

MALARIAL PARASITES

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Abstract

Malaria is a mosquito-borne disease that is caused by a parasite that grows in human blood after the human has been bitten by a female Anopheles mosquito. Malaria parasites reproduce inside human red blood cells. Malaria symptoms from Plasmodium infections include fever, chills, and other flu-like symptoms, and can lead to death.

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Introduction

The species of Plasmodium that infect humans and animals are distinct. Reptiles, birds, and non-human mammals can be infected by over 100 different species of Plasmodium (P).(1) The 4 species of malaria parasites that infect humans are: (1,2)

- 1.P vivax (tertian malaria)
- 2.P falciparum (malignant tertian malaria)
- 3.P malariae (quartan malaria)
- 4.P ovale

P vivax and P falciparum cause the most infections worldwide.(1)

P vivax has the widest geographical range because it can survive at lower temperatures, and is prevalent in temperate and tropical and subtropical areas.(2) P falciparum is the most lethal strain, causing the deaths of an estimated 0.7 to 2.7 million humans each year, most of them young children in Africa; it is the most prevalent species throughout the tropics and subtropics.(1,2)

P malariae is patchily present over the same range as P falciparum, while P ovale is found only in tropical Africa, and occasionally in Asia and the western Pacific.(2)

P vivax and P ovale have dormant liver stage parasites, which can reactivate and cause malaria months or years after the infecting mosquito bite.(1) P malariae produces long-lasting infections and, if left untreated, can persist asymptotically in a human host for years.

LIFE CYCLE OF MALARIA PARASITES

The Plasmodium parasites that cause malaria have

complex life cycles has 2 hosts; humans and female Anopheles mosquitoes, Figure 1.(1) Plasmodium, like all parasites, must feed on other organisms to survive.(3) In humans, the malaria parasites grow and multiply first in the liver cells and then in the red blood cells. Successive broods of parasites grow inside the red blood cells and destroy them, releasing daughter parasites that continue the cycle by invading other red blood cells.(1) The blood stage parasites cause the symptoms of malaria.(1) When some forms of blood stage parasites are picked up by a female Anopheles mosquito during a blood meal, they start another, different cycle of growth and multiplication in the mosquito. After 10 to 18 days, the parasites are detected in the mosquito's salivary glands.(1) When the Anopheles mosquito takes a blood meal on another human, the parasites are injected with the mosquito's saliva and start another human infection when they parasitize the liver cells.

Thus the mosquito carries the disease from one human to another.(1) Unlike the human host, the mosquito is not adversely affected by the presence of the parasites.

HUMAN HOSTS

After being infected with malaria parasites, human hosts can develop symptoms, ranging from fever, chills, sweating, headaches, and muscle pains, to severe complications, including cerebral malaria, anemia, or kidney failure.(1) The immune and genetic background of the human host affect the severity of the symptoms, as does the species of the infecting parasite.

ANOPHELES MOSQUITOES

Human malaria is transmitted only by female Anopheles mosquitoes, which need a supply of blood before laying their eggs.(1,3) The link between the human and the mosquito hosts in the parasite life cycle occurs when female mosquitoes take blood meals.(1,2) Of the approximately 400 known species of Anopheles mosquitoes worldwide, only 30 to 50 transmit malaria.(1) Growth and replication of the malaria parasite in the mosquito depends on ambient temperature and humidity as well as whether or not the Anopheles mosquito survives long enough for the mosquito host cycle to complete (10 to 18 days).

