Journal of
Microbial & Biochemical Technology

OPEN ACCESS Freely available online

Short Communication

Bacterial Iron Biomineralisation in Nature

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ABSTRACT

It is a two-step process; in first step metals are electrostatically bound to the anionic surfaces of the cell wall and surrounding organic polymers, where they afterward serve as nucleation sites for crystal growth. Because of its moderately high activity in aqueous solutions, iron is preferentially bound to reactive organic sites. As the latter stages of mineralisation are inorganically driven, the sort of iron mineral designed is inevitably hooked in to the available counter-ions, and hence, the chemical composition of the waters in which the microorganisms are growing.

Keywords: Bacteria, Biomineralization

INTRODUCTION

Bacterial biomineralization may be a diverse and widespread phenomenon that results from cellularly mediated physiological processes. There are two different methods of mineral formation.

1. Biologically Controlled Mineralisation: it is a completely regulated process whereby the organism precipitates essential mineral phases within a preformed framework. Because the location at which a mineral forms is isolated from the external environment by a barrier through which ions cannot freely diffuse, mineralisation may proceed under thermodynamically unfavourable conditions.
2. Biologically Induced Mineralisation: it is not designed specifically for mineralisation, but one in which minerals still form. Biologically induced mineralisation is that the dominant process among bacteria, with biominerals commonly generated as secondary events from interactions between the activity of the microorganisms and their surrounding environment. Minor perturbations such as the introduction of biologically produced metabolic end-products, the release of cations by the cell, or the development of a charged surface can all induce the nucleation of minerals with crystal habits similar to those produced by precipitation from inorganic solutions

In recent years, high resolution studies on bacterial communities, using transmission electron microscopy, coupled with energy dispersive X-ray spectroscopy and selected area electron diffraction , have shown the almost ubiquitous presence of fine-grained iron minerals associated with bacterial cells. Because the second step in biomineralization is inorganically driven, the biominerals formed are going to be largely hooked in to the available counter-ions, and hence, the chemical composition of the waters in which they are growing. This paper reviews some of the environments where iron mineralisation has been observed, and outlines some common geochemical conditions associated with bacterial biomineralization.

IRON MINERAL FORMATION

The microbial precipitation of ferrihydrite is widespread in nature. It has been shown associated with bacteria growing in acid mine drainage environments; rivers; deep groundwater; geyser outflow channels; marine sediments; around deep sea vents; and on exposed rock surfaces. TEM analyses commonly indicate bacterial cells partially to completely enclosed within iron-rich epicellular matrices or with intracellular precipitates, where the cytoplasmic material has been completely replaced once the cell had lysed. Not only do the bacteria function templates for iron deposition, but within the acid mine drainage sites, for instance , their organic remains were also incorporated into the mineral precipitates

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Received: February 10, 2021; **Accepted:** February 17, 2019, 2021; **Published: February** 21, 2021

Citation: Mamatha D(2021) Bacterial Iron Biomineralisation in Nature. J MicrobBiochem Technol. 13:457 Doi: 10.35248/1948-5948.21.13.457

The formation of epicellular iron hydroxides by bacteria can occur either passively or actively. In the first instance, the oxidation and hydrolysis of cell-bound ferrous iron or the binding of cationic colloidal species can induce the transformation to insoluble hydroxide forms. Alternatively, ferrous iron transported into an oxygenated environment