

**LIFE SCIENCES UTILIZATION OF SPACE STATION FREEDOM**

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**ABSTRACT**

Space Station Freedom will provide the United States' first permanently manned laboratory in space. It will allow, for the first time, long term systematic life sciences investigations in microgravity. This presentation provides a top-level overview of the planned utilization of Space Station Freedom by NASA's Life Sciences Division. The historical drivers for conducting life sciences research on a permanently manned laboratory in space as well as the advantages that a space station platform provides for life sciences research are discussed. This background information leads into a description of NASA's strategy for having a fully operational International Life Sciences Research Facility by the year 2000. Achieving this capability requires the development of the five discipline-focused "common core" facilities. Once developed, these facilities will be brought to the space station during the Man-Tended Capability phase, checked out and brought into operation. Their delivery must be integrated with the Space Station Freedom manifest. At the beginning of Permanent Manned Capability, the infrastructure is expected to be completed and the Life Sciences Division's SSF Program will become fully operational. A brief facility description, anticipated launch date and a focused objective is provided for each of the life sciences facilities, including the Biomedical Monitoring and Countermeasures (BMAC) Facility, Gravitational Biology Facility (GBF), Gas-Grain Simulation Facility (GGSF), Centrifuge Facility (CF), and Controlled Ecological Life Support System (CELSS) Test Facility. In addition, hardware developed by other NASA organizations and the SSF International Partners for an International Life Sciences Research Facility is also discussed.



# Life Sciences Utilization of Space Station Freedom



## Space Station Freedom Utilization Conference

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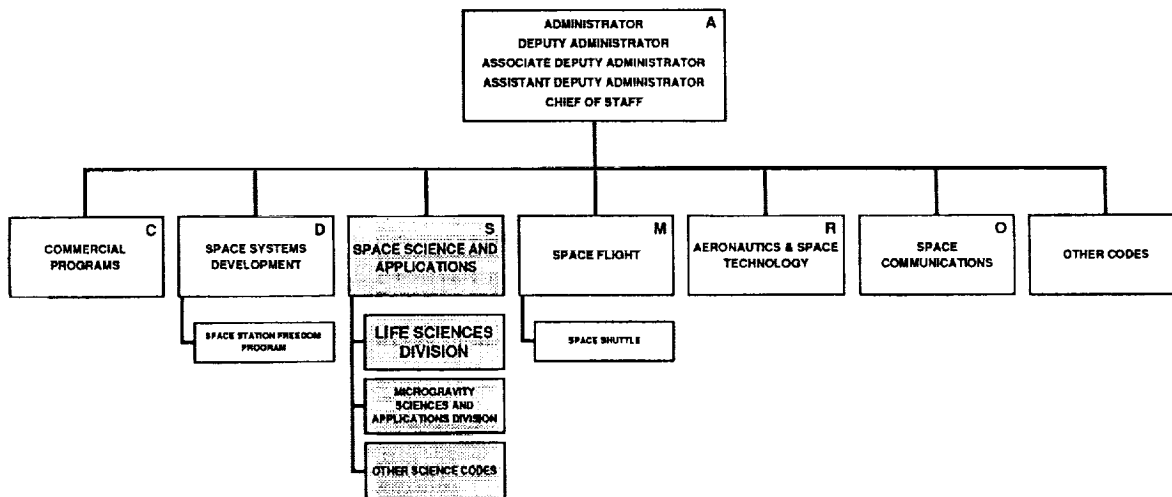


### Space Life Sciences Goals and Objectives

- Ensure the health, safety, and productivity of humans in space
- Acquire fundamental scientific knowledge concerning space 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

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# NATIONAL AERONAUTICS AND SPACE ADMINISTRATION



## Historical Drivers for Space Life Sciences Research on Space Station Freedom

- 1958 NASA Charter called for the expansion of human knowledge of phenomena in the atmosphere and space
- 1987 Goldberg Report - Identified a complementary strategy combining basic life sciences and clinical research on Space Shuttle and early SSF
- 1988 Robbins Report - Endorsed the capability of basic research on the Space Station using plants, animals, and humans
- 1990 Augustine Report - Identified life sciences research as a major reason for building the Space Station
- 1992 NASA Advisory Council - Developed list of science questions to be answered by life sciences research on Space Station to enable a mission to the Moon or Mars



## Why Space Station for Biological Research?

- **First permanently manned laboratory in space**
- **Allows long-term, systematic investigations under controlled conditions**
  - Study growth and maturation over time
  - Examine living specimens through multiple generations (seed to seed to seed)
  - Replication based on experimental results
- **Statistical Analysis**
  - Adequate sample size
  - Appropriate control populations
  - Verification through replication



## Life Sciences Space Station Freedom Strategy

- **Life Sciences Space Station Freedom Program will be performed using a suite of discipline-focused "common core" facilities**
  - Five common core facilities being developed by NASA Life Sciences
  - Generic hardware will be used for numerous applications
  - Will be able to support the wide range of life sciences disciplines
  - Integral part of International Life Sciences Research Facility
- **Use Man-Tended Capability (MTC) to develop research infrastructure to establish an International Life Sciences Research Facility. Major objectives during the MTC Phase are:**
  - Bring facilities to orbit and install in pressurized volume
  - Verify and check-out hardware for proper operation
  - Perform science experiments (i.e. Spacelab class) that can be adequately performed in an MTC environment



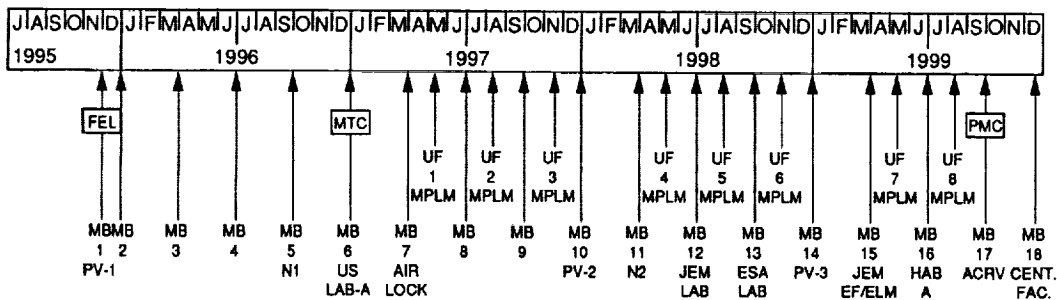
## Life Sciences Space Station Freedom Strategy (Continued)

- Once Permanent Manned Capability achieved (year 2000), life sciences capabilities will be fully operational
  - Can devote in-depth study to each discipline for extended periods of time (nominally 6 months)
  - Hardware items (including Experiment Unique Equipment) can be changed out to match particular discipline focus

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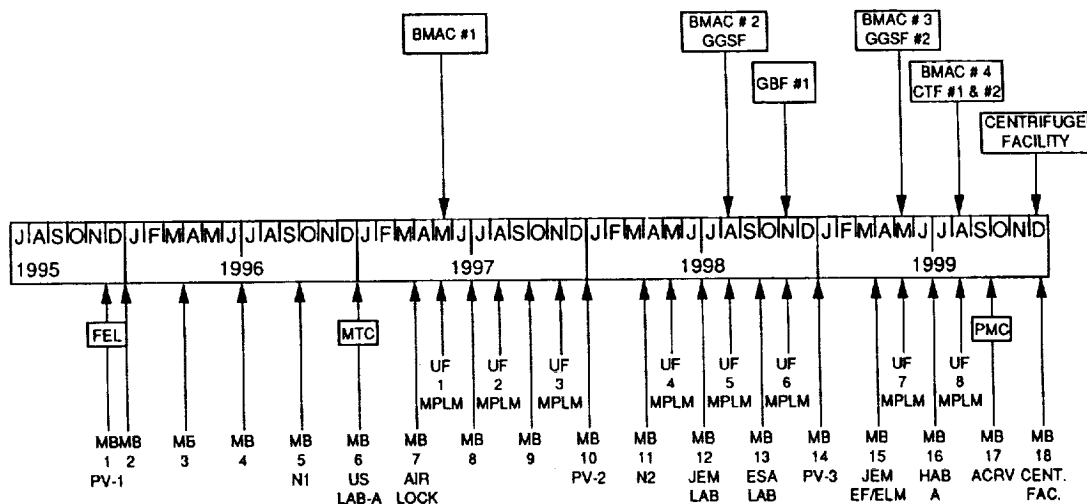
## Space Station Freedom Manifest



