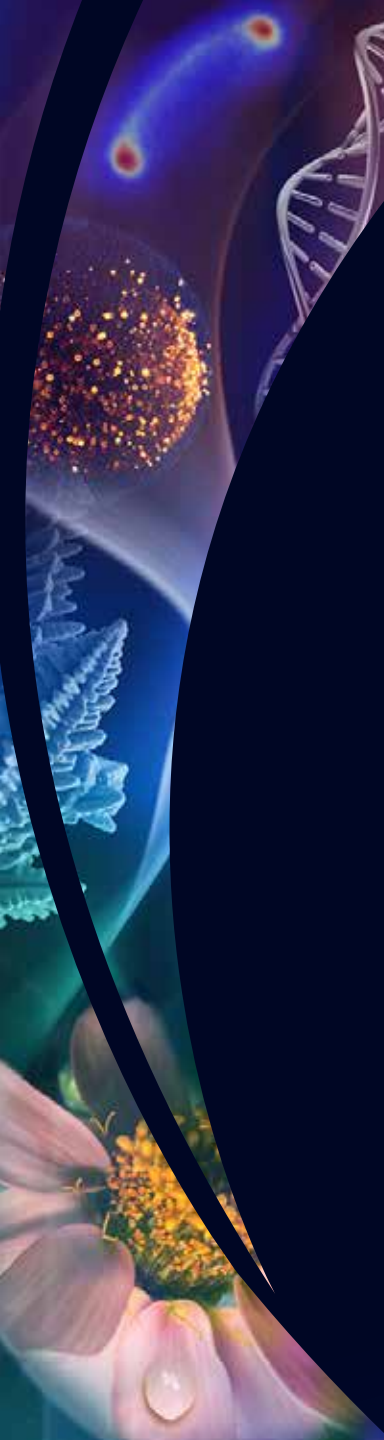




Statement of Task

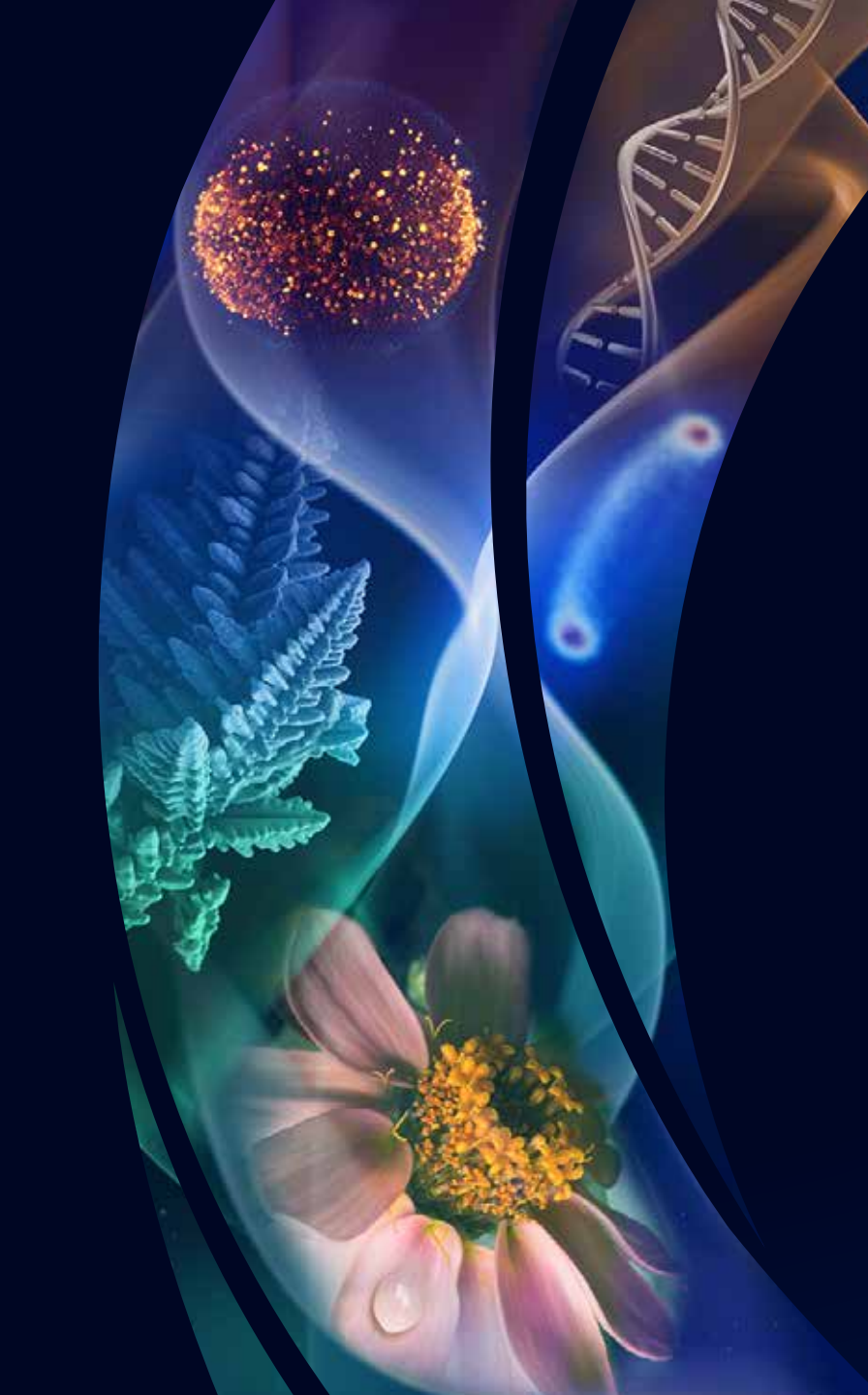
Craig Kundrot
Director
Biological and Physical Sciences Division





