

Novel Cobamide Structure May Hold Clues for More Effective Biological Degradation of Chlorinated Compounds

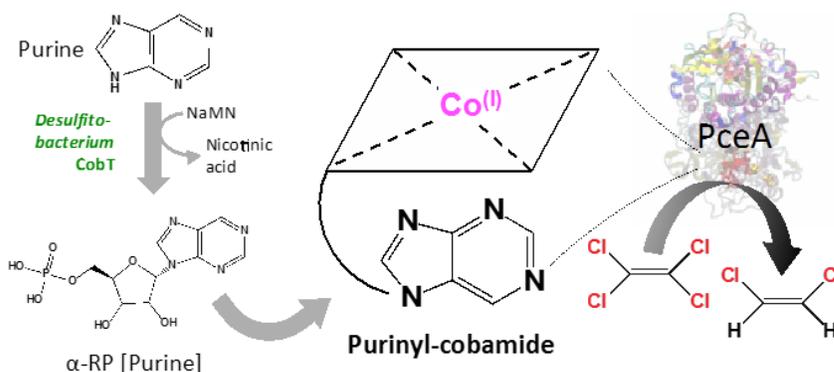
Researchers at the University of Tennessee have discovered a crucial compound that helps specific bacteria degrade pollutants like tetrachloroethene (PCE). This compound, called purinyl-cobamide, assists enzymes during degradation reactions.

Researchers identified purinyl-cobamide in a study led by Superfund Research Program grantee Frank Loeffler, Ph.D. These helper molecules are part of a larger group of chemical structures known as cobamides. A majority of organisms, including humans, require cobamides for normal functioning. Vitamin B12 is the best-known member of this group of helper molecules.

Investigating how Chemical Structure Affects Molecular Function

The researchers previously discovered that changes to the lower base structure of cobamides influence the bioremediation efficiency of the bacterium *Dehalococcoides mccartyi*, a key organism for in situ treatment of toxic chlorinated compounds. They found that minor structural differences in the lower base affected whether degradation of PCE stopped at vinyl chloride, a carcinogen, or proceeded all the way to non-toxic ethene. Since *Dehalococcoides* cannot synthesize its own helper molecules, the findings emphasize the importance of understanding how other microorganisms interact with *Dehalococcoides* and enable efficient detoxification.

Building on this work, they investigated the structure of the helper molecules involved when a different type of bacterium, *Desulfitobacterium hafniense*, partially degrades PCE. Combining cultivation and sophisticated analytical techniques, they found that *Desulfitobacterium* uses unsubstituted purine to build a functional cobamide that enables PCE degradation. Interestingly, the *Desulfitobacterium* cobamide does not support *Dehalococcoides* dechlorination activity, and knowledge and availability of the correct lower base type is crucial to sustain the activity of bacteria involved in priority pollutant detoxification.



Desulfitobacterium uses unsubstituted purine to form purinyl-cobamide, a helper molecule that initiates PCE detoxification. (Image courtesy of Frank Loeffler)

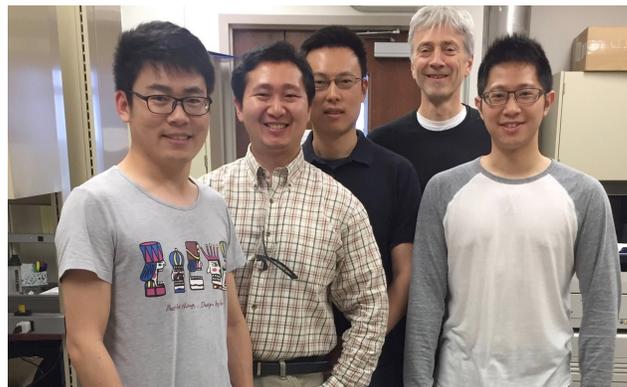
Many types of substituted purine bases, which are derivatives of unsubstituted purine, have known biological functions, including as essential building blocks of DNA. However, unsubstituted purine, which gives its name to the wider class of molecules, was not assigned a specific biological function until now.

Implications for Environmental Cleanup and Human Health

This study further demonstrates that the type of lower base in the cobamide structure plays an important role in the function of enzymes to speed up degradation of chlorinated compounds by bacteria. Understanding the biological and geochemical conditions that support the production of specific cobamides, which efficiently promote dechlorination

to non-toxic end products, may lead to faster detoxification at contaminated waste sites, and can substantially reduce cleanup costs.

These findings also expand the diversity of naturally occurring cobamide structures and assign the first biological function to unsubstituted purine. Enzymes that depend on cobamides fulfill essential metabolic functions in most organisms, including mammals. As a result, a better understanding of how the lower base of the cobamide structure controls enzyme activity may be relevant to any natural and engineered microbiome, and even have implications for the progression of certain human diseases



Project researchers include, from left, Yongchao Yin; Nannan Jiang; Jun Yan, Ph.D.; Loeffler; and Po-Hsiang Wang. (Photo courtesy of Frank Loeffler)

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To learn more about this research, please refer to the following source:

Yan J, Bi M, Bourdon AK, Farmer AT, Wang PH, Molenda O, Quaille AT, Jiang N, Yang Y, Yin Y, Şimşir B, Campagna SR, Edwards EA, Löeffler FE. 2017. Purinyl-cobamide is a native prosthetic group of reductive dehalogenases. Nat Chem Biol [Online Nov 6 2017]. doi: [10.1038/nchembio.2512](https://doi.org/10.1038/nchembio.2512) PMID: [29106396](https://pubmed.ncbi.nlm.nih.gov/29106396/)

