ANIMAL ASSOCIATIONS - SYMBIOSIS

VSAQ s:

1. What is symbiosis?

- Living together in close and prolonged association of two or more organisms of different species with or without mutual benefit or harm.

2. Explain the association between termite and protozoan in its intestine.

- Mutualism is the association between termite and protozoans where both are benefited
- Large number of flagellate protozoans like *Trichonympha* or *Trichomonas termopsidis* lives in the intestine of termites (*Zootermopsis*).
- Termites feed on cellulose-containing wood materials but unable to digest cellulose.
- *Trichonympha* or *Trichomona*s produce cellulose and help in digestion of cellulose.
- They get nutrients and shelter from the termite.

3. How is commensal differs from parasite?

- Commensal gets benefit from host where the host is unaffected.
- Parasite gets benefit from host while host gets harm/loss always.

4. Differntiate between ectocommensal and endocommensal.

- Ecotcommensal lives on the body surface of its host. e.g., Hydractinia lives as ectocommensal present one the surface of gastropod shell in which the hermit crab lives.





- Endocommensal lives with in the body of the host. e.g., *Escherichia coli* live as endocommensal in intestine of man.

5. Distinguish between facultative and obligate parasite.

- A)Facultative parasite : parasite which leads either a free living or parasitic existence
  e.g. *Mycobacterium tuberculosis*

  B) Obligate parasite: parasite which is completely dependent upon its host.
  e.g. *Plasmodium vivax*

6. Distinguish between Histozoic and cytozoic parasite.

- A)Histozoic or Intercellular Parasite : A parasite that lives among the cells in host-tissue.
  e.g. *Entamoeba histolytic*a in the wall of colon and rectum of man.
  Wuchereria bancrofti in lymph vessels and glands of man.

  B)Cytozoic or Intracellular parasite : It lives within the host-cell.
  e.g. *Plasmodium vivax* lives in liver cells and RBC of man.

7. What is Hyperparasite ? Give an example.

- A parasite which lives as parasite in another parasite is hyperparasite to host.
  e.g. *Nosema notabilis* lives as parasite in *Sphaerospora polymorpha* which lives as parasite in urinary bladder of toad fish.

8. Distinguish between monoxenous and heteroxenous parasites?

- A)Monoxenous parasite : A parasite with direct life cycle which completes in one host.
  e.g. *Enterobius vermicularis*

  B)Heteroxenous parasite : A parasite with indirect life cycle requires definitive host and an intermediate host.
  e.g.*Taenia solium* with man as definitive host and pig as intermediate host.

9. Difference between definitive host and intermediate host.

- The host that accommodates the adult or sexually mature stage of parasite OR the host in which parasite attains the sexual maturity.
  e.g. Man is definitive host for *Taenia solium* ; Female *Anopheles* for *Plasmodium*
- The host that accommodates the developing larval stage of parasite OR asexual stages of parasite.
  e.g. Female *culex* for *Wuchereria*

10. Distinguish between vector and a carrier of a parasite?

- Vector is the organism which transfers infective forms of a parasite from one host to the other.
- A carrier has a light infection with a parasite but is not harmed by it.

11. Distinguish between mechanical vector and biological vector?

- In mechanical vector, the parasite does not undergo development before the transfer to another host.



  e.g. Housefly.
- In biological vector, the parasite undergoes development.
  e.g.*Anopheles* for *Plasmodium*



12. What is parasitic castration?

- Degeneration of host gonads by parasite is known as castration.
  e.g. *Sacculina* causes the degeneration of ovaries in the crab*, Carcinus maenas*

13. What is paratenic host (transfer host)?

- The host in which the immature stage of parasite does not normally undergo development but remains encysted until that host is consumed by the final host.

e.g. Second stage larva of *Taxocara* in chickens, lambs, rodents.

14. Differentiate between obligatory and facultative anaerobes?

Obligatory anaerobes	Facultative anaerobes
They can live as anaerobes in their hosts e.g., *Entamoeba histolytica*	They can carry aerobic respiration in the Presence of Oxygen, or anaerobic method In the absence of oxygen. e.g., Most intestinal parasites

15. Why it is very difficult to produce vaccine against malaria?

- *Plasmodium* which causes malaria changes its antigens from time to time.

SAQs:

1. Describe the mutualism with two examples.

- Mutualism is a close association between two organisms of different species which is beneficial to both partners.
- Mutualistic symbionts are incapable of living independently, because they are mutually dependent on each other metabolically.
- E.g. 1) Flagellate protozoans like *Trichonympha or Trichomonas termopsidis* live in the intestine of white ants like *Zootermopsis* (Termites). They secrete cellulase and help in the digestion of cellulose present in the food of termites.
  They get nutrients from termites.
  They can not live separately which indicates the mutualistic relationship between them.



TERMITES



TRICHONYMPHA

2)Zoochlorella, *Chlorella* is present nutritive-muscular cells of endoderm of *Chlorohydra.* Chlorohydra provides the zochlorella with shelter, protection, CO_2, nitrates, phosphates etc. Algae supply the end products of photosynthesis like O_2 and starch to hydra.

2. Describe the Parasitic effects on their hosts?

- Pathogenic parasites cause several types of diseases. *Plasmodium* causes malaria, *Leishmania* causes Delhi Boils.
- *Fasciola hepatica* causes hypertrophy, increase in the rate of multiplication of cells in bile duct of its host i.e., Sheep.

- Some parasites cause Neoplasia, the growth of cells in a tissue to form new structures. E.g. Tumour caused by viruses.
- *Plasmodium vivax* causes Hypertrophy, an increase in size of infected host RBC.
- Larval stage of *Fasciola hepatica* causes gigantism, an abnormal increase in the size of the host like snail.
- *Sacculina* degenerates the ovaries in crab, *Carcinus* and thus causes Castration.

3. Describe the parasitic adaptations..?

- Intestinal parasites of man like *Ascaris* and *Enterobius* have a protective cuticle to give resistance to the digestive enzymes of host. Tapeworm a protective tegument.
- Tapeworms have holdfast organs like suckers and hooks to attach with the wall of intestine.
- Some intestinal parasites are obligatory anaerobes leading only the anaerobic life.
- Most intestinal parasites are facultative anerobes which can lead either aerobic or anaerobic respiration.
- Parasites like *Entamoeba* undergo cystic stage to face unfavourable conditions.
- Some parasites can live in vectors aso.
- Reproductive system of parasitic worms is highly developed and females can lay huge number of eggs to ensure the infection a host and perpetuation their species.
- Digeneitic parasites like *Faasciola hepatica* have complex life history which includes sequential polyembryony.
- Parasites like *Plasmodium* change their antigens from time to time to face different conditions very effectively.

IMPORTANT QUESTIONS

1. Which lives in the intestine of termites? What are the benefits for termites? (March'04)
2. What are obligate parasites? Give an example? (May'04)
3. Commensalism, write two examples ? (March'06;May'06)
4. Onchosphere,where does it occur? (May'06)
5. Infective stage and disease caused by Entamoeba histolytica ? (May'06)
6. 2 diagnostic features of amoebiasis? (March'07; March'09; May'10; March'06)
7. Larva of Wuchereria Bancrofti in thoracic muscles of female culex mosqutoe?
8. How many moults in the life history of Wuchereria bancrofti? (March'07)
9. Incubation period? (May'07 ; May'10)
10. Hyperparasitism. Give an example? (March'08)
11. Facultative parasite & Obligatory parasite? (March '09 ;May'09; March'10)
12. Lymphadenitis and lymphangitis? (May'09)
13. Parasitic castration?

14. Hypnozoite ?
15. What are chromatoid bodies? (March'11)
16. Monogenetic and digenetic parasites ? (March'11)

SAQ :

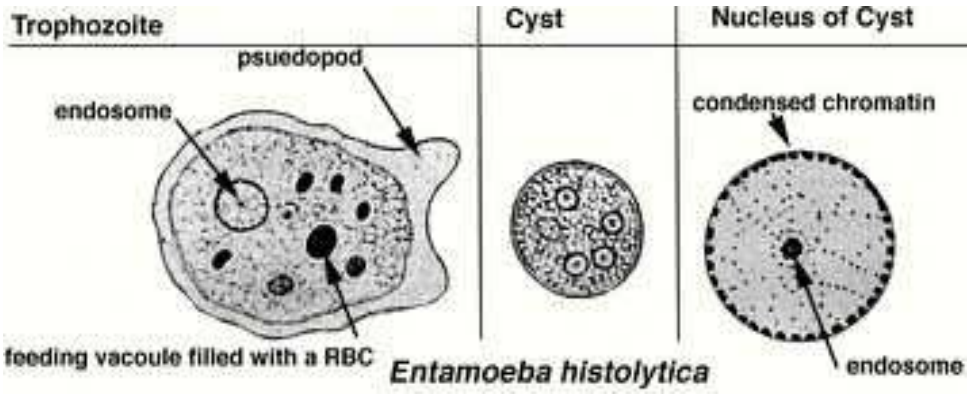
01. Structure of microfilaria larva ? (March '09 ;March'10; March'05 ;May'05)
02. Pathogenicity of Taenia solium? (May '09 ; March'11)
03. Parasitic adaptations ? (May'10; May'07)
04. Life cycle of *Entamoeba histolytica* ? (March'04)
05. Mutualism.. Two examples ? (June'04)
06. Scolex of Taenia solium? (March'05)
07. Life cycle of filarial worm in female culex ? (March'06)
08. Sexual dimorphism in *Wuchereria bancrofti* ? (May'06)
09. Parasitic adaptations in *Taenia solium?* (March'07)
10. Sporogony in *Plasmodium*? (May '07)
11. Importance of cysticercus in *Taenia solium ?* (March'08)
12. Parasitic effects on hosts?
13. Pathogenicity of *Entamoeba?*

ENTAMOEBA, WUCHERERIA

VSAQs :

1.Why the nucleus in *Entamaoeba* is considered as cartwheel like nucleus ?

- A small nucleolus is present in the centre of nucleus. Fine filaments of nucleoplasm radiate like the spokes of a wheel, from the endosome to peripheral beads of chromatin. It looks like a cartwheel.



2. Write any two diagnostic features of the infection by *Enatamoeba histolytica?*

- A)Presence of large number of trophozoites with ingested RBC in food vacuoles
  B)Tetranucleatye cysts in stools

3. Write diagnostic features of Trophozote of *Enatamoeba histolytica?*

- A) Cartwheel like nucleus.
  B) Food vacuoles with RBC C) Single pseudopodium

4. What are metacystic forms of *Entamoeba histolytica ?*

- The parasite after excystment is refered to as metacystic form.
- It occurs in the lumen of small intestine by the action of enzyme Trypsin.

