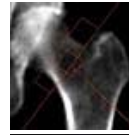


ENTERPRISE: Biological and Physical Research

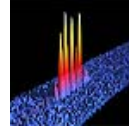


Peggy Whitson, the International Space Station's first Science Officer, inspects soybean plants in the Advanced Astroculture plant growth chamber. She dried these plants and beans, and the Space Shuttle Atlantis returned them to Earth. Researchers in NASA, academia, and industry are studying the first-ever soybean crop grown on the Station to understand how microgravity influences its growth and development, and whether such influence may yield unique and desirable traits.

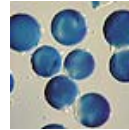
THEMES



**Biological Sciences
Research**



**Physical Sciences
Research**



**Research Partnerships
and Flight Support**

BIOLOGICAL AND PHYSICAL RESEARCH

PURPOSE

As humans take the first steps into space, we have a new opportunity to explore profound questions about the laws of nature. At the same time, we enter an environment unique in our evolutionary history that poses serious medical and environmental challenges. NASA's Biological and Physical Research (BPR) Enterprise addresses the opportunities and challenges of space flight through basic and applied research on the ground and in space. The program pursues answers to a broad set of scientific questions that support NASA's goals to explore the fundamental principles of physics, chemistry, and biology through research in space and to extend the duration and boundaries of human space flight to create new opportunities for scientific exploration and discovery. The outcomes of this research include fundamental scientific progress and safer, more efficient space travel. BPR implements its program through three budget themes described below.

In FY 2002, a task force of the NASA Advisory Council performed an independent review and assessment of research productivity and priorities for the entire scientific, technological, and commercial portfolio of BPR. The Council formed a Research Maximization and Prioritization Task Force (ReMaP) that recommended a series of priorities across research disciplines. This review was based upon past performance in these disciplines as presented by BPR and examination of a substantial body of existing reports from the National Research Council. NASA's FY 2004 budget for BPR focuses on research areas identified as high priority by the Research Maximization and Prioritization Task Force. It expands planned

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biomedical research and countermeasures experiments, including a new Human Research Initiative. It initiates a limited flight program in high priority advanced human support technology and places additional emphasis on physical science research, including applications to human space flight. It also reinstates funding for plant and animal habitats for planned centrifuge research on the International Space Station (ISS). As development of the ISS continues, BPR is expanding research activities and continuing to develop research equipment for the ISS. Development will be completed on facilities for materials science research and fluid physics research and on racks that will eventually house the habitats for plant and animal specimens for biological research.

Implementing ReMaP priorities in the FY 2004 budget is a crucial first step in a longer-term planning and prioritization process including 5-year, 10- year, and strategic planning. BPR has responded to NASA's new Strategic Plan by adopting a 5-year direction consistent with overall agency Vision, Mission, and goals. This direction identifies major research thrusts and the management changes required to support these thrusts. BPR has developed a 10-year research plan that addresses BPR's role within the NASA Strategic Plan by establishing a focused set of organizing questions and supporting top-level roadmaps that will drive BPR research. The 10-year plan has been drafted in consultation with outside advisors and will be subject to additional scientific review. Over the budget development cycle that begins in 2003, BPR will engage its scientific community in developing more detailed interdisciplinary roadmaps, which will be guided by the 10-year plan. These roadmaps will form the basis for a BPR plan that will serve as the guiding document for future research solicitation, selection, and implementation in support of NASA's Vision, Mission, and goals.

FY 2002 ACCOMPLISHMENTS

FY 2002 saw a major increase in research productivity on the ISS as construction and outfitting of the Station progressed. We added three equipment experiment racks to the orbiting laboratory. Researchers on the Station used this and previously installed racks to conduct 48 science and technology development experiments. Experiments in biological and physical science fields included 11 (26.2 percent) in Human Life Sciences, 24 (57.1 percent) in Physical Sciences, and 7 (16.7 percent) in Space Product Development. Astronauts conducted the first materials science research on the ISS, tested medical procedures for controlling the negative effects of space flight, deepened our understanding of changes to bone and the central nervous system that occur in space, conducted advanced cell culturing research, and broke new ground in the study of dynamic systems made up of tiny particles mixed in a liquid (colloids).

The Physics of Colloids In Space experiment provided new information about the development and dynamics of colloid materials. Colloids are mixtures of very small particles suspended in a liquid; paint and toothpaste are both usually made of colloids. Physicists studying colloids in space are exploring the processes by which particles in colloids arrange themselves into regular patterns, or crystal lattices. These researchers report that they have observed significant phenomena on the ISS never observed on Earth. These findings may improve future telecommunications networks and displays that use optical switches, filters, and lasers to store, transfer, and process information. Other potential uses include improvements in the shelf life of common products made of colloids, including paints, cosmetics, and foods.

NASA and the biotechnology research company, StelSys, LLC, teamed up to test how human liver cells function in the microgravity environment aboard the Station and to compare this to the function of such cells on Earth. The scientists grew cells in a cell culturing apparatus onboard the Station, froze them, and sent them to researchers on Earth. Researchers at StelSys are comparing the micro anatomical, biochemical, and molecular genetic properties of the samples from ISS with those of ground controls. This experiment will provide unprecedented information about how microgravity affects human liver cell function, including insights into how to preserve the health of humans living and working in space.

THEME DISTRIBUTIONS

Budget Authority (\$ in millions)	FY 2002	FY2003 President's Budget, As Amended	FY2004 President's Budget
Biological Sciences Research	218.0	245.1	358.6
Physical Sciences Research	227.4	247.2	353.2
Research Partnerships and Flight Support	196.9	169.5	260.9
Institutional (includes Agency Health and EOS)	181.7	180.5	0.0
Total	824.0	842.3	972.7

Note: For all formats, the FY 2002 column reflects the FY 2002 Congressional Operating Plan dated 9/30/02. The FY 2003 column reflects the FY 2003 Presidents Budget Submit (PBS) as Amended. FY2004 column is in full cost.

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Biological Sciences Research

Within this theme, we determine ways to support a safe human presence in space. Space flight exposes humans to physiological and psychological health risks from radiation, reduced gravity, and isolation. We are researching how to define and control these risks. This theme also conducts research and development to improve the performance of life support systems. It includes a basic biology research component that seeks both to pursue fundamental biological research questions from cell to tissues to whole organisms, which produce results that can support advanced methods for enabling human exploration of space. Highlights for FY 2004 include:

Overall budget

FY 2004 request is \$359 million, a \$55 million or 18 percent increase over FY 2003 President's Request (full cost):

- \$210 million for Bioastronautics Research. In response to ReMAP prioritization, expands planned ground research program in countermeasures development by \$27 million, which includes an increase of approximately \$20 million in funding for the National Space Biomedical Research Institute from \$10 million to \$30 million and a \$7 million increase through the new Human Research Initiative. The initiative also starts a flight program in high priority areas of advanced human support technology by adding \$18 million.
- \$149 million for Fundamental Space Biology. In response to ReMAP prioritization, adds \$20 million for habitat holding rack development, cell culture unit and ground based research, and animal and plant habitats for research on the Space Station Centrifuge.
- Adds \$12 million to ensure adequate levels of reserves for Space Station hardware development and research operations.

New Initiative – Human Research Initiative

Request includes \$39 million for this new initiative (\$347 million over five years). Of the total, \$25 million is directed towards Biological Science Research (\$283 million over five years) and \$14 million towards Physical Sciences Research (\$64 million over five years). Goals include:

- Certify crew safety for missions beyond low Earth orbit over 100 days by mitigating the highest risks.
- Enable knowledge and technology to reduce mass to orbit and beyond for life support by a factor of three by 2010.

Physical Sciences Research

This theme supports research that takes advantage of the unique environment of space to expand our understanding of the fundamental laws of nature. We also support applied physical science research to improve safety and performance for human exploration and research that has applications in terrestrial industry. Highlights for FY 2004 include:

Overall budget

FY 2004 request is \$353 million, a \$2.0 million or 0.6 percent increase over FY 2003 President's Request (full cost):

- Responds to the ReMaP prioritization external study by realigning Physical Sciences Research funds. Provides adequate funding and reserve levels for the major PSR International Space Station Research Capability Development facility class space flight hardware, while reducing funding for lower priority areas such as bimolecular technology, and structural biology future facility class space flight hardware, and level II program management support. Increases funding for research of strategic importance to NASA's long-range goals, including radiation protection and basic research in power and propulsion technologies. Rephased deployment of Low Temperature Microgravity Physics Facility consistent with the availability of the Japanese Experiment Module (JEM) Exposed Facility.

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- Reallocates \$11 million in FY 04 reserves to ensure adequate levels of reserves for Space Station hardware development (Fluids and Combustion Facility, Low Temperature Microgravity Physics Facility, and Materials Science Research Rack) and research operations.
- Reallocates \$28 million for Space Station research equipment initial deployment of the Combustion Integration Rack (CIR) component of the Fluids and Combustion Facility (\$22 million) and Materials Science Research Rack (MSRR) (\$6 million).

Research Partnerships and Flight Support

This theme establishes policies and allocates space resources to encourage and develop research partnerships in the pursuit of NASA missions and Enterprise scientific objectives. This research supports product development on Earth and leverages industry resources to accelerate progress in our strategic research areas. Ultimately, research partnerships may support development of an infrastructure that can be applied to human exploration. Highlights for FY 2004 include:

Overall budget

FY 2004 request is \$261 million, a \$6.8 million or 2.7 percent increase over FY 2003 President's Request (full cost):

- \$49 million for Space Product Development. Restructures program by aligning industrial partnerships with NASA mission needs and Enterprise scientific objectives. Will review the existing research partnership centers to determine those centers to be retained. The focus will remain on the flight program.
- As part of FY 2003 Budget Amendment, provides funding for additional research/logistics missions to Space Station beginning in FY 2006. Of the total \$113 million over five-years added to budget for these research missions, Space Product Development has \$4 million over five years and Multi-User Systems and Support has \$93 million. The remaining \$16 million is distributed between Biological Sciences Research and Physical Sciences Research.
- \$212 million for Multi-User Systems and Support funding.
- Space Product Development budget was augmented by two activities: (1) the transfer of the Anti-Matter Spectrometer program management and budget from Physical Sciences Research; and (2) the consolidation of the Enterprise Support program content and budget, previously diffused across various programmatic components.