Amudhan Venkateswaran

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Research Intrests

Molecular Microbiology, Molecular Biology, Microbial Genomics and Imaging, Environmental Microbiology

Education

Ph.D., Molecular Biotechnology **June 1999 – July 2003**

Indo-US Collaborative Program
Department of Pathology, Uniformed Services University of the Health Sciences, Bethesda, MD
Birla Institute of Technology and Science, Pilani, India
Thesis Title: Characterization of the Extreme Radiation Resistance Phenotype of *Deinococcus radiodurans* by Physiologic and Differential Expression Analyses

M.S., Biotechnology **Aug 1998 - June 1999**

Birla Institute of Technology and Science (BITS), Pilani, India

B.S., Biological Sciences **Aug 1994 - May 1998**

Birla Institute of Technology and Science (BITS), Pilani, India

Research Experience

Postdoctoral Fellow, Biosciences Division, Oak Ridge National Laboratory, Oak Ridge, TN **April 2005 – Present**

Current Research on Environmental Microbiology The purpose of my current project is to develop a method involving direct sequencing of cDNA from the environment samples utilizing a high throughput sequence analysis system such as Bio454. These methods will allow for total transcriptome sequencing and analysis from environmental samples, unknown bacteria, or uncultured cells. We will develop these novel methods using *Desulfovibrio vulgaris* as model organism followed by studying sediments samples from the ERSP-FRC site or other simple communities to determine gene expression of microorganisms present within low biomass environments.

- Optimizing methods for efficient removal of ribosomal and other structural RNAs. These include testing of different strategies for enrichment of mRNA and examined their effectiveness and any potential for systematic biases based on microarray gene expression profiles. The methods tested include Subtractive Hybridization, Selective Reverse Transcription, and Exonuclease Digestion
- Developing and testing methods for unbiased amplification of cDNA. Different methods to be evaluated in terms of sensitivity (starting from as little as 1ng), minimization of introduced biases (preferential amplification of select templates), and yield using *D. vulgaris* material for optimization similar to the above task.
- Enrichment and amplification of an uncultured thermophilic Ammonia Oxidizing Archaea (AOA) as a test for the application these methods using next generation sequencers

Microbial Genomics and Advanced Imaging My research integrated molecular biology and microbial genomics with advanced imaging (*e.g.*, Confocal Laser Scanning Microscopy (CLSM)) to study protein-protein interactions in live cells from a systems biology perspective. I studied the carbohydrate metabolism in *Escherichia coli*, specifically the relationship between

genes and their products. These studies could be expanded to describe the molecular basis underlying microbial adaptation to environmental stress.

- Genetic modification of proteins involved in glucose uptake in *E. coli* (ptsG and mlc) to encode GFP-fusion proteins at their chromosomal to monitor the subcellular localization and dynamics of these biologically active fusion proteins in the presence and absence of glucose by confocal laser scanning microscopy (CLSM)
- Detection of direct protein-protein interaction between fluorescently-labeled IICBGlc and Mlc in the presence of glucose using Fluorescence Resonance Energy Transfer (FRET)
- Hands-on experience with advanced imaging techniques including Confocal Laser Scanning Microscopy (CLSM) and Atomic Force Microscope (AFM)

Postdoctoral Fellow, Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN **July 2003 – April 2005**

Research Abstract: The bacterium *Deinococcus radiodurans* is one of the most radiation resistant organisms known and is currently being engineered by the U. S. Department of Energy (DOE) for remediation of the toxic metal and organic components of these environmental wastes. My primary research interests and expertise focus was on the molecular mechanisms that enable *D. radiodurans* to survive extreme doses of radiation and the use of high throughput technologies, such as DNA microarray based transcriptome profiling and proteomics to describe the molecular basis underlying *D. radiodurans*' adaptation to environmental stress. The data obtained from these studies established the role of deinococcal physiology in its extreme radiation resistance phenotype and will further aid to the genetic development of *D. radiodurans* for treatment of environments where radiation is the principle factor limiting microbial survival. Following is a brief summary of my research goals and accomplishments

- Microbial Genomics: Systematic analysis of the dynamic changes in the global gene and protein expression profiles of the extremohpile *Deinococcus radiodurans* induced by environmental stress, including ultra violet (UV) light, ionizing radiation, exposure to hydrogen peroxide (H_2O_2), and desiccation
- Construction and use of cDNA microarrays and real-time polymerase chain reaction (RT-PCR)
- Hands-on experience with microarray data analysis software such as ImaGene™ 5 (Imaging Research Inc. Ontario, Canada), GeneSpring 6 (Silicon Genetics, Redwood City, CA), ArrayStat™ (Imaging Research Inc.)

