**Class: Sporozoa.**

**Subclass: Haemosporidia.**

**Family: Plasmodiidae.**

**Genus: *Plasmodium.***

**Species: *Plasmodium vivax.***

***Plasmodium malariae.***

***Plasmodium falciparum.***

***Plasmodium ovale.***

*** Malaria → bad air ..... plasmodioses.**

**In Algeria 1880 – infected RBCs by the parasite.**

**In 1894 – mosquito-transmitted disease.**

**It is one of the greatest killers in the world in addition to cancer and heart diseases.**

**Geographical distribution:**

- **As far north as 64ºN latitude (Russia).**
- **As far south as 32ºS latitude (Argentina).**
- **Dead sea – 400 meters below sea level.**
- **At 2600 m. above sea level – Kenya.**
- **At 2800 m. above sea level – Bolivia.**

***P. vivax*= most extensive in distribution.**

***P. falciparum*= tropical & subtropical.**

***P. malariae*= Less common but wide distribution.**

***P. ovale*= East & West Africa.**

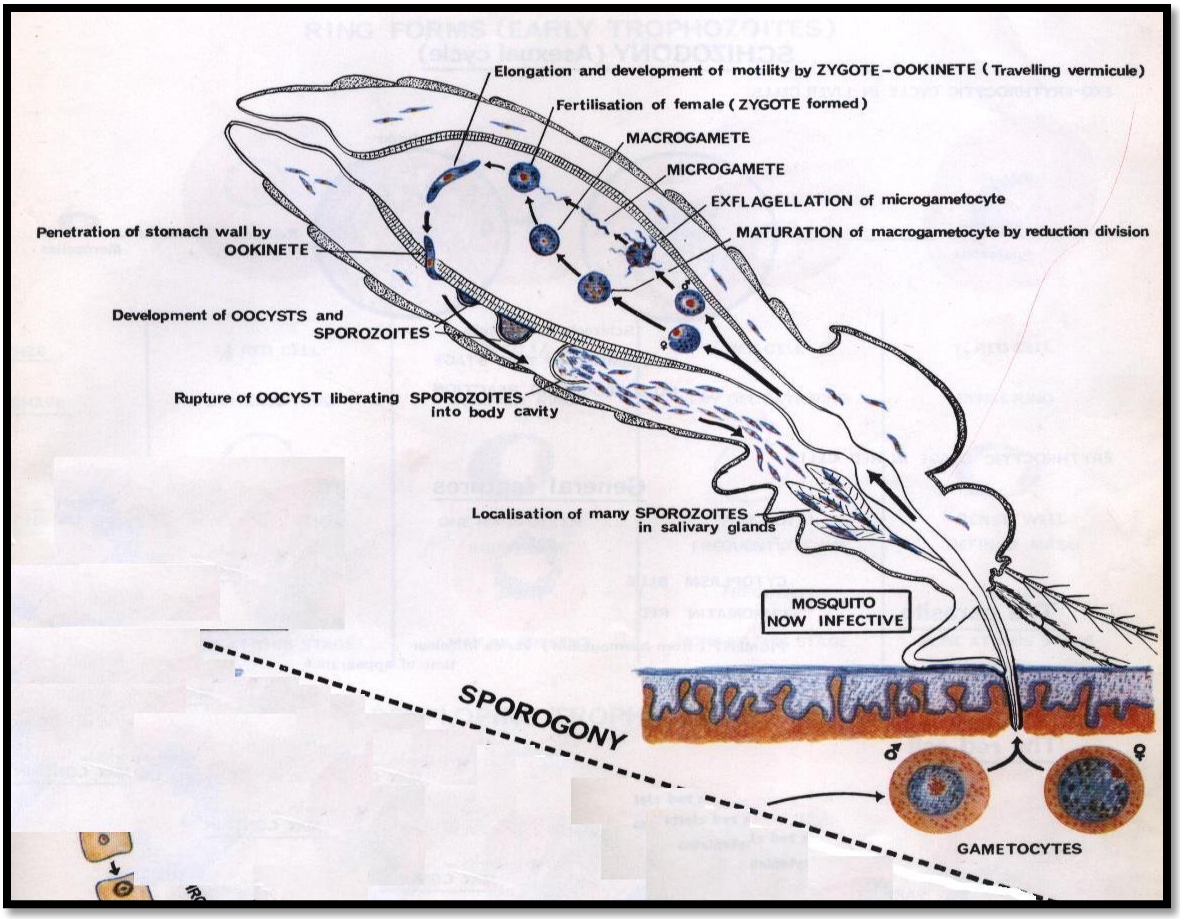
## Risk factors for wide distribution:

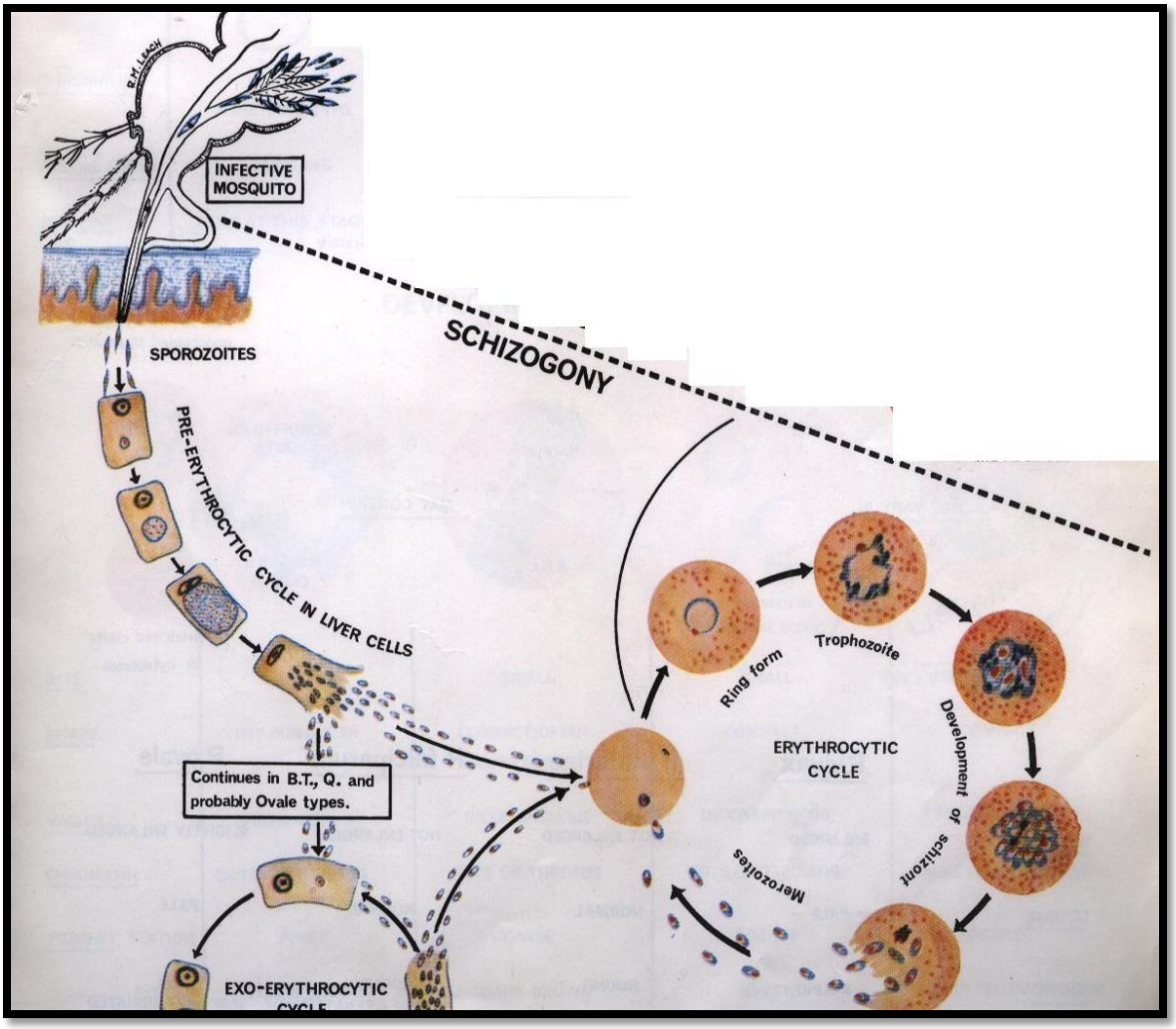
1) **The impact of the Korean & Vietnam wars.**
2) **Air transpory among countries.**