5. What are chromatoid bodies?

- Rod – shaped chromatoid bodies are ribonucleoproteins present in cystic stage of *Entamoeba histolytica.*

6. A person is suffering from bowel irregularity, abdominal pain, blood and mucus in stools etc. Name the disease and its causative organism.?

- Amoebiasis or Amoebic dysentery is the disease.
- *Entamoeba histolytica* is the causative parasite for that disease.

7. Distinguish between primary amoebiasis and secondary amoebiasis. ?

- Primary amoebiasis occurs due to the ulceration of wall of colon by Entamoeba. The symptoms are discharge of blood and mucus in faeces of host.
- Secondary amoebiasis occurs due to invasion of tissues other than the intestinal mucosa by Entamoeba. It occurs when trophozoites after reaching organs like liver,lungs,kidneys or brain by causing abscesses.

8. Who are carriers or asymptomatic cyst passers?

- The persons with cyst in their stools and which can spread the parasite to other persons but never have any ill effects for them are known as carriers.

9. When the multiplication of species occurs in the life history of *Entamoeba histolytica*?

- Multiplication of species occurs at two stages

- A)Trophozoite …. In the wall of large intestine
  B)Metacystic stage …. In the lumen of small intestine.

10. Where encystment and excystment occur in the life cycle of Entamoeba histolytica ?

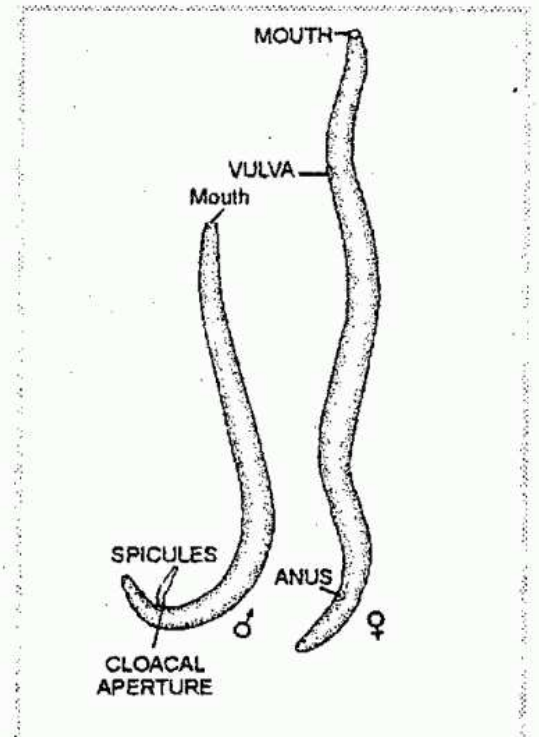
- A)Encystment …. Occurs in the lumen of large intestine.
- B)Excystment …. Occurs in the lumen of small intestine by the action of Trypsin.

11. Name the infective stage and mode of infection of *Entamoeba histolytica* to man?

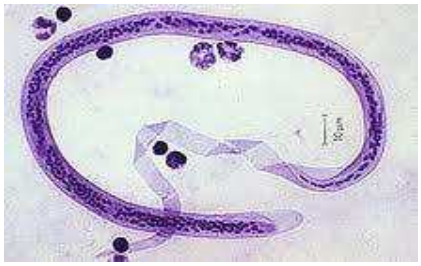
- Tetranucleate cyst is the infective stage and Contamination in the mode of infection.

12. Write differences between male and female *Wuchereria bancrofti.?*

Male Wuchereria	**Female Wuchereria**
1.Shorter & thinner	Longer & thicker than male
2. Curved posterior end	Straight posterior end
3. Cloaca at curved posterior part	Anus is present near posterior end
	Female genital pore(vulva) is ventral
4. A pair of unequal penial setae or copulatory spicules is present in cloacal region.	Penial setae are absent
5. Many copulatory papillae are present	Copulatory papillae are absent.



Wuchereria bancrofti



Microfilaria Larva

13. What is meant by ovoviviparity?

- Ovoviviparity is condition where the females produce eggs that hatch within its body without obtaining nourishment from them.
- It is shown by female *Wuchereria.*

14.Name the larval form of *Wuchereria.* Why is it called sheathed larval form?

- Microfilaria is the larval from of *Wuchereria.*
- It is surrounded by a loose cuticular sheath or egg membrane (modified shell). So it is known as sheathed larva.

15. What is meant by nocturnal periodicity?

- Nocturnal periodicity the character shown by microfilariae of *Wuchereria* where the larva is active during night time and comes to peripheral blood vessels.
- It coincides with the feeding habit of *Culex* mosquito.

16. What are lymphangitis and lymphadenitis?

- Inflammation in lymph vessels due to infection with wuchereria is LYMPHANGITIS.
- Inflammation in lymphatic glands is known as LYMPHADENITIS.

17. What is Lymphoedema ?

- Immense swelling of the extremities of limbs, scrotum of males and mammary glands of females due to blocking of lymph vessels by the accumulation of dead worms or due to inflammatory reactions to worms is known as Lymphoedema.

18. Describe the conditions occur in elephantiasis?

- In filariasis, the fibrous tissue accumulates in the affected organs. Sweat glands in the affected parts disintegrate and the skin becomes rough and dry.

19. Describe the conditions of Lymphangiovarix, Lymphorrhage,hydrocele and occult Filariasis.?

- A)Lymphangiovarix ----- Dilation of lymph vessels in inguinal, scrotal and abdominal regions.
- B)Lymphorrhage ------- Rupture of lymph vessel.
- C)Hydrocele ----- Accumulation of fluid due to the obstruction of spermatic cord.
- D)Occult filariasis ----- Hypersensitivity reaction to filarial antigens

20. Name the infective stage and mode of transmission of filarial worm to man?

- Third stage larva is the infective stage. Inoculation (mosquitoe's bite) is the mode of transmission.

21. How many moults occur in the life cycle of *Wuchereria bancrofti ?*

- 4 moults occur in the life cycle of filarial worm. Of them, first two occur in thoracic muscles of female culex and last two occur in lymph vessels of man.

SAQs:

1. Describe the structure of a trophozoite of *Entamoeba histolytica.?*

- Trophozoite stage is the feeding stage of Entamoeba histolytica.
- Trophozoite is surrounded by plamalemma.
- Cytoplasm has outerviscous and nongranular ectoplasm and inner fluid like and granular endoplasm.
- It is monopodial form with a single short, blunt and fingerlike lobopodium type of pseudopodium.
- It has a vesicular nucleus.
- Chromatin occurs peripherally as minute beads attached to inner surface of nuclear membrane.
- A small nucleolus is present in the centre of nucleus. Fine filaments of nucleoplasm radiate like spokes of wheel between endosome and and peripheral beads. It gives a cartwheel like appearance to nucleus.
- Absence of mitochondria indicates the condition of anaerobic respiration.
- It reproduces asexually by binary fission in the wall of gut.

2. Explain the life cycle of *Entamoeba histolytica*.?

- Entamoeba histolytica is a monoxenous parasite which completes its life cycle in a single host (Man). It completes life cycle in the following stages…..

A) PRECYSTIC STAGE:

- Trophozoites undergo binary fission in the wall of large intestine.
- Some of the daughters transform into trophozoites while the remaining daughters enter the lumen of intestine and get round or oval shaped precystic.
- Precystic stages get encysted by losing food vacuoles and pseudopodia.
- They store glycogen granulses and rod-shaped chromatoid bodies with ribonucleoproteins.

B) CYSTIC STAGE:

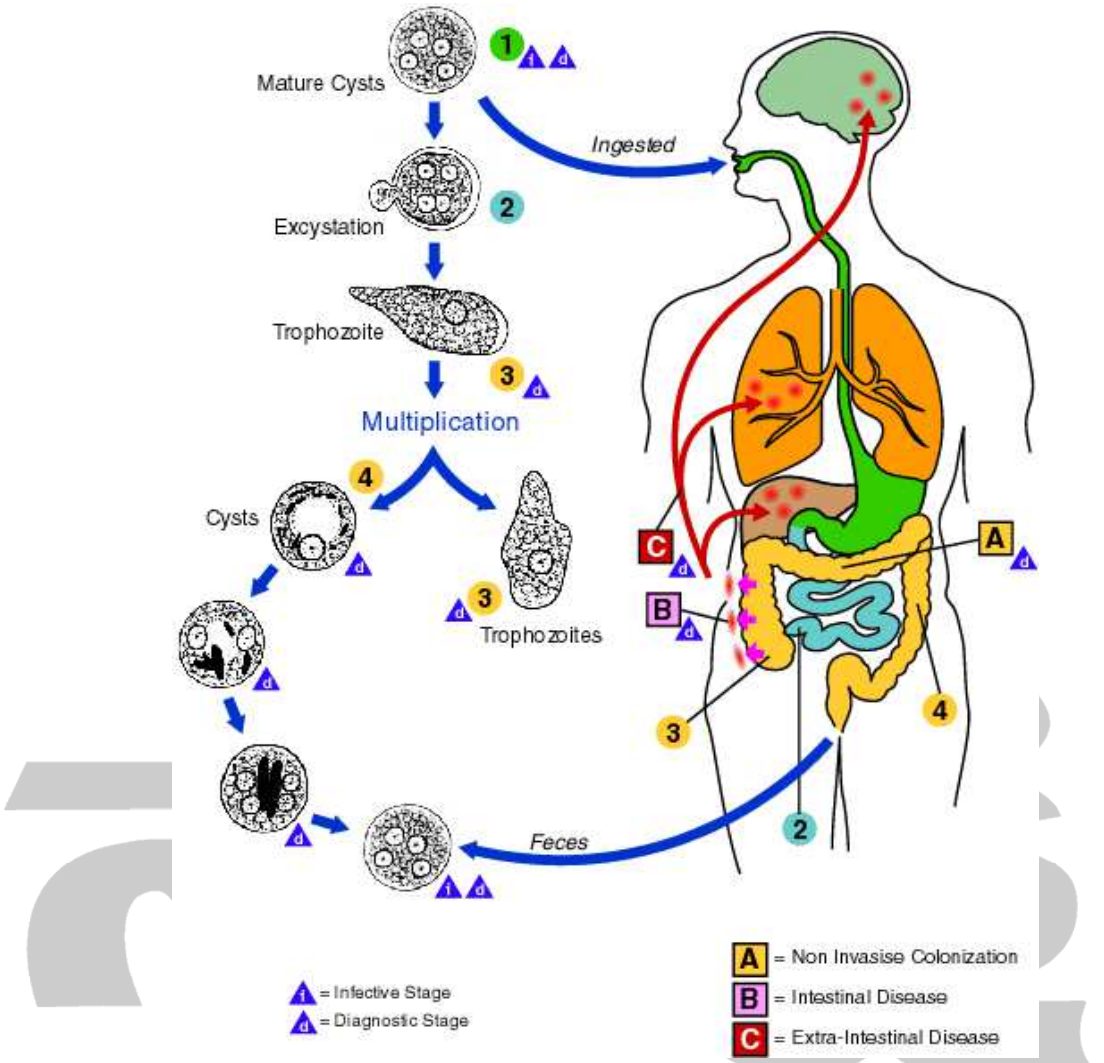
- Formation of cyst is known as encystment. It occurs in the lumen of large intestine.
- Nucleus undergoes two successive mitotic divisions to form four nuclei and this stage is known as TETRANUCLATE CYST.

