Environment

Chemistry of uranium-eating microbes

Scientists who demonstrated the potential of a particular bacterium to remove heavy metals from polluted streams and to decontaminate nuclear waste have figured out how these microbes do their dirty work.

In weeks, this *Citrobacter* species can accumulate 9 grams of uranium for each gram of its own dry weight without suffering ill effects, says Lynne E. Macaskie of the University of Birmingham, England. The microbe makes a metal phosphate, she and her colleagues report in the Aug. 7 SCIENCE.

Macaskie's group observed the bacteria through an electron microscope. In 12 hours, the cells became opaque to electrons, especially along the edges. Dried cells turned yellow and emitted fluorescence characteristic of uranium compounds. X-ray data indicated that the cells had simultaneously used equal amounts of phosphate and uranium, the researchers report. Further analysis confirmed that the bacteria made crystals of a metal phosphate that chemists often synthesize.

"The more you know about the mechanism, the better your chances of improving on the process," comments Derek Lovley, a microbiologist with the U.S. Geological Survey in Reston, Va.

Macaskie suggests that enzymes in the bacterium make a negatively charged phosphate that then automatically joins with a positively charged uranium-oxygen complex to form a crystal. Water surrounding these chemicals helps stabilize their fibrous crystal structures, she says. Macaskie has watched these fibers grow out of the cell surface once the bacterium starts to accumulate material. Those whiskers may appear where the enzyme is making phosphate available to combine with uranium, the researchers note.

In 1991, Lovley discovered a different bacterium useful for removing uranium. Instead of storing uranium in its cells, this microbe uses enzymes to convert uranium ions to an insoluble form. Thus, dissolved uranium settles out as uraninite (uranium ore) and can be filtered from water. "It's a very stable process; we don't even need a living cell," he notes.

In a report coming out this fall in ENVIRONMENTAL SCIENCE AND TECHNOLOGY, Lovley and his colleagues describe their success in using this microbe to decontaminate nuclear waste sites.

Also, in the May ENVIRONMENTAL SCIENCE AND TECHNOLOGY, Lovley's team reported the discovery of bacteria that get rid of chlorofluorocarbons, common chemicals blamed for destroying ozone in the atmosphere. These bacteria do not accumulate chlorofluorocarbons but probably break them down into carbon dioxide and chloride or fluoride salts, Lovley says.

Public unaware of water problems

Water utilities often fail to notify customers when temporary problems arise in the quality of drinking water, according to a June report by the General Accounting Office (GAO).

From 1989 to 1991, GAO surveyed 28 water systems in Arizona, New Jersey, Ohio, Tennessee, Texas, and Washington. It determined that consumers learned of problems quickly in only 17 of 157 incidents, even though the law requires timely notification. Also, 103 violations of the Safe Drinking Water Act involved problems that may pose long-term health risks. More than half the time, consumers never received warnings at all.

The report cites inadequate manpower and resources plus complex notification regulations as the chief causes of the problem. It also notes that government officials expect that eventual regulation of 83 contaminants in drinking water will make compliance even more difficult.

The Environmental Protection Agency requires specific venues of communication for violations with immediate, long-term, or indirect effects on public health. The GAO report calls for greater flexibility in the notification requirements and for reduced emphasis on notification for less serious infractions.

Food Science

Fungal fish-oil factories


Scott Bauer/ARS

Blade harvesting fungus off cylinder.

Over the past decade, researchers have documented numerous health benefits — including reduced risks of cancer, heart disease, and autoimmune disorders — from fish oils rich in long-chain, omega-3 fatty acids. But many people object to the oil's fishy taste. So scientists at the Agricultural Research Service (ARS) in Philadelphia have engineered a fishless alternative: bioreactors that grow fungi rich in one of fish oil's most beneficial constituents, eicosapentaenoic acid (EPA).

In 1990, Eric W. Wessinger and his co-workers at ARS identified four species of *Pythium* fungi that naturally manufacture EPA. Though industrial systems can harvest such fermentation products from fungi grown in bioreactors, the strand-like structure of *Pythium* and other filamentous fungi precluded their efficient use in such reactors. So Dennis J. O'Brien and his ARS colleagues came up with a new design.

Most industrial fermenters grow free-floating clumps of fungus within a soup of nutrients. Key to the new ARS device is a rotating cylinder, half submerged in the fungus' nutrient soup. About a day after biochemists seed the soup with *Pythium*, the fungus begins locking onto the cylinder. O'Brien says the growing fungus feels like raw chicken skin and "looks similar to fibers on a paint roller." To obtain EPA, technicians periodically scrape mats of fungus off the cylinder.

Because the fungi also feed on whey, a by-product of cheesemaking, the process may even provide dairy farmers a market for a waste they currently pay to get rid of, adds Wessinger, now with A. E. Staley Manufacturing Co. in Decatur, Ill.

Like raw oysters? Drink to your health

As you sit at a beachfront bistro dining on fresh oysters, consider this sobering fact: Raw shellfish can transmit the hepatitis A virus. Last year, Jean-Claude A. Desenclos of the Centers for Disease Control in Atlanta and his co-workers reported on a 1988 outbreak of the disease, which they linked to tainted oysters consumed in Panama City, Fla. They estimated medical costs and lost wages for its 61 victims — some of whom remained sick for 49 days — at roughly $200,000.

Drinkers may be tempted to drown such thoughts with a stiff belt. Indeed, for diners unwilling to eschew raw shellfish, that may prove useful, according to a new study led by Desenclos.

The researchers queried victims of the Panama City outbreak — and their unaffected dining companions — about what they drank on that fateful day. Just one drink of liquor or a glass of wine appeared to offer protection against hepatitis infection, the team reports in the July EPIDEMIOLOGY. Among diners eating at least a dozen oysters, those who imbibed liquor or wine were only 30 percent as likely to become infected compared with teetotalers. However, taking more than one alcoholic drink offered no additional protection, and drinking beverages containing less alcohol — such as beer — appeared to confer little protection.

Desenclos and his coauthors cite two unpublished studies indicating that alcohol consumption may also reduce the infectivity of two diarrhea-causing bacteria, *Shigella* and *Salmonella*, probably by increasing stomach acidity. Because the hepatitis virus can withstand very acidic conditions, the researchers suspect a different protective mechanism here, such as a reduction in the virus' ability to latch onto cell membranes in the digestive tract.