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National Aeronautics and Space Administration
Office of Biological and Physical Research
Washington, DC 20546-0001

Research Announcement

Research Opportunities for Flight Experiments in Space Life Sciences

NASA Research Announcement Soliciting Research Proposals for the Period Ending May 5, 2004

TABLE OF CONTENTS

Tables

Figures

Sample Forms

Research Opportunities for Flight Experiments in Space Life Sciences

Summary and Supplemental Information

The Vision of the National Aeronautics and Space Administration (NASA) is: ***To improve life here, To extend life to there, To find life beyond.*** NASA's Office of Biological and Physical Research (OBPR) contributes to this Vision through its support of research that addresses the following questions:

- *How can we assure the survival of humans traveling far from Earth?*
- *How does life respond to gravity and space environments?*
- *What new opportunities can research bring to expand understanding of the laws of nature and enrich lives on Earth?*
- *What technology must we create to enable the next explorers to go beyond where we have been?*
- *How can we educate and inspire the next generations to take the journey?*

The OBPR Strategy for answering these questions and fulfilling NASA's mission can be accessed at: **http://spaceresearch.nasa.gov/general_info/strat.html**.

This NASA Research Announcement (NRA) solicits proposals for new research in selected areas of Fundamental Space Biology (FSB), and Biomedical Research and Countermeasures (BR&C). ***This NRA solicits research proposals that support the opening of the space frontier by providing scientific information to reduce the risks or enhance the capabilities of humans exposed to the environments of space flight or an extraterrestrial destination.*** This research will further increase knowledge of nature's processes using the space environment and enrich life on Earth through the use of space technology and the application of biomedical knowledge. NASA will support a limited number of innovative, competitive, and multidisciplinary studies selected through this solicitation process.

All investigators responding to this NRA who are selected for funding are strongly encouraged to promote general scientific literacy and public understanding of life sciences, the space environment, and OBPR programs through formal and informal education opportunities. Where appropriate, supported investigators will collaborate with NASA to develop a plan for communicating their work to the public.

Proposals similar to research already published or currently being conducted as flight investigations will be of lower priority. Therefore, investigators are strongly encouraged to review the research published or currently funded by OBPR. Descriptions of currently funded research tasks may be found at: **http://research.hq.nasa.gov/taskbook.cfm**.

For details of Space Life Sciences Flight Experiments, see Appendices A-E and the associated document, *Space Life Sciences Flight Experiments Information Package,* available at: **http://research.hq.nasa.gov/code_u/nra/current/NRA-04-OBPR-01/index.html**.

Proposal submission procedures described in Appendix B and evaluation criteria described in Appendix A in this NRA supersede those in Appendix D.

For general information, proposers should refer to the "2004 NRA Proposers Guidebook" which may be found at: **http://www.hq.nasa.gov/office/procurement/nraguidebook/**.

Proposals submitted in response to this NRA must address the research emphases defined here and are expected to have a firm justification for space flight implementation derived from ground-based and/or previous flight research results. ***The Biomedical Research and Countermeasures Program (BR&C) is soliciting only research proposals that study human space physiology, psychology or medicine. The Fundamental Space Biology Program (FSB) is soliciting only research using the model organisms specified in Appendix A section I.A. of this NRA. In addition, proposals should clearly identify how the data generated will reduce the risks or enhance the capabilities of humans exposed to the environments of space flight or an extraterrestrial destination.*** Proposals that do not address the identified research emphases will not be fully evaluated by NASA and will be returned to the investigator. ***Proposals for purely ground-based research will not be accepted or considered for this NRA***. Other NRAs 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 NRA. However, NASA reserves the right to act in the best interest of the Federal Government in the matter of proposal acceptance and evaluation.

All proposals meeting the above criteria will be evaluated for scientific and technical merit by independent peer review panels. A panel of technical experts from NASA and other cooperating space agencies will evaluate the feasibility of carrying out the flight experiment. Relevance to NASA's programmatic needs and goals will be evaluated separately by NASA. Meritorious proposals that are determined by NASA to be feasible to implement as space flight experiments and which are relevant to programmatic needs and fit within budgetary constraints will be selected. Selected proposals will enter a period of ***Definition*** usually requiring six to twelve months. This is a period during which the specific requirements of the proposal and implementation approaches and options are characterized. In addition, where appropriate, investigator teams will be established to optimize resource utilization and science yield. Specifics associated with the Definition period will be addressed with the investigator at the time of selection. ***Selection for Definition neither assures a flight opportunity nor continued funding beyond the Definition period.*** A review of the progress achieved during the Definition period will result in a decision to either proceed to develop the flight experiment proposal or discontinue the project. The Selecting Official identified in the Summary and Supplemental Information Section of this NRA is responsible for this decision.

Funds are not currently available for awards under this NRA. The Government's obligation to make award(s) is contingent upon the availability of appropriated funds from which payment can be made and receipt of proposals that NASA determines are acceptable for award under this NRA. 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. It is anticipated that a typical award will average $400,000 (total annual cost) for BR&C and $200,000 (total annual cost) for FSB, but should not exceed $500,000 (total annual cost). It is

planned that selections for Definition will ***be announced by October 2004 and grants or contracts will be awarded shortly thereafter.***

Proposals successfully completing the Definition period will be funded in one-year increments until the experiment is completed. However, flight experiments will be reviewed periodically for technical progress, availability of flight opportunities, implementation feasibility and to ensure that the science continues to be relevant. This review may result in a decision to either continue or discontinue a flight experiment before its implementation or completion.

Participation in this NRA is open to all categories of organizations, industry, educational institutions, other nonprofit organizations, NASA laboratories, and other Government agencies. This solicitation is being coordinated with solicitations from the Canadian Space Agency, European Space Agency, the Japan Aerospace Exploration Agency, and the National Space Agency of Ukraine. Proposals from entities within countries represented by these agencies should be made in response to the solicitation from the corresponding agency. Information on locating these solicitations may be found in the *Space Life Sciences Flight Experiments Information Package.* See Appendix A, Section IV, for details concerning requirements for proposals from institutions located outside of the United States.

A notice of intent (NOI) to propose is requested by March 2, 2004 (see Instructions, Appendix B). Submit NOIs at: **http://proposals.hq.nasa.gov/proposal.cfm.** If you do not have access to the Web, you may submit an NOI via email to: **noi@hq.nasa.gov.** The subject heading of the e-mail message should read "Notice of Intent-04-OBPR-01." If you do not have access to e-mail, you may submit an NOI by U.S. Postal Service or commercial delivery to the address listed below for proposal submission.

Proposals must be submitted to NASA Peer Review Services (NPRS) by May 5, 2004. Proposals may not be submitted electronically. Proposals must be received by 4:30 PM Eastern Time. Proposals and NOIs mailed through the U.S. Postal Service by express, first class, registered, or certified mail are to be sent to the following address:

NASA Peer Review Services
SUBJECT: 04-OBPR-01 Flight Experiments in Space Life Sciences
500 E Street, SW - Suite 200
Washington, DC 20024-0001

Proposals and NOIs 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, 202-479-9030, may be used when required for reference by delivery services. NPRS cannot receive deliveries on Saturdays, Sundays, or Federal holidays. NPRS will send notification to the investigator confirming its arrival; however, there will not be a response from OBPR.

In order to be accepted as a complete submission, proposals **must include** completed copies of the appropriate forms provided in Appendix E.

The following items apply only to this NRA:

Solicitation Announcement Identifier:	NRA 04-OBPR-01
Number of Copies Required:	Original + 25 copies
Notices of Intent Due:	March 2, 2004
Proposals Due:	May 5, 2004
Selection Announcement:	October 2004
Funding for Definition Period Begins:	January 2005

Selecting Officials:

For Flight Experiments in Fundamental Space Biology	Terri L. Lomax, Ph.D. Director, Fundamental Space Biology Division Office of Biological and Physical Research
For Flight Experiments in Biomedical Research	Guy C. Fogleman, Ph.D. Director, Bioastronautics Research Division Office of Biological and Physical Research

Additional information is available from:

Fundamental Space Biology Research Emphasis	Louis H. Ostrach, Ph.D. NASA Headquarters, Mail Code UF Washington, DC 20546-0001 Telephone: (202) 358-0870 Fax: (202) 358-4168 E-mail: louis.h.ostrach@nasa.gov
Biomedical Research and Countermeasures Research Emphasis	David L. Tomko, Ph.D. NASA Headquarters, Mail Code UB Washington, DC 20546-0001 Telephone: (202) 358-2211 Fax: (202) 358-4168 E-mail: dtomko@ nasa.gov
ISS and Shuttle Hardware and Mission Constraints for Fundamental Space Biology	Louis H. Ostrach, Ph.D. (see above)
ISS and Shuttle Hardware and Mission Constraints for Biomedical Research and Countermeasures	Angelene M. Lee NASA Headquarters, Mail Code UB Washington, DC 20546-0001 Telephone: (202) 358- 0799 E-mail: angelene.m.lee-1@nasa.gov
Office of Procurement	Harold Jefferson NASA Headquarters, Mail Code HS Washington, DC 20546-0001 Telephone: (202) 358-0409 E-mail: harold.v.jefferson@nasa.gov

This NRA is restricted to the programs named above and described in detail in Appendix A. Potential investigators should read with care the program descriptions that are of interest and focus their proposals on the specific research emphases defined in this NRA.

All prospective investigators to this NRA are advised that the highest priority in all of NASA's programs is given to safety and mission assurance, occupational health, environmental protection, information technology, export control, and security. Safety is the freedom from those conditions that can cause death, injury, occupational illness, or damage to or loss of equipment. NASA's safety priorities are to protect (i) the public, (ii) astronauts and pilots, (iii) the NASA workforce (including employees working under NASA instruments), and (iv) high-value equipment and property. All proposals submitted in response to this solicitation are expected to comply with this policy.

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

Original Signed by

Mary E. Kicza
Associate Administrator
Office of Biological and Physical Research

APPENDIX A
NRA 04-OBPR-01

Flight Experiments in Space Life Sciences

I. Description of the Opportunities

This Appendix defines the research program and elements encompassed by this NASA Research Announcement (NRA), describes the specific areas of flight research that proposals should address, and describes the specific emphases that are acceptable for submission in response to this NRA.

The Fundamental Space Biology Program (FSB) is soliciting only research using the model organisms specified in Appendix A section I.A. of this NRA. The Biomedical Research and Countermeasures Program (BR&C) is soliciting only research proposals that study human space physiology, psychology or medicine. Proposals for purely ground-based research will not be accepted or considered for this NRA. 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 NRAs. ***Proposals that do not address the opportunities specified in this NRA will be returned without review. Additionally, proposals that require space flight equipment, facilities, or other resources not identified in this NRA or in the accompanying Space Life Sciences Flight Experiment Information Package (http://research.hq.nasa.gov/code_u/nra/current/NRA-04-OBPR-01/index.html) will have a lower priority for selection.*** In addition, this Appendix includes guidelines for preparing and submitting proposals and defines the administrative policies governing the program and investigators.

Successful proposals will be selected for Definition. This is a period during which the specific requirements of the proposal and implementation approaches and options are characterized. In addition, where appropriate, investigator teams will be established to optimize resource utilization and science yield. Specifics associated with the Definition period will be addressed with the investigator at the time of selection. ***Selection for Definition neither assures a flight opportunity nor continued funding beyond the Definition period.*** A review of the progress achieved during the Definition period will result in a decision to either develop the flight experiment proposal or discontinue the project. The Selecting Officials identified in the Summary and Supplemental Information Section (p. 4) of this NRA are responsible for this decision.

Experiments requiring up to 180 days exposure to the space environment are being solicited. Proposals must comply with the operational and hardware constraints and requirements associated with the current space flight program. Investigators proposing flight experiments should consult the *Space Life Sciences Flight Experiments Information Package* for this information. Note that assurance of compliance with applicable Federal regulations regarding human subjects is required as part of the proposal submission process (see the "Special Matters" instructions in Appendix B). NASA may ask grant recipients to provide sufficient information to

assure that the proposed experiments are within the scope of the Environmental Impact Statements for the Space Shuttle and the ISS before receiving final NASA approval.

Flight Experiment Opportunities and Constraints. NASA solicits proposals for space flight experiments that would be conducted during the following time periods:

- Research Involving Model Organisms (specified below): Beginning mid-2004 and ending late 2006.
- Research Involving Human Subjects: First flight opportunity beginning 2007.

Two types of flight experiments are currently being solicited: (1) pre-mission and post-mission studies involving data collection and analysis of biological specimens enumerated in Appendix A section I of this NRA, and research performed on human subjects prior to and on return from space, and (2) on-orbit experiments that can be implemented on the space platforms of the Space Shuttle or the International Space Station (ISS). Proposals must be compatible with the operational constraints and capabilities of the ISS and the Space Shuttle. The *Space Life Sciences Flight Experiments Information Package* provides detailed information on these constraints as well as a description of the unique aspects of the evaluation and selection process for flight experiments.

All flight experiments must address one or more of the research program emphases defined below in Section I.A. for Fundamental Space Biology and Section I.B. for Biomedical Research and Countermeasures, and should address one or more of the following OBPR organizing questions.

- How can we assure the survival of humans traveling far from Earth?
- How does life respond to gravity and space environments?
- What new opportunities can research bring to expand understanding of the laws of nature and enrich lives on Earth?
- How can we educate and inspire the next generation to take the journey?

Flight investigations must represent mature studies strongly anchored in previous ground-based research or previous flight research. Ground-based research may, and usually 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. Preparatory ground research designed to define a mature space flight experiment should be proposed separately in response to solicitations from the ground-based programs.

Opportunities for flight experiments continue to be extremely limited at this time. For the next five years, a majority of the capacity of the Space Shuttle fleet is dedicated to assembly and operation of the ISS. Therefore, opportunities for Shuttle-based experiments are limited. It will be possible to conduct experiments on board the ISS. However, ISS experiments will be severely constrained by limitations on resources such as mass, volume, power, re-supply of

consumables, and crew time. Priority for initial use of some research hardware on the ISS will be for validation testing of the hardware operation and capabilities. See Sections 2 and 3 of the *Space Life Sciences Flight Experiments Information Package* for detailed limitations on Space Shuttle and ISS flight experiments. Proposals requiring resources beyond the capabilities defined in this document should not be submitted in response to this NRA.

Meritorious and feasible individual proposals will initially be selected for a Definition period at which point the experiment requirements will be documented and budget requirements reevaluated. Funding for the Definition period will be negotiated at the time of selection. Full funding of the proposed budget will be initiated only after successful completion of the Definition phase. Selection of a flight experiment through this Announcement does not represent a guarantee for flight. Funds are not currently available for awards under this NRA. The Government's obligation to make award(s) is contingent upon the availability of appropriated funds from which payment can be made, and receipt of proposals that NASA determines are acceptable for award under this NRA. 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. It is anticipated that a typical individual award will average $400,000 (total annual cost) for BRC and $200,000 (total annual cost) for FSB, but should not exceed $500,000 (total annual cost). It is anticipated that selections will be announced by October 2004 and grants or contracts will be awarded shortly thereafter.

A. Fundamental Space Biology Flight Research Opportunities

This NASA Research Announcement (NRA) only solicits proposals for flight opportunities using the model organisms yeast *Saccharomyces cerevisiae,* nematode *Caenorhabditis elegans,* and the vascular plants *Arabidopsis thaliana* and *Brassica rapa*. The current concept for the timing of these flight opportunities are shown in Figure 1. ***It is important to note that the actual flight schedule will not be established until NASA has returned to flight successfully.*** Flight experiment constraints are enumerated for each opportunity in its description.

Fundamental Space Biology Research Program Emphases

To elucidate the effects of space environments on life and provide an understanding of life's foundations on Earth and beyond, four detailed questions need to be answered:

1) How do space environments affect life at molecular and cellular levels?

" How do cells sense and respond to gravity?" is a fundamental aspect of our research. What are the effects of microgravity, radiation, and other unique aspects of space environments on gene expression and other cellular responses? Alterations in gravity affect cells in many ways including cell proliferation, chromosomal aberrations, gene expression and processes of reproductive cell formation.

The research targets for this include: to analyze unique genetic, protein and metabolic responses to gravity and space radiation; to determine the gravity-detection mechanisms in cells; to

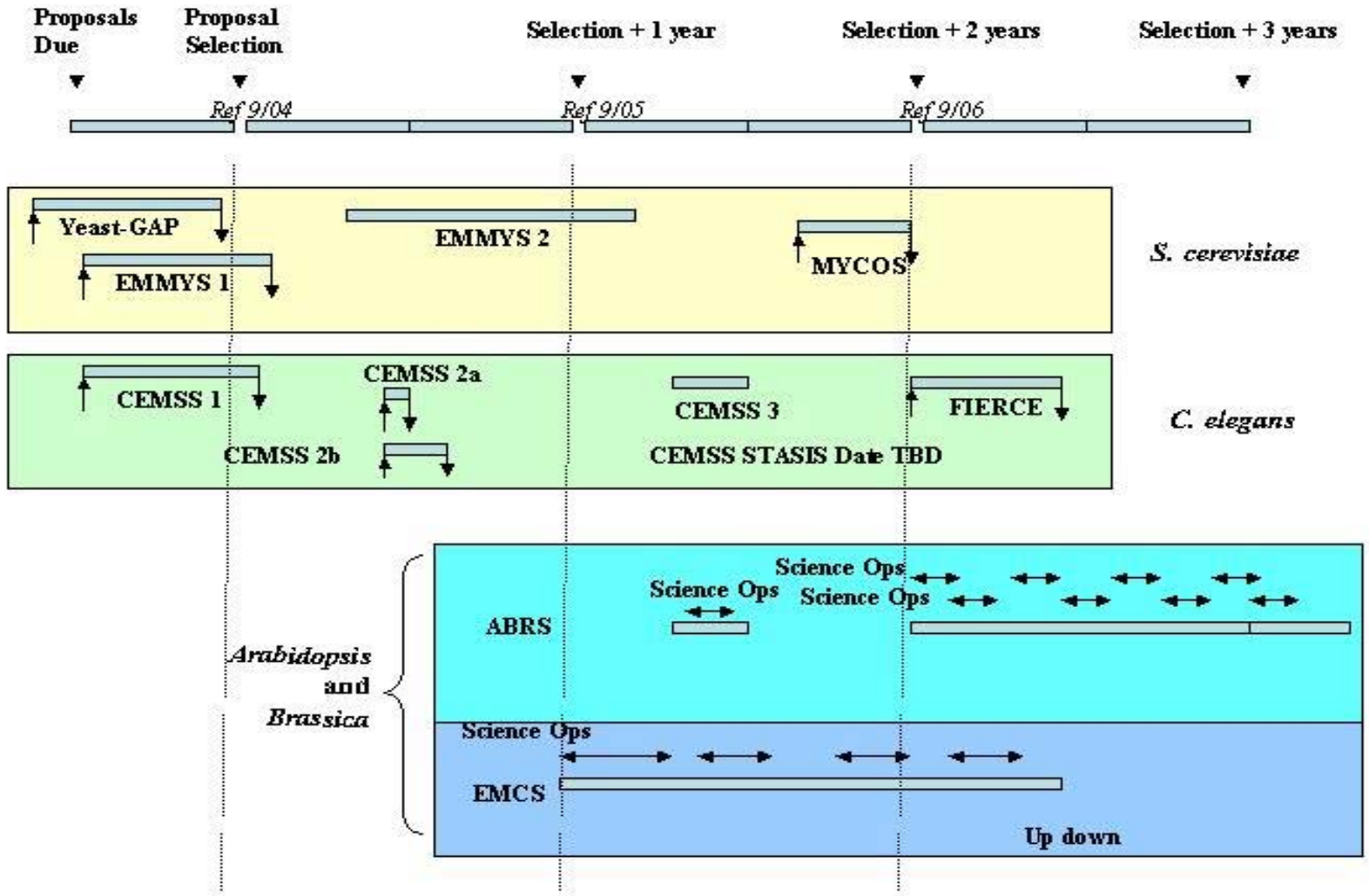

Figure 1. Tentative schedule for Model Specimens Flight Opportunities.
The actual flight schedule will be established after NASA has returned to flight successfully.

determine the signaling pathways involved in gravity sensing, transduction, and response; to develop physical and genetic/protein models of cellular responses to space environments.

2) How do space environments affect organisms throughout their lives?

This question addresses the developmental, physiological, and maturation processes of life at many levels, including tissues, organs, organ systems, and whole organisms.

The research targets for this include: to develop models of the process by which organisms detect and respond to gravity; to determine gravity-induced changes and their underlying mechanisms at critical life stages in model organisms; to identify radiation-induced changes and to investigate mechanisms of change in organisms.

3) How do space environments influence interactions between organisms?

Research is needed to determine the effect of space environments on interrelationships between the organisms that populate constructed ecosystems. The research targets for this include: to examine how differences in species affect ecological processes in space environments; to design studies that determine which ecological processes are sensitive to or tolerant of the environmental conditions in space; to identify key biological characteristics of ecological systems for long-duration human space missions.

Deciphering and then predicting and controlling the evolutionary pathways of ecosystems in space are vital. Space-bound ecosystems must be self-sustaining communities of plants, animals, and microorganisms.

4) Can life be sustained and thrive in space across generations?

This question studies living systems over multiple generations as they move beyond the Earth for increasingly long periods. The research targets for this include: to identify effects of altered gravity on patterns of change over multiple generations in organisms with short life cycles; to raise organisms through several generations in space environments; to assess changes in reproductive capacity induced by space environments.

Fundamental Space Biology Program Experiment Definition Process

The intent of the model specimens approach for experiments on the ISS is to maximize the science return from the ISS by performing as many experiments as possible during the flight opportunity period. To that end, following the selection of individual proposals, the experiments will enter a ***Definition*** period. During this period, the Principal Investigators (PIs) will attend a workshop where teams will be formed that are compatible regarding specimens, operations, data (video, gas samples, etc), and treatment and sharing of biological samples. It is likely that some compromises will be required. Investigators are encouraged to identify/propose teaming agreements, if possible, before submitting proposals.

A1. Yeast Model Specimen Flight Opportunities

This NRA solicits proposals for participation in a series of Fundamental Space Biology Program flight opportunities designed to progressively develop yeast as a model specimen for space flight experiments. These experiments will study biological mechanisms associated with astronaut health, safety, and performance during long duration space flight and/or extraterrestrial exploration missions (Table 1). *S. cerevisiae* is an excellent model organism for studying the effects of space flight on living organisms because: (1) it is a well studied eukaryotic organism; (2) its complete genome has been sequenced; (3) many genes in yeast have significant mammalian homologs; and (4) it replicates quickly and multiple generations can be grown in space.

The earliest opportunity is a Biospecimen Sharing Opportunity that seeks to maximize the scientific yield from the previously selected and currently manifested Yeast Group Activation Packs (Yeast GAP) experiment, and solicits proposals for the scientific utilization of samples that will be available after completion of approved procedures for this experiment. Due to mission constraints and to minimize interference with the approved Yeast-GAP experiment objectives, the experiment design, the on-orbit processing, and temperature conditions are limited to the on-orbit processing described. The other opportunities are described below - Effects of Microgravity on Model Yeast Specimens (EMMYS-1, and EMMYS-2) and Model Yeast Cultures On Station (MYCOS). These opportunities will follow the Office of Biological and Physical Research model specimen approach. This approach will involve investigating space biology associated with on the ISS, and for both EMMYS and MYCOS investigations, will offer the opportunity for submission of full proposals that fit within the described capabilities and constraints.

Yeast-GAP Biospecimen Sharing Program Opportunity

The Yeast-GAP Biospecimen Sharing Program (BSP) Opportunity seeks to maximize the scientific yield from the Yeast-GAP experiment and solicits proposals for the scientific utilization of samples that will be available after completion of approved procedures for the Yeast-GAP experiment. Samples of deletion series *Saccharomyces cerevisiae,* grown in microgravity at ambient conditions and then stabilized at ambient conditions, in RNALaterII supplemented with Nystatin, will be available upon return from the ISS.

The experiment approach was developed by the Yeast GAP team and involves the use of a mixture deletion series *S. cerevisiae*. At approximately launch minus (L-) 75 days, the yeast deletion strain mixture was dried down, spotted onto filter paper, and placed into 8 Fluid Processing Apparatus (FPA) from BioServe Space Technologies. The FPAs were then loaded into a Group Activation Pack (GAP) from BioServe Space Technologies. During shipment, launch, and while on-orbit, the experiment will be maintained at ambient temperature conditions.

This opportunity is targeted to launch in early 2004. Dried down deletion series *S. cerevisiae* will be launched and stored on the ISS at ambient conditions. The yeast will be activated in microgravity by introduction of Yeast extract, Peptone, Dextrose media (YPD) and incubated at ISS ambient temperature for 60 -72 hours. Following incubation, the cultures will be stabilized in flight with RNALaterII supplemented with Nystatin. The stabilized cultures will be maintained

at ISS ambient temperature until return from flight. Quantities of approximately 1 ml of the flight and ground control sample populations will be made available to the PIs.

Effects of Microgravity on Model Yeast Specimens (EMMYS)

The EMMYS flight opportunities will help delineate how the space environment affects life processes at the molecular and cellular levels and how the space environment affects organisms throughout their lives. Results from these flight opportunities will lay the foundation for determining the role that the space environment plays on regulating *S. cerevisiae* gene expression and other cellular responses and will address how the space environment affects *S. cerevisiae* development and maturation. Data from these flight opportunities can be subsequently linked to the wealth of information from ground-based studies on Earth obtained from *S. cerevisiae*, which is widely used in biomedical research as a model for human genetics and disease. This combined information will also contribute to our understanding of how the space environment affects organisms at the molecular level and will provide insight into potential countermeasures necessary to prepare humans for long-duration exploratory missions.

The EMMYS flight opportunities represent early opportunities to study *S. cerevisiae* as a model specimen and the information described here is intended to be use as a framework upon which respondents can propose. Due to the timeframe of the EMMYS experiments, hardware that has been previously approved and used for space flight will be required for EMMYS-1 and, although not a requirement, will have distinct advantages for EMMYS-2. Specific details related to final selection of hardware and details of the experimental design will be dependent upon input provided by the PIs, but must fall within the constraints of the flight opportunity described.

Principal Investigator Participation: PIs will participate in 1) identifying specific yeast strains, 2) identifying storage and experiment initiation conditions, 3) determining the incubation and storage thermal requirements, 4) identification of hardware (for EMMYS-2), 5) ground testing studies, and 6) defining specimen processing and collaborative efforts. The consideration for each of these items must fit within the constraints of the EMMYS opportunities. Depending the processing requirements, PIs may be involved in pre-and postflight sample processing operations at the launch site processing facility and at the primary and secondary landing facilities. PIs may also be involved in ground communication activities.

EMMYS-1 Experiment Design

The EMMYS-1 opportunity will provide the opportunity to study cultures of wild type and/or mutant strains of *S. cerevisiae* over multiple generations utilizing techniques such as Green Fluorescent Protein (GFP) tagged organisms. This opportunity is targeted for launch in 2004.

Wild type *S. cerevisiae* (BY4743 [ATCC 4040005] homozygous diploid) and cultures of a mixture of GFP tagged *S. cerevisiae* and/or mutant strains that will have grown in space over multiple generations will be utilized. The cultures will be stabilized in orbit in a flight qualified fixative and/or stabilizer. Specimens will be available for postflight molecular and morphological analyses.

Due to the timeframe of the EMMYS-1 experiments, hardware that has been previously approved and used for space flight must be utilized for this experiment. Current plans call for the use of the FPA and GAP hardware described in the Yeast-GAP opportunity.

EMMYS-1 Objective: Determine the effects of space flight on wild type and/or mutant strains and GFP tagged *S. cerevisiae* at its most fundamental levels, from the gene to the cell.

EMMYS-1 Protocol: The wild type and/or mutant strains and GFP tagged *S. cerevisiae* will be lyophilized before flight, and flown in the FPA/GAP hardware described in the Yeast-GAP opportunity. Specimens will be prepared at around 9 weeks before flight. Specimens will be cultured on-orbit, under static conditions, to early/mid log phase and to mid/late log phase. Samples will be fixed/stabilized on-orbit for postflight molecular and morphological analyses. Provided that nominal activation and incubation and fixation occur on-orbit, wild type *S. cerevisiae* grown and stabilized in microgravity, will be available postflight for molecular analysis and GFP tagged *S. cerevisiae*, grown and fixed in microgravity, will be available postflight for morphological analysis. Synchronous ground controls will be performed using culture and media from the same stock used for flight. Asynchronous ground controls will be performed after the mission following temperature conditions recorded during all mission phases. A control using a clinostat or rotating wall vessel may also be available. The flight and control samples will be distributed postflight to PIs.

EMMYS-2 Experiment Design

The EMMYS-2 opportunity will establish continuous cultures of *S. cerevisiae* during space flight. This opportunity would use static and, possibly, stirred cultures and on-orbit passaging capabilities.

EMMYS-2 Objective: This opportunity will allow investigation into the links between changes observed in the genome, gene expression, and development from samples cultured under static conditions from Yeast-GAP and EMMYS-1 compared to samples cultured with perfused media under both static and, possibly, stirred conditions in microgravity. The on-orbit passaging capability will allow for the extended multi-generational comparisons.

EMMYS-2 Protocol: Wild type, select mutants or deletion series *S. cerevisiae* will be cultured in microgravity with perfused media under static and, possibly, stirred conditions. Portions of the yeast populations, at multiple sampling time points, will be stabilized in orbit for postflight genetic analyses and for analyses of the effects of microgravity on mass transport in yeast. Hardware that could be considered for this opportunity are the Single Loop Cell Culture (SLCC) hardware described in MYCOS and Table 2, or the SHOT Advanced Separation (ADSEP) hardware described in CEMMS experiments and Table 3. Synchronous ground controls will be performed using culture and media from the same stock used for flight. Asynchronous ground controls will be performed after the mission utilizing temperature conditions recorded during all mission phases. The flight and control samples will be distributed postflight to PIs.

Model Yeast Cultures on Station (MYCOS)

This NRA solicits proposals for participation in the Fundamental Space Biology-1 (FSB-1) Model Yeast Cultures on Station (MYCOS) experiment. In this experiment, yeast (*S. cerevisiae*) will be cultured on the ISS using the Space Station Biological Research Project (SSBRP) Incubators. These incubators have temperature control (+4 °C to +45 °C), temperature and humidity sensors, air circulation, telemetry, data, video pass-through, and commanding capabilities.

MYCOS will follow the Office of Biological and Physical Research model specimen approach to space biology on the ISS and will review and select experiment proposals that are meritorious, that address biological mechanisms associated with astronaut health, safety, and performance during long duration space flight and/or extraterrestrial exploration missions, and fit within the described constraints of the FSB-1 MYCOS scenario and protocol (see below and Table 1). Proposed experiments that do not conform to the scenario and constraints of the protocol framework will not be considered. NASA highly encourages the teaming of projects and sharing of specimens and resources.

MYCOS Experiment Design

MYCOS is designed to support experiments directed at investigating how the space flight environment affects the cellular, molecular, and biochemical processes of *S. cerevisiae*. In particular, experiments that can be supported by MYCOS include mass transport, radiation biology, and the process of pseudohyphal growth.

MYCOS Objective: Provide early science return for the use of the SSBRP Incubator with the model organism *S. cerevisiae.*

MYCOS Protocol: The yeast specimens, which are in growth and metabolic stasis, will be delivered to the ISS. For ascent, the yeast specimens will be stored in a thermally conditioned carrier that is located in the ascent Orbiter Middeck. After docking and then transfer to the ISS, the yeast will be stored in an ISS cold storage unit that supports the maintenance of the stasis condition until required hardware operations are completed. Within two to three weeks of the docking of the descent Orbiter, the yeast experiment will be initiated. Two SSBRP Incubators will be used to culture the yeast specimens. At the end of the incubation period, the yeast will be placed under conditions that return the specimens back into stasis for the remainder of the ISS phase. The yeast will be returned to Earth in a thermally conditioned carrier (+4 °C or lower).

Data on the environmental conditions of the Incubator will be transmitted regularly. The Passive Dosimeter System (PDS, see *Space Life Sciences Flight Experiment Information Package*) will be used to provide data on space radiation exposure during the on-orbit duration of the experiment.

Principal Investigator Participation: PIs will participate in 1) identifying specific yeast strains, 2) identifying storage and experiment initiation conditions, 3) determining the incubation and storage thermal requirements, 4) identification of growth chamber type, 5) ground testing studies, and 6) defining specimen processing and collaborative efforts. The consideration for

each of these items must fit within the constraints of the MYCOS protocol. Depending the processing requirements, PIs may be involved in pre- and postflight sample processing operations at the launch site processing facility and at the primary and secondary landing facilities. PIs may also be involved in ground communication activities.

Accessory Hardware: The MYCOS protocol can support the use of OptiCells, Petri dishes, and the Single Loop Cell Culture (SLCC) system. Each SLCC contains one 30 ml Cell Specimen Chamber. The capacity of the Incubator allows for a the use of 1) forty-two OptiCells, 2) a minimum of forty 100 mm Petri dishes, 3) a minimum of sixty 60 mm Petri dishes, or 4) two SLCC systems. Please see the FEIP for more information on the SLCC and OptiCells. In addition, gloveboxes will be available for operations that require containment.

Table 1. MYCOS Protocol Framework Summary

Organism	***S. cerevisiae***
Incubator	2 SSBRP Incubators
Duration On-Orbit	30 to 110 days
Experiment Duration	Incubation period[1]
Ascent Thermal Requirement	+4 °C live specimen storage
ISS Thermal Requirement **- Pre-incubation** **- Incubation period** **- Post-incubation**	 +4 °C live specimen storage (approx. 14 to 80 days) +20 °C to +30 °C +4 °C (approximately 14 to 21 days)
Descent Thermal Req.	+4 °C live specimens
Culturing Chamber	OptiCell
Medium	YPD[2]
Radiation Monitoring	Passive Dosimeter System

[1]Duration dependent on strains selected and ground studies

[2]Medium used is dependent on strains selected

Table 2. Yeast Model Specimen Research Questions and Objectives

Critical Research Questions	Flight & Date	# of Days	Environment & Hardware	Media & Conditions of Specimens	Fixation and/or Freeze	Perfused Media	Objectives (Analyses)
How does life respond to gravity and space environments? (Supports strategic goal #4) How do space environments affect life at molecular and cellular levels?	**Yeast GAP** 13P Progress Targeted for launch in 2004	72 hrs for experiment incubation.	Passive 16 Fluid Processing Apparatus/ 2 Group Activation Packs (FPA/GAP) Ambient temperature conditions throughout experiment	Dried down yeast, YPD media, *S. cerevisiae* deletion series	1 fixative, 1 time point. 16 replicates. • Stabilized in flight in RNALaterII supplemented with Nystatin. • Experiment is maintained at ambient conditions throughout. • Experiment could remain on ISS for up to 1-year post stabilization.	No	**Yeast GAP Objectives:** Determine the effects of space flight on *S. cerevisiae* deletion series (diploid homozygous and heterozygous) at its most fundamental levels, from the gene to the cell. PIs will perform various molecular post flight analyses.
How does life respond to gravity and space environments? (Supports strategic goal #4) How do space environments affect life at molecular and cellular levels? How do space environments affect organisms throughout their lives?	**EMMYS-1** 15P Progress Targeted for launch in 2004	Two time points for incubation (early to mid log phase and mid to late log phase)	Passive 64 Fluid Processing Apparatus/ 8 Group Activation Packs (FPA/GAP) Ambient temperature conditions throughout experiment with the possibility of 22°C for incubation	Lyophilized yeast, YPD media wild type and/or mutant and GFP tagged *S. cerevisiae*	Cultured in flight under static conditions fixed/stabilized inflight for post flight morphologic and molecular or genetic analysis.	No	**EMMYS-1 Objectives:** Determine the effects of space flight on wild type and/or mutant and GFP tagged *S. cerevisiae* at its most fundamental levels, from the gene to the cell. PIs will propose specific experimental design and will perform various molecular and morphological post flight analyses.
How does life respond to gravity and space environments? (Supports strategic goal #4) How do space environments affect life at molecular and cellular levels? How do space environments affect organisms throughout their lives? Can life be sustained and thrive in space across generations?	**EMMYS-2** Targeted for launch in 2005	Passaging and multiple sampling time points	Passive Single Loop Cell Culture (SLCC) system or SHOT ADSEP fluid processing cassette Ambient temperature conditions throughout experiment with the possibility of 22°C for incubation	Lyophilized yeast, YPD media & passage Wild type, select mutant, or deletion series *S. cerevisiae*	Wild type, select mutant or deletion series *S. cerevisiae* will be cultured under static and/or stirred conditions and with perfused media on the ISS. At multiple sampling timepoints, portions of the yeast populations can be fixed/stabilized on-orbit for postflight genetic analysis and to look at the effects of microgravity on mass transport.	Yes	**EMMYS-2 Objectives:** This opportunity will allow investigation into the links between changes observed in Yeast GAP and EMMYS-1 compared to perfused and passaged culture conditions in microgravity. PIs will propose specific experimental design and will perform various molecular and morphological post flight analyses.

Table 2 continued. Yeast Model Specimen Research Questions and Objectives

Critical Research Questions	Flight & Date	# of Days	Environment & Hardware	Media & Conditions of Specimens	Fixation and/or Freeze	Perfused Media	Objectives (Analyses)
How does life response to gravity and space environments? (Supports strategic goal #4) How is life affected by the space environment at the molecular and cellular level? How does the space environment affect organisms throughout their lives? How does the space environment affect organisms throughout their lives?	**FSB-1** Targeted for launch in 2006	Incubation duration is approxi-mately 72 hours	SSBRP Incubator +4 °C or lower during ascent flight, ISS stowage, and descent flight. +20 °C to +30 °C during incubation	Growth medium and growth chambers Wild-type and mutant *S. cerevisiae* strains	Yeast strains in stasis will be stored at +4 °C or lower during delivery to ISS. After transfer to ISS, the yeast will be stored at +4 °C or lower until the SSBRP facility class hardware installation and checkout is completed. Initiation of experiment will be on-orbit and incubation in the SSBRP Incubator. The experiment will be started within 2 -3 weeks of the docking of the return Orbiter. Post-incubation, samples will be returned to +4 °C or lower for the remainder of the ISS duration and then returned on the Orbiter in +4°C or lower storage.	No	**FSB-1 Objectives** Provide a protocol framework that will support the Fundamental Space Biology Model Specimen Approach, early science return for the use of the SSBRP Incubator. PIs will be involved in development of the specific experiment design for MYCOS and team collaboration and specimen distribution agreements.

Note: The Cell Culture Unit is not included in this solicitation and will be included in a future solicitation

A2. *C. elegans* Model Specimen Flight Opportunities

This NRA solicits proposals for participation in a series of Fundamental Space Biology Program flight opportunities designed to progressively develop *C. elegans* as a model specimen for space flight experiments. *C. elegans* is an excellent model organism for studying the effects of space flight on living organisms for the following reasons: (1) it is an extensively utilized eukaryotic organism in the fields of developmental biology, genetics, neurology, and aging; (2) its complete genome has been sequenced and many well characterized mutants are available; and (3) its hardiness, short life cycle, and small size make it easy to maintain for long periods without complex hardware. These flight opportunities will help delineate the requirements for long-term survival and will provide significant baseline data regarding development and genetic and cellular responses.

The opportunities are described below: *C. elegans* Model Specimen in Space (CEMSS) and the Fundamental Space Biology (FSB) Incubator Experiment using *Caenorhabditis elegans* (FIERCE). These opportunities will follow the Office of Biological and Physical Research model specimen approach, and will offer the opportunity for submission of full proposals that address biological mechanisms associated with astronaut health, safety, and performance during long-duration space flight and/or extraterrestrial exploration missions and fit within the described capabilities and constraints described.

Results from these flight opportunities will provide a basic understanding of culture conditions and sample processing, and will lay the foundation for determining the role that the space environment plays on regulating *C. elegans* morphology, gene expression, development, and behavior. Precise development of *C. elegans* as a model specimen in space will allow the discovery of genes, gene products, and signaling pathways that are responsive to the environment of space. Data from CEMSS can be subsequently linked to the wealth of information from ground-based studies on Earth obtained from *C. elegans*, which is widely used in biomedical research as a model for human development, genetics, aging, and disease. This combined information will contribute to our understanding of how the space environment affects organisms at the most fundamental levels and will provide insight into potential countermeasures necessary to prepare humans for long-duration exploratory missions. Additional information on how the different flight opportunities with *C. elegans* relate to critical research questions is summarized on Table 4 "*C. elegans* Model Specimens in Space Research Questions & Objectives".

Experimental Design and Specimens Available

Three different experimental designs will be flown to progressively answer critical questions regarding how the space flight environment effects *C. elegans* culture, growth, development, behavior, and gene expression.

CEMSS-1

The first experiment (CEMSS-1) will establish long-term cultures of *C. elegans* in space aboard the ISS for a period up to 8 months. Live specimens returned from space flight will be processed

postflight at the landing site and distributed to PIs for postflight molecular and morphological studies. The experiment is targeted for launch in the timeframe between March and June 2004.

CEMSS-1 Objectives: Determine the effects that long-term exposure to the space environment has on *C. elegans* over multiple generations in space.

CEMSS-1 Protocol: Duplicate sets of a mixed population of worms will be prepared at approximately Launch minus (L-)5 weeks. The experiment will be passively stowed in the launch vehicle and the specimens will be at ambient vehicle temperatures during launch. The specimens will be transferred to the ISS and maintained at temperatures between 18 and 26 ^{o}C. While in orbit, a small portion of the worm population from each set will be passaged to a fresh media bag approximately every 4 to 8 weeks for 4 to 8 months on board the ISS. Worms will be maintained in liquid axenic media, passaged three to six times and the resultant worm population (duplicate 20 ml cultures; approximately 25-45 generations after launch) will be returned alive at ambient Shuttle (or Soyuz) temperatures. Synchronous ground controls will be conducted using cultures and media from the same stock used for flight. Asynchronous ground controls will be conducted postflight utilizing the temperature conditions recorded during all mission phases. Upon return to the Earth landing site, at approximately Recovery plus (R+) 6 hours or sooner, a portion of the worm cultures will be frozen slowly to keep them alive for production of clonal populations from single organisms and subsequent genetic and morphologic analysis. Additional portions of the worm cultures will be immediately fixed in formaldehyde and will be available for morphology/antibody staining analysis or frozen for subsequent molecular preparation and analysis.

In addition, worm cultures in the upstream bags will be available. However, upon return, these cultures will be approximately 3, 5, and 7 months old without fresh media exchange and, therefore, the scientific value of each bag will decrease dramatically for the older cultures . It is possible that sheath length determinations may be obtained from the 3 and 5 month old cultures.

CEMSS-2

The second opportunity (CEMSS-2) has two components. The first component (CEMSS-2.a) will establish axenic *C. elegans* cultures from staged dauer larvae grown in space for a relatively short period of time and then fixed on-orbit for postflight molecular and morphological/antibody staining analyses. This experiment is targeted for a 10 to 16 day mission. The second component (CEMSS-2.b) will provide long-term axenic cultures of *C. elegans* over multiple generations that are fixed in space aboard the ISS for postflight RNA, morphological, and antibody staining analyses. This opportunity is targeted for approximately 4 months on-orbit. These opportunities are scheduled to launch in the 9/2004 to 12/2005 timeframe. These opportunities will provide short- and long-term data addressing the question: How does space affect life at its most fundamental levels, from the gene to the cell?

CEMSS-2 Objectives: 1. (CEMSS-2.a) Determine short-term effects of space on *C. elegans* at its most fundamental levels, from the gene to the cell. 2. (CEMSS-2.b) Determine long-term effects of the space environment on *C. elegans* at its most fundamental levels, from the gene to the cell. The objectives of CEMSS-2.b are similar to CEMSS-2.a. However, since the

opportunity is designed to maintain the population on-orbit for several months, a mixed population of worms will be fixed on-orbit for gene expression, morphology, and various cellular protein-level changes by antibody staining. These opportunities are designed to allow the characterization of novel signal transduction pathways used for life in the space environment.

CEMSS-2.a Protocol: Dauer worms will be launched and cultured on-orbit. This synchronized population will be subsequently passaged to a growth bag containing fresh media, releasing them from the dauer stage. The worms will be grown for approximately one generational cycle at ambient temperatures. Quadruplicate 20 ml *C. elegans* cultures will allow two of the cultures to be fixed in flight for RNA analysis and two of the cultures to be fixed in flight for morphology/antibody staining. Portions of the worm populations will be terminated on-orbit for postflight RNA analysis and for morphological and antibody staining analyses by transferring the worms to subsequent bags containing the appropriate fixatives. Live worms will be recovered from residual fluid in the growth bag for cloning purposes. These samples will be distributed postflight to PIs. Synchronous ground controls will be performed using culture and media from the same stock used for flight. Asynchronous ground controls will be performed after the mission utilizing temperature conditions recorded during all mission phases.

CEMSS-2.b Protocol: Mixed stage worms will be cultured on the ISS for approximately 8 weeks. A small portion of the worm population will be subsequently passaged to a fresh media bag and allowed to grow for another 8 weeks. Portions of the worm populations will be stabilized on-orbit for postflight RNA analysis and portions will be fixed for morphological and antibody-staining analyses by transferring the worms to subsequent bags containing the appropriate fixatives. Live worms will be recovered from residual fluid in the growth bag for cloning purposes. These samples will be distributed to PIs. Synchronous ground controls will be performed using culture and media from the same stock used for flight. Asynchronous ground controls will be performed post mission utilizing temperature conditions recorded during all mission phases.

Upon return, the samples from CEMSS-2.a and CEMSS-2.b will be provided to PIs to determine how microgravity alters morphology, protein production, and gene expression. By fixing cultures on-orbit this design eliminates potentially confounding re-adaptation responses that may occur upon return to a 1g environment. Postflight, specimens can also be collected from the residual worms in the non-fixative bags and processed for clonal analyses of mutations and to determine sheath lengths, as discussed for CEMSS-1.

CEMSS-3

The third opportunity (CEMSS-3) will establish long-term cultures of *C. elegans* during space flight. This opportunity will also allow investigation into the links between changes observed in the genome, gene expression, and development from CEMSS-1 and CEMSS-2 compared to behavior observed over long-term space flight. The experiment is designed for a 70–180 day mission on board the ISS, targeted for launch in 2005. This opportunity will provide data focused on addressing the question: How does the space environment affect the life cycle and behavior of *C. elegans?*

CEMSS-3 Objectives: This opportunity will use information from the previous experiments to correlate changes observed in gene expression and development with changes in behavior during long-term space flight. Long-term exposure to the space environment will likely produce multiple changes in gene expression that will lead to developmental and behavioral changes. The focus of this opportunity will be analysis of development, behavior, morphology, and gene expression over multiple generations in space.

CEMSS-3 Protocol: Cultures of *C. elegans* will be launched, transferred to the ISS, and will be allowed to grow over multiple generations. Behavioral data will be captured by video imaging at designated intervals. Periodically, samples will be fixed and/or frozen for molecular and morphological analyses. The cultures flown will be based upon results from the CEMSS-1 and CEMSS-2 opportunities and may contain mutants or cultures labeled for specific analyses. Synchronous ground controls will be performed using culture and media from the same stock used for flight. Asynchronous ground controls will be performed after the mission utilizing temperature conditions recorded during all mission phases. Upon return, video images, specimens fixed inflight, and specimens fixed postflight for RNA analysis and morphological/antibody staining analysis will be provided to approved investigators to provide links between alterations in gene expression and developmental and behavior changes in the organism.

Fundamental Space Biology Incubator Experiment using C. elegans (FIERCE)

This NRA solicits proposals for participation in the Fundamental Space Biology (FSB) Incubator Experiment using *Caenorhabditis elegans* (FIERCE). The experiments will be conducted on the ISS, utilizing the SSBRP Incubator. The incubators have temperature control (+4 °C to +45 °C), temperature and humidity sensors, air circulation, telemetry, data, video pass-through, and commanding capabilities.