Research Assistant, Department of Pathology, Uniformed Services University of Health Sciences, Bethesda, MD **Jan 1999 – July 2003**

PhD Dissertation Abstract: The principal aim of this dissertation was to define the multiple cellular components expressed by *D. radiodurans* that determine its resistance to ionizing irradiation. The work was conducted using experimental approaches that are based on a combination of physiologic, molecular, and computational biology, as well as recent developments in whole cell analysis by DNA arrays. These approaches were central to the conducted research on developing a better understanding of the global interactions between multiple cellular components and the functional networks within which they operate in *D. radiodurans*.

- Development of a defined minimal medium to examine the effect of nutrient conditions on *Deinococcus radiodurans*' ability to survive acute or chronic irradiating exposures This study identified key nutritional components that govern its radiation resistance phenotype, and how defects identified in its metabolic configuration may contribute to resistance functions
- Physiologic and differential expression analyses were used to study the molecular basis of *D. radiodurans*' radiation resistance phenotype and determine the relationship between its metabolism and resistance phenotype

- A whole genome *D. radiodurans* DNA microarray was used together with real-time polymerase chain reaction (RT-PCR) to examine the expression dynamics of *D. radiodurans* recovering from an acute dose of irradiation
- Laboratory responsibilities included ordering and maintaining inventory for chemicals, interacting with company representatives, and ensuring proper radioactive and chemical waste disposal

Articles in Preparation

- Live Cell Imaging of GFP-tagged Proteins Involved in Glucose Uptake in *Escherichia coli* K12. **Amudhan Venkateswaran**, Mitchel J. Doktycz and Jennifer L. Morrell-Falvey
- A High Throughput Live Cell Imaging-Based Protein Interaction Assay and Automated Image Analysis for Confirming Interactions between Microbial Proteins. Jennifer L. Morrell-Falvey, Sankar Venkatraman, **Amudhan Venkateswaran**, Elizabeth Owens, Dale A. Pelletier, Hairong Qi, and Mitchel J. Doktycz

Journal Publications

- **Venkateswaran**, S. C McFarlan, D. Ghosal, K. W Minton, A. Vasilenko K. Makarova, L. P Wackett, and M. J. Daly. 2000. Physiological determinants of radiation resistance in *Deinococcus radiodurans*. ***Applied and Environmental Microbiology***. 66(6); 2620-2626.
- M. S. Lipton, L.Paa-tolic, G.A. Aderson D.J.Anderson D. Auberry, J.R.Battista, Michael. J. Daly, J.K.Fredrickson, K.K.Hixson, H.Kostandarithes, T. Conrads, C. Masselon, M. Markille, R. J. Moore, M.F.Romine, Y.Shen, N.Shen, N.Tolic, H.R. Udseth, T.D Veentra, **A. Venkateswaran**, K.K.Wong, R.Zhao, and R.D Smith. 2001. Global analysis of the *Deinococcus radiodurans* R1 proteome using accurate mass tags. ***Proc. Natl. Acad. Sci. USA*.** 99(17); 11049-11054.
- Y. Liu, J. Zhou, M. Omelchenko, A. Beliaev, **A. Venkateswaran**, J. Stair, L. Wu, D. K Thompson, D. Xu, I. B Rogozin, E. K. Gaidamakova M. Zhai, K. S. Makarova**,** E. V. Koonin, and and M. J. Daly. 2003. Transcriptome dynamics of *Deinococcus radiodurans* recovering from ionizing radiation. ***Proc. Natl. Acad. Sci. USA***. 100(7); 4191-4196.
- H. Brim, **A. Venkateswaran**, H. M. Konstandarithes, J. K. Fredrickson and M. J. Daly. 2003. Engineering *Deinococcus geothermalis* for bioremediation of high-temperature radioactive waste environments. ***Applied and Environmental Microbiology.*** 69(8): 4575-82.
- M. J. Daly, E. K. Gaidamakova, V. Y. Matrosova, A. Vasikenko, M. Zhai, **A. Venkateswaran,** M. Hess, M. V. Omelchenko, H. Kostandarithes, K. S. Makarova, L. P. Wackett, J. K. Fredrickson, and D. Ghosal. 2004. Accumulation of Mn(II) in a mechanism towards surviving gamma-radiation in *Deinococcus radiodurans*. ***Science***, 306(5698): 1025-8 Epub. September 30, 2004.
- D. Ghosal, M.V Omelchenko, E. K. Gaidamakova, V. Y. Matrosova, A. Vasilenko, **A. Venkateswaran**, M. Zhai, H. M. Kostandarithes, H. Brim, K. S. Makarova, L. P. Wackett, J. K. Fredrickson, and M. J. Daly. 2005. How radiation kills cells: survival of *Deinococcus radiodurans* and *Shewanella oneidensis* under oxidative stress. FEMS Microbiol Rev. Apr;29(2):361-75. Review.

