



## 39

## PLASMODIUM

### 39.1 INTRODUCTION

Malaria is characterized by intermittent fever associated with chills and rigors in the patient. There may be enlargement of the liver and spleen in the patient. Sporozoa of the genus plasmodium which cause malaria in man are pigment producing amoeboid parasites of vertebrates. They live in red blood cells and hepatocytes. Transmission of parasite occurs through the bite of infected female anopheles mosquito.



### OBJECTIVES

After reading this lesson you will be able to:

- describe the characteristics of Malarial Parasite
- describe the morphology of Plasmodium vivax, Falciparum, Ovale
- describe the life cycle of Malarial Parasite
- discuss the Pathogenicity of Malarial Parasite
- demonstrate the Laboratory Diagnosis of Malarial Parasite

### 39.2 MALARIAL PARASITE

They belong to

Phylum Apicomplexa

Order Sporozoa

Genus Plasmodium

There are four species

- (a) Plasmodium vivax
- (b) Plasmodium falciparum
- (c) Plasmodium ovale
- (d) Plasmodium malariae

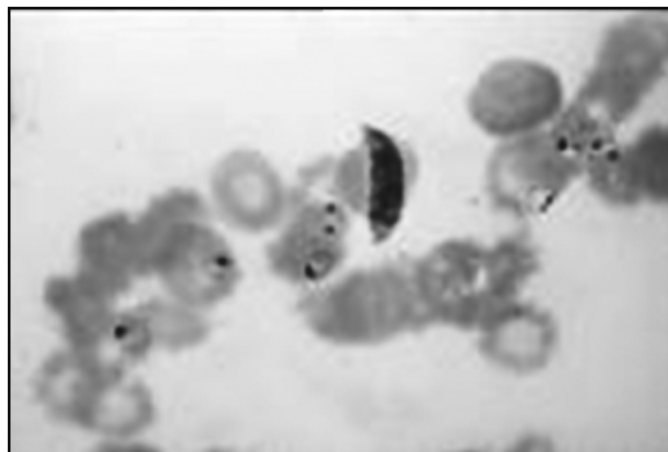
**39.3 MORPHOLOGY OF PLASMODIUM FALCIPARUM**

In the peripheral smear only the ring form and the gametocytes are seen. The other developmental stages of the parasite occur in the endothelial lining of the venules in internal organs like the brain and kidneys.

- (a) **The ring form:** Early trophozoite- “Ring form” containing a reddish chromatin “dot” and blue cytoplasm “ring”. A ring may contain double chromatin. The size of the ring is small and is 2-4  $\mu\text{m}$ . Maurier’s dots may be seen in the infected red blood cells. The stain deposits may be confused with the chromatin dot of the ring form
- (b) **Gametocyte form:** Gametocyte, is crescent or banana shaped, cytoplasm in female is more bluish than that of male. Female gametocyte has compact nucleus while in the male the nucleus is not compact.



Notes

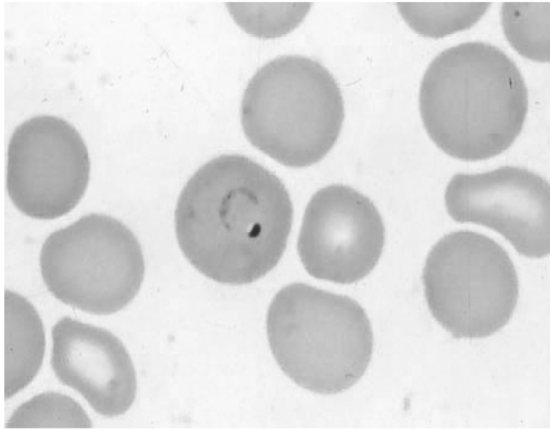


**Fig. 39.1: Giemsa stained smear: ring form and gametocytes of Plasmodium falciparum seen**

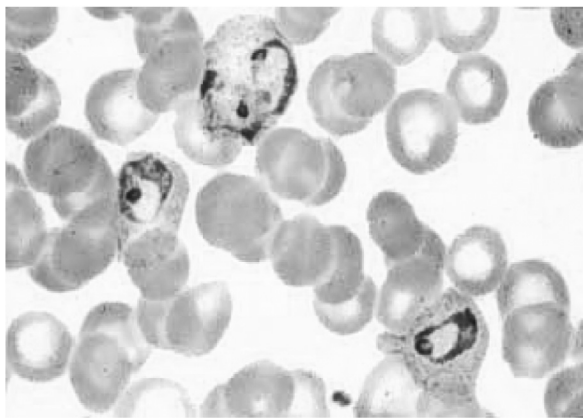
**39.4 MORPHOLOGY OF PLASMODIUM VIVAX**

In the peripheral smear all the stages of the parasite are seen. These include the trophozoite form, shizont form and the gametocyte form. The other developmental stages of the parasite occur in the endothelial lining of the venules in internal organs like the brain and kidneys.

