

# Anaerobic mercury methylation and demethylation by *Geobacter bemidjiensis* Bem discovered

Contact: Baohua Gu (GuB1@ornl.gov, 865-574-7286)

DOE Office of Science/Biological & Environmental Research

## Objective

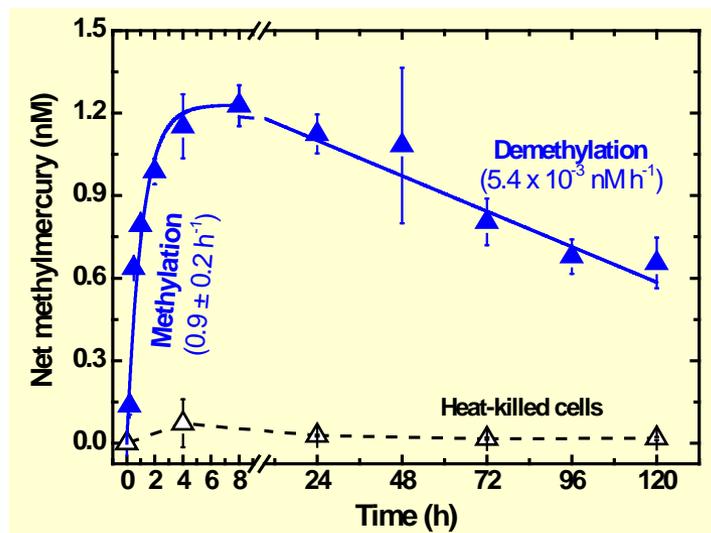
- Determine if the iron reducing bacterium *Geobacter bemidjiensis* Bem can degrade methylmercury under anoxic conditions and, if so, by what mechanism.

## New Science

- For the first time, strain *G. bemidjiensis* Bem is found to methylate mercury and degrade methylmercury concurrently under anoxic conditions.
- A reductive demethylation pathway is utilized by Bem to degrade methylmercury, likely due to its genes encoding homologs of a organomercurial lyase (MerB) and a mercuric reductase (MerA).
- Bem cells can strongly sorb mercury and methylmercury, as well as reduce or oxidize mercury, resulting in both time and concentration-dependent Hg species transformations.

## Significance

- *Geobacter bemidjiensis* bacteria widely occur in sediments and water, including permafrost soils, and may thus play an important role in controlling net methylmercury production and bioaccumulation in biota in natural aquatic environments.



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Microbial methylation and demethylation are two competing processes controlling the net production and bioaccumulation of neurotoxic methylmercury in natural aquatic ecosystems. Although mercury (Hg) methylation by anaerobic microorganisms and demethylation by aerobic Hg-resistant bacteria have both been extensively studied, little attention has been given to MeHg degradation by anaerobic bacteria, particularly the iron-reducing bacterium *Geobacter bemidjiensis* Bem. We report, for the first time, that the strain *G. bemidjiensis* Bem can mediate a suite of Hg transformations, including Hg(II) reduction, Hg(0) oxidation, MeHg production and degradation under anoxic conditions. Results suggest that *G. bemidjiensis* utilizes a reductive demethylation pathway to degrade MeHg, with elemental Hg(0) as the major reaction product, possibly due to the presence of genes encoding homologs of a organomercurial lyase (MerB) and a mercuric reductase (MerA). In addition, the cells can strongly sorb Hg(II) and MeHg, reduce or oxidize Hg, resulting in both time and concentration-dependent Hg species transformations. Moderate concentrations of Hg-binding ligands such as cysteine enhance Hg(II) methylation but inhibit MeHg degradation. These findings indicate a cycle of Hg methylation and demethylation among anaerobic bacteria, thereby influencing net MeHg production in anoxic water and sediments.

Lu, X., Y. Liu, A. Johs, L. Zhao, T. Wang, Z. Yang, H. Lin, D. A. Elias, E. M. Pierce, L. Liang, T. Barkay, B. Gu. Anaerobic Mercury Methylation and Demethylation by *Geobacter bemidjiensis* Bem. *Environ. Sci. Technol.* 2016, 50 (8), 4366-4373. DOI: [10.1021/acs.est.6b00401](https://doi.org/10.1021/acs.est.6b00401).