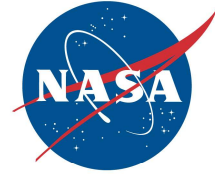


National Aeronautics and Space Administration

Mary W. Jackson NASA Headquarters
Washington, DC 20546-0001



March 19, 2024

Reply to Attn of: SMD/DAA/R

Dr. Colleen Hartman
Director, Aeronautics, Astronomy, Physics, and Space Science
National Academies of Sciences, Engineering, and Medicine
500 5th Street, NW
Washington, DC 20001

Dear Dr. Hartman:

I would like to express my appreciation for the publication copy of *Thriving in Space: Ensuring the Future of Biological and Physical Sciences Research: A Decadal survey for 2023-2032 (2023)* delivered in September of 2023. I would like to express my gratitude to the co-chairs -- Dr. Robert Ferl and Dr. Krystyn Van Vliet -- volunteers, and staff who diligently worked to bring this complex and comprehensive project to successful conclusion.

The leadership team of the Biological and Physical Sciences (BPS) Division has been analyzing the recommendations in detail since the pre-publication release and has been focused on developing a strategic response. Appended to this letter, we have provided an initial acknowledgement as well as preliminary assessments and responses to the report's recommendations. Overall, it is apparent that our existing programs and plans are well aligned with the recommendations. We are supportive of almost all of the guidance and proposed activities, and we are discussing ways to address the Key Science Questions through an integrated, multi-disciplinary approach.

We will fully consider the recommendations, along with the stated Budgetary Decision Rules, in our future planning, as enabled by the budget allotted to BPS. While the responses herein address many of the actions that we will take in response to the Decadal Survey recommendations, it will take us multiple budget cycles to develop more complete strategic approaches. We expect to report on these developments regularly to the Committee on Biological and Physical Sciences in Space (CBPSS) as they emerge. For updates about this process or any other questions related to our response, please do not hesitate to contact the

Director of our Biological and Physical Sciences Division, Dr. Lisa Carnell,
Lisa.a.ScottCarnell@nasa.gov or 202-963-9415.

In closing, I thank you again for the Academies' report and continued support in advancing biological and physical sciences research in space.

Sincerely,

Nicola Fox Digitally signed by Nicola Fox
Date: 2024.03.21 18:27:34
-04'00'

Nicola Fox, PhD
Associate Administrator
Science Mission Directorate

Enclosures:

cc:
NASA/SMD/L. Carnell
NASA/SMD/M. New

Attachment: Preliminary response to Decadal Survey report recommendations.

Thriving in Space: Ensuring the Future of Biological and Physical Sciences Research: A Decadal Survey for 2023-2032 provided 25 recommendations, 11 Key Science Questions (KSQs), and two research campaigns addressed to NASA. BPS values these recommendations and will develop a strategic approach to address them within the budgets appropriated to the division.

Chapter 3: Framework for Thriving in Space

Recommendation 3-1: *NASA should direct its research resources toward the key scientific questions identified in this study.*

Response: NASA BPS acknowledges this recommendation and will prioritize resources to begin addressing the KSQs. NASA BPS plans to develop roadmaps for new research opportunities that align with these KSQs as well as assess currently funded research in both the Space Biology and Physical Sciences Programs against the KSQs.

Recommendation 3-2: *NASA should work with other U.S. government agencies and other nations' space agencies to coordinate research resources toward the key scientific questions, as relevant to multiple-agency missions.*

Response: NASA BPS agrees with this recommendation. BPS and its predecessor organizations have collaborated with international space agencies and other U.S. government agencies for over 20 years. These partnerships have produced numerous benefits to BPS science, such as the development of space flight hardware, International Space Station (ISS) crew time provided by the international partner, extended in-space testing, open science collaborations, broader science team participation, and joint publications. These collaborations have been mutually beneficial to BPS and the participating organization, and BPS will continue to pursue such opportunities.

Recommendation 3-3: *As activity in low Earth orbit increases, and lunar and Martian missions are increasingly likely, NASA should increase resources dedicated to understanding the answers to these key scientific questions.*

Response: NASA BPS will develop research roadmaps dedicated to answering the key scientific questions, budgets to implement those roadmaps. Increasing available resources will be very challenging in the near future due to national-level funding constraints. As part of these roadmaps, BPS will pursue answering the fundamental research questions supporting the architecture and resources as defined in [The Moon to Mars Architecture Definition Document](#). BPS participates in the development and revision of this Definition document, which is the responsibility of Exploration Systems Development Mission Directorate (ESDMD).