FIERCE will follow the OBPR model specimen approach to space biology on the ISS and will review and select experiment proposals that are meritorious, address mechanisms associated with astronaut health, safety, and performance during long duration space flight and/or extraterrestrial exploration missions, and fit within the described constraints of the FIERCE scenario and protocol (see below and Table 3). Proposed experiments that do not conform to the scenario and constraints of the framework will not be considered.

Experiment Design

FIERCE Objective: Provide a protocol framework that will support the Fundamental Space Biology Model Specimen Approach and early science return for the use of the SSBRP Incubator.

FIERCE Protocol: This protocol includes 1) four separate incubation periods, 2) video recording sessions, 3) three subculture sessions, 4) on-orbit preservation of specimen aliquots by freezing (-80 °C) or immersion in Trizol, and 5) return of live specimens. A total of 18 (10 ml) OptiCells will be inoculated, preflight, with *C. elegans* in axenic medium (Lu, N. C; Goetsch K. M. Nematologica 39(3): 303-311). The *C. elegans*-OptiCells will be stored at +20 °C during delivery to the ISS.

Once on the ISS, the *C. elegans*-OptiCells will be transferred to the SSBRP Incubator (+20 °C) and four of the 18 *C. elegans*-OptiCells will placed into the Incubator video system holders. Periodically during each incubation period, the *C. elegans* in each video system holder will be video recorded. The video data will be transmitted at the earliest opportunity. At the end of each incubation period, all of the *C. elegans*-OptiCells will be subcultured and then aliquots will be sampled for freezing at –80 °C and for nucleic acid and protein preservation in Trizol. The Trizol-treated samples will be stored at –20 °C or colder. For the descent phase of the experiment, the *C. elegans* from the fourth incubation period will not be processed on-orbit, and the specimens will be returned alive. The –80 °C samples will be returned in a gaseous nitrogen Dewar (GN2 Dewar), and the Trizol-treated samples will be returned at +4 °C or colder. A ground control experiment that mirrors the flight experiment will be conducted.

The Passive Dosimeter System (PDS) will be used to provide data on space radiation exposure during the on-orbit duration of the experiment. The PDS is designed to measure and record the biologically active space radiation dose at experimenter-defined locations. The PDS consists of a two-component assembly and a Reader. The assembly contains one Pille Thermoluminescent Detector (TLD) system and three stacks of Plastic Nuclear Track Detector (PNTD) system inserted into a PDS holder. The PNTD component of the PDS will be used to measure dosage during the ascent and descent flights. The scenario for use of the PDS is as follows. A PDS holder containing the PNTDs will be placed into the transport container, which is carrying the *C. elegans*-OptiCells, for ascent. Once on the ISS, a TLD will be inserted into the holder and then the PDS assembly will be co-localized at all times with the *C. elegans*–OptiCells. At the end of the mission, the PNTD will be returned in the same transport container that will hold the *C. elegans*-OptiCells, and the Pille memory cards will be stowed in the Middeck. The team at the Hungarian Space Agency will analyze the data from the Pille memory cards and then the data will be delivered to the PNTD processing team. The PNTD processing team will analyze the PNTD stacks and combine this data with the TLD data to determine the corrected total dose, dose equivalent, and average quality factor. The PDS report will be provided to PIs.

Principal Investigator Participation: PIs will participate in 1) identifying specific *C. elegans* strains (including deletion mutant series) and incubation thermal requirements, 2) ground testing studies, and 3) defining specimen processing and collaborative efforts. The consideration for each of these items must fit within the constraints of the FIERCE protocol. Depending upon the processing requirements, PIs may be involved in pre- and postflight sample processing operations at the launch site processing facility and prime and secondary landing facilities. PIs may be involved in ground communication**.**

Table. 3 FIERCE Protocol Framework Summary

Organism	*C. elegans*
Habitat	1-2 SSBRP Incubators
On-Orbit Duration	30 to 110 days
Ascent Thermal Requirement	+ 20°C Incubation
ISS Thermal Requirement	+ 20 °C incubation + 4 °C media storage ≤-20 °C Trizol sample storage -80 °C sample storage
ISS Flight H/W	Glovebox
Descent Thermal Req.	+ 20 °C live specimens ≤+4 °C sample storage ≤-80 °C sample storage
Culturing Chamber	OptiCell
Medium	Axenic Liquid Medium* C. elegans Maintenance Medium
Incubation Period Duration	17 to 28 days
Subculture	3 sessions
Sampling	Concurrent with subculture sessions
Specimen Video Sessions	7 to 14 day intervals (4 C. elegans-OptiCells)
Radiation Monitoring	Passive Dosimeter System

*LU, N.C., and Goetsch, K.M. 1993, Nematologica 39 (3):303-311

Table 4: *C. elegans* Model Specimen in Space Research Questions & Objectives

Critical Research Questions	Flight & Date	# of Days	Environment & Hardware	Media & Conditions Specimens	Fixation and/or Freeze	Video Image	Objectives (Analyses)
Long Term Survival: How does the unique environment of space affect *C. elegans* over multiple generations and its ability to acclimate to this new niche?	CEMSS-1 Targeted for launch in 2004	180 - 245	Passive ADSEP Vented Fluid Processing Cassette (VPC)	Liquid axenic Passaged Mixed Population	Fixed Post Flight -Quick Freeze (LN2) -Slow Freeze with glycerol for clonal analyses -*Formaldehyde /β-mercaptoethanol -Residual worms will be processed for analysis of sheath lengths, indication of general health, and population numbers	No flt Ground only	Live specimens returned from space flight and fractions will be fixed or frozen postflight at the landing site and distributed to PIs for various molecular and morphological analyses
Short Term Survival & Flourish: How do space environments affect life at the molecular and cellular levels? (Determine short-term effects of space on *C. elegans* at its most fundamental levels, from the gene to the cell.)	CEMSS-2.a Targeted for launch in 2004	10 - 12	Passive ADSEP Vented Fluid Processing Cassette (VPC) Passive Kennedy Space Center Fixation Tube	Liquid axenic Staged Liquid NGM vs. Axenic media	Fixed Inflight -*RNALater /BME -*Formaldehyde /BME -Residual worms will be processed for clonal analyses of mutations, sheath lengths, general health, and population No fixative (KFTs)	No flt Ground only	Fractions of samples fixed in flight will be distributed postflight to PIs for molecular and morphological analysis, media comparison, and behavioral analyses.
Long Term Survival & Flourish: How do space environments affect life at the molecular and cellular levels? (Determine long-term effects of space on *C. elegans* at its most fundamental levels, from the gene to the cell.)	CEMSS-2.b Targeted for launch in 2004 - 2005	180 - 145	Passive ADSEP Fluid Processing Cassette (FPC)	Liquid axenic & passage Staged. Mutants	Fixed Inflight -RNALater /BME -*Formaldehyde/BME -Residual worms will be processed for clonal analyses of mutations, sheath lengths, general health, and population numbers	No flt Ground only	Fractions of samples fixed in flight will be distributed postflight to PIs for molecular and morphological analyses

Table 4 continued: *C. elegans* Model Specimen in Space Research Questions & Objectives

Critical Research Questions	Flight & Date	# of Days	Environment & Hardware	Media & Conditions Specimens	Fixation and/or Freeze	Video Image	Objectives (Analyses)
Long Term Survival & Flourish: Can life be sustained and thrive in space across generations?	CEMSS-3 Targeted for launch in 2005	90 to 240	Controlled thermal carrier BRIC-60, GN2 freezer Opticells, CBOSS, ARTIC being considered ADSEP FPC	Liquid axenic & passage Staged Mutants	Cultures will be allowed to grow over multiple generations. Behavioral data will be captured on-orbit by video at designated intervals. Periodically, samples will be fixed/frozen for molecular and morphological analysis.	Yes, flt video	Developmental comparisons: lifespan, Upon return. video images and fixed samples will be distributed to PIs for behavioral, molecular anatomical and physiological analyses.
Long Term Survival & Flourish How do space environments affect life at the molecular and cellular levels? How does the unique environment of space affect C. elegans over multiple generations and its ability to acclimate to this new niche?	FIERCE Targeted for launch in 2006	30 to 110	Thermal control carrier, SSBRP Incubator, Incubator Video System, OptiCell, PDS, CONTEX	Liquid axenic and subculture Wild-type or the PIs will select *C. elegans* strain	Cultures will be grown over multiple generations. Movement and behavioral data will be collected by video at specific time points. Periodically, samples will be subcultured and sampled for preservation by –80 °C freezing or treatment with Trizol	Yes, flt and ground video	Live and preserved samples will be returned. The PIs will develop postflight sample distribution and processing activities. The on-orbit video recordings will be downlink periodically during flight. The flight and ground video recordings will be provided to the PIs.

A3. Plant Model Specimens in Space

Introduction

This NRA solicits proposals for participation in a two-year series of flight opportunities for plant model specimens. The specific model specimens targeted for participation are *Arabidopsis thaliana* and *Brassica rapa.* Proposals using these plant organisms will be considered if their use is justified for specific scientific investigations and fits within the constraints listed below. Proposals must include appropriate previous ground research data/results that show why a flight experiment is required.

It is the intent of the model specimen approach to solicit and select meritorious experiments that fit within defined space flight constraints and that address research questions associated with the use of plants in life support systems. It is anticipated that this approach will facilitate rapid implementation of selected experiments and increase flight opportunities. These flight opportunities will occur on the ISS and it is expected that this approach will aid in maximizing ISS science productivity. Proposed experiments that do not fit within the experiment scenarios and constraints listed below will not be considered for selection. It should be noted that teaming and sharing of specimens and resources across investigations is highly desired.

Many critical questions regarding plant gravitational biology need to be answered. For example, what is the gravitational threshold for normal and productive plant growth and development? Can plants go from seed to seed in the space flight environment? Can we grow plants reliably and repeatedly in space? Are biological (microbial) communities stable in the space environment, in particular plant-associated microbial communities growing under closed environmental conditions?

Experiment Scenarios:

Description: The experiment can be initiated from either seeds or live plants. Flight opportunities for seeds will occur at a greater frequency than those with live plants. Plant growth in a controlled environment can be accommodated at microgravity and variable artificial gravity conditions (while on the ISS). Two hardware platforms are available, the European Modular Cultivation System (EMCS) and the Advanced Biological Research System (ABRS). See the Flight Experiment Information Package for information about the functional capabilities of these hardware systems. Candidate proposals must include explicit justification for the need to launch live plants, return live plants, and/or utilize on-orbit centrifugation. Requirements for use of available hardware/resources will need to be addressed in Form F (Appendix E).

Mission Scenarios:

Experiment operations, vehicle constraints, and operational activities vary during different phases of a mission and are dependant on the physical location of the payload hardware and/or biological samples. The following phases address capabilities and limitations during those periods:

Late Access/Ascent:
Payload hardware and biological specimens are loaded into the Shuttle Middeck or into the Multi-Purpose Logistics Module (MPLM) in the Shuttle payload bay before launch. Loading of the MPLM typically occurs one to two months prior to launch with limited access approximately 4 days before launch. Access to the Middeck can be as late as 17 hours prior to launch on an extremely limited basis.

Passive thermal carriers, ambient temperature, and soft stowage are also available for transport of biological specimen. Opportunities for launch of live plants to the ISS will be available but less frequent than those for dry seeds. Proposals must address the experiment requirement to launch live plants versus seeds.

During the ascent phase, limited crew procedures may be performed on the experiment/hardware before Shuttle/ISS docking (launch + 3 days). Proposals must provide explicit justification for crew-mediated operations during this flight phase. Items that are stowed in the MPLM will not be accessible during this period.

Docked Operations:
During docking operations (docking operations are defined as launch + 3 days through launch + 10 days), experiment hardware/stowage will be transported from the Middeck and MPLM to the ISS. During this phase, it is highly unlikely that the flight crew will be available for performing experiment operations.

ISS Operations:
The duration of the proposed experiments on the ISS may range from days to weeks. Given the constraints and priority of ISS assembly requirements, it is advantageous if the proposed experiments are flexible regarding initiation, termination, and operational performance. Plant growth can be accommodated at various gravity levels during ISS operations using EMCS.

If biological samples are collected during the experiment and/or at its end, the proposal must address how the samples will be stored. There is capability for chemical fixation. The availability of refrigerator or freezer storage of the fixed or unfixed samples is limited. Proposals that utilize sample storage at ambient temperature are preferable for this solicitation.

Descent/Early Access:
Limited opportunities are available for return of live plants. During the descent phase, crew operations on plants (i.e. harvesting, fixation) are highly limited. Limited freezer volume will also be available. The proposal must address the need for return of live plants, the descent crew operations required, and the justification for requiring fixation/freezing resources.

Early access (within 3 hours) to the hardware/samples following landing is available for items stowed in the Middeck. Items that are stowed in the MPLM will be accessed within 2-3 days following landing.

Limited Resources:

As described in the mission scenarios, several Shuttle and ISS resources are severely limited. It is the goal of this solicitation to maximize the overall science return by managing these limited resources with the best cadre of proposed experiments. It is anticipated that most experiments will require some limited resources, and that some experiments may require several. Utilization of these resources will be assessed during the selection process and may affect the ability of the proposal to be successfully implemented. The following items must be addressed on Form F (Appendix E) including anticipated need and rationale:

- Ascent/return of live tissue
- Crew operations during all mission scenarios listed above
- Ascent, on-orbit, and descent cold stowage/ambient stowage/fixation requirements, including the quantities of tissues to be preserved

B. Biomedical Research and Countermeasures Flight Research Opportunities

Proposals for Biomedical Research and Countermeasures Program flight research must be aligned with the Critical Path Roadmap, which defines the research required to systematically reduce or eliminate identified risks to astronaut health, safety, and performance during and after space flight. There are 55 risks identified in the Critical Path Roadmap (CPR). There are 250 CPR critical questions that must be answered to mitigate the 55 risks. To be responsive, proposals submitted in response to this solicitation MUST explicitly seek to answer one or more of the CPR critical questions. The entire CPR is available at **http://criticalpath.jsc.nasa.gov/.**

Primary research focus of this solicitation. This solicitation requests proposals for flight research that will lead to the development of effective countermeasures or operational techniques for problems associated with preparation or pre-adaptation/pre-habilitation of humans for space flight, and/or for their re-adaptation/rehabilitation after return to Earth (beginning 3-5 days after landing). ***Research proposals for long-duration ISS research should not require data collection during the first two weeks of flight or during the first 72 hours after return to Earth.*** Critical questions from the CPR that deal specifically with the issues of human pre-adaptation/pre-habilitation and/or re-adaptation/rehabilitation after return to Earth are enumerated below for proposers. Critical questions are in the areas of: 1) bone loss, 2) cardiovascular alterations, 3) food and nutrition, 4) human behavior and performance, 5) immunology, infection and hematology, 6) muscle alterations and atrophy, 7) neurovestibular (sensorimotor) adaptation and 8) clinical capabilities. Each critical question listed below refers to the risk that it addresses. Proposals may address critical questions in any of the physiological

disciplines described in the CPR, so long as they can be convincingly ascribed to the pre-habilitation/rehabilitation thrust areas.

The first flight opportunity for human life sciences investigations will be no earlier than 2007 due to the required processes and procedures for implementing these types of experiments. The amount of time it takes to complete a study is based on the required number of subjects and crewmember participation. Investigations selected under this solicitation will be flown while there are three crewmembers on board the ISS, and it should be assumed that two Increment crews will be flown every year for a total of six potential subjects a year. In order to account for variations in subject participation and suitability, it should be assumed that two subjects per Increment will participate, for a total of four subjects per year. Therefore, if an investigation requires a minimum of six crewmember subjects, it will take a minimum of three ISS Increments (1.5 years) to complete the inflight data collections. Investigations requiring short duration crewmembers as subjects should assume flight data could be collected on six subjects per year.

Due to the limited resources (e.g., crew time, on-orbit experimental supplies, temperature-controlled sample storage) available for the conduct of ISS research, NASA is pursuing the intentional formation of teams of investigators whose experiments will leverage resources by addressing different facets of the same critical question. NASA anticipates that such intentional teaming will result in better utilization of available resources to resolve specific critical questions. NASA strongly encourages individual investigators submitting applications in response to this NRA to consider identifying such collaborations between individual proposals as part of the development of their individual proposals and to identify this pre-coordination in their submissions.

