GeneLab: A Systems Biology Platform for Spaceflight Omics Data

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NASA's mission includes expanding our understanding of biological systems to improve life on Earth and to enable long-duration human exploration of space. Resources to support large numbers of spaceflight investigations are limited. NASA's GeneLab project is maximizing the science output from these experiments by: (1) developing a unique public bioinformatics database that includes space bioscience relevant "omics" data (genomics, transcriptomics, proteomics, and metabolomics) and experimental metadata; (2) partnering with NASA-funded flight experiments through bio-sample sharing or sample augmentation to expedite omics data input to the GeneLab database; and (3) developing community-driven reference flight experiments.

The first database, GeneLab Data System Version 1.0, went online in April 2015. V1.0 contains numerous flight datasets and has search and download capabilities. Version 2.0 will be released in 2016 and will link to analytic tools.

In 2015 Genelab partnered with two **Biological Research in Canisters** experiments **(**BBRIC-19 and BRIC-20) which examine responses of *Arabidopsis thaliana* to spaceflight. GeneLab also partnered with **Rodent Research-1** (RR1), the maiden flight to test the newly developed rodent habitat. GeneLab developed protocols for maxiumum yield of RNA, DNA and protein from precious RR-1 tissues harvested and preserved during the SpaceX-4 mission, as well as from tissues from mice that were frozen intact during spaceflight and later dissected. GeneLab is establishing partnerships with at least three planned flights for 2016. Organism-specific nationwide Science Definition Teams (SDTs) will define future GeneLab dedicated missions and ensure the broader scientific impact of the GeneLab missions.

GeneLab ensures prompt release and open access to all high-throughput omics data from spaceflight and ground-based simulations of microgravity and radiation. Overall, GeneLab will facilitate the generation and query of parallel multi-omics data, and deep curation of metadata for integrative analysis, allowing researchers to uncover cellular networks as observed in systems biology platforms. Consequently, the scientific community will have access to a more complete picture of functional and regulatory networks responsive to the spaceflight environment.. Analysis of GeneLab data will contribute fundamental knowledge of how the space environment affects biological systems, and enable emerging terrestrial benefits resulting from mitigation strategies to prevent effects observed during exposure to

space. As a result, open access to the data will foster new hypothesis-driven research for future spaceflight studies spanning basic science to translational science.