## Order : Haemosporidia

## *Plasmodium* sp.

### Definition

• Malaria is a mosquito-borne infectious disease of humans and other animals caused by the genus Plasmodium, transmitted by the bite of female anopheles mosquito. Malaria is the most important parasitic disease being widespread in tropical and subtropical regions in a broad band around the equator, including much of Sub-Saharan Africa, Asia, and the Americas.

• The disease results from the multiplication of malaria parasites within red blood cells, causing symptoms .

• Name is derived from Italian **Mal' aria or bad air**

## Etiology

Causative organism*: Plasmodium*

*P. Vivax*: tertian malaria *P. Malariae*: quartan malaria

*P. Falciparum*: malignant malaria P. *Ovale:* tertian malaria

**Pathogenicity**: merozoite, malarial pigment & products of metabolism

### Mode of transmission

• Malaria is transmitted by the bite of an infective female Anopheles mosquito. Rarely, transmission can be congenital (via the placenta) or can occur through transfusions or the use of contaminated needles.

### Life Cycle

A- *Human cycle-Shizogony*

**Included Four stages**

**1 - *Pre or (Exo) erythrocytic schizogony***

***2 - Erythrocytic Schizogony***

***3 - Gametogony***

***4 – Latent Stage***

• Man – Intermediate host.

• Mosquito – Definitive host

• Sporozoites are infective formsPresent in the salivary gland of female anopheles mosquito

• After bite of infected mosquito sporozoites are introduced into blood circulation.

**1 - PRE-ERYTHROCYTIC SHIZOGONY**

• Developmental phase inside the tissue (liver)of man,Site-parenchyma cells (hepatocyte) of liver, Sprozoites are elongated and spindle shaped become rounded inside the liver parenchyma,Multiple nuclear divisions develop to Schizonts,Consists of single generation of pre erythrocytic

• schizont which liberates merozoites

• Duration -- P.V.-8 days, P.O.-9 days, P.F.-6 days, P.M.-15days

• Cryptozoites—liberated merozoitesi) merozoites – enter circulation

ii)merozoites—re-enter liver cells

• No clinical manifestations or pathological damage

*Erythrocytic merozoites do not reinvade the liver cells. So malaria transmitted by blood transfusion reproduces only erythrocytic cycle

• **In case of P. falciparum and P. malariae,** all merozoites invade RBC's without re-invading liver cells. However, but P. vivax and P. ovale, some merozoites invade RBC's and some re-invade

• liver cells initiating Exo-erythrocytic schizogony, which is responsible for relapses. Some of the merozoites remain dormant (hypnozoites) becoming active later on.

***2 - Erythrocytic Schizogony***

• Merozoites released invade red cells,P.vivax infects young erythrocytes

• P.malariae Infects old erythrocytes,

• *P.falciparum infects RBC of all ages*

• The Merozoites are pear shape

• The receptors for Merozoites are on red cells in the glycoprotein

• Liberated Merozoites penetrate

**RBC,Three stages occur:**1. **Trophozoites 2 .Schizont 3. Merozoite**

• Ruptured red cells release Merozoites which attack new red cells

Continue with Schizogony, Repeated cycles will continue

• In P.falciparum – infected erythrocytes with Schizonts aggregate in the capillaries of brain and other internal organs

• Only ring forms are seen in the blood smears

**3 - GAMETOGENY**

• After many cycles of erythrocytic shizogony

• Some merozoites give rise to **GAMETOCYTES**, capable of sexual reproduction after leaving human host

• Develop in RBCs of the capillaries of internal organs

• Mature gametocytes are seen in peripheral blood

• Microgametocyte of all species are similar in size

• Macro gametocytes are larger in size.

• Duration of maturation- 4 days

• No febrile reactions

**4 - LATENT STAGE**

• Some Sprozoites do not undergo sporogony in the first instance

• But go into resting stage called as Hypnozoites

**• HYPNOZOITE STAGE**

• Only in Vivax and ovale

• Arises from the initial tissue phase, capable of developing merozoites

• Responsible for relapses of vivax and ovale

• Within 2 years reactivate to form Schizonts release Merozoites and **attack red cell and produce relapses**

B - *Mosquito cycle – SPOROGONY*

• Sexual cycle will be initiated in the Humans by the formation of Gametocytes

• Develop further in the female Anopheles Mosquito

• Only mature sexual forms are capable of further development in Mosquito

• In midgut one Microgametocyte develops into 4-8 thread like filamentous structures named Micro gametes

• From one macrogametocyte only one macrogamete is formed

• Fertilization occurs when a Microgametocyte penetrate into Macrogametocyte

• Fertilized macrogametocyte is known as ZYGOTE

• ZYGOTE matures into OOKINETE

• OOKINETE to OOCYST

• OOCYST matures with large number of Sporozoites ( A few hundred to thousands.)

