LIFE SCIENCES RECRUITMENT OBJECTIVES

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ABSTRACT

The goals of the Life Sciences Division of the Office of Space Sciences and Applications are to ensure the health, well-being and productivity of humans in space and to acquire fundamental scientific knowledge in space life sciences. With these goals in mind, Space Station Freedom represents substantial opportunities and significant challenges to the Life Sciences Division. For the first time it will be possible to replicate experimental data from a variety of simultaneously exposed species with appropriate controls and real-time analytical capabilities over extended periods of time. At the same time, a system for monitoring and ameliorating the physiological adaptations that occur in humans subjected to extended space flight must be evolved to provide the continuing operational support to the SSF crew. To meet its goals, and take advantage of the opportunities and overcome the challenges presented by Space Station Freedom, the Life Sciences Division is developing a suite of discipline-focused sequence. The research phase of the Life Sciences Space Station Freedom Program will commence with the utilization flights following the deployment of the U.S. laboratory module and achievement of Man Tended Capability. Investigators that want the Life Sciences Division to sponsor their experiment on SSF can do so in one of three ways: submitting a proposal in response to a NASA Research Announcement (NRA), submitting a proposal in response to an Announcement of Opportunity (AO), or submitting an unsolicited proposal. The scientific merit of all proposals will be evaluated by peer review panels. Proposals will also be evaluated based on relevance to NASA’s missions and on the results of an Engineering and Cost Analyses. The Life Sciences Division expects that the majority of its funding opportunities will be announced through NRAs. It is anticipated that the first NRA will be released approximately three years before first element launch (currently scheduled for late 1995). Subsequent NRAs will be released on a rotating two year cycle.
SPACE LIFE SCIENCES GOALS AND OBJECTIVES

• Ensure the health, safety, and productivity of humans in space
• Acquire fundamental scientific knowledge concerning biological sciences
• Expand our understanding of life in the Universe
• Develop an understanding of the role of gravity on living systems
• Provide for the health and productivity of humans in space
• Promote the application of life sciences research to improve the quality of life on Earth
Phase I
Mercury, Gemini, Apollo (1960's)

Objectives
• Human Survival
• Adequate Human Performance for Lunar Trip

Methodology
• Pre-/Post-flight Human Studies
• Highly Limited Inflight Studies

Phase II
Skylab (1970's)

Objectives
• Human Adaptation for 2-3 Months
• Biomedical Research Focus

Methodology
• Extensive Noninvasive Biomedical Studies
• Frequent Inflight Collection of Blood and Urine
• First Provocative Testing in Space

Phase III
Spacelab, Middecks, COSMOS (1980's, Early 1990's)

Objectives
• Focused Second Generation Biomedical Studies
• Initial Testing of Animals as Human Surrogates
• Initiation of Research in Basic Biology

Methodology
• Limited Invasive Studies on Humans
• Invasive Animal Studies
• Sophisticated Laboratory Equipment
• Plant and Cell Biology Facilities

Phase IV
LIFE SCIENCES SPACE RESEARCH STRATEGY

Phase IV
Late Spacelab, MIR, Early Space Station Freedom (Mid-Late 1990's)

Objectives
• Third Generation Biomedical Studies (Countermeasures Emphasis)
• Development of Animal Models
• Develop Foundations for Exploration
• Fundamental Studies in Basic Biology

Methodology
• Integrated International Laboratories
• Comprehensive Laboratory Research Facilities
• Carefully Controlled Human, Animal, and Plant Studies
• Replications as Required

IMPETUS FOR SPACE STATION FREEDOM

"...back to the Moon, back to the future. And this time, back to stay. And...a journey into tomorrow...a manned mission to Mars." President George Bush, 1989.

"...the Space Station is deemed essential as a life sciences laboratory, for there is simply no Earth-bound substitute. The Space Station is a critical next step if the U.S. is to have a manned space program in the future." Report of the Advisory Committee on the Future of the U.S. Space Program, 1990.

"[Space Station] Freedom will provide the means to acquire basic knowledge on mechanisms of gravity perception while paving the way for extended-duration exploration missions with humans." Space Life Sciences Strategic Plan, 1992.
RECENT RECOMMENDATIONS TO THE LIFE SCIENCES

- Life Beyond the Earth's Environment: The Biology of Living Organisms in Space. NRC Space Science Board. Neal S. Bricker, Chairman. 1979
  - Focused on science priorities for Spacelab missions

- A Strategy for Space Biology and Medical Science: for the 1980s and 1990s. NRC Space Science Board. Jay M. Goldberg, Chairman. 1987
  - Focused on developing priorities for late STS and early space station program

  - Focused programmatic requirements for Space Station Freedom

- Life Sciences Discipline Working Group Science Plans. 1991
  - Focused on discipline specific science
  - Developed prioritized list of critical questions within each discipline

  - Focused on meeting requirements for Moon/Mars missions
  - Developed prioritized list of science questions across disciplines

SPACE LIFE SCIENCES CUSTOMERS

1. MISSION IMPLEMENTORS
   - Requirement: Capability for human exploration of space
   - LSD Product: Deliverables identified by AMAC strategy

2. SCIENCE COMMUNITY
   - Requirement: Access to space for conduct of scientific research
   - LSD Product: Support of science described in discipline plans

3. PUBLIC
   - Enhance the quality of life on Earth
   - Stimulate the imagination
   - Motivate science and engineering education
## Categories for Life Sciences Disciplines

**Human Physiology and Performance**
- Behavior
- Performance
- Human Factors
- Regulatory Physiology
- Cardiopulmonary
- Musculoskeletal
- Neuroscience

**Life Support**
- Environmental Health
- Radiation Health
- Life Support, including CELSS

**Gravitational Biology**
- Cell and Developmental Biology
- Plant Biology

**Exobiology**
- Exobiology
- Planetary Protection

### Enabling Life Sciences Research Thrusts for Human Exploration Missions

**Environmental Health and Life Support Systems (EHLSS)**
- Protect from the space environment
  - Vacuum
  - Radiation
  - Absence of atmosphere, food, water

**Countermeasure Systems (CMS)**
- Compensate for the effects caused by the space environment
  - Hypogravity
  - Confined space
  - Limited crew size

**Medical Care Systems (MCS)**
- Provide clinical intervention or treatment
  - Decompression sickness
  - Transfusions
  - Bone fracture
DEFINITIONS OF CRITICALITY, ROBUST AND CONSTRAINED PROGRAMS

<table>
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<tr>
<th>Criticality 1</th>
<th>Criticality 2</th>
<th>Criticality 3</th>
<th>Criticality 4</th>
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Criticality 1: Consensus that answer is required for Mars mission (known effect and known problem for mission).*
Criticality 2: Answers might be required, science basis to evaluate risk is not adequate.
Criticality 3: Required for practical optimization of resources (or countermeasure effectiveness) and minimization of risk.
Criticality 4: Important science that is relevant to exploration mission.

* Crewmembers must be able to effectively perform mission tasks in transit vehicles and on planetary surfaces; and must recover, in a reasonable time, upon return to Earth

LIFE SCIENCES RESEARCH RESOURCES

- Space Station Freedom
  - Predominantly manned operations
  - Lengthy exposure to all levels of hypogravity
  - Variable gravity experimental comparisons
  - Replication of experimental procedures
  - Real-time analytical capabilities

- STS/Spacelab
  - Manned or man-tended operations
  - Testbed for SSF techniques/equipment
  - 7-16 day missions, evolving to 30-day
  - Earth based analyses of samples/data

- Unmanned Free Flyers
  - Unmanned science
  - Earth based analyses of samples/data
  - Variable inclination/orbital environment
  - "Quiet" periods of microgravity available

- Validation of Hypotheses & Experimental Models

- Ground Based Experimentation
  - University/industry and NASA Unique Resources

Life Sciences planning matches Science Requirements with the most appropriate Platform
## SOLICITED PROPOSALS

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<th>NASA Research Announcements (NRA)</th>
<th>Announcements of Opportunity (AO)</th>
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| **Types of investigations** | • ground-based research  
• flight experiments not requiring major hardware development |
| **Funding mechanism** | • usually grants  
• flight hardware development oriented projects |
| **Funding level** | • varies, depending on requirements/justification  
• varies usually larger than NRA due to complex nature of hardware development |
| **Evaluation process** | • peer reviewed science  
• NASA programmatic evaluation  
• peer reviewed science  
• NASA programmatic evaluation  
• more involved "CEM" evaluation than NRA |

**UNSOLICITED PROPOSALS**

- Investigator initiated
- Mailed directly to appropriate Program Manager
- Evaluated like NRA/AO
- Appropriate for small, low cost experiments utilizing existing hardware/facilities

**SOLICITATION OF RESEARCH ON SPACE STATION FREEDOM**

- Primary method of solicitation/funding will be through discipline focused NASA Research Announcements (NRA).
  - Discipline sequence will be determined in consultation with the scientific community and our international partners.
- NRAs will announce submittal dates for established discipline sequences.
- Nominal two year cycle from solicitation to funding.
EXAMPLE DISCIPLINE FOCUSED INCREMENTS

Regulatory Physiology
Plant Biology
Cardiopulmonary Physiology
Musculoskeletal Physiology
Cell and Developmental Biology
Neuroscience
Cardiopulmonary Physiology
Musculoskeletal Physiology


METHODS OF FUNDING

Unsolicited Proposals
Announcement of Opportunity
NASA Research Announcement

Target Funding Range $60 - $100 K per year
PROPOSAL EVALUATION CRITERIA

- Scientific merit - determined by an extramural peer review panel
- Relevance to NASA's mission - determined by NASA
- Engineering, Cost, and Management Review - standardized review performed by NASA. Used to assess costs, development risks, hardware availability, potential incompatibilities, and the technical aspects of implementing the proposed investigation.

TYPES OF FLIGHT OPPORTUNITIES ON SPACE STATION FREEDOM

Utilization of common-core facilities

- Nominal use
  - facilities used as provided, no additional hardware built
  - solicitation to integration/flight cycle = 2 years
- Experiment Unique Equipment required
  - additional hardware or significant modifications to facilities required
  - solicitation to integration/flight cycle > 2 years

- Small and Rapid Response Payloads
  - small experiments
  - integrated tissue sharing protocols
  - integration/flight may be accomplished in 6 months
SUPPORT PROVIDED BY THE NASA GRANT

- Experiment definition, development, and ground based data collection.
- Development of Experiment Unique Equipment (EUE) - if approved.
- Postflight data analysis

OTHER SUPPORT PROVIDED BY NASA

- Experiment integration
  - Physical
  - Analytical
- Use of common-core facilities and hardware
- Mission operations/ logistics
- Inflight data collection
- Data Archive