Sporozoa—I (Malaria parasite)

- Sporozoa contains one Class Coccidea which in turn has three Orders (1) Eimeriida (2) Haemosporida (3) Piroplasmida

Table 6.1: Classification of Sporozoa

phylum	subphylum or super class	class	order	Genus
protozoa	sporozoa (Apicomplexa)	coccidea	Eimerida	*Isospora* *Cryotosporidium* *Sarcocystic* *Toxoplasma* *Cyclospora*
			Haemosporida	*Plasmodium*
			piroplasmida	*Babesia*

The causative Agent of malaria

1. *P. vivax* causes benign tertian malaria.
(periodicity of fever is once in 48 hours, i.e. recurs every third day)
2. *P. falciparum* causes malignant tertian
malaria. (severe malaria, periodicity of fever is once in 48 hours, recurs every third day)
3. *P. malariae* causes benign quartan malaria.
(periodicity of fever is once in 72 hours, i.e. recurs every fourth day)
4. *P. ovale* causes ovale tertian malaria. (periodicity of fever is once in 48 hours, i.e. recurs every third day)

5. *P. knowlesi* causes quotidian malaria. (fever periodicity is once in 24 hours, i.e. recurs every day).

Life Cycle (Fig. 6.1)

Host: *Plasmodium* completes its life cycle in two hosts:

1. Female *Anopheles* (*Anopheline*) mosquito is the definitive host where the sexual cycle (sporogony) takes place

2. Man acts as intermediate host where the asexual cycle (schizogony) takes place

- Male *Anopheles* doesn't feed on man and feeds exclusively on fruit juices, i.e. why male *Anopheles* doesn't transmit the disease. Whereas female *Anopheles* needs at least two blood meals before laying eggs.
- In humans, the asexual cycle takes place through the following stages:

1. Pre-erythrocytic schizogony
2. Erythrocytic schizogony
3. Gametogony.

- The life cycle of malaria parasites comprises two stages—an asexual phase occurring in humans and the sexual phase occurring in the mosquito.

asexual cycle: 1.Pre-erythrocytic schizogony

1. sporozoites

↓

2. This form enters the human bloodstream with the mosquito's saliva.

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3. This phase disappears after 30 minutes from the bloodstream.

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4. The stage enters the liver to go through one or more asexual cycles known as (Pre-erythrocytic schizogony or Exo- erythrocytic cycle).

5. The sporozoites stage transforms into the trophozoite stage and then into the schizont stage.

6. The division of telophase produces a large number of merozoites (10.000-40.000) 8-12 day. Therefore, this stage is called (primary tissue phase).

7. When infected liver cells burst, they release merozoites, so when they re-infect new liver cells, it is called the stage of(Scondary tissue phase).

Important note:

1. The parasite growing inside the hepatocytes is called(Cryptozoite)
2. Attachment: The circumsporozoite protein present on the surface of sporozoites binds noncovalently to the receptors on the basolateral surface of hepatocytes facilitating the entry of sporozoites.

2.Erythrocytic cycle:

1. The hepatic merozoites after released from preerythrocytic, attack RBCs.

2. The process of entry into RBC takes about 30 seconds.

3. Merozoites transform into trophozoites.

4. **Ring form:** Early trophozoite form is known as ring form. Ring form occupies onethird of RBC except in *P. falciparum*, where it occupies onesixth of RBC.

5. **Late trophozoite:** Ring form enlarges and becomes more irregular due to amoeboid movement and transforms into late trophozoite or amoeboid form.

6. **Erythrocytic schizont**

7. **Schizogony:** Erythrocytic schizont undergoes multiple nuclear divisions (erythrocytic schizogony or merogony) and produces 6–30 daughter merozoites.

- Number of merozoites per mature schizont varies:

  - *P. vivax*—12–24 number (average 16)
  - *P. falciparum*—18–24 number (average 20)
  - *P. malariae*—6–12 number (average 8)
  - *P. ovale*—8–12 number (average 8)

- RBCs then rupture to release the daughter merozoites, malarial pigments and toxins into the circulation which result in malarial paroxysm of fever at the end of each erythrocytic cycle

life cycle takes roughly 48 hours for *P. falciparum, P. vivax* and *P. ovale*, 72 hours for *P. malariae and* 24 hours for *P. knowlesi*

Incubation period: *P. vivax*—14 days (ranges 8–17 days)
P. falciparum—12 days (ranges 9–14 days)
P. malariae—28 days (ranges 18–40 days)
P. ovale—17 days (ranges 16–18 days)

sexual cycle or **Mosquito Cycle**

- After a series of erythrocytic cycles, some merozoites after entering into RBCs, instead of developing into trophozoites, they transform into sexual forms called as **gametocytes.**

- The gametocytic development takes place in the blood vessels of internal organs such as spleen and bone marrow and only the mature gametocytes appear in the peripheral blood.