- (a) **The ring form:** Early trophozoite- “Ring form” containing a reddish chromatin “dot” and blue cytoplasm “ring”. Note infected red cell is larger than uninfected red cell. Schuffner’s dots may be seen as fine reddish dots on infected red cell membrane



**Fig. 39.2:** Early ring form: *P vivax*

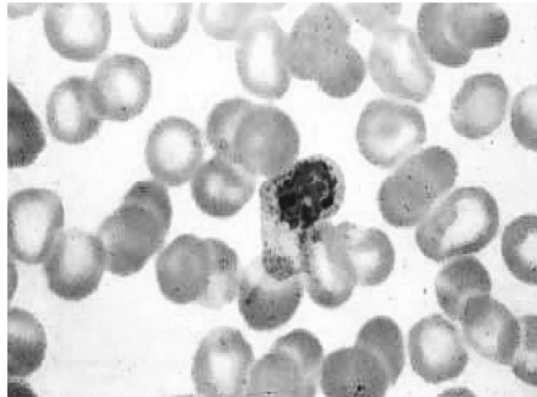


**Fig. 39.3:** Growing trophozoite- “Amoeboid form”

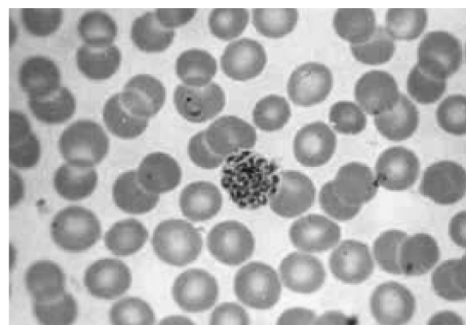
- (b) **Growing trophozoite:** “Amoeboid form” with “pseudopodia-like” cytoplasmic extension. Note infected red cell is larger than uninfected red cell. Schuffner's dots appear as fine reddish dots on infected red cell membrane.
- (c) **Schizont:**
- (i) **Immature schizont** has 2-24 nuclei. Schuffner's dots appear as fine reddish dots on infected red cell membrane. Infected red cell becomes irregular in shape and pale in color and enlarged.
  - (ii) **Mature schizont**, containing 12-24 merozoites. Schuffner's dots appear as fine reddish dots on infected red cell membrane. Infected red cell becomes irregular in shape and pale in color and enlarged.



Notes



**Fig. 39.4: Immature Schizont**



**Fig. 39.5: Mature Schizont**

- (d) **Gametocyte form** Gametocyte, is round to oval in shape, cytoplasm in female is more bluish than that of male. Female gametocyte has compact nucleus while in the male the nucleus is not compact.

### 39.5 LIFE CYCLE OF MALARIAL PARASITE

The life cycle of the plasmodium is spent in two hosts' man and anopheles mosquito. The mosquito is the definitive host as the sexual development and multiplication of the parasite occurs in it. Man is the intermediate host.

Sporozoite is the infective form of malarial parasite which is passed on to man through the bite of infected vector, the female anopheles mosquito. The various stages of the parasite in man are:-

- (a) Pre-erythrocytic schizogony
- (b) Erythrocytic schizogony
- (c) Gametogony
- (d) Exoerythrocytic schizogony



Notes

- (a) **Pre-erythrocytic schizogony:** This phase lasts for 8 days. Sporozoites are elongated and spindle shaped. The sporozoites enter the liver parenchymal cells and become rounded. They undergo multiple divisions and develop into schizonts. One schizont contains 20,000 – 30,000 merozoites. The liver cells rupture and release the merozoites into blood.
- (b) **Erythrocytic schizogony:** This has a duration of 48 hours. The merozoites penetrate the red blood cells. The merozoites enlarge in size and develop into trophozoites. The trophozoites develop into schizont which further develops into merozoites. There may be 6-24 merozoites in red blood cells. In the case of *Plasmodium falciparum* the schizonts aggregate in the capillaries of the brain and other internal organs. So that only ring forms are formed in the peripheral blood.
- (c) **Gametogony:** Some merozoites enlarge and get transformed to microgamete and macrogamete. The malarial parasite now becomes infective as the presence of gametocytes is a must for sexual development in the mosquito. The mosquito gets these gametocytes after taking a blood meal from a patient of malaria.
- (d) **Exo-erythrocytic schizogony:** This phase resembles the pre-erythrocytic schizogony. Some sporozoites after entering the liver cells do not undergo multiplication but go into resting phase. The resting stage of the parasite is known as hypnozoite. These can reactivate up to after 2 years and become schizonts and release merozoites. This phase is responsible for relapse of malaria



### INTEXT QUESTIONS 39.1

1. The life cycle of *Plasmodium* is spent in two hosts namely ..... and .....
2. .... is the intermediate host in the transmission of the parasite.
3. Relapse of Malarial infection occurs in ..... phase
4. The resting stage of parasite is .....

