BIOREMEDIATION CRIB SHEET #1

How do microbes remediate organic pollutants?

BIOREMEDIATION is the beneficial use of microbes to transform compounds to reduce the concentration or toxicity of pollutants.

THE BASICS OF MICROBIAL METABOLISM

Microbes metabolize chemicals in the environment by allowing select compounds to pass through the cell wall and degrading the molecule in the cell to create energy or building blocks for cell components. Cells are capable of metabolizing a range of chemicals depending on the metabolic pathways encoded in their DNA. *Pseudomonas sp.* are probably the most metabolically diverse, with some species capable of degrading more than 100 organic compounds. Some by more than one pathway. Bioremediation is most commonly by cellular respiration, which involves glycolysis, the Kreb cycle and the electron transport chain. These series of chemical reactions oxidize organic compounds to carbon dioxide to create energy stored as ATP molecules.

ENZYMES are proteins that speed up chemical reactions. Each cell has thousands of enzymes that catalyze chemical reactions. Enzymes facilitate the metabolism of organic compounds by initiating the molecule degradation.

Constitutive enzymes are always present in a cell.

Induced enzymes are created in a cell only when a specific inducing substrate is present.

PETROLEUM METABOLISM

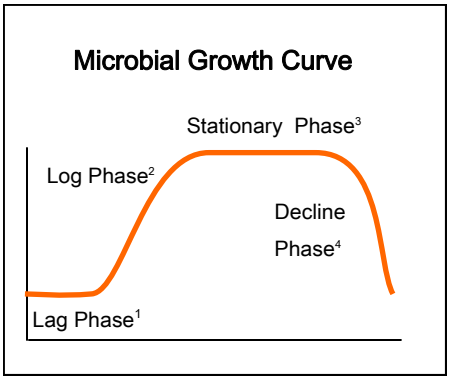
Petroleum degradation is initiated by terminal or subterminal oxidation to the corresponding primary alcohol, which is further oxidized by alcohol and aldehyde dehydrogenases. The resulting fatty acid enters the β–oxidation cycle where a sequence of redox reaction produce stored energy for the cell.

COMETABOLISM

Chlorinated solvents and other organic compounds may be degraded by **Cometabolism** even though they do not produce sufficient energy to maintain a microbial population. The cells derive energy from a primary substrate and produce enzymes that initiate the beneficial degradation of other compounds.

APPLICATION OF FOR SOIL OR GROUND WATER BIOREMEDIATION

Under the right conditions, native microbes may metabolize organic contaminants. Remediation under these conditions is called **monitored natural attenuation.** The microbial population may be in a **lag phase** (1) of the growth curve where the population is relatively low. If the natural degradation rate is too slow, nutrients or other amendments may be added to the soil or ground water. This **biostimulation** can push the population into the **log phase** (2) of exponential growth. **Bioaugmentation** is the introduction of microbes grown in the lab into the soil or ground water. The population is injected at the high population of the **stationary phase** (3) of microbial growth. After the organic contaminants are removed or ecological conditions change, the population enters the **decline phase** (4).



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FIELD APPLICATION

Microbes for **bioaugmentation** or nutrients for **biostimulation** are injected into the contaminated soil or ground water using mobile drill rigs.