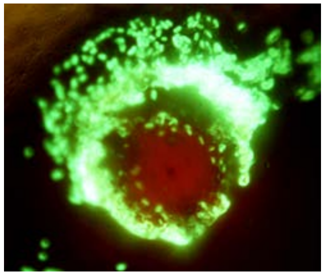
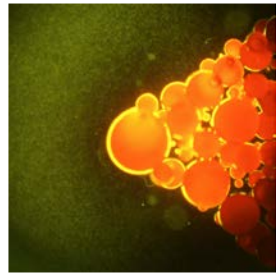
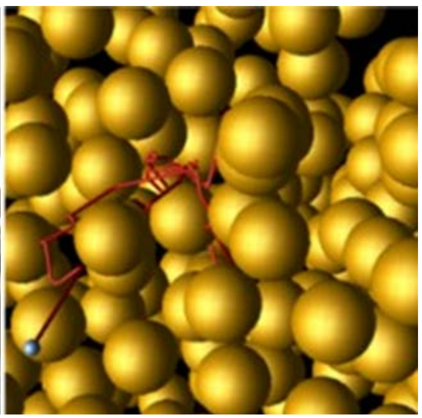
Ford Group








Our research focuses on the application of chemical engineering principles to problems in microbial ecology. The aim is to develop a fundamental understanding of mechanisms underlying microbial behavior, which will provide insights for future technological innovation.

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"Improving the knowledge of how bacteria migrate in subsurface environments, especially within polluted groundwater."

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Bioremediation

In August 2010, government reports claimed that three-quarters of the 4.1 million barrels of oil that spilled from the Deepwater Horizon site was removed or degraded. Although it may appear on the surface that the oil has disappeared, the long-term effects are yet to be realized. Twenty years after the Exxon Valdez oil spill, an estimated 25,000 gallons still remain trapped several feet below the surface on the beaches of Prince William Sounds, Alaska. The oil has persisted because it is trapped within a layer of fine-grained sediment that is impermeable to water flow. Biodegradation rates slowed considerably in this layer because of mass transfer limitations in delivering nutrients, oxygen and bacteria to the residual oil. One way to enhance the delivery of oil-degrading bacteria to the fine-grained layer is to exploit the chemotactic properties of some bacteria.

Our research group studies the transport properties (diffusion, dispersion, retardation, sorption) of chemotactic bacteria that are able to degrade chemical contaminants in groundwater. Chemotactic bacteria detect chemical concentration gradients in their surroundings and migrate toward high concentrations of chemicals that are beneficial to their survival, in this case, the contaminants, which serve as a carbon and energy sources for the bacteria. Using experimental modeling and computational tools that we have developed in our laboratory that range from microfluidic devices, to packed columns to larger-scale microcosms, we evaluate degradation rates for chemotactic and nonchemotactic bacteria in systems with a heterogeneous distribution of chemical contaminants. The goal is to determine the effect of chemotaxis on the overall rates of degradation and design a field-scale study to evaluate predictions of a fate and transport model.

Biofilms

The general focus of this research area is toward understanding factors which govern the attachment of bacteria to surfaces. This is important because when bacteria attach to surfaces it can lead to infection and disease (ranging in severity from gingivitis to cystic fibrosis). By understanding the factors which influence bacterial adhesion, surfaces can be better designed and conditions better controlled to eliminate adhesion and prevent biofilm formation. We are observing how the swimming behavior of a bacterium affects the initial events leading up to its attachment to a surface.

We participate in a number of interdisciplinary activities such as the NIH Biotechnology Training Program. Interdisciplinary training with faculty and students in the departments of Civil Engineering, Environmental Sciences, Cell Biology and Biomedical Engineering is available through common coursework, seminar programs and industrial internships.

RECENT RESEARCH DEVELOPMENTS

- With a collaborator at NIST we developed a microfluidic device to detect and quantify the chemotactic sensitivity of bacteria isolated from groundwater to chemical pollutants.

RECENT GRANTS

- Gulf of Mexico Research Initiative – *Role of Microbial Motility in Degradation of Dispersed Oil*
- NIH - *Understanding Aromatic Hydrocarbon Uptake as the First Step in Biodegradation*
- NSF - *A Multiscale Analysis of the Transport of Chemotactic Bacteria in Heterogeneous Porous Media*

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