Main Points

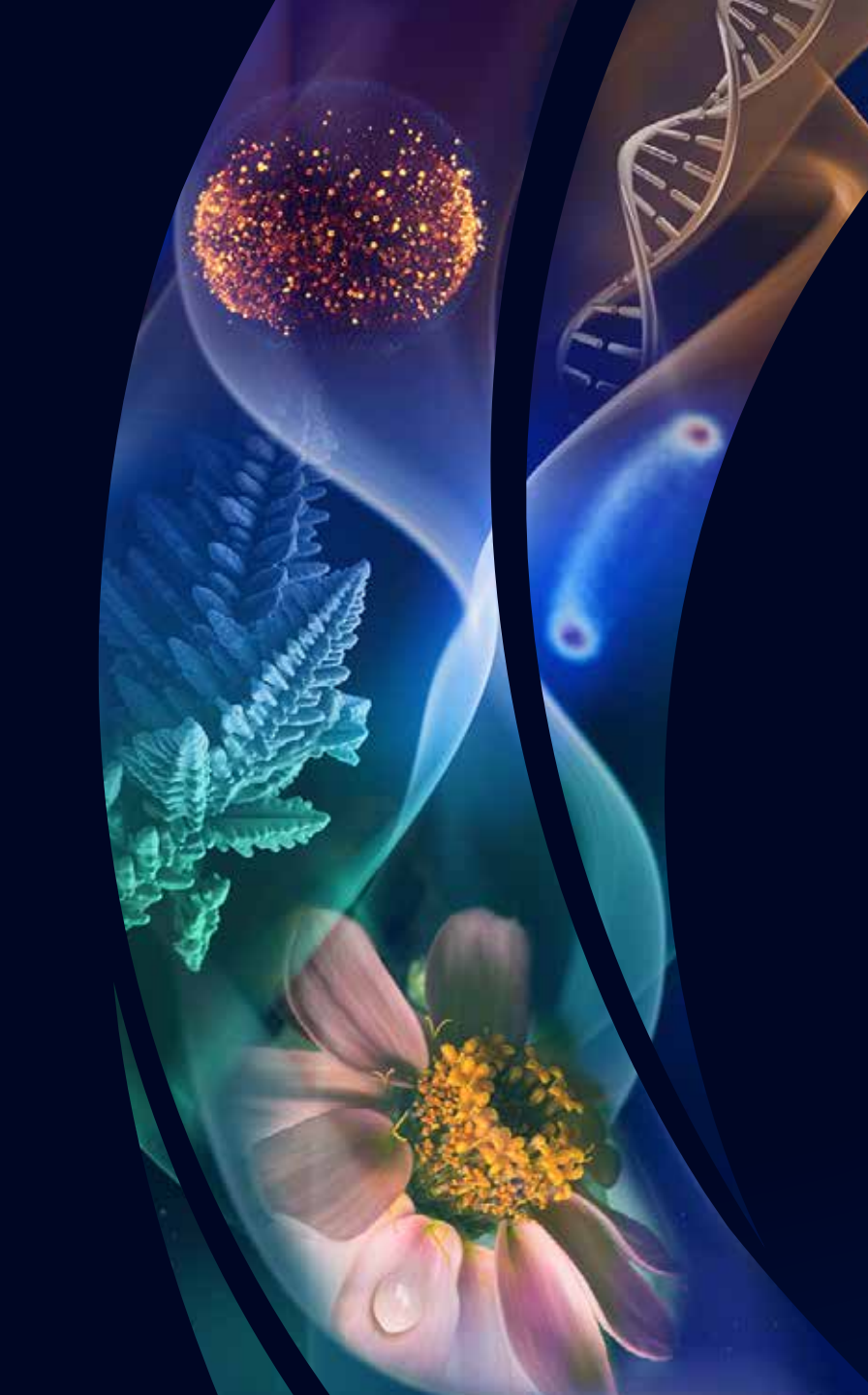
- Transformative science
 - The most compelling science challenges
 - At the frontiers of biological and physical sciences research in space
- Three areas of benefit
 - Uniquely advance scientific knowledge
 - Meet the needs of human and robotic exploration missions
 - Provide terrestrial benefits
- Recommendations for
 - Research activities including facilities and platforms (e.g., “Keystone Capabilities”)
 - Including those not currently available but which could be developed in the future
 - Research Campaigns
- Provide broad cost categories for facility and platform capabilities, and research campaigns



