

# Summary Reports on Previous Projects

George E. Fox  
Department of Biology and  
Biochemistry and  
Department of Chemical Engineering

Richard C. Willson  
Department of Chemical Engineering  
and Department of Biology and  
Biochemistry

Duane L. Pierson  
NASA-JSC

Don L. Tucker  
Post-Doctoral Fellow

## Effects of Simulated Microgravity on Microbial Gene Expression

These are the predecessor projects to projects discussed earlier. Initial funding was used to support postdoctoral fellow Dr. Gary Schultz who was replaced after the first year by Dr. Don L. Tucker, a USRA Fellow currently working with Dr. Duane Pierson at NASA-JSC. Although the ongoing current research is a continuation of these earlier projects, it should be noted that the initial results obtained contributed to the successful effort by Drs. Fox and Willson to obtain major funding from the National Space Biomedical Research Institute (NSBRI). That funding was responsible for multiple publications in the current year. Ongoing work on the current PDAF provided significant preliminary results for a current award from the Office of Biological and Physical Research to Dr. Fox and Dr. Willson.

### Publications

DeWalt, B., J. C. Murphy, G. E. Fox, and R. C. Willson. "Compaction Agent Clarification of Microbial Lysates," *Protein Expression and Purification* 28 (2003): 220-23.

Kourentzi, K. D., G. E. Fox, and R. C. Willson. "Hybridization-Responsive Fluorescent DNA Probes Containing the Adenine Analog 2-AminoPurine," *Analytical Biochemistry* 322 (2003):124-26.

Martin, K. A., J. L. Siefert, S.Yerrapragada, Y. Lu, T. Z. McNeil, P. A. Moreno, G. M. Weinstock, W. R. Widger, and G. E. Fox. "Cyanobacterial Signature Genes,"

*Photosynthesis Research* 75 (2003): 211-21.

Murphy, J. C., G. E. Fox, and R. C. Willson. "Enhancement of Anion-Exchange Chromatography of DNA Using Compaction Agents," *J. Chromatogr. A* 984 (2003): 215-21.

Murphy J. C., D. L. Jewell, K. I. White, G. E. Fox, and R. C. Willson. "Nucleic Acid Separations Using Immobilized Metal Affinity Chromatography," *Biotechnology Progress* 19 (2003): 982-86.

Nagaswamy, U. and G. E. Fox. "RNA Ligation and the Origin of tRNA," *Origins Life and Evolution of the Biosphere* 33 (2003): 199-209.

### Presentations

Yerrapragada, S., J. L. Siefert, K. A. Martin, and G. E. Fox. "Cyanobacterial Signature Genes," NASA Astrobiology General Meeting 2003, Phoenix, AZ, Feb. 10-12, 2003.

Nagaswamy, U. and G. E. Fox. "Transfer RNA May Have Arisen by RNA Ligation," NASA Astrobiology General Meeting 2003, Phoenix, AZ, Feb. 10-12, 2003.

D'Souza, L. M., M. Larios-Sanz, R. A. Setterquist, R. C. Willson, and G. E. Fox. "Numerous Primary Sequences Can Be Incorporated Into Artificial Stable RNAs," Environmental Biotechnology Session, Annual Meeting American Chemical Society, New Orleans, LA, March 23-27, 2003.

Larios-Sanz, M., K. D. Kourentzi, G. E. Fox, and R. C. Willson. "Microbial Identification Using Signature Probes," Annual Meeting American Chemical Society, New Orleans, LA, March 23-27, 2003.

DeWalt, B., J. C. Murphy, T. Cano, J. Zijffer, G. E. Fox, and R. C. Willson. "Compaction Agent Clarification of Microbial Lysates," Annual Meeting American Chemical Society, New Orleans, LA, March 23-27, 2003.

Belapurkar, C., T. B. Li, G. E. Fox, R. C. Willson, and Y. Fofanov. "Improved R-Q Set Operations Facilitate Subsequence Analysis of Genomes," 20th annual meeting of Houston Society for Engineering in Medicine and Biology, Houston, TX, April 3-4, 2003.

Shi, L., T. B. Li, D. Tucker, F. Karouia, R. C. Willson, G. E. Fox, and Y. A. Fofanov. "Pair-Wise Correlation Analysis Applied to Gene Expression Data from Two *Escherichia coli* Strains," 20th annual meeting of Houston Society for Engineering in Medicine and Biology, Houston, TX, April 3-4, 2003 (poster).

Wang J., Y. Luo, T. B. Li, D. L. Tucker, F. Karouia, G. E. Fox, R. C. Willson, and Y. Fofanov. "ImageAnalyzer: A Flexible Application for Microarray Image Analysis," Eighth Annual Structural Biology Symposium, Sealy Center for Structural Biology, Galveston, TX, May 2-4, 2003.

Tucker, D. L., C. M. Ott, D. L. Pierson, R. C. Willson, and G. E. Fox. "Functional Genomic Analysis of *E. coli* in a Low-Shear Modeled Microgravity Environment," 103rd General Meeting American Society Microbiology, Washington, DC, May 18-May 22, 2003.

Larios-Sanz, M., K. Kourentzi, Z. Zhang, R. C. Willson, D. L. Pierson, D. L. Tucker, and G. E. Fox. "Molecular Tools to Monitor Microbial Ecosystems During Long-Term



**Dr. Don L. Tucker (l.), post-doctoral Aerospace Fellow, conducts research with Dr. George Fox (r.) and Dr. Richard C. Willson (not shown) in the development of molecular tools designed to monitor microbial ecosystems during space missions devoted to long-term exploration. Dr. Tucker conducts research both on the main campus and in NASA labs.**

**NASA LABORATORIES—Dr. Charlie Ott conducts medical-related research in NASA Laboratories. Recent studies have shown that different organisms may dramatically differ in their responses to medically significant low-shear environments and space environments.**

Exploration Class Missions,” 103rd General Meeting of the American Society for Microbiology, Washington, D.C., May 18–22, 2003.