• OOCYST ruptures and release **SPOROZOITES** in the body cavity of Mosquito

• There is a specific predilection for salivary glands

• **Now capable to transmit the infection to new Host**

## *How Malaria present Clinically*

• Stage 1

• Chills for 15 min. to 1 hour

• Caused due to rupture from the host red cells escape intoBlood

• Preset with nausea, vomitting,headache

• Stage 2

• Fever may reach upto 400c may last for several hours starts invading newer red cells.

• Stage 3

Patent starts sweating, concludes the episode Cycles are frequently Asynchronous Paroxysms occur every 48 – 72 hours, In P.malariae pyrexia may lost for 8 hours or more and temperature my exceed 410c**.**

## *Broad clinical manifestations of Malaria*

• Fever

• Sweating

• Anemia

• Splenomagaly (enlarged spleen)

• Irratability

• Coma, Retinal Hemorrages

• Algid Malaria ( a shocklike syndrome)

• Respiratory distress syndrome

## *Why Falciparum Infections are Dangerous*

(Pernicious Malaria)

• Can produce fatal complications,

1.Cerebral malaria

2.Malarial hyperpyrexia

3.Gastrointestinal disorders.

4.Algid malaria

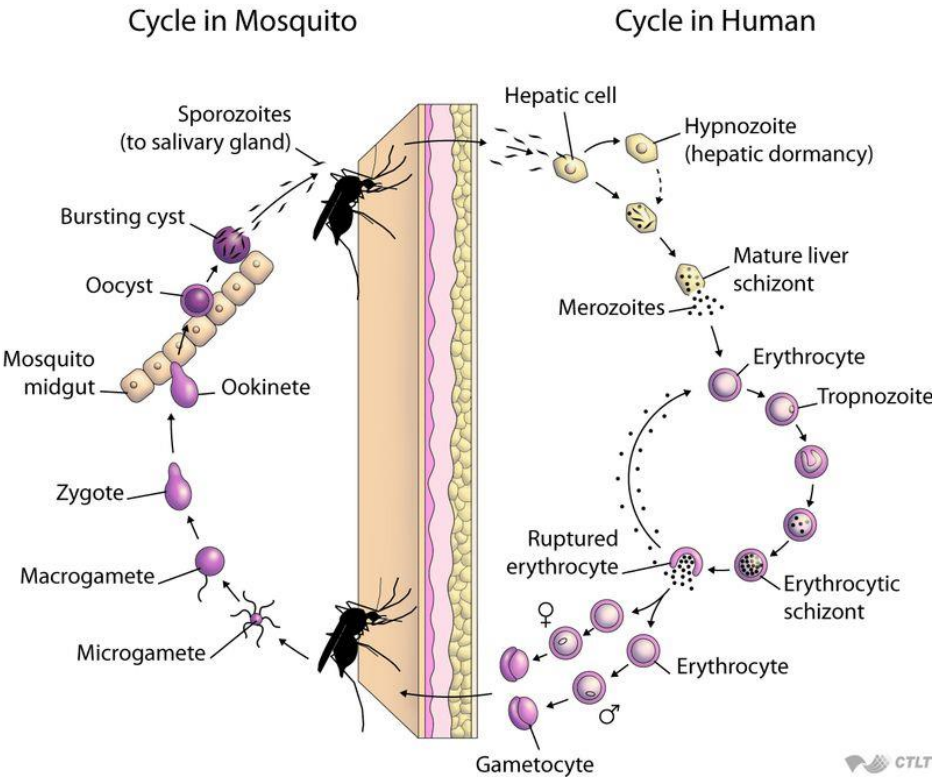
5 .Black water fever can lead to death

## Complication in Malaria

• Pulmonary edema (fluid buildup in the lungs) or acute respiratory distress syndrome (ARDS), which may occur even after the parasite counts have decreased in response to treatment

• Abnormalities in blood coagulation and thrombocytopenia (decrease in blood platelets)

• Cardiovascular collapse and shock




**Diagnosis**

Malaria parasite can be identified by examining under the microscope a drop of the patient's blood, spread out as a "blood smear" on a microscope slide.and also by antigen detection, serological and molecular test**.**

**Treatment**

Malaria can be a severe, potentially fatal disease (especially when caused by *Plasmodium falciparum*) and treatment should be initiated as soon as possible.Patients who have severe *P. falciparum* malaria or who cannot take oral medications should be given the treatment by continuous intravenous infusion.Most drugs used in treatment are active against the parasite forms in the blood (the form that causes disease) and include chloroquine

## *Leucocytozoon* sp.

**Leucocytozoonosis** Caused by the blood parasite *Leucocytozoon*, which is found in many water fowl. Most important blood parasite of birds and is pathogenic in both domestic and wild birds.