- They are of two types—(1) male gametocyte (or microgametocyte) and (2) female gametocyte (or macrogametocyte).

- A female *Anopheles* mosquito during the blood meal, takes both the asexual forms and the sexual forms.

- The asexual forms get digested whereas the sexual forms, i.e. the gametocytes undergo further development
- **Exflagellation:** Nucleus of the male gametocytes divides into eight flagellated actively motile bodies called as **microgametes**.

- This process is called as **exflagellation**. At 28°C, it is completed in 15 minutes for *P. vivax* and 15–30 minutes for *P. falciparum*.

- Female gametocytes don't divide and don't undergo exflagellation but each undergoes maturation to form one **macrogamete or female gamete**.

Zygote: The male microgamete fertilizes with the female macrogamete by fusion, Fertilization occurs in about 30 minutes to 2 hours after the blood meal.

ookinete stage

- **Sporozoites:** Oocysts undergo sporogony (meiosis) to produce thousands of spindle shaped sporozoites.
- On rupture of the mature oocyst, the sporozoites are released and migrate to salivary gland.

Pathogenesis and Clinical Feature

1. **Febrile paroxysm**

- Fever comes intermittently depending on the species. It occurs every fourth day (72 hour cycle for *P. malariae*) and every third day (48 hour cycle for other three species)

- Paroxysm corresponds to the release of the successive broods of merozoites into the bloodstream, at the end of RBC cycle

- **Cold stage:** Lasts for 15 minutes to 1 hour. The patient feels lassitude, headache, nausea, intense cold, chill and rigor

- **Hot stage:** Patient develops high grade fever of 39–41°C and dry burning skin.
- **Sweating stage:** Fever comes down with profuse sweating.

2. **Anemia**
3. **Splenomegaly**
4. Hematin is rapidly converted to bilirubin.

5. Nephritis and increased albumin in urine
6. Capillary occlusion (fatal injury)
7. Monocytes pleocytosis and lymphocytosis
8. Hemoglobinuria
9. Heart failure

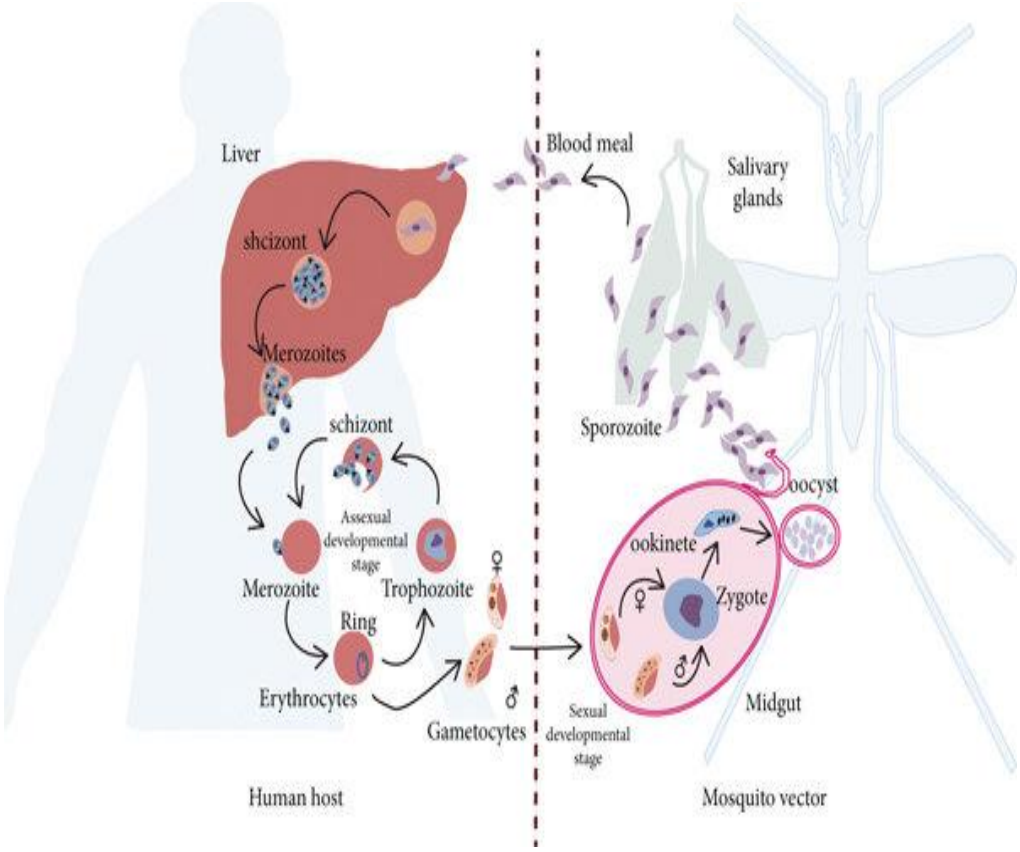

Fig. 6.1: Life cycle of malaria parasite