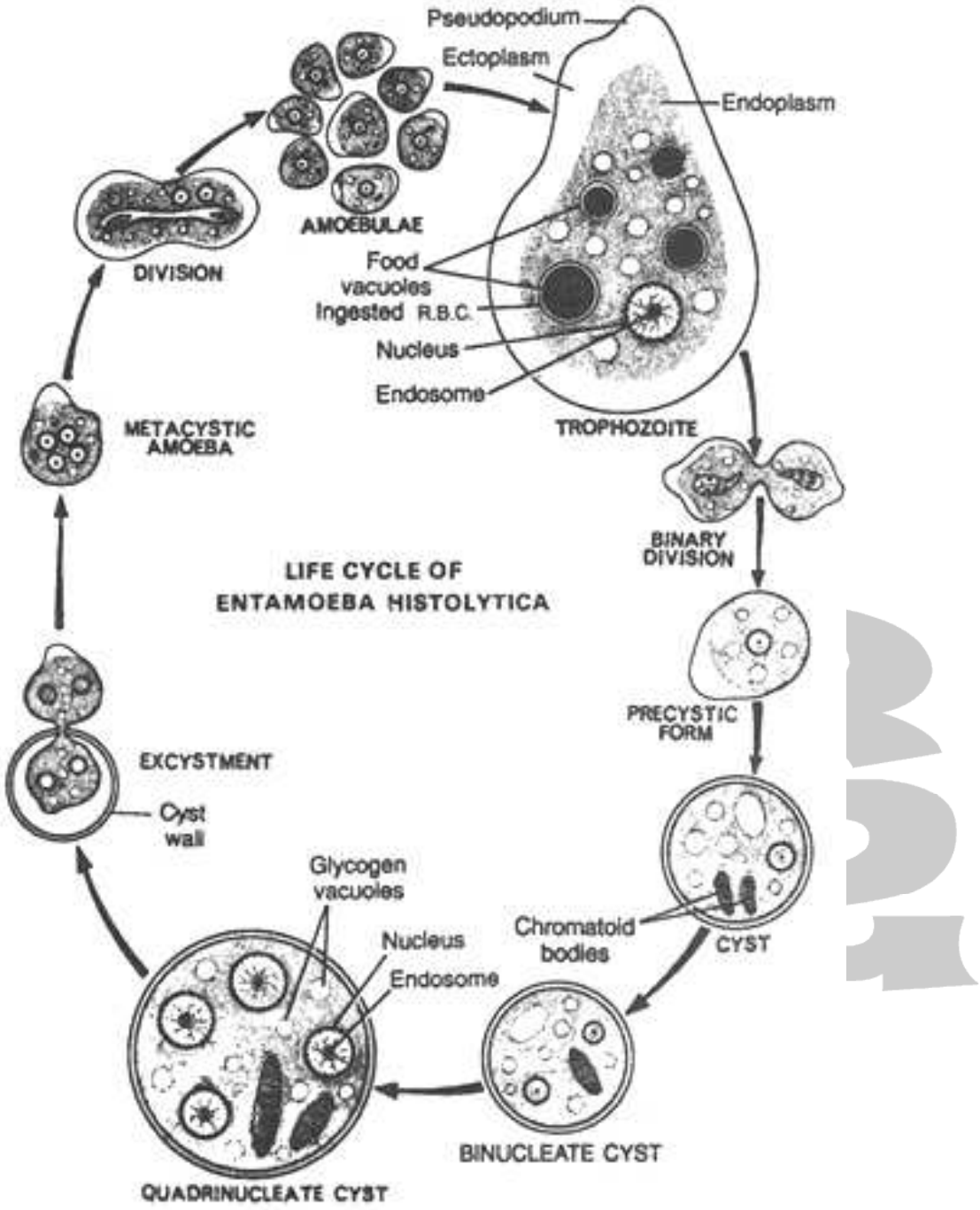
C) INFECTION:

- Tetranucleate cyst is the infective stage to man. These cysts come out along faeces and contaminate food or drinks.

D) EXCYSTMENT:

- Tetranucleate cysts enter the small intestine through food.
- Trypsin dissolves the wall of cyst by the process known as excystment which occurs in lumen of small intestine.
- Parasite after excystment is known as metcystic form with four nuclei.
- Four nuclei and cytoplasm of metacyst divide and from eight Uninucleate daughter amoebulae. It is a characteristic feature of *Entamoeba histolytica.*
- Amoebulae enter the large intestine and enter the wall.
- In the wall of colon, amoebule are transformed into trophozoites.


Mature Cysts
1
Ingested
Excystation
2
Trophozoite
3
Multiplication
4
Cysts
3
Trophozoites
C
A
B
3
4
2
Feces
= Infective Stage
= Diagnostic Stage
A = Non Invasise Colonization
B = Intestinal Disease
C = Extra-Intestinal Disease



Entamoeba histolytica : Reproductive and life history

3. Explain the pathogenicity of *Entamoeba histolytica?*

- It causes amoebiasis. The symptoms are discharge of blood and mucus in faeces(amobic dysentery). It occurs due to ulceration of wall of colon.
- Typical symptoms of amoebic dysentery are acidic stools with blood & mucus, severe abdominal pain.

- Presence of more number of trophozoites with ingested RBCs in their food vacuoles along with tetranucleate cysts in stools is the diagnostic feature of infection by *Entamoeba histolytica.*

4. Describe the structure of microfilaria larva of *Wuchereria bancrofti.*

- Microfilaria larva of *Wuchereria bancrofti* is covered by a loose cuticular sheath or egg membrane.
- Surface of larva is covered by a layer of flattened epidermal cells.
- Its body contains a column of cytoplasm with a number of nuclei.
- Larva has an oral stylet at anterior end where the future mouth develops.
- Other characters of larva are

  a)Nerve ring around pharynx. b) Excretory pore c)Renette cell for excretion
  d)Four large germinal cells e)future anal pore f)Somatic cell mass
  g)A darkly stained inner cell mass which represents rudimentary gut.
- Microfilaria larva shows nocturnal periodicity.



MICROFILARIA LARVA

5. Describe the structure of *Wuchereria bancrofti?*

- The body of *Wuchereria* is elongated,narrow,filiform and round in shape.
- Worms are creamy in colour.
- Anterior end of the body is blunt and posterior end is pointed.
- Mouth is at anterior end without oral lips.
- Alimentary canal has mouth, pharynx,oesophagus,intestine and anus/cloaca.
- Pharynx has muscular anterior part and glandular posterior part.
- Worms show sexual dimorphism in following manner.

Male *Wuchereria*	**Female *Wuchereria***
1.Shorter & thinner	Longer & thicker than male
2. Curved posterior end	Straight posterior end
3. Cloaca at curved posterior part	Anus is present near posterior end Female genital pore(vulva) is ventral
4. A pair of unequal penial setae or copulatory spicules is present in cloacal region.	Penial setae are absent
5. Many copulatory papillae are present	Copulatory papillae are absent.

6. Describe the pathogenicity of *Wuchereria bancrofti.?*

- *Wuchereria bancrofti* causes filariasis or wuchereriasis in man.
- Light infection causes filarial fever, mental depression and headache.

- Inflammation in lymph vessels is llymphangitis and inflammation in lymphatic glands is known as lymphadenitis.
- In heavy infection, accumulation of dead worms blocks the lymph vessels and glands resulting in immense swelling of extremities of limbs, scrotum of males and mammary glands of females. It is known as lymphoedema.
- Fibroblasts accumulate in the oedematous tissues causing fibrosis.
- Swet glands of skin in the affected parts disintegrate and the skin becomes rough and dry. It is known as elephantiasis.
- Other features of filariasis are lymphangiovarix, lymphorrhage, hydrocoel and occult filariasis.

LONG ANSWER QUESTION:

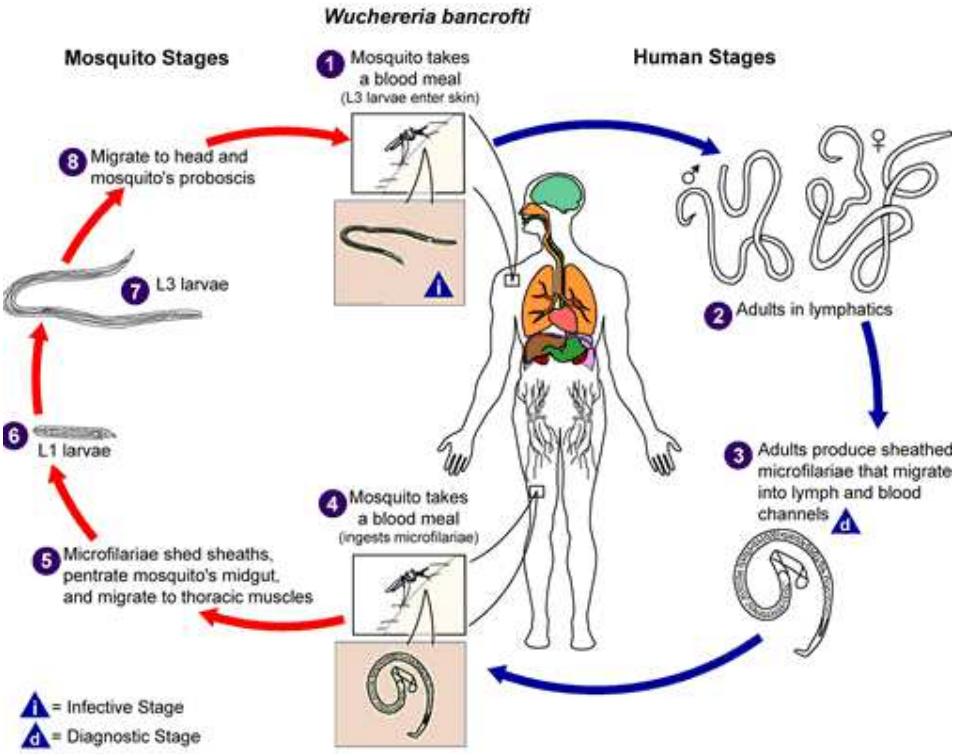
1. **Describe the life cycle of *Wuchereria bancrofti?***
   - *Wuchereria bancrofti* is aheteroxenous parasite tht completes its life cycle in two hosts i.e., man and female *Culex* mosquito.