Proposals submitted to the BR&C Program may request up to four years of study. Since there is limited access to space, it is the BR&C Program intent that each proposal (research questions) should reach clinical and statistical significance with no more than eight subjects.

Proposals must clearly and directly benefit the health and/or performance of astronauts before, during or after space flight. Benefits of the proposed research may take any of the following forms:

- risk assessment, reduction and/or acceptability (monitoring and/or modeling);
- scientific knowledge related to the development of appropriate countermeasures or operational procedures (mechanisms and/or processes);
- development of risk mitigating requirements (pharmacological, psychological, nutritional/dietary, exercise regimes and fitness levels, rehabilitation, and/or stress reduction strategies);
- development of procedures for medical intervention (diagnosis and treatment, and/or post-landing rehabilitation);
- development of improved procedures for crew screening and enhancing crew selection criteria (physiological, genetic and psychological criteria, applicable to the individual and/or the group);

- improvement of crew training procedures (pre-, in- and postflight, including the use of expert systems); and
- enhancement of design specifications (related to environmental habitability, including lighting and noise levels, hygiene, food systems, etc., and the use of artificial gravity and/or mechanical assistance devices) and improvement of mission operations (monitoring of physiological, behavioral and environmental aspects).

All use of human subjects for research must comply with **NASA Policy Directive NPD 7100.8D, Protection of Human Research Subjects.** Informed consent of human subjects must be obtained before carrying out any study in space, and potential applicants should be aware that obtaining such informed consent will involve a uniform process regardless of the country of origin of the applicants. The availability of consenting subjects may affect the probability of achieving experiment objectives within the expected timeframe.

Equipment available for use in human research flight experiments is described in the *Space Life Sciences Flight Experiments Information Package,* available at **http://research.hq.nasa.gov/code_u/nra/current/NRA-04-OBPR-01/index.html**

There are many research tools available to investigators who wish to conduct human physiological research on the ISS. The ISS Human Research Facility (HRF) is a suite of hardware that provides core capabilities to enable research on human subjects. HRF consists of instruments (e.g. ultrasound Doppler, gas analyzing mass spectrometer, computer workstation) mounted in two racks located in the US Lab, as well as separate equipment kept in stowage and brought out as needed. HRF Rack 1 is currently on-orbit. Some additional HRF hardware items are still in development but will be available for use in the near future. A complete list of hardware in the HRF inventory and a web site reference for design details is provided in the *Space Life Sciences Flight Experiments Information Package*.

Investigators are strongly encouraged to review the *Space Life Sciences Flight Experiments Information Package* for more information as to the available hardware as well as some new additions to the on-orbit suite of equipment. The Muscle Atrophy and Exercise System (MARES) developed by the European Space Agency (ESA) is expected to be installed on the ISS sometime in the timeframe March 2005 to October 2005. MARES is designed to measure skeletal muscle performance and function during space flight. MARES will be capable of measuring the torque, position, and velocity generated during contractions of the agonist and antagonist muscle groups of the trunk and extremity joints including ankle, knee, hip, wrist, elbow, shoulder, trunk, whole leg, and whole arm.

B1. Bone Loss Research

Critical Question 2.09 – (Risks 9, 10, 12) What are the most important predictors for bone loss during prolonged exposure to hypogravity, especially with reference to ethnicity, gender, age, baseline BMD, bone morphometry (e.g., femoral neck length)?

Critical Question 2.17 – (Risk 11) What is the incidence of soft connective tissue injury and pain during recovery after prolonged hypogravity or bed rest? (Use pre- and postflight analyses of MRI scan of spine and extremities and postflight follow-up studies over six months to one year.)

Critical Question 2.18 – (Risk 11) What countermeasures can reduce the incidence of soft connective tissue injury and pain during recovery after prolonged hypogravity or bed rest?

Critical Question 2.19 - (Risk 9) Is bone loss reversible and within what timeframe: Can geometry and architecture return to baseline as well as BMD?

Critical Question 2.20 - (Risk 9) What is the most optimal rehabilitation regimen upon return to normal gravity to maximize return to baseline BMD and bone morphometry, especially given that muscle strength will recover more quickly than will bone strength?

Critical Question 2.26 - (Risks 9, 10) What treatment regimen will most effectively restore bone mass, geometry, and strength to their preflight integrity for returning crewmembers with bone loss?

B2. Cardiovascular Alterations Research

Critical Question 3.15 - (Risk 16) What improved screening methods might identify crewmembers with underlying cardiovascular disease that may be aggravated by space flight?

Critical Question 3.17 - (Risk 15) Does long duration space flight lead to diminished cardiac function and, if so, what are the mechanisms and is the process reversible?

B3. Food and Nutrition Research

Critical Question 5.16 - (Risk 54) What monitoring (biochemical, anthropometric, clinical assessments) during rehabilitation is required?

Critical Question 5.17 - (Risk 54) What level of dietary counseling is needed for crewmembers during rehabilitation?

B4. Human Behavior and Performance Research

Critical Question 6.03 - (Risk 18) What behaviors, experiences, personality traits, and leadership styles in crewmembers most contribute to optimal performance? How are these factors related to team performance?

Critical Question 6.04 - (Risk 18) What crewmember behaviors, experiences, personality traits, and leadership styles that optimize performance can be identified during the selection process and be used to select and assemble the best teams for long-duration missions?

Critical Question 6.13 - (Risk 21) What model(s) of behavioral health and task performance best predict problems and provide guidelines for effective treatment of illness (e.g., Depression, Anxiety, Trauma, Psychiatric Dysfunction)?

Critical Question 6.15 - (Risk 21) What are the acute and long-term effects of exposure to the space environment on the human cognition and performance capabilities, including processes of sensation and perception, learning, vigilance, cognition, problem-solving, decision making, and motor skills, and how do such changes affect human performance capabilities and behavior?

Critical Question 6.17 - (Risk 18) What are the systems of knowledge, psychosocial support methods, attitudes, and behavior towards mission operations used by agency management, ground controllers, crewmembers and their families? How do these systems influence individual and group performance and behavior?

Critical Question 6.19 - (Risk 21) What are the acute and long term effects of exposure to the space environment on human emotion and psychological responses, including emotional reactivity, stress responses, long term modulation of mood, and vulnerability to affective disorders?

B5. Immunology, Infection and Hematology Research

Critical Question 7.01 - (Risks 22, 23, 24, 27) Are there assays of immune function that reliably predict immune compromise?

Critical Question 7.03 - (Risks 22, 23, 25, 27) Do factors associated with flight (stress, environment, microgravity, nutritional status, radiation) affect humoral or cell-mediated immune function, non-specific immunity, mucosal immunity, or immune surveillance capabilities of crewmembers in a manner that exposes them to unacceptable medical risk (disease, allergy, delayed wound healing)?

Critical Question 7.14 - (Risk 23) What is the risk of cancer during or following long-duration space flight?

Critical Question 7.15 - (Risk 23) Which oncogenic mechanisms may be activated by inflight radiation exposure?

B6. Muscle Alterations and Atrophy Research

Critical Question 8.01 - (Risk 28, 29) What are the appropriate prescription modalities and the compliance factors needed to minimize losses in muscle mass, strength and endurance, and facilitate rehabilitation?

B7. Neurovestibular (Sensorimotor) Adaptation Research

Critical Question 9.10 - (Risk 33) Can preflight training techniques (e.g., virtual reality simulations) be used to alleviate these (*disorientation*) problems, and to evaluate emergency procedures?

Critical Question 9.17 - (Risk 36) How does neurovestibular adaptation contribute to postlanding postural control and locomotion difficulties?

Critical Question 9.20 - (Risk 37) What are the significant irreversible changes in sensory-motor neurological function associated physiological systems, and anatomical and/or biochemical processes that may be caused by exposure or development in long duration 0-G or partial-G, and what are the mechanisms and time course?

Critical Question 9.21 - (Risk 37) How can these changes (*chronic impairment of balance/equilibrium*) be optimally distinguished from the normal responses to stress, isolation, and normal background physiological variability? What countermeasures can be developed?

Critical Question 9.22 - (Risk 34, 36) What is the relative contribution of neurovestibular adaptation, neuromuscular deconditioning, and orthostatic intolerance to postflight neuromuscular coordination, ataxia, and locomotion difficulties?

Critical Question 9.24 - (Risk 34, 37) Can preflight/inflight training, or sensory aids and prostheses improve postlanding postural and locomotor control?

Critical Question 9.27 - (Risk 33, 35) How can 0-G immersive teleoperation displays be designed to reduce disorientation and/or motion sickness?

B8. Clinical Capability Research

Critical Question 11.14 - (Risk 44) What crew screening and selection criteria should be developed and implemented to identify individuals who are at increased risk for developing hypersensitivity or allergies to space flight compounds, exposures, or payloads?

Critical Question 11.36 - (Risk 48) What are the expected effects and risks of long duration space flight related to landing, egress, and post-landing performance (in various anticipated gravitational environments)?

Critical Question 11.37 - (Risk 48) What are the essential technologies, resources, protocols, skills and training necessary for post-landing performance, recovery and rehabilitation (including psychological, cardiovascular, neurosensory, musculoskeletal, and nutritional)?

Critical Question 11.38 - (Risk 48) What pre-landing and pre-egress performance and health parameters should be monitored to assure adequate cardiovascular tone, neurological function, skeletal integrity, muscular strength, and endurance?

Critical Question 11.39 - (Risk 48) What are the issues related to and resources required for long term rehabilitation and recovery from long-duration space flight?

Critical Question 12.03 - (Risk 49) What rehabilitative measures should be applied after mission completion?

Biomedical Research and Countermeasures Definition Process

Due to the limited resources (e.g., crew time, on-orbit experimental supplies, temperature-controlled sample storage) available for conducting research onboard the ISS, NASA is pursuing the intentional formation of teams of investigators whose experiments will leverage resources by addressing different facets of the same critical question. NASA anticipates that such intentional teaming arrangements will result in better utilization of available resources to resolve specific critical questions. NASA strongly encourages individual investigators submitting applications in response to this NRA to consider identifying such collaborations between individual investigators as part of the development of their individual proposals and to identify this pre-coordination in their management plan.

During the Definition period, NASA reserves the right to form teams of investigators whose experiments have compatible requirements for human subjects, specimens, operations, data, and treatment and sharing of biological samples. A selected investigator who becomes a member of a research team will be required to work with other team members to develop an integrated set of objectives that can be met within fiscal and flight resource constraints. Development of this integrated approach may result in modification, transfer, or deletion of some objectives put forth in an individual proposal. A majority of ISS resources (e.g., crew time, launch and return logistics) available for NASA biomedical research during the target timeframe for implementation of experiments selected from this NRA will be provided to investigator teams to carry out an integrated set of objectives that answers a single CPR critical question or closely related critical questions.

II. Proposal Evaluation and Awards Selection Process

The following information is specific to this NRA and **supersedes** the information contained in paragraphs (i) and (j) of "Instructions for Responding to NASA Research Announcements."

A. Compliance Matrix

All proposals must comply with the general requirements of the NRA as described in both Appendices B (Instructions for Notices of Intent and Proposal Submission) and D (Instructions for Responding to NASA Research Announcements). Appendix B contains specific requirements and explanations for each section of a proposal submitted in response to this NRAthat are in addition to and supersede the general "Instructions for Responding to NASA Research Announcements". Appendix D outlines the NASA-specified requirements for proposal submission and should be used for clarification and reference. Upon receipt, proposals will be reviewed for compliance with the requirements of this NRA. This includes:

1. Submission of complete proposals as specified in this NRA. Proposals must be responsive to the areas of program element emphasis described in this NRA and include a project description that is no more than 20 pages in length.
2. Submission of appropriate Institutional Review Board (IRB) approvals for investigations using human test subjects.
3. Submission of a budget that is within the guidelines specified in this Announcement and is for a funding period not exceeding that described in the Announcement.
4. Proposals that are revised versions of proposals previously submitted to NASA must be clearly designated as such on the proposal cover page and must contain an explanation of how the revised proposal has addressed criticisms from previous NASA review. This explanation should be presented **at the beginning of the project description** in a separate section of **no more than two pages,** in addition to the 20 pages allowed for the project description. Related changes to the research plan should be highlighted in the body of the project description.
5. Submission of all other appropriate information as required by this NRA (Appendix B, Section D).

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

Compliant proposals submitted in response to this NRA will undergo an independent intrinsic scientific or technical merit review. Only those proposals most highly rated in the merit review process will undergo additional reviews for flight feasibility, program relevance, and cost.

B. Intrinsic Scientific or Technical Merit Review and Evaluation Criteria

The **first review** is 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. The merit review panel will assign a ***score from 0-100*** 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.

All of the following criteria, of equal value, will be used in determining the merit score:

- **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? Is there a significant societal or economic impact?
- **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?
- **Innovation:** Does the project employ appropriate novel concepts, approaches, or methods? Are the aims original and innovative? Does the project challenge existing paradigms or develop new methodologies or technologies?
- **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 PI and any co-investigators? Is the evidence of the investigator's productivity satisfactory?
- **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?

C. Flight Feasibility Review

Scientifically or technically meritorious proposals will be evaluated to determine the feasibility of meeting the proposed objectives and the potential for establishing teams of investigators to optimize utilization of human subjects, biological specimens and samples, data, and flight resources. This review will be conducted by technical experts familiar with the development of space flight experiment hardware, ground and flight operations, crew training, and vehicle resources (e.g., power, volume, mass, etc.).

D. Evaluation of Programmatic Relevance

This review will be conducted by NASA Program Scientists and Managers. Programmatic relevance evaluation will assess how the proposed work may help achieve an appropriate balance of scientific and technical tasks required by critical research issues faced by OBPR. These research issues have been articulated in the OBPR Strategy, which is based on five organizing questions:

1. How can we assure the survival of humans traveling far from Earth?
2. How does life respond to gravity and space environments?
3. What new opportunities can research bring to expand understanding of the laws of nature and enrich lives on Earth?
4. What technology must we create to enable the next explorers to go beyond where we have been?
5. How can we educate and inspire the next generation to take the journey?

The answers to these questions determine the platforms or programs to execute the science, applications for the research, and the metrics to measure progress. The OBPR Strategy may be viewed at **http://spaceresearch.nasa.gov/general_info/strat.html**.

E. Evaluation of Cost

This review will be conducted by NASA Program Scientists and Managers. 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.

F. Development of Selection Recommendation

The most important element in the evaluation process is the merit review, which carries the highest weight in final evaluation and selection. The other factors are approximately equal in weight to each other.

The information resulting from these two levels of review, as described above, will 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 scientific or technical merit review score from the peer review panel.
2. The assessment of space flight implementation feasibility
3. The programmatic relevance.
4. The cost of each proposal.

This **selection recommendation** is the responsibility of the NASA program scientist(s). Selection for funding will be made by the Selection Official identified in the Summary and Supplemental Information Section (p. 4) of this NRA.

At the end of the selection process, each proposing organization is notified of its selection or non-selection. NASA provides debriefings to those investigators who request it. The selection letters will include a statement indicating that the selected organization's business office will be contacted by a NASA Contracting or Grant Officer, who is the only official authorized to obligate the Government, and a reminder that any costs incurred by the investigator in anticipation of an award are at their own risk. Selection notification will be in the form of a letter signed by the selection official.

Successful proposals will be selected for Definition. This is a period during which the specific requirements of the proposal and implementation approaches and options are characterized. In addition, where appropriate, investigator teams will be established to optimize resource utilization and science yield. Selection for Definition neither assures a flight opportunity nor continued funding beyond the Definition period. A review of the progress achieved during the Definition period will result in a decision to either develop the flight experiment proposal or discontinue the project. The Selecting Officials identified in the Summary and Supplemental Information Section (p. 4) of this NRA are responsible for this decision.

The NASA Procurement Office will determine the type of award instrument, request further business data, and negotiate the resultant action. They are the only personnel with the authority to obligate Government funds. Flight experiments will be reviewed following the completion of the Definition period and thereafter, periodically, for technical progress, availability of flight opportunities, implementation feasibility and to ensure that the science continues to be relevant. These reviews may result in a decision to either continue or discontinue a flight experiment before its implementation or completion. For a grant, the award will cover the entire proposed project with decision points to continue or discontinue after the completion of the Definition period and periodically thereafter. For contracts, the government will include options that will only be exercised for those projects which successfully complete the Definition period and subsequent periodic reviews.

