A.2.10 ASTROBIOLOGY: EXOBIOLOGY AND EVOLUTIONARY BIOLOGY

1. Scope of Program

The goal of NASA's Exobiology and Evolutionary Biology program is to understand the origin, evolution, distribution, and future of life in the universe. Research is centered around the origin and early evolution of life, the potential of life to adapt to different environments, and the implications for life elsewhere. This research is conducted in the context of NASA's ongoing exploration of our stellar neighborhood and the development of biosignatures for *in situ* and remote sensing applications. For further information on the science scope of Astrobiology, please refer to the Astrobiology roadmap, which can be found on the Astrobiology web page http://astrobiology.arc.nasa.gov/. The areas of research emphasis in this solicitation are as follows:

• *Planetary Conditions for Life*

Research in this area seeks to delineate the galactic and planetary conditions conducive to the origin of life. Topics of interest include the formation and stability of habitable planets, the formation of complex organic molecules in space and their delivery to planetary surfaces, models of early environments in which organic chemical synthesis could occur, the forms in which prebiotic organic matter has been preserved in planetary materials, and the range of planetary environments amenable to life. Emphasis is placed on studies that constrain or extend concepts of possible chemical evolution relevant to the origin, evolution, and distribution of life. Studies of sites thought to be analogues to the early Earth or other planetary environments that might potentially harbor life will be considered as part of NASA's broader interest in the search for life in the universe.

• *Prebiotic Evolution*

Research in the area of prebiotic evolution seeks to understand the pathways and processes leading from the origin of planetary bodies 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. A major objective is determining what chemical systems could have served as precursors of metabolic and replicating systems on earth and elsewhere, including alternatives to the current DNA-RNA-protein basis for life. Both laboratory and theoretical studies will be considered.

• *Early Evolution of Life and the Biosphere*

The goal of research into the early evolution of life is to determine the nature of the most primitive organisms, and the environment in which they evolved. As an approach to understanding life in the universe, the opportunity is taken to investigate two natural repositories of evolutionary history available on Earth: 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 and the characteristics of the first successful living organisms; ii) understand the phylogeny and physiology of

microorganisms, including extremophiles, whose characteristics may reflect the nature of primitive environments; iii) determine the original nature of biological energy transduction, membrane function, and information processing, including the construction of artificial chemical systems to test hypotheses regarding the original nature of key biological processes, iv) investigate the development of key biological processes and their environmental impact; v) examine the response of earth's biosphere to extraterrestrial events; vi) investigate the evolution of genes, pathways and microbial species subject to long-term environmental change relevant to the origin of life on earth and the search for life elsewhere; vii) study the co-evolution of microbial communities, and the interactions within such communities, that drive major geo-chemical cycles, including the processes through which new species are added to extant communities.

- *Evolution of Advanced Life*

The research associated with the study of the evolution of advanced life seeks to determine both the intrinsic and extrinsic factors influencing the development of advanced life, the biological precursors to multi-cellular life, and the potential distribution of complex life in the universe. This research includes an evaluation of the influence of extraterrestrial and planetary processes on the appearance and evolution of multi-cellular 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 environment that affected the evolution of multi-cellular life. This research focus also includes studies of the fundamental evolutionary processes driving the development of early, multicellular life. Studies will be considered that seek approaches to investigations furthering our understanding of the distribution of life elsewhere in the universe.

- *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 Astrobiology. New, analytical instrumentation requests, as well as requests for upgrades to existing instruments, costing more than $25,000 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 NRA for further details).

Note: Development of advanced instrument concepts and technologies as precursors to astrobiology flight instruments should be submitted to the Astrobiology Science and Technology Instrument Development (ASTID) program in this NRA (see Section A.2.13). Proposals for science-driven field campaigns that are expected to produce new science results as well as new operational or technological capabilities should be

submitted to the Astrobiology Science and Technology for Exploring Planets (ASTEP) program in this NRA (see Section A.2.16).

Finally, note that to enable the NASA Office of Space Science to properly evaluate the relevance of proposals submitted to its programs, as well as track its progress towards achieving its goals as mandated by the Government Performance Review Act (GPRA), all research supported by NASA's programs must now demonstrate its relationship to NASA Goals and Research Focus Area's (RFA's) as stated in the latest version of its Strategic Plan (follow links from the Web site http://spacescience.nasa.gov/); see also the discussion in Section 1 of the *Summary of Solicitation* of this NRA. Therefore, all proposers to this program element are asked to state their perception of this relevance in terms of the Goals, Science Objectives, and RFA's given in Table 3 found in the *Summary of Solicitation*. In particular, proposals to this program element may relate to RFA's 2(a) and (b), and 3(a) and (b).of Goal II for Solar System Exploration. The appropriate place for this statement of relevancy is in the introduction to the proposal's "Scientific/Technical/Management" section (see Section 2.3.5 in the *Guidebook for Proposers*). The index numbers in this table may be used to identify a specific RFA, for example, "Goal I, Sun-Earth Connection Theme, RFA 1(c)" or "Goal II, Astronomical Search for Origins, RFA 3(b)."

2. Programmatic Information

Proposals are sought for new projects within the scope of the Astrobiology: Exobiology and Evolutionary Biology Program. Proposals submitted in response to this NRA should be for new work that is not currently supported by the Program, as well as to extend to their next logical phase those tasks that are currently funded in the Astrobiology Program but whose periods of performance are expiring in 2003 or in the first half of 2004. Periods of performance from one to five years (typically three years) may be proposed as appropriate to the nature of the contemplated research. Programmatic balance may limit the opportunities for funding in some areas. The Astrobiology Program usually competes one third of the program every year and so anticipates that approximately $4M 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, should be sent by E-mail directly to the Astrobiology Program Officer 60 days before the anniversary date of the award.

IMPORTANT INFORMATION

- As discussed in the *Summary of Solicitation* of this NRA, the Office of Space Science (OSS) now uses a unified set of instructions for the preparation and submission of proposals given in the document entitled *NASA Guidebook for Proposers Responding to NASA Research Announcement - 2003* (or *NASA Guidebook for Proposers* for short) that may be accessed by opening http://research.hq.nasa.gov/ and linking through "Helpful References," or by

direct access at http://www.hq.nasa.gov/office/procurement/nraguidebook/ (note that the updated 2003-edition of the *Guidebook* is used for this solicitation).

- Section 6 of this NRA's *Summary of Solicitation* contains the Web address relevant to the electronic submission of a Notice of Intent (NOI) to propose and a proposal's *Cover Page/Proposal Summary/Budget Summary*, as well as the mailing address for the submission of the hard copies of a proposal.

Questions concerning this program element may be directed to the Program Officer:

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