Chapter 4: Science to Enable Space Exploration

Recommendation 4-1: *NASA should continue to strengthen the science exchange between the Biological and Physical Sciences Program and the Human Research Program. Such effort may include establishing a coordinating body and shared research initiatives as well as the two-way exchange of technologies, data, mission science, specimen banking, and plans.*

Response: NASA BPS concurs with this recommendation and will continue partnering with the Human Research Program (HRP) on the two-way exchange of technologies, data, mission science, specimen banking, and future planning to advance NASA's science goals. For Moon and Mars exploration, the HRP and BPS division work closely together for all activities associated with the [Moon to Mars strategy](#) and objectives, Architecture Definition Document, and science coordination for [Artemis](#) and [Gateway](#) missions, which includes the Gateway science discipline working groups for space biology and human health.

The HRP Investigators' Workshop (IWS) and American Society for Gravitational and Space Research (ASGSR) meetings are two venues where the communities and leadership interact and foster new scientific collaborations. Examples of joint projects include [VEGGIE](#) and the [multi-agency 3D Tissue Chips Longevity Collaboration](#).

Current communication consists of regular meetings with the Program office for strategic planning and at the Element/Project level for tactical tasks. BPS and HRP plan to create a formal BPS-HRP working group to increase connection, communication, and common work.

Recommendation 4-2: *NASA should increase resources dedicated to producing and understanding the answers to the key scientific questions that address the transitions to and from space. The committee sees potential for significant advances in space exploration if a biological and physical sciences portfolio in the coming decade is aimed at understanding the biological responses that occur during transitions between the Earth and space environments over extended duration and distance to fundamentally enable space exploration; genetic diversity to understand positive and negative responses and long-term adaptations to spaceflight to accelerate the identification of risks, mechanisms of adaptation, and potential positive adaptations that could improve life in space; and how cells, systems, and organisms concurrently adapt to the spaceflight environment and develop mechanisms for encouraging positive and countering negative communicated responses.*

Response: BPS acknowledges and concurs with the recommendation that understanding the key scientific questions that address the transitions to and from space is a critical topic area to advance space exploration. Understanding and using knowledge of genetic diversity in organisms to both identify risks and understand adaptation to the unique environment of space will be key to advance space exploration. BPS will develop and work to execute research roadmaps leading to an in-depth understanding of how the mechanism utilized by cells, systems, and organisms are enhanced or suppressed in the microgravity environment. This research will provide important insights to enable sustainable long-term human exploration of space. BPS will prioritize research to address these key scientific questions within its budget.

Recommendation 4-3: *To ensure the long-term survival of life in the spaceflight environment, NASA should ramp up investigations into space impacts on sustained human presence in space by investigating*

- *Reproduction, development, and evolution within all relevant biological systems;*
- *The relationships between biology and space hardware to ensure structural integrity, optimize recycling, and utilization of local resources;*
- *Effective chemical, physical, and biological methods for locating, extracting, and processing local resources, especially from the Moon, for use in local habitation and downstream production; and*
- *Fluid physics, combustion, and related sciences to enable sustainable space exploration and habitation.*

Response: NASA BPS agrees that the stated topic areas are important for the sustained presence of humans in space. BPS is currently conducting limited reproduction and developmental studies using multiple model systems. Areas not currently being addressed will rely on BPS re-prioritizing research within the budgets appropriated to the Division. BPS is committed to contributing research to enable long term survival of humans in space, including on the Moon and Mars, and during deep space transit. BPS plans to develop research roadmaps across the division and work closely within NASA to align activities that will contribute to sustainable presence in space.

Chapter 5: Science Enabled by the Space Environment

Recommendation 5-1: *NASA should substantially increase resources dedicated to producing and understanding the answers to the key scientific questions detailed in this report. This investment recognizes the potential for significant societal impacts utilizing the space environment for the biological and physical sciences portfolio in the coming decade, aimed at:*

- *Identifying the mechanisms by which organisms sense and respond to the surrounding environment, including gravitational force;*
- *Advancing knowledge of material structure, self-assembly, and stability of materials, including but not limited to soft/active matter, in space environments, cognizant of but distinct from the applications of that knowledge to space exploration and habitation (e.g., manufacturing in space);*
- *Supporting ground-based and microgravity research on understanding the fundamental laws of systems far from equilibrium, especially those that underlie the existence of life; and*
- *Identifying new principles of physics that can only be discovered through experiments in space, including those governing particle physics, general relativity, and quantum mechanics.*

Response: BPS has been mapping past and current research activities to the key scientific questions to identify gaps that require additional research and will re-prioritize research within the budgets appropriated to the Division.

