Plasmodium

❑The genus plasmodium consists of four species which can infect humans and cause Malaria.

❑These are-

- *P. falciparum*
- *P. vivax*
- *P. malariae* and
- *P. ovale*

Geographical Distribution:

✓Malaria occurs extensively in tropical and subtropical regions but can also occur (rarely) in temperate climates.

✓It is one of the leading causes of disease and death in the world.

✓It is estimated that there are 300-500 million new cases every year, with 1.5 to 2.7 million deaths worldwide.

✓*Plasmodium falciparum* is by the most widespread malaria in Africa, it is also occurs in specific areas of Asia and South America.

✓*Plasmodium vivax* is the most common in South America and Asia.

✓*P. malariae* is a parasite of subtropical zone.

✓*P. ovale* is mainly reported from East Africa, Nigeria and Philippines.

Life Cycle:

The life cycle of malaria parasite is completed in two hosts.

1. **Man:** In man it reproduces asexually. Man is a secondary vertebrate host or an intermediate host and
2. **Female Anopheles mosquito:** In mosquito it reproduces sexually. Mosquito is a primary invertebrate host or definitive host.

Life Cycle in Man:

In man, life cycle of man consists of three stages:-

i. Pre-erythrocytic cycle
ii. Erythrocytic cycle
iii. Post- erythrocytic cycle

Pre – erythrocytic cycle:

✓The plasmodium is transmitted by the bites of female anopheles mosquito.

✓When infected female mosquito bites a healthy person, first it punctures the skin and inserts an anticoagulant and saliva in man during feeding on blood.

✓At this time, along with saliva, plasmodium enters in man is sporozoite.

✓The sporozoites are long, slender with curved body narrow at both the ends. It contains nucleus at middle.

Erythrocytic cycle:

✓The parasite enters in RBC as merozoite.

✓In RBC, it becomes rounded and a contractile vacuole develops inside giving it a ring like shape. This stage is known as signet ring stage.

✓After signet stage, the vacuole disappears and the parasite becomes amoeba like in shape. This stage is known as amoeboid stage.

✓In amoeboid stage feeds on haemoglobin of RBC, increase in size and the nucleus divides into number of daughter nuclei.

✓Each daughter nuclei gets surrounded by the cytoplasm. This stage is known as rosette stage.

✓The RBC now burst and liberates a numbers of micromerozoites in blood. These are known as schizonts and the cycle is known as schizogony.

✓Along with schizonts a toxic substance hemozin (derived from hemoglobin) is also released in blood.

✓Sporozoites are injected by the mosquito into the subcutaneous tissue (less frequently directly into the bloodstream) and travel to the liver either directly or through lymphatic channels.

✓In liver, they grow rapidly and multiply in number to form cryptozoite.

✓These cryptozoite again attack new liver cells, where it grows and multiply to produce the second generation cryptozoite. These are known as merozoite (or metacryptozoite).

✓Within the hepatocyte, each sporozoite divides into 10,000-30,000 merozoites. This phase is called pre-erythrocytic cycle.

✓The time taken for the completion of the pre erythrocytic cycle is variable, depending on the infecting species; and this interval is called as pre patent period.

✓During this period, man does not show any symptom of malaria fever.

✓Some of the merozoite again attack new liver cells, while the others rupture the liver cell and escape into the blood to infect red blood cells.

✓These merozoites released by the lysis of the red blood cell immediately invade uninfected red cells.

✓This repetitive cycle of invasion --- multiplication --- release --- invasion continues.

Post erythrocytic cycle:

✓After many erythrocytic cycles some of the micromerozoites changes then into unequal gametes called gametocytes.

✓The larger gamete is female or macrogametocyte and smaller one is male or microgametocyte. This is known as post erythrocytic cycle.

✓The further development of gametocyte is stopped in man.

Life Cycle in Mosquito:

✓Further development of gametocytes takes place sexually in mosquito.

✓The female anopheles mosquito sucks the blood of malarial patient containing gametocyte and other stages and gets infected.

✓Only gametocyte remains active, while the other stages are digested.

✓In the stomach of mosquito some changes in gametocytes takes place.

✓The nucleus of microgametocyte divides to form six to eight nuclei.