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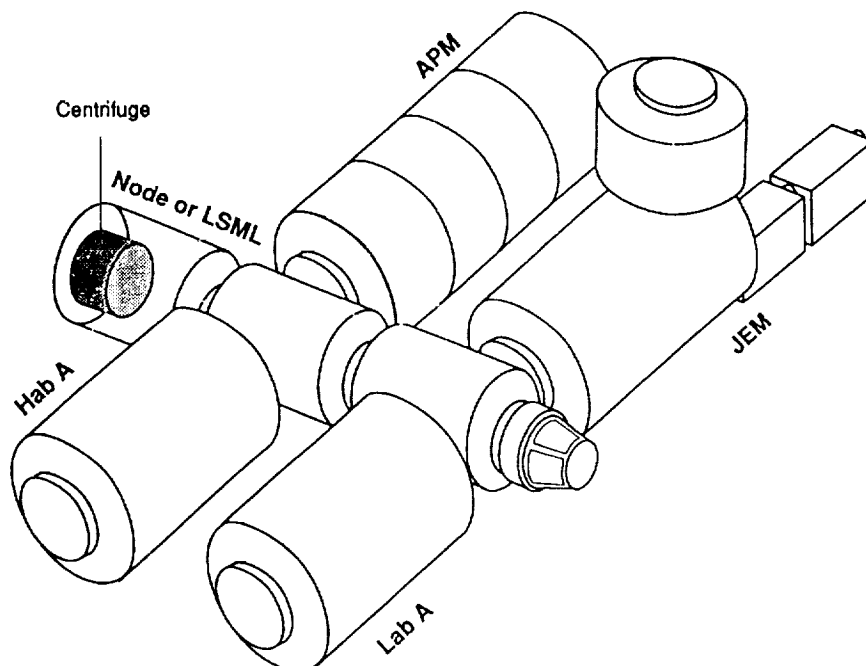
# Space Station Freedom Manifest



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## POTENTIAL CENTRIFUGE LOCATION ON SPACE STATION FREEDOM

### Permanently Manned Capability





## Life Sciences Space Station Freedom Research Facilities

- **Biomedical Monitoring and Countermeasures Facility**
  - 4 rack facility
  - 1st launch—1997
  - Objective is to understand how to maintain crew health and performance for missions of 16 days and longer in a manner that minimally impacts mission operations and resources
- **Gravitational Biology Facility**
  - 2 rack facility
  - 1st launch — 1998
  - Objective is to provide the generic laboratory equipment needed to conduct basic life sciences research in cell biology, developmental biology, and plant biology
- **Centrifuge Facility**
  - 2.5 meter centrifuge plus two habitat racks
  - 1st launch — late 1999
  - Objective is to provide a suite of equipment to allow controlled studies on the influence of gravity on biological systems



## Life Sciences Space Station Freedom Research Facilities (Continued)

- **Gas Grain Simulation Facility**
  - 1 rack facility
  - 1st launch — 1998
  - Objective is to simulate and study fundamental chemical and physical processes of submicron to millimeter sized particles in microgravity to improve understanding of the formative processes of the universe
- **Controlled Ecological Life Support System (CELSS) Test Facility**
  - 2 rack facility
  - Launch — 1999
  - Objective is to study crop growth and productivity in microgravity under a broad range of environmental conditions





## Other Contributions to Life Sciences Research

Other facilities not funded by the Life Sciences Division will be utilized to achieve life sciences research objectives:

- **Laboratory Support Equipment/General Laboratory Support Facilities**
  - **Funded by Office of Space Flight/Office of Space Science and Applications**
  - **Will be shared by all SSF users (life sciences, materials sciences, commercial applications, etc.)**
  
- **International Partner Life Sciences Facilities**
  - **International Partners (ESA, NASDA, CSA) are planning to provide life sciences research hardware for SSF**
  - **NASA Life Sciences will coordinate closely with our International Partners so that an integrated International Life Sciences Research Facility is developed for SSF**
  - **Eliminates duplicate hardware**
  - **Provides most efficient use of limited resources**



## Rack Totals For Life Sciences Facilities

<b>Biomedical Monitoring and Countermeasures</b>	<b>4</b>
<b>Gravitational Biology Facility</b>	<b>2</b>
<b>Gas-Grain Simulation Facility</b>	<b>1</b>
<b>Centrifuge Facility</b>	<b>2 + Centrifuge System</b>
<b>CELSS Test Facility</b>	<b>2</b>
<b>Total Racks:</b>	<b>11 + Centrifuge System</b>



## Summary

- **LIFE SCIENCES LOOKS FORWARD TO SPACE STATION FREEDOM ERA**
- **First permanently manned laboratory in space**
- **Allows systematic, long-term life sciences investigations under controlled conditions**
- **Permits satisfactory statistical analysis of in-flight results**
- **Information obtained from life sciences research on Space Station Freedom will be utilized for lunar and Mars missions**