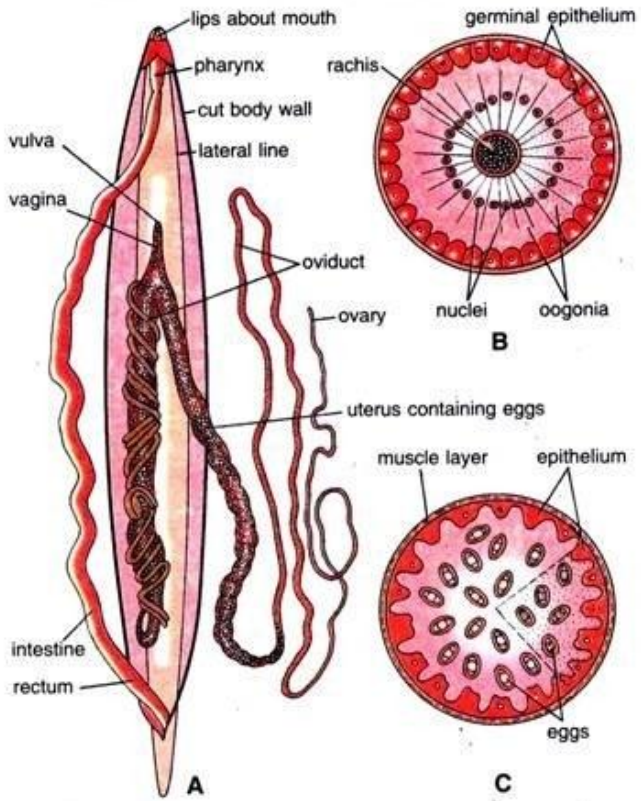


Ascaris lur bricoides. A—Male reproductive system; B—Posterior end of male *Ascaris* in lateral view showing cloaca and spicule; C—T.S. vas deferens; D—A sperm.



Ascaris lumbricoides. T.S. of a mature male.

Female



Ascaris lumbricoides. A—Female reproductive system; B—T.S. of ovary; C—T.S. of uterus.

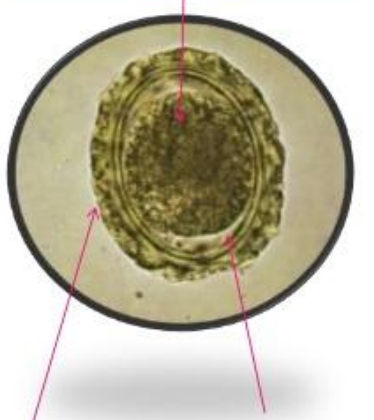
Fertilized & Unfertilized Eggs of *Ascaris Lumbricoides* :

MORPHOLOGY

FERTILIZED EGGS

PARAMETER	DESCRIPTION
SIZE	40-75 um by 30-50 um
SHAPE	Rounder than non-fertilized version
EMBRYO	Undeveloped unicellular embryo
SHELL	Thick chitin
Other features	May be corticated or decorticated