Huang, H.-C., U. Nagaswamy, and G. E. Fox “Structural Bioinformatics on Ribosomal RNA,” Eighth Annual Structural Biology Symposium, Sealy Center for Structural Biology, Galveston, TX, May 2–4, 2003.

Wang, J., U. Nagaswamy, and G. E. Fox. “A Pair of Partially Identical Ribosomal Proteins,” Eighth Annual Structural Biology Symposium, Sealy Center for Structural Biology, Galveston, TX, May 2–4, 2003.

Willson, R. C. and G. E. Fox. “New approaches to Nucleic Acid Purification: Compaction Precipitation and Metal-chelate Affinity,” International Symposium on Biorecognition and Affinity Technology, Cambridge, UK, Aug., 2003.

#### **Funding and Proposals**

Fox, G. E. “The Origins of Translation and Early Life,” NASA Exobiology Program, July 1, 2002–June 30, 2005, \$343,177 (*current funding*).

Fox, G. E. and R. C. Willson. “Microorganisms in the Spacecraft Environment,” National Space Biomedical Research Institute, Oct. 1, 2000–Feb. 29, 2004. \$966,040 (*expired funding*).

Fox, G. E. “Chiral-Selective Planetary Chemistries as a Marker for Life,” NASA ASTID Program. \$429,920 requested for two years (*pending*).

Driks, A., R. C. Willson, and G. E. Fox. “Quantitative Polymerase Chain Reaction (Q-PCR) Technology to Measure Molecular Contamination and Validate Subsystem Cleanliness,” NASA Planetary Protection Program. 3 Years, UH subcontract was for \$100,000/Yr. (*not funded*).

## Characterization of Evolving Bacterial Populations

This project contributed to the preliminary results presented to NASA as part of an Astrobiology Center proposal submitted in early 2003 but not funded. Subsequent discussions of the project with Dr. Kasthuri Venkateswaran of the Jet Propulsion Laboratory led to two proposals which were not funded. These proposals are currently under revision.

### Funding and Proposals

Fox, G. E. and K. Venkateswaran. "Comparative Genome Analysis and the Resistance Properties of Various Bacillus Species," Feb. 1, 2005-Jan. 31, 2008; Total UH Costs \$226,723 (*not funded*).

Fox, G. E., et al. "Evolution of Genomes and Cellular Processes in Astronomically Reasonable Environments," NASA Astrobiology Institute Cycle 3. Requested \$7,188,349 for June 1, 2003-May 31, 2008 (*not funded*).

## Rapid Identification of Unexpected Bacterial Pathogens in Space Environments

This project also contributed key preliminary results to the successful NSBRI application discussed above. In addition this work underlies several grant applications in the area of biodefense that Dr. Fox and Willson may submit in the future. The key finding of the project, the existence of 16S rRNA signature oligonucleotides resulted in a 2002 publication in *Bioinformatics*:

Zhang, Z., R. C. Willson, and G. E. Fox. "Identification of Characteristic Oligonucleotides in the 16S Ribosomal RNA Sequence Dataset," *Bioinformatics* 18 (2002): 244-50.

This paper was highly recognized by the lay science press during 2003 being featured in several stories including:

Ananthaswamy, A. "Getting to Grips with Mystery Space Bugs," *The New Scientist* 177 (Feb. 1, 2003): 20.

"Fighting Bacteria in Space," BBC News Science/Nature, Nov. 15, 2002 <<http://news.bbc.co.uk/2/hi/science/nature/2480357.stm>>.

Rayl, A. J. S. "Above and Beyond," *The Scientist* 12.24 (Dec. 9, 2002): 26

*Odyssey Magazine* (2003).

### Additional papers

Chumakova, S., C. Bepaparkara, C. Putoni, T.-B. Li, M. Pettitt, G. E. Fox, R. C. Willson, and Y. Fofanov. "Theoretical Basis for Universal Identification Systems for Bacteria and Viruses." (Submitted to *J. Biol. Phys & Chem.*)

Warmflash, D., M. Larios-Sanz, J. Jones, G. E. Fox, and D. S. McKay. "Assessing the Biohazard Potential of Putative Martian Organisms for Exploration Class Human Space Missions." (Submitted to *Aviation. Sci. Environ. Med.*)

### Funding and Proposals

Bavykin, S., G. E. Fox, and R. C. Willson. "Universal Phylogenetic Microchip for Microbial Community Profiling," Department of Energy NABIR Program. Dec. 1, 2003–Nov. 30, 2006, UH Subcontract for \$367,795 (*not funded*).

Fofanov, Y., R. C. Willson, and G. E. Fox. "Database of Genomic Subsequences and Ultra-specific Probes for Microbial Detection," National Science Foundation, Jan. 1, 2004–Dec. 31, 2007, \$857,091 (*not funded*).

Fofanov, Y., R. C. Willson, and G. E. Fox. "Ultra-specific Host-Blind Probes and Primers for Pathogen Detection," DOD/Army Res. Office, Aug. 9, 2004–Aug. 8, 2007, \$399,260 (*not funded*).

Fofanov, Y., R. C. Willson, and G. E. Fox. "Ultra-Specific Probes Detecting CDC Category A and B Agents," National Institutes of Health, July 1, 2004–June 20, 2006, \$400,000 (*not funded*).