



THEMES



**Biological
Sciences
Research**



**Physical
Sciences
Research**



**Research
Partnerships
and Flight
Support**

NASA's Biological and Physical Research (BPR) Enterprise conducts interdisciplinary, peer reviewed, fundamental and applied research to address the opportunities and challenges to NASA that are provided by the space environment and the human exploration of space.

BIOLOGICAL AND PHYSICAL RESEARCH

PURPOSE

The Biological and Physical Research (BPRE) Enterprise has a unique role in support of NASA's Vision and Mission. In concert with the new exploration vision, BPRE will refocus research on activities that prepare human explorers to travel beyond low Earth orbit, such as the development of countermeasures against space radiation and the long-term effects of reduced gravity. During FY2004, BPRE will concentrate its efforts on studying, reviewing, and replanning current efforts, goals, and funding to best support the exploration initiatives as it matures. We expect to have an updated research plan and funding justification available Spring 2004. BPRE research seeks innovations and solutions to enable the extension of life into deep space safely and productively. Our fundamental and strategic research, as well as our research partnerships with industry and other agencies, allow new knowledge and technologies to bring improvements to life on Earth while we pursue our mission in space. Our interdisciplinary research in the unique laboratory of microgravity addresses opportunities and challenges on our home planet as well as in space environments. The Enterprise plays a key role in encouraging and engaging the next generation of explorers from primary school through the graduate level via our direct student participation in space research and our other outreach efforts.

Coordinated strategic research thrusts address topics such as radiation health and protection, biomedical countermeasures, bioregenerative life support, and engineering research supporting the technologies required for sustained human exploration of space. For humans to venture into space - beyond where we have been - NASA must be able to provide the same kind of safe cocoon for space explorers that Earth provides for its inhabitants. Understanding the process of adaptation of humans and other life forms to the environment of space is a critical role for BPRE.

The Enterprise's contributions to realizing NASA's vision are structured around five organizing questions. These questions provide a framework for all Enterprise activities:

- (1) How can we assure the survival of humans traveling far from Earth?
- (2) How does life respond to gravity and space environments?

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- (3) What new opportunities can research bring to expand understanding of the laws of nature and enrich lives on Earth?
- (4) What technology must we create to enable the next explorers to go beyond where we have been?
- (5) How can we educate and inspire the next generation to take the journey?

Working together across research disciplines, BPRE is performing vital research and technology development to extend the reach of human space flight. The many investigations supported by this Enterprise in the pursuit of answering our organizing questions are unique to the NASA Mission and distinguish NASA's research in these areas from that of other agencies, as well as BPRE's research from that of the rest of NASA.

FY 2003 ACCOMPLISHMENTS

FY 2003 was a challenging time for Biological and Physical Research Enterprise. Sadly, we remember the loss of the Columbia, and mourn the deaths of seven brave and dedicated astronauts. Perhaps the greatest legacy to STS – 107 is some of the outstanding experiments performed on this mission such as:

- Learning how bone and cancer cells interact when cancer begins to spread. The astronauts used a device invented by NASA called a bioreactor that allowed these cells to grow and form assemblies much larger than anything researchers have seen before. This bioreactor will enable researchers to turn cell cultures into functional tissue, which can be used for experiments, transplants, and drug development.
- Demonstrating an improved way of burning hydrogen that could result in cleaner-burning cars in the future and other fuels in engines and furnaces.
- Collecting data on how granular materials respond to physical stressors, yielding new knowledge that can be applied to better predict how soils react in an earthquake.
- Studying how the formation of flames and the use of water droplets to quench them will provide data to replace chemical fire suppressants that are currently banned for use internationally.

Despite the stand down of the shuttle fleet, 23 BPRE research experiments were conducted on the International Space Station in FY 2003 including 12 in Bioastronautics Research, 10 in Physical Sciences, and 3 in Space Product Development research.

THEME DISTRIBUTION

Budget Authority (\$ in millions)	FY 2003	FY 2004	FY 2005
Biological Sciences Research	268.6	368.0	491.5
Physical Sciences Research	241.4	357.2	300.1
Research Partnerships and Flight Support	170.0	260.0	257.0
Total	680.0	985.2	1048.6

Note: For all formats, the FY 2003 column reflects the FY 2003 Congressional Operating Plan, dated 9/04/03. The FY 2004 column reflects the FY 2004 Conference committee report. The FY 2005 column represents the FY 2005 President's Budget Submit.

Indicates budget numbers in full cost

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 carrying out research to define and control these risks and to improve the performance of life support systems. The Biological Sciences Research theme also pursues fundamental biological questions from cell to tissues to whole organisms to ecosystems, which produce results that support advanced methods for enabling human exploration of space as well as enhancing understanding of biological systems and improving human health on Earth.

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OVERALL BUDGET

The FY 2005 request is \$491.5 million, a \$123.5 million or 34 percent increase over FY 2004 President's Request in support of the new exploration vision.

- \$342.5 million for Bioastronautics Research to perform research and develop technology for systems that will enable humans to live and work safely and effectively in space. These research activities are aligned with the Bioastronautics Critical Path Roadmap that identifies the critical risks associated with long-term human space travel.
- \$149 million for Fundamental Space Biology to focus on research on life's responses to space environments at all levels including cell sciences and genomics, physiological adaptation and developmental biology, ecosystem interactions and multigenerational studies and the development of hardware for the Centrifuge Accommodation Module.

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 and to impact industrial and technological applications on Earth, as illustrated by the bioreactor, combustion, and materials science work mentioned earlier. This theme also supports applied physical science and engineering research to develop reduced gravity technologies critical to human space exploration, such as radiation shielding, microgravity fire safety, and those elements of spacecraft power and propulsion systems that are gravity dependent. The Physical Sciences Research program develops advanced technologies in support to NASA space crew health programs and novel engineering processes for life-sustaining resource production in a reduced-gravity and remote environment.

OVERALL BUDGET

The FY 2005 request is \$300.1 million, a \$57.1 million or 16 percent decrease of the FY 2004 President's Request in support of the new exploration vision:

- The request covers the development of hardware for inserts, such as the Sample Cartridge Development, the Lab-on-a-Chip Application Development, the Multi-user Gaseous Fuel Apparatus, the Granular Flow Module, the Space Acceleration Measurement System, the Microgravity Acceleration Measurement System, and the Primary Atomic Reference Clock in Space, to enable experiments to be performed within the ISS Research Facilities. In addition, the request includes research that in prior years was reduced to cover the shortfall in the ISSRC budget for the development of the major ISS Research Facilities.

Research Partnerships and Flight Support

This theme establishes policies and allocates space resources to support space flight research and also encourage development of research partnerships in the pursuit of NASA missions and Enterprise scientific objectives, while leveraging NASA support by factors of greater than two with contributions from industrial and other partners in the Space Product Development (SPD) program. This research supports product development on Earth and accelerates progress in our strategic research areas. Ultimately, research partnerships may support development of an infrastructure that can be applied to human exploration. This theme also funds ISS research planning, integration and operations, as well as development and maintenance of research hardware that is used across multiple research disciplines such as the Express Rack and refrigerator/freezers.

OVERALL BUDGET

FY 2005 request is \$257 million, a \$3 million or 1 percent decrease of the FY 2004 President's Request in support of the new exploration vision.