A. lumbricoides, fertilized egg

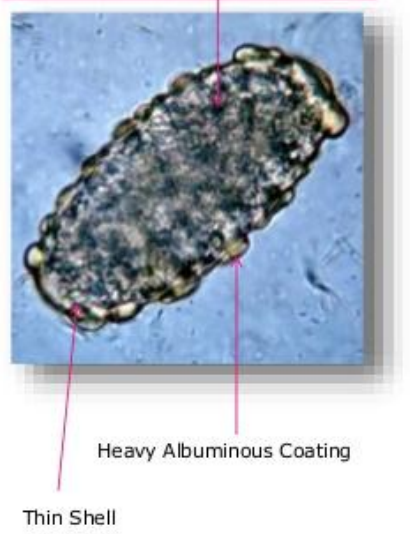


MORPHOLOGY

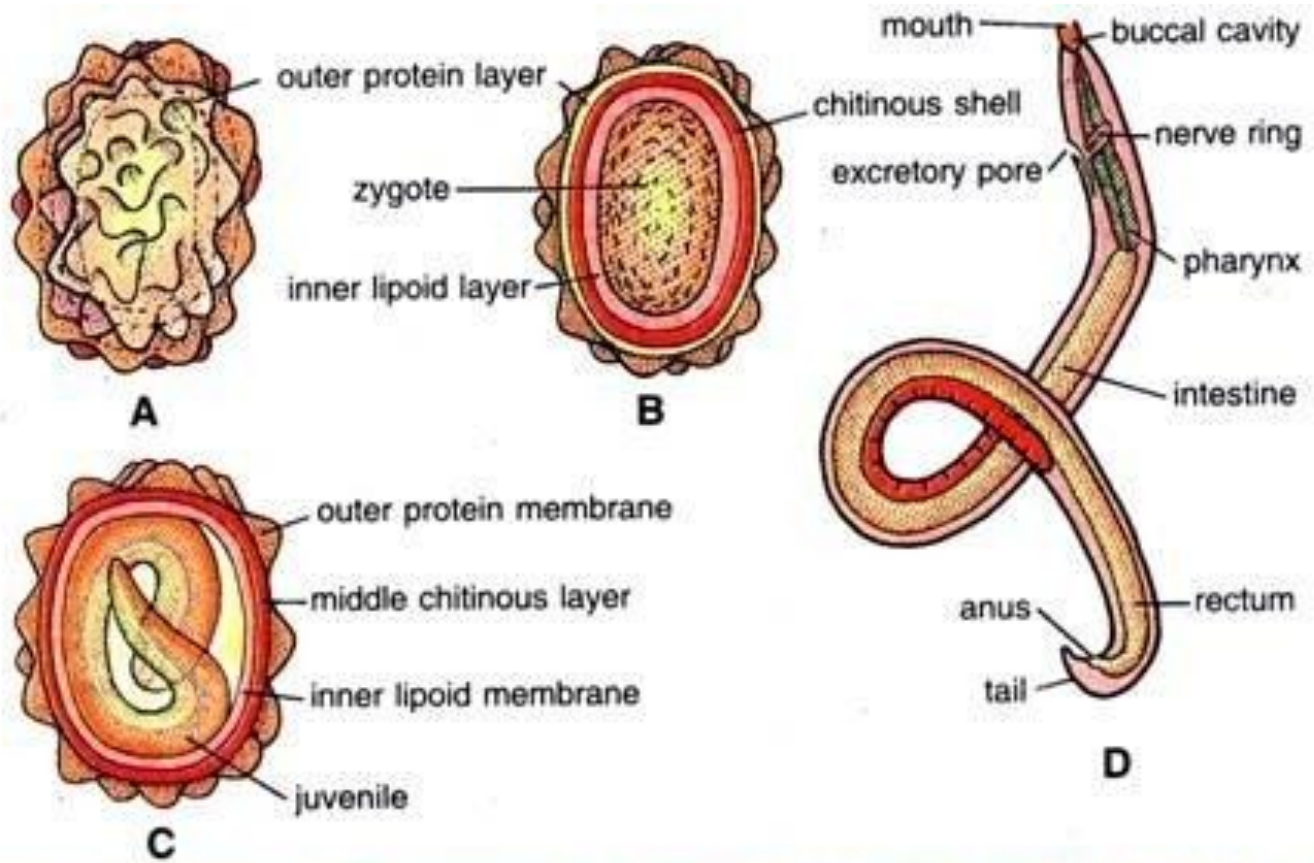
UNFERTILIZED EGGS

PARAMETER	DESCRIPTION
SIZE	85-95 um by 38-45 um; Size variations possible
SHAPE	Varies
EMBRYO	Unembryonated; Amorphous mass of protoplasm
SHELL	Thin
Other features	Usually corticated

