SCIENCE, AERONAUTICS, AND TECHNOLOGY

FISCAL YEAR 2002 ESTIMATES

BUDGET SUMMARY

OFFICE OF BIOLOGICAL AND PHYSICAL RESEARCH **BIOLOGICAL AND PHYSICAL RESEARCH**

	FY 2000 OPLAN REVISED	FY 2001 OPLAN REVISED	FY 2002 PRES BUDGET	Page Number
	(Thousands of Dollars)			
Advanced Human Support Technology (AHST)	30,094	30,832	31,100	SAT 2-7
Biomedical Research & Countermeasures (BR&C)	57,167	70,206	66,792	SAT 2-10
[Construction of facilities]	[9,000]	[8,581]	[9,800]	
Fundamental Space Biology (FSB) (Formerly Fundamental Biology (FB)).....	38,180	40,610	39,200	SAT 2-13
Physical Sciences Research (PSR) (Formerly Microgravity Research (MR))	108,745	130,659	130,087	SAT 2-15
Space Product Development (SPD)	14,400	13,683	14,508	SAT 2-20
Health Research (HR) (Formerly Occupational Health Research (OHR) and Space Medicine Research (SMR)).....	8,700	11,714	9,400	SAT 2-22
Mission Integration (MI)	17,414	15,206	213	SAT 2-25
[Life Sciences Research Facility at the University of Missouri]	[12,814]	[14,967]		
Investments and Institutional Support (MUREP from BR&C in FY 2000 and in FY 2001)	[65,518]	[65,859]	69,620	SAT 2-27
Total.....	274,700	312,910	360,920	

	FY 2000 OPLAN REVISED	FY 2001 OPLAN REVISED	FY 2002 PRES BUDGET
	(Thousands of Dollars)		
Distribution of Program Amount by Installation			
Johnson Space Center (JSC)	106,822	124,215	120,888
Kennedy Space Center (KSC)	6,752	5,349	7,678
Marshall Space Flight Center (MSFC)	48,498	58,713	87,775
Ames Research Center (ARC)	32,767	49,875	48,344
Langley Research Center (LaRC)	52	35	269
Glenn Research Center (GRC)	39,397	36,917	49,883
Goddard Space Flight Center (GSFC)	11,757	4,317	2,087
Jet Propulsion Laboratory (JPL)	10,793	14,706	13,587
Headquarters (HQ)	17,862	18,783	30,410
Total	274,700	312,910	360,920

GENERAL

The Office of Biological and Physical Research (OBPR) was created at the beginning of FY 2001 to affirm NASA's commitment to the essential role biology will play in the 21st century, to establish the core of biological and physical sciences research needed to support Agency strategic objectives, and to ensure an effective management structure to optimize implementation of the Agency's scientific and technological goals in conjunction with internal NASA organizations and other external Agencies and organizations. OBPR assumes an independent role as NASA's fourth research organization and fifth strategic enterprise along with the offices of Space Science, Earth Science, Aerospace Technology, and Space Flight. OBPR was created by restructuring the Office of Life and Microgravity Sciences and Applications (OLMSA) under the premise that revolutionary solutions to science and technology problems are likely to emerge from scientists, clinicians, and engineers who are working at the frontiers of their respective disciplines and are also engaged in dynamic interdisciplinary interactions. OBPR will foster and enhance rigorous interdisciplinary research, closely linking fundamental biological and physical sciences in order to develop leading-edge, world-class research programs. OBPR is dedicated to using the unique characteristics of the space environment to understand biological, physical, and chemical processes, conducting science and technology research required to enable humans to safely and effectively live and work in space, and transferring knowledge and technologies for Earth benefits. OBPR also fosters commercial space research by the private sector towards new or improved products and/or services on Earth, in support of the Agency's mandate to encourage the commercial use of space. Information about OBPR may be accessed at its web site (http://spaceresearch.nasa.gov/). NASA plans to transition management of the ISS Research Budget to OBPR in a phased approach. Commencing in FY 2002, budget execution responsibility

will be transferred from the Office of Space Flight to OBPR. In FY 2003, budget formulation and budget execution responsibility will be transferred to OBPR.

PROGRAM GOALS

The Office of Biological and Physical Research asks questions that are basic to the future of humanity: (1) How do fundamental laws of nature shape the evolution of life?; and (2) How can human existence expand beyond the home planet to achieve maximum benefits from space? The Office pursues the answers to these questions by: (1) using the space environment as a laboratory to test the fundamental principles of physics, chemistry and biology; (2) conducting research to enable the safe and productive human habitation of space; and (3) enabling and promoting commercial research in space for the benefit of life on Earth.

OBPR plays a primary role in the pursuit of the following Agency goals and objectives as outlined in the NASA Strategic Plan:

Goal: Conduct research to enable safe and productive human habitation of space.

Objective- Conduct research to ensure the health, safety, and performance of humans living and working in space.

Objective- Conduct physical science research on planetary environments to ensure safe and effective missions of exploration.

Objective- Conduct research on biological and physical processes to enable future missions of exploration.

Goal: Use the space environment as a laboratory to test the fundamental principles of physics, chemistry, and biology.

Objective- Investigate chemical, biological, and physical processes in the space environment, in partnership with the scientific community.

Objective- Develop strategies to maximize scientific research output on the International Space Station (ISS) and other space research platforms.

Goal: Enable and promote commercial research in space.

Objective- Provide technical support for companies to begin space research.
Objective- Ensure that NASA policies facilitate industry involvement in commercial space research.

Objective- Systematically provide basic research knowledge to industry.

Objective- Foster commercial research endeavors with the International Space Station and other assets.

Goal: Use space research opportunities to improve academic achievement and the quality of life.

Objective- Advance the scientific, technological, and academic achievement of the Nation by sharing our knowledge, capabilities, and assets.
Objective- Engage and involve the public in research in space.

STRATEGY FOR ACHIEVING GOALS

OBPR pursues the goals described above through conducting activities in conjunction with four other major Federal Agencies (the National Institutes of Health; the National Science Foundation; the Department of Defense, including the Defense Advanced Research Projects Agency, the United States Air Force, the Office of Naval Research, and other DOD organizations; and the Department of Energy) through approximately 40 partner agreements. OBPR has recently initiated collaboration with the National Cancer Institute on revolutionary approaches to detecting and diagnosing in-vivo the onset of molecular anomalies related to disease or to space-flight-induced physiological degeneration, establishing the relevance of space-based endeavors to Earth-bound health issues. A joint solicitation for research in Fundamental Technologies for the Development of Biomolecular Sensors between NASA and the National Cancer Institute was released in FY 2001, with selections planned for FY 2002. These Biomolecular Physics and Chemistry projects will be managed at the Ames Research Center. In addition, OBPR manages 11 Commercial Space Centers across the country.

OBPR's major program areas, which focus on specific fields of research are:

Bioastronautics Research (BR) (includes AHST & BR&C)

- Set priorities for issues relating to flight crew health and medical technology, and drive priorities for fundamental and applied research to mitigate risk to crew health, safety, and performance.
- Sponsor research to develop therapeutics, procedures, techniques, and equipment needed to address flight medical, safety, and performance issues.
- Integrate science and medical research to generate the knowledge required to enable flight crews to leave low-Earth orbit, perform their assigned tasks, and return to Earth with their health intact.

Fundamental Space Biology (FSB)

- Use microgravity and the other characteristics of the space environment effectively to enhance our understanding of fundamental biological processes.
- Develop the foundation of fundamental biological knowledge required to enable a long-duration human presence in space.
- Develop the biological understanding to support other NASA activities related to biology.
- Apply this knowledge and technology to improve our Nation's competitiveness, education, and the quality of life on Earth.

Physical Sciences (PS)

- Carry out cutting-edge, peer-reviewed, and multi-disciplinary basic research as enabled by the space environment, to address NASA's goal of advancing and communicating knowledge.
- Develop a rigorous, cross-disciplinary scientific capability, bridging the physical sciences and biology to address NASA's human and robotic space exploration goals.

- Establish the ISS facilities as unique, on-orbit science laboratories addressing targeted scientific and technological issues of high significance.
- Enhance the knowledge base that contributes to Earth-based technological and industrial applications.

OBPR is an operational organization conducting the following functions:

Health Research (HR)

- Space Medicine Research (SMR)
  - Ensure the delivery of clinical care in support of human space flight.
  - Establish requirements for medical care and medical research to support human space flight.
- Occupational Health Research (OHR)
  - Contribute to the health, well-being, safety, and productivity of the NASA workforce.

NASA is in the process of realigning the HR function among the Office of the Chief Health and Medical Officer, the Office of Space Flight, and the Office of Biological and Physical Research. Some realignment of functions and the concomitant budget may occur by FY 2002.

Research Integration (RI) (includes SPD & MI}

- Manage the Commercial Space Centers (CSCs) to foster a robust commercial space research program in diverse fields of biotechnology, materials research, and agriculture.
- Integrate OBPR flight facilities, resources, and operations requirements.
- Integrate flight instruments with platform provider, plan payload manifests, and represent OBPR to the offices of Space Flight, Space Science, and Earth Science.
- Interface with potential non-governmental organization to manage ISS.
- Integrate research missions involving human space flight.
- Integrate ISS increment research missions.

OBPR's program of research and technology development relies upon broad participation by researchers from academia, other government agencies and departments, nonprofit entities, and commercial organizations. In selecting investigations and projects for support, and ultimately for access to space, OBPR follows different, but closely related processes for scientific research, commercial research, and technology research and development.

Non-commercial research is conducted through an open, competitive, peer-reviewed research solicitation process including the regular release of NASA Research Announcements (NRAs) in specific disciplines and reviews of proposals by independent panels of experts. Commercial research initiatives are evaluated against established selection criteria, including leveraged commitment from the private sector, clear product development goals, technical feasibility, and a market assessment.

OBPR supports ground-based research to develop and refine concepts for space experiments and to create a framework of knowledge and expertise in which the full scientific value of the research can be realized. It utilizes the Nation's academic and industrial resources, joining prominent researchers with NASA expertise in multidisciplinary microgravity experimentation. In support of the research community, the program also finances unique gravitational simulation facilities, such as centrifuges, parabolic aircraft, drop towers/tubes, and other specialized support facilities and technologies, such as chambers, bed rest studies, and data archiving.

BASIS OF FY 2002 FUNDING REQUIREMENT

BIOASTRONAUTICS RESEARCH - ADVANCED HUMAN SUPPORT TECHNOLOGY

	FY 2000	FY 2001	FY 2002
	(Thousands of Dollars)		
Advanced Human Support Technology (AHST)	30,094	30,832	31,100

GOALS

The goals of AHST are: (1) to demonstrate and validate fully self-sufficient technologies for air and water regeneration, food production, and waste recycling for long-duration space missions; (2) to demonstrate and validate integrated, fully autonomous environmental monitoring and control systems; and (3) to validate human factors engineering technology and protocols to ensure maintenance of high ground and flight crew skills during long-duration missions. AHST also makes NASA technologies available to the private sector for Earth applications.

STRATEGY FOR ACHIEVING GOALS

AHST includes Advanced Life Support (ALS), Space Human Factors Engineering (SHFE), and Advanced Environmental Monitoring and Control (AEMC). ALS develops advanced regenerative life support technologies and systems by combining biological, physical, and chemical processes capable of producing and recycling the food, air, and water needed to enable long-term human missions in space in a safe and reliable manner while minimizing the need for resupply. SHFE develops technologies that integrate the human and system elements of space flight, and encourages mission planners to use human factors research results and technology developments to improve mission results and crew safety. AEMC develops advanced control technologies, chemical and biological sensors for air and water monitoring and microbial detection, and also refines and micro-miniaturizes currently available sensors.

Center Support

JSC is the Lead Center for implementing AHST. JSC coordinates all Performing Center activities, manages ALS facilities, and conducts all system-level integration and testing for ALS. KSC manages extramural research and conducts specific research tasks directed at using plants in ALS systems. ARC manages extramural research and conducts specific research tasks directed at analytical models and physicochemical processes for ALS systems. JPL is the lead for the AEMC activities, bringing its personnel and industry contacts to the development of sensors and monitoring and control capability.

ACCOMPLISHMENTS AND PLANS

FY 2000 Accomplishments

Environmental Systems Commercial Space Technology Center: A new Commercial Space Center in the field of Environmental Systems with an emphasis on waste management was awarded to the University of Florida. The Center will perform technology development to advance the area of solid, liquid, and gaseous waste management. The research and technology findings will lead to benefits for NASA's human space flight program, as well as improving waste management practices on Earth.

Life Support Test Bed Development: OBPR (as OLMSA) completed the utilities outfitting for the first phase of the BIO-Plex test bed. BIO-Plex is intended to provide the capability to conduct a series of long-duration, human-in-the-loop, advanced integrated life support technology tests, as well as conduct biomedical, space medicine, and human factors research. BIO-Plex power, external ventilation, emergency monitoring systems, fire detection and suppression systems, and flooring were installed. The ALS and SHFE projects completed the Preliminary Design Review (PDR) for the BIO-Plex Human Accommodations System. Systems analysis of candidate technologies for the first BIO-Plex test was initiated, but due to budget shortfalls in the International Space Station program, activities at the BIO-Plex have been suspended

Miniaturized Quadruple Mass Spectrometer Analyzer for EVA: Development of the mini-mass spectrometer continued at JSC in preparation for space flight in early 2001. The mini-mass spectrometer is capable of detecting minute leaks of ammonia, hydrazine, nitrogen, and oxygen during EVA operation.

"Garden Machine Project" at Texas Tech University (TTU): The "Garden Machine" is a small, environmentally controlled and monitored plant growth chamber, developed by NASA ARC and on loan to TTU by NASA JSC. Progress has been made on performing engineering modifications and upgrades to the chamber for growing salad crops, and plant research is ongoing in anticipation of utilizing the chamber. TTU has also made progress on water recovery research, including the definition of a water recovery field demonstration unit for deployment in Texas colonias.

Future Plans

In FY 2001, AHST will initiate a six-month Advanced Water Recovery System demonstration and continue to demonstrate key technology capabilities for human support, such as advanced techniques for water processing using microbes, a no-expendable trace gas contaminant control system, biomass production, food processing, and solid waste processing. An engineering breadboard/prototype of a Vapor Phase Catalytic Ammonia Removal water recovery subsystem will be developed for integrated evaluation at JSC.

In FY 2002, comprehensive project plan documents for future technology solicitations will be developed for food processing, systems engineering, and advanced controls. External input and guidance in the development of these documents will be solicited from experts around the country via a series of workshops.

A flight test of the Immobilized Microbe Microgravity Water Processing System will be conducted. AHST will continue to demonstrate key technology capabilities for human support, such as advanced techniques for water processing, solid waste processing, air revitalization, biomass production, food processing, and thermal control. NASA JSC and the National Space Biomedical Research Institute (NSBRI) will collaborate in a review of NASA-STD-3000, Man-Systems Integration Standards. NASA-STD-3000 is the Agency-wide document that serves as the basis for human interface requirements for major activities, such as International Space Station.

AHST also will continue to solicit the participation of the university community through the re-competition of an expanded new NASA Specialized Center of Research and Training (NSCORT) in the area of Advanced Life Support.