- Definitive host
  - Ducks
  - Turkey
  - Geese
  - Swans
  - Similar waterfowl
  - Vector
    - Black Fly
      - Order Simuliidae

## Life cycle

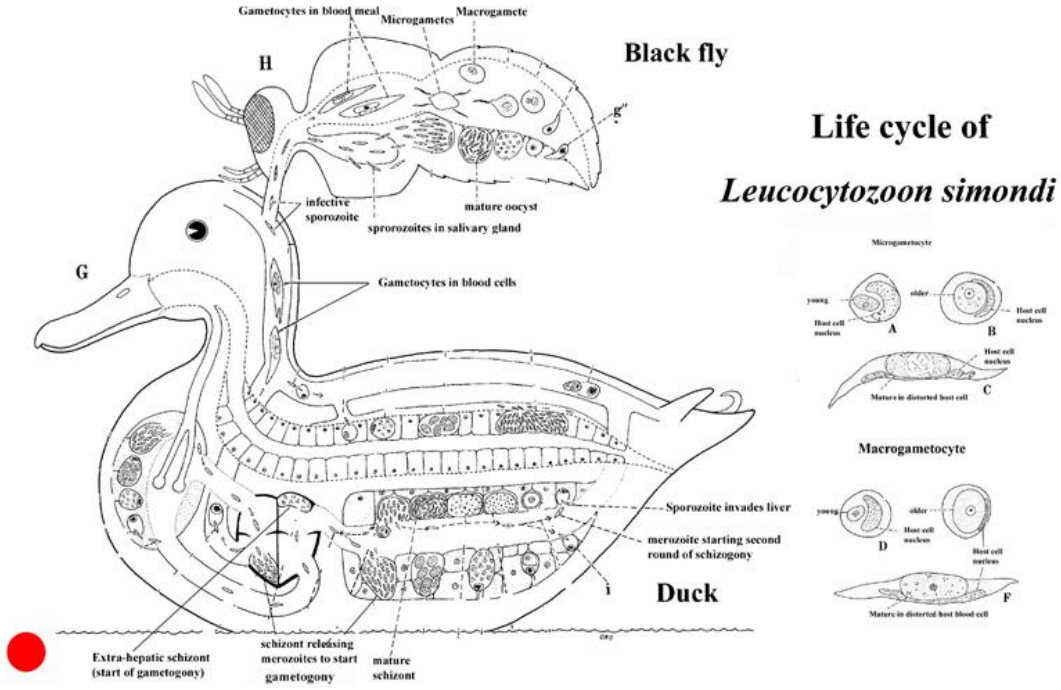
-**Sporozoites** are injected into the bird when the fly feeds.
-**Sporozoites** enter hepatocytes and develop into small schizonts.
-**Schizonts** produce merozoites in 4-6 days.
-**Merozoites** enter erythrocytes or macrophages.
-In the erythrocyte the merozoites develop into round **gametocytes**.
-In the macrophages the merozoites develop into **megaloschizonts**.
-Megaloschizonts divide into **primary cytomeres** which multiply into smaller cytomeres and finally multiply by schizogony into **merozoites.**
-Merozoites at this stage will penetrate leukocytes or developing erythrocytes to become elongated **gametocytes**.
-At this point a non infected fly will feed on an infected bird and ingest the elongated gametocytes.

-The elongated gametocytes become a **macrogametocyte** (female) and a **microgametocyte** (male).

-The macrogametocyte and microgametocyte form an **ookinete**.

-The ookinete penetrates an intestinal cell of the black fly and matures into an **oocyst.**

-The oocyst produces **sporozoites** that leave and migrate to the salivary glands of the black fly, thus starting the life cycle over again.




## Pathology

The typical pathology of infection with these parasites includes anaemia and enlargement of the liver and spleen. Gross lesions also include pulmonary congestion and pericardial effusion.

Megaloschizonts appear as grey-white nodules found in the heart, liver, lung or spleen. Microscopically there is ischemic necrosis and associated inflammation in the heart, brain, spleen and liver due to occlusion of blood vessels by megaloschizonts in endothelial cells. Ruptured schizonts may induce granulomatous reactions in the surrounding tissues.

Clinically the majority of birds affected with leucocytozoonosis exhibit no signs. Among those that do the signs include mild to severe signs of anorexia, ataxia, weakness, anemia, emaciation and difficulty breathing.

The excess mortality due to *Leucocytozoon* in adult birds seems to occur as a result of debilitation and increased susceptibility to secondary infection.

**Clinical signs**

- Anemia
- Luekocytosis
- non-pigmented gametocytes in the blood cells

**Physical signs**

- Thin blood causing tissues to appear pale
- Both hepatomegaly and splenomegaly are present

**Diagnostic criteria**

Form gamonts in white blood cells and/or erythrocytes. Gametocytes cause marked enlargement and distortion of the infected cell producing a football-like appearance.

No merogony occurs in either leucocytes or erythrocytes.

Merogony occurs in the parenchyma of liver, heart, kidney, or other organs. Meronts may form large bodies divided into cytomeres.

Hemozoin deposits (pigment) are not formed - a useful distinguishing feature for *Leucocytozoon* from *Haemoproteus* and *Plasmodium*.

Oocysts develop rapidly in 3 – 5 days. The oocysts are small and nonexpanding, reaching 13 micrometres in diameter and typically have less than 100 short, thick sporozoites.

**Treatment**

Unfortunately no efficient treatments exist for Leucocytozoonosis. Quinine may be useful in early stages, before gametocytes appear