Implications and Applications of Electromicrobiology. Y. A. Gorby Civil and Environmental Engineering, Rensselaer Polytechnic Institute, Troy, NY.

Introduction:

The past decade has provided new insights into components and mechanisms of extracellular electron transfer in diverse microbial systems. Electrically conductive filaments called microbial or bacterial nanowires were first identified in metal reducing bacteria and were implicated in the efficient electron transfer to iron oxide minerals and other solid phase electron acceptors [1]. It was soon recognized that extracellular conductive "nanowires" were broadly distributed throughout the microbial spectrum of life and have now been confirmed in organisms ranging from oxygenic photosynthetic cyanobacteria (Fig. 1) to thermophilic methanogenic cocultures [2]. More recent discoveries, such as multicellular assemblages of "electric cable bacteria" that are known to span distances exceeding 1 cm [3], are fundamentally transforming our understanding of the potential strategies that microbes might have developed for efficiently controlling charge transfer in diverse and, quite likely, extreme environments.

Implications and Approaches:

The ability to transfer charge/electrons over distances measuring tens to hundreds of microns and at rates far exceeding those of diffusion limited reactions may significantly contribute to respiration, power distribution and possibly intercellular communication within complex microbial communities. Perhaps more importantly, this ability can establish steep electrochemical gradients that can directly influence electrochemcial and geochemical phenomena, such as the corrosion of metallic substrates and mineralogical stratification of anoxic sediments.

This presentation provides an update on the approaches and current understanding of charge transfer in diverse microbial system with emphasis given toward the implications for supporting life in extreme and low energy environments.

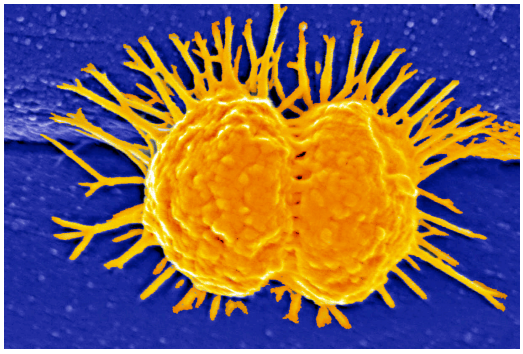

Figure 1. Scanning electron micrograph of the photosynthetic cyanobacterium *Synechocystis* 6803 attached to an electrode surface in a photovoltaic microbial fuel cell via electrically conductive filaments. This organism is able general small amounts of electrity using the sun as the energy source and water as the electron source. (photo credit, Eric Hill, PNNL)

References:

[1] Reguera, G., et al., *Extracellular electron transfer via microbial nanowires.* Nature, 2005. **435**(7045): p. 1098-1101.

[2] Gorby, Y.A., et al., *Electrically conductive bacterial nanowires produced by Shewanella oneidensis strain MR-1 and other microorganisms.* Proc Natl Acad Sci U S A, 2006. **103**(30): p. 11358-63.

[3] Pfeffer, C., et al., *Filamentous bacteria transport electrons over centimetre distances.* Nature, 2012. **491**(7423): p. 218-21.