Recommendation 5-2: *For fundamental physics in space, NASA should facilitate durable formation of collaborations and efficient knowledge transfer between researchers working in multi-disciplinary teams. This scope to address these multi-decadal key scientific questions should include ground-based infrastructure, theoretical and experimental physics, precision measurement and technology development with private sector participants, and should be coordinated with missions in which biological and physical sciences research is one among several whole-of-government objectives.*

Response: NASA BPS concurs with this recommendation. BPS intends to coordinate fundamental physics research within NASA, across other government agencies, including the [National Quantum Coordination Office](#), and with our international partner agencies. Such coordination is vital to ensure the right investments for NASA and the nation.

Additionally, BPS has established a [Fundamental Physics Program Analysis Group](#) (FunPAG). The FunPAG serves as an interdisciplinary community-based forum for soliciting and coordinating community analysis and input in support of NASA fundamental physics research aimed at transformative outcomes enabled by the space environment. The FunPAG will be instrumental in analyzing opportunities for multi-disciplinary teams.

Recommendation 5-3: *In all of the space-enabled research areas, NASA should allocate funding with an anticipation that new directions of research may arise.*

Response: NASA BPS acknowledges this recommendation to set aside funding to take advantage of new research opportunities. BPS expects new and unexpected research areas to emerge as it seeks out answers to the KSQs. The division plans to establish a process to propose new science to take advantage of developments in research that may arise over the next decade. BPS will also identify areas where funding, to the extent feasible within the BPS budget, can be allocated to address emerging research areas.

Chapter 6: Research Campaigns

Recommendation 6-1: *NASA should pursue dedicated research campaigns that, through the coming decade, will drive resolution to specific groups of key scientific questions. Coordination beyond NASA, including other federal agencies and the private sector as well as public-private partnerships, should be considered for the dedicated new funding and materials to support these research campaigns.*

- *BLISS (Bioregenerative Life Support Systems) to build and understand the systems that would provide high-quality food, refresh air and water, process wastes, and enable the creation of space environments sustainable for long periods of time independent of Earth; and*
- *MATRICES (Manufacturing Materials and Processes for Sustainability in Space) to understand and harness the physical processes by which materials and complex fluids can be repeatably utilized in space, to enable sustainable exploration and circular lifecycles for the built environment on Earth and in space.*

Response: NASA BPS acknowledges and concurs with the need to establish dedicated research campaigns. BPS is currently executing research closely aligned to the KSQs which can provide the foundation for the research campaigns outlined in the decadal survey. Fully addressing the research campaigns recommended in the decadal survey (BLISS and MATRICES) will be contingent on availability of resources.

Theme-focused mini-campaigns may be considered as part of addressing big goals aligned with the KSQs to maximize the science return within the budgets appropriated to the Division. These thematic mini-campaigns may be separate or complementary to the BLISS and MATRICES campaigns. BPS will strategically pursue partnerships with other NASA stakeholders, other government agencies, international space agencies, commercial industry, non-profit organizations, and academia to execute mutually beneficial research.

Recommendation 6-2: *NASA should pursue development of the Probing the Fabric of Space Time (PFaST) initiative in this decade only if it can obtain substantial (greater than 75 percent) funding from external (i.e., other than NASA) sources.*

Response: NASA BPS acknowledges and partially concurs with this recommendation. NASA BPS recognizes the potential scope of such a mission and, more importantly, the potential interest in these research areas across the U.S. government and international space agencies. Moreover, similar technologies with complementary missions are of interest across NASA as well. BPS recognizes both the need and benefit to partner with those groups. BPS believes the scope of the mission, and thus appropriate amount of partnering, will depend on a detailed analysis of the trade spaces. As mentioned previously in our response to Recommendation 5-2, the division has established a Fundamental Physics Program Analysis Group (FunPAG) to facilitate collaboration in advancing U.S. research in this area.

