# Inward Electron Transfer of a Metal Reducing Bacterium from High-Redox Potential Molecules

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The microbial interactions between mineral and bacteria play an important role in biogeochemical cycling of metal compounds[1]. One of these activities is extracellular electron transfer (EET), in which microbes exchange electrons with external redox compounds, electrodes or even other microorganisms[2-5]. As an electrochemically active bacteria, *Shewanella oneidensis* MR-1 (MR-1) can accomplish an outward electron transfer, *i.e.,* transfers electrons from the cells to extracellular electron acceptors. Whereas the oxidation of compounds by MR-1, which is an inward EET from extracellular electron donors to the microorganism, is barely studied. Here we present an inward EET of MR-1 from the molecules with high redox potentials. Among the 12 investigated redox molecules with different redox potentials and overall charges, the molecules with high redox potentials and overall charges shown the most asymmetrical peaks on the cyclic voltammetry (CV) on the electrode coated with MR-1. Further studies disclosed that an asymmetrical pattern on CV implied an inward EET process and this process was only discovered in particular molecules. The common features of these molecules are high redox potentials and negatively overall charges. It is conclusive that the inward EET is closely related to the high redox potentials, although the effect of overall charges needs further investigation. The function of MtrC and OmcA, a common cytochrome *c* in the outer membrane of MR-1, was also studied. The results support a model in which the high-redox potential molecules donor electrons to MR-1 by interacting with MtrC, OmcA, and MtrB, and/or unknown active sites and then interacting with redox proteins in the periplasm of MR-1.

## ACKNOWLEDGEMENTS

Financial support from the China Scholarship Council (CSC) (No. 201606130019), Carlsberg foundation (CF15-0164), Universities Denmark, the National Natural Science Foundation of China (41471260, 51478451) and Otto Mønsted foundation is greatly appreciated.

## REFERENCE

1. Myers, C.R. and K.H. Nealson, *Bacterial manganese reduction and growth with manganese oxide as the sole electron acceptor.* Science, 1988. **240**(4857): p. 1319-1321.
2. Xiao, Y., et al., *Extracellular polymeric substances are transient media for microbial extracellular electron transfer.* Science Advances, 2017. **3**(7): p. e1700623.
3. Tian, X., et al., *Interaction between in vivo bioluminescence and extracellular electron transfer in Shewanella woodyi via charge and discharge.* Physical Chemistry Chemical Physics, 2017. **19**(3): p. 1746-1750.

4. Hu, Y., et al., *A near-infrared light responsive c-di-GMP module-based AND logic gate in Shewanella oneidensis.* Chemical Communications, 2017. **53**(10): p. 1646-1648.
5. Windt, W.D., P. Aelterman, and W. Verstraete, *Bioreductive deposition of palladium (0) nanoparticles on Shewanella oneidensis with catalytic activity towards reductive dechlorination of polychlorinated biphenyls.* Environmental Microbiology, 2005. **7**(3): p. 314-325.