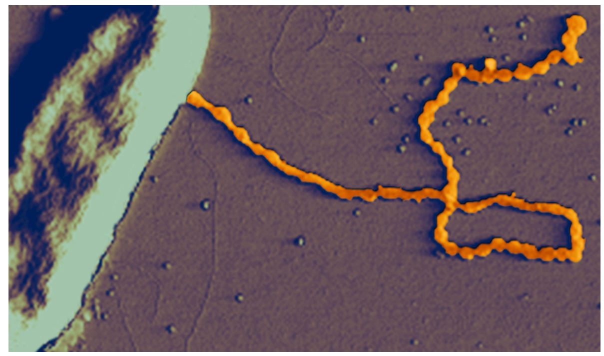
THE BIOPHYSICAL AND STRUCTURAL BASIS OF MICROBIAL ENERGY ACQUISTION BY ELECTRON TRANSPORT ACROSS THE BIOTIC-ABIOTIC INTERFACE. S. Pirbadian[1], H.S. Byun[1], B.J. Gross[1], and M.Y. El-Naggar[1,2,3], [1]Department of Physics and Astronomy, University of Southern California, [2]Molecular and Computational Biology Section, Department of Biological Sciences, University of Southern California [3]Department of Chemistry, University of Southern California (Seaver Science Center, 920 Bloom Walk, Los Angeles, California, USA 90089-0484; mnaggar@usc.edu).

We now know that metal-reducing bacteria can extract free energy from their environment through extracellular electron transport to natural minerals that serve as electron acceptors for respiration outside the cells. In addition to its importance for basic physiology and global elemental cycling here on Earth, this phenomenon of interfacial electron transport has significant implications for astrobiology, since it may facilitate a possible extraterrestrial metabolism on iron-rich planets.

But how can a bacterium transport electrons to an external surface? In contrast to solid-state systems (e.g. metals and semiconductors), where the charge transport physics is well understood, comparatively little is known about the physics of biological charge transport over cellular length scales. Here, we will describe how bacteria organize redox sites on outer cell membranes, and along quasi-one-dimensional filaments known as bacterial nanowires, to facilitate long-range charge transport [1]. The approaches taken include microfluidic fluorescence assays, single-cell respiration measurements, scanning tunneling microscopy of individual redox molecules [2], and nanofabrication-enabled measurements of transport along individual bacterial nanowires produced by the bacterium *Shewanella oneidensis* MR-1 [3]. Based on these measurements, we propose that extracellular respiration is facilitated by an incoherent multistep charge hopping mechanism along redox chains.

In addition, we will describe the first *in vivo* measurements of bacterial nanowire composition, extension, and redox activity. Our measurements demonstrate that the *S. oneidensis* MR-1 nanowires are lipid-based extensions of the outer membrane and periplasm that include the multiheme cytochromes responsible for extracellular electron transport. Redox-functionalized membrane and vesicular extensions may represent a general microbial strategy for electron transport and energy distribution [1].



Atomic force microscopy of a bacterial nanowire extending from a *Shewanella oneidensis* MR-1 cell.

References:

[1] Pirbadian S. et al. (2014) *Proc. Natl. Acad. Sci. USA.*, 111, 12883-12888. [2] Byun H.S. et al. (2014) *ChemElectroChem*, 1, 1932-1939. [3] El-Naggar M.Y. et al. (2010) *Proc. Natl. Acad. Sci. USA.*, 107, 18127-18131.