## Methods of infections & transmission:

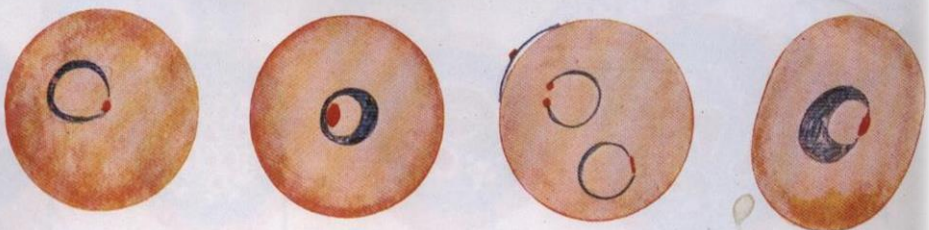
1) **♀ *Anopheles* bits.**
2) **Blood transfusion.**
3) **Organ trasplantation.**
4) **Congenital route.**
5) **Hypodermic needle.**

## Life cycle:


Elongation and development of motility by ZYGOTE – OOKINETE ( Travelling vermicule)
Fertilisation of female ( ZYGOTE formed )
MACROGAMETE
MICROGAMETE
EXFLAGELLATION of microgametocyte
MATURATION of macrogametocyte by reduction division
Penetration of stomach wall by OOKINETE
Development of OOCYSTS and SPOROZOITES
Rupture of OOCYST liberating SPOROZOITES into body cavity
Localisation of many SPOROZOITES in salivary glands
MOSQUITO NOW INFECTIVE
SPOROGONY
GAMETOCYTES

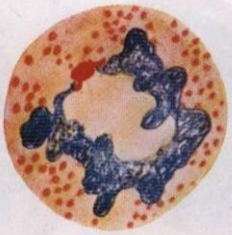

INFECTIVE MOSQUITO
SPOROZOITES
SCHIZOGONY
PRE-ERYTHROCYTIC CYCLE IN LIVER CELLS
Continues in B.T., Q. and probably Ovale types.
EXO-ERYTHROCYTIC
Ring form
Trophozoite
Development to schizont
Merozoites
ERYTHROCYTIC CYCLE

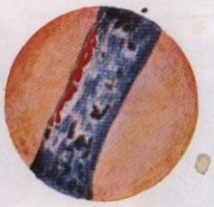
# RING FORMS (EARLY TROPHOZOITES)



| | | | | |
|---|---|---|---|---|
| SIZE | 1/3 RED CELL | UP TO 1/3 | 1/5 RED CELL | 1/3 RED CELL |
| SHAPE | DELICATE RING | COMPACT RING | VERY DELICATE RING | DENSE RING |
| |  |  |  |  |
| CHROMATIN | FINE DOT SOMETIMES TWO | ONE MASS OFTEN INSIDE RING | FINE DOTS FREQUENTLY TWO | DENSE, WELL DEFINED MASS |
| ACCOLÉ FORMS | SOMETIMES | NONE | FREQUENT | NONE |
| PIGMENT | NONE AT THIS STAGE | MAY BE PRESENT | NONE AT THIS STAGE | NONE AT THIS STAGE |