A. lumbricoides, unfertilized egg

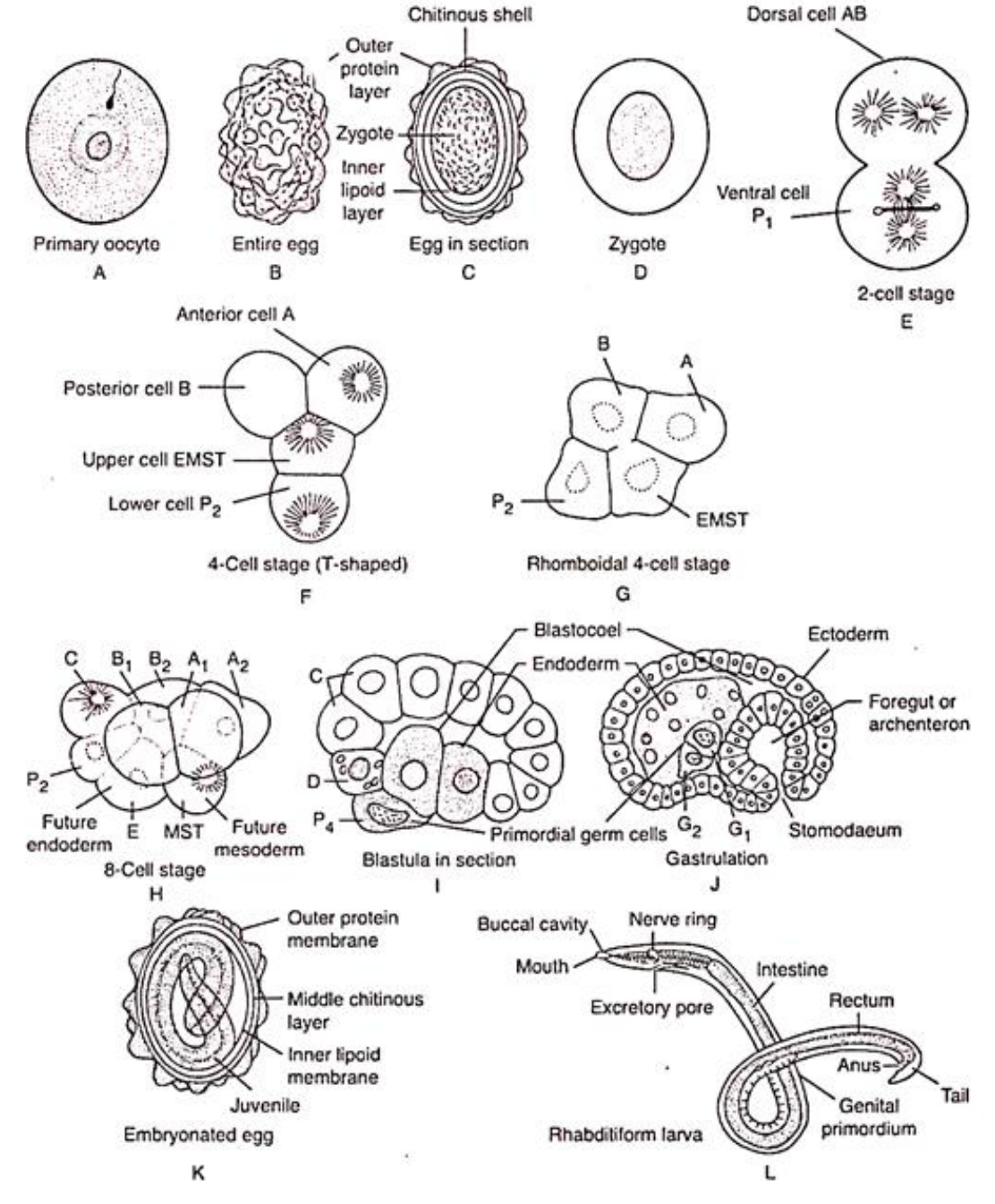


Formation of first stage larva :



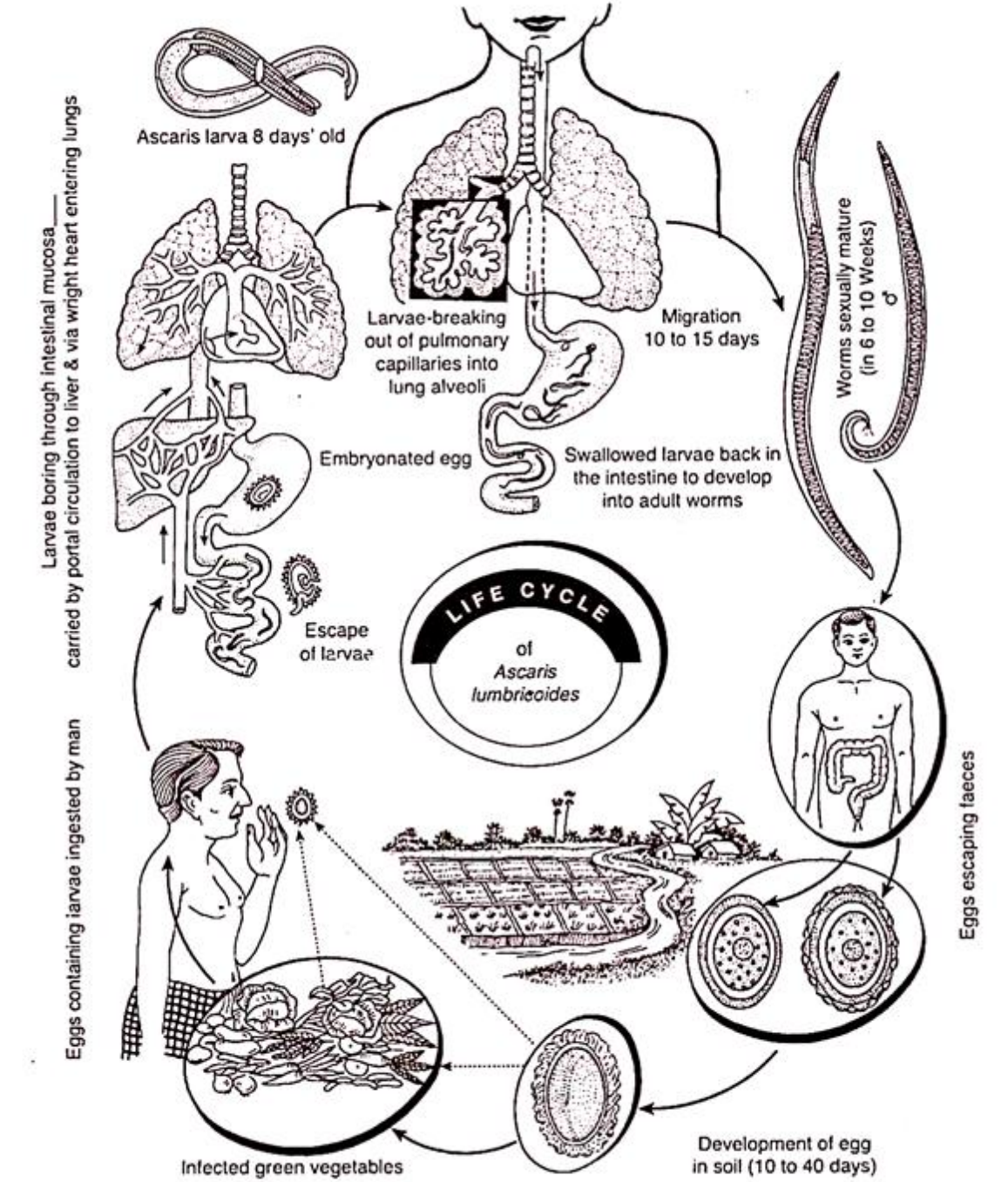
Ascaris: A—An entire mammiliated egg; B—Mammiliated egg in section; C—Embryonated egg; D—Rhabditiform larva.