Chapter 7: Strategy and Challenges

Recommendation 7-1: *Because the nation benefits from global leadership in space science and technology, and given the emergence of commercial platforms that can be tasked to the nation's science, NASA should*

- *Seek significant funding increases for biological and physical sciences with new monies or through rebalancing the portfolio across the Science Mission Directorate, and in coordination with other U.S. government agencies, as the community needs to grow significantly in size to reach the science goals of the nation;*
- *Actively engage commercial spaceflight firms, using science funding as a driver and with all due haste, to ensure that science needs are met with clear priority, guaranteeing that national science needs are enabled along with those of potential commercial customers using those platforms; and*
- *Ensure that the funded science community fully engages diversity and inclusivity in the pursuit of the nation's space exploration science priorities.*

Response: Multiple parts of the NASA Science portfolio contribute to global leadership in space science and technology, and as such, future funding for BPS will need to be balanced against other priorities within the broader space science portfolio. Large increases are unlikely in the near future due to national-level funding constraints. BPS prioritizes research within the budget allocated and maximizes opportunities through partnerships within NASA and across multiple stakeholders. NASA seeks to be one of many customers in the commercial space economy. BPS's [Commercially Enabled Rapid Space Science](#) (CERISS) initiative aims to accelerate the pace and productivity of research by developing transformative commercial research capabilities. BPS will continue to collaborate with other NASA offices and programs, including NASA's Flight Opportunities Program, to develop and utilize commercial platforms to advance scientific research and technologies. and technologies.

NASA BPS follows and complies with NASA's and SMD's policy for inclusion, diversity, equity, and accessibility. SMD ROSES research proposals will be required to provide an inclusion plan, as defined in the NASA/SMD IDEA policy. BPS will be implementing [SMD's Dual-Anonymous Peer Review](#) (DAPR) process demonstrating commitment to ensuring the review of proposals is performed in an equitable and fair manner. The BPS community will benefit from NASA's and SMD's [Bridge Program](#) and other programs to increase inclusivity and diversity.

Recommendation 7-2: *To maintain research campaign momentum, NASA should require external advisory committees to evaluate research campaign team progress and emergent technologies annually.*

Response: NASA BPS acknowledges this recommendation. BPS believes the scope of any research campaign will be contingent on availability of resources, which will then dictate the scope of work for external advisory committees.

BPS believes the [National Academies' Committee on Biological and Physical Sciences in Space \(CBPSS\)](#) and the [Biological and Physical Sciences Advisory Committee \(BPAC\)](#) are sufficient and valuable forums for communicating the division's progress at this time. Our implementation of any additional advisory committees will conform to NASA policies and applicable laws including the Federal Advisory Committee Act (FACA).

Recommendation 7-3: *Because key questions identified in this study benefit from access to multiple spaceflight-related platforms, the Biological and Physical Sciences Program should*

- *Coordinate funding opportunities with the Space Technology Mission Directorate such that access to the range of spaceflight and spaceflight-related platforms is efficiently employed to answer key science questions, especially those questions that inform technology development for space exploration; and*
- *Maintain a foundational approach to science, building through a strong, vibrant program of ground-based, suborbital, orbital, lunar, martian, and beyond missions.*

Response: NASA BPS concurs with this recommendation. BPS currently partners with the Space Technology Mission Directorate (STMD) on several activities and will continue to coordinate research opportunities through project collaborations, co-funding solicitations, and sharing research/technology developments.

BPS maintains a strong program of ground-based and orbital opportunities. Areas for growth include suborbital and exploration missions. BPS will develop and implement a strategy that includes a building-block approach to utilize ground-based, suborbital, orbital, lunar, martian, and beyond low-Earth Orbit (LEO) platforms, balancing the costs with the return on science.

Recommendation 7-4: *Because key scientific questions identified in this study support the effective utilization of, and benefit from access to, deep-space exploration platforms, NASA should ensure that scientific opportunities are maximized within the range of spaceflight and spaceflight-related platforms intended for lunar, cislunar, and Mars transit solutions.*

Response: NASA BPS concurs with this recommendation. BPS is engaged with multiple organizations across NASA to maximize its opportunities for use of lunar, cislunar, and deep space platforms, including Artemis missions, rideshare opportunities, commercial lunar payload services (CLPS), and as secondary payloads on NASA and commercial launches. BPS representatives serving on ESDMD Moon to Mars Office panels and working groups are involved in developing policies to ensure that BPS science resources and requirements are part of the overarching deep space exploration platform portfolio. In addition, the NASA Moon to Mars Strategy and the Architecture Definition Document reflect the Division's science, technology, use cases, capabilities, resources, and needs required for science research beyond LEO.

