2006 NASA EPSCoR Planning Grants

UNIVERSITY OF SOUTHERN MAINE

Project title: Planning for Infrastructure Development in Astrobiology, Microbial and Viral Ecology, and Bio-nanotechnology at the University of Southern Maine

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Summary:

Organisms living in extreme environments have received increasing focus because of what they tell us about the limits of life, and because of their enormous economic potential through bio-prospecting followed by biotechnology applications. Until now, the State of Maine has not participated in these studies. We have identified several novel and exciting candidate sites for extremophile studies within the State of Maine which are likely to yield extremophiles including psychrophiles ("cold loving" organisms) and acidophiles. Further, viruses in extreme environments are poorly studied (with a few exceptions), and our team includes strong background and well developed facilities for virology research.

The purpose of the proposed work is to explore and develop these sites in Maine for extremophile studies with the intent of further development of this research in astrobiology, of great interest to NASA and as a superb educational vehicle, and in biotechnology with potential economic spin-offs to the State of Maine. The team is ideally suited to the project, as it includes the Director and Staff of the University of Southern Maine Virology and Transmission Electron Microscopy Laboratory group and the internationally-recognized astrobiology/extremophile research group of Dr. Lynn Rothschild at NASA's Ames Research Center.

Intellectual Merit - (1) Microbial populations of Maine's ice caves, former copper and iron mining sites, and massive sulfide deposits rich in metal ores remain understudied but may harbor novel microbiota of great interest for astrobiology and bioprospecting. (2) Viruses, the most abundant biological entities on Earth (Brüssow and Hendrix, 2004), are highly significant as controlling factors for living populations and for Earth's biogeochemical cycles (Suttle, 2005). Viruses have predatory roles and major genetic impacts, driving nutrient recycling and lateral gene flow in the three domains of life (Bacteria, Archaea, and Eukarya), (Brüssow and Kutter,2005; Gogarten and Townsend, 2005; Hamilton, 2006). (3) Viral genomics provides rich resources for biotechnology and some of nature's most basic and tractable models of macromolecular self-assembly, a fundamental property of biological entities that can be applied in biologically inspired nanotechnology. Ongoing study of gammaherpesvirus self-assembly in the USM Virology and TEM Laboratory group is providing excellent preparation for efforts to examine nanotechnology potential of viruses of extremophiles which would

contribute to the active research area of designing virus-based tools for nanotechnology (Douglas and Young, 2006; Flynn et al., 2003; Lee et al., 2002; Mao et al., 2004; Nam et al., 2006; Ross, 2005).

Broader Impacts - (1) Explorations proposed in this planning proposal have potential for contribution of biotechnological tools or products, bringing to Maine economic benefits from bioprospecting in the study of extremophiles, an area of proven impact (Rothschild and Mancinelli, 2001). (2) The project will also allow a modest extension in 2007 of a successful Astrobiology Public Lecture Series (sponsored by a Maine Space Grant Consortium Higher Education Program grant) that was well attended by diverse audiences during the Fall semester of 2006. Discussions with these visiting seminar speakers will contribute positively both to the intellectual climate at USM and to the overall planning goals of this project. (3) Educational impact of the project will be at USM and beyond. Virus ecology, genomics, and structural studies are being integrated into graduate level virology and molecular biology laboratory courses taught by the PI at USM. Astrobiology and environmental microbiology are increasingly incorporated into classroom projects of the NSF-funded Maine ScienceCorps Program, a science education outreach program engaging rural high school students in laboratory research-based active learning while adding interdisciplinary dimensions to USM graduate bioscience education.