I) HUMAN PHASE:

- After copulation between male and female worms in lymphatic system of man, the females release the microfilariae larvae into lymph of man.
- Female worms are considered as ovoviviparous.
- Microfilaria is covered by a loose cuticular sheath or egg membrane.
- Microfilariae migrate into the blood circulation and present in the deeper vessels of visceral organs. The larvae move to the peripheral blood vessels during nights between 10 pm and 4 am. Thus te larvae show nocturnal periodicity.
- When mosequito sucks the blood of that man, the larvae enter the midgut of mosquito.
- Microfilaria stage is the infective stage to the mosquito.

II) THE MOSQUITO PHASE:

- The sheath of larva is dissolved in midgut of mosquito within 2 to 6 hrs. of infection. It penetrates the gut wall with stylet and enters the haemocoel.
- Then it reaches the thoracic muscles and begins to grow there.
- Within 2 days, it becomes a flat sausage-shaped larva, the first-stage larva.
- It undergoes 1st moulting and grows into a slender elongated second stage larva.
- Second stage larva undergoes 2nd moulting and becomes a long infective third stage larva. These changes occur within a period of 10-20 days.
- Third-stage larva moves to labium of mosquito and can be transferred to definitive host.
- In man, third stage larva first enters blood, and later passes into the lymphatic vessels.
- In lymphatic vessels, these larvae undergo 3rd and 4th moults and become the adults. They attain sexual maturity in abut 5-18 months time
- Third stage larva is the infective stage to man.



IMPORTANT QUESTIONS

01. Why the nucleus of Entamoeba is called as cartwheel like nucleus (March'05; March'10
02. Infective stage and disease caused by Entamoeba histolytica (May'06)
03. 2 diagnostic features of amoebiasis (March'07; March'09; May'10; March'06)
04. Larva of Wuchereria Bancrofti in thoracic muscles of female culex mosquito. How many moults in the life history of Wuchereria bancrofti ? (March'07)
05. Lymphadenitis and lymphangitis? (May'09)
06. What are chromatoid bodies ? (March'11)

IMPORTANT QUESTIONS

SAQ :

01. Structure of microfilaria larva? (March '09 ;March'10; March'05 ;May'05)
02. Life cycle of *Entamoeba histolytica* ? (March'04)
03. Life cycle of filarial worm in female culex ? (March'06)
04. Sexual dimorphism in *Wuchereria bancrofti*? (May'06)
05. Pathogenicity of *Entamoeba?*

PLASMODIUM VIVAX (Malaria Parasite)



LAVERAN



GOLGI



RONALD ROSS

VSAQs ::

1.What are the two types of merozoites produced in the exoerythrocytic stage of Plasmodium vivax ?

- A)Cryptozoites or First generation merozoites
  B)Metacryptozoites or second generation merozoites



2. Which stages of Plasmodium that infect hepatocytes ?

- A)Sporozoites B)Macrometacryptozoites infect hepatocytes of liver.

3. Which stages of Plasmodium infect RBC of man?

- A)Micrometacryptozoites B)Erythrocytic merozoites C) Hypnozoites D)cryptozoites infect RBC.

4. Define prepatent period.

- The time interval between the initial infection by the sporozoites of Plasmodium and the first appearance of the parasites in the blood of man is Prepatent period.
- It is about 8 days in *Plasmodium vivax.* During this period parasite increases in number, but the host does not exhibit any symptoms of disease.

5. Define incubation period.

- The time interval between the entry of sporozoites of Plasmodium into the body and the onset of malarial fever is known as the incubation period.
- It is about 10-14 days in *Plasmodium vivax.*

6. What are schuffner's dots?

- Schuffner's dots are minute red-staining granules appear in the cytoplasm of RBC.
- These are the antigens produced by *Plasmodium* against RBCs.

7. What are haemozoin granules?

- Digested haematin of haemoglobin by *Plasmodium* forms the brown-colored haemozoin granules appear in *Plasmodium.*
- Haemozoin granules are toxic and cause symptoms of malaria.

8. Distinguish between schizogony and sporogony.?

- Schizogony is the asexual multiple fission occurs in the life history of *Plasmodium.* It occurs in hepatocytes of liver and RBCs of blood.
- Merozoites are formed after schizogony.

- Sporogony is the sexual multiple fission occurs in the wall of crop in female anopheles mosquito in the life history of plasmodium.
- Sporogony results the formation of sporozoites in sporozysts.

9. What is exflagellation ?

- Exflagellation is the process where micro gametes liberate from the flagellated body as male gametes.
- It is a part of life cycle of Plasmodium which occurs in the lumen of crop of female Anopheles mosquito.

10. Explain alternation of generations in the life cycle of *Plasmodium vivax*.?

- Alternation of generations occurs in the life history of *Plasmodium vivax*.
- Asexual phase of life cycle which occurs in man alternates with sexual phase which occurs in female *Anopheles* mosquito.

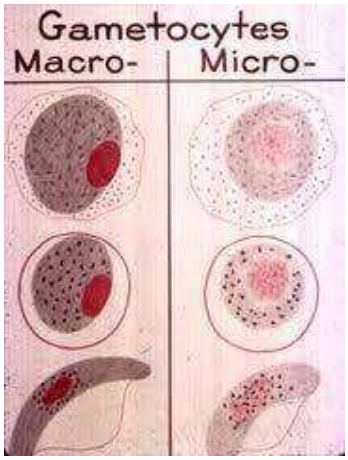
11. What is ookinete ?

- Zygote of *plasmodium* becomes motile ookinete in the lumen of crop of female Anopheles.
- This ookinete helps in piercing the wall of the crop and comes to lie beneath the basement membrane for further develpment

12. Distinguish between Macro gametocyte and micro gametocyte.

- Gametocytes are sexually differentiated forms which are formed in RBCs.
- Formation of them occurs in spleen and bone marrow.

MACROGAMETOCYTE	MICROGAMETOCYTE
1.It is female gametocyte	It is male gametocyte
2.It has a small nucleus	It has a large nucleus
3.Cytoplasm has food materials	No food material
4.Less in number	More in number



13. What do you mean by Tertian fever?

- *Plasmodium vivax* causes tertian fever.
- Haemozoin is released into the blood every 48 hours (2 days) after the completion of Golgi cycle.

- Haemozoin in blood causes the occurrence of malaria symptoms which occur on every third day. So this fever is known as tertian fever.

14. What is the significance of Hypnozoite ?

- Macro metacryptozoites may survive for long period in liver as dormant stages called Hypnozoites.
- Hypnozoites reactivate and initiates the beginning of fresh erythrocytic cycle and new attacks of malaria which is referred to as Relapse of fever.

15. Why the syngamy in *Plasmodium* is known as anisogamy?

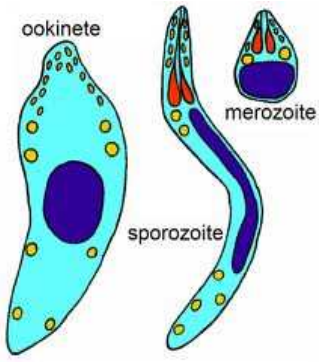
- Fusion of dissimilar gametes is considered as anisogamy.
- It occurs in the lumen of crop in female Anopheles in the life cycle of Plasmodium.
- Macrogamete or female gamete is round in shape while microgamete or male gamete is an elongated form.

16. Describe the biological control of malaria.?

- Culturing of larvivorous fishes like *Gambusia* is one of the biological control of mosquitoes which spread plasmodium that causes malaria.

17. Describe about secretory organelles of sporozoite.?

- Sporozoite is the infective stage of *Plasmodium* to man.
- A cup like depression known as apical cup or apical sucker is present at anterior end of sporozoite.
- A pair of narrow secretory organelles known as Rhoptries open into apical cup.
- Rhoptries secrete a cytolytic enzyme which helps in the penetration of sporozoite into the liver cells.



SAQs::

1. Describe the exoerythrocytic phase of *Plasmdium vivax.?*

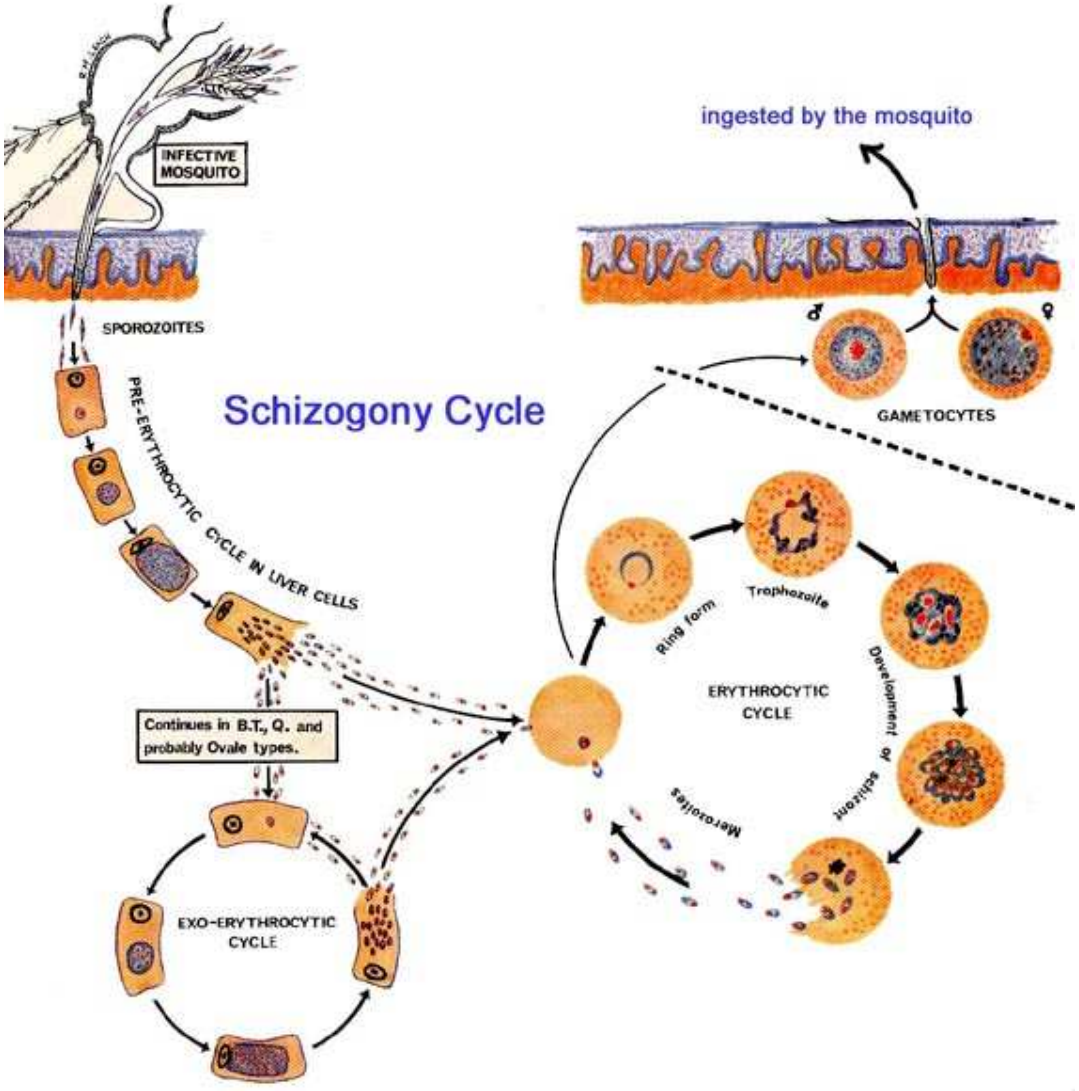
- *Plasmodium vivax* reproduces asexually by multiple fission known as schizogony in man. It completes life cycle in hepatocytes of liver and RBC.
- Exoerythrocytic phase occurs in liver cells in two types of generations like Preerythrocytic generation and Exoerythrocytic generations.

