Transcriptional analysis of Shewanella oneidensis MR-1 with an electrode compared to Fe(III)citrate or oxygen as terminal electron acceptor.

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Abstract

Shewanella oneidensis is a target of extensive research in the fields of bioelectrochemical systems and bioremediation because of its versatile metabolic capabilities, especially with regard to respiration with extracellular electron acceptors. The physiological activity of S. oneidensis to respire at electrodes is of great interest, but the growth conditions in thin-layer biofilms make physiological analyses experimentally challenging. Here, we took a global approach to evaluate physiological activity with an electrode as terminal electron acceptor for the generation of electric current. We performed expression analysis with DNA microarrays to compare the overall gene expression with an electrode to that with soluble iron(III) or oxygen as the electron acceptor and applied new hierarchical model-based statistics for the differential expression analysis. We confirmed the differential expression of many genes that have previously been reported to be involved in electrode respiration, such as the entire mtr operon. We also formulate hypotheses on other possible gene involvements in electrode respiration, for example, a role of ScyA in inter-

protein electron transfer and a regulatory role of the cbb3-type cytochrome c oxidase under anaerobic conditions. Further, we hypothesize that electrode respiration imposes a significant stress on S. oneidensis, resulting in higher energetic costs for electrode respiration than for soluble iron(III) respiration, which fosters a higher metabolic turnover to cover energy needs. Our hypotheses now require experimental verification, but this expression analysis provides a fundamental platform for further studies into the molecular mechanisms of S. oneidensis electron transfer and the physiologically special situation of growth on a poised-potential surface.

Involved units

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