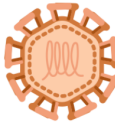
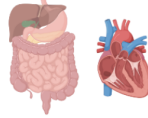
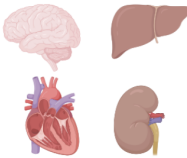
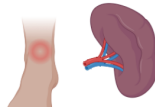


The Antimicrobial Heroes Gallery

Tiny soldiers: how microbes can help us to fight diseases transmitted by blood-feeding insects?

(Lilibeth Torres-Elizalde and Olaya Rendueles)

Vector Borne Diseases

Disease	Chagas Disease (Trypanosomiasis)	Malaria	Zika	Lyme Disease	Leishmaniasis
Disease Causing Pathogen	 <i>Trypanosoma cruzi</i>	 <i>Plasmodium spp.</i>	 <i>Flavivirus</i>	 <i>Borrelia burgdorferi</i>	 <i>Leishmania spp.</i>
Vector Organism	 Kissing Bug (Triatomine)	 Mosquito (<i>Anopheles</i>)	 Mosquito (<i>Aedes aegypti</i>)	 Deer ticks (<i>Ixodes scapularis</i>)	 Sandflies (<i>Phlebotomus</i> , <i>Lutzomyia</i>)
Affected Human Organs or Systems					

This figure provides a graphical representation of the most prevalent vector-borne diseases (VBDs) worldwide. It describes the pathogenic agents, their vectors, and the human organs or systems impacted by various VBDs. The figure was created using BioRender.com, specifically employing the “Zoonotic Diseases Table” template. Comprehensive information regarding the VBDs was acquired from www.nature.com/articles/s41579-023-00901-6

Vector-borne diseases

Infectious diseases such as malaria, dengue fever, and Chagas disease affect millions of people worldwide, especially in tropical countries. They are known as vector-borne diseases (VBDs) because they are transmitted by blood-feeding insects, such as mosquitoes, ticks, and flies. Combating VBDs can be challenging, but we have an important ally in nature: *microbes*. Microbes are tiny organisms characterized by their microscopic sizes, such as bacteria and archaea. They not only share our environment but also thrive within many insects around us!

To understand how microbes can help us, it is important to know how VBDs work. This is a three-way party which requires (i) a pathogen (such as a virus, bacterium, or parasite) that infects (ii) a vector (such as a mosquito) and is then transmitted to (iii) another host (such as humans or animals) through the blood-feeding process of the insect. The remarkable aspect is that the pathogen needs the vector for its reproduction and/or development, its so-called *life cycle*

(<https://www.britannica.com/science/parasitic-disease/Parasite-life-cycles>); however, the vector itself usually remains unaffected. We only observe the resulting disease in the final host, which is often humans. For instance, malaria originates from a parasite called *Plasmodium* that resides within *Anopheles* mosquitoes, while dengue fever is caused by a virus carried by *Aedes* mosquitoes.

Control of vectors by insecticides

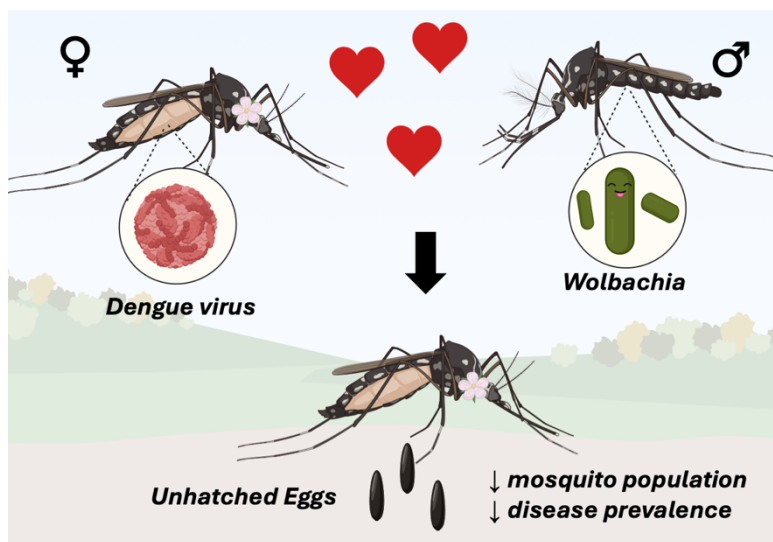
Until recently, the principal strategy for controlling these diseases involved targeting the vectors (insects) themselves, frequently using insecticides. Although these chemicals reduced the spread of some VBDs, they can pollute the environment, be toxic to humans and other organisms and, importantly, may kill non-target beneficial insects, such as pollinators. Vectors can also develop resistance to insecticides, making them more difficult to control.

The possibility of biological control of VBD transmission

Consequently, researchers are turning to the insect's own microbes for assistance. Microbes exist in and around us, as well as within the disease-carrying insects. Within the vectors, these microbes often play significant roles in health, aiding in blood meal digestion, vector development, and combating infections. Some even inhibit the growth of pathogens within vectors, for example through interrupting a key life cycle stage, suggesting that such microbes might be helpful in interrupting the transmission of vector-borne disease.

Wolba: the amazing bacterial agent of VBD transmission control

One revolutionary example involves a bacterium called *Wolbachia* (Wolba), which naturally infects about half of all insects, including some that transmit VBDs. Wolba can block viruses like Dengue, Chikungunya, and Zika from growing inside mosquitoes. Wolba also affects mosquito reproduction: if a Wolba-infected male mates with an uninfected female, her eggs will not hatch. Over time, this method helps lower mosquito numbers and disease rates. By releasing mosquitoes with Wolba into the wild, we can reduce disease transmission and, at the same time control mosquito populations.



The *Wolbachia*-mediated vector control system focuses on releasing male *Aedes* mosquitoes carrying *Wolbachia* strains. This approach helps to lower the population of wild mosquitoes, which in turn decreases the transmission of diseases. The figure was created using BioRender.com. Comprehensive information regarding the use of *Wolbachia* as a pathogen system to control disease transmission was acquired from www.nature.com/articles/s41579-023-00901-6

Other microbial approaches for control of VBDs

But efforts to develop new effective microbial strategies for VBD control continue. For instance, researchers have modified the DNA of bacteria to produce substances that directly kill the pathogen. A good example of this is found in the fight against Chagas disease, which is spread by (triatomine) bugs. In this case, researchers modified a bacterium living in the bug's gut to produce a substance that stops the parasite *Trypanosoma cruzi* from surviving.

These approaches are exciting because they target the disease by limiting the transmission and without harming other animals or the environment. Unlike insecticides, microbes can offer long-term and sustainable solutions.

*Microbes in general, and Wolba in particular,
are mighty powerful weapons we can deploy to fight insect-transmitted diseases*

However, challenges remain; we must keep studying the complex relationships between vectors and their associated microbes. Not all microbes are easy to study or utilize, and scaling up these solutions for widespread application for other diseases requires significant time and resources. Despite the challenges we face, the future looks bright! By collaborating with these tiny “soldiers” within the vectors, we are on the path to discovering better and safer tools that can help us fight VBDs and safeguard the health of millions around the world. The idea of using microbes in this way is not just creative; it beautifully highlights how science and nature can work hand-in-hand to tackle significant obstacles.