Bacteria use Batman-like grappling hooks to 'slingshot' on surfaces

July 18 2011

Bacteria use various appendages to move across surfaces prior to forming multicellular bacterial biofilms. Some species display a particularly jerky form of movement known as "twitching" motility, which is made possible by hairlike structures on their surface called type IV pili, or TFP.

"TFP act like Batman's grappling hooks," said Gerard Wong, a professor of bioengineering and of chemistry and biochemistry at the UCLA Henry Samueli School of Engineering and Applied Science and the California NanoSystems Institute (CNSI) at UCLA. "These grappling hooks can extend and bind to a surface and retract and pull the cell along."

In a study to be published online this week in Proceedings of the National Academy of Sciences, Wong and his colleagues at UCLA Engineering identify the complex sequence of movements that make up this twitching motility in Pseudomonas aeruginosa, a biofilm-forming pathogen partly responsible for the deadly infections seen in cystic fibrosis.

During their observations, Wong and his team made a surprising discovery. Using a high-speed camera and a novel two-point tracking algorithm, they noticed that the bacteria had the unique ability to "slingshot" on surfaces.

The team found that linear translational pulls of constant velocity alternated with velocity spikes that were 20 times faster but lasted only milliseconds. This action would repeat over and over again.

"The constant velocity is due to the pulling by multiple TFP; the velocity spike is due to the release of a single TFP," Wong said. "The release action leads to a fast slingshot motion that actually turns the bacteria efficiently by allowing it to over-steer."

The ability to turn and change direction is essential for bacteria to adapt to continually changing surface conditions as they form biofilms. The researchers found that the slingshot motion helped P. aeruginosa move much more efficiently through the polysaccharides they secrete on surfaces during biofilm formation, a phenomenon known as shear-thinning.

"If you look at the surfaces the bacteria have to move on, they are usually covered in goop. Bacterial cells secrete polysaccharides on surfaces, which are kind of like molasses," Wong said. "Because these polysaccharides are long polymer molecules that can get entangled, these are very viscous and can potentially impede movement. However, if you move very fast in these polymer fluids, the viscosity becomes much lower compared to when you're moving slowly. The fluid will then seem more like water than molasses. This kind of phenomenon is well known to chemical engineers and physicists."

Since the twitching motion of bacteria with TFP depends of the physical distributions of TFP on the surface of individual cells, Wong hopes that the analysis of motility patterns may in the future enable new methods for biometric "fingerprinting" of individual cells for single-cell diagnostics.

"It gives us the possibility of not just identifying species of bacteria but the possibility of also identifying individual cells. Perhaps in the future, we can look at a cell and try to find the same cell later on the basis of how it moves," he said.

Provided by University of California - Los Angeles

Citation: Bacteria use Batman-like grappling hooks to 'slingshot' on surfaces (2011, July 18) retrieved 20 April 2024 from
https://phys.org/news/2011-07-bacteria-batman-like-grappling-slingshot-surfaces.html