The AHST NRA will focus on the development of ALS technologies for all aspects of solid waste processing, with special emphasis on storage and water recovery. This will augment the ISS waste stabilization efforts. Additionally, efforts will also be directed toward the development of nutrient delivery systems for plants in a microgravity environment. Work in the AEMC area will continue in the area of high-risk pilot studies for sensors to monitor the environment. All the efforts in the NRA are directed toward development of technologies that will have applications for space research, as well as improving the state-of-the art for current Earth-based processes.

BASIS OF FY 2002 FUNDING REQUIREMENT

BIOASTRONAUTICS RESEARCH - BIOMEDICAL RESEARCH AND COUNTERMEASURES

	FY 2000	FY 2001	FY 2002
		(Thousands of Dollars)	
Biomedical Research and Countermeasures (BR&C)	57,167	70,206	66,792
Construction of Facilities	[9,000]	[8,581]	[9,800]
Minority University Research and Education Program	[1,000]	[1,000]*	

* MUREP funds were transferred to Academic Programs beginning in FY 2002.

GOALS

The goals of BR&C are to conduct research in space biomedicine that: (1) defines the strategies and develops the tools to reduce the risk to crew health from space radiation; (2) defines strategies and tools to reduce risk of acute and chronic health problems, including psychological and behavioral issues; (3) will provide tools to increase crew productivity in flight, and ensure complete crew rehabilitation for a full, healthy life on Earth; and (4) transfer biomedical knowledge and technology gained through research on the ground and in space to the Earth-based medical community.

STRATEGY FOR ACHIEVING GOALS

BR&C includes research on physiology, behavior and performance, biomedical countermeasures, operational and clinical problems, environmental health, and radiation health. BR&C seeks to characterize and determine the mechanisms of physiological change in weightlessness, including those that threaten to limit the duration of human space missions. It also develops methods that allow humans to live and work in microgravity, optimize crew safety, well-being and performance, and minimize the deleterious effects of returning to Earth's gravity after space flight. BR&C: 1) provides scientific knowledge required to specify, measure, and control spacecraft environments;
2) develops standards and countermeasures, where necessary, to optimize crew health, safety, and productivity; (3) develops monitoring techniques, procedures, and standards for extended missions; and (4) establishes the scientific basis for protecting humans engaged in the development and exploration of space from radiation hazards.

Center Support

JSC is the Lead Center for implementing BR&C work. ARC and KSC conduct Performing Center activities. JSC also manages the significant ground-based grant activities and all flight experiment activities focused on human research. ARC supports biomedical research investigations, and plays the primary life sciences role in the development of biomedical flight experiments requiring non-human subjects. KSC provides pre- and post-flight support for BR&C flight experiments. The countermeasure-focused research is

managed by a cooperative agreement between NASA JSC and Baylor College of Medicine. This cooperative agreement governs the National Space Biomedical Research Institute (NSBRI), a 12-university consortium managed by Baylor College of Medicine and JSC, in developing countermeasures. The NSBRI provides a direct link to many of the Nation's top biomedical research universities.

ACCOMPLISHMENTS AND PLANS

During FY 2000, preparations continued for STS-107, OBPR's next major Space Shuttle flight opportunity, which will be dedicated to health and safety research; 13 biomedical experiments are manifested on STS-107. The experiments will focus on bacterial virulence in space, fungal growth, immune dysfunction, viral reinfection, sleep-wake activity monitoring, muscle atrophy, nutrition, balance, bone metabolism, and renal stone risk. An agreement to conduct radiation-induced genomic instability research was signed with the National Cancer Institute. Construction of the Booster Applications Facility (BAF) at Brookhaven National Laboratory (BNL) continued. In cooperation with Loma Linda University and Brookhaven National Laboratory (BNL), OBPR research used the Loma Linda Proton Beam Facility and BNL Heavy ion accelerators to simulate space radiation for radiation health research experiments. Shielding properties of one U.S. and one Russian Extravehicular Activity (EVA) suit (NASA's Extravehicular Mobility Unit [EMU] and RSA's Orlan, respectively) were measured with proton and electron beams, and the analysis of the experimental data is underway. Approximately 55 scientists from 16 U.S. institutions and one supported by the Italian Space Agency used iron and silicon beams at BNL to perform 19 experiments involving the exposure of more than 1,300 biological samples using 165 hours of beam time. Research studying the interaction of high-energy charged particles with matter showed that hydrogen-rich materials, such as polyethylene, have superior shielding properties. This research is currently being used to improve radiation protection on board the ISS. NASA continues to participate in international efforts, including research at the Heavy Ion Medical Accelerator (HIMAC) facility of the National Institute of Radiological Sciences (NIRS) in Chiba, Japan. NASA also participates in the development of consensus recommendations to the Multilateral Medical Operation Panel for radiation protection on the ISS, and international workshops jointly sponsored with the Japanese and Italian space agencies, as well as with NIRS.

An integrated Critical Path Research Plan was baselined and placed on a website on the Internet for community comment (http://criticalpath.jsc.nasa.gov). It outlines a biomedical risk-based mitigation strategy for defining research requirements and selecting research to support future successful long-duration human space flights. This plan will be used as a guide for selection of peer-reviewed research based on program relevance.

FY 2001 plans include continued logistics planning for the initial research on the ISS. The Crew Health Care System (CHeCS) and the first rack of the Human Research Facility (HRF) will be deployed to the International Space Station, and OBPR will begin initial operations of these facilities. Following the FY 2001 budget increase in Bioastronautics, a significant portion of which went to the National Space Biomedical Research Institute (NSBRI) to strengthen countermeasure development and improve the safety and performance of flight crews, the NASA Chief Scientist had a distinguished external panel review the NSBRI. The panel recommended continued funding of the NSBRI; however, they also had recommendations for improvement, which will be reviewed by NASA and the NSBRI.

BR&C continues funding for the BAF construction at Brookhaven National Laboratory from within the baseline BR&C program budget. The BAF will provide the capability to simulate all major ion components and energies of galactic cosmic rays and solar

proton events. Once the BAF becomes operational, Brookhaven National Laboratory will provide NASA access to more than 600 beam-hours–per year in order to meet the goals of the NASA Strategic Radiation Health Plan.

BR&C will continue to expand research operations on the ISS. OBPR is preparing a wide range of experiments for flight on the International Space Station in FY 2001, and is developing an expanded research program to take full advantage of growing ISS capabilities in the future. Over the next three years, 11 research projects are planned for Station increments 2 through 10. Facilities for human research and the Microgravity Science Glove Box will be available to support this research as part of the continuing deployment of the ISS.

FY 2002 includes planning for a possible Shuttle research flight beyond STS-107; this R2 mission is currently under review. Crew health and safety, as well as public health and outreach will be the BR&C highlights for this mission. Six experiments are proposed, focusing on balance, microbial growth, bone metabolism, renal stone risk, growing food, and producing safe drinking water. Also, the BAF construction progresses toward completion in FY 2003, with plans for the beginning of operational research.

MUREP transferred to Code F in FY 2002 to consolidate Agency educational activities and provide renewed focus for educational priorities.

BASIS OF FY 2002 FUNDING REQUIREMENT

FUNDAMENTAL SPACE BIOLOGY

	FY 2000	FY 2001	FY 2002
	(Thousands of Dollars)		
Fundamental Space Biology (FSB) (Formerly Fundamental Biology (FB))	38,180	40,610	39,200

GOALS

The goals of FSB are to: (1) effectively use microgravity and the other characteristics of the space environment to enhance our understanding of fundamental biological processes; (2) develop the foundation of fundamental biological knowledge required to enable a long-duration human presence in space, and to provide the biological understanding to support other biologically-related NASA activities; and (3) transfer biological knowledge and technology gained through research on the ground and in space to the medical and scientific communities.

