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INCOMPLETE BACTERIAL METABOLISM OF POLYCYCLIC AROMATIC
HYDROCARBONS

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The main goal of bioremediation is to remove pollutants that have been identified as posing risks to human health. Accordingly, we measure the success of bioremediation practices by measuring the disappearance of the regulated compounds. In most cases we overlook the potential for microorganisms (more specifically the enzymes they express) to transform these compounds to products that cannot be metabolized further, either by the organism responsible for the transformation process or, perhaps, by other organisms in the same microbial community. There are several well-known examples of microbial enzymes that have substrate specificities much broader than the range of substrates that the host organism can metabolize completely, so that such incomplete metabolism is likely to be common in complex environmental systems. We rarely, however, characterize the products of incomplete microbial metabolism with respect to their effects on biodegradation processes or their potential risks to human health. We have identified major products from the incomplete metabolism of pyrene and fluoranthene by bacteria able to grow on other polycyclic aromatic hydrocarbons (PAH). Two of these products, pyrene-4,5 dione (pyrene quinone) and fluoranthene-2,3-dione (fluoranthene quinone), have been shown to inhibit the mineralization of benzo[a]pyrene by PAH-degrading bacteria. We have also shown recently that, like other quinones derived from mammalian metabolism of PAH, these quinones can cause oxidative damage to DNA in vitro through a copper-mediated redox cycle and subsequent production of reactive oxygen species. Pyrene quinone also produced DNA damage in HeLa cells, whereas the fluoranthene quinone was toxic to the HeLa cells in a manner that did not lead to DNA damage. Since these and other potentially toxic products from the bacterial transformation of PAH are formed by organisms isolated from PAH-contaminated systems, we hypothesize that their formation in contaminated systems is inevitable. Accordingly, we propose that further research should focus on investigating the occurrence and fate of such compounds in environmental systems.