Wired Microbe Electrodes

D. Boyd, J. Erickson, N. Lebedev, J. Roy, R. M. Snider, S. Strycharz-Glaven, L. Tender

Geobacter spp. are microorganisms that can acquire energy by coupling intracellular oxidation of organic matter such as acetate with extracellular electron transfer to solid phase electron acceptors such as iron oxide particles. This is a distinct capability; microbes generally utilize soluble oxidants that are reduced inside the cell. *Geobacter* can also use electrodes (graphite, gold, etc.) as electron acceptors. When grown on an electrode, they form a multi-cell thick biofilm in which the distance electrons are transported from cells to the underlying electrode surface can exceed 20 microns; enormous for a biological system. As it turns out, *Geobacter*-modified electrodes exhibit electrochemical properties similar to those exhibited by wired enzyme electrodes. This led to the hypothesis that long-range electron transport in *Geobacter* biofilms occurs by incoherent multi-step hopping through a network of bound redox cofactors which appear to be hemes of outer membrane and extracellular matrix *c*-type cytochromes. Here I will describe voltammetric, spectroelectrochemical, and conductivity measurements performed on actively respiring *Geobacter sulfurreducens*-modified electrodes that support this model. This model is not without controversy and I will discuss what information is lacking, a competing model of biofilm long-range electron transport, and where that model fails.