Larvaval development of *Ascaris Lumbricoides* :



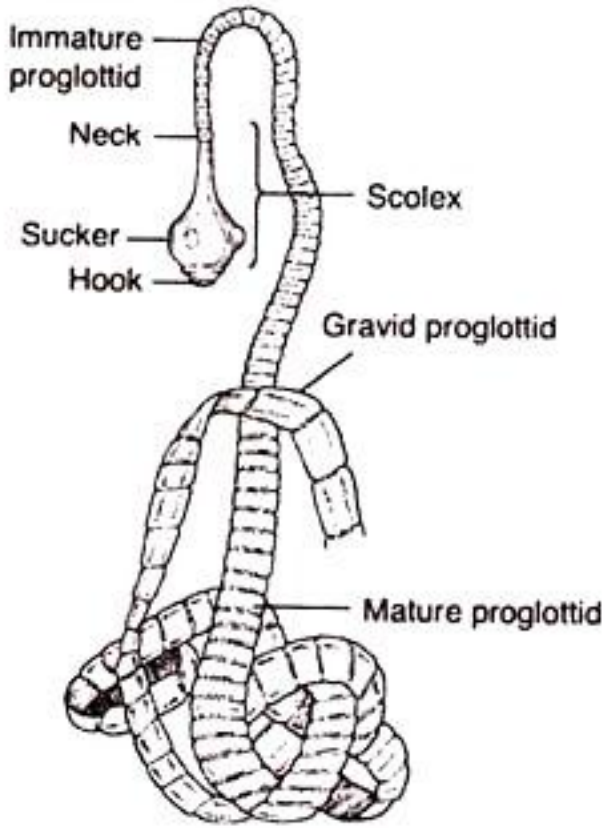
Round worm (*Ascaris*): Stages of development

Life Cycle of *Ascaris Lumbricoides* :

