phylum: apicomplexa Class: sporozoa Subclass: coccidia Order: eurococcidina Suborder: haemosporina Genus: *plasmodium*

There are four species infecting humans, namely,

•Plasmodium falciparum (Malignant tertian malaria)

- •Plasmodium vivax (Benign malaria)
- Plasmodium ovale (Ovale tertian Malaria)

•Plasmodium malaria (Quartun Malaria)

lab. 5

Life cycle of malaria

In man (schizogony): The parasites in the liver and red blood cells (RBCS) multiply asexually. Man acts as intermediate host

in female Anopheline mosquito (sporogony): The sexual form develops in mosquito which acts as definitive host.

Life cycle in man:

Pre-erythrocytie Schizogony :

When the infected mosquito bites man, sporozoites are injected together with saliva and circulate in blood stream, then have invaded the liver cells where pre-erythrocytie forms develop. These rupture in 6-15 days and release merozoites.

• Erythrocytie Schizogony:

When some of merozoites enter erythrocytes and pass through stages (ring, trophozoite develop to schizont ruptures, merozoites are released and re-invasion of erythrocyte take place).

• Gametocyte production (gametogony) :

After erythrocyte schizogony some of the merozoites instead of developing into trophozoites and schizonts give rise to two forms of gametocytes (male and female) develop in the RBCS of capillaries of internal organs and peripheral blood reveals only the mature gametocytes

Exoerythrocytic schizogony:

After the establishment of the blood infection (pre-erythrocytic phase) disappear in P. falciparum, where as in P.vivax and P.ovale hepatic forms called hypenozoites persist and remain in the hepatocytes, liberating merozoites in the blood stream causing relapse of infection this is described as exo-erythrocytic schizogony. P.vivax and P.ovale may continue to relapse for several years.

In P. malariae can remain in the blood for years and then suddenly initiate a clinical condition. This is known as a recrudescence.

life cycle in female of nepheline mosquito

For initiation of a mosquito cycle, sexual forms (male and female gametocytes) are first developed inside the human host and then transfer to their insect host where they develop further and are transformed to sporozoites. These sporozoites are infective to man

• Methods of tranSmission :

Classified into two main types

1-Sporozoite induced: In a natural way (by the bite of infected mosquito) or under experimental conditions by injecting emulsion of salivary glands containing sporozoites.

2-Trophozoite induced :

Transfusion malaria (blood transfusion)

-Congenital malaria (from mother to fetus through placenta defects)

-Malaria in drag addicts (use infected syringe)





Anopheles Female (Mosquito) The vector of malaria

Plasmodium spp Exflagellation Fig : some stages of Plasmodium spp in insect

Differential characters of malaria parasites

characters	Plasmodium falciparum	Plasmodium vivax	Plasmodium malaria	Plasmodium ovale
Early trophozoite (ring stage)	Small, delicate, 2 chromatin dots and multiple red cell infection common	Large, usually 1, sometimes 2 chromatin, accole *	Compact, 1 chromatin dote, double cell infections rare	Similar to <i>Plasmodium</i> falciparum
Late trophozoite (malaria pigment appear	Medium, compact vacuole in conspicuous, rare in peripheral blood	Large, irregular actively amoeboid, vacuole prominent pigment in fine rod lets	Small, band shaped vacuole in conspicuous pigment coarse	Small compact vacuole in conspicuous pigment coarse
Schizont (pre segmented)	Medium, compact chromatin mass numerous rare in peripheral blood	Large, amoeboid chromatin mass numerous pigment in fine rod let	Small, compact chromatin mass numerous few pigment coarse	Medium, compact chromatin mass numerous few pigment coarse
Mature Schizont (segmented)	Smaller than normal red cells single rosette	larger than normal red cells may have double rosette	Smaller than normal red cells single rosette	larger than <i>Plasmodium malaria</i>
Number of merozoites	20-24	16	8	8
Microgametes	Crescents, chromatin diffuse large nucleus	Spherical, compact, no vacuole, large nucleus diffuse coarse pigment	Similar to <i>Plasmodium</i> <i>vivax</i> but smaller and less numerous	Similar to <i>Plasmodium</i> <i>vivax</i> but smaller

