A radical solution for environmental pollution

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Nature abounds with examples of bacteria that can thrive in extreme situations—surviving on toxic chemicals, for instance. In a paper published online in the Journal of the American Chemical Society (JACS) May 25, University of Michigan researchers show how some bugs manage to do that: by harnessing other potentially harmful chemicals known as free radicals to degrade the toxins they live on.

Such insights could lead to new ways of engineering bacteria to clean up environmental messes, said associate professor of chemistry E. Neil Marsh, who did the work with postdoctoral fellow Chunhua Qiao.

Free radicals—highly reactive chemical species that have been implicated in aging, diseases such as Alzheimer's and cancer, and even destruction of the ozone layer—aren't all bad, Marsh said. Many essential chemical reactions occurring in living organisms involve enzymes that use radicals. In the work described in the JACS paper, Marsh and Qiao investigated the chemical reactions that allow the bacterium Thauera aromatica to live on toluene as its sole source of carbon and energy.

"Toluene is a by-product of oil refining, so there's quite a lot of environmental contamination with this and related hydrocarbons, from refineries or chemical plants," Marsh said. "Because of their molecular structure, these compounds are very difficult to degrade, which is why they're pollution hazards." Toluene is especially worrisome because it's more soluble in water than most organic compounds are, which means

that it can contaminate groundwater.

Bacteria such as *T. aromatica* hold promise for use in cleaning up environmental pollutants because they not only can break down hazardous chemicals, but they can also do it underground, in oxygen-scarce environments—just the sort of places where toluene could be causing problems.

Marsh would like to transfer *T. aromatica*'s toluene-degrading abilities to other bacteria that are more easily cultured and more tolerant of various environmental conditions. He'd also like to coax T. aromatica into neutralizing other kinds of pollutants, but the first step is understanding exactly how the bug breaks down toluene.

"The challenge is that the chemical reactions these bacteria use are very unusual—not the standard chemical reactions that chemists usually think about," said Marsh. "It turns out that the solution to metabolizing these very inert compounds is to harness the reactive chemistry of free radicals. To a chemist it's an elegant solution to a difficult problem—even if we still don't really understand how the enzymes that catalyze these reactions work, for everyone else it could mean less pollution."

Links: JACS paper

Source: University of Michigan