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Bacterial Nickel Metabolism and Storage

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Nickel is an element required for the growth of many microorganisms, as the metal functions as a key component of a metal center for several enzymes. For the organisms that rely on nickel, the metal must be transported, temporarily stored or sequestered, and then processed by accessory proteins for proper metal center assembly into the designated enzyme. The research conducted for this project addressed the nature and roles of key proteins that are involved in the above Ni-enzyme expression/synthesis processes. Mutant strains of the nitrogen-fixing bacterium *Bradyrhizobium japonicum* were studied in comparison to the parent strain, to reveal that certain nickel-binding proteins are involved both in regulating nickel-enzyme synthesis and in sequestering nickel for metal storage. Nickel storage proteins were purified and characterized, and nickel-sensing proteins were studied by many approaches. The results will be applicable to a variety of environmentally important bacterium, as nickel-proteins (and therefore storage of nickel by organisms) play key roles in nutrient cycles in nature, as well as for energy producing biotechnological processes.

Especially pertinent are the roles of a novel bacterial cell component called nickelin, a protein that sequesters nickel for the symbiotic nitrogen fixing process. The Ni-sequestering portion of the protein that aided symbiotic nickel-hydrogenase activity and nickel retention in the root nodules of leguminous plants was localized to a histidine rich domain of the protein. Another section of the same protein was found to be responsible for using cell energy to mobilize nickel into other proteins. Deletion of the last function (energy using domain) of nickelin resulted in the formation of inactive nickel enzymes (presumably devoid of the key metal, nickel). The mechanistic characteristics of this protein as well as another one, in permitting Ni-hydrogenase synthesis only in conditions in which nickel is available was also determined. Genes were discovered that are responsible for synthesizing proteins involved in these Ni-mobilization processes.

A manuscript that was published due to this work is the following:

Olson, J.W. and R.J. Maier, 2000. Dual roles of *Bradyrhizobium japonicum* Nickelin Protein in Nickel Storage and GTP-Dependent Ni Mobilization. *J. Bacteriol* 182: 1702—1705.