characters	Plasmodium falciparum	Plasmodium vivax	Plasmodium malaria	Plasmodium ovale
Alteration in the infected RBC	Normal, Maurer's or clefts dots seen large dark red spots	Enlarged schuffner's dotes seen small red dots	Smaller, ziemann's dots seen tiny pink stippling	Enlarged schuffner'sor james dots seen small red dots
Incubation periods	8-11 days	10-17 days	18-40 days	10-17 days
Duration of schizogony	36-48 hours	48 hours	72 hours	48 hours
Distribution in peripheral blood	Only ring and gametocytes	All forms	All forms	All forms
RBC preference	Younger cells can invade cells of all ages	Reticulocytes	Older cells	Reticulocytes

	vivax	ovale	malariae	falciparum
Ring Stage				
Trophozoite				
Schizont				
Segmenter				
Gametocytes				

- Figs. 2-18: Trophozoites
- Figs. 2-10 correspond to ring-stage trophozoites)
- Figs. 19-26: Schizonts
- Fig. 26 is a ruptured schizont
- Figs. 27, 28: Mature macrogametocytes (female);
- Figs. 29, 30: Mature microgametocytes (male)



• Figs. 2-6: Young trophozoites (ring stage parasites);

• Figs. 7-18: Trophozoites;

- Figs. 19-27: Schizonts;
- Figs. 28 and 29: Macrogametocytes (female);
- Fig. 30: Microgametocyte (male)



- Figs. 2-5: Young trophozoites (rings);
- •Figs. 6-13:
 - Trophozoites;
- •Figs. 14-22:
 - Schizonts;
- •Fig. 23: Developing gametocyte.
- Fig. 24: Macrogametocyte (female);
- Fig. 25: Microgametocyte (male).



- Figs. 2-5: Young trophozoites (Rings);
- Figs. 6-15:
 - Trophozoites;
- Figs. 16-23: Schizonts;
- Fig. 24: Macrogametocytes (female);
- •Fig. 25: Microgametocyte (male)





A, B, C, D: Gametocytes of P. falciparum in thin blood smears. Note the presence of a "Laveran's bib", which is not always visible E: Two gametocytes captured from a thick blood smear.

Leo Nine



- A, B, C: Multiply infected red blood cellswith appliqué forms in thin blood smears
- D: Signet ringform.
- E: Doublechromatin dot
- F: A thick blood smear showing many ring forms of P. falciparum (X 1000)

Laboratory diagnosis

Depending on blood film for parasites from patients, two kinds of smears are prepared from the peripheral blood.

1-Thin blood smears: preparation after cleaning the finger tip with ethyl alcohol or ether, dry then using sterile prickle needle give a prick and wipe off first drop of blood. The next drop is placed towards one end on the slide use a second slide (spreader), fixation in methanol for 30 seconds and staining by Giemsa stain and examine.

Morphological features: The basic characters of a stained malarial parasite inside a RBC are: Cytoplasmic body stained blue, nucleus known as chromatin is red, there is central unstained portion called vacuole in the early stage, pigment granules of different colors and stippling appears as pink dots.(thin smear uses for identification the species of Plasmodium). 2-Thick blood smear: Preparation by made on the same slide or separately. 3 drops of blood are spread over a small area then staining and examine.

- Morphological features: Lysis RBCS, parasites and WBCS are seen. Thick smear for identification the infection with Plasmodium. (Time of collection the blood when parasites abundant in peripheral blood late in the febrile paroxysm a few hours after peak of the fever).
- **3-Culture examination:** For differentiation between (ring form) of P. vivax and P. falciparum.
- **4-Immunological test:** (IHA, IFA, ELISA, RIA and agar gel diffusion) no serological test can match the sensitivity and specifity of microscopic diagnosis of malaria.
- **5-Use of fluorescent dyes:** Like benzothiocarboxypurine, this dye enters **the RBCS and stains the malarial parasite.**
- **6-Finding the DNA of Plasmodium in the blood by PCR.**