Ion Transporting Pumps in Plant Cells

Project ID: 55097

Jeffrey F. Harper, The Scripps Research Institute

Karina Quon , The Scripps Research Institute
Yuwen Wang, The Scripps Research Institute
Jeff Young, University of Wisconsin
Michael R. Sussman, University of Wisconsin

Research Objective

The long-term goal of this research is to learn how to engineer a plant to selectively extract metal cations such as the RCRA metals or radionuclides from the soil. The approach being pursued is based on first understanding how plants use membrane transporters (pumps) to take up metals from the soil. The specific focus is on a family of heavy metal pumps that use ATP to drive the high affinity transport of ions across membranes. Heavy metal pumps are known to transport metals such as manganese, copper, molybdenum, zinc, cadmium and silver. The objective is to understand how these pumps selectively transport various metals. With that knowledge, it is expected that new transport systems can be designed that will increase the efficiency of plants to take up various toxic elements, such as plutonium. Modified transport systems will be introduced into plants by genetic engineering.

Research Progress and Implications

Three metal ion pumps are being studied in a model plant system *Arabidopsis*. One pump (AMA1) is a member of a subfamily of heavy metal pumps. Genetic evidence indicates that AMA1 is involved in molybdenum uptake, as indicated by a deficiency of this micronutrient in a plant line harboring a disruption of the AMA1 gene. This nutrient deficiency is reversed in mutant plants that have been transformed with an AMA1 pump under the control of a constitutive promoter (35s). Two other pumps being studied (ECA1 and ACA2) are members of two different subfamilies of calcium pumps. Genetic evidence suggests that (i) both pumps can also transport cerium (which has chemical properties similar to plutonium), and (ii) ECA1, but not ACA2, can also transport manganese, as indicated by the ability of these pumps to provide yeast with an increased resistance to toxic levels of these metals. These molybdenum and calcium pumps may be useful in engineering plants with an increased capacity to uptake and accumulate toxic metals.