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Harnessing the Novel Feammox Bacterium, Acidimicrobium sp. Strain A6, for PFAS Defluorination: The Path from Discovery to Applications

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Abstract

PFAS, per and polyfluorinated alkyl substances, are a large group of chemical compounds that are found in a wide range of consumer products, they are ubiquitous in the environment and extremely stable. Among the most common PFAS are perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS), which have been associated with various health effects, including cancer. Hence, in 2016 EPA has established Drinking Water Health Advisories for PFOA and PFOS. The strong carbon-fluorine bond gives these molecules their desirable properties, making them extremely stable even at very high temperatures, so that they have been dubbed "forever chemicals."

We have recently discovered a novel bacterium Acidimicrobiaceae sp. A6 (referred to as A6), that can oxidize of ammonium to nitrite under iron-reducing conditions, a process referred to as Feammox. The genome of A6 has been sequenced and contains genes for reductive dehalogenases (RDases). RDases are a group of enzymes that facilitate organohalide respiration by some bacteria, and PFAS are organohalides. Upon further investigation we have shown that A6 is capable of degrading PFOA and PFOS, that a novel reductive dehalogenase gene is expressed during this process, and that in the presence of PFAS electrons from the ammonium are transferred to both, iron and PFAS.

While some organisms have been known that are able to defluorinated polyfluorinated (partially fluorinated) compounds, A6 is the first bacterium that has been shown to defluorinate perfluorinated (fully fluorinated) compounds such as PFOA and PFOS. This talk will highlight how this novel bacterium was discovered, how incubations were conducted to show that PFAS are defluorinated by A6, how this defluorination is linked to specific gene expression, as well as emerging applications of these findings to treat PFAS contaminated waters, and biosolids.