Researchers find clue that may get biofilm to leave teeth alone

Harmful bacteria on marine sponge collectively decide when it’s time to break up and move on

A new study shows that when enough bacteria gather together in one place, they can make a collective decision to grow an appendage and swim away. This type of behavior has been seen for the first time in marine sponges, and it could lead to an understanding of how to break up harmful bacterial biofilms, such as plaque on teeth or those found on internal medical devices, such as artificial heart valves.

Bacteria have ways of communicating with each other, and scientists have now identified a new signaling system that, when there is a critical mass of bacteria present, causes the bacteria to produce an appendage known as a flagellum that moves like a corkscrew and gives them the ability to swim away, inhibiting the formation of biofilm.

“Anything we can discover about this bacterial communication could be really important in understanding how bacteria become pathogenic in humans or how they form film on teeth or internal medical devices,” said study coauthor Dr. Russell Hill, Director of the Institute of Marine and Environmental Technology in Baltimore. “Understanding that process may help in the future for controlling biofilms.”

It is estimated that pound by pound there are more bacteria on the Earth than all other life forms combined. They are simple organisms that consist of one cell and can be seen only through a microscope. However, bacteria have evolved ways to gather into densely populated and slimy communities called “biofilms,” which attach to hard surfaces. They also know how to talk to each other, and can make group decisions about how to behave, called “quorum sensing.”

Just like in a business meeting, once enough bacteria gather in one place — or a quorum is met — a decision about their collective behavior can be made. This “quorum sensing” is responsible for a number of cellular processes, including triggering molecular mechanisms that can make the surface of the ocean light up at night and the gathering of bacteria that causes plaque on teeth, otherwise known as biofilm.

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The bacteria that colonize and are dependent on these marine sponges use quorum sensing to activate their locomotion when their population becomes dense, naturally limiting the amount of biofilm they form.

"This precise calibration of the bacterial interactions within the sponge may have evolved to help maintain a healthy, well-distributed symbiotic population," said study coauthor Clay Fuqua of Indiana University. "Similar mechanisms may be at play in other complex microbial communities within hosts such as those within human intestines and in symbiotic plants."

The study, by scientists from the University of Maryland Center for Environmental Science's Institute of Marine and Environmental Technology, Indiana University, and University of Colorado Denver's School of Medicine, is in the September 2012 issue of Molecular Microbiology.

The marine sponge research is the latest in a series of discoveries to emerge from long-running efforts to find new ways of combating biofilm in humans to improve oral health.

Most bacteria in nature exist in communities of biofilms, structures that serve as physical barriers and severely limit the effect of antibacterial agents. Oral biofilms are commonly associated with infections such as cavities, gingivitis and periodontal disease. With antibiotic resistance continually on the rise, researchers are constantly exploring alternative sterilization methods to effectively treat biofilms.

In another recent effort, researchers from Hebrew University, Hadassah, Jerusalem, Israel and the University of California San Francisco, determined that the blue light commonly used by dentists to cure resin fillings, when combined with hydrogen peroxide (H2O2), may be capable of reaching and treating bacteria in deep layers of biofilms that can cause cavities and gingivitis.

The study exposed biofilms of Streptococcus mutans to wavelengths of visible light consisting of 400-500 nm for 30-60 seconds while in the presence of 3-300 mM of hydrogen peroxide. Microbial counts from each treated sample were compared with those of the control and results showed that visible light and hydrogen peroxide combined successfully penetrated all layers of the biofilm creating an antibacterial effect.

"The ability of noncoherent visible light in combination with H2O2 to affect bacteria in deep layers of the biofilm suggests that this treatment may be applied in biofilm-related diseases as a minimally invasive antibacterial procedure," the researchers said.

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