

## 蚊子與感染症

### Mosquitoes and infectious diseases

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Mosquitoes are able to transmit human infectious diseases resulting in millions of deaths annually. The microbes that may be carried and transmitted by mosquitos to human include protozoa (e.g., *Plasmodium* in malaria), helminthes (e.g., Filarioidea in filariasis) and viruses. The majority of mosquito-borne infections occur developing countries of tropical and subtropical regions, but developed countries are also threatened by such diseases due to increasing international travel and migration. To increase spreading, microbes are able to change their host range to include human. In the case of arboviruses, humans are usually “dead-end hosts” not capable to function as a reservoir for reinfection of mosquitos, but instead infection leads to clinical diseases that may be debilitating or even fatal. Among the mosquito-borne disease, the ancient malaria is still a major threat to human health. There had once been more than one million deaths and 300 - 500 million cases reported worldwide annually. In the recent decade, both the global incidence and mortality of malaria have declined significantly, with a 37% reduction in global incidence and a 60% reduction in mortality rates between 2000 to 2015 reported by World Health Organisation (WHO). On the other hand, mosquito-transmitted viral infections emerged to endanger people’s health. In the past three decades, the incidence of Dengue fever has risen 30-fold, with more and more countries reporting new outbreaks. Other viral infections with the same vector *Aedes aegypti* mosquito (which is present in the living areas of more than half of the world’s population) include yellow fever, chikungunya fever, and Zika virus disease. In recent years there has been a steep rise in Zika transmission in the Americas and since 2015, 62 countries and territories reported mosquito-transmitted Zika virus.

Transmission of mosquito-mediated infection starts when a mosquito bites human skin and injects saliva and anti-coagulants, as well as infectious microorganisms. The bite of mosquitos only becomes noticed when the local host immune reaction at the biting site is induced. Mosquitoes carrying microorganisms remain healthy because of their immune recognition of virions, which renders them inactive. Microbes that infect mosquitos may also influence the vector’s behavior to facilitate disease transmission. In the case of malaria, the

female mosquito's biting frequency increases when infected by Plasmodium, thus increasing the chance of spreading the parasite. The initial transmission step of infection to host is inoculation of microorganisms into the mosquito-biting site, which is an important and common stage of all mosquito-mediated infections. In the case of arbovirus infection, inoculation of viruses from mosquito-biting is followed by viral replication in tissues, resulting in a transient but very high level of infectious virus particles in blood. The mosquito biting sites are characterized by edema and inflammation, which may be used by the microbes to facilitate infection. It has been demonstrated that an edema retain virus at the inoculation site, while an inflammatory response characterized by influx of neutrophils coordinates the local innate immune response at the biting site but at the same time inadvertently encourages entry of virus to permissive immune cells (such as myeloid cells). Such responses result in a high viral titer at the biting site and then in the blood of the host. Different from the mosquito vector that remains healthy despite microbe's infection, the high titer viremia in hosts frequently accompanies febrile illnesses and other debilitating symptoms, such as headache, myalgia and arthralgia. The clinical importance of the initial step is reflected by the observation that a high initial burden of peripheral virus usually correlated with severity and mortality of the disease. To control mosquito mediated infectious diseases, in recent years substantial progress has been made in developing alternative strategies other than insecticides, such as genetic modification of wild insect populations. However, there are still challenges in obtaining regulatory approval and community acceptance.