Transformative Research

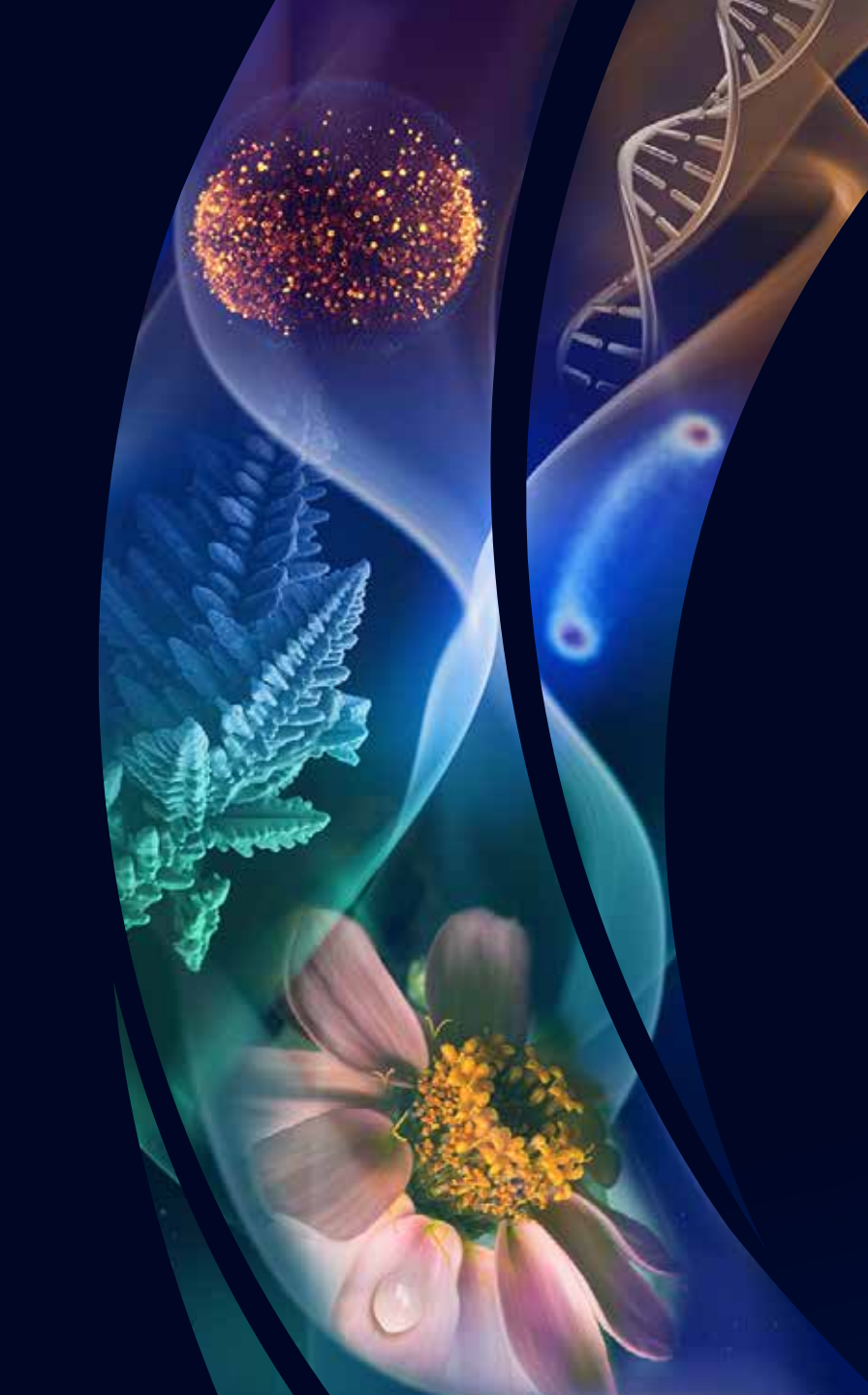
- Transformative research challenges current understanding or provides pathways to new frontiers
- Transformative research involves
 - ideas, discoveries, or tools that
 - radically change
 - our understanding of an important existing scientific or engineering concept or
 - educational practice or
 - leads to the creation of a
 - new paradigm or
 - field of science, engineering, or education.

https://www.nsf.gov/about/transformative_research/definition.jsp



Major Elements

- “Keystone Capabilities or Missions”
 - Like Flagship missions in other SMD divisions, but much smaller
 - Hardware centric like Cold Atom Lab, Combustion Rack, Fluids Rack
 - Single environment (e.g., ground, LEO, Lunar orbit or surface)
 - Includes facilities that support multiple investigations
 - Includes missions that execute one prime mission
- Research Campaigns
 - Overarching research question with clear, transformative goal
 - Decomposes into multiple subordinate research questions
 - Subordinate research question may call for a series of investigations
 - Not focused on facilities, platforms, or single environment

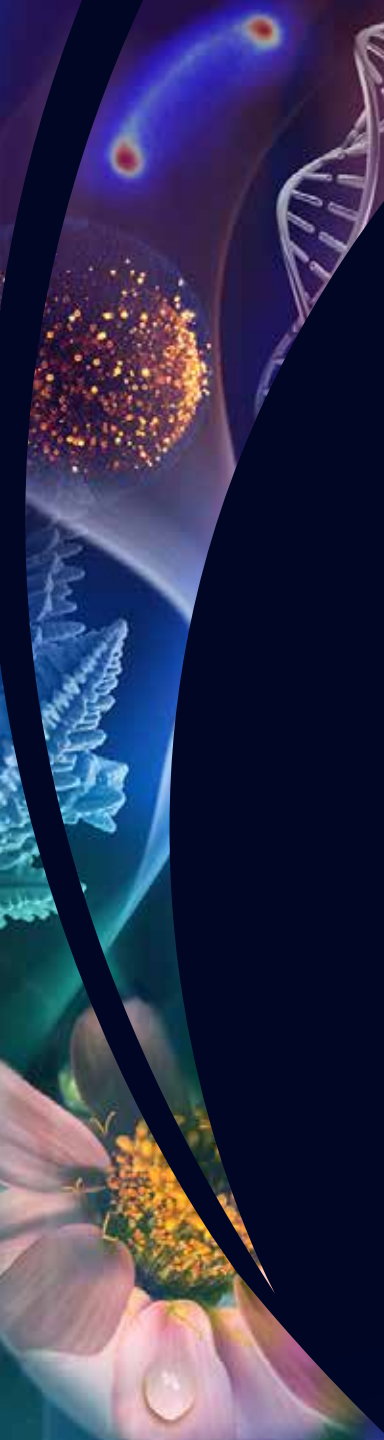


Cost Estimates

- Cost estimates for Keystone Capabilities/Missions and Research Campaigns
 - Needed for scaling the implementation of the activity appropriately
 - Should be a range
 - Content may have flexibility
 - Accuracy may be difficult to achieve
 - No single database captures the wide range of costs for past BPS projects
 - The commercial payload developer market is evolving and is difficult to forecast