# DEVELOPING TROPHOZOITES





(RARELY SEEN IN PERIPHERAL BLOOD)

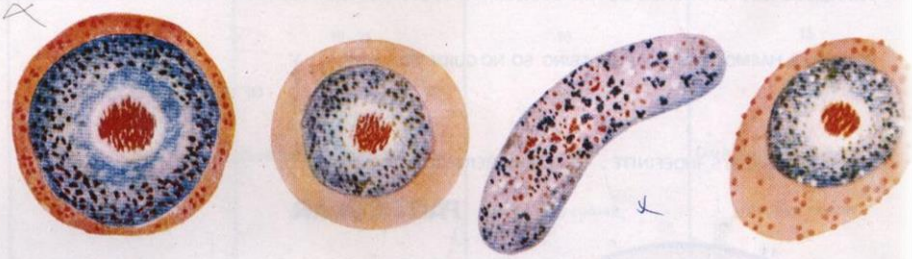


| | | | | |
|---|---|---|---|---|
| SIZE | LARGE | SMALL | SMALL | LARGE SMALL |
| SHAPE | VERY IRREGULAR | COMPACT, OFTEN BAND FORMS | COMPACT | COMPACT |
| VACUOLE | PROMINENT | INCONSPICUOUS | INCONSPICUOUS | INCONSPICUOUS |
| CHROMATIN | DOTS OR THREADS | DOTS OR THREADS | DOTS OR THREADS | LARGE IRREGULAR CLUMPS |
| PIGMENT TEXTURE | FINE | COARSE | COARSE | COARSE |
| COLOUR | YELLOW BROWN | DARK BROWN | BLACK | DARK YELLOW BROWN |
| QUANTITY | MEDIUM | ABUNDANT | MEDIUM | MEDIUM |
| DISTRIBUTION | SCATTERED FINE PARTICLES | SCATTERED CLUMPS AND RODS | AGGREGATED IN TWO CLUMPS | SCATTERED COARSE PARTICLES |

