Microbial Metal Respiration: From Geochemistry to Potential Applications

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Microbes can respire on metals. This seemingly simple finding is one of the major discoveries that were made in the field of microbiology in the last few decades. The importance of this observation is evident. Metals are highly abundant on our planet. Iron is even the most abundant element on Earth and the forth most abundant element in the Earth's crust. Hence, in some environments iron, but also other metals or metalloids, are the dominant respiratory electron acceptors. Their reduction massively drives the carbon cycle in these environments and establishes redox cycles of the metallic electron acceptors themselves. These redox cycles are not only a driving force for other biotic reactions but are furthermore necessary for initiating a number of geochemically relevant abiotic redox conversions. Although widespread and ecologically influential, electron transfer onto metals like ferric iron or manganese is biochemically challenging. The challenge is to transfer respiratory electrons onto metals that occur in nature at neutral pH in the form of metal oxides or oxihydroxides that are effectively insoluble. Obviously, it is necessary that the microbes specially adapt in order to catalyze the electron transfer onto insoluble electron acceptors. The elucidation of these adaptations is an exciting ongoing process. To sum it up, dissimilatory metal reduction has wide-spread implications in the field of microbiology, biochemistry and geochemistry and its discovery was one of the major reasons to establish a novel scientific field called geomicrobiology. Recently, the discovery of potential applications of dissimilatory metal reducers in bioremediation or current production in a microbial fuel cell further increased the interest in studying microbial metal reduction.

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