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Engineering electron transfer among bacteria for improved bioenergy and biofuels.

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Living cells are required to get rid of a large number of electrons left behind in metabolism when nutrients convert into energy. Aerobic organisms inhale oxygen to dump these excess electrons. However, bacteria, that are important in the production of bioenergy and biofuels, don't afford the luxury of soluble, ingestible electron acceptors. Cells devise unique strategies using membrane proteins to export electrons outside their body, but the exact mechanism remains unclear. Electron transfer in proteins generally occurs via tunneling or hopping mechanism and the possibility of electron delocalization or metal-like conductivity has been considered previously impossible. In this talk, I will present our recent work on protein nanofilaments, pili, of electricity-producing *Geobacter sulfurreducens* that challenge this long-standing belief. Using nanoelectrodes and scanning probe microscopy-based imaging approach to quantify electron transfer in native proteins, we have found out that pili propagate charges in a delocalized manner similar to carbon nanotubes [1], enabling cells to generate electricity [2] and produce methane via cell-to-cell electron exchange [3]. Structural and molecular studies revealed that conductive pili possess unique arrangement of aromatic amino acids that facilitate intermolecular electron delocalization. I will present strategies to engineer electron transfer in environmentally as well as clinically important systems for energy, environmental and biomedical applications.

[1] Malvankar *et al.* ***Nature Nanotechnology***, 9, 1013 (2014)
[2] Malvankar *et al.* ***Nature Nanotechnology***, 6, 573 (2011)
[3] Summers, Forgarty, Leang, Franks, Malvankar and Lovley ***Science***, 330, 1413 (2010)