

**GRAVITATIONAL BIOLOGY FACILITY ON SPACE STATION:
MEETING THE NEEDS OF SPACE BIOLOGY**

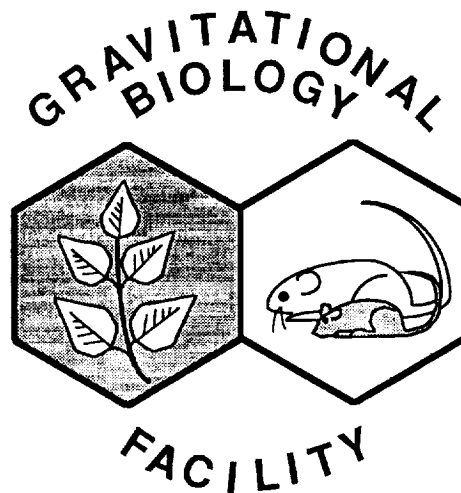
Prepared by Katherine Allen and Dr. Charles Wade
GE Government Services
NASA Ames Research Center

Presented by Katherine Allen

ABSTRACT

The Gravitational Biology Facility (GBF) is a set of generic laboratory equipment needed to conduct research on Space Station Freedom (SSF), focusing on Space Biology Program science (Cell and Developmental Biology and Plant Biology). The GBF will be functional from the earliest utilization flights through the permanent manned phase. Gravitational biology research will also make use of other Life Sciences equipment on the space station as well as existing equipment developed for the space shuttle. The facility equipment will be developed based on requirements derived from experiments proposed by the scientific community to address critical questions in the Space Biology Program. This requires that the facility have the ability to house a wide variety of species, various methods of observation, and numerous methods of sample collection, preservation and storage. The selection of the equipment will be done by the members of a scientific working group (5 members representing cell biology, 6 developmental biology and 6 plant biology) who also provide requirements to design engineers to ensure that the equipment will meet scientific needs. All equipment will undergo extensive ground based experimental validation studies by various investigators addressing a variety of experimental questions. Equipment will be designed to be adaptable to other space platforms. The theme of the Gravitational Biology Facility effort is to provide optimal and reliable equipment to answer the critical questions in Space Biology as to the effects of gravity on living systems.

GRAVITATIONAL BIOLOGY FACILITY: MEETING THE NEEDS OF SPACE BIOLOGY



Katherine Allen, Project Bioengineer
GE Government Services
NASA Ames Research Center



Gravitational Biology Facility Description

- Provides laboratory equipment items to conduct state-of-the-art, critical space life sciences research in:
 - Cell Biology
 - Developmental Biology
 - Plant Biology
- Includes common research equipment
 - Supports a wide range of specimen types
 - Various sample manipulation and preservation methods
- Hardware developed in evolutionary manner
 - Functional from Utilization Flights through PMC



Cell Biology Critical Questions

- How are cell functions influenced by gravity and or affected by microgravity?
 - Gene activation and function
 - Membrane/Signal transduction
 - Cellular differentiation/Cell division
 - Cellular immunology (immune cell function)
- Do single cells "sense" gravity directly (intracellularly) or indirectly (environmentally-mediated effect)?
 - In vitro macromolecular assembly
 - Oxygen tension and cellular respiration

SSF Utilization Conference, Huntsville, Alabama, August 5, 1992



Developmental Biology Critical Questions

- Which developmental mechanisms have evolved to be dependent on gravity (1-g)?
 - Oocyte maturation
 - Axis formation, pregastrulation & gastrulation
- How does gravity effect organogenesis and the development of anatomical structures?
 - Vestibular development
 - Skeletal growth and maturity
 - Structural muscle development and morphology
- Does the ontogeny of animals raised through more than one life cycle in microgravity differ from the 1-g classical pattern?
 - Insect, avian, aquatic and mammalian studies



Plant Biology Critical Questions

- **What are the mechanisms that underlie gravity perception?**
 - Altered gene expression
- **Can plants successfully reproduce through more than one generation in space?**
 - Seed production
 - Anthesis and Fertilization
 - Plant embryogenesis
- **Are anabolic and catabolic pathways and the photosynthetic apparatus and pathway altered in microgravity?**
 - Photosynthetic partitioning
 - Nutrient absorption and up take
 - Alterations in cell wall synthesis

SSF Utilization Conference, Huntsville, Alabama, August 5, 1992



GBF Science Working Group

Program Scientist:

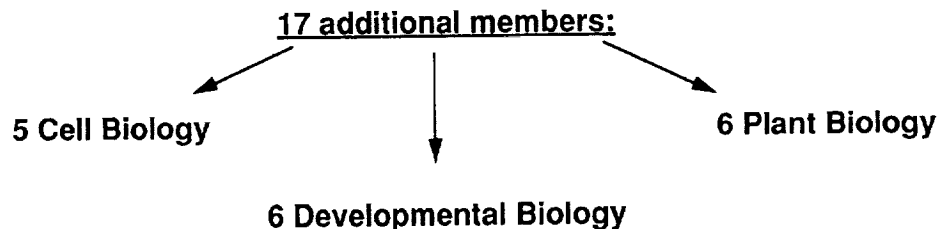
- Dr. Thora Halstead, NASA HQ

Project Scientist and SWG chair:

- Dr. Charles Wade, ARC

Deputy Project Scientist:

- Dr. William Knott, KSC



Responsible for:

- Developing and reviewing GBF Reference Experiments
- Developing GBF Science Requirements for equipment items
- Providing science review and guidance in GBF equipment development effort



Equipment Development Process

- Develop and Solicit Experiments for GBF
- Identify equipment items from GBF Reference Experiments
- Develop prioritized list of GBF hardware
- Science Working Group provides science requirements to engineers
- Studies to evaluate different hardware designs
- Develop approach for the design and development of GBF hardware
- Prototype hardware testing (ground-based, parabolic flights, shuttle experiments)

SSF Utilization Conference, Huntsville, Alabama, August 5, 1992



Reference Experiment Development

- Solicitation for reference experiments from the science community.
- Provided guidelines for:
 - areas of research
 - flight opportunities and time frames
 - justification for space flight
- SWG review, critique, and revision of experiments
- Solicitation for additional experiments for research areas not fully covered



Reference Experiment Set

- More than 125 experiments received (> 75 authors).
- Distribution between early flights (MTC) and PMC.
- Distribution over discipline specific research areas and critical questions.
- High degree of similarity of equipment required among the experiments and among the disciplines.

SSF Utilization Conference, Huntsville, Alabama, August 5, 1992



GBF Specimen Habitats

<ul style="list-style-type: none">√ Cell culture apparatus• Small Plant• Medium Plant• Insect• Egg incubator• Small Aquatic (salt and fresh water)• Medium Aquatic• Rodent Birthing	<ul style="list-style-type: none">• Large Plant• Rodent Breeding• Avian Hatchling• Rodent Rearing• Rodent Weanling to Adult• Avian Adult• Large Aquatic
------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Habitat characteristics:

- 1-g control
- Environmental control
- Video monitoring

√ = Multi-Discipline Equipment Item



GBF Preservation & Storage Equipment

- √ Freezers (-196°C, -70°C, -20°C)
- √ Fixation capability
- √ Refrigerator
- √ Freeze Drier
- √ Snap Freezer
- √ Ambient Storage
- √ Refrigerator/Incubator

Purpose:

- Preserve and store samples on orbit
- Preserve samples during return to Earth for analysis

√ = Multi-Discipline Equipment Item

SSF Utilization Conference, Huntsville, Alabama, August 5, 1992



GBF Manipulation & Analysis Equipment

- √ Fluid handling tools
- √ Compound Microscope (CCD)
- √ Work Area
- √ Dissection Equipment
- √ Dissecting Microscope
- √ Temperature Controlled Laboratory Centrifuge
- √ Data Storage
- √ Radioisotope Handling Equipment

- Digital Multimeter
- Ion Selective Electrodes
- Spectrophotometer
- √ Mass Measurement Device
- Electrophysiology Measuring Equipment
- √ Micromanipulation Device
- Luminometer

Purpose:

- Preparation of samples for ground-based analysis
- On orbit measurements and analysis



Summary

Gravitational Biology Facility supports:

- Earliest life sciences experiments on Space Station Freedom
- Diverse specimen types and areas of research in Cell, Developmental, and Plant Biology
- Common laboratory equipment for life sciences research

- For more information, contact:

Kellie McKeown
GBF Project Manager
MS 244-14
NASA Ames Research Center
Moffett Field, CA 94035-1000
(415) 604-4862

Dr. Charles Wade
GBF Project Scientist
MS 239-11
NASA Ames Research Center
Moffett Field, CA 94035-1000
(415) 604-3943

SSF Utilization Conference, Huntsville, Alabama, August 5, 1992