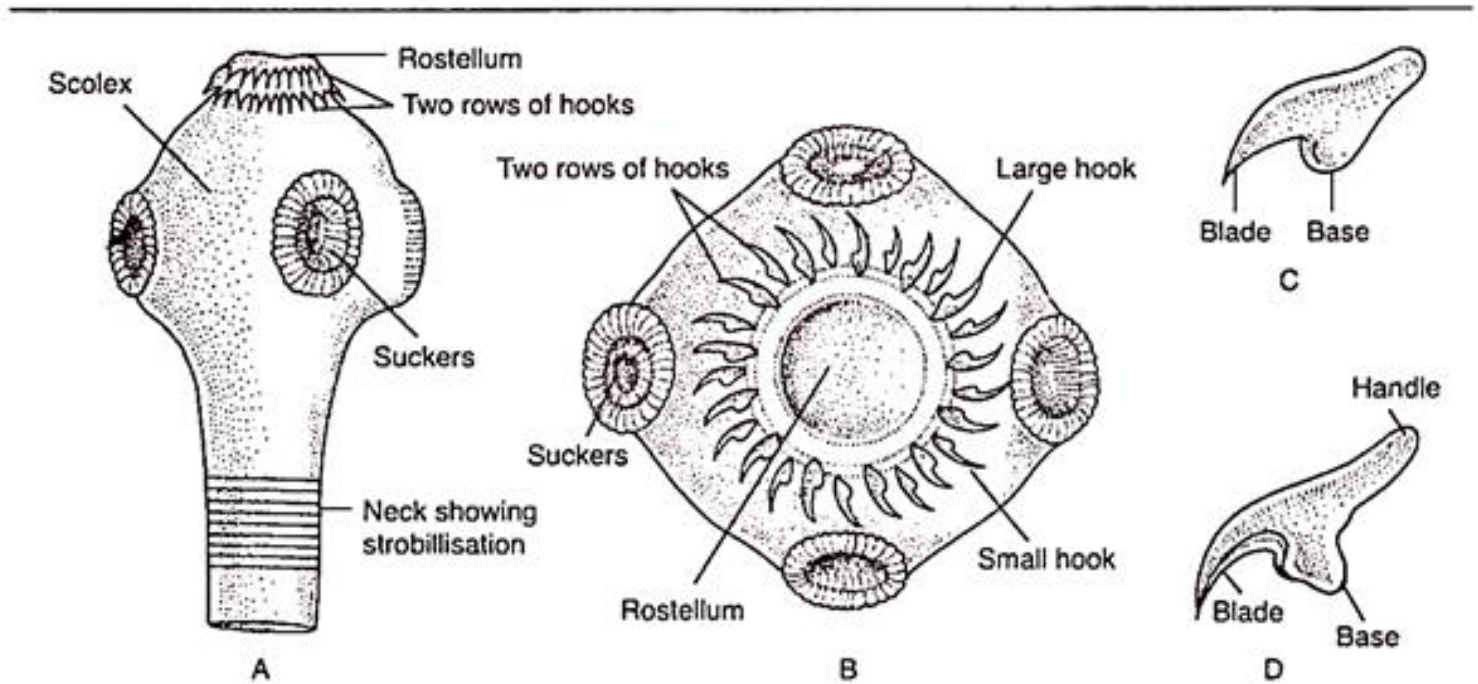


Round worm—Life cycle of *Ascaris lumbricoides*

5.4 Taenia Solium (The Pork Tapeworm)

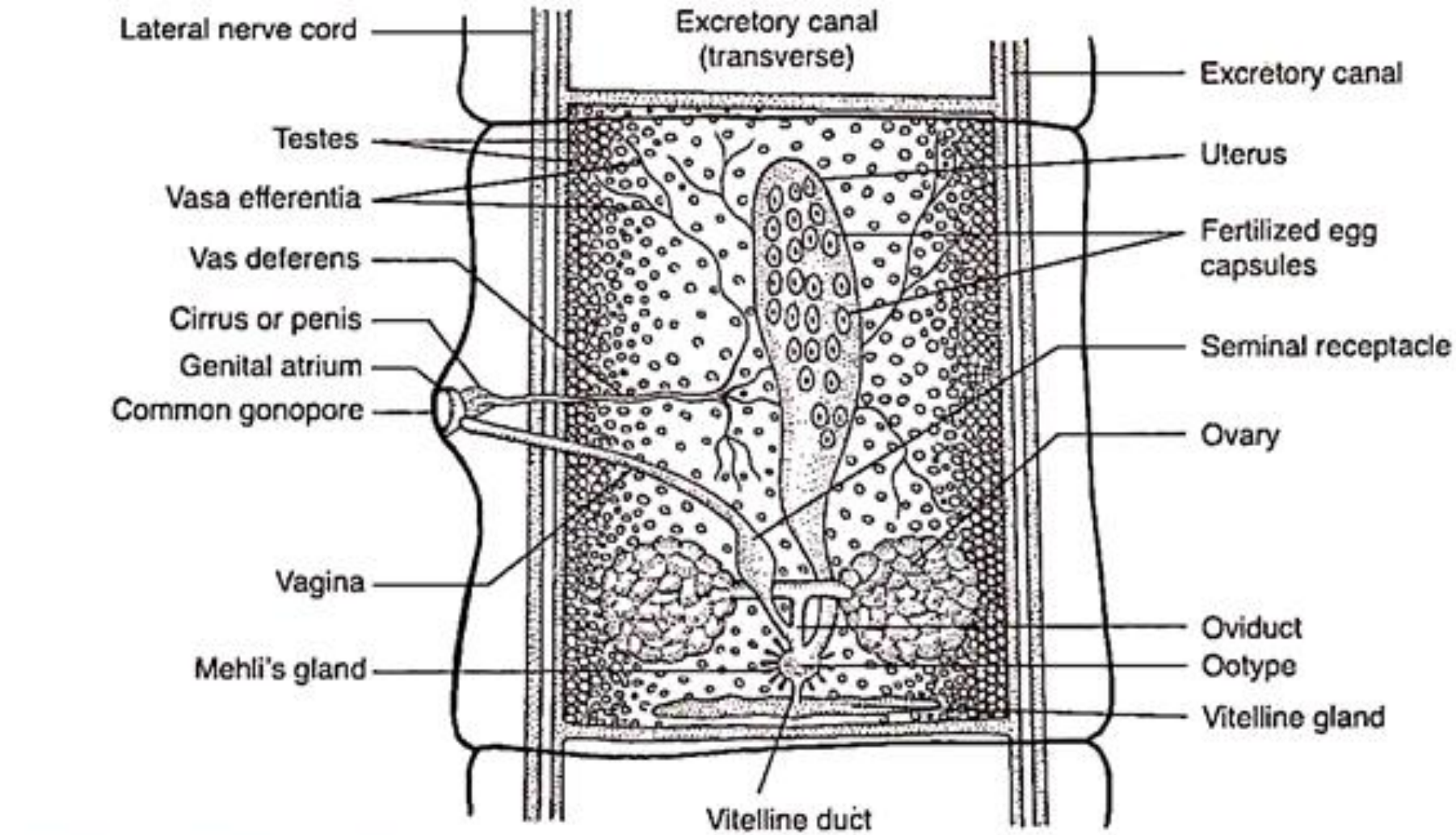


Gross structure of *Taenia solium*



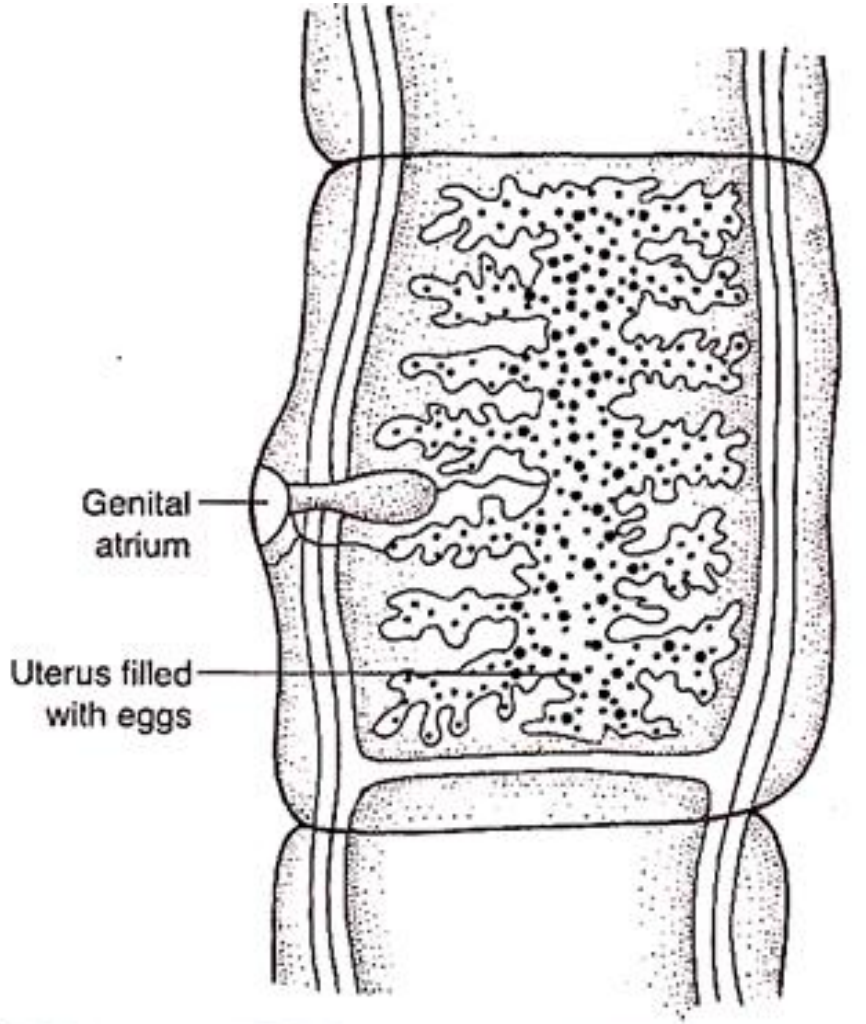
A. Magnified view of scolex, B. Dorsal view of the scolex with enlarged hooks, C. Small hook, D. Large hook

Male Reproductive System of Taenia Solium :