✓These nuclei move towards the periphery and gather some cytoplasm.

✓From each nucleus, flagella like projections arise and each nucleus gets separated.

✓The flagella gets detached from the microgamatocyte to form male gamete.

✓On the other side macrogametocyte forms a small conical projection on its surface called as cone of fertilization through this area male gamete enters in female gamete and fertilize the egg.

✓The fertilized egg is called as zygote.

✓It is rounded non motile.

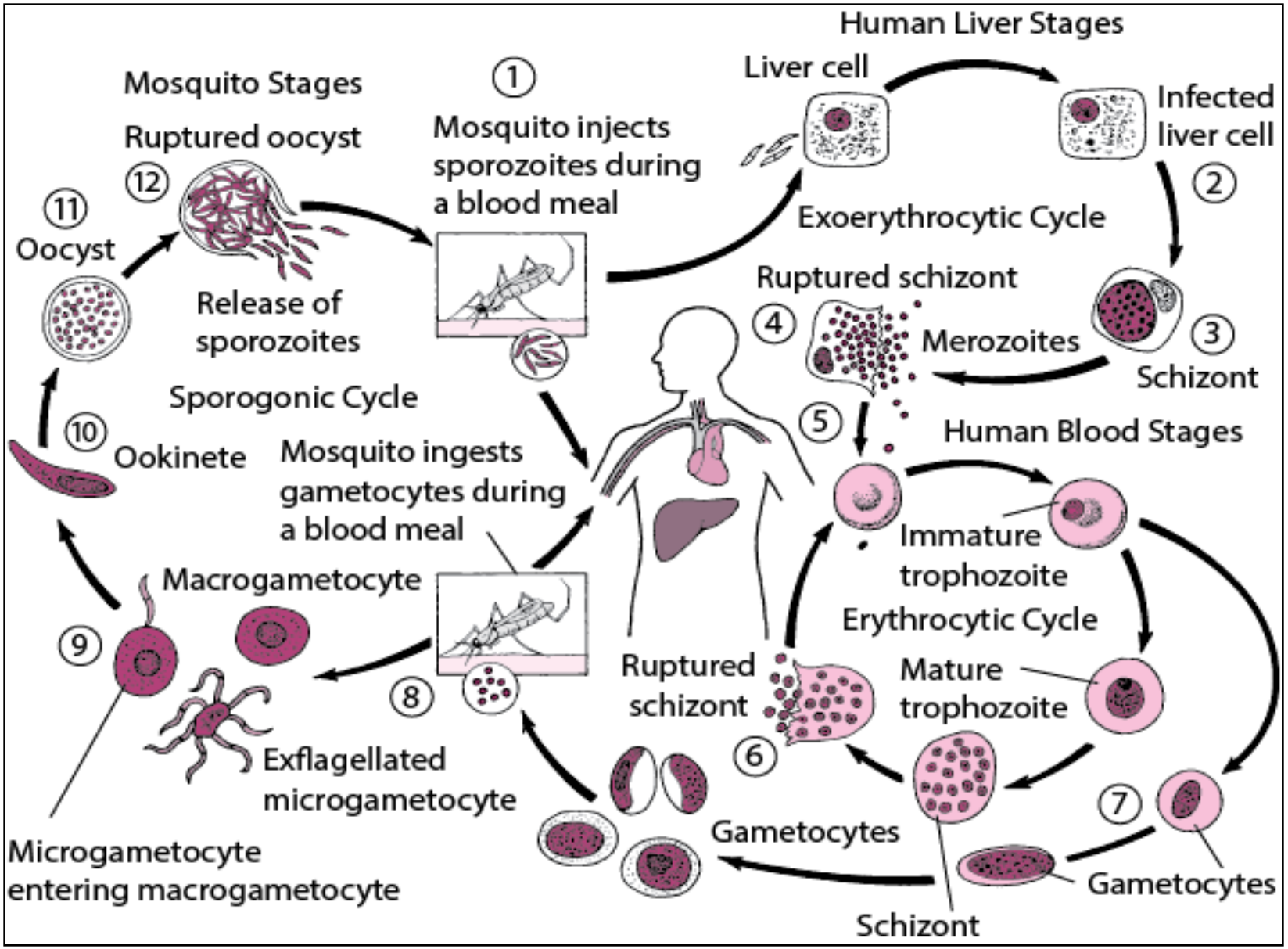
✓After some time it becomes active, motile and worm like structure called ookinete.

