

## parasite digenic?

The parasite has two hosts in its life cycle: a Dipteran insect (definitive host) and a vertebrate host (intermediate host).

## What is the genetic material of plasmodium?

*Plasmodium* species has 14 chromosomes in the nucleus, as well as genetic material in the mitochondrion and in the apicoplast. {An **apicoplast** is a derived non-photosynthetic plastid found in most Apicomplexa, including malaria parasites such as *Plasmodium falciparum*}

## What is primary and secondary host?

1. Primary host or definitive host: The organism where sexual phase of the parasite is completed. Here the Female *Anopheles* mosquito is the primary host.
2. Secondary host or intermediate host: The organism where asexual phase of the parasite is completed and develops symptoms of disease due to the presence of parasite is termed as secondary host. Human is the secondary host.

## Describe Life cycle of malarial parasite.

Life cycle of *Plasmodium vivax* is divided into:

1. Asexual life cycle or schizogony in man
2. Sexual life cycle or sporogony in female *Anopheles* mosquito

## Asexual cycle or Schizogony in man

Schizogony is the process of asexual reproduction by which *Plasmodium* undergoes asexual multiplication in liver cell and RBCs of man. It occurs in human liver or hepatocyte (liver schizogony) and in RBC (erythrocytic schizogony). When an infected female *Anopheles* mosquito bites a healthy person, it injects thousands of sporozoites along with saliva into the bloodstream.

Asexual cycle or schizogony in human is completed in following phases:

1. Pre-erythrocytic cycle
2. Exo-erythrocytic cycle
3. Erythrocytic cycle
4. Post-erythrocytic cycle
5. Formation of gametocytes

### 1. Pre-erythrocytic cycle

When the sporozoites enters the blood it remains active for about half an hour and disappears from the blood circulation. Then it enters into parenchymatous cell of liver (to escape the phagocytic action of leucocytes) through blood circulation by secreting lytic enzymes from the apical cap. Sporozoites in liver cell grow in size and become spherical in shape called schizonts.

The nucleus of schizont multiply asexually (multiple fission) and forms thousands of merozoites. These gives pressure to the wall of liver cell and liberated out in the form of cryptozoites or cryptomerozoites through ruptured liver (hepatocyte) cell. It is completed in 8-10 days. The process of formation of many cryptozoites from single sporozoites in liver cell is called pre-erythrocytic schizogony.

## 2. Exo-erythrocytic schizogony

The cryptozoites are ready to infect the fresh liver cell where they grow and become schizont. The same process is repeated several times and the liberated merozoites in this phase is called metacryptozoites. The process of formation of many metacryptozoites (micro and macro) from the cryptozoites in liver cell is called exo-erythrocytic schizogony. *The micro metacryptozoites enter the red blood cells to start the erythrocytic phase while the macro metacryptozoites infects the fresh liver cells to continue exo-erythrocytic phase.*(NOTE: Exo-erythrocytic cycle is absent in *Plasmodium falciparum*.)

## 3. Erythrocytic cycle

This cycle starts when the **micro metacryptozoites** enter into erythrocytes. Single metacryptozoite enters into single RBC and passes through trophozoite stage, signet ring stage, amoeboid stage and schizont stage.

When metacryptozoites invade the RBC it becomes rounded with large nucleus *and grows in size by ingesting hemoglobin of corpuscles*. This stage of parasite is called trophozoite stage. Inside the trophozoite, a large non-contractile vacuole appears which pushes the nucleus towards periphery and forms a ring like structure known as **signet ring stage**.

Trophozoites enlarges and vacuole starts disappearing and develops pseudopodial processes in the cytoplasm and changed into amoeboid stage. In this stage, it feeds on haemoglobin and breaks down into **hematin** and **globin**. The globin is absorbed by the cell and hematin is deposited in the form of **hemozoin**, a toxic malarial pigment.

Thereafter becomes rounded, grows in size and becomes erythrocytic schizont. Asexual multiplication takes place in schizont and merozoites are formed which give pressure to the wall of weak RBC and liberated out in the form of erythrocytic merozoites.