NASA reserves the right to offer selection of only a portion of a proposal. In these instances, the investigator will be given the opportunity to accept or decline the offer.

III. Eligibility

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. PIs 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 of any investigator is neither a prerequisite to submission of a proposal nor a competing factor in the selection process.

IV. Guidelines for International Participation

Flight experiment proposals may be from U.S. or international entities according to the following rules: This solicitation is coordinated with solicitations from the Canadian Space Agency, European Space Agency (ESA), Japan Aerospace Exploration Agency, and The National Space Agency of Ukraine. Flight experiment proposals that have PIs from entities of Canada, Japan, Ukraine, or the member countries of ESA must be submitted to their respective agency, including those with U.S. researchers and co-investigators. Proposals for flight experiments with PIs from entities of countries other than the U.S., Canada, Japan, Ukraine, or the member countries of ESA will not be reviewed unless they involve substantive co-investigator collaboration from one of the above-mentioned countries. Proposals for flight experiments with PIs from entities of countries other than the U.S., Canada, Japan, Ukraine, or the member countries of ESA, and with substantive co-investigator collaboration from one of the above-mentioned countries, should be submitted to the solicitation of the respective space agency associated with the country in which the co-investigator's entity is located. 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.

Foreign entities are not eligible for funding from NASA. Therefore, if the proposal involves substantial collaboration with a U.S. institution, a cost plan for only the participation of the U.S. entity must be included. Proposals from U.S. entities that include foreign participation must be endorsed by the respective Government agency or funding/sponsoring institution in the country from which the foreign entity is proposing. Such endorsement should indicate that the proposal merits careful consideration by NASA, and if the proposal is selected, sufficient funds will be made available to undertake the activity as proposed.

All foreign proposals must be typewritten in English and comply with all other submission requirements stated in the NRA. All proposals will undergo the same evaluation and selection process as those originating in the U.S.

All proposals must be received before the established closing date. Foreign sponsors may, in exceptional situations, forward a proposal without endorsement if the endorsement is not possible before the announced closing date. In such cases, the NASA sponsoring office should be advised when a decision on endorsement can be expected.

Successful and unsuccessful foreign entities will be contacted directly by the NASA sponsoring office. Copies of these letters will be sent to the foreign sponsor. Should a U.S. proposal with

foreign participation be selected, NASA's Office of External Relations will arrange with the foreign sponsor for the proposed participation on a no-exchange-of-funds basis, in which NASA and the foreign sponsor will each bear the cost of discharging their respective responsibilities. Depending on the nature and extent of the proposed cooperation, these arrangements may entail:

(i) an exchange of letters between NASA and the foreign sponsor; or

(ii) a formal Agency-to-Agency Memorandum of Understanding (MOU).

Export Control Guidelines Applicable to Foreign Proposals and Proposals Including Foreign Participation. Foreign proposals and proposals including foreign participation must include a section discussing compliance with U.S. export laws and regulations, e.g., 22 CFR Parts 120-130 and 15 CFR Parts 730-774, as applicable to the circumstances surrounding the particular foreign participation. The discussion must describe in detail the proposed foreign participation and is to include, but not be limited to, whether or not the foreign participation may require the prospective investigator to obtain the prior approval of the Department of State or the Department of Commerce via a technical assistance agreement or an export license, or whether a license exemption/exception may apply. If prior approvals via licenses are necessary, discuss whether the license has been applied for or, if not, the projected timing of the application and any implications for the schedule. Information regarding U.S. export regulations is available at:

http://www.pmdtc.org/ and **http://www.bxa.doc.gov/**

Investigators are advised that under U.S. law and regulations, spacecraft and their specifically designed, modified, or configured systems, components, and parts are generally considered "Defense Articles" on the United States Munitions List and are subject to the provisions of the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120-130.

V. 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 are required to provide NASA with an annual summary report. This report is due each year 60 days before the anniversary of the grant start date. The information contained in this report will be made available to the scientific community and will be used to assess the strength of OBPR's research programs. It will also serve as the basis for determining the progress of the Investigator's project.

In addition, the information provided in the Investigator's annual report will be included in the OBPR Program Tasks and Bibliography (Task Book), a comprehensive on-line document that includes descriptions of all peer-reviewed activities funded by OBPR. Since its inception, the Task Book has served as an invaluable source of information for OBPR as well as the scientific and technical communities.

The information requested will include:

- 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,
- a listing of presentations or activities conducted at 6-12 educational institutions,
- a listing of interactions, presentations, or other activities with the general public, and
- a statement of potential scientific, technological, economic or societal impact.

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.

All articles submitted for publication must include the following statement: "This research was funded in whole or in part by a grant from the Office of Biological and Physical Research of the National Aeronautics and Space Administration." Publications not including this acknowledgement will not be considered to be the product of NASA-funded research when NASA assesses the progress of the grant.

Final Report. A final report is required that shall include all peer-reviewed publication.

VI. Support of Education and Outreach

OBPR envisions that the selected proposals will be structured and operated in a manner that supports the nation's educational initiatives and goals (including support of historically black colleges and universities and other minority universities), and in particular, the need to promote scientific and technical education at all levels. OBPR envisions that the selected proposals will support the goals for public awareness and outreach to the general public (see below). The selected PIs are invited to participate in OBPR-funded educational programs.

OBPR Policy for Education (Grades 6-12) and Public Outreach

The proposal represents an opportunity for NASA to enhance and broaden the public's understanding and appreciation of the value of space life sciences research in the context of NASA's mission. Therefore, all PIs are strongly encouraged to promote general scientific literacy and public understanding of FSB and BR&C research through formal and/or informal education opportunities. If appropriate, proposals should include a clear and concise description of the education and outreach activities proposed. Examples include such items as involvement of students in the research activities, technology transfer plans, public information programs that will inform the general public of the benefits being gained from the research, and/or plans for incorporation of scientific results obtained into educational curricula consistent with educational standards. Where appropriate, the supported institution will be required to produce, in collaboration with NASA, a plan for communicating to the public the value and importance of their work.

Once proposal selections are made, the selected PIs will have an opportunity to request additional funding through an OBPR-sponsored pilot program to implement an education outreach program at the grades 6-12 level, at an amount not to exceed $10,000 per year for the term of the grant. A request for proposal will accompany the selection notification letter. Proposals will be due within 60 days of selection notification and shall be limited to 4 pages. A review of these proposals by educational specialists will determine which proposals will be funded.

For more information, the OBPR Educational Outreach Vision, Mission, Goals and Operating Guidelines are provided in the Educational Outreach handbook. The handbook is available at:

http://spaceresearch.nasa.gov/docs/Ed_Outreach_Handbook.pdf

If you would like assistance in preparing outreach proposals, the National Space Grant College and Fellowship Program is available to help. Visit their Web site to identify the state-by-state listing of Space Grant Directors at **http://education.nasa.gov/spacegrant.**

VII. Bibliography

1. **OBPR Program Tasks and Bibliography (Task Book)** for FY 1995 through FY 2002 are available online at **http://research.hq.nasa.gov/taskbook.cfm**

2. **Space Life Sciences Flight Experiment Information Package.** This document is available online at **http://research.hq.nasa.gov/code_u/nra/current/NRA-04-OBPR-01/index.html**

3. Information about space life sciences research publications can be found by using the National Library of Medicine's PubMed, LOCATORplus, and Gateway search systems. Coverage of space life sciences references in these systems has been enhanced by the SPACELINE Project through the support of NASA's Office of Biological and Physical Research. In addition, a space "limit" has been added to PubMed that permits limiting searches to a subset of space life sciences-related references only. Additional information may be obtained from the SPACELINE Project (phone: 301-295-2482; e-mail: spaceline@usuhs.mil)

   SPACELINE Project: **http://spaceline.usuhs.mil**
   National Library of Medicine: **http://www.nlm.nih.gov**

4. **The Space Life Sciences Data Archive (LSDA)** is an online 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 online for reasons of privacy.

   Web address: **http://lsda.jsc.nasa.gov/**

LSDA Help Desk: (281) 483-7876
E-mail: lsda@semail.jsc.nasa.gov

5. **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 at **http://www.mbl.edu/CASSLS/**

6. **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. Richard Williams (202-358-2390) for more information.

7. **A Strategy for Research in Space Biology and Medicine in the New Century.** National Academy of Science. National Research Council Committee on Space Biology and Medicine. Mary J. Osborn, Committee Chairperson. 1998. Washington D.C: National Academy Press. **http://www.nas.edu/ssb/csbm1.html**

8. **Space Physiology and Medicine, 3rd ed**. A. Nicogossian, C. Huntoon, and S. Pool. (Eds.). 1994. Philadelphia, PA: Lea & Febiger.

9. **Cell & Molecular Biology Research in Space**. *The FASEB Journal*, Vol. 13, Supplement, 1999.

10. **Modeling Human Risk: Cell & Molecular Biology in Context**. June, 1997. Ernest Orlando Lawrence Berkeley National Laboratory Report LBNL-40278. Berkeley, CA

11. **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. **http://peer1.nasaprs.com/peer_review/prog/countermeasures/countermeasures.html**

12. **Plant Biology in Space: Proceedings of the International Workshop**. *Planta,* Supplement to Volume 203, 1997.

13. **International Workshop on Cardiovascular Research in Space**. *Medicine and Science in Sports and Exercise*, Volume 28, Number 10 Supplement, 1996.

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

15. **Space Neuroscience Research**. *Brain Research Reviews*, Volume 28, Numbers 1/2, Special Issue, 1998.

16. **International Workshop on Bone Research in Space**. *Bone, Official Journal of the International Bone and Mineral Society*, Volume 22, Number 5 (Supplement), 1999.

APPENDIX B
NRA 04-OBPR-01

Instructions for Notices of Intent and Proposal Submission

Except where specifically stated otherwise in this NRA, applicants must prepare proposals in accordance with the "Instructions for Responding to NASA Research Announcements," which is part of the NASA Federal Acquisition Regulations (FAR) Supplement (NFS), Part 1852.235-72 (APPENDIX D).

A. SYS-EYFUS Registration

SYS-EYFUS is an electronic system used by NASA Headquarters to manage research solicitation activity, plan for the receipt of research proposals, track the receipt and peer evaluation of these proposals, and manage funded research (grants, cooperative agreements, etc.) sponsored by NASA's Office of Equal Opportunity (Code E), Office of Human Resources & Education Division (Code F), Office of Space Flight (Code M), Office of Space Science (Code S), Office of Biological and Physical Research (Code U) and the Office of Earth Science (Code Y). SYS-EYFUS also supports the funding and administration of awards pursuant to selection of these research opportunities.

The SYS-EYFUS Help Desk is available at (202) 479-9376. Help desk hours are from 8 a.m. to 6 p.m. Eastern time.

All investigators planning to submit a proposal to this solicitation are requested to register online with SYS-EYFUS. Comprehensive help, instructions, and contact information are provided online. SYS-EYFUS can be accessed at the following Web address:

http://proposals.hq.nasa.gov/proposal.cfm

If you have previously registered with SYS-EYFUS, you are asked to verify and update your user information. If you have forgotten your user ID or password, select the "Forgot Your Password" option and type in your first and last name to search our database. The system will send an automatic e-mail message with your username and password to the e-mail address listed in our database.

B. Instructions for Preparing a Notice of Intent

All investigators planning to submit a proposal in response to this solicitation are requested to submit a **non-binding** notice of intent (NOI) to propose by the due date identified in the Summary and Supplemental Information Section of this NRA at:

http://proposals.hq.nasa.gov/proposal.cfm

1) Login to SYS-EYFUS at the URL listed above and select "New Notice of Intent."

2) The Division Specific Opportunities screen will appear. In the selection window, highlight **All Opportunities** and click on "Continue."

3) The List of Existing Opportunities screen will appear. In the selection window, highlight **04-OBPR-01 Research Opportunities for Flight Experiments in Space Life Sciences** and then click on "Continue."

4) This will bring you to the Notice of Intent Submission Form. **All fields are required.**

   a. The proposal summary should be a succinct and accurate description of the proposed work when read separately from the project description. The summary should contain a brief description stating the specific aims of the proposed work. Describe concisely (300-500 words) the research design and methods for achieving these aims.

   b. Please select from **only** the following three options: For the proposal type field on this form, new / no prior support means that the investigator has not received NASA funding from 2001 through 2003, new / prior support means that the investigator has received NASA funding between 2001 through 2003, and revised means that the proposal is a revised version of a proposal submitted to NASA and reviewed from 2001 through 2003, but not funded. A proposal previously submitted but not funded should be identified as being "revised" even if the original PI has changed.

   c. Indicate the status of the Institutional Review Board (IRB) for your proposal. If the IRB review is unavoidably delayed beyond the submission of the application, enter "Pending" on the Proposal Cover Page, and be advised that the certification must be received within 90 days after the due date for which the application is submitted.

   d. Provide your TIN and CAGE numbers. Every U.S. institution that submits a proposal to a U.S. agency must provide their permanently-assigned Taxpayer Identification Number (TIN) and must register with the Department of Defense Central Contractor Registration (CCR) database for a permanently-assigned Commercial and Government Entity (CAGE) number. For additional information, reference the 2004 NRA Proposers Guidebook at **http://www.hq.nasa.gov/office/procurement/nraguidebook/.** If you are unsure of your institution's TIN number, please contact your institution's Office of Sponsored Research to obtain the your institution's Taxpayer Identification Number (TIN) or Employer Identification Number (EIN).

5) Click on "Submit NOI Page."

6) The Team Member Page screen will appear, where you can add or remove team members (e.g., Co-Investigators). Select "Continue" if there are no other team members. To add a team member, highlight the role option on the selection list, type in first and last name and click on "Search." When the resulting set appears, choose the appropriate radio button and

click on ADD to add the person to the NOI. After you are done, click on "Continue." **IMPORTANT:** If the team member is not listed in our database, please have them add themselves as a new user to the system. You may then add them to your team member list.

7) After continuing from the Team Members Page, your NOI will be displayed. Click on "Resubmit NOI Page" to complete your NOI submission.

8) You may edit and resubmit your NOI at any time before the submission deadline as indicated in the Summary and Supplemental Information Section of this NRA. Once you submit an NOI, it cannot be deleted, only edited. For title, team member, or any other changes, please edit your existing NOI and resubmit changes to avoid duplicate records.

C. Instructions for Preparing and Electronically Submitting a Proposal Cover Page

All investigators planning to submit a proposal in response to this NRA must electronically submit proposal cover page information online and provide a hardcopy of the cover page attached to each proposal copy by May 5, 2004. The proposal cover page can be submitted and printed at:

http://proposals.hq.nasa.gov/proposal.cfm

1) Login to SYS-EYFUS at the URL listed above.

2) To submit a New Proposal Cover Page, click the "New Proposal Cover Page" option on the SYS-EYFUS Options screen, and the New Proposals Cover Page screen will appear.

3) If you previously submitted an NOI in response to this solicitation, choose to carry over the existing NOI. This option will populate the cover page fields with the NOI information. Edit the information as necessary, click "Continue," and proceed to #8 below.

4) If you did not previously submit an NOI, click on New Proposal Cover Page option, and the Division Specific Opportunities screen will appear.

5) In the selection window, highlight **All Opportunities** and click on "Continue."

6) The List of Existing Opportunities screen will appear. In the selection window, highlight **NRA-04-OBPR-01 Research Opportunities for Flight Experiments in Space Life Sciences** and then click on "Continue."

