

Plasmodiidae

Plasmodiidae

- Macro and microgametes develop separately from each other.
- Zygote is active.
- Schizogony stage occurs in vertebrate hosts, while sporogony stage occurs in invertebrate hosts (vector).
- They form pigments in the host cells.
 - *Plasmodium*
 - *Haemoproteus*
 - *Leucocytozoon*

Plasmodium

- They develop as heteroxene.
 - Vector: Mosquitoes species belonging to *Anopheles*, *Aedes*, *Culex* genus of *Culicidae* family
 - In mammals- *Anopheles* females
 - In birds - *Culex*, *Aedes* females
 - Syngamy and sporogony occur in the vectors.
 - Vertebrate hosts: Humans, mammals, reptiles and birds.
 - Schizogony stage occurs in erythrocytes and endothelial cells of internal organs of the vertebrates,
 - While gametogony occurs in erythrocytes.

Plasmodium

- The species belonging to *Plasmodium* genus cause “malaria” disease.
- This disease is highly important in humans and similar symptoms are seen in birds.
- The disease caused by these species in monkeys and rodents is also called as “ague”.
- Malaria is common in tropic and sub-tropic regions.
- *P. vivax* is seen in Mediterranean and East Anatolia region of Turkey.

Plasmodium species

Human	Monkey	Birds
<i>P. falciparum</i> Malignant tertian malaria	<i>P. knowlesi</i>	<i>P. gallinaceum</i> <i>P. cathemerium</i>
<i>P. vivax</i> Benign tertian malaria	<i>P. cynomolgi</i>	<i>P. relictum</i> <i>P. juxtannucleare</i>
<i>P. malaria</i> Quartan malaria	<i>P. simium</i>	<i>P. circumflexum</i> <i>P. durae</i>
<i>P. ovale</i> Ovale tertian malaria	<i>P. coetreyi</i>	<i>P. elongatum</i> <i>P. fallax</i>

In rodents: *P. berghei*

- Example of life cycle, *P. vivax*

- In vertebrates: An infected female Anopheles injects the sporozoites to humans during blood feeding.
 - **Exo-erythrocytic schizogony:** The protozoa firstly enter to parenchymal cells of liver and form the schizonts. And later, merozoites are formed in the mature schizonts. They break down the parenchymal cell and some of these merozoites enter to new parenchymal cell (second generation merozoite), while the others enter to the erythrocytes.

These schizogony continue as long as the endurance of human. However, there is only an exo-erythrocytic period in *P. falciparum*.

- Erythrocytic stage: Some of the merozoites pass to blood and enter erythrocytes. They form forms that vary according to the species (ring form in *P. vivax*.)
- developments continue in the following ways; young trophozoite, mature trophozoite, young schizont, mature schizont.
- The gametocytes are formed from mature schizonts. Macro and micro gametocytes occur.
- When the merozoites go to blood plasma, the hemozoin (metabolic residue) is poured into the plasma and the symptoms are seen at this stage. (the parasites feed with globin of erythrocytic hemoglobin and the hemozoin pigment remains)

In the vector: *Anopheles* mosquitoes take the infected erythrocytes during blood feeding. The erythrocytes are digested and micro- and macrogametes are released.

- In intestine of the vector, the microgamete fertilizes the macrogamete and the zygote is formed. This zygote (OOKINET) is active and located under the stomach serosa.
- The sporozoites formed as a result of sporogony break down the serosa and pass to salivary glands of the vector by means of hemolymph.

Plasmodium

- In vertebrate host
 - Merogony (Schzogony):
 - In internal organs (liver)= exo-erythrocytic merogony,
 - In erythrocytes= erythrocytic merogony
 - Gametogony:
 - In erythrocytes = Macro and microgamets

- In vector (Culicidae)
 - Syngamy
 - The formation of active ookinet (whipped) in the intestinal lumen.
 - Sporogony
 - The formation of sporozoites under the intestinal serosa.
 - The sporozoites pass to the salivary glands by hemolymph.