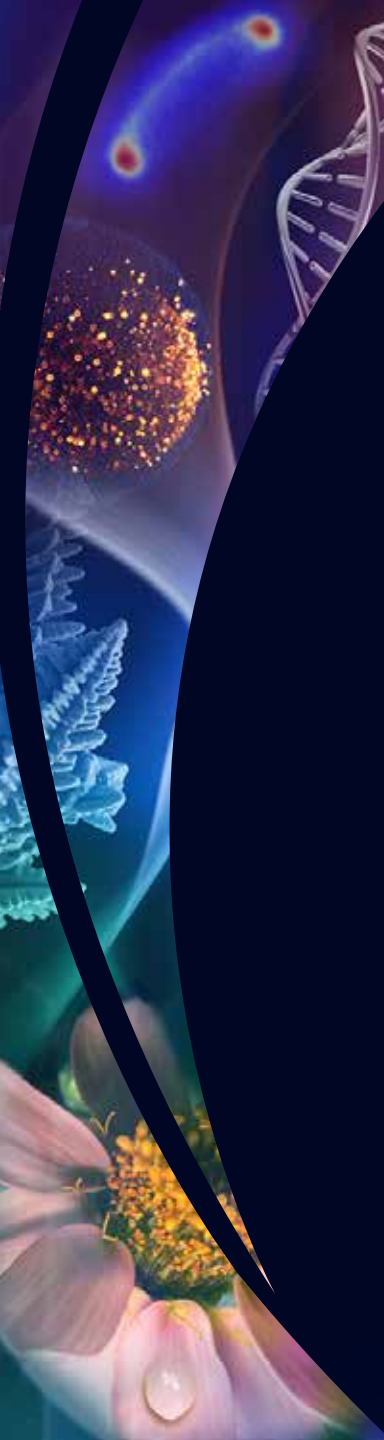
Reference: Statement of Task





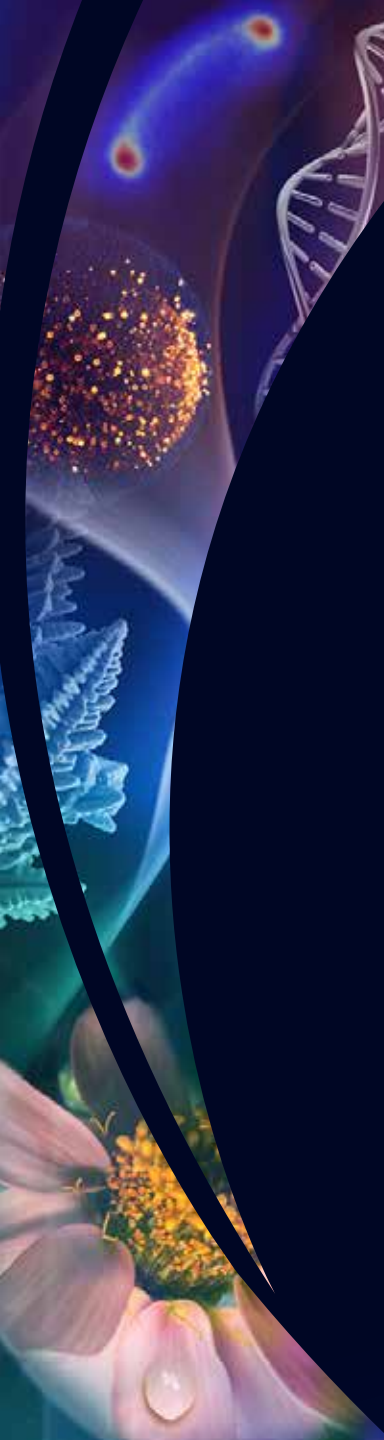
Introduction

The National Academies of Sciences, Engineering, and Medicine will appoint a decadal survey committee to carry out a decadal survey of biological and physical sciences research in space. The study will generate consensus recommendations to implement a comprehensive strategy and vision for a decade of transformative science at the frontiers of biological and physical sciences research in space. The results of the study will assist NASA in defining and aligning biological and physical sciences research to uniquely advance scientific knowledge, meet the needs of human and robotic exploration missions, and provide terrestrial benefits.