STRATEGY FOR ACHIEVING GOALS

Investments in FSB will improve understanding of the role of gravity in biological processes and provide new knowledge about biological systems on Earth. This will be accomplished by using a variety of gravitational environments as research tools and by determining the combined effects of gravity and other space environmental factors on biological systems. The emphasis is on research in cell and molecular biology, evolutionary and developmental biology, and organismal and comparative biology. This research includes plants, animals, or other organisms as subjects, as well as cell or tissue cultures. The disciplines supported are Physical Interactions, Cellular and Molecular Biology, Evolutionary Biology, Developmental Biology, Organismal and Comparative Biology, Global Monitoring and Disease Prediction, Gravitational Ecology, as well as outreach activities.

Center Support

ARC is the Lead Center for implementing FSB, with other Performing Centers used to administer tasks or for their unique expertise. KSC provides pre- and post-flight support for FSB flight experiments.

ACCOMPLISHMENTS AND PLANS

During FY 2000, FSB funded 17 new investigations, for a funding rate of approximately 13%, and released an NRA for ground-based research proposals to be funded in FY 2001. FSB flight experiments provided information on the effects of exposure to microgravity

on the development of the nervous system in *Drosophila* (a type of fly) and on gene expression in cultured cells. Workshops were held in the area of developmental biology to assist in the planning of future research efforts for both flight and ground studies. Planning for the collection of normative data on targeted model organisms to assist future ISS research was begun.

During FY 2001, the transition of Fundamental Biology in the former Life Sciences Division to the Fundamental Space Biology Division will be completed. Strategic planning for the new Division will be carried out in conjunction with the Lead Center Program Office. A wider range of investigations in Fundamental Space Biology will be supported. FSB will solicit flight research as part of the International Space Life Sciences Strategic Working Group (ISLSSWG) flight solicitation and will release its annual solicitation for ground research. Collaborative efforts with the Astrobiology Program will be planned, including funding of research at the Astrobiology Institute. Increased integration and coordination of the FSB with other components within OBPR, including biomedical and biotechnology research, will be implemented.

During FY 2002, FSB will increase fundamental knowledge in the biological sciences and address critical questions in crew health and safety by conducting flight investigations on the STS-107 Space Shuttle mission and ISS. These include investigations of: the effects of gravity on plant growth and physiology, the effect of the space environment on bacterial virulence, the effect of microgravity on skeletal myofibers, avian development in space, the effects of microgravity on bone as a function of age, changes in gene expression in bacteria in space, and the effects of gravity on plant photosynthesis and respiration. The programmatic capability of FSB will be enhanced, including the study of genomics and other cellular mechanisms, through both ground-based and space flight experiments. Research Announcements for ground-based and flight research will be released.

BASIS OF FY 2002 FUNDING REQUIREMENT

PHYSICAL SCIENCES RESEARCH – MICROGRAVITY RESEARCH

	FY 2000	FY 2001	FY 2002
	(Thousands of Dollars)		
Physical Sciences Research (PSR) (Formerly Microgravity Research (MR))	108,475	130,659	130,087

GOALS

The goals of PSR are to: (1) carry out cutting-edge, and multi- and cross-disciplinary basic research enabled by the space environment to address NASA's goal of advancing and communicating knowledge; (2) develop a rigorous cross-disciplinary scientific capability, bridging the physical sciences and biology to address NASA's human and robotic space exploration goals; (3) establish the International Space Station facilities as unique on-orbit science laboratories addressing targeted scientific and technological issues of high significance; and (4) enhance the knowledge base, benefiting Earth-based technological and industrial applications.

STRATEGY FOR ACHIEVING GOALS

PSR strategy for achieving the goals includes sustaining leading-edge research focused in three areas: (1) Fundamental Microgravity Research (which includes combustion science, fluid physics, fundamental physics, materials science, and exploration research); (2) Biotechnology and Earth-based applications (which encompasses cellular biotechnology, macromolecular biotechnology, and earth-based applications); and (3) Biomolecular Physics and Chemistry. PSR will continue to effectively engage the national research community, fostering a synergistic and creative interdisciplinary community, which provides value to NASA for achieving its strategic goals. PSR's research community will promote the exchange of scientific knowledge and technological advances among academic, governmental, and industrial communities, and disseminate the results to the general public and educational institutions. PSR will enable this research through the development of an appropriate infrastructure of ground-based facilities, diagnostic capabilities, and flight facilities and opportunities. Additionally, PSR will raise the awareness in the Physical Sciences Research community (formerly microgravity research) regarding the long-term direction of the recently established OBPR, and discuss with the community the role of Physical Sciences Research in support of Agency objectives.

Center Support

MSFC is the Lead Center for PSR's Fundamental Microgravity Research, Biotechnology and Earth-Based Applications. During FY 2002, plans are to designate the Ames Research Center (ARC) as the Lead Center for PSR's area of Biomolecular Physics and Chemistry. The process of delegating management of specific science disciplines and associated hardware development to ARC,

GRC, JPL, JSC, and MSFC continues. All Centers provide pre- and post-flight support for PSR flight experiments. In addition, The National Center for Microgravity Research on Fluids and Combustion, under a joint cooperative agreement among the Universities Space Research Association, Case Western Reserve University, and NASA, leads a national effort to increase both the number and quality of researchers, and to accomplish integrated, critical-path research in microgravity fluids physics and combustion science.

ACCOMPLISHMENTS AND PLANS

During FY 2000, PSR enabled broad, productive ground-based and space-based research, which included the first long-duration experiment on the ISS. The Protein Crystal Growth-Enhanced Gaseous Nitrogen Dewar (PCG-EGN) was launched on STS-106 in September 2000 and returned to Earth on STS-92, launched in October 2000. Proteins were crystallized in this dewar (a thermally controlled container) during its stay aboard the ISS for analysis in laboratories on the ground upon return. This particular payload had support from both middle and high schools in four states (Alabama, California, Florida, and Tennessee). The Principal Investigator worked with numerous middle and high school science teachers and students to train them in aspects of structural biology and protein crystallization, allowing the students to prepare protein samples that ultimately flew aboard the payload. Upon return of the samples on STS-92 to the schools, analysis was begun. Different protein samples flew on the dewar on STS-98 (February 2001) and are planned for flight on STS-102 (March 2001). This experiment went from identification of flight opportunity, through the analytical integration process, to flight in eight months. While the number of future experiments will preclude a compressed schedule for all payloads, this shortened integration process addresses a long-standing concern, demonstrating that NASA is capable of integration and flying experiments on short notice.

Three investigations using suborbital rockets were targeted for FY 2000, and two of these were completed. The third suborbital rocket investigation was deferred until mid-FY 2001 due to technical delays in preparation of both the sounding rocket and the payload. The two completed investigations were the Subcooled Pool Boiling Heat Transfer Mechanisms In Microgravity, launched in the first quarter of FY 2000, and the Extensional Rheology Experiment (ERE), launched during the fourth quarter of FY 2000. The Subcooled Pool Boiling Heat Transfer Mechanisms in Microgravity project was successfully conducted, and the final report was completed during the fourth quarter of FY 2000. While the second flight was also completed, the ERE project had significant hardware failures, resulting in the minimum science requirements not being met. However, the project is continuing to analyze the limited science data received and the engineering data received to understand the hardware performance and nature of the failures. The Spread Across Liquids (SAL-6) experiment, deferred from FY 2000, is projected for a suborbital rocket in second quarter, FY 2001. No additional sounding rocket flights are scheduled beyond this flight, as the resources used for sounding rocket research will be more effectively employed in funding microgravity research aboard the Space Station.

Using the Protein Crystallization Apparatus for Microgravity (PCAM) research results from the Microgravity Space Lab (MSL)/Microgravity Space Lab-Reflight (MSL-R) Spacelab missions continued to produce exciting results during FY 2000. Protein and enzyme crystals of exceptional quality were grown; this will help answer questions related to the nervous system and DNA processes.