A) EXOERYTHROCYTIC STAGE :

- Sporozoites enter the liver cells first.
- In liver cells sporozoites become trophozoites which feed on liver cells and increase in size. Nucleus of trophozoite divides many times and forms a multi-nucleate Schizont.

- Cytoplasm also divides and releases many Cryptozoites or First generation merozoites with 8 days into liver sinusoids.
- These cryptozoites may enter RBCs to continue the erythrocytic cycle or invade other liver cells to produce the second generation.
- Cryptozoites become trophozoites in liver cells and feed on hepatocytes.
- Its nucleus divides many times and form a multinucleate Schizont. Cytoplasm also divides and release more number of metacryptozoites or Second generation merozoites into the liver sinusoids.
- Metacryptozoites are of two types ….

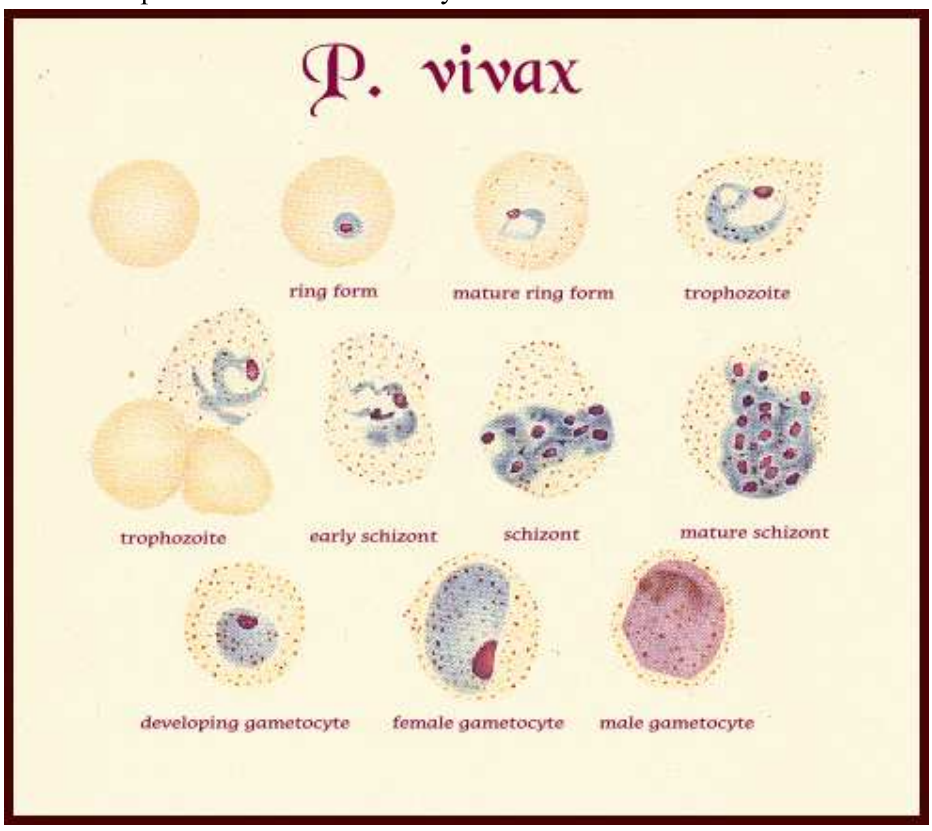
Macrometacryptopzoites	**Micrometacryptozoites**
1.Larger 2.infects hepatocytes of liver	Smaller Infect RBCs of blood

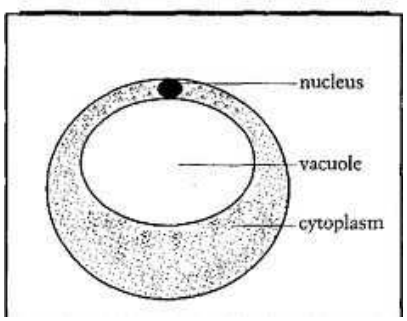


2. Describe the Erythrocytic phase of *Plasmodium vivax* (Golgi cycle) GOLGI

- Cryptozoites of preerythrocytic generation or the micrometacryptozoites of exoerythrocytic generation enter RBCs.

- These merozoites become trophozoites in RBCs.
- Vacuole of trophozoite increases in size and pushes the cytoplasm and nucleus to periphery and forms Signet ring stage. Later the vacuole disappears.
- Parasite develops pseudopodia and becomes amoeboid, feeding on contents of RBC. It is known as amoeboid stage (Late trophozoite). The size of RBC doubles (hypertrophy).
- Infected RBCs become pale in color due to the loss of Haemoglobin.
- Minute red-staining granules 'Schuffner's dots appear in the cytoplasm of RBC. They are antigens formed parasite.
- Trophozoite becomes Schizont. It undergoes Erythrocytic Schizogony. It results the formation of Erythrocytic merozoites. About 15-20 merozoites formed and arranged irregularly in RBC. It completes in 48 hrs.
- Parasite feeds on haemoglobin of RBC. The ingested haemoglobin is broken down into globin and haematin. Haematin becomes brown-colored Haemozoin granules. Hamemozoin is toxic and casuses symptoms of malaria.
- In the case of Plamodium vivax, haemozoin is released in to blood for every 48 hrs which results recurring of fever on every third day. It is known as Tertian malaria.
- Incubation period is about 10-14 days for Plasmodium vivax.





3. Describe the parasitic effects of *Plasmodium Vivax?*

- *Plasmodium vivax* causes benign tertian malaria which is less dangerous
- Clinical feature of malaria are series of febrile paroxysms(bouts of fever) followed by anaemia and splenomegaly.
- A febrile paroxysm includes three stages :

1.Cold stage	**2.Hot stage**	**3.Sweating stage**
Chills, headache and giddiness	High fever up to 106^{O}F, Increase in breathing Rate and pulse rate	Profuse sweating

- Hypnozoites reactivate and cause relapse of malaria.

LAQ s ::

1. **Describe the human phase of *Plasmodium vivax?***

- *Plasmodium* is a digenetic parasite which completes its asexual and sexual life cycles in two hosts like man and female *Anopheles.*
- Female Anopheles is the definitive host ---Sexual life cycle occurs
- Man is considered as intermediate host --- Sexual life cycle occurs

HUMAN PHASE:

- *Plasmodium vivax* completes asexual multiple fission(schizogony) in liver cells and erythrocytes of man. It occurs in two stages

  a)Exoerythrocytic stage --- occurs in liver in 2 types of generations like Preerythrocytic generation and exoerythrocytic generations

  b)Erythrocytic stage (Golgi cycle) --- occurs in RBCs (erythrocytes)

A)EXOERYTHROCYTIC STAGE :

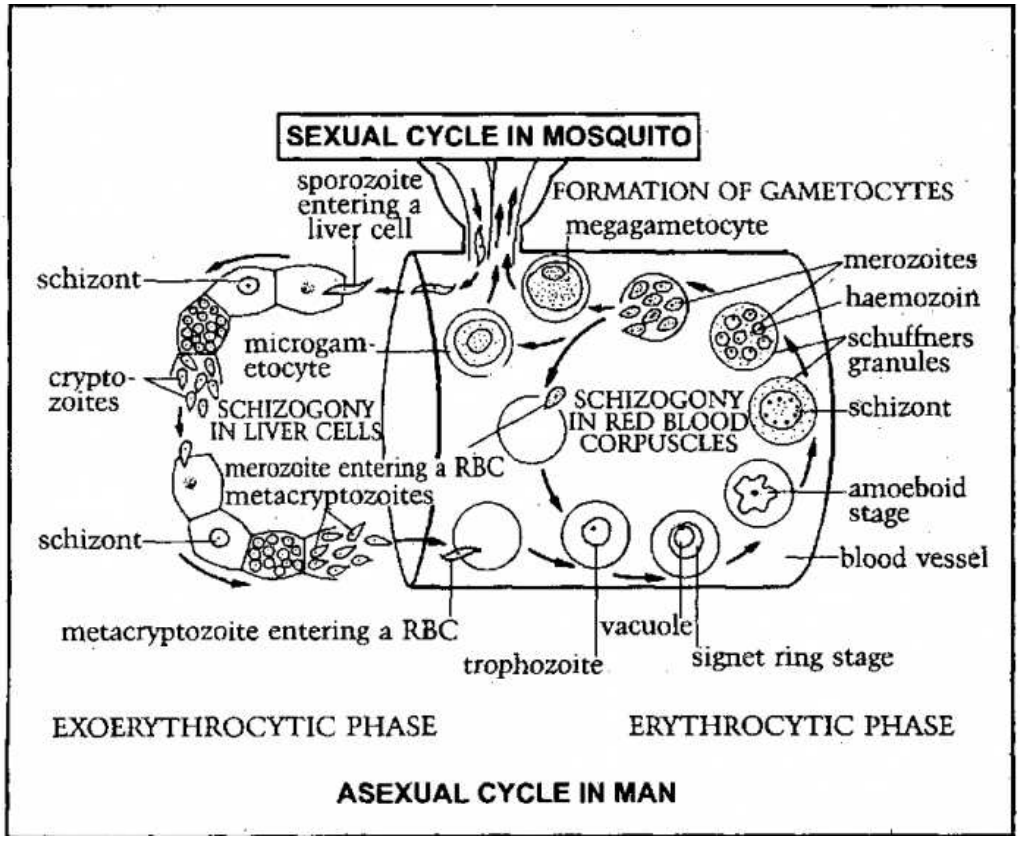
- Sporozoites enter the liver cells first according to Shortt and Garnham.
- In liver cells sporozoites become trophozoites which feed on liver cells and increase in size. Nucleus of trophozoite divides many times and form a multi-nucleate Schizont.
- Cytoplasm also divides and release many Cryptozoites or First generation merozoites within 8 days into liver sinusoids.
- These cryptozoites may enter RBCs to continue the erythrocytic cycle or invade another liver cells to produce the second generation.
- Cryptozoites become trophozoites in liver cells and feed on hepatocytes.