✓It penetrates the stomach of mosquito and comes out side of stomach. It forms a cyst around itself, called as oocyst.

✓The oocyst divides asexually into numerous sporozoites which reach the salivary gland of the mosquito. This phase is called sporogony.

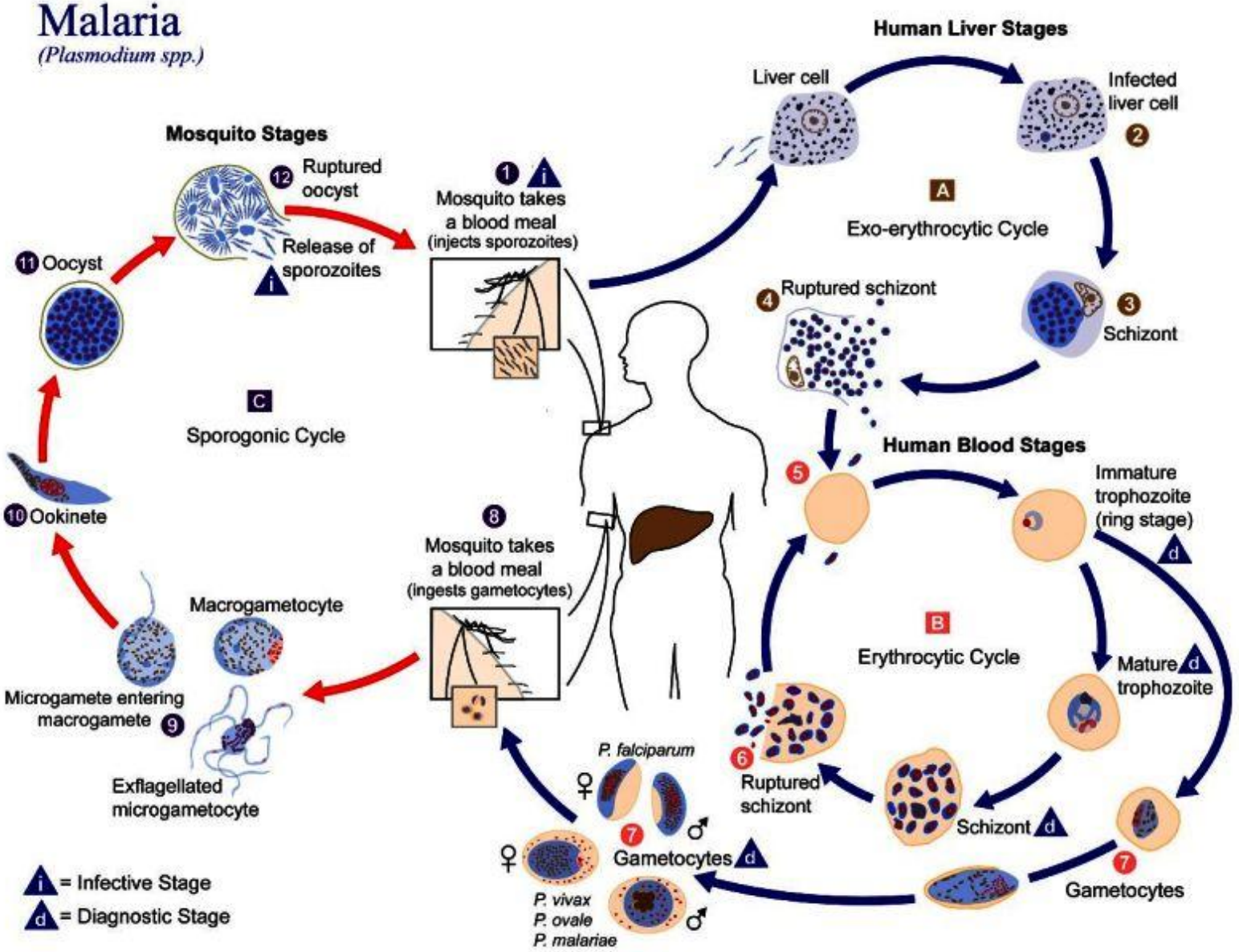
✓On biting a man, these sporozoites are inoculated into human blood stream along with saliva. Thus the life cycle continues.