Conference Presentations

- **A. Venkateswaran**, M.J. Doktycz and J. L. Morrell-Falvey. Live Cell Imaging of GFP-tagged Proteins Involved in Glucose Uptake in *Escherichia coli* K12. American Society of Microbiology; 106th General Meeting. May 21 – 25, 2006. Orlando. Florida.
- **A. Venkateswaran**, M. Omelchenko, H. Brim, D. Ghosal, A.r Vasilenko and M. J Daly. January27-31, 2002. Relationship between metabolism, oxidative stress and radiation resistance in the family *Deinococcaceae*. Poster presentation at department of energy genome contractor-grantee workshop IX, Oakland, California.
- Y. Liu, J. Zhou, M. Omelchenko, A. Beliaev, **A. Venkateswaran**, J. Stair, L. Wu, D. K. Thompson, D. Xu, I. B. Rogozin, E. K. Gaidamakova, M. Zhai, K. S. Makarova, E. V. Koonin, and M. J. Daly. Transcriptome

dynamics of *Deinococcus radiodurans* recovering from ionizing radiation. Poster presentation, US-Japan joint workshop on systems biology of useful microorganisms. September 16-18, 2002. Japenese society of bioinformatics. Institute of Advanced Biosciences, Keio University, Japan.

- Y. Liu, **A. Venkateswaran,** A. Beliaev, J., Liyou Wu, D. Thompson, M. J Daly, and J. Zhou. Microarray profiling of global gene expression in *Deinococcus radiodurans* upon exposure to acute radiation. Poster presentation at 9th International conference on microbial genomics, October 28-november 1, 2001.Gatlinburg, Tennessee.
- **A. Venkateswaran**, K. Makarova, H. Brim and M. J. Daly. Genomic informatic based expression (GIBE) analysis of radioactive resistant bacterium *Deinococcus radiodurans*. 2000. Poster Presentation at USUHS Annual Day, USUHS Maryland.

Technical Skills

Molecular Biology Techniques: Whole Genome Microarray, Real Time PCR (RT-PCR), targeted deletion mutagenesis, DNA Sequencing, Western blotting, Southern blotting and Northern blotting techniques, protein tagging, protein-protein interactions, and autoradiography. Hands-on experience with microarray data analysis software such as ImaGene™ 5 (Imaging Research Inc. Ontario, Canada), GeneSpring 6 (Silicon Genetics, Redwood City, CA), ArrayStat™ (Imaging Research Inc.) **Imaging Techniques:** Live-cell imaging (preparation of cells and analysis) using open lab software. Confocal Laser Scanning Microscopy (CLSM) image acquisition and analysis and experience with Atomic Force microscopy (AFM).

Professional Society Memberships, Honors and Awards

- American Society of Microbiology (ASM)
- Member, The American Association for the Advancement of Science (AAAS)
- Henry M. Jackson Foundation, Research Assistantship (1999-2003)
- Postdoctoral Fellowship, Henry M. Jackson Foundation (2003-2005)
- Postdoctoral Fellowship, Oak Ridge Associated Universities (ORAU), Oak Ridge (2005-Present)
- Undergraduate Internship, Industrial Toxicology Research Centre, Lucknow, India

Personal Details

- Citizenship: India