Malaria

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Means of Transmission: Malaria is transmitted through the bite of an infected female *Anopheles* mosquito. It can also be transmitted through blood transfusions, organ transplants, use of contaminated needles or syringes, or from mother to unborn child. (1)

Etiological Agents: The etiological agents of malaria that cause infection in humans are four parasites: *Plasmodium falciparum, Plasmodium vivax, Plasmodium ovale,* and *Plasmodium malariae*. The strain of malaria caused by *P. falciparum* has the potential to cause severe illness and possibly death. (1,2)

Reservoirs: Humans are the most common reservoir for malaria, although some species of *Plasmodium* can infect animals such as macaques, chimpanzees, and some species of lizards and rodents. (2,7)

General Characteristics: *Plasmodia* are unicellular protozoan parasites belonging to the phylum *Apicomplexa*. (6) *P. falciparum* is most prevalent on the African continent, and *P. vivax* is most common outside of Africa. (2)

Signs and Symptoms of Infection: Signs and symptoms of a malarial infection appear 10 to 15 days after an infective bite. They include fever, chills, headache, and vomiting. Signs and symptoms of a severe malarial infection include severe anemia and respiratory distress. (2)

Microbial Mechanism:

The life cycle of the *Plasmodium* parasite is a complex one. It consists of four stages:

Stage one takes place in the human body. It begins when an infected mosquito bites a human and injects its saliva which contains sporozoites into the blood stream. (4,7)

Stage two also takes place in the human body. Within an hour after the initial bite, the sporozoites move through the blood stream to the liver. The sporozoites then enter liver cells and begin dividing, creating schizonts in 6 to 7 days. These schizonts each give birth to thousands of merozoites, which are released into the blood stream. (4,7)

In stage three there are two separate paths that can be taken:

The first is called the erythrocytic cycle, which is responsible for the clinical manifestations of the disease. In this cycle, the merozoites enter the red blood cells and mature into trophozoites, which then further mature into schizonts. These schizonts rupture and release merozoites, and the cycle repeats. (4)

In the second path, after the trophozoite has matured to a schizont, they separate into male and female gametocytes. (4)

In the final stage, a mosquito takes a blood meal from a host whose blood contains mature gametocytes. In the mosquito, the male and female gametocytes merge to form a zygote, which matures into an oocyst. The oocyst ruptures and releases thousands of sporozoites, which travel to the mosquito’s salivary glands. (4)
Key Tests for Identification: A malarial infection can be identified through several methods including microscopic techniques, serology, and rapid diagnostic tests.

Using microscopy, a blood specimen from the patient is spread and stained with a Giemsa stain. It is then examined under oil immersion at 100x and *Plasmodium* parasites are identified. (3,5)

Using serology, a malarial infection is diagnosed by identifying malaria antibodies in the blood. This is done by performing an Indirect Fluorescent Antibody Test. To perform this test, the serum of a patient is taken and exposed to *Plasmodium* schizonts, which act as an antigen. If antibodies are present in the blood, they will form a complex with the antigen. Fluorescently labeled anti-human antibody, which is meant to attach to the human malaria antibody, is added to the mixture. When the slide is observed under a fluorescence microscope, visible fluorescence indicates the presence of antibodies, which indicates a malarial infection. No fluorescence indicates that no antibodies are present, which indicates that no *Plasmodium* parasites are present in the blood. (3)

Using a rapid diagnostic test, a sample of blood from the patient is applied to a pad on a test card that contains specific reagents. Blood that contains *Plasmodium* is applied to a second test card, which is used as a positive control. After allowing the test card to develop for 15 minutes, it is then examined for the presence of certain bands. If the specific bands are present, then that serves as an indication that the patient has a malarial infection. (3)
**Historical Information:** Historical evidence shows that malaria has been plaguing human beings for thousands of years. It has been mentioned in ancient Greek writings such as *The Iliad*, ancient Chinese medical writings, and has had its antigens detected in ancient Egyptian remains.

Malaria, whose name is inspired by the Italian word *mal'aria* which translates to ‘bad air’(6,8), arrived in Europe through Rome during the first century AD. Historians believe that malaria travelled from the Nile River into the Mediterranean Sea, and from there was spread by traders, colonists, and soldiers. For thousands of years, Europeans that lived in crowded communities near stagnant water were frequently exposed to malaria. Many historians believe that the abundance of malaria caused by *Plasmodium falciparium* in Rome contributed to the fall of the city. (8)

In 1880 while on post in Algeria, French army doctor Charles Louis Alphonse Laveran microscopically examined blood specimens from 192 malaria patients. In most of them, he observed pigment-containing crescents that took one of four different forms. After more investigation, these were found to be the parasite that causes malaria in different stages within its life cycle. In 1907, Laveran received the Nobel Prize in Physiology or Medicine for his discovery. (8)

**Current Cases and Outbreaks:** Between 1957 and 2015, 63 outbreaks of malaria have occurred in the United States. About 1,500 to 2,000 cases are reported each year in the U.S. (9)

Worldwide, 3.2 billion people live in an area where malaria is prevalent. In 2015, there were 214 million cases of malaria and 438,000 deaths caused by it (9). Also in 2015, 91 countries and areas had ongoing malaria transmission. (2)

In 2015, Sub-Saharan Africa accounted for 90% of malaria cases and 92% of malaria deaths. (2)

**Prevention and Control:** The best way to prevent contracting malaria is to protect yourself from mosquitoes. This can be done using a number of methods:

Sleeping under an insecticide treated mosquito net and using an indoor insecticide spray are both good ways to reduce malaria transmission. (2)

For people travelling to areas with a high incidence rate of malarial infection, chemoprophylactic drugs can be used to protect oneself from infection. (2)

Other preventative measures include wearing long pants and long-sleeved shirts when going outdoors, using an insect repellent containing DEET, staying in a screened area or an air conditioned area when it is dark outside, and avoiding areas with standing water.

**Treatment:** Treatment of malaria depends on several factors including the species of *Plasmodium* that is causing infection, any co-existing conditions, drug allergies, and pregnancy. Drugs that are used to combat malaria include chloroquine, quinine, and mefloquine. Antibiotics such as doxycycline and clindamycin can be used in combination with quinine. (10)

A major issue that affects the treatment of malaria is drug resistance. Due to the heavy use of certain antimalarial drugs such as chloroquine, cases of malaria diagnosed in the United States are evaluated for drug resistance prior to constructing a treatment plan. (3)

Currently, there are no licensed vaccines for malaria, but there is a research vaccine that combats *P. falciparum* named RTS, S/AS01. In 2015, the vaccine underwent clinical trials in seven African countries
and received favorable reviews from the European Medicines Agency. It will be introduced in a pilot project into three Sub-Saharan African countries in 2018. (2)

Sources:


