June 1, 1998
NRA 98-HEDS-02
OMB Approval No. 2700-0042

National Aeronautics and Space Administration

Research Announcement

Research Opportunities in Space Life Sciences

Gravitational Biology and Ecology and Biomedical Research and Countermeasures Programs

1998

A Research Announcement for the Life Sciences Division

Letters of Intent Due:	**August 3, 1998**
Proposals Due:	**October 1, 1998**

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NASA Research Announcement

Research Opportunities
in
Space Life Sciences

Gravitational Biology and Ecology
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This National Aeronautics and Space Administration (NASA) Research Announcement (NRA) solicits proposals for research in two major programs in Space Life Sciences: (1) Gravitational Biology and Ecology, and (2) Biomedical Research and Countermeasures. This Announcement solicits research proposals that support the opening of the space frontier by exploring, using, and enabling the development of space and by expanding human experience in space. In support of NASA's mission and the Human Exploration and Development of Space (HEDS) Strategic Plan, research supported by the Life Sciences Division will increase knowledge of nature's processes using the space environment, aid in the exploration of the Solar System, support the achievement of routine space travel, and enrich life on Earth through the use of space technology and the application of biomedical knowledge.

The Life Sciences Division will achieve these goals by supporting innovative, competitive, and multidisciplinary ground-based scientific research and technology development; flight experiments using space platforms such as the Space Shuttle and the early phase of the International Space Station will also be supported. Ground-based research leading to the development of mature experiments for flight are particularly encouraged. Proposals for flight experiments are very competitive and should be based on solid ground-based research findings. The Gravitational Biology and Ecology Program will be particularly interested this year in supporting proposals in evolutionary, developmental, and cellular and molecular biology. Proposers in Evolutionary Biology selected as a result of this solicitation will have the opportunity to become affiliated with the Astrobiology Program through the new Astrobiology Institute. These affiliations could lead to further inter-disciplinary activities in the study of the evolution of living things. Further, these affiliations would provide a substantial contribution of HEDS to the Astrobiology program. In the Biomedical Research and Countermeasures Program, proposals for research leading to better medical care of crews will be favored.

Proposals that will enhance or complement the scientific return from research currently being supported by the National Institutes of Health, the National Science Foundation, or other government agencies are encouraged. Proposals for advanced technology that directly support the goals and objectives of the Biomedical Research and Countermeasures Program and the Gravitational Biology and Ecology Program are also sought under this Announcement.

Details relevant to the Gravitational Biology and Ecology and Biomedical Research and Countermeasures Programs are included in the attached appendices and the associated document, *Space Life Sciences Standard Companion Document 1998*.

- Appendix A provides a detailed description of the research areas solicited by this Announcement.

- Appendix B contains detailed instructions for this specific NRA and includes the relevant application forms.
- Appendix C contains general instructions applicable to the preparation of proposals in response to NASA Research Announcements.
- The *Space Life Sciences Standard Companion Document 1998* describes the evaluation process for space flight experiments, the functional capabilities of the flight research facilities available to investigators, and the specialized ground facilities available for use by proposers.

Proposals may be for activities lasting up to three years. They will be evaluated for overall merit by independent peer-review panels. Relevance to NASA's programmatic needs and goals, and the feasibility of flight proposals will be evaluated separately by NASA. **A selection announcement will be made in March or April 1999. Funding of selected ground-based proposals will begin in June 1999.** The government's obligation to make awards is contingent upon the availability of appropriated funds from which payment for award purposes can be made, and the receipt of proposals that the government determines are acceptable for award under this NRA. It is anticipated that awards averaging $150,000 (total annual costs) will be made. The total annual cost may not exceed $350,000.

Participation in this Announcement is open to all categories of domestic and foreign organizations, industry, educational institutions, other nonprofit organizations, NASA laboratories, and other government agencies. **Though, under certain circumstances, NASA will review proposals from non-U.S. institutions, NASA does not fund non-U.S. institutions** (see Appendix A, Section VIII, Part C of this Announcement for details).

A letter of intent (LOI) to propose is requested by August 3, 1998 (see Appendix A, Section VIII, Part F of this Announcement). LOIs may be submitted by U.S. Postal Service or commercial delivery to the address below, or electronically via e-mail to:

loi@hq.nasa.gov

The subject heading of an electronic submission should read "LOI NRA 98-HEDS-02."

Proposals may not be submitted electronically. Proposals must be received by October 1, 1998. Proposals and LOIs mailed through the U.S. Postal Service by express, first class, registered, or certified mail are to be sent to the following address:

Information Dynamics, Inc.
SUBJECT: NASA Life Sciences Research Proposal
300 D Street, SW
Suite 801
Washington, DC 20024

Proposals and LOIs that are hand delivered or sent by commercial delivery or courier services are to be delivered to the above address between 8:00 AM and 4:30 PM. The telephone number, 202-479-2609, may be used when required for reference by delivery services. Information Dynamics, Inc. (IDI) cannot receive deliveries on Saturdays, Sundays, or federal holidays. Upon receiving a proposal, IDI will send a postcard to the proposer confirming its arrival.

In order to be accepted as a complete submission, proposals **must include** completed copies of the appropriate forms provided in Appendix B. Form C is only required for flight experiment proposals. Special instructions apply to proposals by institutions which are not entities of the United States (see Appendix A, Section VIII, Part C of this Announcement).

The following items apply only to this Announcement:

Solicitation Announcement Identifier:	NRA 98-HEDS-02
Number of Copies Required:	Original + 25 copies
Letters of Intent Due:	August 3, 1998
Proposals Due:	October 1, 1998
Selecting Official:	Director Life Sciences Division Office of Life and Microgravity Sciences and Applications

Additional information is available from the appropriate Science Program or Element Coordinator, as indicated below, at the following address:

[name of coordinator]
UL/Life Sciences Division
NASA Headquarters
Washington, DC 20546-0001
Telephone: (202) 358-2530
Fax: (202) 358-4168

Program or Element	**Coordinator**	**E-Mail**
Gravitational Biology and Ecology	David Liskowsky, Ph.D.	david.liskowsky@hq.nasa.gov
Biomedical Research and Countermeasures	Mary Anne Frey, Ph.D.	mfrey@hq.nasa.gov
Environmental Health	Mary Anne Frey, Ph.D.	mfrey@hq.nasa.gov
Behavior and Performance	David Liskowsky, Ph.D.	david.liskowsky@hq.nasa.gov
Space Radiation Health	Walter Schimmerling, Ph.D.	walter.schimmerling@hq.nasa.gov
Flight Experiments	Peter R. Ahlf	peter.ahlf@hq.nasa.gov

This Announcement will be updated and issued annually and is the primary means of obtaining research and technology proposals from the life sciences community. This Announcement is restricted to the programs named above and described in detail in Appendix A. Potential proposers should read with care the program descriptions that are of interest, and focus their proposals on the specific research emphases defined in this Announcement.

Your interest and cooperation in participating in this effort is appreciated.

Original Signed by

Arnauld E. Nicogossian, M.D.
Associate Administrator for
Life and Microgravity Sciences and Applications

APPENDIX A
NRA 98-HEDS-02

Gravitational Biology and Ecology and Biomedical Research and Countermeasures Programs

I. Introduction

This Announcement (NRA 98-HEDS-02) is the primary solicitation for scientific proposals in Gravitational Biology and Ecology, and Biomedical Research and Countermeasures in 1998. Proposals outside of the research emphases specifically defined in this Announcement will be returned to the proposer. A separate Life Sciences Division Announcement for Advanced Human Support Technologies (NRA 98-HEDS-01) was released in January 1998. Other Announcements calling for focused research or utilization of unique resources may be issued throughout the year. Unsolicited proposals received at other times during the year will be held until the next annual review period if the proposed research is relevant to the programs described in this Announcement. However, NASA reserves the right to act in the best interests of the federal government in the matter of proposal acceptance and evaluation.

This Appendix describes the types of proposals that are acceptable for submission in response to this Announcement, defines the research programs of the Division that are included in this Announcement, and describes the current specific areas of ground-based and flight research that proposals should address. In addition, this Appendix includes guidelines for preparing and submitting proposals and defines the administrative policies governing the program and grantees.

One goal of the Human Exploration and Development of Space (HEDS) Enterprise is to "share HEDS knowledge, technologies, and assets that promise to enhance the quality of life on Earth." Individuals participating in NASA's Life Sciences Division programs have a responsibility to foster the development of a scientifically informed public. The Life Sciences Division programs represent an opportunity for NASA to enhance and broaden the public knowledge, understanding, and appreciation of biological and biomedical research, and the value of this research in the space environment. Therefore, all participants in this NRA are strongly encouraged to promote general scientific literacy and public understanding of life sciences, the space environment, and the Space Life Sciences programs through formal and informal education opportunities. Where appropriate, supported investigators will be required to produce, in collaboration with NASA, a plan for communicating their work to the public.

NASA has a strong commitment to the ethical treatment of human and animal research subjects, and assurance of compliance with federal regulations regarding human subjects and animal care and use is required as part of the proposal submission process (see the "Special Matters" instructions in Appendix B of this Announcement). Applicants should note that the review of a proposal is not guaranteed if the required information is not supplied.

II. Proposal Types

Proposals may be submitted for ground-based or flight investigations.

1. Proposals for Ground-Based Investigations
   Research proposals must have a clearly defined hypothesis and set of research objectives relevant to NASA's mission. All proposals must be consistent with the

program elements, research areas, and especially the emphases defined in this Announcement to be considered for funding. Proposals to conduct ground-based research aimed at developing mature flight experiments designed for later phases of the International Space Station utilization (from 2001 onward) are particularly encouraged. Some proposals may require special NASA Earth-based facilities for their completion (see the *Space Life Sciences Standard Companion Document 1998,* Section 5 for a description of special ground facilities). Proposers should contact pertinent NASA centers to arrange for access to these facilities prior to submitting their proposal.

Finally, as part of their research plan, investigators may propose to analyze tissues provided through the Division's Biospecimen Sharing Program from organisms that have flown in space (see Section V of this Appendix).

2. Proposals for Space Flight Investigations

Flight experiments will be accommodated on whichever carrier is best suited to execute the experiment. Two types of experiments are currently solicited: (1) "pre-mission and post-mission" studies involving data collection and analysis on crew members prior to and on return from their space mission, and (2) on-orbit experiments that can be implemented on space platforms such as the Space Shuttle or the International Space Station.

On-orbit experiments will be constrained by limitations on resources such as mass, volume, power, and crew time. Proposals requiring resources beyond the capabilities defined in this Announcement and the *Space Life Sciences Standard Companion Document 1998* should not be submitted in response to this Announcement.

Flight investigations must represent mature studies strongly anchored in previous ground-based research or previous flight research (see Section VI of this Appendix). Ground-based research may, and often must, represent one component of a flight experiment proposal. However, that research should be limited to activities that are essential to the final development of an experiment for flight and for the completion and publication of the scientific results of the experiment.

Regardless of its type, every proposal should focus on at least one of the two scientific research programs defined in the next section. Multidisciplinary approaches are particularly sought involving combinations of these research programs; however, if this is the case, it should be stated clearly at the beginning of the proposal. Proposals must include a well-defined research plan that can be accomplished within three years or less. Highly innovative proposals are encouraged.

III. Research Programs and Emphases

The major goals of NASA's Life Sciences Division, located within the Office of Life and Microgravity Sciences and Applications, are to:

- Effectively use gravity and microgravity and the other characteristics of the space environment to enhance our understanding of fundamental biological processes.
- Develop the scientific and technological foundations for a safe and productive human presence in space for extended periods and in preparation for exploration.
- Apply this knowledge and technology to improve our nation's competitiveness, education, and quality of life on Earth.

To accomplish these goals, the Life Sciences Division supports activities in three distinct but related Programs: Gravitational Biology and Ecology, Biomedical Research and Countermeasures, and Advanced Human Support Technology [see NASA Research Announcement, *Research Opportunities in Space Life Sciences: Advanced Human Support Technology Program, 1998* (NRA 98-HEDS-01) for solicitation information within the AHST Program]. This Announcement is concerned with two of the three major Programs: (1) Gravitational Biology and Ecology, and (2) Biomedical Research and Countermeasures. These two programs contain several elements (see Figures 1 and 2) and extend from basic gravitational research in the biological, environmental, and psychosocial sciences (especially as they relate to gravity) to applied gravitational research related to the development of countermeasures that mitigate the detrimental effects of space flight on humans, protect humans from the harsh environment of space, and enable safe, efficient, and productive use of space laboratories. In addition, the Division supports the utilization of specialized NASA facilities and the development of special technologies required in the pursuit of its research goals.

In the remainder of this section, the research programs and elements encompassed by this Announcement are defined, their research focus is delineated, and the specific emphases solicited for the 1999 fiscal year (October 1998 - September 1999) are specified. **It is important that the prospective investigator read the relevant section(s) carefully, as many of the programmatic emphases are different from those appearing in previous Division Announcements**.

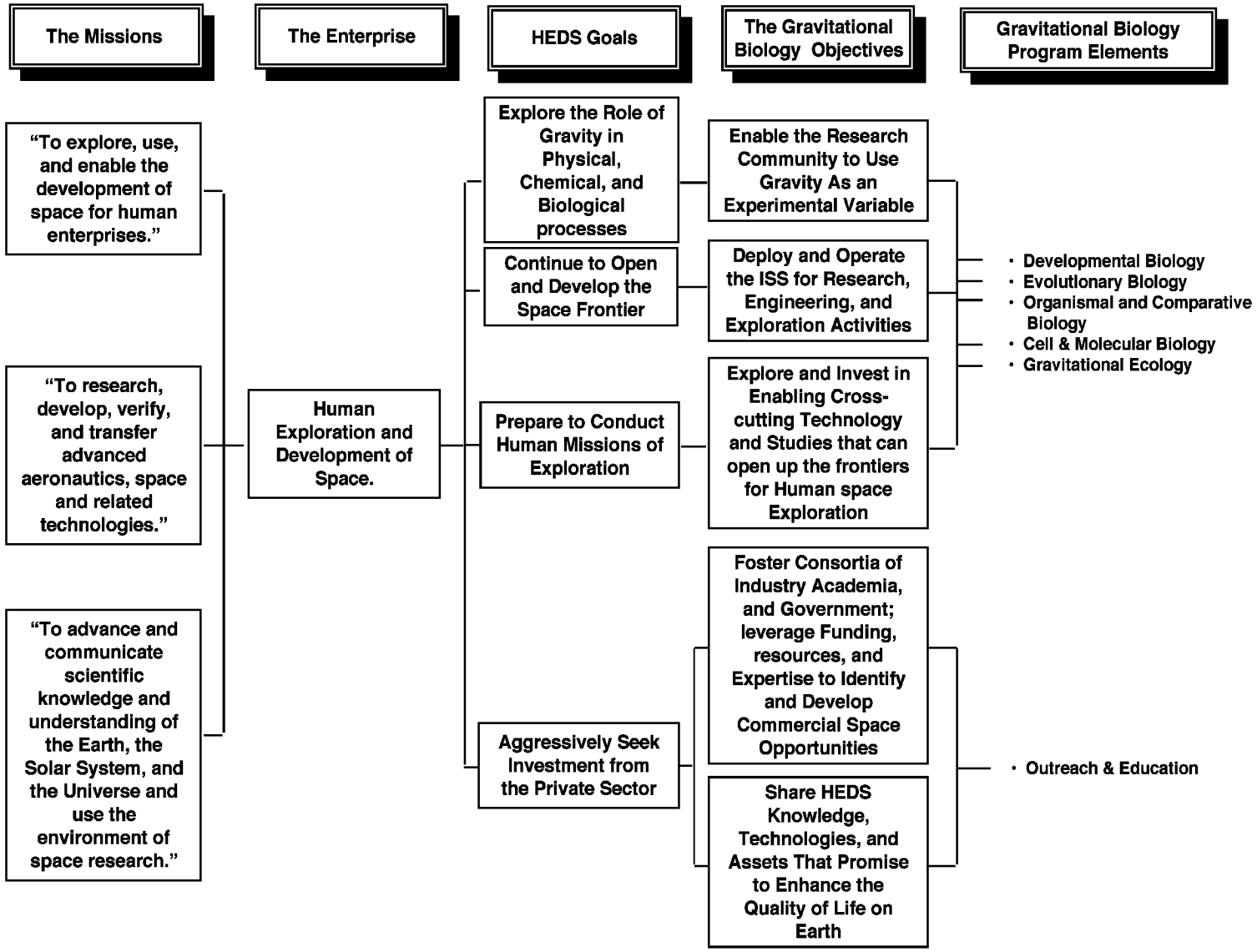

Figure 1. Relationship of the Gravitational Biology and Ecology Program to the NASA/HEDS Strategic Plan

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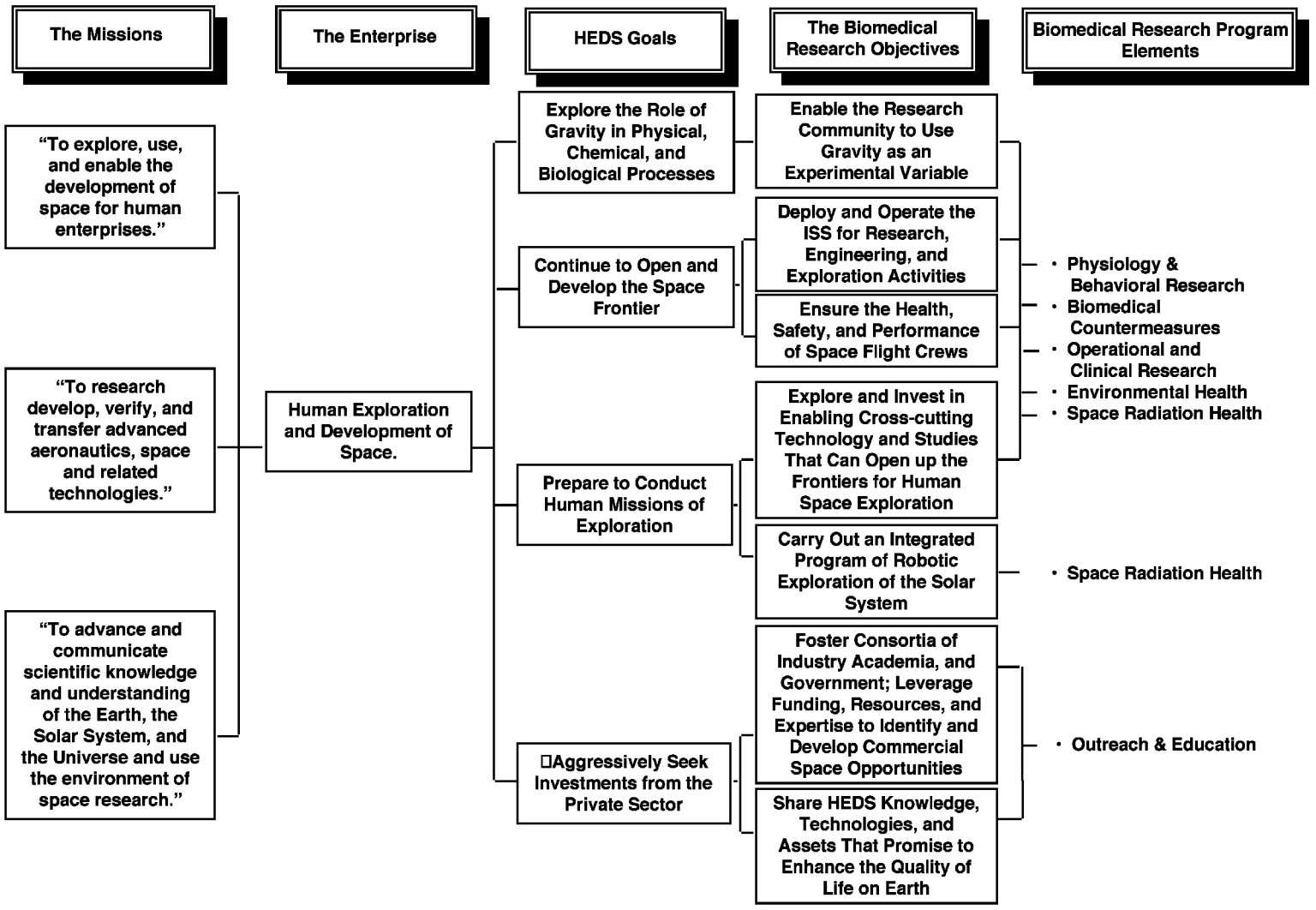

Figure 2. Relationship of the Biomedical Research and Countermeasures Program to the NASA/HEDS Strategic Plan

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A. Gravitational Biology and Ecology Program

Program Description

The Gravitational Biology and Ecology (GB&E) Program contributes to NASA's Human Exploration and Development of Space (HEDS) Enterprise as illustrated in Figure 1. GB&E's major scientific objective is to determine how gravity shapes life, and how life responds to gravity or the absence of gravity. To accomplish this objective, researchers must determine the mechanisms by which evolution, development, cell processes, physiological systems, and organisms respond and adapt to gravity.

The specific aims of this Program are to discover through ground-based and space flight investigations:

- whether, and how, the *development* of cells, systems, and organisms depend on gravitational force
- the role of the *genome and cellular structures* in response to gravitational force
- how and for what purposes *different organisms* in the animal and plant kingdom sense and use gravity
- how *physical and chemical forces* interact to determine biological structure and function
- the role of gravity in evolution
- the role of gravity in determining the structure, function, evolution, and interactions of *space and planetary ecosystems*

Program objectives are accomplished by using a variety of gravitational environments (hypergravity, simulated hypogravity, and microgravity) as research tools or by determining the effects of the interaction of gravity (hypergravity or microgravity) with other environmental factors on biological systems. The emphasis in this Program is on using these gravitational research tools to advance fundamental knowledge in the biological sciences. Research that applies this knowledge to NASA's other goals of enabling human exploration of space and improving the quality of life on Earth is also encouraged.

Studies may include animals (including humans), plants, tissues, or cells. Note that assurance of compliance with applicable federal regulations regarding human subjects or animal care and use is required as part of the proposal submission process (see the "Special Matters" instructions in Appendix B). Researchers are encouraged to use whatever species are most appropriate for their research. Prop\sals may take advantage of transgenic and mutant species as well as comparative biology approaches that enhance the research scope. **The program particularly values ground-based research that leads to flight experiments that can confirm or refute the fidelity of ground-based models and hypotheses**. Flight experiments may be proposed in any scientific area of GB&E in this NRA. Research in cell and molecular biology and avian development will be emphasized in the initial utilization flights that are planned for the International Space Station.

A full spectrum of biological specimens will only be available for gravitational biology and ecology experiments on International Space Station after assembly is complete (2004). Until then, additional opportunities for such experiments may arise on Space Shuttle flights. For these opportunities, NASA is soliciting proposals for flight experiments that address, in particular, similarities in the mechanisms underlying physiological changes during aging and space flight.

Please refer to the document titled *Space Life Sciences Standard Companion Document 1998* for a description of the capabilities available for investigations on space platforms such as the Space Shuttle and the International Space Station.

Elements and Emphases for FY 1999

This section describes the elements and research emphases within the Gravitational Biology and Ecology Program for FY 1999. High priority in FY 1999 will be given in particular to proposals for ground-based research in the areas of developmental biology and evolutionary biology, and for flight research in the areas of cell biology, avian development, and neuroscience.

i. Developmental Biology
NASA's goals in developmental biology are to determine the mechanisms by which gravity induces normal development and function, how gravity affects the capacity of organisms to reproduce, and the mechanisms by which subsequent generations are affected by gravity. Proposals that use different gravitational states to elucidate the effects of gravity during development are encouraged. Research in developmental biology should be focused on the influence of hypergravity and microgravity in the critical stages of development on growth, morphology, physiological system development (particularly the nervous system), behavior, reproduction, genetic integrity, life span, senescence, and subsequent generations. Examples of important issues concerning developmental biology in space are whether normal development depends on gravity exposure during critical time periods during development, whether such exposure results in irreversible changes in morphology and function in adulthood, and whether an organism can undergo a complete life cycle or several life cycles in microgravity.

ii. Evolutionary Biology
The primary focus of this element is on developmental molecular studies investigating the fundamental mechanisms and pathways by which multicellular organisms have evolved on Earth. These studies should be hypothesis driven and experimental in nature. Major areas of interest include developmental mechanisms involved in the evolution of metazoan body plans, evolutionary diversification of gene regulatory systems, comparative developmental studies of evolutionary importance, and investigation of the origins of metazoa. Research may include, but is not limited to, the experimental analysis of the role of gravity in the evolution of multicellular organisms and the possible role of gravity as a cause of biological diversity. Evolutionary biology research may propose to use any group of organisms from microbes and fungi to multicellular plants and animals. Selected proposers may be encouraged to form a consortium to coordinate appropriate activities. Collaboration with the Astrobiology Institute may also be explored.

iii. Organismal and Comparative Biology
The comparative element elucidates the physiological, cellular, and molecular mechanisms of the effects of gravity on the growth, development, composition, and physiological and behavioral functions of animals and higher plants *across the phylogenetic scale.* The organismic element seeks to understand how whole organisms perceive, transduce, and respond to a gravitational force; the effect of hypergravity and hypogravity on developmental, regenerative, and reproductive processes; the regulation of physiological systems (e.g., the nervous system); and how gravity and other environmental factors interact.

iv. Cellular and Molecular Biology
The principal aim of this element is to employ research at the genetic, molecular, and cellular levels to elucidate the mechanisms by which cells, unicellular organisms, or organized structural and functional units of multicellular biological systems respond to gravitational perturbations. The goals of research in this area are to understand how direct or indirect effects

of altered gravitational forces impact cellular signal transduction mechanisms, gene regulation and expression, cell-cell and cell-substrate interactions, cytoskeletal structure and function, ion channel function, and membrane properties. Research investigating both acute and long-term effects of altered gravity are desirable. Of particular interest is how altered gravity impacts cellular processes such as regulation of the cell cycle, apoptosis, cell growth, and nerve cell process formation and response to injury. Cellular and molecular studies investigating the mechanisms underlying the physiological changes seen in whole animals in response to altered gravity environments are also highly encouraged.

v. Gravitational Ecology
This element invites proposals directed at understanding how gravity might affect the structure, function, and evolution of ecosystems, particularly as they might relate to spacecraft and planetary habitats. By conducting ecological research at different gravity and space radiation levels, it will be possible to determine the influence of those factors on the evolution of ecosystems and their interaction with the chemical and other biological environments of a life support system for human crews. Examples of such research might include studies of chemical or pathogen species released by one organism that may have important characteristics that impact other organisms.

For FY 1999, the primary emphasis of **advanced technology development (ATD)** is on: 1) advanced biological and physiological sensors and monitoring systems for non-human species; 2) non-refrigerated sample preservation processes and systems for storing biological samples without the need for refrigeration, thereby reducing payload power and volume requirements on spacecraft; and 3) the broad area of silicon chip-based analytic laboratories (lab on a chip) capable of in-flight evaluation of biological samples for physical parameters, inorganic and organic chemical content, and enzyme activity. The Gravitational Biology and Ecology Program is also particularly interested in proposals directed toward the development of highly innovative, biology-based technologies that address the emphases discussed in this Research Announcement. Some examples of these technologies include: 1) development and use of transgenic animals to study various biological effects of space flight; 2) innovative use of reporter gene technology and automated monitoring systems for new approaches to space biology research; 3) development of a library of cell lines, each containing a variety of reporter gene constructs driven by different promoter elements, as a means of assessing expression and function of large numbers of genes; and 4) development of molecular methods for detection and identification of microorganisms and microbial communities in the space environment.

B. Biomedical Research and Countermeasures

Program Description

The Biomedical Research and Countermeasures Program is directly related to NASA's missions and the Human Exploration and Development of Space (HEDS) Enterprise (see Figure 2). It also responds directly to the requirements established by the Medical Policy Board (see *Medical Policies and Requirements Document,* Bibliographic reference #7 of this Appendix).

The goals of the Biomedical Research and Countermeasures Program are:

- to develop an understanding of the physiological mechanisms that are responsible for space flight-related biomedical and behavioral changes in humans;
- to develop countermeasures that allow humans to live and work in microgravity for durations over a year, minimize the risks in readapting to Earth's gravity, and optimize crew safety, well-being, and performance;

- to identify, characterize, and mitigate (preventing and reducing) health, environmental, and other operational human medical risks associated with space exploration.

The emphasis of the current ground-based component of this research program is on the consequences of extended periods of flight that will be characteristic of International Space Station (ISS) missions or of missions to explore the solar system. The Biomedical Research and Countermeasures Program supports basic and applied research utilizing models that simulate the effects of hypogravity and hypergravity models and can include human subjects and other animal models. The Biomedical Research and Countermeasures Program is composed of five elements: **i) Physiology and Behavioral Research, ii) Biomedical Countermeasures**, **iii) Operational and Clinical Research, iv) Environmental Health,** and **v) Space Radiation Health**.

Some Examples of Background Data

Removal of the force of gravity results in structural and functional changes in muscle. Weight-bearing muscle, bone, and other connective tissues are directly affected. Prolonged exposure to microgravity poses a serious risk to every crewmember in terms of loss of muscle mass, reduced strength, and reduced endurance. To date, space flight experience has demonstrated muscle atrophy in terms of decreased volume, altered muscle phenotype, decreased muscle strength and endurance, and altered motor performance, which threatens the capacity to accomplish mission objectives. The most significant risk resulting from these changes is the compromised ability during space flight to perform extravehicular activity (EVA), or after a prolonged mission, to egress, stand, or walk normally on return to Earth or in partial gravity.

Weight-bearing bones atrophy with loss of both mineral and collagen matrix. The resultant change of architecture and loss of strength may increase the risk of fracture on return to Earth after extended stays on the International Space Station (ISS) or during planetary trips. These changes have been well documented during space stays on Mir of 115 to 439 days. In addition, space flight induced hypercalciuria increases the potential risk for the formation of renal stones. It may also be anticipated that bone fracture healing may be impaired under these conditions. Changes also occur in other connective tissues. However, little is known of the recovery process after space flight. Ground simulation and clinical studies have found similar changes in healthy volunteers and patients during and after bed rest but have failed to identify conclusively the underlying mechanisms responsible for the deleterious changes, although several hypotheses have been considered.

Bone and muscle atrophy are expected to be serious problems for extended-duration space flight, and exercise protocols or other countermeasures (preflight, in-flight, or postflight) will be required as part of an effort to mitigate these effects.

Cardiovascular function is altered during space flight with damping of the carotid baroreflex response, decreased plasma volume, and decreased cardiac volume. Orthostatic intolerance is a problem for astronauts returning from short and long stays in microgravity as evidenced by responses to post-flight stand tests. Considerable progress has been made towards identifying the underlying mechanisms for this orthostatic intolerance, but research has been complicated by increased cabin temperatures prior to landing and by the fact that astronauts fluid load in an attempt to improve plasma volume and also inflate anti-G trousers in attempts to reduce the post-flight orthostatic hypotension. Sporadic cardiac arrhythmias have also been noted during space flight. Recently, a non-life-threatening short episode of ventricular tachycardia was recorded in a space-flight crewmember; other reported arrhythmias have been premature atrial contractions, premature ventricular contractions, and paroxysmal atrial tachycardia. The program is seriously lacking in

knowledge of vascular biology and the role nitric oxide may play in the cardiovascular changes associated with space flight.

Gravity proprioceptor stimulation, nervous system interpretation, and processing of afferent sensory input may be different upon exposure to microgravity and may change again upon re-exposure to gravity. Space flight may also cause changes in spatial orientation and sensorimotor interaction, including neuromuscular function. Postural instability is well documented after flight.

Knowledge of the effects of space flight on the endocrine and immune systems, hematological, gastrointestinal, and renal functions, metabolism, nutritional state, sleep, biological rhythms, temperature regulation, pharmacokinetics, and pharmacodynamics is limited; physiologic alterations in these systems may further confound crew health care. For instance, red cell mass decreases early in space flight secondary to decreased erythropoietin stimulation and increased apoptosis of newly formed red blood cells. What the long-term effects of these changes may be is not known.

Immune deficiency has been reported but has not been substantiated because of the measures used and the relationship of time of sampling to mission events. Changes in immune function may be related to microgravity, living in a "closed environment," cumulative sleep loss, the effect of stress during launch or landing, radiation-induced inhibition of white cell maturation or decreased cell function, or persistent or reactivated microorganisms. Exposure to the space environment also poses the potential for other adverse reactions such as allergic hypersensitivity and exposure to environmental (biological or chemical) agents. The risks may be serious in terms of incapacitation or illness of the crewmember and its impact on mission objectives.

Nutrition is important not only because of the effects of nutrients on crew health, but also for the psychosocial benefits surrounding mealtime, such as the taste and smell of food, feeling of fullness, satisfaction, and companionship. Nutritional requirements are currently based on terrestrial knowledge of how food is digested, absorbed, and metabolized. Microgravity may induce physiologic changes that could cause malabsorption and malnutrition; however only reduced calcium absorption has so far been documented in bed rest and in space flight. Information related to changes in lipid metabolism, oxidative products during space flight, and antioxidant, vitamin, and micronutrient requirements could be important in developing countermeasures. In short-duration Space Shuttle flights, dietary intake provides only 67 percent of predicted energy requirements. Although dietary input met expected energy requirements for Skylab crewmembers, this has not been so for the Mir crewmembers participating in the NASA-Mir Project.

Health risks associated with inappropriate therapeutics may also be a problem. The changes that occur in microgravity in such physiologic areas as blood flow, gastrointestinal motility and transit time, and hormonal interactions may change the dissolution, absorption, tissue distribution, and action of drugs given for prevention or therapy. Limited and inconsistent data are currently available on the bioavailability of drugs in space. Studies reported that peak concentrations and time to peak concentrations for oral scopolamine and acetaminophen may significantly increase or decrease during space flight as compared to Earth-bound controls.

Why and how physiologic and behavioral changes progress with flight duration is not well defined. As astronauts undertake longer tours of duty, multiple trips in space, and missions to more remote settings, changes may become more pronounced and may even result in pathological conditions.

During the next several years, extensive EVA will be performed during the construction of the ISS. Current observations suggest that painful symptoms of rapid decompression known as the "bends" do not occur in microgravity. This may be related to a successful program of pre-breathing oxygen before the EVA and relative immobility of crewmembers during the EVAs. The potential risk of a

neurological incident based on ground studies warrants additional studies to learn more about the mechanisms of atmospheric gas bubble formation and movement. Reducing the pre-breathe time before an EVA is also operationally important because its length impacts operations.

Radiation also poses significant health and safety concerns for personnel who embark on long duration space missions. These risks include, in priority order: carcinogenesis, damage to the central nervous system, synergistic effects, early and acute effects that may be caused by unplanned exposures (e.g., due to Solar Particle Events), and risks involving fertility, sterility, and heredity. Energetic beams of protons and of some of the nuclei found in galactic cosmic radiation (GCR) are available at ground-based laboratories. These beams can be used to simulate components of the space radiation environment in order to acquire the necessary database, study basic mechanisms of biological responses to radiation, explore potential preventive or recovery-enhancing countermeasures, and develop effective dosimetry.

Elements and Emphases for FY 1999

For FY 1999, emphasis in the Biomedical Research and Countermeasures Program Elements will be on understanding and developing preventative and corrective remedies against the maladaptive effects of long-duration space flight within **i) Physiology and Behavioral Research, ii) Biomedical Countermeasures**, **iii) Operational and Clinical Research, iv) Environmental Health, and v) Space Radiation Health** areas. Multidisciplinary research proposals are particularly sought that emphasize significant findings in both genders.

NASA is soliciting two types of proposals: 1) Ground-based research and 2) Flight experiments.

Ground-based research proposals should fall into one of three categories: basic research, development of countermeasures, or evaluation and validation of developed countermeasures.

Basic research proposals are requested that explore physiological and molecular mechanisms of the space flight-related changes in order to (1) facilitate the development of integrative countermeasures to prevent or minimize undesirable responses to microgravity, or (2) enhance recovery and physiological readaptation following space flight. Proposals for multidisciplinary integrated approaches studying responses of several physiological systems to hypogravity and hypergravity states using appropriate animal or human subjects are especially encouraged.

Proposals for research to *develop a countermeasure* through ground research should be based on sound mechanistic hypotheses. The NASA Johnson Space Center's Space and Life Sciences Directorate is developing procedures to support the evaluation and validation of countermeasures developed in the research program. Potential countermeasure candidates developed in the ground or flight research programs by both extramural and intramural investigators will be evaluated through this process for inclusion into operational medical protocols. Original investigators will become part of the team in the evaluation and validation process. Investigators who believe they have developed a countermeasure candidate that is mature enough for evaluation should provide comprehensive evidence, include a description of any special hardware to be used or delivered, and include protocols required for implementation.

Ground-based proposals in other areas covered in the Biomedical Research and Countermeasures Program will be considered, however, selection for funding will be at a lower priority regardless of scientific merit score.

Flight proposals for early utilization of the Space Station should address issues surrounding repeated EVA activities during the assembly of the Space Station, environmental health including microbiology, behavior and performance, and the post-flight physiological process of recovery; they must also require the unique facilities and attributes of a Space Station such as duration greater

than 16 days. Areas of particular importance that are best suited to early utilization include effects of human factors on behavior and performance (as affected by a culturally diverse crew, perturbed sleep-work cycles, commonly used medications, etc.); cardiovascular function (including atrial bubble detection); hematology as it relates to red cell mass changes in microgravity and altered oxygen concentration in EVA; muscle function, strength, endurance, and biomechanics as they may relate to EVA activities and thermoregulation; energy balance; and neuroscience research such as eye-hand coordination.

A full spectrum of biological specimens will be available for biomedical experiments on International Space Station only after assembly is complete (2004). Until then, additional opportunities for such experiments may arise on Space Shuttle flights. For these opportunities, NASA is soliciting proposals for flight experiments that address whether there are similarities in mechanisms underlying physiological changes during aging and space flight.

i. Physiology and Behavioral Research
Ground-based proposals are requested in neuroscience, musculoskeletal physiology, pharmacokinetics, nutritional science, and cardiovascular physiology as described in detail below.

a. Neuroscience
In neuroscience, the program is seeking outstanding proposals that will (1) identify mechanisms of adaptation, specifically including changes in both neuromotor muscle control and its relationship to maintaining balance and fine motor control during and after flight, and (2) determine the effects of simulated space flight on brain function, metabolism, senescence, and plasticity. Proposals that can be used to determine potential risk or to develop countermeasures while elucidating neurologic mechanisms will receive special attention. **Purely descriptive or observational studies should not be proposed.**

b. Nutrition and Metabolism
Proposals are requested to 1) determine the effect of simulating the effects of space flight in ground-based models on the nutritional requirements for space including fluids, macronutrients, micronutrients, compounds or elements, and the mechanisms for such changes; and 2) determine shifts in the metabolism of compounds that may affect health status such as lipids, cholesterol, fatty acids, and oxidative products. Proposals for research leading to simple, noninvasive, or minimally invasive methods for monitoring and assessing nutritional status during space flight are also requested.

c. Immunology
The Program is seeking research in relevant ground-based models to understand the causes and mechanisms of observed immunodeficiencies during and after prolonged space flight. Changes involved in cell-mediated immune function, nonspecific immunity, or immune surveillance capabilities may be related to stress, nutritional status, dysautonomia, or sleep deprivation which could be factors in alteration of immune function during or after space flight.

d. Behavior and Performance
This emphasis is designed to understand the mechanisms by which microgravity, confinement, cumulative sleep loss, mission design and events, and spacecraft environment affect the behavior and performance of crews and dependent support. It also addresses psychosocial, gender, and cross-cultural aspects of human missions in space. Studies of relationships between individuals and in groups are also addressed. Existing databases and

ground simulations in extreme and isolated analogs and test beds have been used. Behavior and performance research priorities for ground-based studies include:

1) Psychological Research
Research on cognitive processing, mood, and emotion, as these are affected by multicultural and gender variables in long-duration space missions; the development of tools and procedures to enhance the formation of healthy cultures in small groups on space missions; and research into sense of presence and after effects in virtual environments.

2) Psychiatric Issues
Research on the detection and treatment of acute psychiatric disorders that occur in remote locations from usual health care facilities, e.g., during long-duration space flight.

For a broader and more detailed listing of NASA Life Sciences Behavior and Performance research priorities, please reference the Countermeasures Task Force Report on Behavior and Performance online (http://peer1.idi.usra.edu/peer_review/prog/prog.html) or by phoning (202) 358-4180 and providing your full name, mailing address, phone number, and the title of this document.

ii. Biomedical Countermeasures
Proposals for the development of novel countermeasures are requested particularly in neuroscience and musculoskeletal physiology:

a. Neuroscience
In neuroscience, the program is seeking outstanding proposals that will produce effective countermeasures to the undesirable balance and gait disorders observed after space flight. These could include the potential use of intermittent exposure to centrifugation during space flight. In such research, it would be important to determine the tradeoffs of artificial gravity as a countermeasure specifically examining the risks and benefits of long-arm continuous versus short-arm intermittent centrifugation using existing ground facilities (see the *Space Life Sciences Standard Companion Document 1998*). Development or construction of hardware for ground or flight will not be supported.

b. Musculoskeletal System
For the musculoskeletal system, the program is seeking outstanding ground-based proposals using appropriate simulation models that (1) investigate the fundamental mechanisms for the development of space flight-associated sarcopenia; and (2) develop novel means of preventing it during flight or enhancing recovery after flight with minimal injury. Proposals for the evaluation and validation of countermeasures developed from previous ground-based or flight research must be applicable to an astronaut population of men and women between 30 and 60 years of age. Proposed countermeasures must have realistic requirements for crew time and other resources and must be proven to be safe for the crew.

iii. Operational and Clinical Research

a. Pharmacokinetics
High priority will be given to proposals that investigate, in ground-based studies simulating the effects of space flight, the mechanisms and changes that could occur during space flight or immediately post flight in pharmacology and pharmacokinetics of representative classes of drugs. Proposals addressing adverse drug interactions under these two operational

conditions are also solicited. The research should be relevant to the astronaut population of men and women between 30 and 60 years of age.

b. Recovery/Readaptation to a Gravity Environment

1) Anesthesia Risk
An astronaut requiring emergency surgery immediately post space flight should be considered equivalent to an advanced diabetic patient with autonomic dystrophy and myocardial impairment (anesthesia risk rating, ASAIV) although, before flight, they are in superb health and would have an excellent risk rating for anesthesia. Ground-based research proposals are requested that will develop appropriate testing components to acutely measure the risk for anesthetics or other emergency medical treatment. The research should use relevant simulation models for the effects of microgravity or other aspects of space flight such as cumulative sleep loss.

2) Risk of Infection and Antibiotic Sensitivity
As in the case above, proposals are being sought for ground-based research studying the degree of risk of infection during and following simulation of space flight effects, or associated variables such as cumulative sleep loss. As in other areas, innovative multidisciplinary proposals are particularly sought that address space flight related changes in responsiveness to operational challenges.

iv. Environmental Health

Research within the Environmental Health element includes three interrelated disciplines, each dealing with a specific aspect of the spacecraft environment – barophysiology, microbiology, and toxicology. The Environmental Health element has established the following goals: (1) to understand the effects of the spacecraft environments on humans and other organisms; (2) to develop standards and countermeasures, where necessary, to optimize crew health, safety, and productivity; and 3) to enhance health care delivery to injured or sick crew members, taking into consideration the physiological effects of space flight.

For FY 1999, proposals are sought for ground studies to determine how space flight may affect (1) how and why atmospheric gas bubbles are formed and how they move through the vascular system; (2) the relationship of bubble formation to exercise, rigid space suits (forced immobility), circadian rhythms, pre-breathe times, etc.; and (3) optimal nitrogen washout protocols. Additionally, ground-based research which seeks to understand the physiologic effects of EVA activities on crewmembers to develop risk-mitigation countermeasures is a priority.

Although very limited crew time and logistical support will be available for research studies during construction of the ISS, well designed flight proposals are encouraged that would (1) use the multiple EVA opportunities for noninvasive passive studies, pre-EVA and post-EVA simple evaluations are encouraged; (2) establish physiological norms for atmospheric gases in habitable and research spacecraft; and (3) mechanistic studies of microbial populations in spacecraft during long-duration flight, including their migration, colonization, pathogenicity, or products[1].

[1] Proposals for developing technologies to monitor environmental quality of the air and water, as well as the microbial environment, are covered in the Advanced Environmental Monitoring and Control Element of the Advanced Human Support Technology (AHST) Program described in NRA 98-HEDS-01, which was released January 15, 1998. The next solicitation for the AHST program is expected to be in January 1999.

v. Space Radiation Health

For FY 1999, the primary areas of emphasis for the Space Radiation Health element is on ground-based experimental radiobiology studies using proton and high-energy heavy ion beams in the energy range corresponding to space radiation[2].

Proposals will be considered in the following areas:

- Studies leading to significant advances in our understanding of the genetic mechanisms of radiation damage and repair in cells and tissues, especially those aspects that are complementary to research in genomic instability currently jointly funded with the National Cancer Institute. Proposals addressing genetic sensitivity to space radiation and genetic intervention to alter such sensitivity are particularly encouraged.
- Studies leading to significant advances in our understanding of the risk of cancer, the consequences of CNS damage, and the acute and early damage due to solar particle events.
- Studies based on basic mechanisms of molecular biology that are likely to result in the development of biological countermeasures in humans that could lead to prevention or intervention (including genetic or pharmacological agents) against effects of radiation damage in space.
- Studies linking biological mechanisms to significant improvements in the accuracy of predictions of radiation risk for exposure of humans in space (especially carcinogenesis).

A very strong rationale will be required to justify support of studies not directly using protons or heavy ions in the relevant energy range or not directly relevant to the interpretation of experiments already conducted at such facilities. Research that can lead to future space flight investigations will be welcome. Such research should take into account the impact of gender, age, nutrition, stress, genetic predisposition or sensitivity to other factors of importance in managing space radiation risks.

Other Emphasis in the Biomedical Research and Countermeasures Program

Advanced technology development (ATD) scientific and technical proposals that are highly innovative are sought. Bold, novel approaches to solving technology needs are encouraged; because of this, it is recognized that each proposal may contain some risk of failure. Some sample topics are:

- The development of new highly innovative technologies applied to routine ground-based model systems (i.e. transgenic animals, cell culture, reporter gene technology, etc.) that would make

[2]NASA has signed agreements with Loma Linda University Medical Center related to the use of proton beams and with Brookhaven National Laboratory for the use of heavy ion beams at the Alternating Gradient Synchrotron (further details are provided in Section 5.0 of *Space Life Sciences Standard Companion Document 1998*). **NASA negotiates beam delivery directly with these institutions, and investigators proposing to use these irradiation facilities should not include the cost of beam time in their budgets. However, investigators should include the cost of carrying out the experiments at the beam site, including travel.** Investigators are not required to use these facilities, however if exposures at other facilities are needed for proposed studies, proposers must obtain them at no cost to NASA. If exposures not available at Loma Linda or Brookhaven are needed for studies proposed in response to this NRA, proposers must indicate in their application how such exposures will be accomplished, provide evidence that the sources will be available for their use, and indicate how the dosimetry and other physical characteristics of the radiation fields will be measured.

flight experiments feasible by reducing the time required for technical analysis and the equipment requirements for in-flight data collection.

- Development of implantable sensors, electronics and software to monitor and analyze long-term nerve and muscle activities in unrestrained subjects.
- Technologies of common interest to several elements within the Biomedical Research and Countermeasures Program. Examples include: 1) development of exercise apparatuses which provide a means of quantifying not only the amount and pattern of work performed, but also control the levels and patterns of loading imposed upon muscles, bones, and joints; and 2) the use of biochips (biological cells and computer chips used in combination) to detect radiation or metabolic processes.
- The development of new highly innovative technologies based on cutting-edge, state-of-the-art methods to non-invasively monitor physiological variables such as cognitive and emotional states of the astronauts during prolonged space flight.
- Non-refrigerated sample preservation processes and systems for storing biological samples thereby reducing payload power and volume requirements on spacecraft.

Investigators are encouraged to include advances in instrumentation in their experimental proposals, especially advances that might lead to remote or automated measurements of molecular changes or biological processes, and that may lend themselves to development for space flight telescience.

If proposals depend on availability of NASA or non-NASA technologies, facilities, data, or simulation capabilities, it is **required** that investigators demonstrate within the proposal that such availability and access has been assured by the responsible NASA personnel or appropriate non-NASA sources.

IV. Research in Bioethics

Concern has been raised that direct investigator financial involvement related to a research investigation may pose a possible conflict of interest and this information should be discussed with potential research subjects during the informed consent. Research proposals are requested that will investigate the ethical and practical implications of the following two suggestions:

1) The funding Agency and scientific merit peer review panels should be notified prior to their deliberations that there is a financial or other potential interest that the investigator has in the successful outcome of a research proposal other than the advancement of knowledge; and

2) That part of each informed consent contain specific language indicating the exact nature of the investigator's interest in the proposed research, i.e., financial gain, etc.

It is expected that at the end of the funded activity, successful proposers would justify the required level of investigator disclosure regarding conflict of interest and the level of explanation required to be given to a research subject in the informed consent based on their findings discovered through current scientific research methods. The goal of this research would be to determine how to increase the maintenance of scientific integrity and protect the research subject while not adding undue burden to the research community or inhibiting free enterprise.

A working definition of potential financial conflict is as follows:

a) Any non federal employee who: (1) as an investigator receives (or whose immediate family receives) >$10,000 per year in salaries or royalties from a company which has an interest in the results of the research; (2) has equity interests in such a company whose value is >$10,000 or

is greater than 5 percent of the equity of the company; or (3) has intellectual property rights in the drug or device being tested in the research.

b) Federal employees governed by conflict of interest rules contained in 5 C.F.R. 2635 should disclose any potential conflict of interest regardless of the amount involved.

The following language is an example of the additional language that could be added to consent forms:

"In deciding whether to participate in research, potential subjects should be aware that researchers often have personal interests (e.g., professional advancement) in the outcome of research projects. [In this particular case, the researchers have disclosed that they have the following financial interests in the outcome of this research project....] It is rare, however, for a researcher to permit such considerations to interfere with the scientific integrity of the research or the safety of the research subjects."

V. Biospecimen Sharing

Biospecimen Sharing provides the scientific community with access to NASA's inventory of biological materials from organisms that have flown in space. These materials were not required by the primary experiments of the space flights on which they were flown. The available material includes tissue from flight or ground control studies that were designed to enable the primary investigation to be carried out successfully. Applicants may submit proposals specifically for analysis of materials obtained from this Program or as an adjunct or supplementary component of an experimental proposal in one of the other research areas above. In either case, it is expected that the use of the requested materials will be fully justified in the proposal. Applicants should indicate their requirement for materials at the appropriate place on Form B (Appendix B).

Previously Collected Materials. Rodent, avian, and plant materials are currently available from previously flown flight experiments. Specific information regarding which samples are still available, characteristics of each mission from which the samples were obtained (e.g., mission length and orbital inclination), experimental conditions used to obtain and preserve the samples, and protocols (e.g., diet, light/dark cycle, housing, fixation/storage) used by the primary investigation can be obtained on-line from the Space Life Sciences Data Archive (http://lsda.jsc.nasa.gov; see Biospecimen page at this site) or by contacting:

Mr. Marc Shepanek
UL/Life Sciences Division
NASA Headquarters
Washington, DC 20546
(202) 358-2530
(202) 358-4168 (Fax)

VI. Flight Experiments

All flight experiments must address one or more of the research programs and emphases defined in Section III above. Preparatory ground research designed to define a mature space flight experiment should be proposed separately and in its own right as part of the ground-based program.

Detailed information regarding proposals for flight experiments is provided in the *Space Life Sciences Standard Companion Document 1998*. This document describes the evaluation process,

flight opportunities, and the capabilities of the space research facilities available to life sciences researchers. This document is available online at:
http://peer1.idi.usra.edu/peer_review/nra/98_heds_02_scd.html

VII. Proposal Evaluation and Awards Selection Process

The following information is specific to this NRA and **supercedes** the information contained in Sections I and J of Appendix C, *Instructions for Responding to NASA Research Announcements.*

All proposals must comply with the general requirements of the Announcement. Upon receipt, proposals will be reviewed for compliance with the requirements of this Announcement. This includes:

1. Submission of complete proposals on or before the due date specified in this Announcement (see Section VIII, Part F of this Appendix).
2. Responsiveness to the areas of program element emphasis described in this Announcement.
3. Submission of a complete proposal including a project description that is not more than 25 pages in length (see Instructions, Appendix B).
4. Submission of appropriate Institutional Review Board (IRB) or Animal Care and Use Committee (ACUC) certification for all proposals using human or animal test subjects. Certification must be specific to the proposal. NASA shall require current IRB or ACUC certification prior to award (see Special Matters, Appendix B of this Announcement). If IRB or ACUC review is unavoidably delayed beyond the submission of the application, enter "Pending" on line 9b or 10b of Form A. The certification must be received within 60 days after the due date for which the application is submitted. If certification is not received within 60 days after the application due date, the application will be considered incomplete. For additional information relative to IRB or ACUC approval and definitions of "human subjects" and "vertebrate animals," see Application for a Public Health Service Grant (PHS 398) at the website:
http://www.nih.gov/grants/funding/phs398/phs398.html.
5. Submission of a budget that is within the guidelines specified in this Announcement and is for a funding period not exceeding three years in duration (see Section VIII, Part A of this Appendix).
6. Proposals that are revised versions of proposals previously submitted to NASA must be clearly marked as such and must contain an explanation of how the revised proposal has addressed criticisms from previous NASA review (see Instructions, Appendix B).
7. Submission of all other appropriate forms as required by this NASA Research Announcement (refer to Checklist for Proposers, Form H, Appendix B).

Note: At NASA's discretion, non-compliant proposals may be withdrawn from the review process and returned to the proposer without further review.

The overall review process for each proposal submitted in response to this Announcement will include the following factors:

- Intrinsic scientific or technical merit
- Flight feasibility (flight experiments only)
- Relevance to NASA programs
- Cost

The most important factor in the evaluation is intrinsic scientific or technical merit, followed by flight feasibility (if applicable), relevance to NASA programs, and cost.

Compliant proposals will undergo a three-tiered review process consisting of: a merit review, a flight feasibility review (flight experiments only), and an evaluation of programmatic relevance and cost.

A. Merit Review

The **first review tier** will be a merit review by a panel of scientific or technical experts. The number and diversity of experts required will be determined by the response to this NRA and by the variety of disciplines represented in the proposals relevant to the research emphases described in Section III or IV of this Appendix. The merit review panel will assign ***a score from 0-100*** or a score of "not recommended for further consideration" based upon the intrinsic scientific or technical merit of the proposal. This score will reflect the consensus of the panel.

The score assigned by this panel ***will not be affected by the cost of the proposed work nor will it reflect the programmatic relevance of the proposed work to NASA***. However, the panel will be asked to include in their critique of each proposal any comments they may have concerning the proposal's budget and relevance to NASA.

The following will be used in determining the merit score:

1. **Significance:** Does this study address an important problem? If the aims of the application are achieved, how will scientific knowledge or technology be advanced? What will be the effect of these studies on the concepts, methods, or products that drive this field?
2. **Approach:** Are the conceptual framework, design, methods, and analyses adequately developed, well integrated, and appropriate to the aims of the project? Is the proposed approach likely to yield the desired results? Does the applicant acknowledge potential problem areas and consider alternative tactics?
3. **Innovation:** Does the project employ novel concepts, approaches, or methods? Are the aims original and innovative? Does the project challenge existing paradigms or develop new methodologies or technologies?
4. **Investigator:** Is the investigator appropriately trained and well suited to carry out this work? Is the work proposed appropriate to the experience level of the principal investigator and any co-investigators? Is the evidence of the investigator's productivity satisfactory?
5. **Environment:** Does the scientific environment in which the work will be performed contribute to the probability of success? Do the proposed experiments take advantage of unique features of the scientific environment or employ useful collaborative arrangements? Is there evidence of institutional support?

B. Flight Feasibility Review

The **second tier of review**, applicable only to flight experiment proposals, will be an evaluation of the flight feasibility of the proposed work on a space platform. This review is described in the *Space Life Sciences Standard Companion Document 1998*.

C. Evaluation of Programmatic Relevance and Cost

The **third tier of review** is of 2 factors: relevance and cost. This review will be conducted by NASA program scientists and managers, who will evaluate the programmatic relevance and cost of each proposal. Evaluation of the cost of a proposed effort includes consideration of the realism

and reasonableness of the proposed cost and the relationship of the proposed cost to available funds. Programmatic relevance will include an evaluation of how the proposed work may help achieve an appropriate balance of scientific and technical tasks required by critical research issues faced by the Gravitational Biology and Ecology and Biomedical Research and Countermeasures Programs.

D. Development of Selection Recommendation

The information resulting from these three levels of review will in turn be used to prepare a **selection recommendation** developed by NASA program scientists and managers for each of the program elements described in this Announcement. This recommendation will be based on:

(1) The score for merit from the peer review panel.
(2) The results of the flight feasibility review (if applicable).
(3) The programmatic relevance and cost of each proposal.

This **selection recommendation** will be presented by NASA program scientists and managers to the Director of the Life Sciences Division. Selection for funding will be made by the Director of the Life Sciences Division.

VIII. Program Management Information

A. Type of Awards to be Made

Funding increment:	One year at a time
Funding duration:	One to three years, depending on proposal requirement, review panel recommendation, and continuing progress of the activity
Direct and Indirect Costs:	NASA does not provide separate funding for direct and indirect costs; thus, the amount of the award requested is the total of all costs submitted in the proposed budget
Number awarded:	Approximately 40 expected, depending on number received, review panel recommendation, and available funding
Average funding:	$150,000 per year
Funding range:	up to $350,000 per year

B. Eligibility

All categories of institutions are eligible to submit proposals in response to this NRA. Principal Investigators may collaborate with universities, Federal Government laboratories, the private sector, and state and local government laboratories. In all such arrangements, the applying entity is expected to be responsible for administering the project according to the management approach presented in the proposal.

The applying entity must have in place a documented base of ongoing high quality research in science and technology or in those areas of science and engineering clearly relevant to the specific programmatic objectives and research emphases indicated in this Announcement. Present or prior support by NASA of research or training in any institution or for any investigator is not a prerequisite to submission of a proposal or a competing factor in the selection process.

All categories of institutions are eligible to submit proposals in response to this NRA, but only approved proposals from U.S. institutions will be selected for funding.

C. Foreign Proposals

This solicitation is being coordinated with solicitations from the European Space Agency (ESA), and the space agencies of Canada (Canadian Space Agency, CSA), France (Centre National d'Ètudes Spatiales, CNES), Germany (Deutsche Agentur Für Raumfahrtangelegenheiten, DARA), and Japan (National Space Development Agency of Japan, NASDA). Flight experiment proposals from entities of the member countries of ESA, Canada, and Japan must be submitted to their respective space agency, including those with U.S. researchers and co-investigators. U.S. co-investigators who are collaborating on such proposals must ensure that their scientific role is clearly delineated in the proposal, that their expertise is shown to make a substantial contribution, and that their funding requirements are included in the proposal. The solicitation, review, and selection process for flight experiments proposed through this coordinated effort is described in the *Space Life Sciences Standard Companion Document 1998*.

Although NASA does not fund proposals from non-U.S. entities, NASA will accept for review foreign proposals from institutions that are not entities of the member countries of ESA, Canada, or Japan and which require use of NASA facilities or utilization of NASA-sponsored flight opportunities. Such proposals must include a written endorsement from the respective government agency or funding/sponsoring institution in the country from which the proposal originates. This endorsement must indicate that:

1) The proposal merits careful consideration by NASA, and
2) If the proposal is selected, sufficient funds will be made available by that country or agency to undertake the activity as proposed.

Should such a proposal be selected, NASA will arrange with the non-U.S. sponsoring agency for the proposed participation on a no-exchange-of-funds basis, in which NASA and the non-U.S. sponsoring agency will each bear the cost of discharging its respective responsibilities. Proposals by a U.S. institution which include participation by non-U.S. institutions who are also not entities of the member countries of ESA, Canada, or Japan require the same endorsement and, if selected, will also undergo similar coordination with the non-U.S. sponsoring Agency.

D. Program Reporting

It is expected that results from funded research will be submitted to peer-reviewed journals as the work progresses. Only published papers that acknowledge NASA's support and identify the grant or contract will be counted as resulting from the research project and used to evaluate its productivity.

Annual Reporting Investigators will be expected to provide NASA with annual summary information. This information will consist primarily of:

- an abstract
- a bibliographic list
- copies of publications
- a statement of progress

This information will be made available to the scientific community and will be used to assess the strength of the Division's programs. It will also serve as the basis for determining the degree of progress of the project.

Annual Task Book Reporting The NASA Life Sciences Division publishes a comprehensive annual document titled Life Sciences Program Tasks and Bibliography (or Life Sciences Task Book) which includes descriptions of all peer-reviewed activities funded by the division during the previous fiscal year. Since its inception in fiscal year 1995, the Task Book has served as an invaluable source of information for NASA Life Sciences as well as the scientific and technical communities.

Investigators are required to provide information for this publication on an annual basis. Please note that this requirement is in addition to the annual report which investigators are required to submit at the end of each funding cycle. Supplying the requested information for the Life Sciences Task Book does NOT fulfill the requirement for the annual report. Unlike the annual report, information requested for the Task Book must be for the government's fiscal year rather than the project funding cycle and brief.

The information requested for inclusion in the Task Book consists primarily of:

- an abstract
- a brief statement of progress during the fiscal year
- a brief statement of benefits of the research with respect to life on Earth
- a bibliographic list for the fiscal year
- a copy or reprint of each publication listed in the bibliography for the fiscal year

Note that although this publication will be made available to the general scientific community, it is not a substitute for traditional scientific reporting in journals and elsewhere.

Final Report A final report is required which shall include all peer-reviewed publications.

Flight Experiment Reports Investigators selected to carry out space flight experiments are expected to provide NASA with two reports:

(1) A "quick-look" report of preliminary flight results that is due one month after the space flight takes place, and

(2) A final report containing all data and information on the flight study is due approximately one year after all required data/materials are provided by NASA to the investigator. At this time, all of the data must also be provided to NASA for placement in the Life Sciences Data Archive; data in this archive will be made available to the scientific and technical community.

E. Other Considerations

Travel If travel is planned, the proposal must include travel funds for the following:

- Annual Principal Investigator meeting
- Visits to NASA field centers (as many as necessary)
- Presentation at professional society meetings

Resident Research Associates Intramural investigators who plan to request Resident Research Associate (RRA) postdoctoral fellows supported by the NASA-National Research Council program should include this in their budget summary and list of personnel.

F. Letter of Intent and Proposal Submission Information

Letters of Intent To facilitate proposal processing, potential Principal Investigators are requested to confirm plans to submit a proposal responding to this Announcement by sending a ***letter of intent to propose***, which is not binding, by ***August 3, 1998.*** The letter of intent, which should be no more than two pages, should contain:

- The names, addresses, and telephone numbers of a single Principal Investigator and all co-investigators
- A descriptive title of the research or technical proposal
- A brief summary describing the proposed research and clearly indicating the GB&E and BR&C program element(s) defined in this Announcement that is/are most relevant to the proposal
- The major participating institutions
- Up to six (6) key words that best describe the research area of the pending proposal

Letters of Intent to propose may be submitted through the U.S. Postal Service or commercial delivery services in the same manner as proposals (described below). In addition, letters of intent (only) may be submitted electronically via e-mail to the following address:

loi@hq.nasa.gov

The subject heading of an electronic submission should read "LOI NRA 98-HEDS-02."

Proposals An original signed proposal, plus twenty-five (25) complete copies of that proposal and a 3.5-inch computer disk (containing an electronic copy of the Principal Investigator's name, address, telephone and fax numbers, e-mail address and the complete project title and abstract, as provided on Form B) in either Macintosh or PC format ***must be received by October 1, 1998.***

Proposals and Letters of Intent mailed through the U.S. Postal Service by express, first class, registered, or certified mail are to be sent to the following address:

Information Dynamics, Inc.
SUBJECT: NASA Life Sciences Research Proposal
300 D Street, SW
Suite 801
Washington, DC 20024

Proposals and Letters of Intent hand delivered or sent by commercial delivery or courier services are to be delivered to the above address between the hours of 8:00 AM and 4:30 PM. The telephone number (202) 479-2609 may be used when required for reference by delivery services.

Note that Information Dynamics, Inc. (IDI) cannot receive deliveries on Saturdays, Sundays, or federal holidays.

G. Proposal Schedule

The following schedule is planned for the acquisition of investigations under this Announcement:

Letter of Intent to Propose Due	August 3, 1998
Proposal Due	October 1, 1998
Selection Announcement	March - April 1999
Initial Funding Available	June 1999

IX. Bibliography

1. **Life Sciences Program Tasks and Bibliography (Task Books)** for FY 1995 through FY 1997 are available on-line at the following World Wide Web address: http://peer1.idi.usra.edu/peer_review/taskbook/taskbook.html

2. **Space Life Sciences Standard Companion Document 1998**, this document is available on-line at the following World Wide Web address: http://peer1.idi.usra.edu/peer_review/nra/98_heds_02_scd.html

3. **SPACELINE**, an on-line bibliographic database, is available for searching for references to publications about space life sciences research. A cooperative venture between NASA's Life Sciences Division and the National Library of Medicine (NLM), SPACELINE is similar in structure to NLM's MEDLINE database. University or medical school librarians should be able to conduct requested searches; individuals can perform their own searches after establishing an NLM account. Additional information may be obtained from the SPACELINE Office. Phone: 301-295-2482;
   email: **SPACELINE@mx3.usuhs.mil**
   Web address 1: **http://spaceline.usuhs.mil**
   Web address 2: **http://igm.nlm.nih.gov** (MEDLINE)

4. **The Space Life Sciences Data Archive (LSDA)** is an on-line database containing descriptions and results of completed NASA-sponsored flight experiments. Descriptions are included of experiments, missions, procedures, hardware, biospecimens collected, personnel, and documents. Biospecimens that are available for research purposes are described in detail. A limited number of experiments contain final reports and spreadsheet data suitable for downloading. Data from human subjects are unavailable pending a final policy for their release.

   Internet access: **http://lsda.jsc.nasa.gov**
   LSDA Help Desk: (281)483-7876
   Email: lsda@semail.jsc.nasa.gov

5. National Aeronautics and Space Administration, Life Sciences Division, Washington, DC 20546. Series of **Discipline Science/Technology Plans** produced by the programs of the Division.*
   a. **Cardiopulmonary Discipline Science Plan**, Space Physiology and Countermeasures Program (1991). *(NTIS #N9319648 - $17.50)*
   b. **Environmental Health Discipline Science Plan**, Environmental Health Program (1991). *(NTIS #N9321369 - $17.50)*

c. **Musculoskeletal Discipline Science Plan**, Space Physiology and Countermeasures Program (1991). *(NTIS #N9319892 - $17.50)*
d. **Neuroscience Discipline Science Plan**, Space Physiology and Countermeasures Program (1991). *(NTIS #N9319882 - $17.50)*
e. **Regulatory Physiology Discipline Science Plan**, Space Physiology and Countermeasures Program (1991). *(NTIS #N9319891 - $17.50)*
f. **Space Biology: Cell Biology Discipline Plan**, Space Biology Program (1993).
g. **Space Biology: Developmental Biology Discipline Plan**, Space Biology Program (1993).
h. **Space Biology: Gravity Sensing Neuroscience Discipline Plan**, Space Biology Program (1991).
i. **Space Biology: Musculoskeletal (Support Structures and Biomineralization) Discipline Plan**, Space Biology Program (1991).
j. **Space Biology: Regulatory Biology Discipline Plan**, Space Biology Program (1991).
k. **Space Biology: Plant Biology Discipline Science Plan**, Space Biology Program (1993).
l. **Space Human Factors Program Plan**, Space Human Factors Program (1995).
m. **Space Human Factors Requirements Definition**, Space Human Factors Program (1996).
n. **Space Human Factors Discipline Science Plan**, Space Human Factors Program (1991).
o. **Space Radiation Health Program Plan** (1991). *(NTIS #N9318375 - $17.50)*

6. National Aeronautics and Space Administration, Life Sciences Division, Washington, DC 20546. Cumulative bibliographies of publications resulting from research supported by the Division.*
   a. **Space Human Factors Publications: 1980-1990**. 1991. K. J. Dickson (Ed.). NASA Contractor Report 4351. *(NTIS # N9120620 - $22.00)*
   b. **Publications of the Space Physiology and Countermeasures Program, Regulatory Physiology Discipline: 1980-1990**. 1992. J. W. Robinson, K. J. Dickson, E. Hess, and J. V. Powers (Eds.). NASA Contractor Report 4469. *(NTIS #N9233657 - $34.50)*
   c. **Publications of the Space Physiology and Countermeasures Program, Musculoskeletal Discipline: 1980-1990**. 1992. E. Hess, J. W. Robinson, K. J. Dickson, and J. V. Powers (Eds.). NASA Contractor Report 4468. *(NTIS #N9312898 - $34.50)*
   d. **Publications of the Space Physiology and Countermeasures Program, Cardiopulmonary Discipline: 1980-1990**. 1992. J. V. Powers, J. W. Robinson, K. J. Dickson, and E. Hess (Eds.). NASA Contractor Report 4475. *(NTIS #N9318376 - $27.00)*
   e. **Publications of the Space Physiology and Countermeasures Program, Neuroscience Discipline: 1980-1990**. 1992. K. J. Dickson, J. W. Robinson, J. V. Powers, and E. Hess (Eds.). NASA Contractor Report 4476. *(NTIS #N9315583 - $27.00)*
   f. **Publications of the Environmental Health Program: 1980-1990**. 1992. J. W. Robinson, E. Hess, and K. J. Dickson (Eds.). NASA Contractor Report 4455. *(NTIS #N9229341 - $19.50)*
   g. **Publications of the NASA Controlled Ecological Life Support System (CELSS) Program: 1989-1992**. 1994. J.V. Powers (Ed.). NASA Contractor Report 4603. *(NTIS #N9430122 - $17.50)*

7. **Center for Advanced Studies in the Space Life Sciences** contains a list of workshops and seminars sponsored by the Center. The proceedings and final reports of these workshops are also posted as they become available. Web address: **http://www.mbl.edu/html/NASA/**

8 **Medical Policies and Requirements Document**. National Aeronautics and Space Administration, Medical Policy Board. Arnauld Nicogossian, Chairperson. NASA Headquarters. This document is currently in revision. Please contact Dr. James Collier (202-358-4538) for more information..

9. **A Strategy for Space Biology and Medical Science for the 1980s and 1990s**. National Academy of Sciences. National Research Council. Committee on Space Biology and Medicine. Jay M. Goldberg, Committee Chairperson. 1987. Washington, DC: National Academy Press. *(NTIS #N8924024 - $46.50)*

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17. **Plants in Space**. T. W. Halstead and F. R. Dutcher. 1987. *Annual Review of Plant Physiology* 38:317-345.

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19. **Proceedings of a Conference on Correlations of Aging and Space Effects on Biosystems**. R. L. Sprott and C. A. Combs. 1991. *Experimental Gerontology*, 26:121-309.

20. **Gravity Effects on Reproduction, Development and Aging**. J. Miguel and K. A. Souza. 1991. In: *Advances in Space Biology and Medicine*, 1:71-97.

21. **Gravity and the Cell**. Conference Report. 1991. *ASGSB Bulletin*, Vol. 4, No. 2, 260 pp.

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23. **COSMOS 2044 Mission**. 1992. Supplement to *Journal of Applied Physiology* 73(23).

24. **Spaceflight Immunology**. G. R. Taylor (Ed.). 1993. *J. Leukocyte Biol.*, 54:179-268.

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26. **The Effects of Space Travel on the Musculoskeletal System**. R. W. Lymn, S. L. Gordon, and F. M. Sulzman. 1992. NIH Publication No. 93-3484. Bethesda, MD: NIAMS, National Institutes of Health.

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31. **NASA's Enterprise for the Human Exploration and Development of Space: The Strategic Plan**. 1996. Washington, DC: National Aeronautics and Space Administration. *

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34. **Workshop on Space Flight Validation of Radiation Risk**. January 24-26, 1996. Universities Space Research Association, 3600 Bay Area Boulevard, Houston, TX 77058

35. **Shielding Strategies for Human Space Exploration**. J. W. Wilson, J. Miller, A. Konradi and F. A. Cucinotta, Editors. NASA CP-3360, December 1997, pp. 456. Also available from the NASA Langley Technical Reports Server at:
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40. **Task Force on Countermeasures**. This report incorporates the output of the Countermeasures Task Force, the Vestibular Countermeasures Task Group, and the Behavior and Performance Working Group into a unified document. Available at: **http://peer1.idi.usra.edu/peer_review/nra/98_heds_02_scd.html** or (202) 358-4180.

41. **Nutrition in Space: Lessons from the Past Applied to the Future**. H.W. Lane, S.M.Smith, B.L. Rice, C.T. Bourland, *Am. J.Clin. Nutr.* 1994, 60:801S-805S.

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45. **Muscle Research in Space: International Workshop**. *International Journal of Sports Medicine*, Volume 18, Supplement 4, S257-S331, 1997.

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**Obtaining cited papers*:
Many of the documents may be ordered through your library or through the National Technical Information Service (NTIS). Documents available through NTIS are accompanied by their NTIS order number and price. To order a document through NTIS, call 1-800-553-6847. If you are unable to locate a document through this means, please contact Information Dynamics, Inc. at (202) 358-4180.

APPENDIX B
NRA 98-HEDS-02

Instructions for Proposal Preparation and Required Application Forms

This section contains the general instructions for proposal preparation and the specific forms required by proposers responding to agency solicitations in the Space Life Sciences in 1998. This section is specific to this NRA and supercedes the information contained in Appendix C. The forms at the end of this section include the following:

Form A	Solicited Proposal Application
Form B	Proposal Abstract
Form C	Space Flight Experiment Preliminary Description Form (required for Flight Experiments only)
Form D	Biographical Sketch
Form E	Other Support
Form F	Detailed Budget, First Year
Form G	Detailed Budget, Entire Project Period
Form H	Checklist for Proposers

For your convenience, a NRA Mailing List Update form is also included at the end of the Appendix.

Instructions for Proposal Preparation

All proposals must include each of the forms provided in this Appendix as part of the complete submission, with the exception of Form C, which is submitted only with flight experiments, and Forms F and G, which are not required for some non-U.S. proposals (see the form-specific instructions included in this Appendix).

The proposal must include the following material, in this order:

(1) Cover Page: Solicited Proposal Application (Form A), including certification of compliance with U.S. code (if applicable)*
(2) Proposal Abstract (Form B)
(3) Proposal Title Page, with Notice on Restriction on Use and Disclosure of Proposal Information, if any
(4) Project Description
(5) Space Flight Experiment Preliminary Description Form (to be submitted with flight experiments only) (Form C)
(6) Management Approach
(7) Letter of Assurance of Foreign Support (to be submitted with proposals by non-U.S. entities)
(8) Biographical Sketch (Form D)
(9) Other Support (Form E)
(10) Facilities and Equipment
(11) Special Matters (specific information on animal or human subjects protocol approval required, if applicable)*
(12) Detailed Budget, 12 Month (Form F)
(13) Detailed Budget, Entire Project Period (Form G)
(14) Supporting Budgetary Information
(15) Checklist for Proposers (Form H)
(16) Appendices, if any
(17) Computer diskette (3.5 inch, Macintosh or PC format) containing an electronic copy of the principal investigator's name, address, telephone and fax numbers, e-mail address, and the complete project title and abstract as provided on Form B

* One signed original required

The Project Description Section is limited to 25 pages. Any pages in this section beyond 25 will not be reviewed. There is no specific page limitation on other sections of submitted proposals. However, every effort should be made to keep proposals as brief as possible. The name of the Principal Investigator should appear in the upper right hand corner of each page of the proposal, except on the forms in this Appendix where special places are provided for this information. Note that the proposal must specify the period of performance for the work described; periods of performance may be for any duration up to three (3) years but should be suitable for the project proposed.

(1) Cover Page: Solicited Proposal Application (Form A)

All of the information requested on Form A must be provided, and one original signature version of this form should be submitted. This form meets the requirements of the transmittal memo described in Appendix C, Section C(1).

For Item (7) on this form, new means that a proposal for this project has not been submitted to NASA in 1996 or 1997, renewal means that this proposal is for the continuation of a currently funded task beyond the term of the funded proposal, and revised means that this proposal represents a revision of a proposal submitted to NASA and reviewed in 1996 or 1997, but not funded. A proposal previously submitted but not funded should be termed revised even if the original Principal Investigator has changed for 1998. Renewal and revised applications should contain special material described in the Project Description section below.

Note: Items (9) and (10) on Form A require assurance of compliance with human subject or animal care provisions of NASA regulations (see Special Matters section below). If IRB or ACUC

review is unavoidably delayed beyond the submission of the application, enter "Pending" on line 9b or 10b in Form A. Applicants should be aware that proposal review will not be undertaken without prior assurance of compliance.

(2) Proposal Abstract (Form B)

The information requested on this form is essential to the review of the proposal. It determines how the application will be evaluated and which program manager(s) will receive the final review materials for possible inclusion in one of the research programs of the Life Sciences Division.

(3) Proposal Title Page

The title page should contain the project title, name and address of the submitting institution, the name, address and telephone number of the Principal Investigator, and the names and institutions of any co-investigators. It is NASA policy to use information contained in proposals for evaluation purposes only. While this policy does not require that the proposal bear a restrictive notice, offerors or quoters should, in order to maximize protection of trade secrets or other information that is commercial or financial and confidential or privileged, place the following notice on the Title Page of the proposal and specify the information subject to the notice by inserting appropriate identification, such as page numbers, in the notice. In any event, information (data) contained in proposals will be protected to the extent permitted by law, however NASA assumes no liability for use and disclosure of information not made subject to the notice.

NOTICE

Restriction on Use and Disclosure of Proposal Information

The information (data) contained in [insert page numbers or other identification] of this proposal constitutes a trade secret and/or information that is commercial or financial and confidential or privileged. It is furnished to the Government in confidence with the understanding that it will not, without permission of the offeror, be used or disclosed other than for evaluation purposes; provided, however, that in the event a contract (or other agreement) is awarded on the basis of this proposal the Government shall have the right to use and disclose this information (data) to the extent provided in the contract (or other agreement). This restriction does not limit the Government's right to use or disclose this information (data) if obtained from another source without restriction.

(4) Project Description

The length of the Project Description section of the proposal should not exceed 25 pages using regular (12 point) type. **Any pages beyond 25 will not be reviewed**. The proposal should contain sufficient detail to enable reviewers to make informed judgments about the overall merit of the proposed research and about the probability that the investigators will be able to accomplish their stated objectives with the resources requested and with their own resources. In addition, the proposal should indicate clearly the relationship between the proposed work and the research emphases defined in this Announcement. The project description should be consistent with the type of proposal that is being submitted (ground-based research investigation or space-flight experiment). If an investigator wishes to propose related studies of two different types (e.g., a ground-based research investigation and a related space-flight experiment), then two proposals should be submitted with their linkage described in each proposal.

Renewal applications (for competing renewal of currently funded activity) must include a progress report as an Appendix to the proposal, and should refer to this Appendix appropriately throughout the Project Description section.

Revised applications (revisions of 1996 or 1997 submissions) must include, as part of the Project Description section, an **Introduction** that contains responses to the criticisms of the previous review. Applicants should highlight the changes they have made in their research plan by appropriate bracketing, indenting, or changing of typography. Clearly present any work done since the prior version was submitted. Note that revised applications that do not address the criticisms in the previous critique or do not include substantial revisions will be considered unresponsive and will be returned without review.

(5) Space-Flight Experiment Preliminary Description Form (if applicable, Form C)

All applicants proposing space flight research must provide the information requested on Form C. The information on this form is essential for the evaluation of the feasibility of performing the proposed study. Before filling out this form, applicants should read the *Space Life Sciences Standard Companion Document 1998* carefully and make certain that they understand the constraints that are associated with flight experiments.

(6) Management Approach

Each proposal must specify a single Principal Investigator who is responsible for carrying out the proposed project and coordinating the work of other personnel involved in the project. In proposals that designate several senior professionals as key participants in the research project, the management approach section should define the roles and responsibilities of each participant, and note the proportion of each individual's time to be devoted to the proposed research activity. The proposal must clearly and unambiguously state whether these key personnel have reviewed the proposal and endorsed their participation.

(7) Letter of Assurance of Foreign Support

Applications submitted to the this Announcement by organizations outside of the U.S., European member countries of the European Space Agency, Canada, or Japan, must include a written endorsement from the respective agency or funding/sponsoring institution (see Appendix A, Section VIII, Part C of this Announcement for details).

(8) Biographical Sketch (Form D)

The Principal Investigator is responsible for direct supervision of the work and must participate in the conduct of the research regardless of whether or not compensation is received under the award. A short biographical sketch of the Principal Investigator that includes his or her current position title and educational background, a list of principal publications, and a description of any exceptional qualifications must be included. Use Form D to describe the research and professional experience of each professional staff member. Concluding with present position, list, in chronological order, previous employment, experience, and honors. Include present membership on any Federal Government public advisory committee. List, in chronological order, the titles, all authors, and complete references to all publications during the past three years and to representative earlier publications pertinent to this application. If the list of publications in the last three years exceeds two pages, select the most pertinent publications. Do not exceed two pages. Omit social security numbers and other personal items which do not merit consideration in evaluation of the proposal. Provide similar biographical information on other senior professional personnel who will be directly associated with the project. Provide the names and titles of any other scientists and technical personnel associated substantially with the project in an advisory capacity. Universities should list the approximate number of students or other assistants, with information as to their

level of academic attainment. Any special industry-university cooperative arrangements should be described.

(9) Other Support (Form E)

Use the format described in Form E to list other sources of research support (including active NASA support) for the proposed Principal Investigator and each of the proposed Co-Investigators. Please list all active support as well as any pending support.

(10) Facilities and Equipment

Describe the available facilities and major items of equipment specially adapted or suited to the proposed project, and any additional major equipment that will be required. Identify any government-owned facilities, industrial plant equipment, or special tooling that are proposed for use on the project. Provide evidence that such facilities or equipment will be made available if the applicant is successful in obtaining funding. Before requesting a major item of capital equipment, the proposer should determine if the sharing or loan of equipment already within the organization is a feasible alternative to purchase. Where such arrangements cannot be made, the proposal should so state. The need for items that can be typically used for research and non-research purposes should be explained.

(11) Special Matters

The Special Matters section must contain a statement from the proposer's institution which states that the proposed work will meet all Federal and local human subject requirements and animal care and use requirements, if applicable. Note that no animal subjects may be utilized unless specific information justifying and describing their use is included in the proposal. Policies regarding the protection of human research subjects in NASA-sponsored research are detailed in NASA Management Instruction (NMI) 7100.8B (Protection of Human Research Subjects), and animal care and use requirements are detailed in the NASA Code of Federal Regulations (CFR) 1232 (Care and Use of Animals in the Conduct of NASA Activities), both of which are available from the Life Sciences Division, Code UL, NASA Headquarters, Washington, DC 20546. Assurance of compliance with human subject or animal care provisions is required on Form A, to be submitted with each proposal. In addition, a letter signed by the chairperson of the Institutional Review Board (IRB) or institutional Animal Care and Use Committee (ACUC) or both, as appropriate, regarding approval of the experimental protocol, should be included with each copy of the proposal. If IRB or ACUC review is unavoidably delayed beyond the submission of the application, the certification must be received within 60 days after the due date for which the application is submitted. If certification is not received within 60 days after the application due date, the application will be considered incomplete. NASA shall require current IRB or ACUC certification prior to award. All U.S., non-NASA proposals providing ACUC approval must also contain the institution's Public Health Assurance number.

(12) Detailed Budget, 12 Month (Form F) and (13) Detailed Budget, Entire Project Period (Form G)

These forms must be submitted with each U.S. proposal, or with non-U.S. proposals that have a U.S. component for which NASA funding is sought. NASA intramural Principal Investigator's research budgets for all years are to be submitted in a full-cost mode in accordance with the NASA CFO, Enterprise Office and Center full-cost budget policy. Funds to support the Resident Research Assistant (RRA) Postdoctoral Program costs (e.g., stipend, travel, computer time, supplies, etc.) are to be budgeted within the NASA intramural Principle Investigator budget.

Foreign proposals from entities who are not members of ESA member countries, Canada, or Japan which have no U.S. component should not submit these forms.

(14) Supporting Budgetary Information

This section must include information which supports the costs submitted in Forms F and G. In this solicitation, the terms "cost" and "budget" are used synonymously. Sufficient proposal cost detail and supporting information are required; funding amounts proposed with no explanation (e.g., Equipment: $1,000, or Labor: $6,000) may cause delays in evaluation and award. Generally, costs will be evaluated as to realism, reasonableness, allowability, and allocation. The budgetary forms define the desired detail, but each category should be explained in this section. Offerors should exercise prudent judgment in determining what to include in the proposal, as the amount of detail necessarily varies with the complexity of the proposal.

The following examples indicate the suggested method of preparing a cost breakdown:

Direct Labor

Labor costs should be segregated by titles or disciplines with estimated hours and rates for each. Estimates should include a basis of estimate such as currently paid rates or outstanding offers to prospective employees. This format allows the Government to assess cost reasonableness by various means including comparison to similar skills at other organizations.

Other Direct Costs

Please detail, explain, and substantiate other significant cost categories as described below:

a) Subcontracts: Describe the work to be contracted, estimated amount, recipient (if known), and the reason for subcontracting.
b) Consultants: Identify consultants to be used, why they are necessary, the time they will spend on the project, and the rates of pay (not to exceed the equivalent of the daily rate for Level IV of the Executive Schedule, exclusive of expenses and indirect costs).
c) Equipment: List separately. Explain the need for items costing more than $5,000. Describe basis for estimated cost. General purpose equipment is not allowable as a direct cost unless specifically approved by the NASA Grant Officer. Any equipment purchase requested as a direct charge must include the equipment description, how it will be used in the conduct of the basic research proposed, and why it cannot be purchased with indirect funds.
d) Supplies: Provide general categories of needed supplies, the method of acquisition, and estimated cost.
e) Travel: Describe the purpose of the proposed travel in relation to the grant and provide the basis of estimate, including information on destination and number of travelers where known.
f) Other: Enter the total of direct costs not covered by a) through e). Attach an itemized list explaining the need for each item and the basis for the estimate.

Indirect Costs

Indirect costs should be explained to an extent that will allow the Government to understand the basis for the estimate. Examples of prior year historical rates, current variances from those rates, or an explanation of other basis of estimates should be included. Where costs are based on allocation percentages or dollar rates, an explanation of rate and application base relationships should be given. For example, the base to which the General and Administrative (G&A) rate is applied could be explained as: application base equals total costs before G&A less subcontracts.

(15) Checklist for Proposers (Form H)

One copy of a completed version of this checklist should be attached to the transmittal letter.

(16) Appendices, if Any

Renewal applications (for competing renewal of currently funded activity) must include an appendix providing a Progress Report of the previously funded activity. This report should provide the beginning and ending dates for the period covered since the project was last reviewed competitively, and provide a list of all personnel who have worked on the project during this period (including dates of service and percentages of their appointments devoted to the project). The report should also summarize the previous project's original goals and specific objectives, and provide a succinct account of published and unpublished results indicating progress toward their achievement. Changes in these objectives during the course of the project and a rationale for these changes should be presented. The importance of the findings should be summarized and discussed. Finally, a list should be provided of the titles and complete references to all publications, manuscripts submitted or accepted for publication, patents, invention reports, and other printed materials that have resulted from the project since it was last competitively reviewed.

Other appendices may be appropriate for particular proposals.

(17) Computer Diskette

A diskette (3.5 inch, Macintosh or PC format) should contain an electronic copy of the Principal Investigator's name, address, telephone and fax numbers, e-mail address, and the complete project title and abstract as provided on Form B

.

The Required Application Forms

must be downloaded separately from

http://peer1.idi.usra.edu/peer_review/nra/98_HEDS_02.html

APPENDIX C
NRA 98-HEDS-02

INSTRUCTIONS FOR RESPONDING TO NASA RESEARCH ANNOUNCEMENTS

(JANUARY 1997)

A. General.

(1) Proposals received in response to a NASA Research Announcement (NRA) will be used only for evaluation purposes. NASA does not allow a proposal, the contents of which are not available without restriction from another source, or any unique ideas submitted in response to an NRA to be used as the basis of a solicitation or in negotiation with other organizations, nor is a pre-award synopsis published for individual proposals.

(2) A solicited proposal that results in a NASA award becomes part of the record of that transaction and may be available to the public on specific request; however, information or material that NASA and the awardee mutually agree to be of a privileged nature will be held in confidence to the extent permitted by law, including the Freedom of Information Act.

(3) NRA's contain programmatic information and certain requirements which apply only to proposals prepared in response to that particular announcement. These instructions contain the general proposal preparation information which applies to responses to all NRAs.

(4) A contract, grant, cooperative agreement, or other agreement may be used to accomplish an effort funded in response to an NRA. NASA will determine the appropriate instrument. Contracts resulting from NRA's are subject to the Federal Acquisition Regulation and the NASA FAR Supplement. Any resultant grants or cooperative agreements will be awarded and administered in accordance with the NASA Grant and Cooperative Agreement Handbook (NPG 5800.1).

(5) NASA does not have mandatory forms or formats for responses to NRA's; however, it is requested that proposals conform to the guidelines in these instructions. NASA may accept proposals without discussion; hence, proposals should initially be as complete as possible and be submitted on the proposers' most favorable terms.

(6) To be considered for award, a submission must, at a minimum, present a specific project within the areas delineated by the NRA; contain sufficient technical and cost information to permit a meaningful evaluation; be signed by an official authorized to legally bind the submitting organization; not merely offer to perform standard services or to just provide computer facilities or services; and not significantly duplicate a more specific current or pending NASA solicitation.

B. NRA-Specific Items. Several proposal submission items appear in the NRA itself: the unique NRA identifier; when to submit proposals; where to send proposals; number of copies required; and sources for more information. Items included in these instructions may be supplemented by the NRA.

C. Proposal Content. The following information is needed to permit consideration in an objective manner. NRAs will generally specify topics for which additional information or greater detail is desirable. Each proposal copy shall contain all submitted material, including a copy of the transmittal letter if it contains substantive information.

(1) *Transmittal Letter or Prefatory Material.*

(i) The legal name and address of the organization and specific division or campus identification if part of a larger organization;

(ii) A brief, scientifically valid project title intelligible to a scientifically literate reader and suitable for use in the public press;

(iii) Type of organization: e.g., profit, nonprofit, educational, small business, minority, women-owned, etc.;

(iv) Name and telephone number of the principal investigator and business personnel who may be contacted during evaluation or negotiation;

(v) Identification of other organizations that are currently evaluating a proposal for the same efforts;

(vi) Identification of the NRA, by number and title, to which the proposal is responding;

(vii) Dollar amount requested, desired starting date, and duration of project;

(viii) Date of submission; and

(ix) Signature of a responsible official or authorized representative of the organization, or any other person authorized to legally bind the organization (unless the signature appears on the proposal itself).

(2) *Restriction on Use and Disclosure of Proposal Information.* Information contained in proposals is used for evaluation purposes only. Offerors or quoters should, in order to maximize protection of trade secrets or other information that is confidential or privileged, place the following notice on the title page of the proposal and specify the information subject to the notice by inserting an appropriate identification in the notice. In any event, information contained in proposals will be protected to the extent permitted by law, but NASA assumes no liability for use and disclosure of information not made subject to the notice.

Notice

Restriction on Use and Disclosure of Proposal Information

The information (data) contained in [insert page numbers or other identification] of this proposal constitutes a trade secret and/or information that is commercial or financial and confidential or privileged. It is furnished to the Government in confidence with the understanding that it will not, without permission of the offeror, be used or disclosed other than for evaluation purposes; provided, however, that in the event a contract (or other agreement) is awarded on the basis of this proposal the Government shall have the right to use and disclose this information (data) to the extent provided in the contract (or other agreement). This restriction does not limit the Government's right to use or disclose this information (data) if obtained from another source without restriction.

(3) *Abstract*. Include a concise (200-300 word if not otherwise specified in the NRA) abstract describing the objective and the method of approach.

(4) *Project Description.*

(i) The main body of the proposal shall be a detailed statement of the work to be undertaken and should include objectives and expected significance; relation to the present state of knowledge; and relation to previous work done on the project and to related work in progress elsewhere. The statement should outline the plan of work, including the broad design of experiments to be undertaken and a description of experimental methods and procedures. The project description should address the evaluation factors in these instructions and any specific factors in the NRA. Any substantial collaboration with individuals not referred to in the budget or use of consultants should be described. Subcontracting significant portions of a research project is discouraged.

(ii) When it is expected that the effort will require more than one year, the proposal should cover the complete project to the extent that it can be reasonably anticipated. Principal emphasis should be on the first year of work, and the description should distinguish clearly between the first year's work and work planned for subsequent years.

(5) *Management Approach*. For large or complex efforts involving interactions among numerous individuals or other organizations, plans for distribution of responsibilities and arrangements for ensuring a coordinated effort should be described.

(6) *Personnel*. The principal investigator is responsible for supervision of the work and participates in the conduct of the research regardless of whether or not compensated under the award. A short biographical sketch of the principal investigator, a list of principal publications and any exceptional qualifications should be included. Omit social security number and other personal items which do not merit consideration in evaluation of the proposal. Give similar biographical information on other senior professional personnel who will be directly associated with the project. Give the names and titles of any other scientists and technical personnel associated substantially with the project in an advisory capacity. Universities should list the approximate number of students or other assistants, together with information as to

their level of academic attainment. Any special industry-university cooperative arrangements should be described.

(7) *Facilities and Equipment.*

(i) Describe available facilities and major items of equipment especially adapted or suited to the proposed project, and any additional major equipment that will be required. Identify any Government-owned facilities, industrial plant equipment, or special tooling that are proposed for use. Include evidence of its availability and the cognizant Government points of contact.

(ii) Before requesting a major item of capital equipment, the proposer should determine if sharing or loan of equipment already within the organization is a feasible alternative. Where such arrangements cannot be made, the proposal should so state. The need for items that typically can be used for research and non-research purposes should be explained.

(8) *Proposed Costs.*

(i) Proposals should contain cost and technical parts in one volume: do not use separate "confidential" salary pages. As applicable, include separate cost estimates for salaries and wages; fringe benefits; equipment; expendable materials and supplies; services; domestic and foreign travel; ADP expenses; publication or page charges; consultants; subcontracts; other miscellaneous identifiable direct costs; and indirect costs. List salaries and wages in appropriate organizational categories (e.g., principal investigator, other scientific and engineering professionals, graduate students, research assistants, and technicians and other non-professional personnel). Estimate all staffing data in terms of staff-months or fractions of full-time.

(ii) Explanatory notes should accompany the cost proposal to provide identification and estimated cost of major capital equipment items to be acquired; purpose and estimated number and lengths of trips planned; basis for indirect cost computation (including date of most recent negotiation and cognizant agency); and clarification of other items in the cost proposal that are not self-evident. List estimated expenses as yearly requirements by major work phases.

(iii) Allowable costs are governed by FAR Part 31 and the NASA FAR Supplement Part 1831 (and OMB Circulars A-21 for educational institutions and A-122 for nonprofit organizations). NASA does not provide separate funding for direct and indirect costs; thus, the amount of the award requested is the total of all costs submitted in the proposed budget.

(9) *Security*. Proposals should not contain security classified material. If the research requires access to or may generate security classified information, the submitter will be required to comply with Government security regulations.

(10) *Current Support*. For other current projects being conducted by the principal investigator, provide title of project, sponsoring agency, and ending date.

(11) *Special Matters*.

(i) Include any required statements of environmental impact of the research, human subject or animal care provisions, conflict of interest, or on such other topics as may be required by the nature of the effort and current statutes, executive orders, or other current Government-wide guidelines.

(ii) Proposers should include a brief description of the organization, its facilities, and previous work experience in the field of the proposal. Identify the cognizant Government audit agency, inspection agency, and administrative contracting officer, when applicable.

D. Renewal Proposals.

(1) Renewal proposals for existing awards will be considered in the same manner as proposals for new endeavors. A renewal proposal should not repeat all of the information that was in the original proposal. The renewal proposal should refer to its predecessor, update the parts that are no longer current, and indicate what elements of the research are expected to be covered during the period for which support is desired. A description of any significant findings since the most recent progress report should be included. The renewal proposal should treat, in reasonable detail, the plans for the next period, contain a cost estimate, and otherwise adhere to these instructions.

(2) NASA may renew an effort either through amendment of an existing contract or by a new award.

E. Length. Unless otherwise specified in the NRA, effort should be made to keep proposals as brief as possible, concentrating on substantive material. Few proposals need exceed 15-20 pages. Necessary detailed information, such as reprints, should be included as attachments. A complete set of attachments is necessary for each copy of the proposal. As proposals are not returned, avoid use of "one-of-a-kind" attachments.

F. Joint Proposals.

(1) Where multiple organizations are involved, the proposal may be submitted by only one of them. It should clearly describe the role to be played by the other organizations and indicate the legal and managerial arrangements contemplated. In other instances, simultaneous submission of related proposals from each organization might be appropriate, in which case parallel awards would be made.

(2) Where a project of a cooperative nature with NASA is contemplated, describe the contributions expected from any participating NASA investigator and agency facilities or equipment which may be required. The proposal must be confined only to that which the proposing organization can commit itself. "Joint" proposals which specify the internal arrangements NASA will actually make are not acceptable as a means of establishing an agency commitment.

G. Late Proposals. A proposal or modification received after the date or dates specified in an NRA may be considered if doing so is in the best interests of the Government.

H. Withdrawal. Proposals may be withdrawn by the proposer at any time before award. Offerors are requested to notify NASA if the proposal is funded by another organization or of other changed circumstances which dictate termination of evaluation.

I. Evaluation Factors.

(1) Unless otherwise specified in the NRA, the principal elements (of approximately equal weight) considered in evaluating a proposal are its relevance to NASA's objectives, intrinsic merit, and cost.

(2) Evaluation of a proposal's relevance to NASA's objectives includes the consideration of the potential contribution of the effort to NASA's mission.

(3) Evaluation of its intrinsic merit includes the consideration of the following factors of equal importance:

(i) Overall scientific or technical merit of the proposal or unique and innovative methods, approaches, or concepts demonstrated by the proposal.

(ii) Offeror's capabilities, related experience, facilities, techniques, or unique combinations of these which are integral factors for achieving the proposal objectives.

(iii) The qualifications, capabilities, and experience of the proposed principal investigator, team leader, or key personnel critical in achieving the proposal objectives.

(iv) Overall standing among similar proposals and/or evaluation against the state-of-the-art.

(4) Evaluation of the cost of a proposed effort may include the realism and reasonableness of the proposed cost and available funds.

J. Evaluation Techniques. Selection decisions will be made following peer and/or scientific review of the proposals. Several evaluation techniques are regularly used within NASA. In all cases proposals are subject to scientific review by discipline specialists in the area of the proposal. Some proposals are reviewed entirely in-house, others are evaluated by a combination of in-house and selected external reviewers, while yet others are subject to the full external peer review technique (with due regard for conflict-of-interest and protection of proposal information), such as by mail or through assembled panels. The final decisions are made by a NASA selecting official. A proposal which is scientifically and programmatically meritorious, but not selected for award during its initial review, may be included in subsequent reviews unless the proposer requests otherwise.

K. Selection for Award.

(1) When a proposal is not selected for award, the proposer will be notified. NASA will explain generally why the proposal was not selected. Proposers desiring additional information may contact the selecting official who will arrange a debriefing.

(2) When a proposal is selected for award, negotiation and award will be handled by the procurement office in the funding installation. The proposal is used as the basis for negotiation. The contracting officer may request certain business data and may forward a model award instrument and other information pertinent to negotiation.

L. Cancellation of NRA. NASA reserves the right to make no awards under this NRA and to cancel this NRA. NASA assumes no liability for canceling the NRA or for anyone's failure to receive actual notice of cancellation.