Enzyme Engineering for Biodegradation of Chlorinated Organic Pollutants

Project ID: 55343

Dr. Peter G. Schultz, Lawrence Berkeley National Laboratory

Research Objectives

Halogenated organic compounds have had widespread use as fungicides, herbicides, insecticides, algaecides, plasticizers, solvents, hydraulic fluids, refrigerants and intermediates for chemical syntheses. As a result, they constitute one of the largest groups of environmental pollutants. Chlorinated organic compounds comprise the largest fraction of these materials, having been synthesized by large scale processes over the past few decades. Their ubiquitous use and distribution in our ecosystem has raised concern over their possible effects on public health and the environment.

The biodegradation potential of halogenated compounds is difficult and not well understood. Biological cleavage of carbon-halide bonds can be achieved by either enzymatic or biocatalytic dehalogenation or by spontaneous chemical dehalogenation of unstable intermediates. This research involves the protein engineering of existing enzymes and the "creation" of new enzymes (catalytic antibodies) with enhanced dechlorination capability for a wide variety of chlorinated organic pollutants. These enzymes could be used as such or could be inserted into microorganisms designed for high activity in contaminated environments.

Development of antibodies that catalyze the hydrolysis of halogenated aromatics will be carried out through a combination of chemical and genetic approaches. Haptens will be developed to generate antibodies that stabilize the transition state for hydrolysis of halogenated nitroaromatics. We will then randomize the variable regions of the antibodies and screen for antibodies with enhanced catalytic properties. If successful such an approach could be generalized and might allow one to tailor the specificity of a bioremediation catalyst for a given synthetic halogenated aromatic using the machinery of the immune system.

We will also attempt to clone, express, purify and to determine the structure and chemical mechanism of a known detoxifying enzyme, dechlorinating dehalogenase. In addition, knowledge gained from such studies will be used to redesign the dehalogenase for the purpose of expanding its biodegradative potential to include environmental pollutants that are currently non-biodegradable.