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Introduction

Special Issue of Journal of Industrial Microbiology: Metals and Microorganisms

Metals are directly or indirectly involved in all aspects of microbial growth, metabolism, and differentiation. Many metals are essential, including Ca, Co, Cu, Fe, K, Mg, Mn, Mo, Na, Ni and Zn, whereas others have no known essential biological function, including Ag, Al, Au, Cd, Cr, Hg, Pb, Sn, Sr and Tl. Virtually all metals, whether essential or not, can exhibit toxicity above certain threshold concentrations which for highly toxic metal species may be extremely low. The metalloid, selenium, can be required at low concentrations but inhibit growth at higher concentrations. Almost every aspect of cell growth, metabolism, and differentiation may be affected. In physiological and environmental contexts, nearly every index of microbial activity in aquatic and terrestrial ecosystems may be affected by metal pollution, including primary productivity, nitrogen fixation, biogeochemical cycling of C, N, S, P and other elements (including other metals), decomposition of organic matter, and enzyme synthesis and activity.

However, metal tolerance in microorganisms is well known with several areas now receiving intensive attention at the molecular and genetic level. Microbial mechanisms implicated in survival in the presence of potentially toxic concentrations of metal species include extracellular precipitation, complexation and crystallization; transformations including oxidation, reduction, methylation, and dealkylation; biosorption to cell walls and extracellular polysaccharide; impermeability; decreased transport; efflux; intracellular compartmentation and/or sequestration. A given organism often relies directly and/or indirectly on several survival strategies.

Organic and inorganic metal species, compounds and particulates, metalloids and radionuclides can be accumulated by microbial cells as a result of physico-chemical mechanisms and transport systems of varying specificity, independent of, or directly and indirectly dependent on metabolism. Many of these processes are of global importance as components of major biogeochemical cycles for metal(loid) elements and include microfossil formation, iron and manganese deposition, silver and uranium mineralization, as well as resulting in transfer to other organisms via food webs. Organometal(loid)s arise in the environment from anthropogenic sources but also as a result of natural processes—both chemical and biological. Methylated derivatives of several elements occur naturally as a result of chemical and biological methylation, microorganisms playing highly significant roles in the latter process. Such processes, as well as organometal(loid) degradation, are components of global biogeochemical cycles for elements including As, Ge, Hg, Pb, Sb, Se, Sn and Te. Apart from their biogeochemical significance, some of these interactions are of biotechnological importance, being relevant to metal removal and/or recovery from mineral deposits and industrial effluents for industrial use or environmental bioremediation. A variety of *in situ* and *ex situ* processes are now being developed for use in industrial contexts.

Clearly, interactions of microorganisms with metals is an important subject area of relevance to pure and applied microbiologists. The roles and functions of metals within and exterior to microbial cells, and their provision in media, should be considered in all aspects of microbiology, including ecology, physiology, biochemistry, differentiation, molecular biology, genetics, biotechnology, and bioremediation. Biotechnological exploitation is dependent on an adequate reservoir of fundamental scientific information: it is hoped that the contributions contained in this Special Issue provide a focus for fundamental and applied studies and stimulate further appreciation and application of metal–microbe interactions. This Special Issue on Metals and Microorganisms was initiated with that in mind. It is a reflection of the importance of the topic that manuscripts accepted for publication are more than enough for four issues of the *Journal of Industrial Microbiology*. The review articles are being published in this double issue and the next issue (Vol. 14, issues 3 and 4) will be a second double issue containing reports of experimental work.

Special Editors:

Joseph J. Cooney
University of Massachusetts Boston
Boston, MA 02125-3393
USA

Geoffrey M. Gadd
University of Dundee
Dundee DD1 4HN
Scotland