The Coarsening in Solid-Liquid Mixture Investigation also continued evaluation of the MSL-1/MSL-1R flight data, which reinforced theories extending the “zero-volume fraction” theory of coarsening to the finite volume cases. These new data and theories are of great interest to manufacturers and users of high temperature materials; use of the older formulae leads to erroneous results. Convection had previously been believed to be insignificant during crystal growth of ZnSe and related ternary compound semiconductors during the use of low-vapor-pressure Physical Vapor Transport techniques. Theoretical modeling, backed up by experimental results, has proven this premise to be incorrect. The work has been published in the "Journal of Crystal Growth."

Spacecraft Fire Safety data were verified through cooperative US/Russian MIR experiments. The flammability of selected U.S.-supplied plastic materials was tested under microgravity conditions in a Russian-supplied combustion tunnel operated on the Mir space station. The data were compared to reference testing of the flammability, heat release, thermal properties, and combustion products of identical materials in ground laboratories at both the Russian Keldysh Research Center and the NASA JSC White Sands Test Facility. This cooperative research investigation was concluded during the second quarter of FY 2000 with the publication of a final report.

Exciting fundamental research results were obtained from fluid physics experiments conducted on MIR. In the experiment "Growth and Morphology of Supercritical Fluids," led by a U.S./French team of scientists, it was observed that in a fluid consisting of liquid and gas phases on the verge of a transition, the gas temperature can exceed that of its surrounding heat source, a condition known as local overheating. This counterintuitive effect was predicted theoretically a decade ago, and it demonstrates the complex nature of heat transfer in fluids. It is a significant milestone in our understanding of phenomena such as the boiling of fluids and heat transfer in gas-liquid systems.

A book on microgravity combustion research tentatively titled Fire in Free Fall was requested by, and recently submitted to, Academic Press, a subsidiary of Harcourt Brace, as an introduction to the progress made in understanding combustion in a microgravity environment. This over-400-page book was written after ten to fifteen years of research using drop towers, aircraft, and occasionally spacecraft.

Combustion synthesis, or self-propagating high temperature synthesis, has been investigated as a means of synthesizing a wide range of advanced materials, such as ceramics, intermetallics, metal matrix, and ceramic matrix composites. Recent ground-based results show that these advanced materials can be easily formed, and their porosity can be controlled in the range of what is required for bone replacement.

Activities within Cellular Biology continued during FY 2000, with the signing of the agreement for the first major private investor in space research. Fisk Ventures will use the NASA bioreactor as the basis for research and commercial development on the ground as well as in space. Other significant activities included the signing of an agreement with Wiley and Sons Publishing for a textbook on Basic and Applied Space Cell Biology, and securing a dedicated issue of the journal “In Vitro Biology” for NASA-sponsored research in a cell-based system using the Bioreactor in the near future.

For the first time, in-situ coarsening has been observed in an experiment entitled "Evolution of Local Microstructures." Studies of liquid-liquid coarsening on slides have shown for the first time the evolutionary nature of the process. Areas were observed over

periods of months, and the growth kinetics of 3-D “particles” in a 2-D matrix was monitored in real-time. These results are very important in the context of strengthening mechanisms in high temperature materials.

Results from ground-based research in Colloidal Stability in Complex Fluids were highlighted on the cover of the October 2000 "Journal of the American Ceramic Society." Nano particles of ceramics interspersed within particles of silica have been shown to modify considerably the properties of the resultant fluid. This work has important applications for advanced ceramics manufacture. In the study of colloidal suspensions, it was reported that 3-D ordered colloid systems with structures comparable to the wavelength of visible light might find important applications as photonic crystals, optical switches and filters, and chemical sensors. Research development in the Fundamental Physics discipline revealed a significant cooperative achievement with the Commerce Department’s National Institute of Standards and Technology (NIST). Science team members of the Primary Atomic Reference Clock in Space (PARCS) research project developed a laser-cooled fountain clock in collaboration with NIST, and placed into operation a new atomic clock that will neither gain nor lose a second in nearly 20 million years. Termed NIST-1, the new cesium atomic clock at NIST’s Boulder, Colorado laboratories began its role as the Nation’s primary frequency standard by contributing to an international pool of the world’s atomic clocks that are used to define Coordinated Universal Time (known as UTC), the official world time.

Technology development in the area of Atomic Physics has led to a technique to amplify a beam of atoms. The process for performing and detecting the amplification involves the use of a Bose-Einstein Condensate (BEC) cloud and light pulses. In the sequence of light pulses, the third light pulse demonstrates that the atoms in the matter wave were increased, or amplified. The atom amplification process is one study to help improve the accuracy of atomic instruments that are used in ground, air, and space navigation.

Work on Advanced Concepts for Radiation Shielding continued. Two workshops with invited prominent scientists were held to study the requirements for materials for protecting crewmembers during long duration space flight. The first workshop concentrated on reviewing existing transport codes and establishing their accuracy. The ultimate objective is to provide engineering teams with comprehensive transport property values for engineering materials. The second workshop examined revolutionary concepts for radiation shielding. This included an evaluation of many varied shielding concepts, ranging from using electromagnetic and electrostatic fields to using extraterrestrial resources, such as comets, asteroids, orbital debris, to employing novel materials, including hydrides, hydrogen-stuffed carbon nanotubes, or solid or liquid hydrogen.

The mission integration functions for the Alpha Magnetic Spectrometer (AMS) experiments are provided as part of NASA's efforts in Fundamental Physics. This investigation is a collaboration of NASA and the Department of Energy (DOE) and represents an international effort led by Nobel laureate Professor S. Ting to perform accurate and long-duration measurements of energetic cosmic rays spectra in search of dark matter and antimatter, utilizing the International Space Station.

In FY 2001, the Physical Sciences Research program will continue preparation of upcoming ISS flight research (with seven potential flight opportunities), perform focused research activities on the STS-107 Research Mission, conduct the FY 2000 postponed investigation using a suborbital rocket, and conduct planning for the R2 mission. PSR plans to deliver about twenty payloads in FY 2001. The payloads will support research investigations in the areas of biotechnology (macromolecular and cell science), materials science, fluid physics, and acceleration measurement. Research proposals for the development of low-gravity technology required to

advance human exploration of the solar system will be selected in mid-FY 2001. New research projects will be selected in Combustion Science and Fundamental Physics. In June 2001, a workshop on "Research Needs in Fire Safety for HEDS" will be held at the NASA Glenn Research Center, and will deal with material flammability and testing, fire detection, fire suppression, and environmental control and life support. It is expected that 50-60 leading fire researchers from around the country will participate.

In FY 2002, PSR will continue development and preparation for upcoming ISS flight research and perform focused research activities on the R2 mission. Six flights will deploy research aboard the ISS. PSR will deliver 24 payloads in FY 2002. Early ISS utilization will expand, with science investigations being conducted with the Microgravity Science Glovebox and EXPRESS Rack. An increasing number of investigations will conduct final engineering readiness reviews in preparation for experiment deployment to the ISS science research facilities. New research projects will be selected in Biotechnology, Fluid Physics, and Materials Science. The physical sciences research program has reassessed the need for the creation of National Centers for Materials Science and for Fundamental Physics. In view of the input from the scientific community (through the advisory committees), and because of the scientific realignment of OBPR, the decision has been made to forego the creation of National Centers in those specific disciplines. Instead, the plan is to acquire a research institute in Bioengineering through a competitive procurement process. This will involve the direct collaboration between academic and NASA researchers to closely integrate research at the frontiers of the bio-physical sciences.

BASIS OF FY 2002 FUNDING REQUIREMENT

SPACE PRODUCT DEVELOPMENT

	FY 2000	FY 2001	FY 2002
	(Thousands of Dollars)		
Space Product Development (SPD)	14,400	13,683	14,508

GOALS

SPD: (1) facilitates the use of space for the development of commercial products and services (including appropriate supporting ground-based activities); (2) couples NASA and private sector technology development to the advantage of both; and (3) incubates commercial enterprises that use space on a profit-making basis. SPD also promotes the benefits of space-based research to industry, facilitates industry's access to space, provides space research expertise and flight hardware, and advocates the development of policies to encourage the commercial use of space.

STRATEGY FOR ACHIEVING GOALS

SPD supports the operation of the NASA Commercial Space Centers (CSC), along with the development of commercial flight research hardware for Space Shuttle, and ultimately ISS payload development. SPD provides ground-based and parabolic aircraft flight opportunities for initial commercial research efforts. As the sponsored commercial research evolves, SPD will provide support for flight hardware associated with Space Shuttle flight activity, and ultimately for payload development presently funded by the Space Station office and developed for commercial research on the International Space Station. The CSCs are partnerships of industry, universities, and local, state, and other federal agencies engaged in commercial space research. CSCs furnish an infrastructure that provides a cost-effective and efficient way for companies to conduct research in space. The CSCs initiate industry involvement in two ways: 1) by identifying and investigating industry-led research areas of commercial promise; and 2) by assessing markets for these potential research opportunities. The businesses support the research effort with cash and in-kind resources, such as technical expertise, research materials, personnel, ground facilities, and research hardware.

Center Support

SPD is managed by the Microgravity Research Program Office (MRPO) at the MSFC, and implemented primarily through the CSCs. Each CSC is a non-profit consortium of commercial and academic entities and some also have government agency participation. The CSCs follow business leads and commitments to pursue product-oriented research in three major disciplines: materials research and development, biotechnology, and agriculture. NASA's role in this partnership is to provide leadership and direction for the integrated program and to provide the flight opportunities that are essential to the success of these efforts.

ACCOMPLISHMENTS AND PLANS

In FY 2000, significant commercial research activity was conducted on Space Shuttle Mission STS-101. On this mission, two commercial research payloads were flown: Commercial Protein Crystal Growth (CPCG) and Astroculture™ Glovebox (ASC). These payloads grew large biological crystals in the microgravity environment and continued the investigation of why the absence of gravity permits an increase in the efficiency of genetically transforming plant seeds.

Substantial commercial research gains were achieved in FY 2000, including the following:

- BioServe Space Technologies reached a long-term agreement with Bristol-Myers Squibb to continue collaboration on a research project investigating ways for improving the efficiency of fermentation processes. Preliminary research conducted in prior Shuttle missions using microgravity has demonstrated up to a 200% increase in the fermentation process when compared to ground controls (STS-77). Very good results in increased antibiotic production were again attained on STS-95. BioServe and Bristol-Myers Squibb are continuing this investigation, and will fly further experiments to the ISS on STS-100, which is scheduled for spring 2001. This research could lead to methods for increasing the efficiency of antibiotic production here on Earth.

- Metal Oxide Technologies is commercializing a new technology for the use of High-Temperature Superconducting (HTS) wires using oxide thin films, developed by the Space Vacuum Epitaxy Center. This technology has been licensed, and a pilot plant for producing HTS wires for use in power line transformers is expected to be operational this year.

During FY 2000, SPD began preparations for conducting an external review of the Commercial Space Centers. This review will take place during FY 2001, and will be similar to previous reviews in that it will provide an external assessment as to how the individual CSCs are performing with respect to their mission of encouraging the commercial development of space. SPD also released the first of its annual reports highlighting CSC accomplishments. This annual report format is comparable to corporate annual reports.

Throughout FY 2001, SPD will continue its support for commercial research in biotechnology, agriculture, and materials processing. Six commercial payloads in the fields of materials research, protein crystal growth, agriculture, and fire safety will be flown on STS-107. The first four commercial research payloads, investigating antibiotic production, protein crystal growth, agricultural research, and materials research, will be flown on the International Space Station.

During FY 2002, SPD will be taking advantage of anticipated increased flight opportunities for commercial research. Sixteen payloads are manifested for the ISS, and another seven commercial payloads are scheduled to fly on the Space Shuttle. Planning will continue for additional flights as the ISS assembly progresses.

BASIS OF FY 2002 FUNDING REQUIREMENT

HEALTH RESEARCH

	FY 2000	FY 2001	FY 2002
	(Thousands of Dollars)		
Health Research (HR)	8,700	11,714	9,400
Occupational Health Research (OHR)	[1,400]	[1,066]	[1,200]
Space Medicine Research (SMR)	[7,300]	[10,648]	[8,200]

* - Commencing in FY 2000, the previously separate Occupational Health Research and Space Medicine Research functional activities were combined into one single budget structure entitled Health Research, administered through the OLMSA-based Office of Health Affairs (OHA). In FY 2001, a reorganization created the Health and Medical Office within the Office of the Administrator. This new office was created from the former OHA and given additional broad responsibility for oversight and advice on all aspects of health and medical care for the ground workforce and space crews in training and in flight, medical quality assurance, and protection of human research subjects and patients. Previous responsibilities for the conduct of research relating to astronauts during space flight, countermeasures development, the Astronaut Longitudinal Study and other space medicine areas are being negotiated for disposition and funding between the Office of Biological and Physical Research and the Office of Space Fight. Once the negotiations are completed on the organizational assignment of the former HR content, the HR budget will be realigned accordingly among the three organizations.

GOALS (OCCUPATIONAL HEALTH RESEARCH (OHR))

The goals of OHR include: (1) improve NASA's Occupational Health program effectiveness and efficiency through medical quality assurance and the development of an employee health longitudinal study as part of overall knowledge management; and (2) ensure NASA compliance with all Federal safety and health requirements.

STRATEGY FOR ACHIEVING GOALS

OHR provides for policy formulation and oversight of NASA-wide occupational and environmental health activities. This function consists of several well-defined constituent activities, including Occupational Medicine, Industrial Hygiene, Radiation Health, Physical Fitness, Employee Assistance Programs, Workers' Compensation, Nutrition and Food Safety, and Wellness and Health Education. Collectively, these constituent activities ensure the health, well-being, and productivity of the NASA work force. The Kennedy Space Center (KSC) is the Performing Center for the Agency Occupational Health Program (OHP).

ACCOMPLISHMENTS AND PLANS

During FY 2000, the OHP completed the development, and began the implementation, of a web-based supervisor training module (https://solar.msfc.nasa.gov:443/solar/delivery/public/html/newindex.htm) for the identification and reduction of work-related stress. Life Skills stress management training was made available to all Centers. The draft of a stress measurement tool for measuring the effectiveness of Employee Assistance Program (EAP) interventions was reviewed. A pilot study utilizing the National Depression Screening Project was completed. Study data were compared to the national data set with no significant anomalies, but the review led to the implementation of a new contract for the provision of after-hours EAP coverage to all NASA facilities. The OHP continued its series of professional education ViTS seminars, starting with a series on Emerging Infectious Diseases, followed by a series on Aging. The series was broadcast to the Medical Informatics and Technology Applications Consortium, Medical College of Virginia, the Institute of Biomedical Problems in Moscow, the European Institute of Telemedicine in Toulouse, France, other select academic institutions within the U.S., and to all NASA Centers. A new, comprehensive audit system tool was drafted for review and approval for deployment to 50% of the NASA locations annually. The office initiated the Solar Safe program for skin cancer screening, held a workshop with national dermatology experts, published proceedings, and developed Agency metrics on skin cancer prevention and early diagnosis. Two key NASA sites hosted reviews through the Joint Commission for the Accreditation of Hospitals-affiliated Joint Commission Resources for the assessment of accreditation readiness and NASA-specific recommendations.