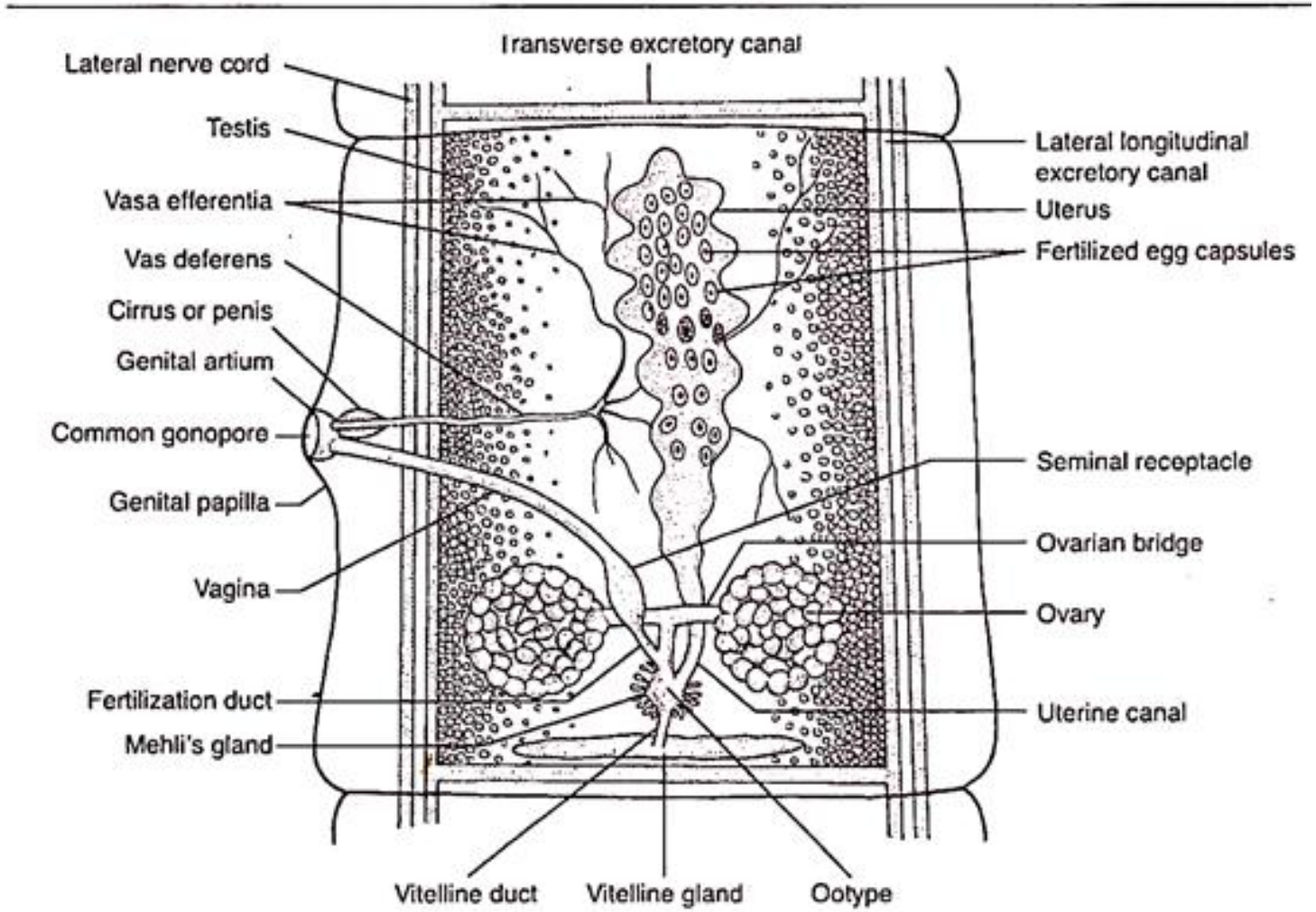


Taenia solium. Reproductive structures in a mature proglottid

Female Reproductive System of Taenia Solium :

