BIOREMEDIATION

Toxic pollutants are released into the environment every day; some of those will remain there for thousands of years. If these sites are not cleaned up they will cause great harm to the environment and the plants, animals and people living nearby. The problem with cleaning up some of these toxic chemicals is that the cleaning process can create more pollution. Wouldn't it be better if toxic pollutants could be removed in a cleaner way? In the 1960s scientists discovered that soil bacteria were capable of degrading (breaking down) **xenobiotic** (meaning 'unnatural' or 'synthetic' from the Greek *xenos* meaning 'foreign') chemicals into harmless products that they could use for energy. The process of using microorganisms to clean up toxic sites, such as oil spills, is called **bioremediation**.

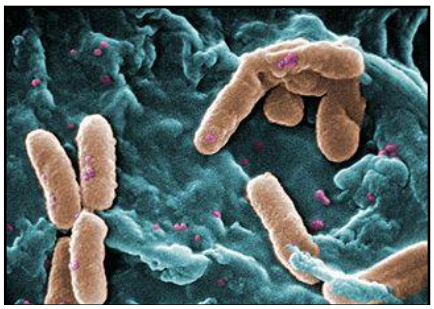

Figure 1: *Pseudomonas aeruginosa*. Image source: http://commons.wikimedia.org/wiki/File:Pseudomonas.jpg Wikimedia Commons.

Certain bacteria are very good at breaking down xenobiotic compounds; for instance the genus Pseudomonas is capable of detoxifying more than 100 different compounds. They are able to do this because they carry genes that code for enzymes which are able to break down toxic compounds. Unfortunately, this is not a perfect process. The breakdown of toxic compounds may be very slow, the bacteria may not be able to degrade all of the chemicals and the chemicals may actually kill the bacteria themselves at high concentrations. But scientists have a trick up their sleeves.

Just as scientists can make bacteria produce valuable products that the bacteria would otherwise never make, scientists can also make bacteria break down compounds that they would never be capable of breaking down - with a little assistance from genetic engineering. Genes coding for degradative enzymes are usually located in plasmids. Many of these different plasmids can be transferred to a single strain of bacteria to make it a '**superbug**.' This means that a scientist could control which toxic chemicals are broken down. An example of this procedure resulted in bacteria that are capable of degrading camphor (CAM), octane (OCT), xylene (XYL) and naphthalene (NAH) - all toxic chemicals (see Figure 2). The inventor of this 'superbug' obtained the first **patent** (intellectual property rights granted to an inventor) ever for a genetically-engineered microorganism.

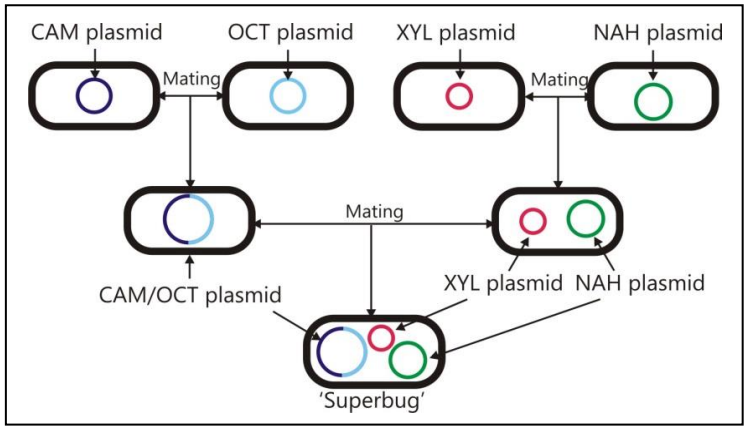

Figure 2: Cloning procedure for creating a 'superbug.' Image source: Let's Talk Science.

Bioremediation was one of the tools used to help clean up the *Exxon Valdez* oil spill that occurred on March 24, 1989 when the *Exxon Valdez* oil tanker hit a reef, spilling 260,000 to 750,000 barrels of crude oil into Prince William Sound, Alaska. More recently, in the massive *Deepwater Horizon* oil spill, in which the oil rig exploded on April 20, 2010 causing a sea-floor oil gusher that took 87 days to cap off, the alkane-degrading marine bacterium *Alcanivorax borkumensis* was added to the waters to speed digestion of the crude oil in the Gulf of Mexico.

Thank you to the Let's Talk Science Challenge volunteer writers who provided content in this backgrounder.