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# Life cycle of Plasmodium vivax





#### Life cycle of Plasmodium vivax

Life cycle of *Plasmodium vivax* is digenetic i.e. they complete their life cycle in two hosts:

**1. Primary host or definitive host**: Female Anopheles mosquito is the primary host. The organism which contains sexual phase of the parasite and is regarded as definitive host.

**2. Secondary host or intermediate host**: human is the secondary host. Human contains asexual phase of the parasite and develops symptoms of disease due to the presence of parasite and is termed as secondary host.

#### 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 occus in human liver cell (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. Inside liver and RBC different form of sporozoite cause infection.

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

- 1. Pre-erythrocytic schizogony
- 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 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. The liberated merozoites in this phase is called metacryptozoites.

The process of formation of many metacryptozoites from the cryptozoites in liver cell is called exo-erythrocytic schizogony.

Some metacryptozoites are smaller in size called micro metacryptozoites and some are larger in size called macro metacryptozoites.

The micro metacryptozoites enter the red blood cells to start the erythrocytic phase while the macro metacryptozoites infects the fresh liver cells to continue exoerythrocytic 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 corpusles*. 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. This stage is called amoeboid stage.

The amoeboid feeds completely the component of corpuscles in the form of hemoglobin. During feeding the hemoglobin breakdown into hematin and globin. The globin is absorbed by the cell and hematin is deposited in the form of hemozoin (toxic malarial pigment).

The amoeboid trophozoites after feeding, becomes rounded, grows in size and becomes erythrocytic schizont. Asexual multiplication takes place in schizont and forms merozoites 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 dot 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 posterythrocytic 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.

#### Inoculation

When an infected female Anopheles mosquito bites a healthy person it suck his/her blood for meal, she injects saliva containing sporozoites into the wound through its needle like mouth parts. This is called inoculation.

#### Pre patent period

The interval between inoculation and initiation of erythrocytic cyce is called pre-patent period.

#### **Incubation period**

The period between the entry of parasite and appearance of first symptoms is called incubation period. It is about 14 days in *P. vivax* and *P. ovale*, 12 days in *P. falciparum* and 28 days in *P. malariae*.

#### Life cycle in mosquito or Sexual Cycle in mosquito

When female *Anopheles* mosquito bites an infected persons, they suck the gametocytes and other stages of erythrocytic cycle (e.g. erythrocytic merozoite) along with blood. They 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/ Gametogony (Formation of gametes)

Process of formation of gametes from the gametocytes is called gametogenesis.

#### Formation of microgametes

Microgametocytes undergo ex-flagellation process in the mid-gut of mosquito. The nucleus of microgametocytes divides to form 6-8 daughter nuclei, first division is meiotic. These nuclei move to periphery along with cytoplasm, forming flagella like structure. Thus 6-8 flagella like male gametes are formed from each microgametocytes. The elongated structure are called microgametes or sperms. The movement of flagella causes the gametes to separate and move actively in the stomach of mosquito in search of female gametes.

#### Formation of macrogametes

Macrogametocyte undergo some reorganization and become female gametes or macrogametes or megagametes.

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.

A complete fusion of nuclei and cytoplasm of the two gametes occurs, 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

After fertilization, the zygote remains rounded and non-motile for some time. Then it becomes elongated and vermiform known as ookinete. Ookinete is motile and has pointed ends. It penetrates 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 a phase of asexual multiplication.

### It is the process of formation of sporozoites from the zygote nucleus by asexual multiple fission.

**Oocysts** matures and develops. The nucleus of oocyst 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.