During 2001 and FY 2002, the OHP will continue emphasizing quality assurance for its occupational health program through the implementation of a formalized, medical quality assurance program inclusive of credentialing and privileging. OHP will continue its support of certification efforts for safety and health programs under the Occupational Safety and Health Administration Voluntary Protection Program, and will continue its professional education series with the conclusion of the Aging series and initiation of a new series, "Occupational and Environmental Health Primer and Issues." OHP will continue to support the new Health Council, formed in conjunction with the establishment of the Administrator's Health and Medical Office. The Performing Center will host an Agency-wide Occupational Health Conference on risk assessment and management. Emphasis will continue to be placed on teaming with other Federal agencies for the delivery of services in a cost-effective manner. Wherever subject matter expertise can be obtained through interagency agreements, those agreements will be effected.

GOALS (SPACE MEDICINE RESEARCH (SMR))

The goals of SMR are to: (1) ensure the health, safety, and performance of space flight crew members, in training and in flight, for all U.S. Space Shuttle, ISS, and exploration missions; and (2) oversee the establishment of requirements for clinical care and medical research and ensure the protection of human research subjects and patients.

STRATEGY FOR ACHIEVING GOALS

Within SMR, there are five primary elements: (1) mission support for the Space Shuttle and ISS Program; (2) astronaut health care; (3) epidemiology (longitudinal studies of astronaut health); (4) Crew Health Monitoring and Risk Mitigation (CHMRM); and (5) Clinical Care Capability Development Program (CCCDP). SMR functions include responsibility for oversight and approval of policies

and requirements developed to maintain and provide medical support to optimize the health, safety, and productivity of our astronauts in space. This also includes technology and application developments. SMR funding provides for guidance and oversight of the medical operational support for human space flight and astronaut health care. SMR's scope ranges from the development of astronaut health policies, standards, and requirements for medical operations and medical research, as well as oversight of the implementation of these requirements, through operational medical support for all human space flight programs.

Center Support

JSC is the Lead Center for SMR. JSC manages clinical medical and psychological support for the astronauts as well as telemedicine efforts in support of medical operations activities for the Human Space Flight (HSF) Program. The major participating academic institutions are Wright State University School of Medicine, Medical College of Virginia at the Virginia Commonwealth University, and the University of Texas Medical Branch at Galveston.

ACCOMPLISHMENTS AND PLANS

During FY 2000, SMR continued its support of the needs of the space medicine community for Space Shuttle missions including operational medical support for the ISS. CHMRM funding assisted in the development, monitoring, and interpretation of operational health-related data from space flight including: support of the implementation and interpretation of Medical Requirements (MRs) for Shuttle and ISS, and IPT support of rapid responses to clinical studies relative to space medicine issues. ISS CHeCS components were deployed early in the ISS assembly sequence to provide on-orbit medical, environmental, and countermeasure capabilities for all ISS crewmembers. CCCDP funding supported the ongoing evolution of space medicine requirements, procedures, and technologies. Plans were developed to augment ISS CHeCS with new and emerging medical and environmental technologies, many of which began development at the NSBRI. Epidemiological efforts continued to evaluate the growing body of astronaut health data to better define the medical risks associated with space flight. Special emphasis was placed on clinical medical research, radiation research, and psychological/human factors.

During the second quarter of FY 2001, SMR's tasks and concomitant funding were proposed for realignment among the Health and Medical Office, the Office of Space Flight, and the Office of Physical and Biological Research to continue supporting the needs of the operational medicine community for Shuttle and ISS missions. Those negotiations are underway, and there will be no impact to the delivery of SMR products and services during the fiscal year.

During FY 2002, SMR's changed mission, as represented within the Health and Medical Office, will be one primarily of oversight, policy review and approval, advice, special studies, permanent medical waiver authority, and assurance of professional education and competency. Funding is designated for continued support of the Wright State Residency Program and the Space Medicine Fellowship, University of Texas Medical Branch at Galveston, and medical quality assurance efforts.

BASIS OF FY 2002 FUNDING REQUIREMENT

MISSION INTEGRATION

	FY 2000	FY 2001	FY 2002
	(Thousands of Dollars)		
Mission Integration (MI)	17,414	15,206	213
(University of Missouri Life Sciences Research Facility)	[12,814]	[14,967]	

GOALS

The goals of Mission Integration (MI) are: (1) provide physical, analytical, and operations integration support for Human Space Flight missions, to achieve NASA mission objectives for the science and technology communities; and (2) ensure integrated scientific, technological, and commercial user advocacy and coordination of requirements for the next generation of space laboratories, the ISS. These activities include the integration, coordination, and policy planning and analysis for international research activities within OBPR, as well as across the Agency, for ISS research.

STRATEGY FOR ACHIEVING GOALS

In order to meet the function goals and objectives, MI performs the space-based research utilization planning for all OBPR payloads flown on the Space Shuttle payloads, and planning across the Agency for science payloads flown on ISS. In addition, through this function, MI carries out systems engineering efforts to develop and evaluate strategies and processes for satisfying current and future research mission objectives. These tasks not only address the current human-based space flight platform mission integration processes, but support the development of new processes and tools for carrying out integrated research advocacy, requirements coordination, mission planning, and operations for future space platforms. In particular, the program is investigating ways to apply the engineering and operations lessons learned in the Spacelab program and the NASA/MIR Research Program (NMRP) to the ISS program to achieve greater efficiencies.

Center Support

Headquarters remains the Lead Center for planning and directing Mission Integration. JSC is the primary Center for providing the mission implementation function for Headquarters research mission activities.

ACCOMPLISHMENTS AND PLANS

During FY 2000, MI continued to support the second DOE-sponsored Alpha Magnetic Spectrometer (AMS) mission planned for the ISS, including the Preliminary Design Review (PDR) for integration on ISS and the initial safety reviews. In addition, MI continued to support Space Shuttle "pathfinder" research missions, such as STS-107, which will provide space access to the science and commercial programs until a continuing substantive research capability is available on the ISS.

Additionally, as directed by the Congress in the FY 2000 Appropriations Act, MI funded $12.814M towards the construction of a life sciences research facility at the University of Missouri, Columbia.

In FY 2001, MI transferred management oversight in support of the DOE-sponsored AMS mission, including the Critical Design Review (CDR) and the first NASA integration hardware deliveries to the DOE/AMS payload developer, to the Physical Sciences Research Division (formerly Microgravity Research). The first SpaceHab Research Double Module (RDM) will be flown on STS-107. In the interim, science research at the middeck locker equivalent (MLE) level will be flown on ISS assembly flights on a space-available basis. Plans for an additional research mission, STS 112-(R2), are being defined.

In addition, as directed by the Congress in the FY 2001 Appropriations Act, MI funded an additional $14.967M towards the construction of a life sciences research facility at the University of Missouri, Columbia.

In FY 2002, work will begin on definitizing the potential payload complement for the R2 mission.

BASIS OF FY 2002 FUNDING REQUIREMENT

INVESTMENTS

	FY 2000	FY 2001	FY 2002
	(Thousands of Dollars)		
Investments (MUREP)	[1,000]	[1,000]	[--]

The OBPR Strategic Enterprise investments in higher education institutions include Federally mandated outreach to the Nation's Historically Black Colleges and Universities (HBCUs) and Other Minority Universities (OMUs), including Hispanic-Serving Institutions and Tribal Colleges and Universities. This outreach is achieved through a comprehensive and complementary array of strategies developed in collaboration with the Office of Equal Opportunity Programs. These strategies are designed to create a broadbased, competitive aerospace research capability within Minority Institutions (MIs). This capability fosters new aerospace science and technology concepts by integrating OBPR Enterprise-related cutting-edge science and technology concepts, practices, and teaching strategies into MIs' academic, scientific, and technology infrastructures. As a result, the Agency is helping to increase the number of competitively trained U.S. students from groups currently underrepresented in NASA-related fields who, because of their research training and exposure to cutting-edge technologies, are better prepared to enter graduate programs or the workplace. Other initiatives are focused on enhancing diversity in the OBPR Strategic Enterprise's programs and activities. This includes exposing faculty and students from HBCUs and OMUs, and students from underserved schools with significant enrollments of minority students, to the Enterprise's research efforts and outcomes, educational programs, and activities. The Centers and JPL support the MUREP through the availability of their unique facilities, program management and grant administration, and commitment of their personnel to provide technical and program implementation assistance. Further detail as to how this funding is utilized is located under the MUREP portion of the budget.