# Morphology of Malaria parasites (cont.)

PLATE

## MICROGAMETOCYTES



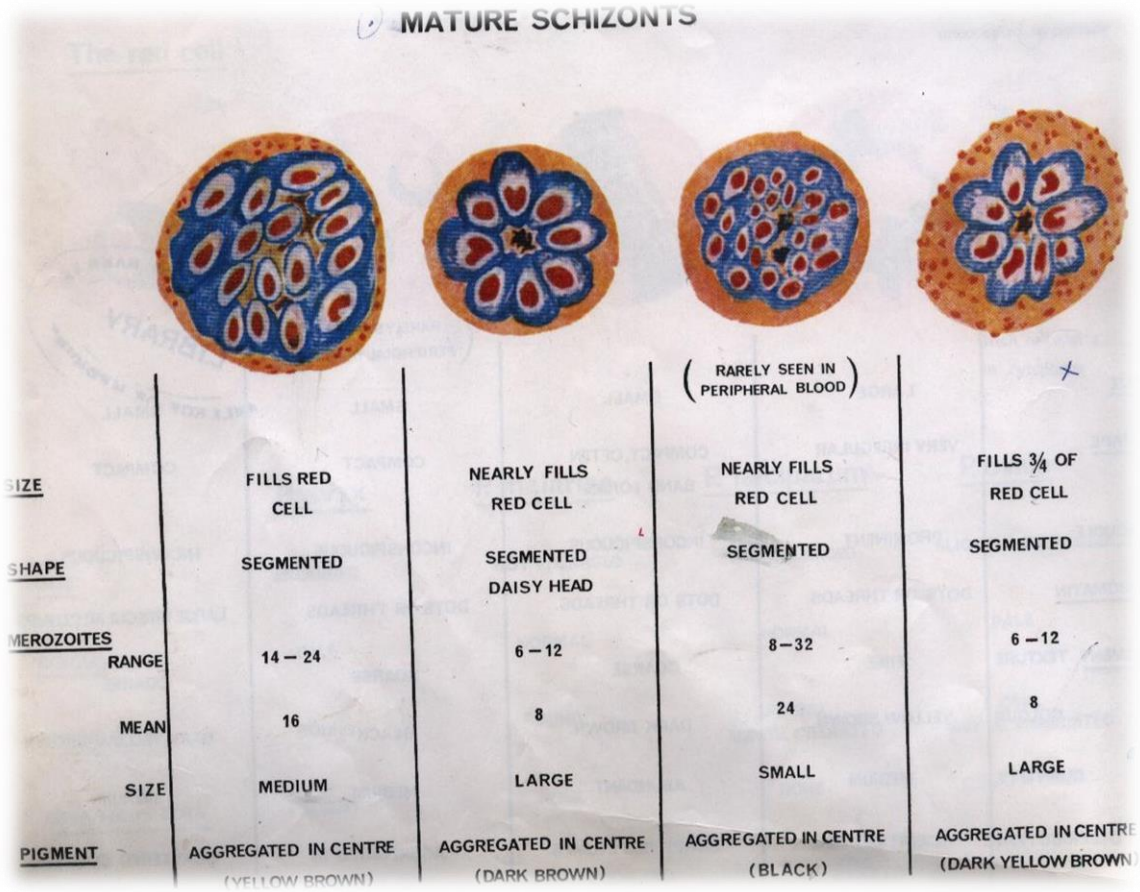
| | P.vivax | P.malariae | P.falciparum | P.ovale |
|---|---|---|---|---|
| TIME OF APPEARANCE | 3–5 DAYS | 7–14 DAYS | 7–12 DAYS | 12–14 DAYS |
| NUMBER IN BLOOD STREAM | MANY | SCANTY | MANY | SCANTY |
| SIZE | FILLS ENLARGED RED CELL | SMALLER THAN RED CELL | LARGER THAN RED CELL | SIZE OF RED CELL |
| SHAPE | ROUND OR OVAL COMPACT | ROUND COMPACT | KIDNEY SHAPED BLUNTLY ROUND ENDS | ROUND COMPACT |
| CYTOPLASM | PALE BLUE | PALE BLUE | REDDISH BLUE | PALE BLUE |
| CHROMATIN | FIBRILS IN SKEIN WITH SURROUNDING UNSTAINED AREA | AS FOR P.vivax | FINE GRANULES SCATTERED THROUGHOUT | AS FOR P.vivax |
| PIGMENT | ABUNDANT BROWN GRANULES THROUGHOUT | AS FOR P.vivax | DARK GRANULES THROUGHOUT | AS FOR P.vivax |

## MACROGAMETOCYTES

| | | | | |
|---|---|---|---|---|
| TIME OF APPEARANCE | 3–5 DAYS | 7–14 DAYS | 7–12 DAYS | 12–14 DAYS |
| NUMBER IN BLOOD STREAM | MANY | SCANTY | MANY | SCANTY |
| SIZE | FILLS ENLARGED RED CELL | SMALLER THAN RED CELL | LARGER THAN RED CELL | SIZE OF RED CELL |
| SHAPE | ROUND OR OVAL COMPACT | ROUND COMPACT | CRESCENTIC–SHARPLY ROUNDED OR POINTED ENDS | ROUND COMPACT |
| CYTOPLASM | DARK BLUE | DARK BLUE | DARK BLUE | DARK BLUE |

## IMMATURE SCHIZONTS

| | P.vivax | P.malariae | P.falciparum | P.ovale |
|---|---|---|---|---|
| | | | (RARELY SEEN IN PERIPHERAL BLOOD) | |
| SIZE | ALMOST FILLS RED CELL | ALMOST FILLS RED CELL | ALMOST FILLS RED CELL | ALMOST FILLS RED CELL |
| SHAPE | SOMEWHAT AMOEBOID | COMPACT | COMPACT | COMPACT |
| CHROMATIN | NUMEROUS IRREGULAR MASSES | FEW IRREGULAR MASSES | NUMEROUS IRREGULAR MASSES | FEW IRREGULAR MASSES |
| PIGMENT | SCATTERED | SCATTERED | SCATTERED | SCATTERED |