- Its nucleus divides many times and form a multinucleate Schizont. Cytoplasm also divides and release more number of metacryptozoites or Second generation merozoites into the liver sinusoids.
- Metacryptozoites are of two types ….

Macrometacryptopzoites	**Micrometacryptozoites**
1.Larger 2.infects hepatocytes of liver	Smaller Infect RBCs of blood

B) ERYTHROCYTIC STAGE (GOLGI CYCLE) GOLGI

- Cryptozoites of pre erythrocytic generation or the micrometacryptozoites of exoerythrocytic generation enter RBCs.
- These merozoites become trophozoites in RBCs.
- Vacuole of trophozoite increases in size and pushes the cytoplasm and nucleus to periphery and forms Signet ring stage. Later the vacuole disappears.
- Parasite develops pseudopodia and becomes amoeboid, feeding on contents of RBC. It is known as amoeboid stage (Late trophozoite). The size of RBC doubles (hypertrophy).
- Infected RBCs become pale in color due to the loss of Haemoglobin.
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- Incubation period is about 10-14 days for *Plasmodium vivax.*



- ❖ After several erythrocytic schizogony, some merozoites develop into gametocytes in RBCs. It occurs in spleen and bone marrow.
- ❖ Gametocytes are of two types i.e., Macro and microgametocytes. They remain in blood of man for one week. Within one week, if they enter to mosquito, they develop into gametes in crop of mosquito.

2. Describe the mosquito phase of *Plasmodium vivax* (Ross cycle)

- ❖ Life cycle of Plasmodium in female Anopheles mosquito is known as cycle of Ross.
- ❖ Gametocytes from man enter into crop of female Anopheles mosquito along with blood. In mosquito, the following stages occur in the development of plasmodium

A)Formation of gametes B)Fertilization C)Sporogony

A)Formation of gametes ::

i)Formation of microgametes or male gametes :

- Nucleus of microgametocyte divides into 8 daughter nuclei.
- Eight flagella like processes of cytoplasm appear on its surface.
- It is considered as Flagellaed body.
- Each nuclear bit passes into each of cytoplasmic processes and forms a Microgamete or male gamete.
- Microgametes begin lashing movements to get themselves liberate from the flagellated body as male gametes. This process of formation of male gametes is known as Exflagellation.

ii) Formation of macrogamete or female gamete:

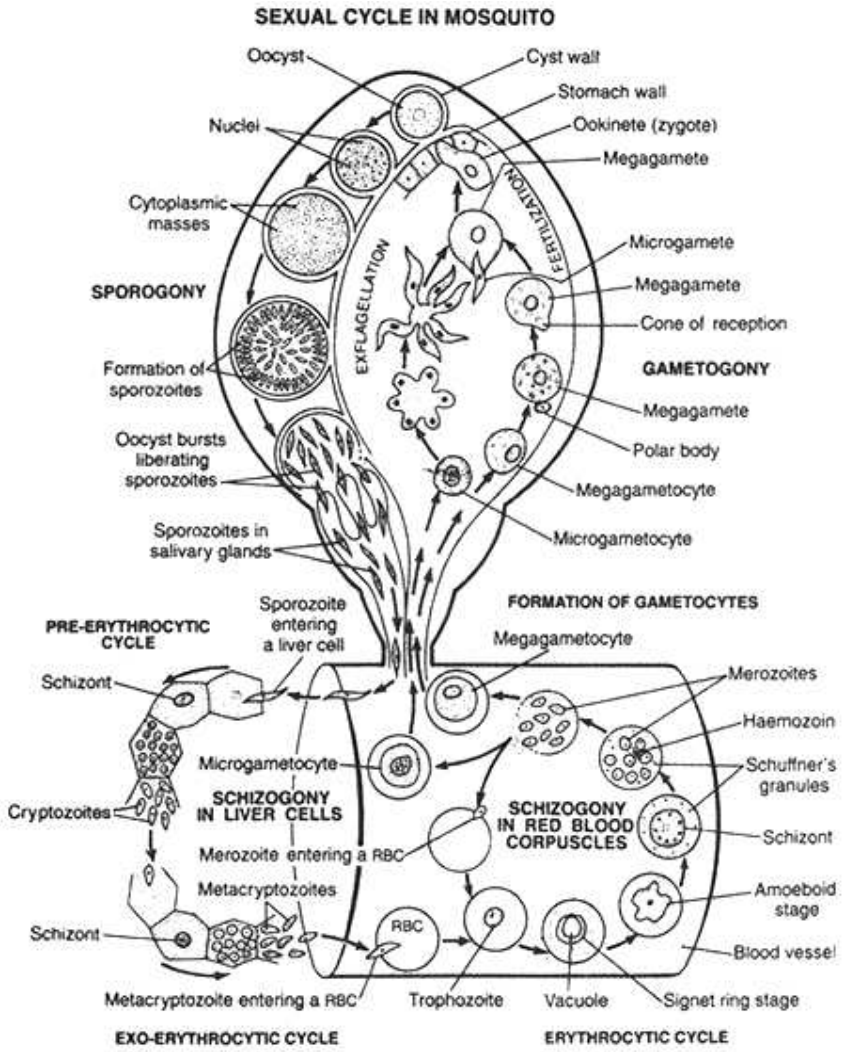
- Macrogametocyte undergoes the maturation to form the femae gamete or Macrogamete. Nucleus moves towards periphery and the cytoplasm forms a projection at that point. This projected region is Reception cone or Fertilization cone.

B) Fertilization ::

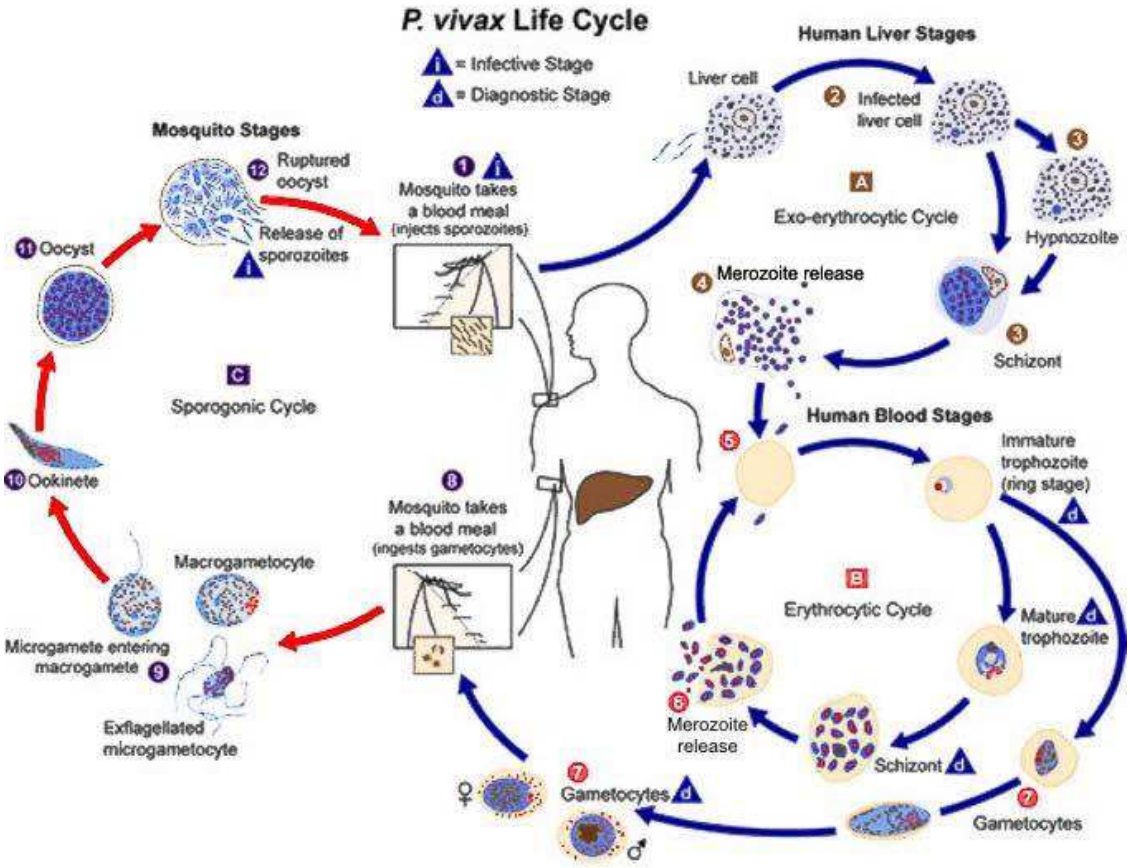
- Microgamete with lashing movements enters into macrogamete at reception cone of it.
- Pronuclei both macro and microgametes fuse.
- As the fusing gametes are dissimilar, it is known as Anisogamy.
- It result the formation of spherical Zygote.