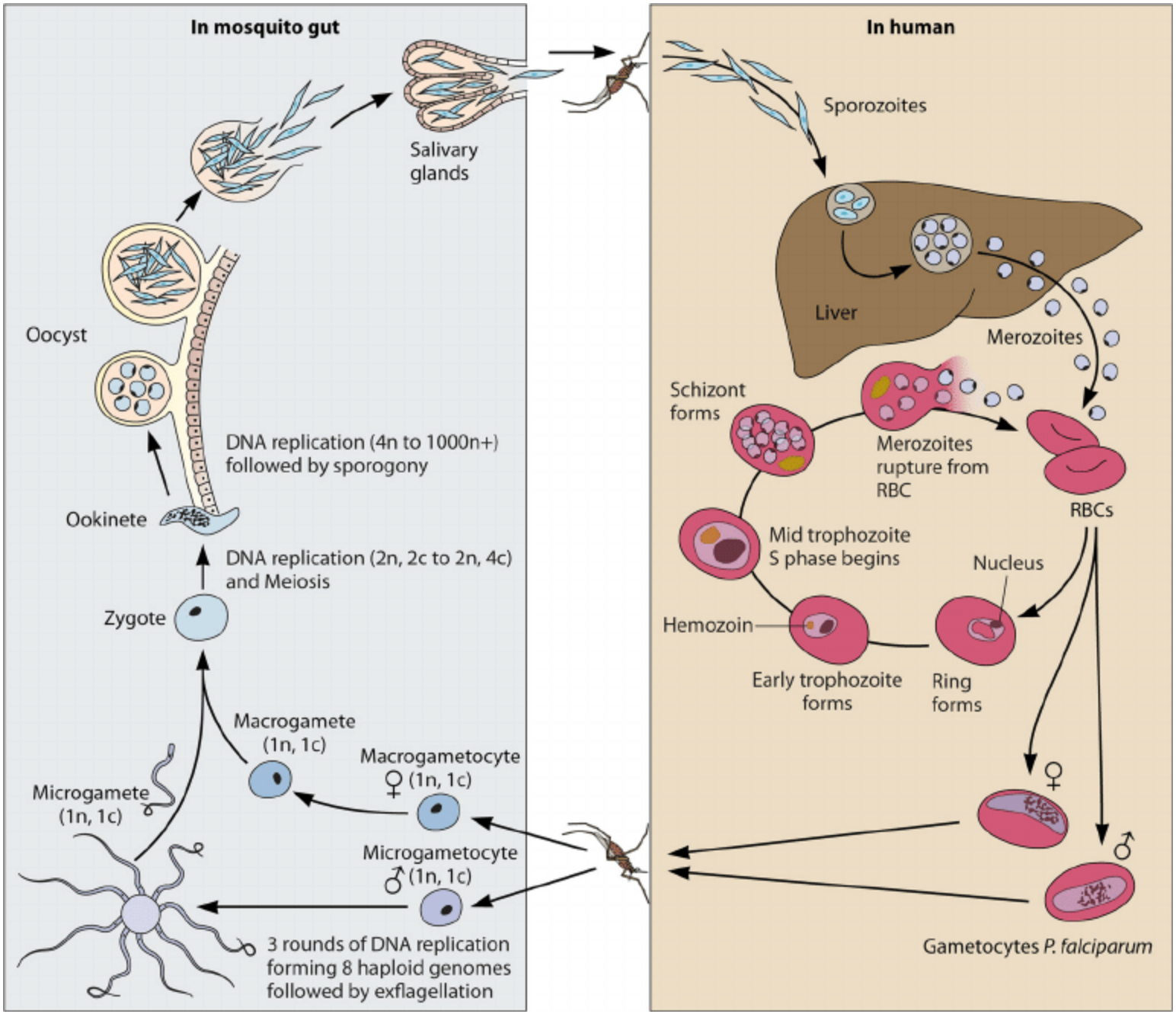
✓The sporogony in the mosquito takes about 10-20 days and thereafter the mosquito remains infective for 1-2 months.


