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Biochemical Mechanisms Controlling Terminal Electron Transfer in *Geobacter sulfurreducens*

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The ability of *Geobacter sulfurreducens* to use a variety of metals as terminal electron acceptors (TEAs) for cellular respiration makes it attractive for use in bioremediation and implies its importance to mineral cycling in the environment. This study is aimed at understanding the biochemical mechanisms that allow *Geobacter sulfurreducens* to use soluble and insoluble iron and manganese forms as TEAs for cellular respiration and is the first of its kind to address the kinetics of manganese use as a TEA by *G. sulfurreducens*. First, *G. sulfurreducens* was conditioned to grow on various soluble and insoluble iron and manganese forms. *G. sulfurreducens* demonstrated enhanced growth rates when cultured using soluble TEAs compared with insoluble TEAs. However, the lower growth rate on insoluble iron compared with soluble iron was observed concomitantly with a 1-2 log lower cell density in stationary phase in insoluble iron cultures and a lower growth yield per electron donor used in log growth phase. Furthermore, the growth yield per electron was similar with both soluble and insoluble iron. These results suggest that the net amount of energy available for biomass production achieved from reducing insoluble iron is lower than with soluble iron, which may be due to a different biochemical mechanism catalyzing the electron transfer to TEA dependent upon the solubility of the TEA. One scenario consistent with this notion is that protein(s) in the outer membrane of *G. sulfurreducens* that transfers electrons to insoluble TEAs does so in a manner that uncouples electron flow from the proton pump in the cellular membrane, similar to what we have observed with *Shewanella oneidensis* MR-1.

Both the growth rate and growth yield of *G. sulfurreducens* on insoluble manganese were higher than on insoluble iron, indicating that there is a difference in the flow of electrons to the TEA in these two situations. While the different redox potentials of these elements may affect these values, it is also possible that differential protein expression occurs when *G. sulfurreducens* is grown with insoluble iron versus insoluble iron. These initial results indicate that *G. sulfurreducens* allocates energy to unique cellular functions depending on the type of TEA used, suggesting that novel mechanisms are used to enable use of various metal forms for respiration. Follow-up protein expression studies were then conducted and are now being used to begin to delineate what biochemical mechanisms and cellular pathways are involved in these processes.