3.60 Bioleaching and Biomining for the Industrial Recovery of Metals

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Glossary

biofilm A layer of adhesive exopolimeric substances attached to a surface and secreted by microorganisms forming colonies on it.
bioleaching Refers to the microbial conversion of an insoluble metal (usually a metal sulfide or oxide) into a soluble form (metal sulfate).
biomining The use of microorganisms to recover metals in industrial operations.
bioremediation Use of microorganisms to remove toxic chemicals from the environment.
chemolithoautotroph A microorganism that fixes CO_2 and obtains its energy by the oxidation of inorganic compounds.
consortium A group of microorganisms living together in which each individual benefits from the others.
genome The complete set of genes present in an organism.
genomics Refers to mapping, sequencing, and analyzing genomes.
proteome The total complement of proteins present in a cell at any one time.
proteomics Genomewide study of the structure, function, and regulation of proteins in the cell.
systems microbiology Considers microorganisms or microbial communities as a whole to create an integrated picture of how a microbial cell or community operates.

3.60.1 Introduction

A group of special acidophilic microorganisms (bacteria and archaea) known as chemolithoautotrophs are capable of using minerals as fuels. Their oxidation generates electrons to obtain adenosine triphosphate (ATP) and the carbon is obtained by fixing CO_2 from the air. During this aerobic mineral oxidation, metals are solubilized or bioleached. The redox reactions performed by microorganisms are part of normal biogeochemical processes in nature. They can be performed under neutral conditions or as the majority of microorganisms do, at very acidic values of pH (usually between 1 and 3). Some of the most common oxidation reactions catalyzed by acidophiles are the following:

Ferrous iron:

$$2Fe^{2+} + \frac{1}{2}O_2 + 2H^+ \rightarrow 2Fe^{3+} + H_2O \quad [1]$$

A metal sulfide:

$$MS + 2O_2 \rightarrow M^{2+} + SO_4^{2-} \quad [2]$$

Pyrite:

$$4FeS_2 + 15O_2 + 2H_2O \rightarrow 2Fe_2(SO_4)_3 + 2H_2SO_4 \quad [3]$$

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