### Development in the mosquito

The female anopheles mosquito takes a blood meal from a malaria patient and the plasmodium gametocytes (Both microgametes and macrogametes) reach the gut of the mosquito. Only the mature gametocytes undergo further development. Microgametes penetrate the macrogametes and fertilize it leading to the



formation of a zygote. In the midgut of the mosquito one microgamete develops into 4-8 filamentous structures called microgamete.

The **zygote** matures into an **ookinete**. The ookinete further develops into oocyst. The oocyst further matures and increases in size. A large number of **sporozoites** (100-1000) develop inside the oocyst.

The oocyst ruptures and releases the sporozoites in the body cavity of the mosquito. The sporozoites go to all the organs but prefer to go to the salivary glands. The mosquito is now infective to man.

### 39.6 PATHOGENECITY

#### Malaria

The plasmodium species in man cause malaria. Plasmodium vivax causes a mild form of the disease where the fever comes after every 72 hours and is called **benign tertian malaria**. Plasmodium falciparum causes a severe form of the disease where the fever comes after every 72 hours and is called **malignant tertian malaria**.

The clinical features in malaria are characterized by high grade fever which is associated with chills and rigors. The fever is intermittent in nature and comes after 48-72 hours. After the period of chills and rigors comes the hot phase when the patient starts sweating and feels very hot. The patient may develop anaemia. The liver and spleen are also enlarged in this disease.

#### Complications of P falciparum malaria

**Cerebral malaria:** it is a serious form of the disease where the brain is severely affected by the malarial parasite. The patient can go into coma and may die if not treated in time.

**Algid malaria** is due to the involvement of the gastrointestinal system.

**Black water fever** is due to severe intravascular hemolysis.

### 39.7 LABORATORY DIAGNOSIS

#### Microscopy

Demonstration of parasite in blood film: The definitive diagnosis of malaria is established when the parasite is demonstrated in the blood smear taken from a suspected case of malaria. The blood smear should preferably be prepared during the febrile phase of malaria, but can be taken at any time that the patient reports

## Plasmodium

for investigation. The smears are stained by Romanowsky stains. Lishman stain is usually preferred . However staining with Giemsa is also acceptable. For screening purposes a **thick blood smear** is prepared. This smear must be de-hemoglobinized before staining. The disadvantage of this smear is that the morphology of the parasite is not visualized properly. For proper morphological identification a **thin blood smear** which is properly stained is required. It must be noted that in Plasmodium falciparum infection only the ring form and gametocytes are seen in the peripheral blood smear. While in Plasmodium vivax infection all the different stages of the trophozoite and gametocytes are seen,

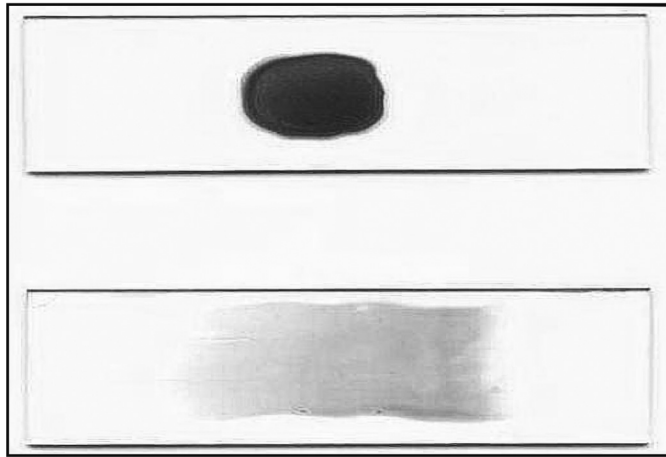


Fig. 39.6: Thick and thin smears Serology

### Rapid diagnostic test (RDT)

Indirect evidence of malaria is also established by the demonstration of malarial antigen or antibodies to malaria antigen. Tests based on immunochromatography are available (malaria card test).