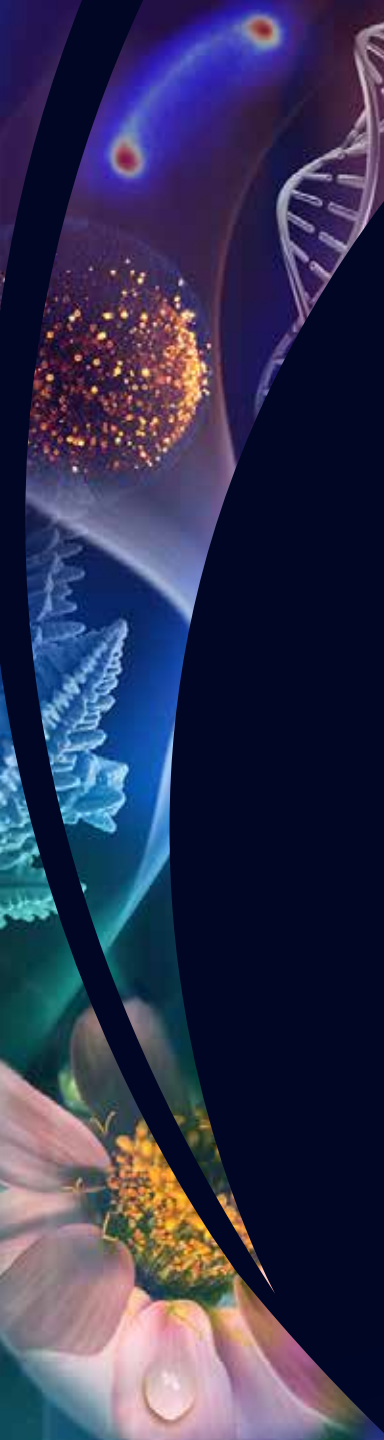
Task 1

Conduct a review of the current state of knowledge in the major and emerging areas of space-related biological and physical sciences research;



Task 2

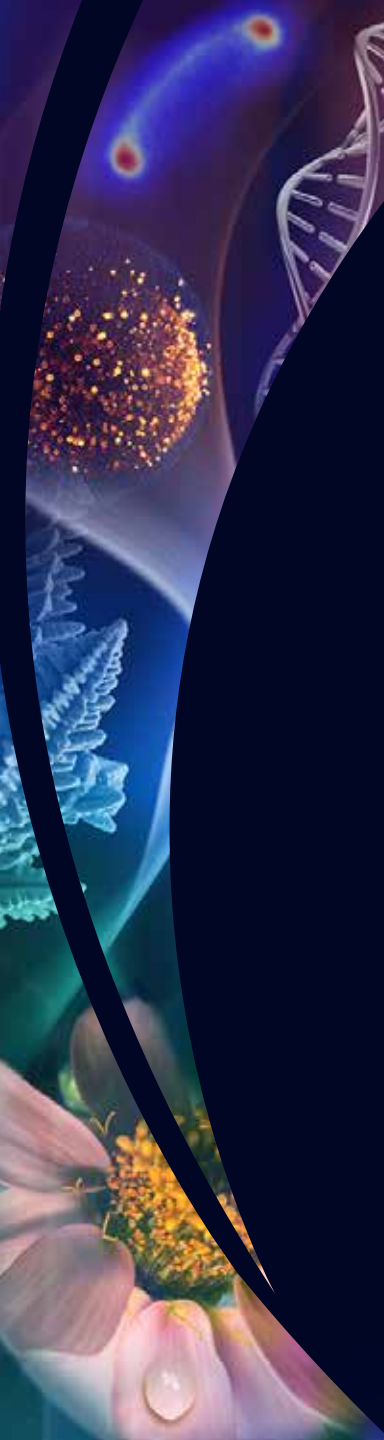
Identify the most compelling science challenges and frontiers to be pursued utilizing spaceflight environments and analogues of spaceflight conditions that will enable scientific discovery, address the needs of space exploration, and/or result in applications on Earth;



