

The Role of Cellular Cysteine in Microbe-Metal Interactions

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Cysteine is a sulfur-containing amino acid that interacts strongly with chalcophilic elements. In microorganisms, cysteine biosynthesis occurs by the uptake of sulfate into the cytoplasm via specific membrane transporters, followed by assimilatory reduction which converts sulfate to sulfide. The intracellular sulfide is then incorporated into amino acids to form cysteine. In this presentation, I will discuss cysteine biosynthesis and how sulfur metabolism affects microbe-metal interactions. The topics will include: 1) the role of sulfate transporters in metal/metalloid cellular accumulation; 2) the binding of metals by cysteine-containing molecules; and 3) the release of cysteine degradation products and extracellular reactions with bacteriogenic sulfur compounds.

First, I will discuss sulfate transporters which are known to be gateways for chromium and selenium oxyanion entry into the cytoplasm of bacterial cells. Recently, we discovered that tellurium entry into the cell is also mediated by a sulfate transporter. In laboratory experiments, we investigated tellurate uptake and toxicity in *E. coli* cells. Mutant strains carrying a deletion of the *cysW* gene accumulated less cellular tellurium and exhibited higher resistance to tellurate compared to the wild type strain. Complementation of the mutation restored tellurate sensitivity and uptake. Together, these data demonstrate that tellurate enters bacterial cells via the CysPUWA sulfate transport system to cause toxic effects.

In the second part of this presentation, I will discuss our recent work on Hg(0) oxidation and complexation by cellular thiols. We conducted experiments with the Hg-methylating bacterium *Desulfovibrio desulfuricans* ND132 and demonstrated that intracellular Hg(0) oxidation occurs by reactions with sulfhydryl functional groups associated with cysteine residuals in solvent exposed proteins. EXAFS analyzes revealed that multiple different forms of Hg-thiols are produced by the Hg(0) oxidative complexation reaction.

Finally, I will discuss our new findings on the formation of extracellular sulfite and thiosulfate by *Bacillus* sp. JG-17. Preliminary results indicate that sulfite and thiosulfate are formed as a consequence of cysteine biosynthesis and degradation. These inorganic sulfur species are released into the spent medium and subsequently react with metals and minerals. Using elemental selenium as an example, I will show how these bacteriogenic sulfur compounds can facilitate mineral dissolution and affect selenium solubility.