GeneLab: “Omics” Data Systems for Space Biology Research

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http://genelab.nasa.gov
I. Introduction
II. GeneLab Motivation
III. GeneLab Data Systems
IV. Summary
What is GeneLab?

- new *systems approach* to space biology research
- open science and open data platform
GeneLab Structure

Data Systems & Repository

- Data Repository
- Analysis
- Access to Data
- Modeling

Research & Development

- Ground Research
- Flight Research
- Data Generation from Model Organisms
- Sample Processing

Access to Data from Model Organisms

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GeneLab Motivations
ISS Based Research

• New technologies to produce high quality Omics data from research missions aboard the ISS

• Limited access and high demand for the ISS platform

• Facilitate Systems biology to predict and/or mitigate changes due to microgravity

NASA astronaut Barry "Butch" Wilmore setting up the Rodent Research-1 Hardware in the Microgravity Science Glovebox aboard the International Space Station

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GeneLab Motivations

• Maximize ROI for ISS Utilization

• Create a PI Multiplier Effect

• Leverage NASA and External Partner Strengths

• Maximize Utilization of Cutting Edge Bioanalytical Tools and Techniques

• Speed the Pathway to Translation

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GeneLab Goals

1. Develop an integrated repository and bioinformatics data system

2. Enable the discovery and validation of molecular networks using next-generation omics technologies.

3. Engage the broadest possible community

4. Strengthen international partnerships

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Material sent back to earth for processing in investigators lab. Controls (ground and/or flight) processed at the same time.

Extracted DNA, RNA and/or protein sent to validated omics center to generate sequence, transcript or protein expression data.

Crew performs experimental protocol and harvests tissues.

Data shared with larger scientific community. Results feedback to GeneLab and other databases accelerating scientific discovery by leveraging a bigger community.

Data returned to investigator or GeneLab for analysis. Raw data uploaded into GeneLab database for public viewing.

Iterative research solicitations for experiments utilizing GeneLab data for ground validation and next generation flight research.

Computational modeling and wet lab validation.

Data Collection & Hosting

GeneLab Data Systems

Next Generation Research

Modeling and Validation

Process Samples

Launch

Return to Earth

Experiment on ISS

Concept of Operations
## Mission Types

<table>
<thead>
<tr>
<th>Mission</th>
<th>Type</th>
<th>Definition</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dedicated</td>
<td>Reference Data</td>
<td>Mission is entirely dedicated to GeneLab objectives; the Science Definition Team (SDT) defines the experiment and requirements; SDT is selected through the NASA Research Announcement process</td>
<td>TBD</td>
</tr>
<tr>
<td>Collaborative</td>
<td>Data &amp; Sample Sharing</td>
<td>GeneLab obtains specimens/samples from the existing PI space flight and ground control experiment</td>
<td>Rodent Research (Mouse)</td>
</tr>
<tr>
<td></td>
<td>Data &amp; Sample Augmentation</td>
<td>GeneLab provides supplemental funding to a PI experiment to increase the quantity of specimens and perform processing to obtain dedicated sample; augmentation requires NASA SLPS experiment review approval process</td>
<td>BRIC-19 (plant), BRIC-20 (plant) (BRIC=Biological Research in Canisters)</td>
</tr>
<tr>
<td>Individual</td>
<td>PI Mission</td>
<td>Funded and planned PI experiments</td>
<td>Data Submission</td>
</tr>
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# Current Collaborative Missions

<table>
<thead>
<tr>
<th>Year</th>
<th>Payload</th>
<th>Mission Type</th>
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</thead>
<tbody>
<tr>
<td>2015</td>
<td>BRIC-19</td>
<td><strong>Dr. Simon Gilroy</strong>&lt;br&gt;University of Wisconsin-Madison&lt;br&gt;Space Biology NRA Award</td>
</tr>
<tr>
<td></td>
<td>BRIC-20</td>
<td><strong>Dr. Sarah Wyatt</strong>&lt;br&gt;Ohio University&lt;br&gt;Space Biology NRA Award</td>
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<tr>
<td></td>
<td>RR-1</td>
<td><strong>Dr. Ruth Globus</strong>&lt;br&gt;NASA&lt;br&gt;Validation Mission for Rodent Habitat</td>
</tr>
</tbody>
</table>

(RR: Rodent Research; BRIC: Biological Research In Canisters)

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GeneLab Data Systems
GeneLab Phased Data Implementation

Overview 2014-2021

We Are Here

**Phase 1**
Searchable Data
FY2014 – 2015

**Phase 2**
Data Acquisition
FY2015-2016

**Phase 3**
System Integration
FY2017 – 2018

**Phase 4**
Implementation
FY2019 – 2021

**GLDS**
- Public website
- Searchable data repository

**Science**
- Pre-Flight validation, rodent proteomic profiling
- Collaborate with two flight experiments

**GLDS**
- Link to public databases

**Science**
- Data analysis from initial ground and flight studies

**GLDS**
- Integrated Platform

**Science**
- Outreach
- Dedicated flight experiments

**Community engagement**
- Development of analytical and modeling tools
- Ongoing dedicated flight experiments

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Anticipated Sources of Data

- NASA funded Legacy Data
- NASA PI research (SLPS)
- PI research (other flight program)
- Collaborative experiment
- National Labs
- NASA International partners
- GeneLab science definition team (dedicated experiment)
- Other

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Types of Analyses

Building Blocks of life

Genes (DNA) ↔ Genomics ↔ Epigenomics

mRNA ↔ Transcriptomics

Protein ↔ Proteomics

Metabolomics

Functional States

What can happen

What appears to be happening

What makes it happen

What has happened and is happening

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Systems Biology

Modules generate a scale-free hierarchical architecture

Building blocks, cell's functional modules

cell's metabolic pathways

cell's functional organization

(from Oltvai-Barabasi, Science, Oct 02)

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• Omics Data Repository (22 dataset online)
• Basic study metadata search
• Omics Data Repository
• Basic study metadata search
• Study metadata display
GeneLab Data Systems v1.0
http://genelab.nasa.gov/data

- Omics Data Repository
- Basic study metadata search
- Study metadata display
- Data retrieval

DEMO
GeneLab will serve as an open access database containing “Omic” datasets for model organisms relevant to spaceflight, allowing cross-species comparison.

Will provide a tool for basic research to translate into discovery utilizing ISS research.

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Call to Action

• **Visit** the gene lab site: [http://genelab.nasa.gov](http://genelab.nasa.gov)

• **Sign up** for the gene lab mailing list at: [http://genelab.nasa.gov/community.html](http://genelab.nasa.gov/community.html)

• **Share/Submit** your data sets: [http://genelab.nasa.gov/data/](http://genelab.nasa.gov/data/)
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