***P. vivax = vivax tertian malaria (benign).***

***P. malariae = Quartan malaria.***

***P. falciparum = malignant tertian malaria.***

***P. ovale = ovale tertian malaria***

***The periodic febrile response is related to the time of rupture of a sifficient No. of mature schizonts and consequent discharge of merozoites into the blood stream ( Synchronised schizogony).***

***THE SEVERITY OF THE ILLNESS DEPENDS ON:***

***1. The degree of parasitaemia.***

*2. The extent of RBCs destruction.*

*3. The defence responses of the host.*

*Relapse (Delayed primary attack): Re-ocurrence of malarial attack after apparent cure due to persistent exo-erythrocytic stages or dormont sporozoites (hypnozoites). It occurs in P.vivax (2-3 years) & P.ovale (longer than a year).*

*Recrudescence: Renewal of clinical manifestation due to subclinical population of the parasites. It occurs in P. falciparum (1 year) & P. malariae (many years).*

*MALARIA IN HYPERENDEMIC AREAS*

*The typical malarial manifestation occurs in young children only. Older children & adults who survive previous infection develop tolerance to the disease.*

*CONGENITAL MALARIA*

*The mechanism of the transplacental passage of the parasite is obscure. It has not been reported in laboratory animals.*

## *Pathology:*

*Anemia: Acute = normocytic & normochromic.*

*Chronic & relapses = Pernicious anemia.*

*Falciparum malaria = Sludging RBCs.*

*C.N.S: 1. Congestion of meninges & brain.*

*2. Occlusion of the capillaries of the cortex.*

*3. Necrotic lesions in midzonal brain*

*(malarial granuloma).*

*Spleen: 1. Dark, congested & enlarged.*

*2. Hyperplasia of red & white pulp.*

*3. Erythropoiesis & lymphopoiesis.*

*4. Haemosiderosis.*

**Liver:**

**1. Enlarged & dark in colour.**

**2. Hypertrophy of the kupffer cells with ingested malarial pigments.**

**3. Degeneration & necrosis in the centro- lobular regions.**

**Kidney:**

**1. Falciparum malaria = congestion & Punctate haemorrhages in the Cortex & medulla.**

**2. Malariae malaria = nephrotic syndrome ( hyalinisation of the tuft of the glomeruli & segmental cells.**

**Thickening basal membrane due to**

**Deposition of Ag-Ab complexes).**

**Heart: Embolic blockage of the coronary vessels.**

**Placenta: Falciparum malaria, mature schizonts in the intervillous spaces with histiocytes in the maternal side of the placenta.**

## Complications:

**Quartan malaria → nephrosis.**

**Falciparum malaria → Cerebral malaria.**

**Gastrointestinal malaria.**

**Hyperpyrexia.**

**Algid malarial.**

**Black water fever.**

## Immunity:

## I) Natural immunity:

- **Duffy group determinants among west African & American blacks.**
- **Sickle cell anemia.**
- **Haemoglobin C & E.**
- **G 6 PD deficiency.**

## II) ACQUIRED IMMUNITY :

**# Premunition immunity.**

**# Stable & unstable malaria.**

## Why *Plasmodium falciparum* is malignant:

1. **It invades erythrocytes of all ages.**
2. **Schizogonic cycle requires 36-48 h.**
3. **Several parasites in a single RBC.**
4. **Adherence of RBC one to another & to the lining of the blood vessels.**
5. **The toxic products interfere with oxygen utilization by the host cells.**
6. **Autoimmunity in destruction both the parasitized & the non-parasitized RBCs.**

## Diagnosis:

1. **Clinical picture.**
2. **Thick blood film.**
3. **Thin blood film.**
4. **Serological tests.**