

Appendix A:

1.0 Biological and Physical Sciences (BPS)

In July 2020, NASA's biological and physical sciences research was transferred from the Space Life and Physical Sciences Research & Applications (SLPSRA) Division in the Human Exploration and Operations Mission Directorate (HEOMD) into the Biological and Physical Sciences (BPS) Division in the Science Mission Directorate (SMD).

The mission of BPS is two-pronged:

- Pioneer scientific discovery in and beyond low Earth orbit to drive advances in science, technology, and space exploration to enhance knowledge, education, innovation, and economic vitality
- Enable human spaceflight exploration to expand the frontiers of knowledge, capability, and opportunity in space

Execution of this mission requires both scientific research and technology development.

BPS administers NASA's:

- Space Biology Program, which solicits and conducts research to understand how biological systems accommodate to spaceflight environments
- Physical Sciences Program, which solicits and conducts research to understand how physical systems respond to spaceflight environments, particularly weightlessness

BPS partners with the research community and a wide range of organizations to accomplish its mission. Grants to academic, commercial and government laboratories are the core of BPS's research and technology development efforts.

Additional information on BPS can be found at: <https://science.nasa.gov/biological-physical>

1.1 Space Biology Program

The Space Biology Program within NASA's Biological and Physical Sciences Division focuses on pioneering scientific discovery and enabling human spaceflight exploration. Research in space biology has the following goals:

- To effectively use microgravity, radiation, and the other characteristics of the space environment to enhance our understanding of fundamental biological processes.
- To develop the scientific and technological foundations for a safe, productive human presence in space for extended periods and in preparation for exploration.
- To apply this knowledge and technology to improve our nation's competitiveness, education, and the quality of life on Earth.

Research proposals are being solicited on the following topics:

- Organismal Biology – responses of whole organisms and their systems to ionizing radiation and/or other spaceflight-relevant stressors such as altered gravity simulators.
 - These will be ground-based studies.
 - Ionizing radiation and altered gravity regimes (partial gravity and microgravity) are a hallmark of the deep space environment. These stressors may cause direct physiological changes in the organisms or result in indirect effects such as loss of sleep in some organisms. Studies should effectively delineate the biological effects of these factors, separately and/or in combination where possible. See information on radiation facilities below.
 - Understand the mechanistic bases of the changes induced in these unique environments, preferably from a systems biology perspective, and could include genetic, cellular, or molecular biological effects.

- Advanced *in vitro* models: 3D Tissues and Tissue Chips or Microphysiological Systems – Using advanced *in vitro* models to investigate biological mechanisms associated with exposure to ionizing radiation.
 - These will be ground-based studies.
 - Ionizing radiation, specifically space radiation, is a concern for astronauts on deep space long duration missions. Understanding the mechanisms of damage induced by ionizing radiation will be important to inform risks to astronauts and develop effective countermeasures. Studies proposing ionizing radiation should use space relevant radiation exposures and doses. See information on radiation facilities below.

Information on radiation facilities:

- The NASA Space Radiation Laboratory (NSRL) is an irradiation facility capable of supplying particles from protons to gold with primary energies in the range of 50-2500 MeV for protons and 50-1100 MeV/n for high-mass, high-energy (HZE) particles. Selection of beam species and energies for experimental periods will be made by NASA officials in consultation with scientists proposing experiments for these beams. Activities at the NSRL are a joint effort of Brookhaven National Laboratory's Collider-Accelerator Department, providing accelerated particle beams, and the Biosciences Department, providing experimental area support, animal care, and cell and biology laboratories. The NSRL includes irradiation stations, beam controls, and laboratory facilities required for most radiobiological investigations. Additional information about NSRL may be found at <https://www.bnl.gov/nsrl/>.
- Colorado State University low dose rate neutron facility is another ionizing radiation facility that provides low dose rate neutrons. Details can be found at: <https://three.jsc.nasa.gov> under "IN THE NEWS– JULY 2018" or by email to michael.weil@colostate.edu. Gamma-rays (Cs or Co) should be used as the reference radiation for studies. Significant justification needs to be provided to use X-rays with energies below 300 peak kilovoltage (kVp) as a reference radiation. Gamma controls must be completed at BNL for comparison with heavy

charged particles, specifically for the calculation of relative biological effectiveness (RBE). Gamma ray exposures can also be performed at Colorado State University.

All proposals submitted to the EPSCoR Research Announcement are required to include a data management plan (DMP) that describes how data generated through the course of the proposed research will be shared and preserved, including timeframe, or explain why data sharing and/or preservation are not possible or scientifically appropriate, or why the data need not be made publicly available. Specifically, for this Research Announcement, award recipients are required to upload all relevant data in the GeneLab Data Systems (<https://genelab.nasa.gov>), as well as make all analytical models, tools, and software produced under the funded research, as well as related documentation, available to NASA. Furthermore, articles published in peer-reviewed scholarly journals and papers published in peer-reviewed conference proceedings, should be made publicly accessible via NASA's PubSpace website (Submit to PubSpace - Scientific and Technical Information Program (nasa.gov)).

Further information for the Space Biology program are available at:
<https://science.nasa.gov/biological-physical/programs/space-biology>
<https://science.nasa.gov/biological-physical/documents>