FROM MOSQUITO HOST TO HUMAN HOST

Human malaria begins when a female Anopheles

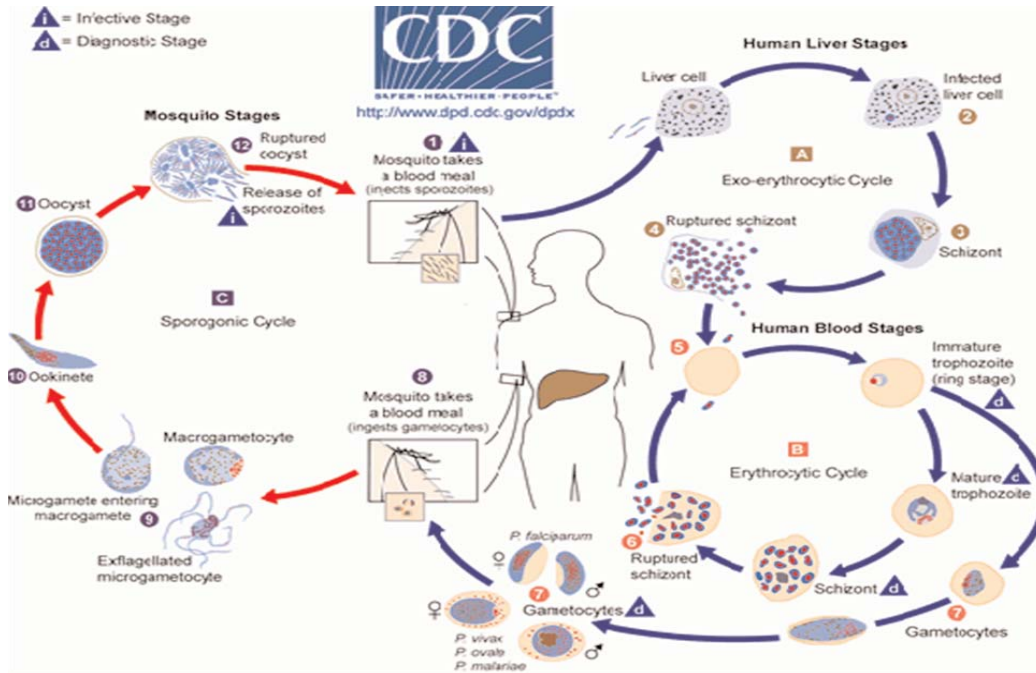


Figure 1. Schema of the life cycle of malaria from Centers of Disease Control. (1)

mosquito injects malaria acquired from a previous human blood meal into a new human host. (2) While probing for a capillary, the infected mosquito injects the sporozoite form of the malaria parasite from her salivary glands. A single sporozoite can infect a human with malaria.

Shortly after entering the human bloodstream, sporozoites navigate through the bloodstream to the liver. (2) Over the next 5 to 25 days, the sporozoites reproduce asexually, generating 10,000 to 30,000 descendants, which are contained within a structure called a liver schizont. During this time, the human host is asymptomatic.

Eventually, the liver schizont ruptures and parasites rush out of the liver. The parasites invade the red blood cells in the bloodstream. There, they consume hemoglobin and transform from delicate rings to larger ameboid forms called trophozoites and then to a blood schizont stage containing 8 to 24 daughter parasites.

Mature blood schizonts of *P. falciparum* sequester deep within the venous microvasculature where they are difficult to detect on routine blood smears. (2) This is the core pathological process in severe *P. falciparum* malaria. When the blood schizont eventually ruptures, a new generation of parasites is released into the bloodstream of the human host. Each parasite then enters a new red blood cell and continues the cycle of bloodstream infections.

When parasites are released from the blood schizonts, recurring attacks of fever, sweats, and chills are triggered. (2) The frequency of these attacks is a reflection of the time needed for a single cycle of growth inside a red blood cell and development, which occurs every 48 hours for *P. vivax* and every

72 hours for *P. malariae*. For *P. falciparum*, which also has a 48-hour growth cycle, rupture of blood schizonts occurs in waves and the cycle of fever, sweats, and chills is less predictable. With each cycle of replication, the number of parasites increases significantly. For example, in *P. falciparum* infection, the total body parasite load increases approximately 8- to 10-fold every 48 hours.

Some of the malaria parasites contained within human red blood cells develop into male and female sexual forms of the parasite gametocytes. (2) Although gametocytes do not multiply in the human host, they do replicate the malaria parasites in the mosquito host. After being withdrawn from the blood of an infected human host by a female *Anopheles* mosquito, male and female gametocytes produce a mature, fertilized oocyst in the mosquito in approximately 7 to 10 days. Then the sporozoites are released and they penetrate many sites in the mosquito, including the salivary glands. If the mosquito lives long enough to feed again, she injects sporozoites from her salivary glands into a new human host during her next blood meal, thus completing the *Plasmodium* life cycle.

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