New research seeks beneficial qualities of viruses

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Left to right, this shows : Researchers Elizabeth Rowland, Samantha Dewerff, and María Bautista with Associate Professor of Microbiology Rachel Whitaker. Credit: Kathryn Coulter, provided courtesy of Institute for Genomic Biology

Viruses are responsible for much more than sore throats and stuffy noses. Researchers now believe that some viruses may protect hosts from competitors and help them survive. Despite the fact that viruses are practically everywhere and affect every living thing, scientists know very little about their positive impact on their hosts.

The National Science Foundation awarded a five-year, $2-million grant to Rachel Whitaker, a microbiologist at the Institute for Genomic Biology at the University of Illinois, and an interdisciplinary, multi-institutional team to explore the idea of viruses and their hosts coevolving together in the lab in the model system of hot springs at Yellowstone National Park.

"I hope to find that viruses are not just pathogens—that they are influencing dynamics in a bigger way," said Whitaker, who is leading the Illinois team. "Sometimes they are good for their hosts, acting as symbionts or mutualists. I think it would be really neat if there were little infectious particles that could help the organisms they infect to survive and compete against their foes."

Preliminary data has already shown that if an organism survives infection, it can use the virus to kill its competitors in the environment.

"It was once thought that viruses infect a microbe and kill it, or they don't infect at all," Whitaker said. "We have realized, given genomics and metagenomics, that it is a much more complex dynamic. Now we are asking, if hosts can use their viral infection as a weapon against their competitors, how does that affect these populations and their ecosystems? It's a new way of looking at things."

Through laboratory experiments, Whitaker's team will study host-viral interactions, including the costs and benefits of chronic (long-term) infections. Mark Young, a professor of virology at Montana State University, will study these interactions in a natural hot spring using a device developed by Sascha Hilgenfeldt, a professor in the Department of Mechanical Science and Engineering at Illinois.

Evolutionary ecologist Joshua Weitz from Georgia Tech University will use Whitaker and Young's findings to develop a theoretical and computational eco-evolutionary model of how viruses and microbes interact.

"We are figuring out the parameters that will go into the model, then using the model to project what's happening in nature, and finally going into nature to see if it works," Whitaker said. "We will also learn things about natural populations that we didn't know and that we can test in the lab then apply in our models. It will be an iterative process."

To study the natural populations systematically, a method is needed to separate the host cells from the viruses. Hilgenfeldt has developed a device that currently separates particles by size that are between two to ten micrometers in diameter. In comparison, a human hair is about 75 micrometers wide. Archaeal cells, however, are just one micrometer wide and viruses are about 10 times smaller.

Hilgenfeldt says he will have to use some "fluid-dynamical tricks" on his device to make it work for such small particles: the larger archaeal cells are captured in a tiny vortex caused by an oscillating bubble, while the smaller viruses are able to pass unhindered through the channel.

"It's a tunable size filter because the strength of the transport flow and the bubble vibration strength decide what particle size gets through and what particle size is retained," Hilgenfeldt said. "We are excited to apply this principle to the samples from hot springs to figure out how the population dynamics can change."

Through this grant, Whitaker also plans to study microbial adaptive immunity, where a host is able to recognize infectious particles (like viruses) and degrade them if they are infected again.

"This work is pretty important because there is not a very good understanding of how adaptive immunity affects the evolution of pathogens," Whitaker said. "We are hoping to apply some of the things we learn by looking at this simple adaptive immunity system and its diversity in order to understand the evolutionary impacts of diversified adaptive immunity in general."

Through a SEED project funded by the IGB, Whitaker is also using a similar approach to examine how bacterial adaptive immunity and virus infection affects population dynamics of human pathogens. "Every organism on Earth gets infected by viruses. Understanding these dynamics will have a great impact on our understanding of the microbial world."

This grant also supports various outreach and education efforts, including Project MICROBE that will develop age appropriate curriculum materials for K-12 classrooms based on current research in microbiology.

Provided by University of Illinois at Urbana-Champaign

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