Mission: Use the synergy between physical, chemical, and biological research in space to acquire fundamental knowledge and generate applications for space travel and Earth applications.

Throughout most of history, humans have viewed gravity as an inescapable constant. Gravity has also profoundly affected how life on Earth has evolved. But new access to the space environment is now allowing scientists to conduct unprecedented research in low gravity, opening a new window on longstanding questions of science and technology. Space also poses physical challenges to space explorers, who must find ways to withstand space environment hazards for which humanity's evolution on Earth never prepared them. NASA's Biological and Physical Research Enterprise (BPR) conducts interdisciplinary fundamental and applied research to address the opportunities and challenges of human exploration of space.

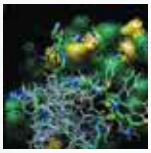
Goal 1

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

Space flight exposes humans to physiological and psychological health risks from radiation, reduced gravity, and isolation. BPR will coordinate research in the physical and biological sciences with biomedical applications to develop methods that will reduce these threats to human health in space and planetary environments. BPR will use results from the continuum of research, from fundamental through applied, to design strategies to maintain health, safety, and performance in the hostile environment of space. In addition to controlling the physical changes that seriously threaten space travelers' health, this Enterprise will conduct research to develop the means to remotely provide crew medical care. BPR will also conduct research on technology for efficient, self-sustaining, life-support systems to provide safe, hospitable environments for space exploration. NASA will team with other research agencies, the private sector, and academia to establish the scientific foundation for cutting-edge, molecular-scale biomedical technologies for use on Earth and in space.

Goal 2

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



The space environment offers a unique laboratory in which to study chemical, physical, and biological processes. Researchers will take advantage of this environment to conduct experiments that are impossible on Earth. For example, most combustion processes on Earth are dominated by the fact that hot gases rise. In space, this is not the case, and hidden properties of combustion emerge. Results from this research promise to improve fire safety, fuel efficiency, and pollution control. Materials scientists will study the role of gravity in important industrial processes. Their results may lead not only to the formation of new materials impossible to produce on Earth, but to better control of Earth-based processes to obtain

Cross-Disciplinary Investigation

NASA's Biological and Physical Research Enterprise creates unique cross-disciplinary research programs bringing the basic sciences of physics, biology, and chemistry together with a wide range of engineering disciplines. The synergy and vigor achieved in this interdisciplinary enterprise will help the Agency meet its needs for new approaches to long-term mission requirements, and ensure that NASA's contribution to fundamental research will be at the leading edge of science. Concurrently, the Enterprise will encourage applications to develop new commercial products and services.

Advances in biology have opened an era of unprecedented gains in understanding of living systems, giving us the ability to modify and, to a limited extent, to mimic the functions of biological systems. These new capabilities have only begun to achieve their potential impact on medicine and technology. When combined with progress in the physical sciences over the past century and with revolutionary capabilities in information technology, the synthesis of biology, physics, chemistry, and engineering will transform the technological foundations not only of the space program but also of our society.

improved products. Physicists will take advantage of microgravity to study exotic forms of matter that are better handled in space. Biological research will investigate the role of gravity in life processes. NASA The Enterprise will conduct research to integrate our understanding of the role of gravity in the evolution, development, and function of living organisms and in basic biological processes. The knowledge derived from BPR's diverse research will not only inform and expand scientific understanding but will also contribute fundamental knowledge NASA needs to achieve its strategic goals.

Goal 3

Enable and promote commercial research in space.

The Enterprise will provide knowledge, policies, and technical support to facilitate industry investment in space research. NASA has designated 30 percent of ISS resources for commercial utilization. NASA will continue to enable commercial researchers to take advantage of space flight opportunities for proprietary research. The commercial sector will grow to become the premier mechanism for applying space knowledge to benefit the American people. Commercial

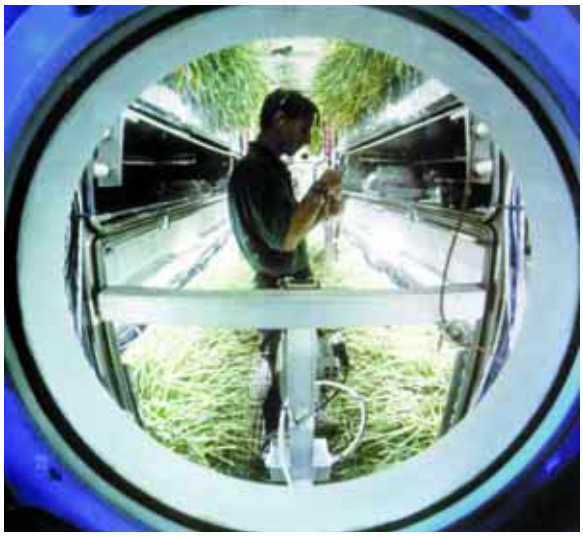
applications of space knowledge will generate new products, new jobs, and new spin-off companies. At the same time, commercial investment will play an ever-increasing role in enabling the exploration and development of space.

