Biological Times

Volume No. 3 | Issue No. 10 | Pages 45-46

Human malarial parasite plasmodium: An overview

Nabeela Jabeen[1], Fariha Munir[2], Fizza Riaz[3], Noor ul ain Arshad[4] and Saleha Tahir[5]*

1. Faculty of Pharmaceutical Sciences, Pharmacognosy Department, Lahore University of Biologicals and Applied Sciences
2. Faculty of Sciences, Medicine and Health, University of Wollongong, Australia
3. Department of Biotechnology, The University of Faisalabad, Pakistan
4. Department of Pathology, The University of Faisalabad, Pakistan
5. Institute of Microbiology, University of Agriculture Faisalabad, Pakistan

*Corresponding Author: **salehatahir999@gmail.com**

ABSTRACT

The Plasmodium spp. parasite causes malaria that infects vertebrates and is spread via female Anopheles mosquito bites. The Plasmodium species leading to malaria in humans are not monophyletic; they have common ancestors with parasites that infect nonhuman primates. Every year, there are 300–500 million cases of malaria worldwide. *Plasmodium falciparum* is mostly responsible for the 1.5 - 2.3 million deaths due to malaria that occur each year. Coordinated regulation of gene expression is necessary for Plasmodium falciparum's complex life cycle in order to facilitate host cell invasion, transmission, and immune evasion. A potential strategy to stop transmission would involve using a mix of long-acting Gametocidal and fast-acting schizontocidal medications. Research is still being done to develop better diagnostic techniques, create therapies that work, and put in place long-term programs to manage and eradicate malaria. In this study, we review *P. falciparum* transmission by discussing gametocyte targetable features and offering a prediction on a forward-genetic method for future identification of novel candidates that block transmission.

Keywords: Plasmodium falciparum, Malaria, Human parasite, Gametocyte

To cite this article: Jahan N, F Munir, F Riaz, N Arshad & S Tahir. Human malarial parasite plasmodium: An overview. Biological Times. 2024 October 3(10): 45-46.

Introduction

Malaria is referred to by the Italian word "mal'aria," which means "bad air," to indicate the association between the disease and marshes. Parasitic infections can lead to a variety of health issues in both humans and animals, from minor discomfort to serious disease and even death [1]. The parasite protozoan genus Plasmodium belonging to the phylum Apicomplexa is responsible for malaria, a serious illness with worldwide health consequences. Plasmodium is a parasite that affects mammals, birds, and reptiles. It has over 200 kinds. The parasites usually have unique qualities to their host. Five species of the Plasmodium cause malaria: *P. malariae P. vivax*, *P. falciparum*, *P.ovale*, and *P. knowlesi* [2]. Most lethal of which is *P. falciparum*. Through the bites of infected female Anopheles mosquitoes these organisms are transmitted to humans. Plasmodium enter red blood cells after entering the human host and cause a variety of signs, including chills, fever, fatigue, and sometimes organ failure and death. In tropical and subtropical areas malaria continues to be a major public health issue. A mix of vector control methods, early diagnosis, and efficient treatment approaches are used to combat malaria; nonetheless, issues including drug resistance and mosquito resistance to insecticides continue to impede efforts to eradicate the disease [3]. In 2019, there were approximately 14 million cases and 69,000 fatalities from malaria; however, according to World Health Organization's current International Malaria Report, 241 million cases were reported, and 627,000 deaths were associated with the disease in 2020. Approximately two-thirds of the COVID-19 pandemic's increase in mortality was brought on by mistakes in malaria diagnosis, treatment, and control [4].

Life Cycle of Plasmodium

The life cycle of Plasmodium is complex and involves both mosquitoes and human hosts. The various morphologically diverse stages of the Plasmodium life cycle define its characteristics shown in Fig 1.

Sporozoite Stage

It begins when an infected female Anopheles mosquito bites a human. When *P. falciparum* shifts from mosquito to human host and from liver to blood stage, coordinated control of gene expression is essential. This ensures the parasite's capacity to adjust, endure, and effectively move through every phase of its complex life cycle. If the human host is infected with the parasite the mosquito will eat the gametocytes along with the blood Upon entering the mosquito's midgut, the male and female gametocytes undergo sexual reproduction to form zygotes. Male microgamete and female macrogamete must fuse with each other in order to complete this process [5]. The mosquito's outermost stomach lining becomes home to oocysts after the zygotes develop into motile ookinetes that pass through the midgut wall. Inside the oocysts, thousands of sporozoites are produced by multiple rounds of mitotic division. The infection process is started when haploid sporozoites are introduced into the dermis of animals during a mosquito blood meal [6].

