PostDoc Journal
Vol. 1, No. 5, May 2013

Journal of Postdoctoral Research
www.postdocjournal.com

Reaching out and holding on: Bacteria use flagella to improve attachment to micro-patterned surfaces.

A. Nicole Billings, PhD
Massachusetts Institute of Technology, Department of Biological Engineering, Cambridge, MA 01239
Correspondence: anb11@mit.edu

Bacterial biofilms are ubiquitous multicellular communities, which form at interfaces or on surfaces. Their prevalence in the environment often results in contamination of industrial processes and devastating infections in medical settings. Since bacterial adhesion is a prerequisite for initiation and development of these microbial communities on surfaces, identifying effective antifouling methods is a critical preventative measure against damage imposed by biofilms. A recent article in the Proceedings of the National Academy of Sciences takes an exciting new look at the bacterial adhesion response to variations in microtopography. In the present study, Friedlander and colleagues predicted that polydimethylsiloxane (PDMS) patterned surfaces in the form of posts separated by sub-micron crevices would decrease *E. coli* attachment relative to a smooth PDMS surface due to a substantial decrease in available surface area. While this hypothesis held true for wild-type *E. coli* at early time points (< 4 hours), an unexpected observation revealed a reversal in adhesion behavior on a patterned substrate at longer incubation times. The observed increase in cell adhesion beyond 4 hours was accompanied by a dense matrix of fibrous material, identified in this work as flagellar filaments. Is it possible that bacteria utilize the flagella as a means to reach into submicron spaces to anchor the cell? The authors addressed this question by exploring adhesion behavior with flagellar mutants.

Over longer incubation times, *E. coli* mutant cells lacking flagella suffered a defect in adhesion to patterned surfaces compared to the wild-type strain. Flagellated cells, harboring a mutation that eliminates motility, accumulated more biomass than their non-flagellated counterparts; however, they exhibited a defect in adhesion relative to the parental strain. This important finding indicates that both the presence and rotational motion of the flagellar filament promotes access to the microscale trenches. Furthermore, the authors microscopically demonstrate that the rotating flagellar appendage could reach into crevices and explore surfaces that are not accessible to the cell body.

The authors also find that the observed reversal in adhesion behavior as incubation time progresses is due to a disruption of the non-wetted Cassie-Baxter state, which is indicative of hydrophobic micro/nano patterned surfaces. They show a pronounced shift in wetting states of the patterned substrate that correlate to the observed changes in biomass over the course of 24 hours. Specifically, at early time points, air trapped in the surface trenches prohibited access of the flagella to the additional surface area in the crevices. However, vibrational energy, perhaps derived from the flagellar motor, displaced the meniscus in the surface trenches resulting in a total wetting effect of the substrate that was not observed without bacteria.

In natural settings, bacteria often encounter micro-textured surfaces. This work is a significant step forward in identifying how bacteria have evolved to manage structured topography by probing their local environment. From an antifouling perspective, it would be advantageous to analyze surfaces that can minimize attachment of the cell body and other extracellular appendages that may promote adhesion.

Paper reference:

Friedlander RS, Vlamakis H, Kim P, Khan M, Kolter R, et al. (2013) Bacterial flagella explore microscale hummocks and hollows to increase adhesion. *Proceedings of the National Academy of Sciences of the United States of America* 110: 5624-5629. http://www.pnas.org/content/110/14/5624.full?sid=bb2ad123-9ca8-4016-a4ae-3479e5a3b1d4