Recommendation 7-5: *The U.S. government, including NASA, should develop and maintain sufficient ground-based infrastructure to validate and support biological and physical sciences missions. Some of these facilities already exist and simply need to be upgraded, while others have yet to be conceived and built.*

Response: NASA BPS acknowledges this recommendation. BPS plans to maintain current ground-based facilities to support a vibrant ground-based research program. The division's ability to expand the ground-based research program will be directly tied to available funding resources. BPS will assess its portfolio of ground-based facilities, their operational status, needs, and identify areas where new research facilities may be needed.

BPS will be seeking partnerships within NASA, across other government agencies, and with commercial industry to maintain and develop ground-based capabilities that will contribute to the nation's exploration objectives and decadal recommendations.

Recommendation 7-6: *NASA should continue to expand the investment in open and shared computational infrastructure (CI) to support storage, analysis, and dissemination of its biological and physical data, while ensuring linkage to the original and archived samples.*

Response: NASA BPS concurs with this recommendation. NASA BPS has developed and continues to maintain its open science archival data bases in Space Biology and Physical Sciences. These data repositories include the Physical Science Informatics System (PSI), Ames Life Sciences Data Archive (ALSDA) and GeneLab (which merged in 2022 to form the NASA Open Science Data Repository (OSDR)), Space Biology Biospecimen Sharing Program (BSP), and the NASA Biological Institutional Scientific Collection (NBISC).

Recommendation 7-7: *NASA should work with the other appropriate U.S. government agencies with a goal to establish an office or a mechanism for commercial sponsorship and collaboration with nonprofit organizations, including academia and government research agencies. That office/mechanism should have the primary focus of*

- *Coordinating the work between these commercial sectors and government agencies;*
- *Providing guidance on or facilitating research compliance, data security, and material transfer agreements, including prototype agreements;*
- *Representing multiple space environments and destinations (e.g., not only the International Space Station in low Earth orbit); and*
- *Communicating these opportunities to the research community.*

Response: NASA BPS will utilize existing offices and mechanisms to support the responsibilities stated in this recommendation. NASA policies and processes, NASA offices—including the Partnership Office—and councils, and an SMD science office, among other mechanisms, are already in place to carry out these functions and responsibilities. These existing organizations and resources provide support for collaboration and communication with other government organizations, commercial industry, and non-profit organizations.

BPS is committed to communicating opportunities for non-traditional collaboration to the research community and uses several mechanisms to do so. This includes using existing channels available through NASA’s Office of Communications and the NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES).

Recommendation 7-8: *NASA should work with appropriate government agencies to establish clear guidelines for international collaborations within the biological and physical sciences—in particular, for support of non-U.S. students and scholars, to balance two goals:*

- *Sustain and advance the U.S. leadership in the relevant areas of research, possibly by attracting the best and brightest globally; and*
- *Support a robust global research community and information exchange, fostering partnerships with other space programs and U.S. access to other nations’ ground-based and space assets.*

Response: NASA BPS concurs and has active programs in place that support this recommendation. For example, BPS’s [Spaceflight Technology, Applications and Research](#) (STAR) course facilitates student entry to space biology and prepares them for conducting spaceflight experiments using NASA and commercial platforms, and is open to international participants. BPS also participates in SMD-wide programs, such as [Future Investigators in NASA Earth and Space Science and Technology](#) (FINESST) and the [NASA Postdoctoral Program](#) (NPP), both of which are open to international participants.

BPS supports and engages in international activities including participation in the International Space Life Sciences Working Group (ISLSWG), and the International Microgravity Strategic Planning Group (IMSPG) with international partners. NASA coordinates at various levels with U.S. government agencies and complies with guidelines relevant to international collaborations.

Recommendation 7-9: *To retire many of the key scientific questions by the end of the decade, NASA should establish support for the Biological and Physical Sciences Program to levels that reflect the current national need and to build the science community in size, diversity of technical expertise and lived experience, and capability to reach the science goals of the nation, toward levels that are an order of magnitude above the current funding and well before the end of the decade.*

Response: NASA BPS acknowledges both the importance of building a research community that fully reflects the capabilities and potential of our country and the need to fully engage the diverse research community in our mission. SMD policy for inclusion diversity, equity, and accessibility define the driving factors for diversifying BPS scientific and technical expertise. Within our available resources, this is a top priority for BPS. The goal of increasing BPS's funding by an order of magnitude will be evaluated against other NASA and national commitments and obligations.

