ENIGMA Microbial Physiology: Assimilatory and Dissimilatory Metallomics of *Desulfovibrio vulgaris* and *Pelosinus* strain A11

W. Andrew Lancaster* (lancaste@uga.edu)[1], Israel Scott[1], Brian Vacarro[1], Angeli Lal Menon[1], Farris L. Poole[1], Jil Geller[2], Jennifer J. Mosher[3], **Terry C. Hazen**[2,3], **Dwayne A. Elias**[3], **Michael W. W. Adams**[1], **Adam P. Arkin**[2] and **Paul Adams**[2]

[1]University of Georgia, Athens, GA 30602, [2]Lawrence Berkeley National Laboratory / ENIGMA, Berkeley, CA 94720, [3]Oak Ridge National Laboratory, Oak Ridge, TN 37830

http://enigma.lbl.gov/

Project Goals: The goals of the ENIGMA (Ecosystems and Networks Integrated with Genes and Molecular Assemblies) project are to understand at a molecular systems biology level the microbial communities at DOE sites contaminated with heavy metals or radionuclides with sufficient detail to predictively model interactions within microbial and community processes that drive complex geochemistry in key environments. We expect to define biological principles governing selection of microbial community function and composition in given environments.

While some heavy metals are environmental contaminants, metals in general have a very positive role in biological systems as they afford proteins virtually unlimited catalytic potential, enable electron transfer reactions and greatly impact protein stability. Consequently, metal-containing proteins play key roles in virtually all biological processes. However, the full complement of metalloproteins within a given cell cannot be predicted solely from bioinformatic analyses of a genome sequence since metal coordination sites are diverse and poorly recognized. Hence it is not possible to predict the number and types of metals that a microorganism utilizes and how these might vary with the growth conditions. Determining the metals that are taken up during microbial growth and the metal content of fractionated native biomass can provide insight into these issues and, using coupled MS/MS analyses with extensive fractionations, can reveal completely new aspects of metal metabolism (1). Herein we report comparative metallomic analyses of the model microbe, *Desulfovibrio vulgaris* strain Hildenborough (DvH), and a newly described microbe, *Pelosinus* strain A11, which was recently isolated from an enrichment of a groundwater sample from the Hanford site by Elias and coworkers at ORNL. DvH was grown on lactate under sulfate-reducing conditions in a 600-liter metal fermenter and in a glass 5-liter fermenter and the nature of metals assimilated were compared. *Pelosinus* A11 was also grown at the 600-liter scale on fructose in the absence of sulfate and the assimilated metals were determined using ICP-MS (53 elements). Both organisms assimilated 20 or so metals into their cytoplasmic fractions, but the types and amounts were species specific. For example, DvH assimilated cobalt, cadmium and tungsten into high molecular weight complexes (> 3 kDa) but *Pelosinus* A11 did not. In contrast to DvH, *Pelosinus* A11 assimilated vanadium, copper and uranium into >3kDa complexes. A number of additional factors affecting metal metabolism were analyzed, including growth with and without added chromium or uranium to study assimilation and dissimilatory reduction of these metals.

The results will be presented in terms of the ranges and types of metals assimilated by DvH and Pelosinus A11 and the metals available in the organisms' natural environments, including Hanford groundwater.

Reference

1. Cvetkovic, A., Menon, A. L., Thorgersen, M., Scott, J. W., Poole, F. L., Jenney, F. E., Lancaster, W. A., Praismann, J. L., Shanmukh, S., Vaccaro, B., Trauger, S. A., Kalisiak, E., Apon, J. V., Siuzdak, G., Yannone, S. M., Tainer, J. A. and Adams, M. W. W. (2010) Microbial metalloproteomes are largely uncharacterized. *Nature* **466,** 779-782

This work was conducted as part of the ENIGMA project and was supported by the Office of Science, Office of Biological and Environmental Research, of the U. S. Department of Energy under Contract No. DE-AC02-05CH11231.