Task 3 a, b

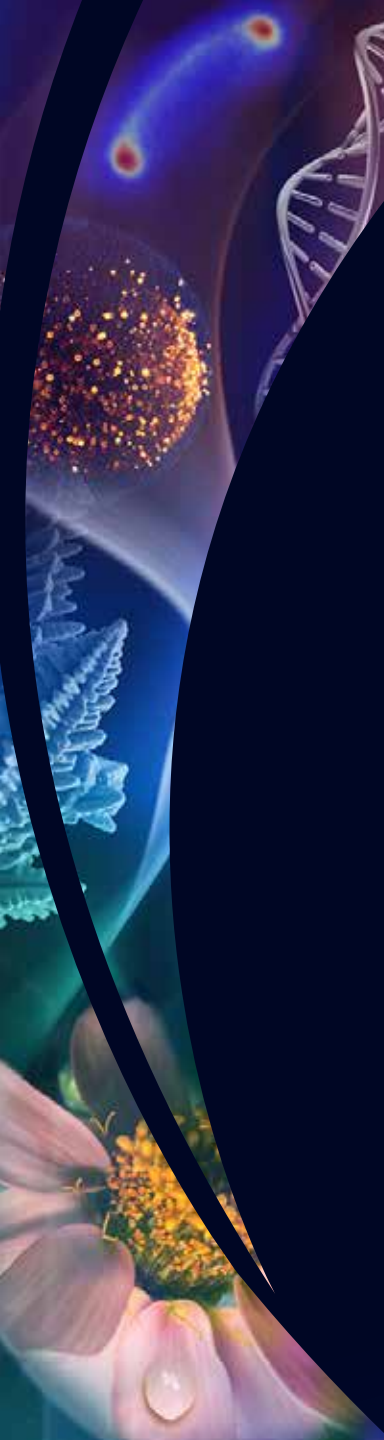
Develop a comprehensive research strategy to advance the frontiers of biological and physical sciences research in space that will include identifying, recommending, and ranking the highest priority research activities — taking into account for each activity the scientific case, international and commercial activities, and opportunities for partnerships. Where feasible and useful, such factors as timing, cost category and cost risk, technical readiness, and technical risk, will also be considered. The strategy should:

- a) Recommend approaches to facilitate the development of a robust, resilient and appropriately balanced program of biological and physical science space research that will enable scientific discovery, address the scientific and technological needs of space exploration and/or result in applications on Earth;
- b) Identify facility and platform capabilities and environmental requirements for each of the recommended research activities as appropriate, including facilities or capabilities not currently available but which could be developed in the future;



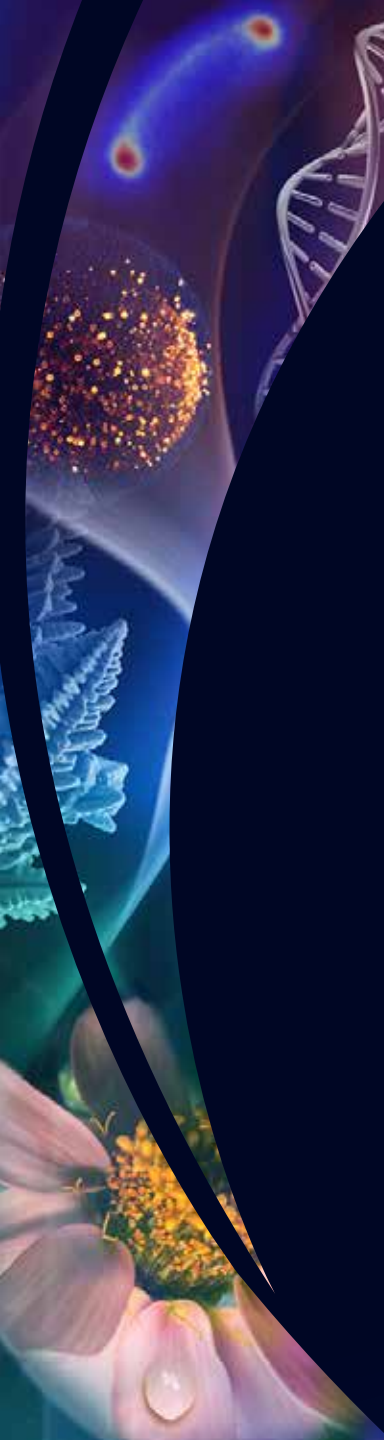
Task 3 c, d, e

- c) Assemble notional proof-of-concept research campaigns, where appropriate synergies may be achieved, that address identified prioritized research activities as part of complex or multi-disciplinary missions or mission sets including those that make use of cost-effective ground analogues and sub-orbital flights.
- d) Utilize the Technical Risk and Cost Evaluation (TRACE) process on large recommended spaceflight projects (those costing more than \$100M) and on any other projects selected by the Committee.
- e) Organize the recommended research activities, associated facilities and platforms, and proof-of-concept research campaigns into broad cost categories in order to assist NASA's understanding of the top-level scientific performance and resource options.



