A.2.10 EXOBIOLOGY

1. Scope of Program

The goal of NASA's Exobiology program is to understand the origin, evolution, and distribution of life in the universe. Research is centered around the origin of life and is focused on achieving this goal by tracing the pathways taken by the biogenic elements, leading from the origin of the universe through the major epochs in the evolution of living systems and their precursors. These epochs (and the approximate percentage of funding historically allocated to each) are: the cosmic evolution of the biogenic compounds (15%), prebiotic evolution (35%), the early evolution of life (35%), and the evolution of advanced life (15%). The areas of research emphasis in this program are as follows:

- *Cosmic Evolution of the Biogenic Compounds*

The principal goal of research in the area of the cosmic evolution of the biogenic compounds is to determine the history of the biogenic elements (C, H, N, O, P, S) from their birth in stars to their incorporation into planetary bodies. Emphasis is placed on studies that constrain or extend concepts of possible chemical evolution relevant to the origin, evolution, and distribution of life.

- *Prebiotic Evolution*

Research in the area of prebiotic evolution seeks to understand the pathways and processes leading from the origin of a planet to the origin of life. The strategy is to investigate the planetary and molecular processes that set the physical and chemical conditions within which living systems may have arisen. Four major objectives are to: i) determine constraints on prebiotic evolution imposed by the physical and chemical histories of planets; ii) develop models of active boundary regions in which chemical evolution could have occurred; iii) determine what chemical systems could have served as precursors of metabolic and replicating systems both on Earth and elsewhere; and iv) determine in what forms prebiotic organic matter has been preserved in planetary materials.

- *Early Evolution of Life*

The goal of research into the early evolution of life is to determine the nature of the most primitive organisms, the environment in which they evolved, and the way in which they influenced that environment. As an approach to understanding life in the universe, the opportunity is taken to investigate two natural repositories of evolutionary history available on Earth, in particular, the molecular record in living organisms and the geological record in rocks. These paired records are used to: i) determine when and in what setting life first appeared; ii) determine the characteristics of the first successful living organisms; iii) understand the phylogeny and physiology of microorganisms whose characteristics may reflect the nature of primitive environments; iv) determine the

original nature of biotic energy transduction, membrane function, and information processing through study of extant microbes; and iv) elucidate the physical, chemical, and biotic forces operating on microbial evolution.

• *Evolution of Advanced Life*

The research associated with the study of the evolution of advanced life seeks to determine the extrinsic factors influencing the development of advanced life and its potential distribution. This research includes an evaluation of the influence of extraterrestrial and planetary processes on the appearance and evolution of multicellular life, conducted by: i) tracing the effects of major changes in the Earth's environment on the evolution of complex life, especially during mass extinction events, and ii) determining the effects of global events and of events originating in space on the production of environmental changes that affected the evolution of multicellular life. Also, studies will be considered that seek approaches to investigations furthering our understanding of the distribution of life elsewhere in the universe.

• *Planetary Protection Research*

There are numerous areas of research in exobiology that also have implications with respect to preventing the contamination of extraterrestrial environments by terrestrial organisms carried by spacecraft and for understanding the potential survival of extraterrestrial organisms that may be returned to Earth by sample-return missions. Research is required in order to allow NASA to understand the potential for both forward as well as reverse contamination and to set standards in these areas for spacecraft preparation and operating procedures and for returned-sample analysis. Many of these research requirements derive directly from recent National Research Council reports on planetary protection requirements for solar system exploration missions (see the online reports and list of publications at the National Academy Press at http://www.nap.edu/).

In addition, this NRA is also soliciting exobiology research pertinent to planetary protection goals in the following areas:

- The use of modern molecular analytical methods to detect and classify the widest possible spectrum of Earth microbes on spacecraft surfaces during assembly and launch processing, as well as the development of new methods for the same purposes;
- Procedures for detection, preliminary characterization, and containment of organisms (living, dead, or fossil) in returned samples;
- Procedures for sample sterilization which largely preserve sample information; and
- The limits of life, including the potential for organisms to originate and thrive on bodies such as Europa, Ganymede, Callisto, Phobos, Deimos, P-type asteroids, D-type asteroids, C-type asteroids, undifferentiated metamorphosed asteroids, differentiated asteroids, and/or comets.

• *Instrumentation*

The Planetary Major Equipment program described in section A.2.12 of this NRA allows proposals for upgrading the analytical, computational, telescopic, and other instrumentation required by investigations sponsored by the Solar System Exploration Division, including Exobiology. New, major analytical instrumentation requests should be identified and requested in a special section of each proposal, to be titled "Major Equipment Request." Details of specific guidelines, restrictions, and exclusions are provided in the Planetary Major Equipment program element. However, note that a Planetary Major Equipment proposal must be affiliated with a "parent" OSS research proposal in order to be considered. (see Section A.2.12 of this ROSS NRA for further details).

Development of advanced instrument concepts and technologies that may enable exobiology research in space exploration is no longer part of the scope of the Exobiology program. However, instrument development is part of the Astrobiology Science and Technology Instrument Development (ASTID) program, and proposals addressing Astrobiology instrumentation should be submitted to that program (see Section A.2.13 of this ROSS NRA)

2. Programmatic Information

Proposals are sought for new projects within the scope of the Exobiology Program. Proposals submitted in response to this NRA should be for new work that is not currently supported by the Exobiology Program, as well as to extend to their next logical phase those tasks that are currently funded in the Exobiology program but whose periods of performance are expiring in 2002 or in the first half of 2003. Periods of performance from one to five years (typically three years) may be proposed as appropriate to the nature of the contemplated research. Proposers are reminded that programmatic balance (see historical percentages above) may limit the opportunities for funding in some areas. The Exobiology Program usually competes one third of the program every year and so anticipates that approximately $3M will be available to support research proposed in response to this NRA.

Progress reports for funding the second or subsequent years of research, for previously approved multiple year awards, will be considered separately and should be sent directly to the Exobiology Discipline Scientist at least 90 days before their funding anniversary date.

IMPORTANT INFORMATION

As discussed in the *Summary of Solicitation* of this NRA, the Office of Space Science (OSS) is now using a single, unified set of instructions for the submission of proposals. This material is contained in the document entitled *NASA Guidebook for Proposers Responding to NASA Research Announcement – 2001* (or *NASA Guidebook for Proposers* for short) that is accessible by opening URL http://research.hq.nasa.gov, and linking through the menu item "Helpful References," or may be directly accessed online at URL http://www.hq.nasa.gov/office/procurement/nraguidebook/. This NRA's Summary of Solicitation also contains the schedule and instructions for the electronic submission of a *Notice of Intent* (NOI) to propose and a proposal's *Cover Page/Proposal Summary*, which now also includes the required *Budget Summary*, and the mailing address for the submission of a proposal.

Questions concerning this program element may be directed to the Discipline Scientist:

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