Sustainable Bio-battery Utilizing Extracellular Charge Transfer Mechanism of Dissimilatory Metal-Reducing Bacteria

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The recent discovery of electrically conductive bacterial nanowires produced by a variety of microbes suggests that extracellular electron transfer via nanowires may be widespread in nature and inspires this project in testing a hypothesized function of bacterial nanowires related to energy generation. This project uses dissimilatory metal-reducing bacteria (DMRB) Shewanella oneidensis to assess the ability of the Shewanella appendages (bacterial nanowires) to conduct an electrical current. The experiment discovered a high amount of nanowires connecting neighboring cells in the bacterial colony. A microbial strategy for extracellular electron transfer to electron acceptors is further investigated by building and testing a DMRB-based bio-battery. The proposed DMRB-based bio-battery functions without a mediator and a separator. Synthetic wastewater made from M9 minimal growth medium and organic substrates was used as electron donor. Generated electricity was measured using a 46-Range PC Interface Digital Multimeter data acquisition system. The results show that the network of extracellular bacterial nanowires serves as electrical connections that link the oxidizing and reducing zones, thus permitting electron transfer for bio-battery. The DMRB-based bio-battery can be powered by less-concentrated reservoirs of organic matter such as marine sediment and wastewater. In addition, S. oneidensis used in the bio-battery can directly reduce heavy metals such as uranium and chromium from dissolved liquid state [U(VI) and Cr(VI)] to insoluble oxides [U(IV) or Cr(III)] (Sheng and Fein, 2014). Such abilities could facilitate the removal of dilute metal pollutants in natural sites such as uranium-contaminated ground water of the Navajo Nation located in the Four Corners area.