Research team analyzes peptides from fish gills to engineer specialized antimicrobial surfaces

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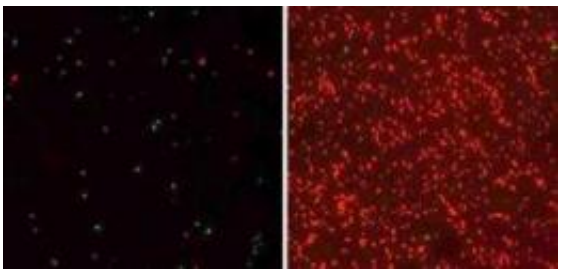

E. coli cells cultured with antimicrobial peptides (AMPs) bound to silicon crystals (the green cells are alive; the red are dead). The AMPs on the left are flat; those on the right are vertical.

(Phys.org)—Living in an environment teaming with bacteria and fungi, fish have evolved powerful defenses against waterborne pathogens, including antimicrobial peptides located in their gills. Undergraduate researchers at Worcester Polytechnic Institute (WPI) are studying the biology and the mechanics of one of those peptides with the hope they can use that knowledge to create engineered surfaces that kill bacteria responsible for foodborne illnesses and hospital-acquired infections.

The research team, led by Terri Camesano, professor of chemical engineering, reports its latest findings in the paper "Creating Antibacterial Surfaces with the Peptide Chrysophsin-1", published

online in October by the journal *ACS* Applied Materials *& Interfaces*.

"Fish have a wonderful solution for blocking bacterial and fungal infections," Camesano said. "In this study, we are working to better understand the biochemical mechanics of that process."

As fish filter water through their gills to extract oxygen, antimicrobial peptides (AMPs), including Chrysosphin-1, trap and kill pathogens before they can invade the fish's bloodstream. Scientists in many laboratories around the world are actively exploring the potential use of these molecules to prevent human infections. In the current study, the WPI team attached AMPs to silicon and gold surfaces using two different approaches and measured the bound peptides' ability to kill the bacterial pathogen E. coli.

In the first method, the AMPs were absorbed directly onto gold and silicon crystals, forming a single layer of molecules with the AMPs lying flat on the surface. In the second method, the tips of the AMPs were attached to the surfaces with a glue-like substance so that the peptides rose vertically, like blades of grass extending up from the ground. Surfaces with both AMP configurations were cultured with E. coli cells. The results showed that when the AMPs were lying flat they killed 34 percent of the bacteria in the culture, but when they were standing up vertically they killed 82 percent.

"The hypothesis is that when peptides are attached vertically to the surfaces, they are better able to move and bend so they take on a shape that is more effective in binding to and disrupting the E.coli cells," Camesano said.

In addition to gathering data about the antibacterial efficacy of the attached AMPs, the WPI research team developed a technique for monitoring, in real time, the attachment of AMPs to surfaces. Using

quartz crystal microbalance with dissipation monitoring (QCM-D), the team measured the quantity of AMPs that successfully attached to the surfaces in the horizontal and vertical orientations and the density of the AMP layers, along with other properties.

"This was a powerful process, to be able to essentially watch the binding process as it happened," Camesano said. "It is a technique that we will continue to apply in further studies."

Camesano said gold and silicon surfaces were selected for the current study because their chemical properties are well-suited for AMP binding. In ongoing work, Camesano's laboratory will continue to characterize the mechanics of AMP binding for optimal antimicrobial activity and test other materials, including titanium, stainless steel, and plastics, that would have greater utility in food preparation and healthcare.

"What is also notable about this study is that it is the work of undergraduates," Camesano said. "They've done excellent work here that will inform future graduate studies in our lab."

More information: pubs.acs.org/doi/abs/10.1021/am301530a

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