

Chapter 13

Biomining Microorganisms: Molecular Aspects and Applications in Biotechnology and Bioremediation

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13.1 Introduction

The microbial solubilization of metals is widely and successfully used in industrial processes called bioleaching of ores or biomining, to extract metals such as copper, gold, uranium and others (Rawlings 2002; Watling 2006). This process is done by using chemolithoautotrophic microorganisms. These microorganisms belong to those groups known as extremophiles, since they live in extremely acidic conditions (pH 1-3.0) and in the presence of very high toxic heavy-metal concentrations. A great variety of microorganisms is capable of growth in situations that simulate biomining commercial operations, and many different species of microorganisms live at acid mine drainage (AMD) sites (Hallberg and Johnson 2001; Schippers 2007). The most studied leaching bacteria are from the genus *Acidithiobacillus*. *Acidithiobacillus ferrooxidans* and *A. thiooxidans* are acidophilic mesophiles, and together with the moderate thermophile *A. caldus*, they belong to the Gram-negative γ -proteobacteria. *Acidithiobacillus ferrooxidans* is a chemolithoautotrophic bacterium that obtains its energy from the oxidation of ferrous iron, elemental sulfur, or partially oxidized sulfur compounds (Lundgren 1980; Suzuki 2001; Rawlings 2002; Olson et al. 2003).

Members of the genus *Leptospirillum* are other important biomining bacteria that belong to a new bacterial division Nitrospora. Some Gram-positive bioleaching bacteria belonging to the genera *Acidimicrobium*, *Ferrimicrobium* and *Sulfobacillus* have also been described (Hallberg and Johnson 2001; Schippers 2007). Biomining extremely thermophilic archaeons capable of oxidizing sulfur and iron (II) have been known for many years, and they are mainly from the genera *Sulfolobus*, *Acidianus*, *Metallosphaera* and *Sulfurisphaera*. Recently, some mesophilic iron (II)-oxidizing

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