BASIS OF FY 2002 FUNDING REQUIREMENT

BIOLOGICAL AND PHYSICAL RESEARCH INSTITUTIONAL SUPPORT

	FY 2000	FY 2001	FY 2002
		(Thousands of Dollars)	
Institutional Support to the Biological and Physical Research Enterprise	[65,518]	[65,859]	69,620
Research and Program Management	[60,934]	[59,543]	63,736
Personnel and Related Costs	[48,389]	[47,924]	49,678
Travel	[1,332]	[1,265]	1,298
Research Operations Support	[11,213]	[10,354]	12,760
Construction of Facilities	[4,584]	[6,316]	5,884
Full-Time Equivalent (FTE) Workyears	**[485]**	**[489]**	**484**

Note - FY 2000 and FY 2001 data in this section are for comparison purposes only. See *Mission Support* sections for more details.

PROGRAM GOALS

The two primary goals of this budget segment are to:

1. Acquire and maintain a civil service workforce that reflects the cultural diversity of the Nation, and is both sized and skilled consistently with accomplishing NASA's research, development, and operational missions with innovation, excellence, and efficiency for the Biological and Physical Research Enterprise.
2. Ensure that the facilities critical to achieving the goals of the Biological and Physical Research Enterprise are constructed and continue to function effectively, efficiently, and safely, and that NASA installations conform to requirements and initiatives for the protection of the environment and human health.

RESEARCH AND PROGRAM MANAGEMENT (R&PM): This program provides the salaries, other personnel and related costs, travel, and the necessary support for all administrative functions and other basic services in support of research and development activities at NASA installations. The salaries, benefits, and supporting costs of this workforce are covered in the Personnel budget, which comprises approximately 71**%** of the requested R&PM funding. Research and Operations Support, which covers administrative and other support, is approximately 27**%** of the request. The remaining 2**%** of the request is required to fund the travel necessary to manage NASA and its programs.

CONSTRUCTION OF FACILITIES (CoF): This budget line item provides funding for discrete projects required by components of NASA's basic infrastructure and institutional facilities; almost all CoF funding is used for capital repair. NASA facilities are critical for the support of research conducted by the Biological and Physical Research Enterprise. NASA has conducted a thorough review of its facilities infrastructure, and determined that, 1) the deteriorating plant condition warrants increased repair and renovation efforts in order to avoid safety hazards to personnel, facilities, and mission, and 2) some dilapidated facilities need to be replaced. Increased investment in facility revitalization is required to maintain an infrastructure that is safe and capable of supporting NASA's missions.

ROLES AND MISSIONS

The detail provided here is for the support of the Biological and Physical Research Enterprise institutions: Johnson Space Center (JSC), Kennedy Space Center (KSC), Marshall Space Flight Center (MSFC), Ames Research Center (ARC), Langley Research Center (LaRC), Glenn Research Center (GRC), Goddard Space Flight Center (GSFC), Jet Propulsion Laboratory (JPL), and NASA Headquarters.

JOHNSON SPACE CENTER (JSC)

The Biological and Physical Research Enterprise funds about 4% of JSC's institutional budget. JSC is the Lead Center for implementing Advanced Human Support Technology and Biomedical Research & Countermeasures work, as well as providing the mission implementation function for Headquarters research mission activities. JSC coordinates all Performing Center activities, manages Advanced Life Support facilities, and conducts all system-level integration and testing for these facilities. JSC also manages the significant ground-based grant activities and all flight experiment activities focused on human research. Countermeasures-focused research is managed by a cooperative agreement between JSC and Baylor College of Medicine. This agreement governs the National Space Biomedical Research Institute (NSBRI), a 12-university consortium managed by Baylor College of Medicine and JSC, in developing countermeasures. JSC manages clinical medical and psychological support for the astronauts as well as telemedicine efforts in support of medical operations activities for the Human Space Flight (HSF) Program. Finally, JSC is also a Performing Center for Fundamental Space Biology, Physical Sciences Research, Space Product Development, and Mission Integration.

KENNEDY SPACE CENTER (KSC)

The Biological and Physical Research Enterprise funds about 1% of KSC's institutional budget. Kennedy Space Center manages extramural research and conducts specific research tasks directed at using plants in advanced life support systems. KSC also provides pre- and post-flight support for Biomedical Research & Countermeasures and Fundamental Space Biology flight experiments. KSC is a Performing Center for Advanced Human Support Technology, Biomedical Research & Countermeasures, Fundamental Space Biology, and Health Research.

MARSHALL SPACE FLIGHT CENTER (MSFC)

The Biological and Physical Research Enterprise funds about 4% of MSFC's institutional budget. Marshall Space Flight Center is the Lead Center for Physical Sciences Research's Fundamental Microgravity Research, and Biotechnology and Earth-Based Applications. The Microgravity Research Program Office (MRPO) at Marshall also manages Space Product Development. Marshall is also a Performing Center for Advanced Human Support Technology, Biomedical Research & Countermeasures, Fundamental Space Biology, and Health Research.

AMES RESEARCH CENTER (ARC)

The Biological and Physical Research Enterprise funds about 5% of ARC's institutional budget. Ames Research Center is the Lead Center for implementing Fundamental Space Biology, and plans are to designate ARC as the Lead Center for Physical Sciences Research's Biomolecular Physics and Chemistry efforts in FY 2002. Ames supports biomedical research investigations, and plays the primary life sciences role in the development of biomedical flight experiments requiring non-human subjects. ARC manages extramural research and conducts specific research tasks directed at analytical models and physicochemical processes for advanced life support systems. Ames is also a Performing Center for Advanced Human Support Technology, Biomedical Research & Countermeasures, and Health Research.

LANGLEY RESEARCH CENTER (LaRC)

The Biological and Physical Research Enterprise does not fund LaRC's institutional budget, due to the limited amount of OBPR work done at the Center. Langley Research Center is a Performing Center for Physical Sciences Research.

GLENN RESEARCH CENTER (GRC)

The Biological and Physical Research Enterprise funds about 5% of GRC's institutional budget. Glenn Research Center is a Performing Center for Physical Sciences Research.

GODDARD SPACE FLIGHT CENTER (GSFC)

The Biological and Physical Research Enterprise does not fund GSFC's institutional budget; the grant-related work for GSFC is done at NASA Headquarters. Goddard Space Flight Center is a Performing Center for Advanced Human Support Technology, Physical Sciences Research, Space Product Development, and Health Research.

JET PROPULSION LABORATORY (JPL)

The Biological and Physical Research Enterprise funds about 8% of JPL's institutional budget. The Jet Propulsion Laboratory is the lead for Advanced Environmental Monitoring and Control activities, bringing its personnel and industry contacts to the development of sensors and monitoring and control capability. JPL is a Performing Center for Advanced Human Support Technology, Biomedical Research & Countermeasures, Physical Sciences Research, Health Research, and Mission Integration.

NASA HEADQUARTERS

The Biological and Physical Research Enterprise funds about 9% of NASA Headquarters' institutional budget. NASA Headquarters is the Lead Center for planning and directing Mission Integration. The Enterprise's Institutional Support figure includes an allocation for funding Headquarters activities based on the relative distribution of direct FTEs across the Agency. A more complete description can be found in the Mission Support/Two-Appropriation Budget section.