Recommendation 7-10: *To maintain a viable scientific community, the numerical majority of supported principal investigators (i.e., fraction of research team leaders) should be extramural (i.e., not NASA employees), and funding levels should be commensurate with addressing the key scientific questions.*

Response: NASA BPS concurs that it will be important for BPS to continue to maintain a viable scientific community, including a robust extramural community, to advance innovation, technology, and cutting-edge research. Simultaneously, BPS must maintain a cadre of intramural scientists to retain corporate knowledge and seed NASA's science leadership for the coming decades. This will ensure that BPS continues to have a vibrant program that is run by skilled scientific professionals who can support a strong community of extramural scientists. BPS ensures that all research scientists compete in the same peer-review process to maintain a high standard of scientific product by all research scientists, whether intramural or extramural. If future funding levels enable the number of principal investigators to increase, BPS will seek to ensure that extramural PIs make up the majority of these increases.

Recommendation 7-11: *NASA should establish periodic reviews of selected research campaigns to ensure coordinated access to the space environment, publicly communicated progress on research milestones, and facilitation of collaborations and public-private partnerships as required to meet these ambitious goals.*

Response: NASA BPS concurs with this recommendation. BPS will establish periodic reviews and communication processes to apprise the community of the division's progress towards the research campaigns that are supported within the budgets appropriated to the Division. The division currently has established review processes with both internal and public forums and participates in multiple forums for discussion of public-private partnerships. These include but are not limited to the BPAC, CBPSS, and ASGSR.

Recommendation 7-12: *NASA should identify mechanisms to compete new or additional research campaigns within 5 years, in light of anticipated changes to access to low Earth orbit and the inevitable but unknown changes in research, technology, funding, and space mission directives that will ensue after this report is issued.*

Response: BPS concurs with this recommendation. SMD has a strong history of campaign-based scientific research. BPS will investigate and use (or modify) SMD-established campaign organizations, formats, and processes to develop its scientific campaigns rather than develop

new processes. An example of the type of campaign format that will be considered by BPS includes a Science Definition Team-based structure. The Human Research Program Twin Study format, based on lessons learned, will be considered as well. Overall, the type of campaign format used will be dependent in part on 1) funding available, 2) science focus and overall goals, and 3) number and diversity of scientific investigations required to meet the goals of the campaign.

Recommendation 7-13: *NASA should ensure diversity, equity, inclusivity, and accessibility in the pursuit of the nation's space exploration science priorities, including instituting a requirement of documented progress in diversity among NASA-sponsored research teams seeking multi-year funding or multiple sponsorship requests over the coming decade. This inclusivity should be intentionally broad in concept, with respect to visible and less visible characteristics of historically underrepresented groups in BPS research and leadership.*

Response: NASA BPS acknowledges and agrees with this recommendation. BPS collaborates with NASA's [Minority University Research and Education Project](#) (MUREP) and [Established Program to Stimulate Competitive Research](#) (EPSCoR) programs to ensure engagement of underrepresented populations and regions in NASA research.

As stated in NASA's response to Recommendation 7-1, NASA BPS follows and complies with NASA's and SMD's policy for inclusion, diversity, equity, and accessibility.

NASA's SMD Deputy Associate Administrator for Research conducts [annual reviews and surveys of research grants and proposals](#) to understand how SMD divisions' solicitations and awards are meeting SMD IDEA priorities, which includes discussions for advancing IDEA for ROSES and Announcements of Opportunities, through understanding best practices, lessons learned, and science community communications and input.

Recommendation 7-14: *Project grants should be funded at levels and duration consistent with the project aims with full support for trainees (post-doctorates, graduate students, and undergraduates), including travel for trainees and principal investigators to support the mission and participate in scientific meetings. Full funding representing the total costs of research (direct and indirect) is imperative to be inclusive of participation by all trainees.*

Response: NASA BPS agrees that travel and conference costs for project participants at the postdoctoral and graduate level are critical components of the training element of research projects, and that undergraduate participation can stimulate wider involvement in NASA research by underrepresented segments of society.

This principle is a factor in determining the award levels of proposals selected for funding in BPS solicitations. The budget elements for a grant proposal are clearly stated in the solicitation; it is the Principal Investigator's responsibility to ensure the science aims and the necessary travel can be completed with the proposed budget.