Task 4

Recommend broad decision rules, where appropriate, so that NASA can consider accommodating significant deviations in the projected budget or changes in priorities precipitated by new discoveries or new commercial achievements.



Cross-cutting Research Needs and Infrastructure

As part of its review the committee will consider and address relevant cross-cutting research needs and key aspects of the infrastructure--including NASA, commercial, and international programs and plans--that may affect the conduct of research. Potential infrastructure topics that will be considered include:

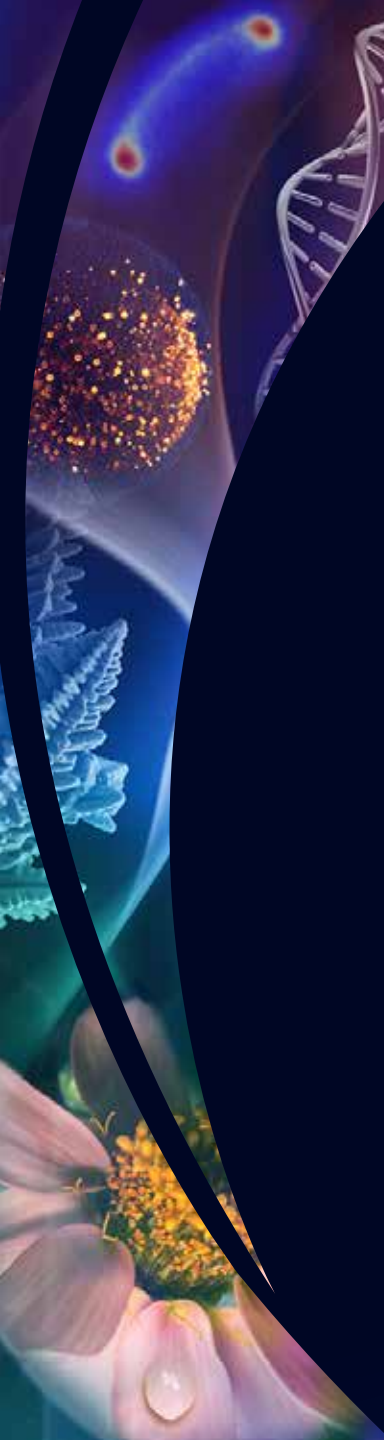
- Where NASA capabilities or ability to assume high risk enable it to uniquely support the research enterprise, and where support roles might feasibly be transitioned to commercial providers,
- Roles played by NASA's biological and physical sciences program in supporting the conduct of space research, particularly in light of the mission and capabilities of the International Space Station (ISS) National Laboratory, limited lifetime of the ISS, and the prospect of commercial platform(s) in low Earth orbit (LEO),
- Existing and potential new research synergies between NASA and other U.S. government agencies, opportunities for collaborative research that are relevant to science priorities between Science Mission Directorate's science divisions, as well as with commercial entities and international partners; and
- The current position and expected evolution of the U.S. relative to other countries in the areas covered by the study, including the uniqueness (or lack thereof) of U.S. efforts.



Considerations

In considering the emerging availability of commercial platforms, facilities and services for research in LEO and beyond, the committee should include an awareness of the space-related programs within other agencies and non-government organizations. While the focus of the committee will be on the next decade, the committee may also identify potential research objectives that extend beyond that timeframe. This study should build upon the findings and recommendations of previous National Academies' studies. As part of its work, the committee will also:

- Describe how the identified research objectives could produce knowledge, enable exploration activities, or provide benefits to terrestrial and other applications;
- Recommend criteria for identifying and updating a high value research portfolio that is enabled by exploration and/or enables exploration;
- Apply these criteria to recommend a high value research portfolio that is enabled by exploration and/or enables exploration.



Scope

When selecting biological and physical science disciplines that will be reviewed in this report, the committee will generally consider discipline areas covered in the previous decadal report, as well as emerging areas of interest. However, the committee will not review the discipline areas of NASA's program of risk identification and mitigation for astronauts except to the extent that biological research in microbiology, animal biology or plant biology could inform that program. Translational research, innovative methods and procedures, and pre-clinical studies (particularly those involving understanding biological processes, normal or pathophysiological adaptation to microgravity, and mechanisms of action) may be included.