The Social Behavior of Bacteria Offers New Ideas for Antimicrobial Drug Design

Video Details →

This movie clip shows *Pseudomonas aeruginosa*, a common bacterium, spreading out on petri dishes. The branching pattern seen on the left is characteristic of a behavior known as swarming, in which the bacterial cells collectively migrate across a soft surface. Bacteria growing on the plate on the right have evolved into more-effective swarmers.

While some naturally occurring strains of *P. aeruginosa* are capable of swarming, the microbe is normally less mobile, with cells living in densely packed communities known as biofilms.

A team of Memorial Sloan Kettering scientists led by computational biologist Joao Xavier is studying the swarming behavior of *P. aeruginosa* to learn about how cells interact. Their latest findings, published in the journal *Cell Reports*, provide new insights about the basic mechanisms of evolution and could open the door to more-effective ways to control bacterial infections in people.

Parallel Evolution

Dr. Xavier and his coworkers grew *P. aeruginosa* on nutrient plates that give swarming colonies a growth advantage. They allowed the cells to branch out and then reseeded small cell samples from these colonies onto new plates.

After a few generations individual colonies had evolved into “hyperswarmers” that quickly covered the entire plate. The researchers analyzed the DNA of these and other colonies.

In all hyperswarmer lineages they looked at, the increased mobility was linked to the same genetic change. The mutation occurred in a gene called *FleN* and caused the bacteria to develop multiple flagella — lash-like extensions of the cell body that whip from side to side to propel the cell’s movement.

As a result, the bacteria became better at moving about while progressively losing their ability to form biofilms, or surface-associated communities. Biofilms are dense aggregates of bacteria embedded in extracellular polymeric substance, a gluey matrix produced by the microbes.

“We saw this happening over and over again,” says Dr. Xavier. “It’s a remarkable example of a phenomenon known as parallel evolution, and it suggests the evolution of new traits might be more reproducible at the mechanistic level than previously thought.”

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New Strategies to Fight Bacteria

P. aeruginosa thrives both in nature and in manmade environments and can be found growing on various types of surfaces — from soil to hospital equipment. Under certain conditions it can cause dangerous infections, especially in people whose immune systems are compromised.

Dr. Xavier notes that the findings one day might translate into new types of antibacterial drugs that work by changing the way cells interact with one another. "It's conceivable that drugs that target *FleN* could prevent the formation of bacterial biofilms, which makes the pathogens more difficult to remove or kill with antibiotics," he explains.

In addition, antibiotics treatment often creates a strong evolutionary pressure that favors the survival of drug-resistant bacteria. "Future drugs that manipulate social behaviors of microorganisms such as swarming are very promising because they are less likely to select for resistance," Dr. Xavier adds.

Read about the study and watch more movies in this *New York Times* article by Carl Zimmer.