Target antigens for commercially available RDTs

Antigen (Species)	HRP 2	pLDH	Aldolase
P. falciparum specific	+	+	
Pan-specific (all species)		+	+
P. vivax specific		+	

Fig. 39.7

## MODULE

Microbiology

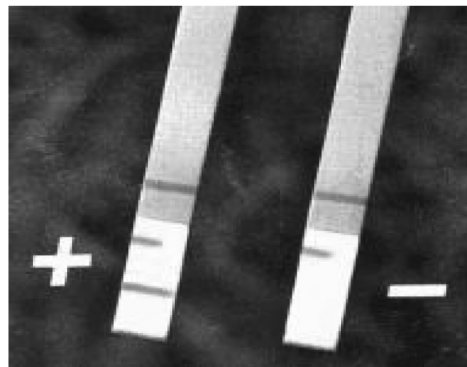


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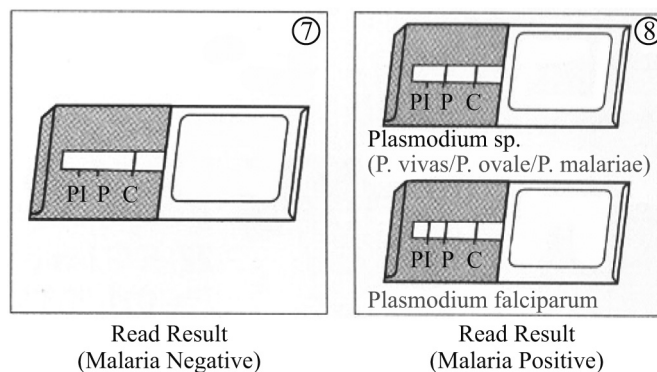
The antigen used for detection of *P. falciparum* infection is HRP II. The antigen detection test may remain positive for up to two after the infection has been cured.



**Fig. 39.8**

**Detection of Malaria antigen by Parasight – F test**

Some tests detect the specific isoenzyme LDH (Lactate Dehydrogenase). These test detect only the living *Plasmodium* parasite. This test has the advantage that it becomes negative when specific treatment is started.



**Fig. 39.9: Parasite LDH Test (Optimal- IT)**

**Fluorescent Microscopy**

Quantitative buffy coat (QBC) examination involves the use of microcapillaries. The blood is drawn into the microcapillary from one end and a fluorescent reagent is drawn in from the other end. This is then centrifuged in a special centrifuge. The centrifugation results in the formation of a buffy coat which contains the parasitized red blood cells. The malarial parasite takes up the fluorescent dye and the nuclei are seen as pink dots and the body of the parasite is greenish in colour. This observed under a special fluorescent microscope.



## Plasmodium

**Polymerase chain reaction:** PCR technique may be employed to diagnose malarial infections in intractable cases. This is a specialized technique requiring special skills and equipment and is expensive too.

### Miscellaneous tests

Patient of malaria may suffer from anaemia if the disease is prolonged in nature. Leucopenia or leucocytosis may be seen in some cases of complicated malaria.



### INTEXT QUESTIONS 39.2

Match the following

- |                            |                               |
|----------------------------|-------------------------------|
| 1. Plasmodium Malaria      | (a) Malignant Tertian Malaria |
| 2. Plasmodium Vivax        | (b) Cerebral Malaria          |
| 3. Plasmodium Falciparum   | (c) Benign Tertian Malaria    |
| 4. Complication of Malaria | (d) Malaria                   |



### WHAT HAVE YOU LEARNT

- Malaria is characterized by intermittent fever associated with chills and rigors in the patient. Sporozoa of genus plasmodium which cause malaria in man are pigment producing amoeboid parasites of vertebrates.
- They belong to Phylum Apicomplexa, Order Sporozoa, Genus Plasmodium
- There are four species namely Plasmodium vivax, Plasmodium falciparum, Plasmodium ovale, Plasmodium malariae
- The life cycle of plasmodium is spent in two hosts man and anopheles mosquito.
- The mosquito is the definitive host as the sexual development of the parasite occurs in it. Man is the intermediate host
- Sporozoites is the infective form of malarial parasite which is passed on to man through the bite of female anopheles mosquito
- Plasmodium species in man cause malaria. Plasmodium vivax causes a mild form of the disease whereas Plasmodium falciparum causes a severe form of the disease.
- Complications of malaria are cerebral malaria, Algid malaria and Black water fever

## MODULE

Microbiology



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### Plasmodium

- The definite diagnosis of malaria is established when the parasite is demonstrated in blood smear and the smear should preferably be prepared during the febrile phase of malaria.
- Smears are stained by Romanowsky stains, lieshman stain is usually preferred.
- Thick blood smear is prepared for screening purposes and thin blood smear is prepared for morphological identification.
- Indirect evidence of malaria is also established by demonstration of antigen or antibodies to malaria antigen.



### TERMINAL QUESTIONS

1. Discuss the life cycle of *Plasmodium falciparum*
2. Draw a labeled diagram of the ring form trophozoite and gametocyte of *P vivax*
3. Discuss the pathogenicity and complications of malaria caused by *P falciparum*.
4. Enumerate the various species of *Plasmodium*.



### ANSWERS TO INTEXT QUESTIONS

#### 39.1

1. Man and Mosquito
2. Man
3. Exo-erthrocytic Schizogony
4. Hypnozoite

#### 39.2

1. (d)
2. (c)
3. (a)
4. (b)