C)Sporogony :

- Zygote becomes an elongated vermiform and motile Ookinete with 18-24 hours. It penetrates the wall of crop and comes to lie beneath the basement membrane.
- It becomes round and secretes an elastic cyst wall around it as Oocyst.
- Oocyst enlarges and begins multiplication by sporogony.
- According to Bano, the nucleus first undergoes reduction division and followed by mitotic divisions and produces a number of nuclei.
- Large vacuoles formed in cytoplasm of oocyst divide it into bits.
- Each bit of nucleus is surrounded by a bit of cytoplasm. This type of indistinct cytoplasmic masses is known as Sporoblasts.
- This stage is known as Sporocysts.
- Sporoblasts develop into thousands of spindle shaped Sprorozoites.
- Sporocysts burst and release sporozoites into haemocoel.
- Motile sporozoites reach salivary glands and ready to enter into another man by mosquitoes bite.
- This life cycle of Plasmodium in female Anopheles was described by Ronald Ross. So it is known as Cycle of Ross.
- It is completed in 10-24 days based on temperature.



Life cycle of *Plasmodium vivax*



IMPORTANT QUESTIONS

01. Prepatent period ? (May'05)
02. Any four stages of endo-erythrocytic cycle in Plasmodium? (May'05)
03. Incubation period ? (May'07 ; May'10)
04. Hypnozoite?

SAQ ::

01. Sporogony in *Plasmodium?* (May '07)

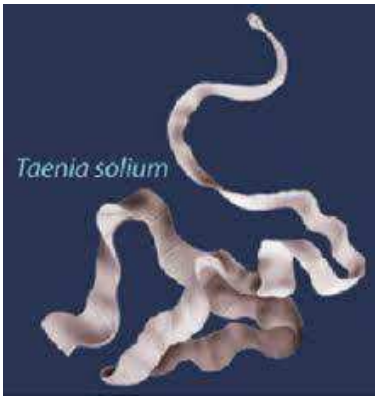
LAQ ;

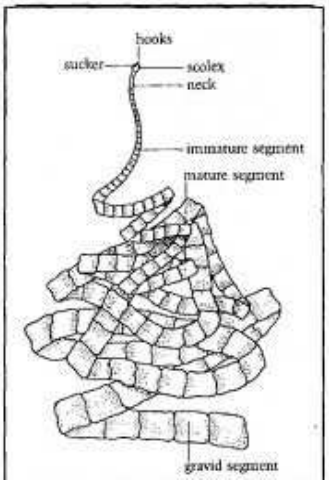
01. Life cycle of Plasmodium in man? (March'08 ; March'07; March'06 ; March'05;May'04)
02. Mosquito phase of Plasmodium? (March'09 ; May'09 ; March '06 ; March'04 ; May'10 ; March '11)

TAENIA SOLIUM (pork tapeworm)



Rudolf Leuckart
Discoverer of Taenia solium





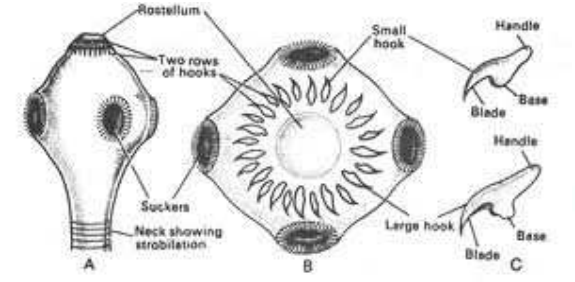
VSAQs ::

1. What is premonition?

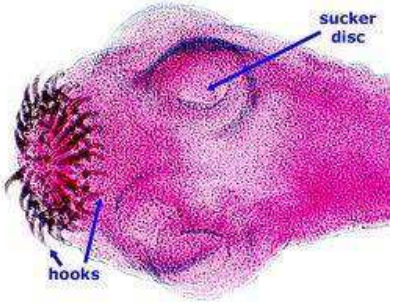
- Complete or partial immunity attained by any host due to infection with parasite is known as premonition.

2. What is the difference between Taenia solium and Taenia saginata regarding scolex?

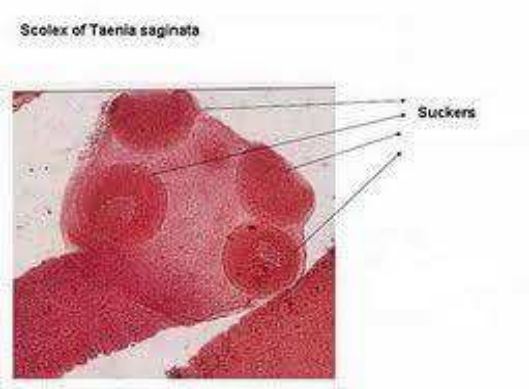
- *Taenia solium* is pork tapeworm. Its scolex has hooks. So it is armed tapeworm.
- *Taenia saginata* is beef tapeworm. Hooks are absent in its scolex.(Unarmed)



Scolex of *Taenia* : (A) side view; (B) en-face view; (C) hooks



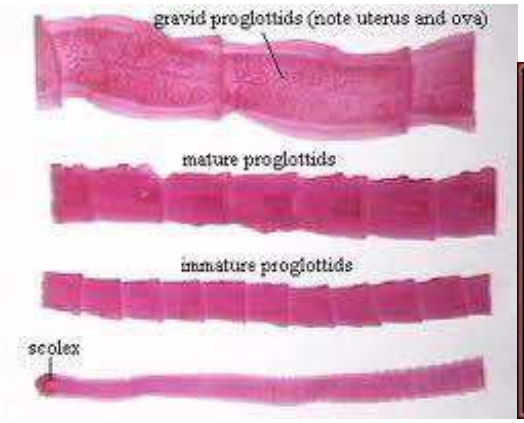
SCOLEX OF T. solium

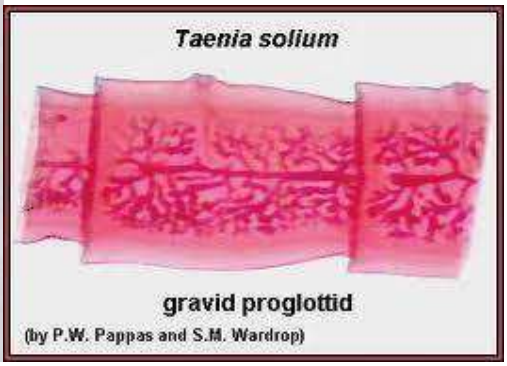


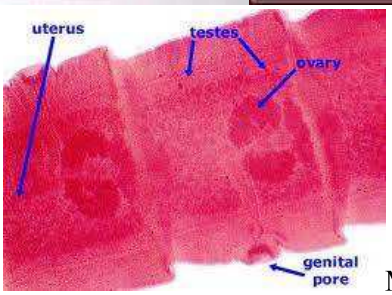
SCOLEX OF T.saginata

3. What are the different types of proglottids in the strobila of *Taenia solium* ?

- Strobila of *Taenia solium* has three types of proglottids
- A)Immature progottids : without development of reproductive organs.
  B)Mature proglottids : with both male and female reproductive organs.
  C)Gravid proglottids : with laterally branched uterus having capsules.







Mature proglottid

4. What is tegument? How is it useful to tapeworms?

- Tegument is thick, syncytial cytoplasmic layer that covers the body of tapeworms. It protects that body.
- It has microtriches which helps in increasing the area of absorption of nutritive substances from the host.
- Tegument has minute pores through which predigested food is absorbed.
- Tegumentary musculature includes circular and longitudinal muscles.

5. How is hydrostatic skeleton formed in *Taenia solium* ?

- In Taenia solium, the spaces around internal organs in proglottids are filled with parenchyma.
- Parenchyma is a syncytial network formed by branched mesenchymal cells. The spaces in network are filled up with a fluid whose turgidity maintains the form of the body and acts as hydrostatic skeleton.

6. What is the infective stage of T.solium to man? How is it transferred to man?

- Cysticercus cellulosae are the infective stage os *Taenia solium* to man.
- They infect through measly pork.

7. Distinguish between taeniasis and cysticercosis.?

- Adult tapeworm causes taeniasis. Abdominal pain, anaemic, giddiness, obstruction to passage of food, indigestion and eosinophilia are symptoms.
- Cysticercosis occurs due to infection of oncospheres. It results the formation of cysts in heart, brain, eyes, liver and muscles. It causes epilepsy alos.

8. Distinguish between metamerism and pseudometamerism.?

- Metamerism is the sengmentation in the body.
- If new segaments are formed from anterior part of the body, it is pseudometamerism.
  E.g., Taenia solium in which new segments are formed from neck.
- If new segments are formed from posterior part of the body, it is true metamerism.
  E.g., Earthworms in which new segments are formed from pygidium (anal segment).

9. What is necrosis?

- Disintegration of living cells in brain due to cysticercosis is necrosis.

10. Differentiate between tegumentary muscles and parenchymal muscles?

- Tegumentary muscles include circular and longitudinal muscles only.
- Parenchymal muscles include longitudinal, transverse/circular and dorsoventral muscles also.

11. What is Apolysis? Write its significance.

- Detachment of gravid proglottids from posterior end of strobila is known as apolysis. It is useful to parasite to keep the constant length of the body.

12.What is holdfast organ in tapeworms ?

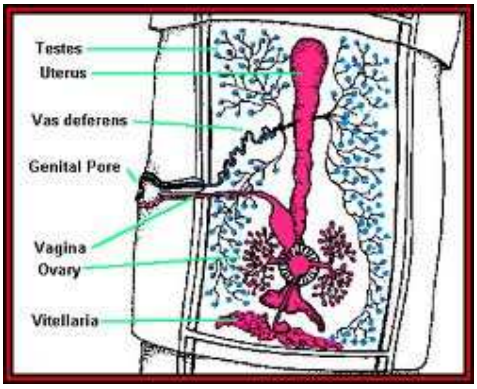
- Scolex is holdfast organ in tapeworms. With movable hooks, rostellum and suckers scolex attaches the tapeworm with the wall of intestine of man.

13. What are the parasitic adaptations in Taenia solium ?

- 1)Complex reproductive system 2)Enzyme resistant tegument
  3) Absence of digestive system 4) presence of hooks and suckers for attachment with host tissues.

SAQ s:

1. **Describe the structure of a mature proglottid of Taenia solium ?**
    - Mature proglottid has well developed male and female reproductive organs.
    - Male reproductive organs include a large number of small and round testes in parenchyma. A delicate tube 'vas eferens' arises from each testis. All vasa efferentia unite and form a large tube known as 'Vas deferens'.
    - Vas deferens ends as a muscular copulatory Cirrus.
    - Cirrus opens into Genital atrium which opens olut through a gonopore
    - Female reproductive organs include a bilobed Ovary in the postero-ventral part of proglottid. Two lobes of ovary are joined by an isthmus. A common Oviduct arises from isthmus and opens into 'OOTYPE'. Fertilization occurs here.
    - A compact Vitelline gland is present at the posterior part of proglottid.
    - Vitelline gland produces Yolk and shella around zygote and form capsule.
    - Oviduct is connected to genital atrium though Vagina.
    - A blind saclike Uterus opens into ootype. It stores fertilized eggs or capsules.
    - Several unicellular Mehlis' glands open into ootype. Their secretions lubricate the passage of capsules into uterus.
    - Each proglottid has excretory canals and nerve cords also.
    - Flame cells open into excretory canal. Flame cells are primarily Osmoregulatory in function. They help in excretion also.