Symptoms

- Malaria attacks
 - The chill stage
 - Extreme feeling of chill
 - Tremors and contraction
 - 15-60 minutes
 - The fever stage
 - Very high fever
 - Headache
 - 2-6 hours
 - Sweating stage
 - Excessive sweating
 - Decrease of fever
 - Excessive fatigue
 - 2-4 hours

Plasmodium

Pathogenesis

- Hemolytic anemia
- Icterus
- Hepatomegaly
- Lymphadenopathy
- CNS disorders
- Brain edema
- Kidney and liver problems

■ Diagnosis

- Peripheral blood smear
 - The observation of
 - trophozoites
 - schizonts
 - macro- and microgametes
- Molecular diagnosis (PCR)
- Serology (ELISA, dipstick)

■ Treatment

- Chloroquine, Quinine, Atebrin, Primaquine

■ Prevention

- Human-vector contact
 - Repellent usage
 - Mosquito net
- Reduction of vector capacity
 - Environmental regulation
 - Insecticide/Larvacide
 - Biological control

Genus: *Haemoproteus*

- They are seen in birds and reptiles.
 - Schizogony stage occurs in the endothelial cells of internal organs (especially in lungs).
 - Gamonts locate in the erythrocytes. Halter-shaped gametocytes surround nucleus of the erythrocyte. They do not allow the growth of host cells and form pigment granules.
- Vectors are *Lynchnia*, *Pseudolynchnia*, *Microlynchnia* and *Culicoides* species.

Haemoproteus columbae

- This species are seen in pigeons, doves and other wild birds.
 - The gamonts are found as long- and sausage shaped inside of the erythrocytes. This parasite partially surrounds the nucleus of the erythrocytes and partially changes the place of the nucleus. They form brown pigment granules and don't allow the growth of host cell.
- The vectors of *H. columbae* are *Pseudolynchia canariensis*, *P. bronnea*, *Lynchia lividicolor*, *L. capensis* and *Microlynchia fusilla*.
- This disease is seen in all of the world. It has also been reported from Turkey.

■ *Haemoproteus sacharovi*

- It is found in pigeons and doves.
- The vector is *Pseudolynchia canariensis*.
- This parasite is common in North America and Europe and it has also been reported from Turkey.

■ *Haemoproteus nettionis*

- It is found in ducks, geese and various birds.
- The vector is *Culicoides piliferus*
- This parasite is common in all of the world.

- *Haemoproteus meleagridis*
 - It is found in turkeys.
 - The vector is *Culicoides* spp.
 - It is common in America.
- *Haemoproteus iophortyx*
 - It is found in quails.
 - The vector is *Lynchia hirsuta*

Genus: *Leucocytozoon*

- The species belonging to this genus cause the infection in birds.
- Schizogony occurs in parenchymal and endothelial cells (megaloschizont) of liver, heart, kidney and other organs.

Genus: *Leucocytozoon*

- Gametogonic stage undergoes in lymphocytes, monocytes and erythrocytes.
- The pigment granules are not formed.
- Vectors are Simuliidae and *Culicoides* spp.
- Sporogony occurs in the vector.

Leucocytozoon simondi

- This parasite is found in ducks, geese and various birds.
- Gametocytes prolong in lymphocytes and monocytes, and have a rounded shape in erythrocytes.
- It is common in North America, Europe, Indochina, Vietnam, Canada and other mountainous regions.
- Vectors are *Simulium* spp.
- Mortality and morbidity are high in young birds.
- They cause anemia, leukocytosis, splenomegaly, and hepatic degeneration and hypertrophy.

Leucocytozoon smithi

- This parasite is found in turkeys.
- The gametocytes locate only in the leucocytes.
- This disease is seen in America, France, Germany, Crimean, Canada, Africa, Europe, and Pacific Coasts.
- It is highly pathogenic in turkey poults.
- Death occurs because the circulatory system is blocked by multiple parasites.
- Anemia and leukocytosis are seen.

Leucocytozoon caulleryi

- This parasite is found in chickens.
- The gametocytes locate in the leucocytes and erythrocytes.
- Mature gametocytes in erythrocytes are rounded.
- It is common in South and East Asia, Far East, Indochina, Malaysia, Burma, India, Sumatra, North America and Northern Carolina.
- It is transmitted by *Culicoides* spp.
- Anemia, hemorrhage, splenomegaly, hepatomegaly and white spots in the heart muscle are common clinical manifestations.

Other *Leucocytozoon* species

- *Leucocytozoon sabrazesi*
 - It is parasitized in pheasants, domestic and wild chickens.
 - It is transmitted by *Simuliidae* spp.
- *Leucocytozoon marchouxi*
 - It is parasitized in doves.
- *Leucocytozoon schoutedeni*
 - It is very common in Africa.