Chemical Engineering Distinguished Young Scholars Seminar

# Directing Electrical Energy Across the Cell Membrane for Precise Bioelectronics


## Anum Azam
Graduate Student
University of California - Berkeley


**Date: Monday, August 3, 2015**
Time: Lecture: 4:00-5:00 p.m.
Place: PAA A110
Happy Hour in Benson Hall Lobby


## Abstract

Bacterial cells acquire and store energy from various redox reactions as part of cellular respiration. One barrier to harvesting cellular energy for electronic applications is the phospholipid double membrane, a heterogeneous electrical insulator enveloping a reducing periplasmic environment. To address this problem, we are using a self-assembling filament protein, PrgI, as a scaffold for bottom-up inorganic nanostructure synthesis. About 120 copies of PrgI spontaneously assemble into a growing structure that extends outwards from the cell membrane; this structure is the type III secretion system (T3SS) filament of *Salmonella enterica*. We engineered PrgI to specifically bind metal ions, and used the resulting assemblies as a template to create metal-plated nanowires of tunable length and composition. We have built filaments that are several microns in length *in vitro*, and confirmed the presence of cell-surface bound gold structures (Fig. 1). These cell-tethered metallic antennae could be used to drive current from cell cytosol to external electrodes using electron transfer proteins localized in the membrane. Concurrently, we are also investigating electrical energy transfer across cell membranes via soluble wires, in which electron-carrying proteins are secreted by the T3SS. Using traditional biochemistry and genetics techniques, we have engineered a 100-fold improvement in secretion titer over native levels to export cytochromes at high enough concentrations to permit the reduction of extracellular substrates. We believe that these two strategies using the T3SS form a unique starting point for engineering precisely controlled bioelectronic interfaces. Apart from enabling applications in electronics, these systems provide a way to investigate biological processes in cells that involve the movement of electrons across membranes, such as signal transduction and energy production.


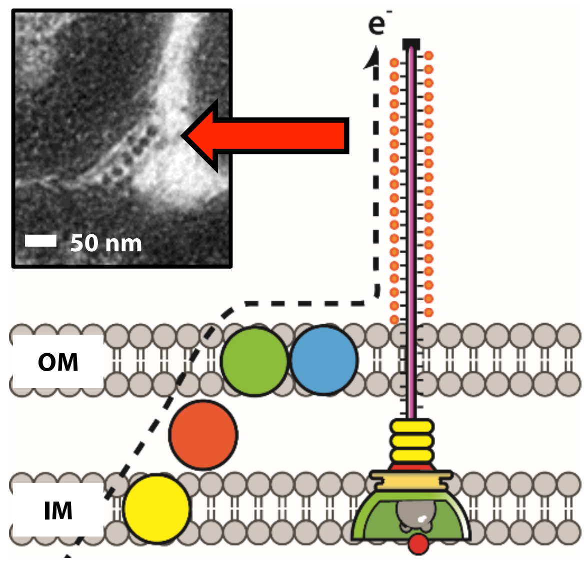


*Figure 1 – Au functionalization of the T3SS needle, coupled with heterologous membrane-localized electron transfer proteins, could enable electronic reduction of extracellular electrodes*

## Bio

Anum Azam received a B.S. in Biomedical Engineering from Johns Hopkins University in 2010 and is currently working towards a Ph.D. in Bioengineering at UC Berkeley. Her research interests are in using protein engineering, bioinorganic chemistry and molecular biology to direct mass and energy transport in cell membranes.

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