

National Aeronautics and Space Administration

NASA GeneLab Concept of Operations

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Abstract

NASA's GeneLab aims to greatly increase the number of scientists that are using data from space biology investigations onboard ISS, emphasizing a systems biology approach to the science. When completed, GeneLab will provide the integrated software and hardware infrastructure, analytical tools and reference datasets for an assortment of model organisms. GeneLab will also provide an environment for scientists to collaborate thereby increasing the possibility for data to be reused for future experimentation. To maximize the value of data from life science experiments performed in space and to make the most advantageous use of the remaining ISS research window, GeneLab will apply an open access approach to conducting spaceflight experiments by generating, and sharing the datasets derived from these biological studies in space.

Onboard the ISS, a wide variety of model organisms will be studied and returned to Earth for analysis. Laboratories on the ground will analyze these samples and provide genomic, transcriptomic, metabolomic and proteomic data. Upon receipt, NASA will conduct data quality control tasks and format raw data returned from the 'omics centers into standardized, annotated information sets that can be readily searched and linked to spaceflight metadata. Once prepared, the biological datasets, as well as any analysis completed, will be made public through the GeneLab Space Bioinformatics System web-based portal.

These efforts will support a collaborative research environment for spaceflight studies that will closely resemble environments created by the Department of Energy (DOE), National Center for Biotechnology Information (NCBI), and other institutions in additional areas of study, such as cancer and environmental biology. The results will allow for comparative analyses that will help scientists around the world take a major leap forward in understanding the effect of microgravity, radiation, and other aspects of the space environment on model organisms. These efforts will speed the process of scientific sharing, iteration, and discovery.

Goals for GeneLab

- Develop an integrated repository and bioinformatics data system for analysis and modeling
- Enable the discovery and validation of molecular networks that are influenced by space conditions through ground-based and flight research using next-generation omics technologies
- Engage the broadest possible community of researchers, industry, and the general public to foster innovation
- Strengthen international partnerships by leveraging existing capabilities and data sharing

Motivation

GeneLab supports goals of NASA's Space Life and Physical Sciences Division and the International Space Station (ISS) Program (figure 1).



Figure 1. These NASA Programs are part of the Human Exploration and Operations Mission, one of the four major missions that help NASA meet its strategic goals.

Flight Research Agreements

GeneLab will acquire space-flown samples (and/or data), process the samples for data generation, and employ an open-access model to expand the scientific audience.

Project	Collaboration	Agreement	Status
RR-1	Specimen Sharing	GeneLab Collaborative Agreement (CGA) with Project	GCA in progress
RR-2	Specimen Sharing	Experiment Requirements Document (ERD)	ERD signed off
RR-3	Specimen Sharing	Experiment Requirements Document	ERD sign off in progress
Bioculture Validation	Specimen Sharing	GeneLab Collaborative Agreement with Project	GCA signed off
BRIC-19	Equipment Augmentation	Collaborative Agreement with PI NASA-Approved augmentation funding	GCA signed off
BRIC-20	Equipment Augmentation	Collaborative Agreement with PI NASA-Approved augmentation funding	GCA in progress

Table 1. 2014-15 missions that will provide tissues and data for GeneLab. GeneLab data will be produced in addition to the data returned for a specific principal investigator-led mission experiment.

GeneLab Cycle of Innovation Through an Open-Access Model

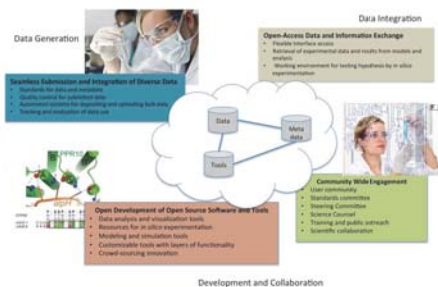


Figure 2. Full data integration, community engagement, and availability of open source software in a single web interface will augment scientific research. This model will enable formation of novel hypotheses and follow-on space grants.

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Approach

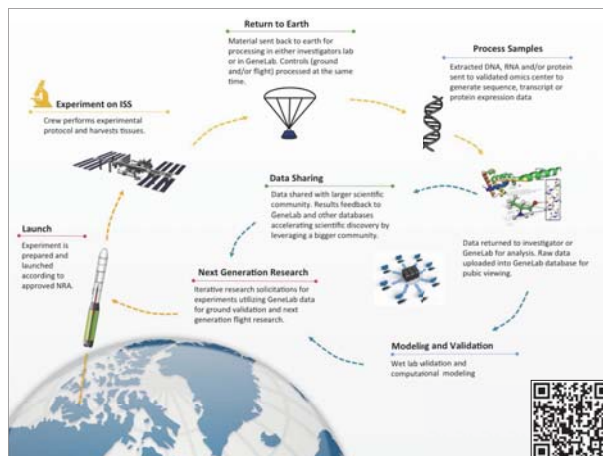


Figure 3. Leveraging space biology experiments to drive an ongoing cycle of innovation. To maximize the value of data from life science experiments performed in space, and to make the most advantageous use of the remaining ISS research window, GeneLab will employ an open-access approach performing spaceflight experiments, generating, saving, and sharing the datasets derived from biological research in space. The quick response code in the lower right corner links directly to the GeneLab Strategic Plan.

Timeline: The GeneLab Project Phases

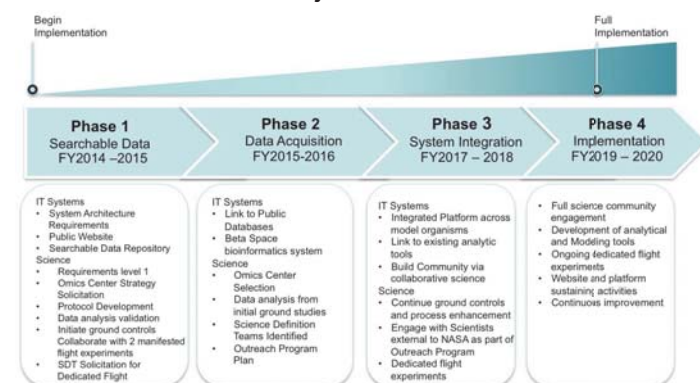


Figure 4. The GeneLab project will follow four distinct phases of implementation. Each phase of the project will be marked by increasing capability and broader data sets available through GeneLab. The final phase of the project will achieve the full implementation of GeneLab.

Expected Impact and Benefits

- Maximize Return On Investment (ROI) for Life Sciences Flight Experiments and ISS Utilization
- Maximize Use of Modern Bioanalytical Tools and Techniques
- Create a PI-Multiplier Effect for Space Biology
- Speed the Pathway to Discovery and Application
- Leverage both NASA and External Partner Strengths

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Visit our website at: <http://genelab.nasa.gov/>