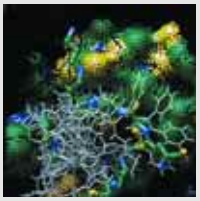
Goal 4

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

BPR seeks to use its research activities to encourage educational excellence and to improve scientific literacy from primary school through the university level and beyond. The Enterprise delivers value to the American people by facilitating access to the experience and excitement of space research. NASA seeks to engage the commercial sector in exploiting the economic benefits of space. We also strives to involve society as a whole in the transformations that will be brought about by research in space.

External Factors — Achievement of Biological and Physical Research goals and objectives is particularly contingent on external factors pertaining to unexpected discoveries and markets. (See External Assessment)



Fundamental Space Research Goals	Objectives	Near-term Plans 2000–2005
 **Enable Exploration:** Conduct research to enable safe and productive human habitation of space	■ Conduct research to ensure the health, safety, and performance of humans living and working in space ■ Conduct physical science research on planetary environments to ensure safe and effective missions of exploration ■ Conduct research on biological and physical processes to enable future missions of exploration	■ Identify mechanisms of health risk and potential physiological and psychological problems to humans living and working in space, and begin developing and testing countermeasures ■ Conduct research in analog test beds and on orbit to enhance medical care for human space flight ■ Test and validate technologies that can reduce the overall mass of human support systems by a factor of 2 (compared to 1990's levels) ■ Begin developing interdisciplinary knowledge (e.g., biology, physics, materials) to support safe, effective, and affordable human/robotic exploration
 **Science:** Use the space environment as a laboratory to test the fundamental principles of physics, chemistry, and biology	■ Investigate chemical, biological, and physical processes in the space environment, in partnership with the scientific community ■ Develop strategies to maximize scientific research output on the International Space Station and other space research platforms	■ Conduct scientific, and engineering research and enable commercial research activities on the ISS to enrich health, safety, and the quality of life on Earth ■ Establish dynamic research partnerships with the scientific community to open new fields of research in chemical, biological, and physical processes, including – • Gravity effects on cellular genomics and mechanisms • Structure of biological materials • Safe and efficient combustion processes • Atomic physics investigations probing relativity and new forms of matter ■ Working with the HEDS Enterprise, identify important science objectives for 100-day class human missions
 **Commerce:** Enable and promote commercial research in space	■ Assure that NASA policies facilitate industry involvement in space research ■ Systematically provide basic research knowledge to industry ■ Provide technical support for companies to begin space research ■ Foster commercial research endeavors with the International Space Station and other assets	■ Provide periodic reports on potential applications of space knowledge and possibilities for industry partnerships ■ Review and make recommendations for changes to NASA commercial policies ■ Advocate policy, legislative, and engineering actions to facilitate privately-funded commercial space development ■ Create new approaches to collaborative partnerships with the private sector for the development of future BPR Enterprise capabilities
 **Outreach:** Use space research opportunities to improve academic achievement and the quality of life	■ Engage and involve the public in research in space ■ Advance the scientific, technological, and academic achievement of the Nation by sharing our knowledge, capabilities, and assets	■ Expand public and K–12 educational access to mission research information ■ Work with colleges and universities in the conduct of biological and physical space research

Mid-term Plans 2006–2011	Long-term Plans 2012–2025
■ Understand the effects of long-duration space flight (e.g., radiation), validate countermeasures and technology and begin developing countermeasures for long-duration space flight ■ Test and validate technologies that can reduce the overall mass of human support systems by a factor of three (compared to 1990's levels) ■ Collaboratively with the space science community, conduct research on ambitious robotic missions to acquire needed research data	■ Apply and refine countermeasures for safe, effective, and affordable long-duration human space flight ■ Conduct life-support and biological technology research to support HEDS in enabling a further 2- to 4-fold reduction in costs for ambitious long-term human exploration ■ Test and validate technologies for safe, self-sufficient, and self-sustaining life support systems that can enable humans to live and work in space and on other planets — independent from Earth-provided logistics — for extended periods
■ Extend our understanding of chemical, biological and physical systems, including – • Long-duration research on material/related topics • Multi-generational studies of organisms • Expand our understanding of the effects of varying levels of gravity on biological processes • Expand our understanding of molecular structures, cells, biological processes, etc., and use that understanding to make human spaceflight safer and more productive • Use our understanding of the fundamental principles that control and energetic processes to enhance spacecraft fire safety and open technology opportunities ■ Working with the HEDS Enterprise, identify important science objectives for 1000-day class human missions ■ Incorporate expanded telescience capabilities into ISS research activities ■ Initiate research missions using small autonomous spacecraft for biological research and technology test beds	■ Achieve a deep of understanding of the role of gravity in complex chemical, biological and physical processes ■ Use NASA leadership in integrated chemical, biological, and physical scientific research to open technology opportunities for revolutionary approaches to new human and robotic missions
■ Transition mature ISS commercial products and technologies to full private sector financing ■ Encourage and enable new commercial products, services, and technologies in space	■ Utilize services of commercially owned and/or operated space facilities for space research ■ Encourage and enable commercial activities in the continuing exploration of space
■ Expand partnerships with colleges, universities, and K–12 to share NASA's discoveries and increase student interest in space research and science	■ Further develop academic and outreach programs to take advantage of advanced long-duration space research