Human Liver Stages
Liver cell
Infected liver cell
Mosquito Stages
1
Mosquito injects sporozoites during a blood meal
Ruptured oocyst
12
11
Oocyst
Release of sporozoites
2
Exoerythrocytic Cycle
Ruptured schizont
4
Merozoites
3
Schizont
Sporogonic Cycle
10
Ookinete
Mosquito ingests gametocytes during a blood meal
5
Human Blood Stages
Immature trophozoite
Macrogametocyte
9
Erythrocytic Cycle
Ruptured schizont
Mature trophozoite
8
6
Exflagellated microgametocyte
Microgametocyte entering macrogametocyte
Gametocytes
7
Gametocytes
Schizont

Malaria

(Plasmodium spp.)




In mosquito gut
In human
Salivary glands
Sporozoites
Oocyst
Liver
Merozoites
Schizont forms
Merozoites rupture from RBC
RBCs
DNA replication (4n to 1000n+) followed by sporogony
Ookinete
Mid trophozoite S phase begins
Nucleus
DNA replication (2n, 2c to 2n, 4c) and Meiosis
Zygote
Hemozoin
Early trophozoite forms
Ring forms
Macrogamete (1n, 1c)
Macrogametocyte ♀ (1n, 1c)
Microgamete (1n, 1c)
Microgametocyte ♂ (1n, 1c)
3 rounds of DNA replication forming 8 haploid genomes followed by exflagellation
Gametocytes P. falciparum

Pathogenecity:

Man develops infection by the bite of infected female anopheles mosquito. Other modes are:-

✓Transfusion of blood from patient of malaria (transfusion malaria)

✓Transmission to fetus *in utero* through some placental defect (congenital malaria).

✓ By contaminated syringes particularly in drug addicts.

✓The above conditions are known as trophozoite induced malaria.

Red Blood Cells:

✓RBCs are the principal sites of infection in malaria.

✓The growing parasite consumes and degrades the intracellular proteins, mainly hemoglobin. It derives nutrition from the oxyhemoglobin of the RBCs. The protein material of the erythrocyte is broken down and re-synthesized into parasite protein. The waste product of this reaction is hematin, which liberated in plasma when RBC ruptures. This causes the malarial symptoms to appear.

✓Anaemia is fairly common problem encountered in malaria and it poses special problems in pregnancy and in children.

✓Anemia of malaria is usually normocytic hypochromic with increase in the number of reticulocytes and polychromatophils.

✓Leukocyte count is usually low to normal in most cases of malaria.

Bone Marrow:

It may show evidence of dyserythropoeisis, iron sequestration and erythrophagocytosis in the acute phase of falciparum malaria. Maturation defects may be present in marrow for 3 weeks after the clearance of parasitemia.

Spleen:

Enlargement of the spleen is one of the early and constant signs of malarial infection.

Liver:

Enlargement of the liver also occurs early in malaria. It is edematous, colored brown, grey or even black as a result of malaria pigment.

Lungs:

Involvement of the lungs occurs in *P. falciparum* malaria and is secondary to the changes in the RBCs and the microcirculation. Acute pulmonary edema is an infrequent but nearly fatal complication of *P. falciparum* malaria.

Cardiovascular system:

Malaria is commonly associated with cardiovascular function abnormalities. The most frequent changes include decrease in blood pressure, muffled heart sounds and occasionally cardiac dilation.

Gastrointestinal Tract:

Malaria is often accompanied by nausea and vomiting.

Kidneys:

Malaria can cause varied problems in the kidneys. During the acute attack, albuminuria may be seen commonly.

Central Nervous system:

CNS manifestations in malaria could be due to pathological involvement of the brain, paroxysms of fever or due to the side effects of ant malarial drugs.

Laboratory Diagnosis:

Laboratory diagnosis of malarial parasite is performed in following ways:-

- Peripheral smear examination
- Quantitative Buffy Coat test
- Rapid diagnostic test
- Other tests for malarial parasite