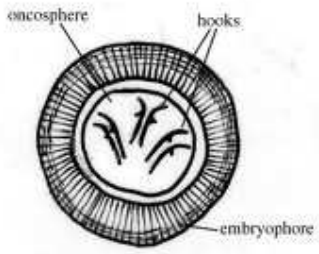
2. **Describe the pathogenicity of Taenia solium.?**

❖ Taenia solium causes taeniasis and cysticercus causes cysticercosis.

A) TAENIASIS: It occurs due to adult tapeworm. Abdominal pain, giddiness, anaemia, obstruction to food passage, vomiting, indigestion and eosinophilia are symptoms.

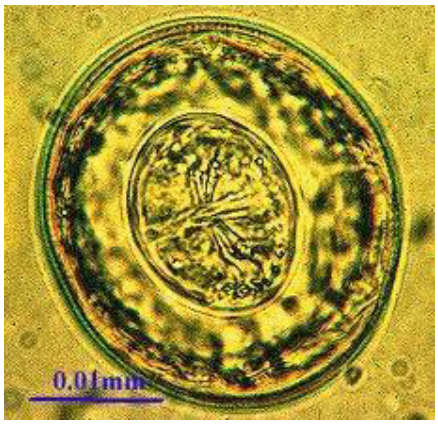
B) CYSTICERCOSIS: It occurs due to infection of oncospheres of conataminated food and water. Due to reverse peristalsis, some gravid proglottids enter into stomach. It is retroinfection. Autoinfection occurs due to digital infection. Onchospheres from gravid proglottids reach the voluntgary muscles and transform into cysticercus. They form cyst in heart, brain, eyes, liver and muscles of man.

In brain, it causes necrosis. Epilepsy is the most common type of Neuro cysticercosis.





ONCHOSPHERE



LAQ :

1. **Describe the life cycle of Taenia solium.?**

Taenia solium is a heteroxenous parasite with man as definitive host and pig as intermediate host.

a) HUMAN PHASE :

- Development of embryo starts in uterus of Taenia solium.
- Zygote in capsule undergoes an unequal cleavage and forms a megamere and an embryonic cell.
- Embryonic cell forms mesomeres and micromeres by repeated unequal divisions.
- Micromeres divide and form a ball of cells known as 'Morula'(embryo).
- Mesomeres divide and form an inner embryonic membrane or embryophore.
- Megamere divides and form the outer embryonic membrane around embryophore.
- Onchoblasts(mesenchymal cells of morula) of embryo secrete three pairs of chitinous hooks. This embryo with 6 hooks is known as 'Hexacanth'. It has a pair of penetration glands also.
- Hexacanth with surrounding two membranes is known as 'Onchosphere' or 'Hexacanth larva'.
- Laterally branched uterus of each gravid proglottid has about 30,000 to 40,000 onchospheres.
- Gravid proglottids detach from strobila by apolysis and pass out through faeces.

b) PIG PHASE :

- Gravid proglottids with onchospheres present in faecal matter enter in to intermediate host i.e., Pig (*Sus scrofa*).
- So onchospheres are the infective stages to pig.
- Onchospheres are released in to lumen of stomach in pig.
- Shell and embryophore are dissolved in the duodenum or jejunum.
- Free hexacanth larvae pass into the intestine and attach to the mucous layer of intestine with hooks.
- They penetrate the intestinal was with the help of penetration glands.
- Hexacanth larvae travel towards the voluntary muscles of in the following waY
- INTESTINE → HEPATIC PORTAL VEIN → LIVER → POST CAVAL VEIN → HEART → VOLUNTARY MUSCLES OF TONGUE, ELBOW, NECK. LIMBS.
- Hexacanth looses hooks in muscles of pig and develops into a pre adult stage known as 'Cysticercus (metacestode)'.
- Early cysticercus absorbs substances from host-tissues and grows in size.
- A cavity appears in centre of its cell mass due to disintegration of mesenchyme and filled with fluid which contains plasma of blood of pig.
- Embryo is covered by outer Cuticle and inner Mesenchymal layer or germinal layer.
- Wall of embryo on one side gets thickened and invaginates into cavity like a knob. It gets 4 suckers, a small rostellum and hooks and thus forms Proscolex.
- This embryo is mature Cysticercus or Bladder worm. It is ellipsoid milky-whitish bladder surrounded by fibrous capsue. These cysts are called Cysticercus cellulsae. The pork with cysticerci is known as measly pork.
- It completes within 10 weeks.

c) INFECTION :

- Cysticercus larvae can live in pig for 5 or 6 years.
- When man consumes improperly cooked measly pork, cysticerci reach stomach of that man. Firbrous capsule of bladder is dissolved in stomach.
- It reaches intestine of man. Proscolex evaginates and forms the scolex.
- With the help of hooks and suckers, it attaches to the wall of intestine.
- New proglottids develop from neck and bladder gets disintegrated and it develops into an adult tapeworm within 2 or 3 months.

IMPORTANT QUESTIONS:

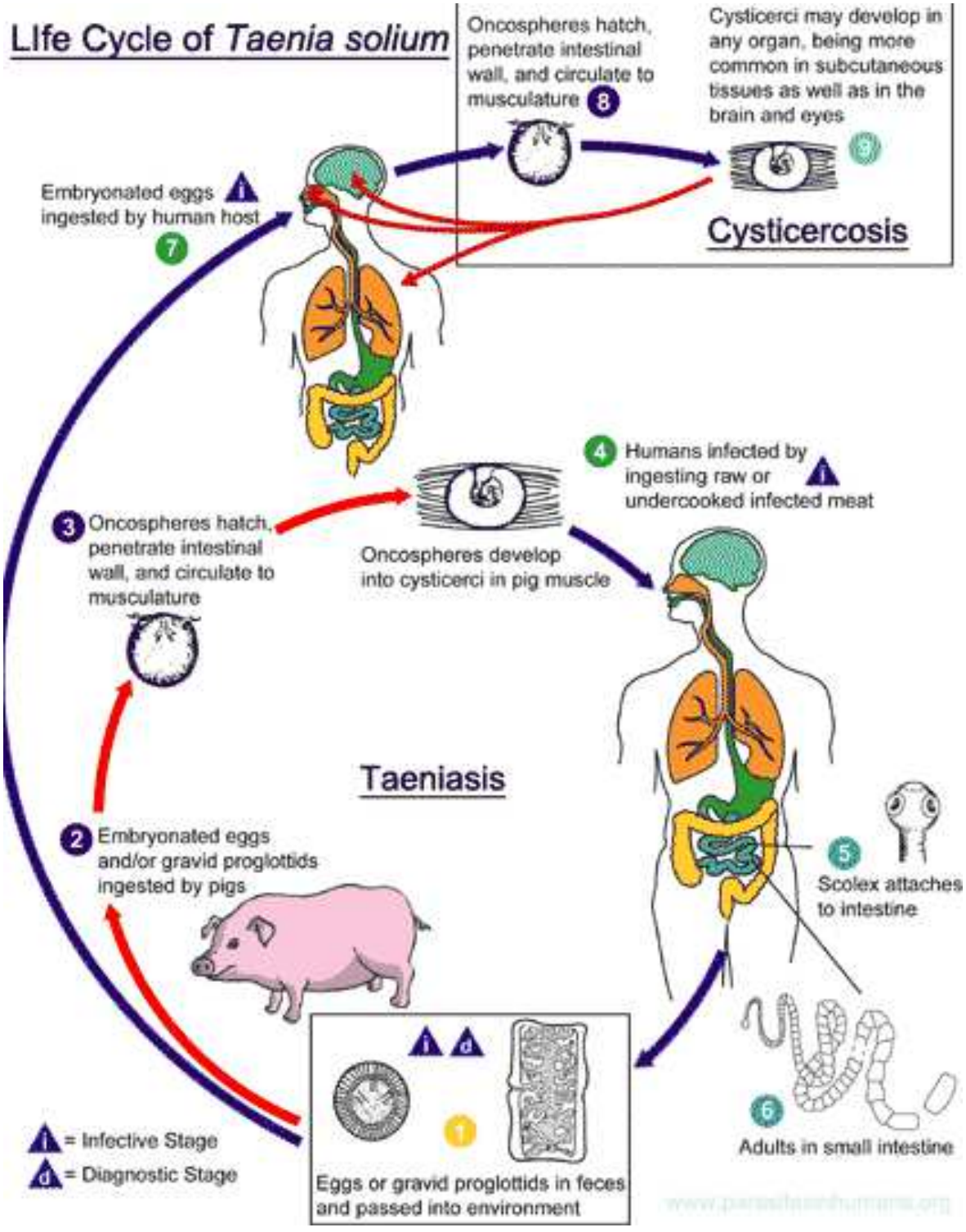
01. Diseases caused by Taenia solium. Two types of prevention methods (March'04)
02. What is protandry (May'04 ; March'07)
03. Onchosphere … where does it occur ? (May'06)
04. What is apolysis ? Write its significance.
05. What are the parasitic adaptations?
06. What is premunition ?

SAQ :

01. Scolex of Taenia solium? (March'05)
02. Pathogenicity of Taenia solium? (May '09 ; March'11)
03. Parasitic adaptations in *Taenia solium*? (March'07)
04. Importance of cysticercus in *Taenia solium?* (March'08)

LAQ:

01. Life history of Taenia solium? (May'07 ; May'05 ; March'10)


Life Cycle of *Taenia solium*
Oncospheres hatch, penetrate intestinal wall, and circulate to musculature 8
Cysticerci may develop in any organ, being more common in subcutaneous tissues as well as in the brain and eyes
9
Cysticercosis
Embryonated eggs ingested by human host
7
4 Humans infected by ingesting raw or undercooked infected meat
3 Oncospheres hatch, penetrate intestinal wall, and circulate to musculature
Oncospheres develop into cysticerci in pig muscle
Taeniasis
2 Embryonated eggs and/or gravid proglottids ingested by pigs
5 Scolex attaches to intestine
6 Adults in small intestine
1 Eggs or gravid proglottids in feces and passed into environment
= Infective Stage
= Diagnostic Stage