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Guest editorial

The environmental applications of microbiological systems are expanding in scope and sophistication. Today, scientists and engineers must deal with the complexities of mixtures of hazardous chemicals, bioremediation of heterogeneous environments, and achieving reliability in the removal of low concentrations of specific contaminants. The emphases on reliability and dealing with mixtures means that we must move well beyond the traditional concepts used in the design and operation of microbiological systems. Advances are required in our understanding of the biochemistry of biodegradation and in how to connect that understanding to the practical tools of kinetics and system design.

This special theme issue of *Biodegradation* addresses one of the key advances: the interactions among different substrates utilized by a microorganism or community. The theme recognizes that the rate of biodegradation of a particular compound depends on the presence of other substrates, as well as depending on the concentrations of the compound itself and the biomass.

The five papers comprising the special issue present insights into the fundamental and practical aspects of substrate interactions. Notice the wide range of xenobiotic substrates that are affected by substrate interactions, such as cosubstrate requirements, inhibition, and induction.

- The paper by Logan et al. documents the critical finding that a cytochrome, P-450$_{\mathrm{CAM}}$, catalyzes reductive dechlorination of several polychlorinated ethanes in whole-cell suspensions of *Pseudomonas putida* and in cell-free extracts. Furthermore, the paper shows that the reductive reactions are possible even when the enzyme's normal cosubstrate, oxygen, is present, as long as the chlorinated substrate has sufficiently strong binding to the enzyme.
- Gibson and Suflita demonstrate that the side-chain cleavage of chlorophenoxyacetates is a reductive reaction that is stimulated by H_2 and a range of organic electron-donating substrates used by an anaerobic consortium that mineralizes phenoxyacetate. These results emphasize the indirect cosubstrate effect of reduced substrates that supply electrons for reductive reactions.
- Sáez and Rittmann describe two interactions between phenol and 4-chlorophenol when both are degraded by a species of *Pseudomonas putida*. First, phenol serves as an indirect cosubstrate by supplying the electrons needed for the initial monooxygenase reaction of chlorophenol. Second, chlorophenol is an inhibitor of the oxidation of phenol. Particularly significant is that Sáez and Rittmann quantify and model both types of substrate interactions.
- The paper of Coyle et al. shows that trichloroethene (TCE) is degraded by mixed heterotrophic cultures and by a pure culture of *Pseudomonas putida* F1. A key finding is that TCE degradation occurs only when phenol is present, presumably as an inducer of TCE-degrading oxygenase enzymes. As phenol becomes an increasing fraction of the total primary substrate, TCE removal increases.
- Finally, Grady et al. show that the biodegradation of 2-chlorophenol is affected by the availability of biogenic primary substrate and by the complexity of the community structure. For an axenic culture, addition of more biogenic substrate impairs the removal of chlorophenol, presumably because of a reduction in specific enzyme activity. On the other hand, increased biogenic substrate to a mixed culture improves the removal of chlorophenol. Thus, substrate interactions occur at the enzyme level and at the community level.

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