

Title: GROWTH AND METABOLISM OF INDIVIDUAL BACTERIAL CELLS UTILIZING NANOSIMS

Termination Date: 08/31/2006 Final Technical Report Due: 11/29/2006

This work involved the use of the Nano-SIMS Instrument at Lawrence Livermore Laboratory, in an effort to utilize this unique tool for experiments in Biology. The work consisted primarily of experiments to measure in real time, C and N fixation in cyanobacteria. The work revealed a number of the difficulties in using the nano-SIMS approach with biological material, but with collaboration from a number of individuals at USC and LLNL, major progress was made.

The collaborators from LLNL were from the Chemistry Group (Dr. Peter Weber), and the Biology Group (Dr. Jennifer Pett-Ridge). In addition, there were a number of other scientists involved from LLNL.

The USC group consisted of Dr. K.H. Nealson, the PI on the grant, Dr. R. Popa, a postdoctoral fellow and research associate at USC, Professor Douglas Capone, and Juliet Finze, a graduate student in biology.

Two major experiments were done, both of which yielded new and exciting data.

1. We studied nitrogen and carbon fixation in *Anabaena*, demonstrating that fixation of N occurred rapidly in the heterocysts, and that the fixed N was transported rapidly and completely to the vegetative cells. C fixation occurred in the vegetative cells, with labeled C remaining in these cells in support of their growth and metabolism. This work was accepted in the ISME Journal (Nature Publication), and published last month.
2. We studied nitrogen and carbon fixation in *Trichodesmium*, a non-heterocystous cyanobacterium that also fixes nitrogen. Interestingly, the nitrogen fixation was confined to regions within the filaments that seem to be identical to the so-called cyanophycean granules. The fixed N is then transported to other parts of the cyanobacterium, as judged by movement of the heavy N throughout the filaments.

On the basis of these very exciting results, we have applied for funding from the NSF to continue the collaboration with LLNL. The results of both studies were presented in the summer of 2007 at the Gordon Research Conference (Applied Environmental Microbiol.)

Publications:

1. Popa, R., P.K. Weber, J. Pett-Ridge, J.A. Finzi, S.J. Fallon, I. D. Hutcheon, K.H. Nealson, and D.G. Capone. 2007. Carbon and nitrogen fixation and metabolite exchange in and between individual cells of *Anabaena oscillarioides*. The ISME Journal 1:354-360
2. Finzi, J.A., J. Pett-Ridge, P.K. Weber, R. Popa, T. Gunderson, K. H. Nealson, and D.G. Capone. 2007. Temporal Segregation of CO₂ and N₂ Fixation in

Trichodesmium IMS-101 Using Nanometer-Resolution Secondary Ion Mass Spectrometry (nanoSIMS) (submitted to Nature).