7) This will bring you to the Proposal Cover Page Submission Form. Fill in all the fields. All fields are required.

   a. The proposal summary should be a succinct and accurate description of the proposed work when read separately from the project description. The summary should contain a

brief description stating the specific aims of the proposed work. Describe concisely (300-500 words) the research design and methods for achieving these aims.

b. Please select from **only** the following three options: For the proposal type field on this form, new / no prior support means that the investigator has not received NASA funding from 2001 through 2003, new / prior support means that the investigator has received NASA funding between 2001 through 2003, and revised means that the proposal is a revised version of a proposal submitted to NASA and reviewed from 2001 through 2003, but not funded. A proposal previously submitted but not funded should be identified as being "revised" even if the original PI has changed.

c. Indicate the status of International Review Board (IRB) for your proposal. If IRB review is unavoidably delayed beyond the submission of the application, enter "Pending" on the Proposal Cover Page, and be advised that the certification must be received within 90 days after the due date for which the application is submitted.

d. Provide your TIN and CAGE numbers. Every U.S. institution that submits a proposal to a U.S. agency must provide their permanently-assigned Taxpayer Identification Number (TIN) and must register with the Department of Defense Central Contractor Registration (CCR) database for a permanently-assigned Commercial and Government Entity (CAGE) number. For additional information, reference the 2004 NRA Proposers Guidebook at: **http://www.hq.nasa.gov/office/procurement/nraguidebook/**
If you are unsure of your institution's TIN number, please contact your institution's Office of Sponsored Research to obtain the your institution's Taxpayer Identification Number (TIN) or Employer Identification Number (EIN).

8) Click on "Continue."

9) The Team Member Page screen will appear, where you can add or remove team members. Every proposal must specify the critically important personnel who are expected to play a significant role in the execution of the proposed effort and their institution of employment. Categories of personnel to be included as Team Members are described in Appendix B, Section III, Part D(5) and in Section 1.4.2 in the 2004 NRA Proposers Guidebook at **http://www.hq.nasa.gov/office/procurement/nraguidebook.**

You must include your authorizing official as a team member. When you complete and print the proposal cover page, you will see signature blocks both for yourself and your authorizing official. You are required to submit one original signed (by both you and your authorizing official) cover page with your proposal hardcopies.

IMPORTANT: If the team member is not listed in our database, please have them add themselves as a new user to the system. You may then add them to your team member list.

10) After continuing from the Team Member Page, the Proposal Options Page appears.

11) Please fill out the budget form by clicking on the "Budget" button, filling in project costs, and clicking "Continue." This will bring you to the Proposal Budget Review Page. Click "Continue" if the information is correct.

12) After verifying your budget information, you will be returned to the Proposal Options Page. Click the "Show/Print" button.

For detailed budget information, you must use Forms C and D. Form D must be filled out for each year of grant support requested. Sample copies of forms are provided in Appendix E, and are available in the NASA forms package at:

http://research.hq.nasa.gov/code_u/nra/current/NRA-04-OBPR-01/index.html

These forms cannot be electronically submitted. Fill out the forms and attach them to your proposal.

13) On the page titled "Proposal Information Item List", click "Continue" to preview your Proposal Cover Page. Print the cover page from your Internet browser once you have reviewed the information. The cover page must be signed by both the Principal Investigator and the Authorizing Official and attached to the front of your proposal before submission of hard copies to NASA. **The electronic portion of your proposal submission is complete when you print your cover page.**

By signing and submitting the proposal identified on the cover sheet, the Authorizing Official of the proposing institution (or the individual investigator if there is no proposing institution): 1) certifies that the statements made in the proposal are true and complete to the best of his/her knowledge; 2) agrees to accept the obligations to comply with NASA Award terms and conditions if an award is made as a result of this proposal; and 3) provides certification to the following, which are reproduced in their entirety in Appendix C of this NRA: (i) Certification Regarding Debarment, Suspension and Other Responsibility matters, (ii) Certification Regarding Lobbying, and (iii) Certification of Compliance with the NASA Regulations Pursuant to Nondiscrimination in Federally Assisted Programs.

14) You may edit and resubmit your proposal cover page at any time before the submission deadline as indicated in the Summary and Supplemental Information Section of this NRA. Please note that once you submit a proposal cover page, it can only be edited, not deleted. For title, team member, budget, or any other changes, please edit your existing proposal cover page and resubmit changes to avoid duplicate records. **The electronic portion of your proposal submission is complete when you print your cover page.**

D. Instructions for Preparation and Delivery of Proposals

All proposals submitted must include the completed cover page form as described in this Appendix. The name of the Principal Investigator should appear in the upper right hand corner

of each page of the proposal, except on the cover page form, where special places are provided for this information.

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

(1) Proposal Cover Page: Solicited Proposal Application, including certification of compliance with U.S. code (if applicable). One signed original required. Please see "Instructions for Preparing and Electronically Submitting a Proposal Cover Page" (Appendix B, Part C) for instructions on how to complete the proposal cover page information.

(2) Transmittal Letter or Prefatory Material, if any (see "Instructions for Responding to NASA Research Announcements" for details).

(3) Proposal Title Page, with Notice of Restriction on Use and Disclosure of Proposal Information, if any (see "Instructions for Responding to NASA Research Announcements" for details).

(4) Project Description

The length of the Project Description section of the proposal cannot exceed 20 pages using regular (12 point) type. Text must be printed on one side only and should have the following margins: left = 1.5"; Right, top, bottom = 1.0". Referenced figures must be included in the 20 pages of the Project Description. The bibliography section is not considered part of the 20-page project description. Proposals that exceed the 20-page limit for the project description (22-page limit for revised proposals; see below) 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 current resources and the resources requested. In addition, the proposal should clearly indicate the relationship between the proposed work and the research emphases defined in this Announcement. Reviewers are not required to consider information presented as appendices or to view and/or consider Web links in their evaluation of the proposal.

New applications where the investigator has received NASA funding in related fields from 2001 through 2003: Results and evidence of progress of the associated NASA supported research must be presented as part of the project description. See "Instructions for Responding to NASA Research Announcements" for details.

Revised applications (revisions of 2001, 2002 or 2003 submissions) must be so designated on the proposal cover page and explained in the project description. This explanation should be presented in a separate section of **no more than two pages at the beginning of the project description**, and is in addition to the 20 pages allowed for the project description. Related changes to the research plan should be highlighted in the body of the project description. Changes within the proposal may be highlighted by appropriate bracketing, indenting, or changing of typography. Clearly present any work done since the prior version was

submitted. **Revised applications that do not address the criticisms in the previous review will be considered non-responsive and will be returned without review.** See "Instructions for Responding to NASA Research Announcements" for additional information.

(5) Management Approach

Each proposal must specify a single PI 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.

PIs are strongly encouraged to identify only the most critically important personnel to aid in the execution of their proposals. Should such positions be necessary, Co-Investigators (Co-Is) who are critical for the successful completion of research through the contribution of unique expertise and/or capabilities, and who serve under the direction of the PI, regardless of whether or not they receive compensation under the award may be identified. Most NRAs require a Co-I to have a well-defined role in the research defined in the Management section of the proposal. Evidence of a Co-I's commitment to participate is often requested through a brief letter to be included with the proposal.

There are three subcategories of Co-Is that a proposal may identify, as appropriate:

- A Co-I may be designated as the *Science PI* for those cases where the proposing institution does not permit that individual to formally serve as the PI. In such a case, the Science PI will be understood by NASA to be in charge of the scientific direction of the proposed work, although the formally designated PI is still held responsible for the overall direction of the effort and use of funds.

- A Co-I may be designated as an *Institutional PI* when their institution is making a major contribution to a proposal submitted by a PI from another institution.

- *Co-Principal Investigators* are not permitted, with one, sole exception: A Co-I from a non-U.S. institution may be designated as a *Co-Principal Investigator* (Co-PI) should such a designation serve required administrative purposes in that Co-I's institution and/or for the procurement of funding by that Co-I from their sponsoring funding authority.

Additional category positions are often included in proposals as defined as follows:

A Postdoctoral Associate holds a Ph.D. or equivalent degree and is identified as a major participant in the execution of the proposed research. Such personnel may be identified

by name or only by function in those cases where their recruitment depends on the successful selection of the proposal.

Other Professional is a description appropriate for personnel who support a proposal in a critical, albeit intermittent, manner, such as a consulting staff scientist or a key Project Engineer and/or Manager, who is not identified as a Co-I or Postdoctoral Associate.
A *Graduate Student* included in a proposal is working for a post-graduate degree and will support the proposed research under direction of the PI. Such a student may be identified by name or only by function in case their recruitment depends on the successful selection of the proposal.

A *Collaborator* is an unfunded position included in a proposal, whose participation is less critical than a Co-I, but who is committed to provide a specific contribution to the proposal.

(6) Personnel/Biographical Sketches

The biographical sketch for each investigator should not exceed two pages. If the list of qualifications and publications exceeds two pages, select the most pertinent information (see "Instructions for Responding to NASA Research Announcements" for details). You must use the biographical sketch form (Form B). Sample copies of forms are provided in Appendix E, and are available in the NASA forms package at:

http://research.hq.nasa.gov/code_u/nra/current/NRA-04-OBPR-01/index.html

These forms cannot be electronically submitted. Fill out the forms and attach them to your proposal.

(7) Facilities and Equipment (see "Instructions for Responding to NASA Research Announcements" for details)

(8) Special Matters (specific information on human subjects protocol approval required, if applicable)

For proposals employing human subjects, assurance of compliance with human subjects provisions is required on the Proposal Cover Page. In addition, the application must include a statement from the applicant institution certifying that the proposed work will meet all Federal and local human subjects requirements.

Policies for the protection of human subjects in NASA sponsored research projects are described in NASA Management Instruction (NMI) 7100.8B (*Protection of Human Research Subjects*). This document is available from the Office of Biological and Physical Research, Code UB, NASA Headquarters, Washington, DC 20546.

Additional Requirements for Research Employing Human Subjects

A letter signed by the Chair of the Institutional Review Board (IRB) identifying the proposal submitted to NASA by title and certifying approval of proposed human subjects protocols and procedures should be included with each copy of the proposal. IRB certifications for other research proposals or grants cannot be substituted (even if they employ the same protocols and procedures).

If IRB certification is pending on the proposal due date, select "pending" from the IRB section menu on the Proposal Cover Page, and include with each copy of the proposal a letter signed by the IRB Chair identifying the proposal by title and indicating the status of the IRB review process at the time of submission. IRB certification must be received no later than 90 days after the proposal due date. An application lacking the required IRB certification 90 days after the proposal due date will be considered incomplete and may be returned to the applicant without review.

With regard to research involving human subjects, NASA has adopted the National Institutes of Health (NIH) policy. Women and members of minority groups and their subpopulations must be included in NASA-supported biomedical and behavioral research projects involving human subjects, unless a clear and compelling rationale and justification is provided showing that inclusion of these groups is inappropriate with respect to the health of the subjects or the purpose of the research.

NASA will require current IRB certification prior to each year's award.

(9) Detailed Budget and Supporting Budgetary Information

For detailed budget information**,** you must use **Forms C and D** provided in Appendix E, also available in the NASA forms package at:

http://research.hq.nasa.gov/code_u/nra/current/NRA-04-OBPR-01/index.html

These forms cannot be electronically submitted. Fill out the forms and attach them to your proposal.

Effective October 1, 2003, NASA is operating on the basis of full cost accounting. All proposals made by NASA PIs must include funds to cover salaries, benefit, travel, service pool allocations, and Center G&A costs as directed by individual center Chief Financial Officers (CFO). Funds to support the Resident Research Assistant (RRA) Postdoctoral Program costs (e.g., stipend, travel, computer time, supplies, etc.) are also to be budgeted within the NASA intramural PI budget. The NASA Full Cost Initiative is located at **http://www.hq.nasa.gov/fullcost/.**

If travel is planned, the proposal budget should include appropriate travel funds for visits to NASA field centers (as appropriate) and presentation of findings at professional society meetings.

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 for realism, reasonableness, allowability, and allocation. The budgetary forms define the desired detail, but each category should be explained. 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.

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 (if 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.

NASA may award a contract, grant or cooperative agreement as appropriate. Fee-bearing contracts are permitted.

(10) Other Support: You must complete Form E for specific sources of other support for the PI and each Co-I (not consultants). Sample copies of forms are provided in Appendix E, and are available in the NASA forms package at:

http://research.hq.nasa.gov/code_u/nra/current/NRA-04-OBPR-01/index.html

These forms cannot be electronically submitted. Fill out the forms and attach them to your proposal.

(11) Letters of Collaboration/Support (if applicable)

Letter of Assurance of Foreign Support

Proposals from non-U.S. entities that meet the criteria specified in Appendix A, Section IV must include a written endorsement from the respective agency or funding/sponsoring institution. In addition to sending the application to the designated address, one copy of the proposal, along with the letter of endorsement from the sponsoring non-U.S. Government agency or funding sponsoring institution, must be forwarded to:

National Aeronautics and Space Administration
Code I
Office of External Relations
04-OBPR-01
Washington, DC 20546-0001 USA

(12) Appendices, if any (**reviewers are not required to consider information presented in appendices**)

(13) Space Flight Experiment Requirements Summary (Form F)

All applicants proposing space flight research **must** complete **Form F**. Sample copies of forms are provided in Appendix E, and are available in the NASA forms package at:

http://research.hq.nasa.gov/code_u/nra/current/NRA-04-OBPR-01/index.html

These forms cannot be electronically submitted. Fill out the forms and attach them to your proposal.

The information on this form is essential for the flight feasibility review of the proposed study. Before filling out this form, applicants must read the *Space Life Sciences Flight Experiments Information Package* carefully and make certain that they understand the constraints associated with flight experiments. Keep in mind that the primary audience for this form is the international technical experts whose expertise may not include your specific area of research.

(14) One (1) signed original and 25 copies of the proposal cover page and the proposals must be received by **4:30 p.m., May 5, 2004**, at the following address:

NASA Peer Review Services
SUBJECT: 04-OBPR-01 Flight Experiments in Space Life Sciences
500 E Street SW
Suite 200
Washington, DC 20024-0001
(202) 479-9030

APPENDIX C
NRA 04-OBPR-01

CERTIFICATION REGARDING DEBARMENT, SUSPENSION, AND OTHER RESPONSIBILITY MATTERS

PRIMARY COVERED TRANSACTIONS

This certification is required by the regulations implementing Executive Order 12549, Debarment and Suspension, 14 CFR Part 1269.

A. The applicant certifies that it and its principals:

(a) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency;

(b) Have not within a three-year period preceding this application been convicted or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State, or Local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;

(c) Are not presently indicted for or otherwise criminally or civilly charged by a Government entity (Federal, State, or Local) with commission of any of the offenses enumerated in paragraph A.(b) of this certification; and

(d) Have not within a three-year period preceding this application/proposal had one or more public transactions (Federal, State, or Local) terminated for cause or default; and

B. Where the applicant is unable to certify to any of the statements in this certification, he or she shall attach an explanation to this application.

C. Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion - Lowered Tier Covered Transactions (Subgrants or Subcontracts)

a) The prospective lower tier participant certifies, by submission of this proposal, that neither it nor its principles is presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in this transaction by any Federal department of agency.

b) Where the prospective lower tier participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

CERTIFICATION REGARDING LOBBYING

As required by S 1352 Title 31 of the U.S. Code for persons entering into a grant or cooperative agreement over $100,000, the applicant certifies that:

(a) No Federal appropriated funds have been paid or will be paid by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, in connection with making of any Federal grant, the entering into of any cooperative, and the extension, continuation, renewal, amendment, or modification of any Federal grant or cooperative agreement;

(b) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting an officer or employee of any agency, Member of Congress, or an employee of a Member of Congress in connection with this Federal grant or cooperative agreement, the undersigned shall complete Standard Form - LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

(c) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subgrants, contracts under grants and cooperative agreements, and subcontracts), and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by S1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

CERTIFICATION OF COMPLIANCE WITH THE NASA REGULATIONS PURSUANT TO NONDISCRIMINATION IN FEDERALLY ASSISTED PROGRAMS

The (Institution, corporation, firm, or other organization on whose behalf this assurance is signed, hereinafter called "Applicant") hereby agrees that it will comply with Title VI of the Civil Rights Act of 1964 (P.L. 88-352), Title IX of the Education Amendments of 1962 (20 U.S. 1680 et seq.), Section 504 of the Rehabilitation Act of 1973, as amended (29 U.S. 794), and the Age Discrimination Act of 1975 (42 U.S. 16101 et seq.), and all requirements imposed by or pursuant to the Regulation of the National Aeronautics and Space Administration (14 CFR Part 1250) (hereinafter called "NASA") issued pursuant to these laws, to the end that in accordance with these laws and regulations, no person in the United States shall, on the basis of race, color, national origin, sex, handicapped condition, or age be excluded from participating in, be denied the benefits of, or be otherwise subjected to discrimination under any program or activity for which the Applicant receives Federal financial assistance from NASA; and hereby give assurance that it will immediately take any measure necessary to effectuate this agreement.

If any real property or structure thereon is provided or improved with the aid of Federal financial assistance extended to the Applicant by NASA, this assurance shall obligate the Applicant, or in the case of any transfer of such property, any transferee, for the period during which the real property or structure is used for a purpose for which the Federal financial assistance is extended or for another purpose involving the provision of similar services or benefits. If any personal property is so provided, this assurance shall obligate the Applicant for the period during which the Federal financial assistance is extended to it by NASA.

This assurance is given in consideration of and for the purpose of obtaining any and all Federal grants, loans, contracts, property, discounts, or other Federal financial assistance extended after the date hereof to the Applicant by NASA, including installment payments after such date on account of applications for Federal financial assistance which were approved before such date. The Applicant recognized and agrees that such Federal financial assistance will be extended in reliance on the representations and agreements made in this assurance, and the United States shall have the right to seek judicial enforcement of this assurance. His assurance is binding on the Applicant, its successors, transferees, and assignees, and the person or persons whose signatures appear below are authorized to sign on behalf of the Applicant.

APPENDIX D
NRA 04-OBPR-01

INSTRUCTIONS FOR RESPONDING TO NASA RESEARCH ANNOUNCEMENTS

(OCTOBER 2002)

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) NRAs 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 award instrument. Contracts resulting from NRAs 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 NRAs; 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) 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 information that does 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 (U.S. Proposals Only).

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).

iv) Use of NASA funds: NASA funding may not be used for foreign research efforts at any level, whether as a collaborator or a subcontract. The direct purchase of supplies and/or services, which do not constitute research, from non-U.S. sources by U.S. award recipients is permitted. Additionally, in accordance with the National Space Transportation Policy, use of a non-U.S. manufactured launch vehicle is permitted only on a no-exchange-of-funds basis.

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) Identify and discuss risk factors and issues throughout the proposal where they are relevant, and your approach to managing these risks.

iii) 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. Proposals or proposal modifications received after the latest date specified for receipt may be considered if a significant reduction in cost to the Government is probable or if there are significant technical advantages, as compared with proposals previously received.

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) Additional Guidelines Applicable to Foreign Proposals and Proposals Including Foreign Participation.

1) NASA welcomes proposals from outside the U.S. However, foreign entities are generally not eligible for funding from NASA. Therefore, unless otherwise noted in the NRA, proposals from foreign entities should not include a cost plan unless the proposal involves collaboration with a U.S. institution, in which case a cost plan for only the participation of the U.S. entity must be included. Proposals from foreign entities and proposals from U.S. entities that include foreign participation must be endorsed by the respective government agency or funding/sponsoring institution in the country from which the foreign entity is proposing. Such endorsement should indicate that the proposal merits careful consideration by NASA, and if the proposal is selected, sufficient funds will be made available to undertake the activity as proposed.

2) All foreign proposals must be typewritten in English and comply with all other submission requirements stated in the NRA. All foreign proposals will undergo the same evaluation and selection process as those originating in the U.S. All proposals must be received before the established closing date. Those received after the closing date will be treated in accordance with paragraph (g) of this provision. Sponsoring foreign government agencies or funding institutions may, in exceptional situations, forward a proposal without endorsement if endorsement is not possible before the announced closing date. In such cases, the NASA sponsoring office should be advised when a decision on endorsement can be expected.

3) Successful and unsuccessful foreign entities will be contacted directly by the NASA sponsoring office. Copies of these letters will be sent to the foreign sponsor. Should a foreign proposal or a U.S. proposal with foreign participation be selected, NASA's Office of External Relations will arrange with the foreign sponsor for the proposed participation on a no-exchange-of-funds basis, in which NASA and the non-U.S. sponsoring agency or funding institution will each bear the cost of discharging their respective responsibilities.

4) Depending on the nature and extent of the proposed cooperation, these arrangements may entail::

(i) an exchange of letters between NASA and the foreign sponsor**;** or

(ii) a formal Agency-to-Agency Memorandum of Understanding (MOU).

M) 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.

APPENDIX E
NRA 04-OBPR-01

Proposal Submission Frequently Asked Questions (FAQs) and Sample Forms

The information provided here is in response to questions from investigators such as yourself. Additional information regarding submission procedures and requirements can be found in the research announcement to which you are responding, and at the NASA online proposal site:

http://proposals.hq.nasa.gov/proposal.cfm.

1. What forms should I use when submitting a proposal?
Currently, the NASA proposal site does not support the uploading of information or forms other than the information gathered while completing the online cover page. Please complete the online cover page early in the process (you can always return and edit the cover page at any time up to the due date). After completing the cover page, any additional information you are required to provide or wish to provide can be submitted in hardcopy in any format you choose.

Please find included in this document several sample forms that you may use when providing additional information. A standard checklist of materials to include is also provided. Information outside of the online proposal cover page can be provided in any format you choose, as long as it adheres to the NRA requirements. Please reference the NRA for information on all material required when submitting your proposal. Please be aware that we ask for copies of the completed proposal package, not just the project description, and must **receive** the copies by the proposal due date. The additional information requested in the NRA does not count towards the 20 page limit of your project description.

2. Where does my authorizing official sign?
You must include your authorizing official as a team member. When you complete and print the proposal cover page, you will see signature blocks both for yourself and your authorizing official. You are required to submit one original signed (by both you and your authorizing official) cover page with your proposal hardcopies.

To be added as a team member to your proposal, the individual must be registered with the SYS-EYFUS system. If you try to add a team member and they are not found in the database, you must contact and have that individual register as a new SYS-EYFUS user. You will then be able to add them as a team member.

3. Who should I contact if I receive errors or have additional problems while using the NASA proposal site?

For technical support, please e-mail proposals@hq.nasa.gov or call (202) 479-9376 (Monday to Friday 8AM-6PM EST/EDT)

Form A

CHECKLIST FOR PROPOSERS

(U.S. Proposals Only-attach one copy to the submittal letter)

- ☐ Checklist for Proposers (Form A)
- ☐ Proposal Cover Page (completed online)
- ☐ Response to previous reviews (if applicable)
- ☐ Project Description
- ☐ Biographical Sketches (Form B)
- ☐ Facilities and Equipment Description
- ☐ Summary Budget /Budget Justification (Form C)
- ☐ Detailed 12-Month Budget (for each year of support) (Form D)
- ☐ Other Support (Form E)
- ☐ IRB or ACUC letter/form (if applicable)
- ☐ Letters of Collaboration/Support (if applicable)
- ☐ Appendices, if any
- ☐ Space Flight Experiment Requirements Summary (Form F)

Form B

BIOGRAPHICAL SKETCH

Provide the following information for the key personnel.
Photocopy this page or follow this format for each person.

NAME	POSITION TITLE

EDUCATION/TRAINING (Begin with baccalaureate or other initial professional education, such as nursing, and include postdoctoral training).

INSTITUTION(S) AND LOCATION	DEGREE(S) (if applicable)	YEAR(S)	FIELD(S) OF STUDY

RESEARCH AND PROFESSIONAL EXPERIENCE: 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.**

Form C

BUDGET FOR ENTIRE PROJECT PERIOD
DIRECT COSTS ONLY

BUDGET CATEGORY TOTALS		*1st BUDGET PERIOD*	*ADDITIONAL YEARS OF SUPPORT REQUESTED*		
			2nd	3rd	4th
PERSONNEL (Salary and Fringe Benefits) (Applicant organization only)					
SUBCONTRACTS					
CONSULTANT COSTS					
EQUIPMENT					
SUPPLIES					
TRAVEL	DOMESTIC				
	NON-DOMESTIC				
OTHER EXPENSES					
TOTAL DIRECT COSTS FOR EACH PERIOD					
TOTAL INDIRECT COSTS FOR EACH PERIOD					
TOTAL DIRECT + INDIRECT COSTS FOR EACH PERIOD					
TOTAL DIRECT + INDIRECT COSTS FOR ENTIRE PROJECT					

JUSTIFICATION FOR UNUSUAL EXPENSES :

Form D

BUDGET FOR 12 MONTH PERIOD
DIRECT COSTS ONLY

DETAILED BUDGET FOR 12-MONTH BUDGET PERIOD DIRECT COSTS ONLY		FROM		THROUGH	
Duplicate this form for each year of grant support requested		FUNDING AMOUNT REQUESTED			
PERSONNEL (Applicant Organization Only)					
NAME	**ROLE IN PROJECT**	**EFFORT ON PROJECT**	**SALARY**	**FRINGE BENEFITS**	TOTALS
	Principal Investigator				
SUBTOTALS →					
SUBCONTRACTS					
CONSULTANT COSTS					
EQUIPMENT (Itemize; use additional sheet if needed)					
SUPPLIES (Itemize by category; use additional sheet if needed)					
TRAVEL	DOMESTIC				
	NON-DOMESTIC				
OTHER EXPENSES (Itemize by category; use additional sheet if needed)					
TOTAL DIRECT COSTS FOR FIRST 12-MONTH BUDGET PERIOD					
INDIRECT COSTS FOR FIRST 12-MONTH BUDGET PERIOD					
TOTAL COST FOR FIRST 12-MONTH BUDGET PERIOD					

Form E

OTHER SUPPORT

Please provide information regarding specific sources of other support for the PI and each Co-I (not consultants). This information should be provided separately for each individual in the format shown below. List all active support for an individual before listing pending support. Include the investigator's name at the top of each page and number pages consecutively.

NAME OF INDIVIDUAL		
ACTIVE/PENDING		
Project Number (Principal Investigator)	Dates of Approved/ Proposed Project	Percent Effort
Source	Annual Direct Costs	
Title of Project (or Subproject)		
One-sentence description of project goals. (The major goals of this project are…)		
Brief description of potential scientific or commitment overlap with respect to this individual between this application and projects described above (summarized for each individual).		

Form F

SPACE FLIGHT EXPERIMENT REQUIREMENTS SUMMARY

In addition to the actual proposal, Form F is required for the Flight Feasibility Review. This form has been designed for a description of all preflight, inflight and post-flight components of the flight experiment. Form F consists of three sections:

- A general section to be completed for all flight proposals,
- A section to be completed only for experiments that require human subjects, and
- A section to be completed only for experiments that require non-human specimens.

If an experiment requires both human and non-human specimens, the entire form must be completed. If no specimens are required (e.g., radiation dosimetry), complete Part 1 and other applicable hardware and procedures questions. If the proposal consists of distinct segments with different requirements, fill out multiple forms to fully describe all segments. **Form F is mandatory for flight experiments.** Flight experiment proposals submitted without Form F completed will not be evaluated.

Please read the questions carefully and keep answers brief but thorough, ensuring that all requested information has been provided. Expand tables/response space as needed. Downloading the RTF file is the most effective way to complete this form.

Part I: General Information

1. Principal Investigator name:_____
2. Proposal title: _____
3. Duration of flight experiment
    a. Minimum number of days in flight:
    b. Desired number of days in flight:

4. Describe the types of procedures required for the inflight portion of the experiment. List each type of procedure separately (e.g., blood sample, record EKG, fix culture, etc.).

5. Storage of equipment and supplies other than animal/plant/specimen habitats (for all flight experiments)

Is temperature control of equipment/supplies needed:	Yes	No	Not Applicable	Not Known	Temperature (ºC)	Estimated Volume (cm3)
-- for launch?						
-- in flight?						
-- for return?						

6. Hazardous materials and controlled/radioactive substances (for all flight experiments)
Add more lines if necessary.

Material	Estimated Volume (cm3)	Usage Time Period (e.g., Preflight, Inflight, Post-flight)
1.		
2.		
3.		

Part II: Research Involving Crewmembers as Subjects

7. Subjects
    a. Number of subjects required for statistical significance:
    b. Special requirements (e.g., gender, age, etc.):
    c. Are inflight procedures needed?
    d. Are pre- and post-flight procedures needed?

8. List all human subject restrictions *(e.g., specific dietary regimens, fluid intake regulation, work/rest cycles, exercise, etc.). Indicate the impact on scientific outcome if restrictions cannot be met.*

9. Is loading of experiment supplies or equipment less than 90 hours before launch required? If so, explain why.

10. Is removal of the experiment samples, data, or equipment less than 24 hours after landing required? If so, explain why.

11. What procedures will the crew need to learn in order to perform their role as subjects for the experiment? *List and briefly describe each procedure separately. Be sure to rate the difficulty of learning each procedure (1= easy; 10= difficult) and indicate when each procedure will be used (e.g., preflight, inflight, post-flight). Assume that the crewmembers do not have a medical background or prior experience with these kinds of experiments.*

12. Does the experiment require a person to assist (operator) with data collection? If so, what procedures will be performed by this person?
List and briefly describe each procedure separately. Be sure to rate the difficulty of learning each procedure (1= easy; 10= difficult) and indicate when each procedure will be used (e.g., preflight, inflight, post-flight). Assume that the crewmembers do not have a medical background or prior experience with these kinds of experiments.

13. Equipment for human subject measurements
Add more lines if necessary.

a. Pre- and Postflight

What Variable will be Measured?	Equipment Needed for Measurement	Equipment Provider (Agency or PI)
1.		
2.		
3.		
4.		

b. Inflight *(List ALL needed inflight equipment for measurement, sample collection, or storage.)*

What Variable will be Measured?	Equipment Needed for Measurement	Equipment Provider (Agency or PI)
1.		
2.		
3.		
4.		

14. Is real-time data transmittal either required or highly desirable*? ("required" means that the experiment cannot be performed if downlink is not available; "highly desired" means that the experiment data will be transmitted if the downlink is available.)*

15. List special requirements for specimen and/or sample accommodation or manipulation.

16. Biological samples collected on the ISS may have to be stored on the station for up to 365 days. *Describe the requirements for preserving those samples (thermal control, preservatives, etc.).*

17. List each procedure that must be performed on each (crewmember) subject to meet experimental objectives. *Indicate the timeframe (e.g., launch minus 60 days (+/- 5 days)) and procedure duration (e.g., 60 minutes). Specifically state if data must be collected on landing day (R+0) or if R+1 or 2 day will suffice.*

a. Pre-/ Postflight procedures

b. Inflight procedures

Part III: Research Involving Non-Human Subjects

18. Use the table below to list the requirements for non-human specimens. *Add more rows if necessary.*

Specimen Type (e.g., species, strain, gender, weight, age)	Drugs, Tracers, Tags, etc.	Number of Specimens Required for Flight Experiment	Number of Specimens Required for Ground Control of Flight Experiment
1.			
2.			
3.			
4.			
5.			

19. Use the table below to list the required inflight experimental conditions for all non-human specimens and samples. *Be sure to completely describe, for each specimen or sample, the environmental parameters (e.g., temperature, humidity, CO2, light level, atmospheric pressure) and allowable range for each parameter. Also indicate when the environmental conditions will be needed (e.g., Flight Day 3-10, mission duration, pre-injection, after fixation).*

Requirement	Tolerance (e.g. ± 1°C)	When needed?	Specimen/Sample
1.			
2.			
3.			
4.			
5.			

20. Is loading of experiment supplies or equipment less than 90 hours before launch required? If so, explain why.

21. Is removal of the experiment samples, data, or equipment less than 24 hours after landing required? If so, explain why.

22. Describe the method for delaying experiment activation until it is installed on the ISS.

23. Describe the method for preserving samples for up to 365 days on the ISS.

24. What procedures will the crew need to learn to perform the experiment?
List and briefly describe each procedure separately. Be sure to rate the difficulty of learning each procedure (1= easy; 10= difficult) and indicate when each procedure will be used (e.g., preflight, inflight, postflight).

25. List the procedures from Item 23 in the table below. *Indicate the frequency and an acceptable time range for each procedure (e.g., change media every 5 days ± 1 day, fix sample on day 10 ± 6 hours).*

Procedure	Flight Day and Time (if necessary)	Frequency	Acceptable Range
1.			
2.			
3.			
4.			

26. For each specimen, list preferred habitat or indicate NO PREFERENCE.

27. List equipment, tools, supplies needed for inflight experiment procedures.

28. List any special requirements for specimen and/or sample accommodation or manipulation.