The FeL model of iron acquisition: Nondissociative reduction of ferric complexes in the marine environment

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ABSTRACT: Recently there has been recognition of the importance of reductive processes in the acquisition of iron by microorganisms in marine environments with Fe(III) reduction induced by either membrane-bound reductases or by superoxide, a powerful Fe(III) reducing agent generated either by photochemical or biological means. We have measured the relative rates of iron uptake achieved by the cyanobacterium *L. majuscula* in the presence of a variety of model- and naturally-derived organic ligands exhibiting a broad range of conditional ferric and ferrous stability constants. Additionally, we have investigated the effect upon iron uptake rate of varying the concentration of both iron and the iron-binding ligands. We have reconciled this data with previous work in which we measured rates of reduction by exogenous superoxide of Fe(III) bound to these same complexes. We show that the rate of formation of ferrous iron and the rate of uptake of iron by *Lyngbya majuscul*a are each independent of the concentration of Fe' and demonstrate that this is consistent with our previous finding that this organism acquires iron via nondissociative reduction of ferric complexes. We also show that the rate of reoxidation of organically complexed Fe(II) is a critical determinant of the subsequent bioavailability of iron, a feature not previously addressed in the literature. In view of the central importance of the complexation and redox behavior of the iron- organic complexes to iron uptake rate, we propose a new kinetic model of iron acquisition, termed the FeL model, that is consistent with presented and previously published data and which describes processes both in natural and artificial conditions.

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