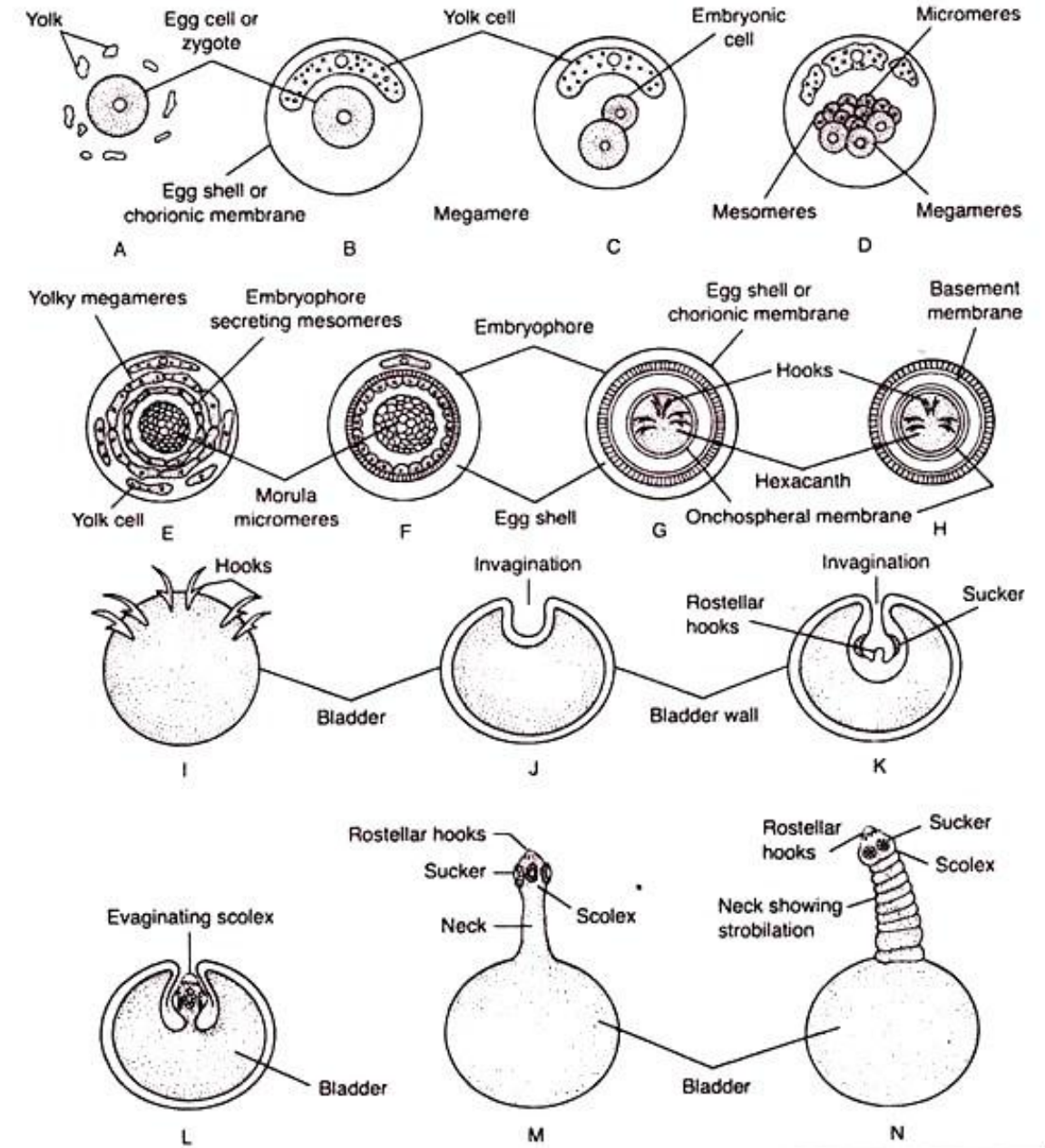


Taenia solium. A gravid proglottid showing branched uterus



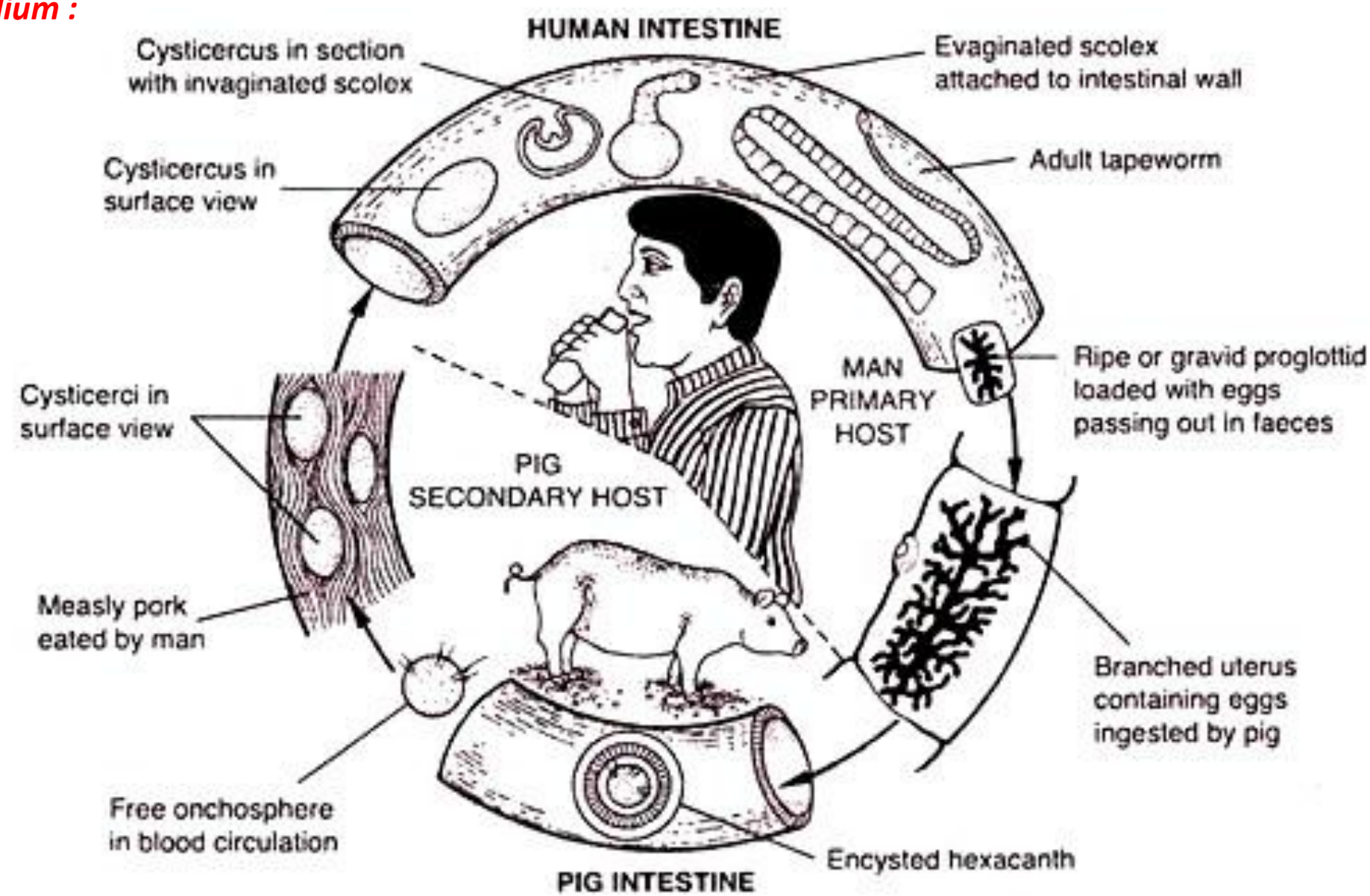
Reproductive system in a mature proglottid

Development Stages of Taenia Solium :



Different stages of development in *Taenia solium*. A. Zygote, B. Zygote in egg shell, C. Two-celled stage, D. Early morula, E. Late stage of morula, F. Embryophore, G. Onchosphere, H. Onchosphere without shell, I. Hexacanth larva, J. Bladderworm with invagination of Scolex, K. Bladderworm with proscolex, L. Evagination, M. Cysticercus, N. Cysticercus with neck, budding of proglottids

Life Cycle of Taenia Solium :



Life cycle of *Taenia solium*

References:

1. https://www.wikipedia.org/
2. https://www.google.com/
3. http://www.biologydiscussion.com/