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Bacterial view of the chemical periodic table: Genes (and proteins) for each element of the chemical periodic table

Microbial activities often provide the basis for useful environmental and agricultural biotechnology, as well as frequently causing problems. Essentially all bacteria have genes for toxic metal ion resistances and these include those for Ag^+, AsO_2^-, AsO_4^{3-}, Cd^{2+}, Co^{2+}, CrO_4^{2-}, Cu^{2+}, Hg^{2+}, Ni^{2+}, Pb^{2+}, TeO_3^{2-}, Tl^+, and Zn^{2+}. Resistance to inorganic Hg^{2+} and to organomercurials such as CH_3Hg^+ and phenylmercury involve a series of metal-binding and membrane transport proteins as well as the enzymes mercuric reductase and organomercurial lyase. Hg is methylated and demethylated by microbial processes. The methylmercury of concern in human food is of microbial origin and microbial bioremediation and phytoremediation can clean polluted sites. Arsenic resistance and metabolizing systems occur in three forms, the widely-found *ars* operon that is present in most bacterial genomes and many plasmids, the more recently-recognized the *aso* genes for the periplasmic arsenite oxidase that serves as an initial electron donor in aerobic resistance to arsenite and the functionally-related arr genes for arsenate reductase that serves as a terminal electron acceptor in anaerobic respiration. The largest group of resistance systems function by energy-dependent efflux of toxic ions. Some of the efflux resistance systems are ATPases and others are chemiosmotic ion/proton exchangers. For example, Cd^{2+} efflux pumps of bacteria are either inner membrane P-type, ATPases or three polypeptide RND chemiosmotic complexes consisting of an inner membrane pump, a periplasmic- bridging protein and an outer membrane channel. Silver compounds are increasingly used in industrial, environmental and medical applications. A cluster of 9 silver-specific genes make proteins that bind extracellular Ag^+ or pump internalized Ag^+ out from the cells, using membrane potential or ATP hydrolysis for energy. The SilE periplasmic Ag^+ binding protein is an unusual small soluble protein that binds 5 Ag^+ cations with 10 histidine residues.

Biography

Simon Silver has over 60 years of bacterial molecular genetics research experience, including a PhD from MIT, postdoctoral times at the MRC (UK) and the University of California Berkeley, followed by professorial appointments at Washington University (St Louis) and the University of Illinois (Chicago). He has published almost 250 papers and edited 9 published monographs. He was Editor in Chief of 2 journals and editor or editorial board member of more than a dozen more.

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