The merozoites are arranged towards the periphery due to the presence of hemozoin at the center. The arrangement is just like the arrangement of petals in rose flowers. So this stage is called **rosette stage**.

*Numerous yellowish eosinophilic granules appear in the cytoplasm of the host corpuscles which are called schuffner's granules. These dots are believed to be the antigen excreted by the parasites.*

The process of formation of merozoites in the RBCs from the metacryptozoites is called erythrocytic schizogony. It completes about 48 hours. Many merozoites enter the fresh RBC and repeat the erythrocytic cycle.

#### **4. Post-erythrocytic cycle**

Sometimes, some merozoites produced after erythrocytic cycle invade the liver cell and undergo another schizogonic development in the liver cell. This is called post-erythrocytic cycle.

#### **5. Formation of gametocytes**

After some generation of erythrocytic cycle, some of the merozoites invade the new RBC. They grow in size but do not develop into schizonts instead they develop into gametocytes.

The gametocytes are of two types:

- i. Macrogametocytes or female gametocytes: These are large (10-12 $\mu$ ) and numerous in number. They have small compact peripheral nucleus. They have reserved food materials and the cytoplasm is dark in color.
- ii. Microgametocytes or male gametocytes: These are smaller (9-10  $\mu$ ) motile and few in number. They have large centrally placed nuclei. They lack reserved food and stains faintly hence the cytoplasm is light in color and clear.

**Further development of gametocyte stop in man and only possible in mosquito due to its low temperature.**

#### **Sexual Cycle in mosquito**

When female *Anopheles* mosquito bites an infected person, they suck the gametocytes which reach the stomach where all the stages along with RBCs are digested except gametocytes. Now, the life cycle is continued towards the completion by following processes:

##### **1. Gametogenesis (Formation of gametes)**

Microgametocytes develop 6-8 flagella, become elongated and are called sperms. The movement of flagella causes the gametes to separate and move actively in the stomach of mosquito in search of female gametes.

Macrogametocyte or the female gamete is non-motile and develops a cytoplasmic projections called cone of reception or fertilization cone on one side.

## 2. Fertilization

One microgamete penetrates into macrogamete through the cone of reception and fertilization takes place known as syngamy resulting in the formation of diploid zygote or synkaryon. Zygote form in stomach of mosquito about 9 to 10 days after the blood meal.

*NOTE: The process of fusion of male and female gametes is called syngamy. Syngamy is anisogamous due to the dissimilar structure of gametes. Hence, their fusion is called anisogamy.*

## 3. Formation of ookinete

Transformation of the round zygote into elongated and motile form is known as ookinete. It has pointed ends which helps to penetrate the wall of stomach with the help of lytic secretion. It settles into the inner portion of stomach wall.

## 4. Formation of Oocysts

The ookinete changes into spherical shape, take nutrition from the wall of stomach and get enclosed in a thin, elastic and permeable cyst wall, such stage is called oocyst stage or sporont.

*The cyst wall is secreted partly by ookinete and partly derived from the stomach tissue of mosquito. Many oocysts (<500) are seen on the stomach wall of infected mosquito. The ookinetes fail to penetrate the stomach wall pass out from mosquito's body with faecal matter.*

## 5. Sporogony

It is the process of formation of sporozoites from the diploid zygote by asexual multiple fission. Oocysts matures and the nucleus divides first by meiosis and then by mitosis, forming large number of haploid nuclei (2-3 days) and forms sporozoites forming cell known as sporoblasts. The nuclei of sporoblast again multiply and cytoplasm gets constricted around them. Thus the resultant structures in the sporoblasts elongate to form slender or sickle shaped sporozoites.

Therefore, each oocyst fills with numerous sporozoites. Now, these give pressure to the oocyst and due to which the oocyst burst or rupture and thousands of sporozoites are released in the body cavity (hemocoel) of mosquito.

The sporozoites are very active and motile, then they reach to the salivary glands of the mosquito. Then the sporozoites are ready to infect the healthy person after each bite. So when the infected mosquito bites a healthy man, thousands of sporozoites are injected into his blood along with saliva.