Erythrocytic Stage

When these sporozoites arrive in the liver, they infect hepatocytes and undergo an exoerythrocytic stage of growth. The erythrocytic stage of infection is initiated when the parasites mature and release their merozoites into the bloodstream, where they penetrate red blood cells [7]. The merozoites attach themselves to specific receptors on the surface of red blood cells (RBCs) after penetrating their membrane. Through a process called schizogony, the merozoites develop into trophozoites inside the RBCs, where they proliferate and spread asexually. This leads to the formation of a schizont with many daughter merozoites. After it is fully designed infected red blood cell burst and discharge extra merozoites into the bloodstream. These merozoites invading RBCs to repeating the cycle. Gametocytes are produced when some merozoites undergo sexual develop and subsequently released into the bloodstream [8].

Mosquito Stage

Gametocytes complete their life cycle sexual reproduction in mosquito's stomach if it bites another infected person and consume them during a blood meal. Plasmodium spread and infect humans with malaria because of its complicated life cycle, which substitutes between humans and mosquitoes. In order to effectively manage malaria and designing interventions and control measures it is essential to comprehend the many stages of the life cycle.

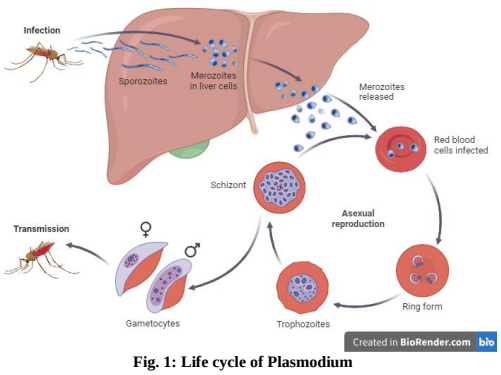

Fig. 1: Life cycle of Plasmodium

Transmission of Malaria

Through the bite of an infected female Anopheles mosquito that malaria is spread. These mosquitoes become infected by feeding of the blood of

individual who possesses mature plasmodium gametocytes [9]. After entering, gametocytes reproduce sexually to become sporozoites, then move in to the salivary glands.

Types of Malarial Parasites

There are four Plasmodium species that infect humans are:

1. *P. Falciparum*

Worldwide this species is the most dominant and fatal cause of malaria, but mostly in Sub-Saharan Africa. It is linked with major serious effects, such as severe anemia, multi-organ failure and cerebral malaria. To eradicate and manage malaria multimodal method is essential, including early diagnosis, vector control, and rapid treatment, as well as research into new strategies to fight drug resistance and reduce the prevalence of malaria worldwide.

2. *P. Vivax*

In Asia, South America, and even parts of Africa huge populations of *P. vivax* can be found. Months or years after the initial infection, recurrent episodes of malaria can occur due to its capacity to produce hypnozoites, or dormant liver stages [10]. Use of indoor residual spraying (IRS) of pesticides, insecticide-treated bed nets (ITNs), chemoprophylaxis, and community-based initiatives are the preventive measures for infection.

3. *P. Malariae*

P. malariae is a persistent form of malaria with less severe symptoms. It can live inside a individual host for decades, having a relatively inadequate range. *P. malariae* cause severe complications like the kidney-damaging nephrotic syndrome and anemia if infections are not treated [11]. Usually, infections are diagnosed by identifying the parasite in blood tests.

4. *P. Ovale*

P. ovale has the ability to induce recurrent and malaria dormant liver stages. It increases the load of malaria in some areas and also it is less general than *P. vivax.* Usually, infections are diagnosed by identifying the parasite in blood tests [12]. Antimalarial medicines, are commonly employed in therapy including chloroquine or artemisinin-based combination therapies (ACTs). however, the choice of a treatment may differ based on geographic areas and trends in resistance to drug.

Treatment of Malaria

Symptoms of malaria include fever, headaches, chills fatigue, vomiting, and muscle aches. If treatment is delayed, malaria can cause severe life-threatening symptoms such as respiratory distress, cerebral malaria, renal failure, and severe anemia. Malaria is diagnosed by in blood smears. Rapid diagnostic tests (RDTs) that detect specific antigens are also commonly used to diagnose malaria [13]. The treatment for malaria depends on the form of severity of the disease and plasmodium infection. Malarial treatment involves the use of antimalarial medications, such as artemisinin-based combination treatments (ACTs). Malarial treatment strategies involve not only antibiotics but also vector control methods such as indoor residual spraying, insecticide-treated bed nets and environmental management to lessen mosquito breeding grounds [14].

Conclusion

Malaria caused by plasmodium parasites, illness that remains to seriously impair humans health. The multimodal strategy required to battle malaria must consider the parasite and its vector, the mosquito, as well as the social and environmental elements that affect transmission. The World Health Organisation (WHO) is responsible for a global malaria control plan that focuses on improving basic healthcare locally, early disease identification, timely treatment, and disease prevention. Malaria appears to be declining in prevalence compared to around a decade ago. Projects currently in progress include developing new drugs and vaccines, improving methods for preventing malaria, and understanding the biology of Plasmodium parasites. Important areas of research include the development of next-generation antimalarial drugs, the study of parasite genomes and drug resistance mechanisms, and the evaluation of novel vector control technologies.

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