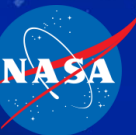


Open Science for Life in Space



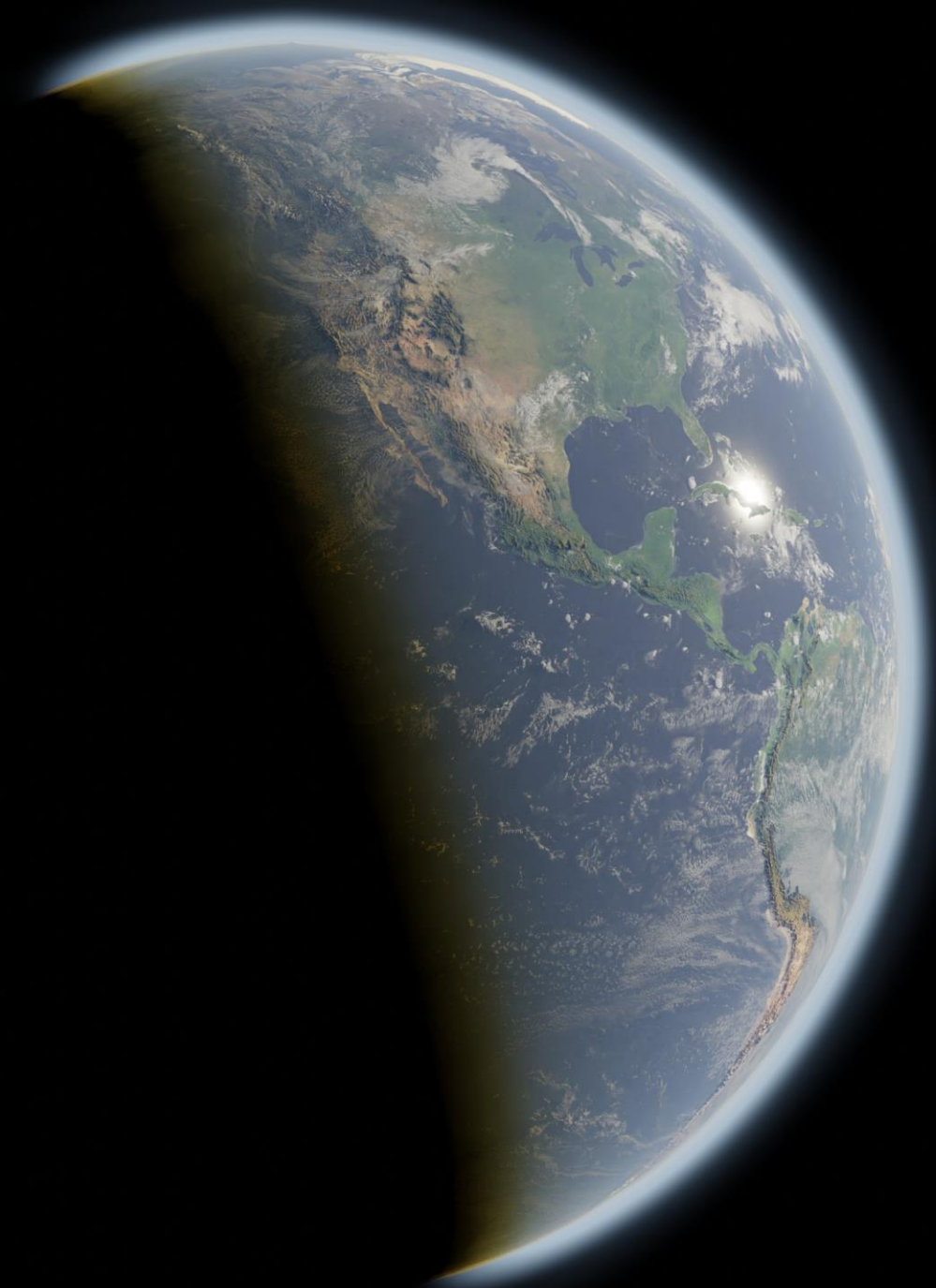
Sylvain V. Costes, Ph.D.
Space Biosciences Research Branch Chief
Project Manager for Open Science for Space Biology (GeneLab/ALSDA)
NASA Ames Research Center

National Aeronautics and
Space Administration



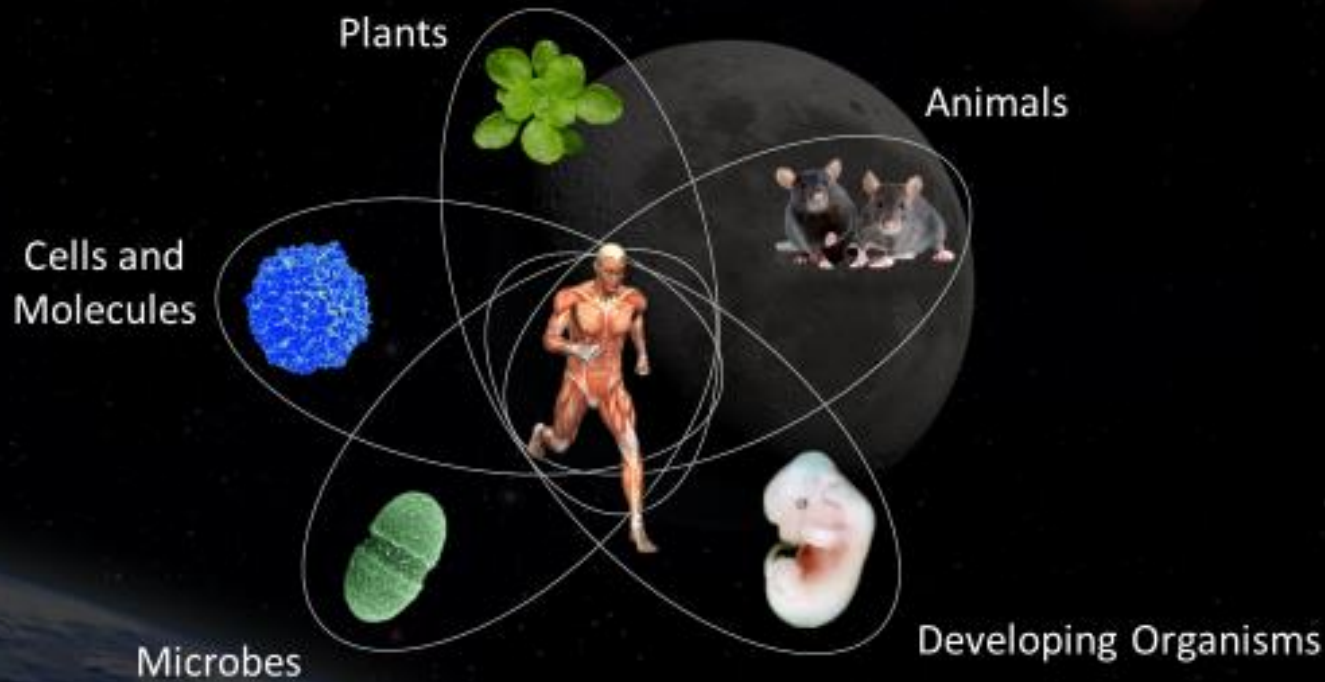
Open Science

“We define open science as a collaborative culture enabled by technology that empowers the **open sharing of data, information, and knowledge** within the scientific community and the wider public to accelerate scientific research and understanding.”



Space Biology

To pursue safe and successful space exploration
Space Biology investigates five elements:

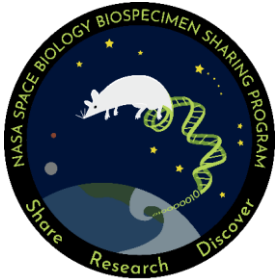


Basic life processes

Applications for human space travel

NASA BPS Open Science

Biospecimen Sharing Program (BSP)



Dissection and preservation of rodent tissues from Flight and Ground investigations. Coordination of internal tissue sharing



NASA Biological Institutional Scientific Collection (NBISC)



Collection of non-human specimens and space microbial culture



Ames Life Sciences Data Archive (ALSDA)



Collection and curation of mission, project, and imaging data

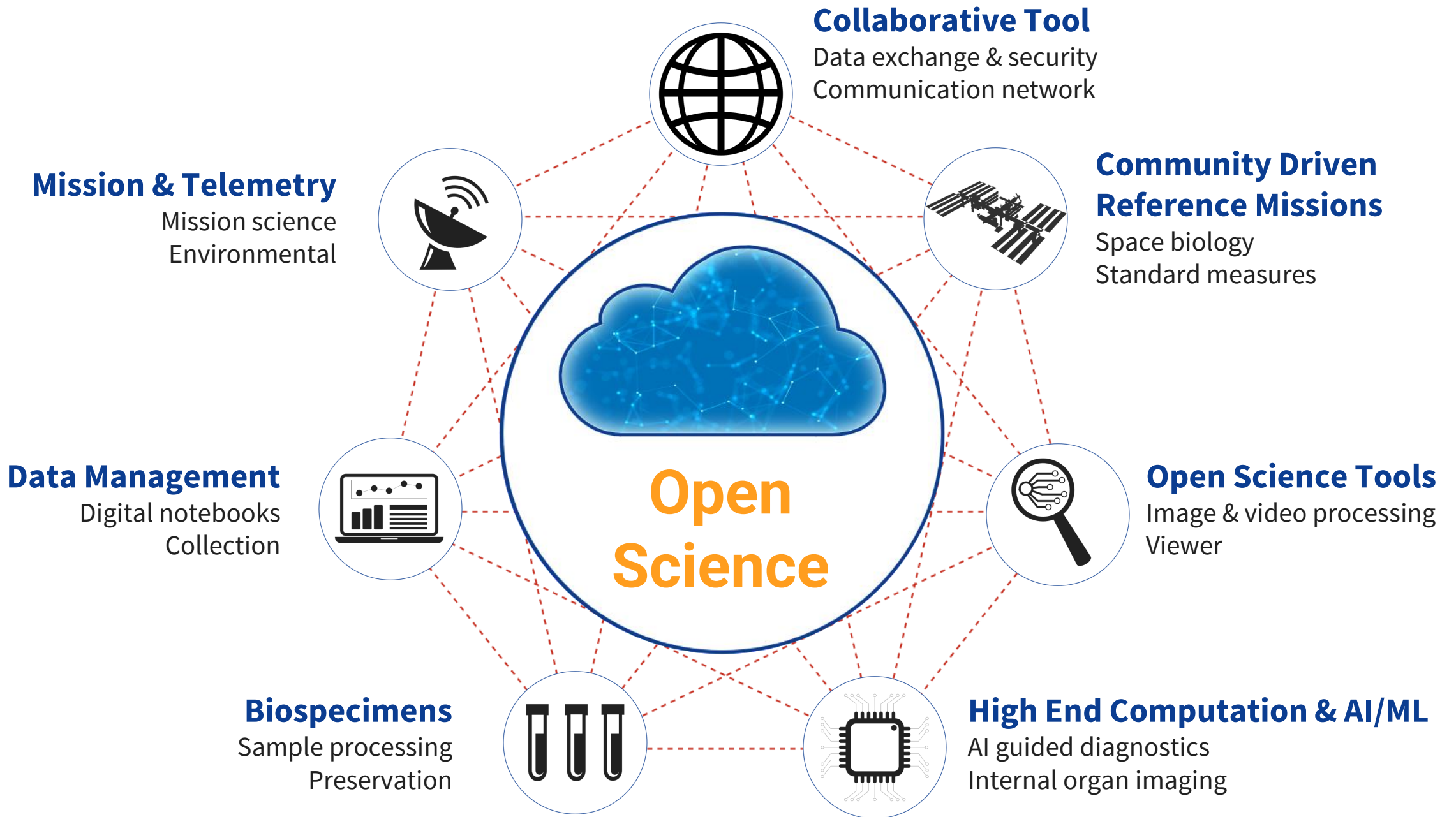
NASA GeneLab (GL)

Collection and curation of omics data



NASA Internal Program

Open-Source Science Programs



Centralizing information of different types of data

osdr.nasa.gov/bio



Open Science Projects

Open Science Projects primary goals aim to increase collaborative scientific data sharing, analysis and more rapid scientific advancement.

GeneLab

GeneLab, an open science multi-omics repository, covering transcriptomics, metagenomics, epigenomics, proteomics, and metabolomics. Studies comprise of data from model organisms including microbes, plants, fruit flies, rodents and humans.

Learn more GeneLab

BSP

The NASA Space Biology Biospecimen Sharing Program (BSP) collects biospecimens to maximize the scientific return from biological spaceflight and associated ground investigations and to encourage and broaden participation from the scientific community in space biology-related research.

Learn more about BSP

ALSDA

Ames Life Sciences Data Archive (ALSDA) collects, curates, and makes available space-relevant higher-order phenotypic datasets. Datasets that enable scientists to perform retrospective analysis across missions, experiments, life science disciplines, research subjects, and species.

Learn more about ALSDA

NBISC

NASA Biological Institutional Scientific Collection (NBISC) is a biorepository of non-human samples collected from NASA-funded spaceflight investigations and correlative ground studies. The purpose of NBISC is to receive, store, document, preserve, and make the collection available to the scientific community.

Learn more about NBISC



Search Filters

Data Source

- GeneLab
- NIH GEO
- EBI PRIDE
- ANL MG-R-ST
- ALSDA

GeneLab Search Filters

Project Type

- Ground
- Spaceflight
- Parabolic Flight Study

Assay Type

- Microarray
- RNA Sequencing (RNA-Seq)
- Single-Cell RNA Sequencing
- miRNA Sequencing (miRNA-Seq)
- Nucleotide Sequencing

Show more

COMMON ONLINE SEARCH

Data Repository Search

Search Datasets

Items per page: 25 | 1 - 25 of 385

Organisms	Factors	Assay Types	Release Date	Description	
GLDS-512	Mus musculus	Spaceflight Ionizing Radiation	transcription profiling	03-Aug-2022	The objective of the Rodent Research-23 missions (RR-23) was to better understand the effects of spaceflight on the eyes, specifically on the structure and function of the arteries, veins, and lymphat...
GLDS-511	Mus musculus	Spaceflight Age Ionizing Radiation	transcription profiling	03-Aug-2022	In Rodent Research Reference Mission-1 (RRRM-1), also known as RR-8, forty female BALB/cAnNTac mice were flown on the International Space Station. To assess differences in outcomes due to age, twenty ...
GLDS-510	Arabidopsis thaliana	Ionizing Radiation Time of Sample Collection After	transcription profiling	15-Nov-2018	To combat DNA damage, organisms mount a DNA damage response (DDR) that results in cell cycle regulation, DNA repair and, in severe cases, cell death.

Mission Telemetry Data

Ascent

Flight

Return

Ground Control

ENVIRONMENTAL DATA (common to both)

Relative Humidity, Temperature, CO2, O2, Airflows, Acceleration, Radiation, Acoustics, etc.

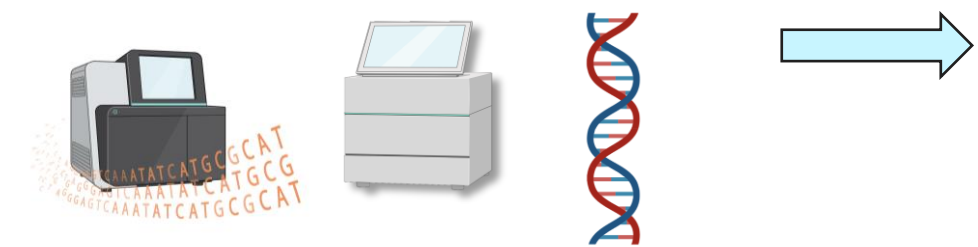
Multi-Hierarchical, Multi-Modal Data Mining Together, for Many Computational-Informatic Approaches Including AI/ML

Formation of NASA's Open Science Data Repository

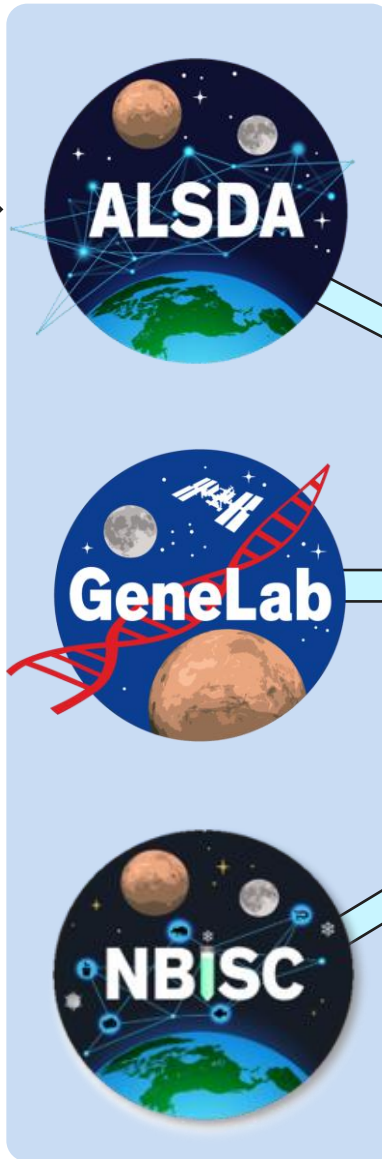
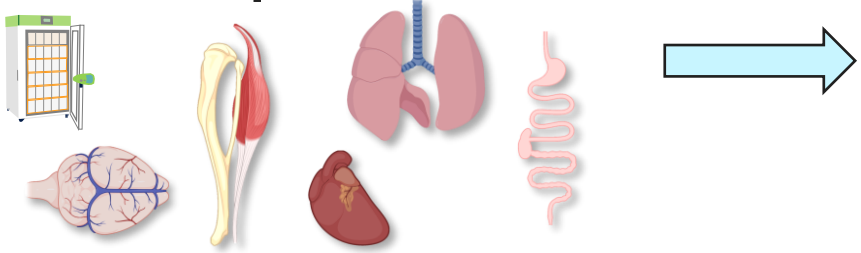
Physiological/Phenotypic/Imaging/ Environmental Telemetry Data



Molecular/Omics Data



Biospecimens

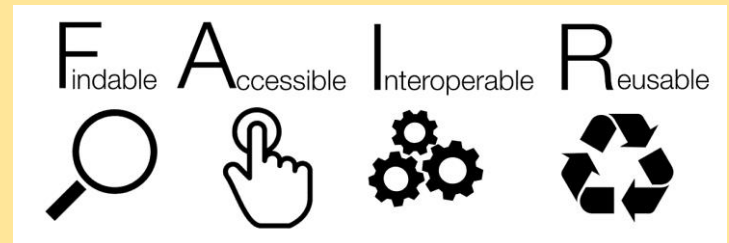


NASA Open Science Data Repository (OSDR)

osdr.nasa.gov/bio

- Single Submission Portal (BDME)
- User Interface/Website Tool for RDSAs (Research Data Submission Agreements)
- Maximally Open Access with Necessary Controls for Sensitive Data

- Data Maximally FAIR



Breakdown of a Reusable Dataset: Architecture, Curation, FAIRness

OSDR Meta/Data Model

Leverages/inspired by "ISAtab"

investigation

- Contacts, description, study factors, provenance

sample

- Table w/individual subject-sample parameters, study design, independent variables, sample collection metadata

assay

- Table w/individual subject-samples by assay with device name, settings, targets, parameters, reagents, **standards** SME-driven

data

- Various formats to maximize reuse, machine-readable
- Tabular, text, images, video
- Molecular-omics, physiological-phenotypic-behavior-imaging
- Raw, submitted, processed, transformed for reusability

Open Science Dataset (OSD-488)



OSD-488 Version 1
Characterizing SERCA of Spaceflight from R

257.05 KB

Study

Submitted Date: 28-Mar-2022
Initial Release Date: 20-Jan-2023

ALSDA ID: LSDS-13
DOI: 10.26030/3nve-tk61

Cite this Study

OSDR Submission Portal

The Biological Data Management Environment (BDME) is a web-based space-relevant data to be published in the Open Science Data Repository. New users create an account. Register account. Note: If it is your first time signing in, you will be directed to a NASA G account, please register using the same email to have access to your account. Already have a NASA Account? Log in



- Global Unique Identifiers



- Secure/Integrated Credentials

investigation

Description

Description

It is well established that microgravity exposure causes significant muscle weakness and atrophy via disproportionate loss in muscle force and size with the loss in muscle force occurring at a faster rate. Ca²⁺ dysregulation has been suggested. The sarco(endo)plasmic reticulum Ca²⁺ ATPase (SERCA) is muscle relaxation and maintaining low intracellular Ca²⁺ ([Ca²⁺]_i). SERCA dysfunction contributes to may contribute to the muscle weakness and atrophy observed with spaceflight. Here, we investigate and reactive oxygen/nitrogen species (RONS) protein adduction in murine skeletal muscle after 35-36 spaceflight led to drastic impairments in Ca²⁺ uptake despite significant increases in SERCA1a protein. RONS production and elevated total protein tyrosine (T) nitration and cysteine (S) nitrosylation. Cont enhancement in Ca²⁺ uptake, which we attribute to a shift towards a faster muscle fiber type (i.e., in elevated total protein T-nitration and S-nitrosylation). Thus, spaceflight affects SERCA function differently from the calcium uptake (spectrofluorometry) assay.

Factor(s)

Factor	Ontology: Concept
Spaceflight	Space Flight
Tissue	Space Mission
Space Mission	Space Mission

Organism(s)

Mus musculus

Assay(s)

Measurement	Technology	Device Platform
Calcium Uptake	Spectrofluorometric Assay	Molecular Devices M2 p

Project

Project Identifier	RR-1, RR-8
Project Title	Rodent Research 1 (RR-1) (ARR0000146), Rodent Research 8 (RR8) (ARR0000200)
Project Type	Spaceflight Study
Flight Program	ISS
Experiment Platform	Rodent Habitat
Space Program	NASA
NASA Center	Ames Research Center (ARC)
Funding Source	This research was funded by an internal (Brook University) unrestricted grant to V.A.F. and a C Plasticity and Remodeling Throughout the Lifespan to V.A.F., J.L.B. was supported by a CNHR by a GEF doctoral award. We thank the NASA Ames Life Sciences Data Archive and the NASA Collection for the provision of the samples and the entire NASA Ames Research Center team missions. We also thank the Brook Library Open Access Publishing Fund.

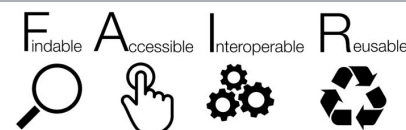
Contact(s)

Val A. Fajardo, Jessica L. Braun, Ma S. Geromella, Sophie I. Hamstra, Holl N. Mesinger



- Metadata Normalization
 - ie., mus musculus
 - ie., Space Flight

How/Why Maximally FAIR?



Breakdown of a Reusable Dataset: Architecture, Curation, FAIRness

sample
n

- Individual Subject/Sample Independent Variable Metadata
- Study Design Metadata

Source Name	Sample Name	Factor Value: Spaceflight	Factor Value: Tibialis	Characteristic: sex	Factor Value: Space Mission	Character: Launch
RRR_GC11	GC11_t1a	Ground Control	tibialis anterior	male	SpaceX-12 (RRR)	10 week
RRR_GC12	GC12_t1a	Ground Control	tibialis anterior	male	SpaceX-12 (RRR)	10 week
RRR_GC13	GC13_t1a	Ground Control	tibialis anterior	male	SpaceX-12 (RRR)	10 week
RRR_GC14	GC14_t1a	Ground Control	tibialis anterior	male	SpaceX-12 (RRR)	10 week
RRR_GC15	GC15_t1a	Ground				
RRR_GC16	GC16_t1a	Ground				
RRR_GC17	GC17_t1a	Ground				
RRR_GC18	GC18_t1a	Ground				
RRR_GC19	GC19_t1a	Ground				
RRR_GC20	GC20_t1a	Ground				

Interoperable

- Metadata Normalization
 - i.e. muscle names / time
- Tibialis anterior

investigation
sample n **assay** n

Find an ontology

Start typing ontology name, then choose from list

Browse Ontologies

Findable **A**ccessible **I**nteroperable **R**eusable

- Rich Metadata
- Metadata Schemas
- Community Standards

Interoperable

assay
n

- Dependent Variable Metadata
- How assay was conducted
- Specs of device, settings, software, processing details, etc

Sample Name	Assay Name	Parameter Value: Condition	Parameter Value: Duration	Parameter Value: Read	Parameter Value: Temperature	Assay Name	Raw Data File	Parameter Value: Read
GC11_t1a	calcium uptake	tibialis anterior	45 min at 20h interval	57 degree Celsius	SpecMax Molecular IM	calcium uptake	Not Available	LSDS-13_calcium uptake_Final
GC12_t1a	calcium uptake	tibialis anterior	45 min at 20h interval	57 degree Celsius	SpecMax Molecular IM	calcium uptake	Not Available	LSDS-13_calcium uptake_Final
GC13_t1a	calcium uptake	tibialis anterior	45 min at 20h interval	57 degree Celsius	SpecMax Molecular IM	calcium uptake	Not Available	LSDS-13_calcium uptake_Final
GC14_t1a	calcium uptake	tibialis anterior	45 min at 20h interval	57 degree Celsius	SpecMax Molecular IM	calcium uptake	Not Available	LSDS-13_calcium uptake_Final

- Metadata Normalization
 - i.e., OCT (optical coherence tomography)
 - OCT (media/sectioning; optimum cutting temperature)

Reusable

data

- Raw, Processed; Submitted, Transformed
- Tabular, text, imaging, video
- AWG standardized nomenclature
- Maximally human & machine-readable

Study Files

Search Files

Selected: 0

OSD-488

Calcium Uptake

Processed Data Files

LSDS-13_calcium uptake_tibialis anterior TRANSFORMED_1

Original Submitted Results Data Files

Study Metadata Files

Version History

Selected Version

Version 1

Updated Date: 20-Jan-2023

Changes: New data release

Files Added (4)

- LSDS-13_calcium uptake_Final
- LSDS-13_calcium uptake_tibialis anterior
- LSDS-13_calcium uptake_tibialis anterior
- LSDS-13_calcium uptake_tibialis anterior

Reusable

- Community Standards
- Data Provenance

45

Species

>150 TB

Data

>25

Assays

433

Studies

819

Datasets

NASA OSDR (GL and ALSDA)

OSDR Database (GeneLab and ALSDA)

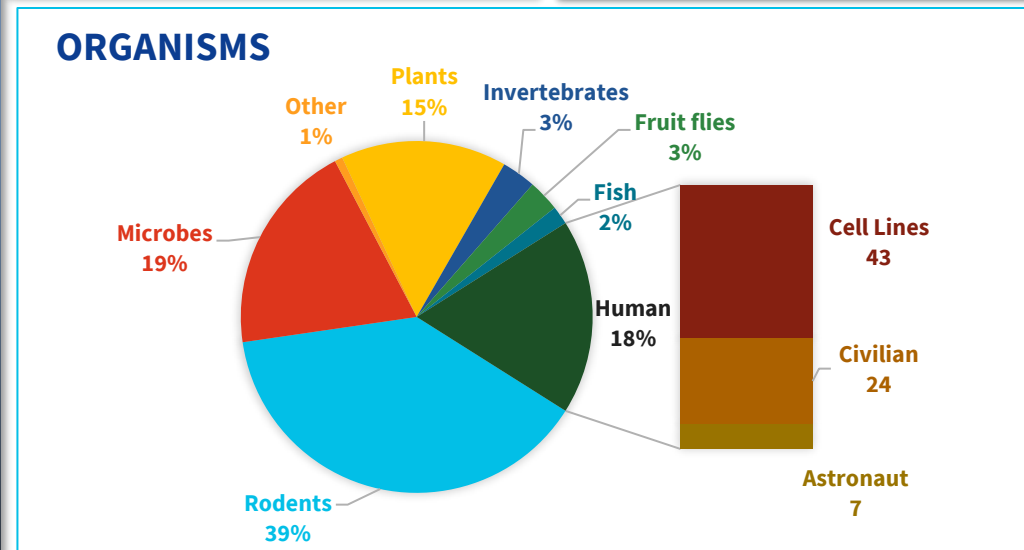
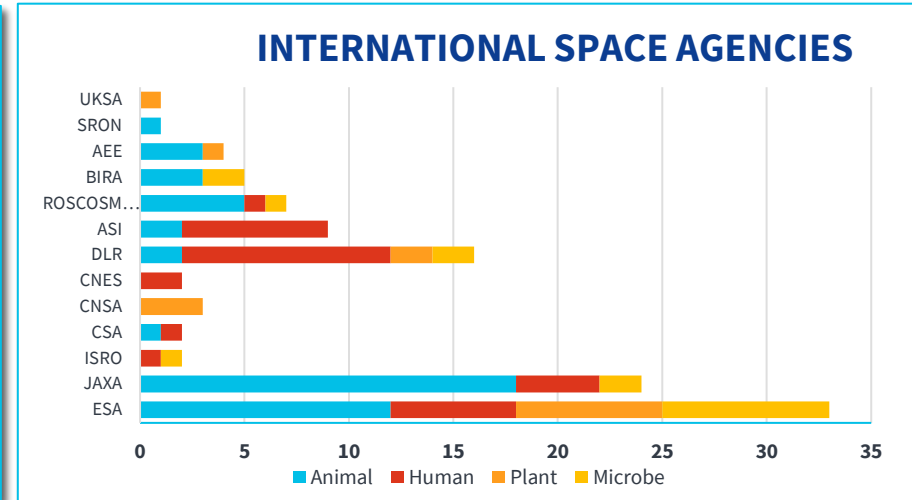
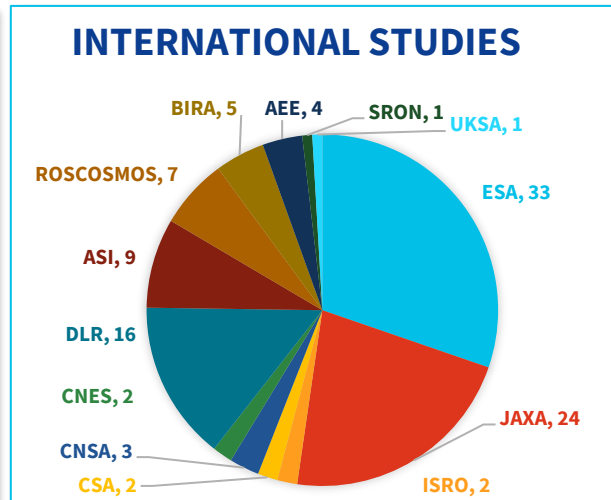
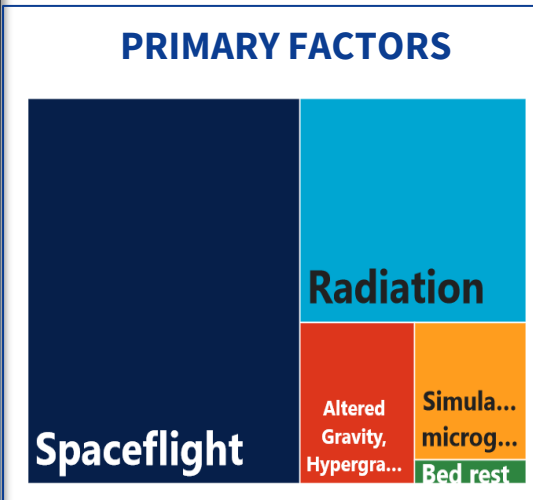
433
Studies

819
Datasets

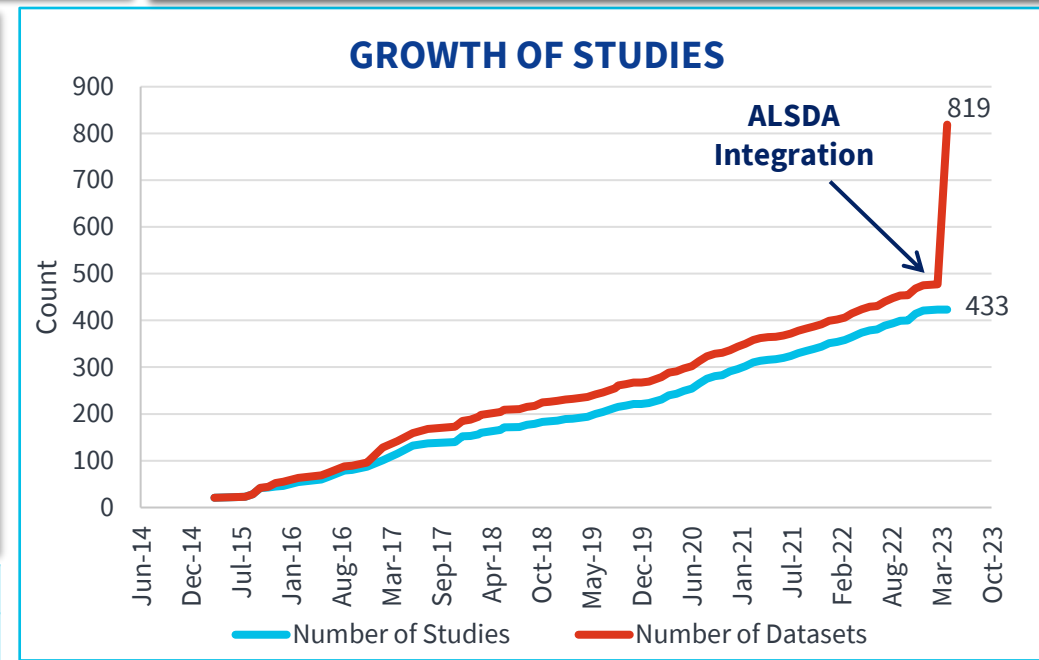
45
Species

>25
Assays

>150TB
Data

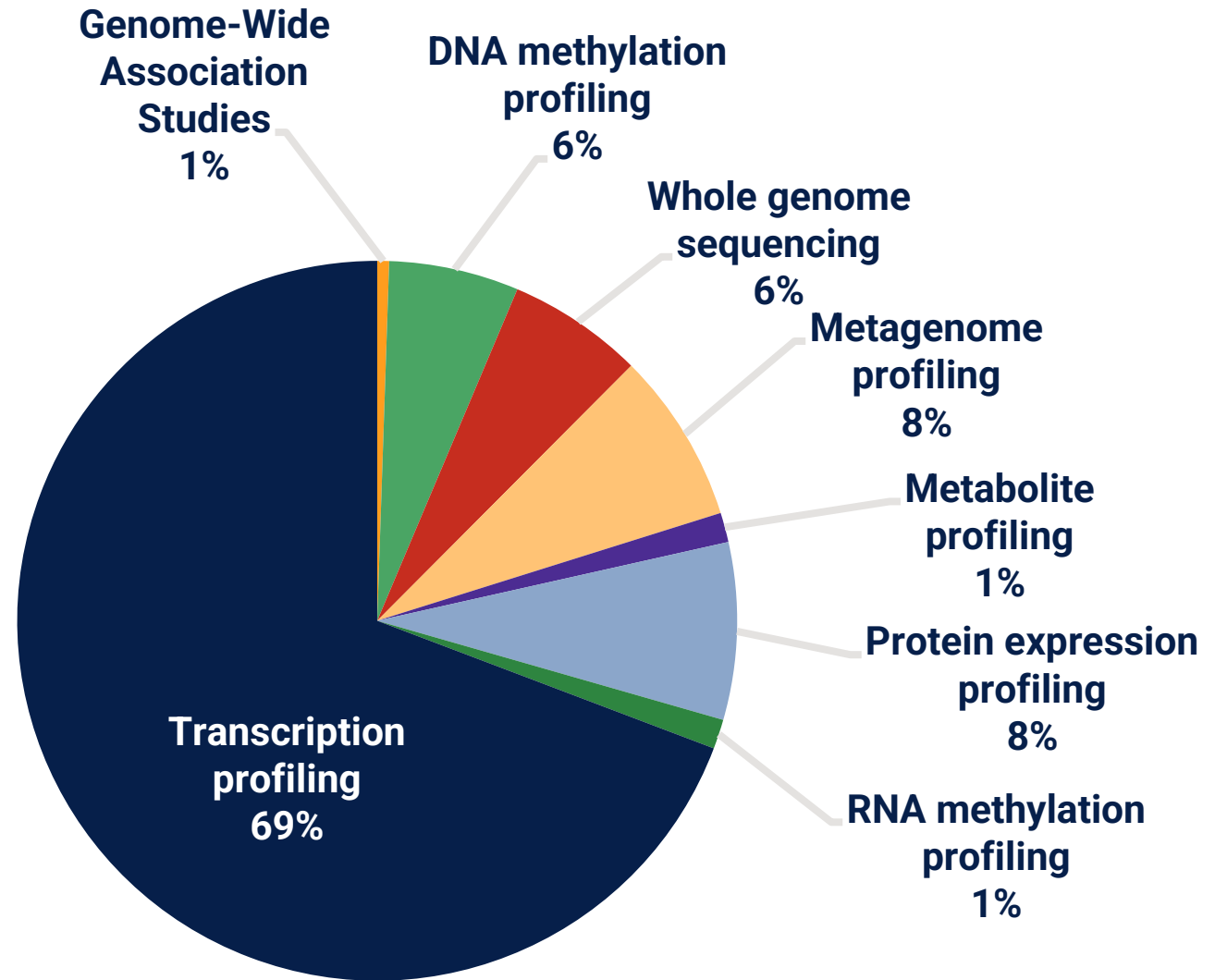


Civilian and Astronaut	Bed Rest, Spaceflight, Mars simulation
Cell Lines	Radiation (Ground), Simulated uG, Spaceflight, Parabolic Flight

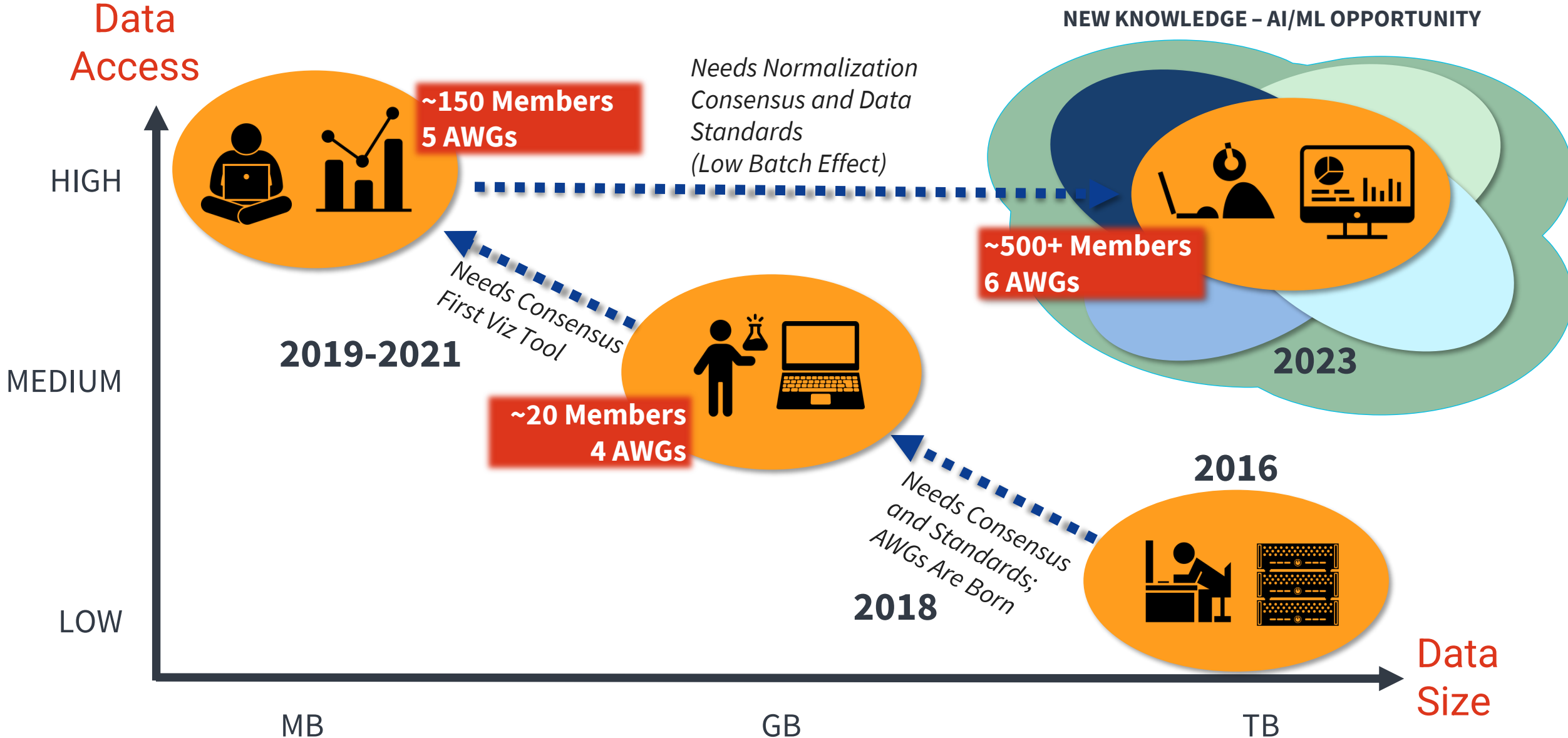


*Data originates from Gene Expression Omnibus (GEO) and EMBL's European Bioinformatics Institute (EMBL-EBI) repositories.

Assays Found in GeneLab



A Brief History of the Open Science AWGs



Metrics for success

3327
Avg Monthly Sessions

1558
Avg Monthly Users

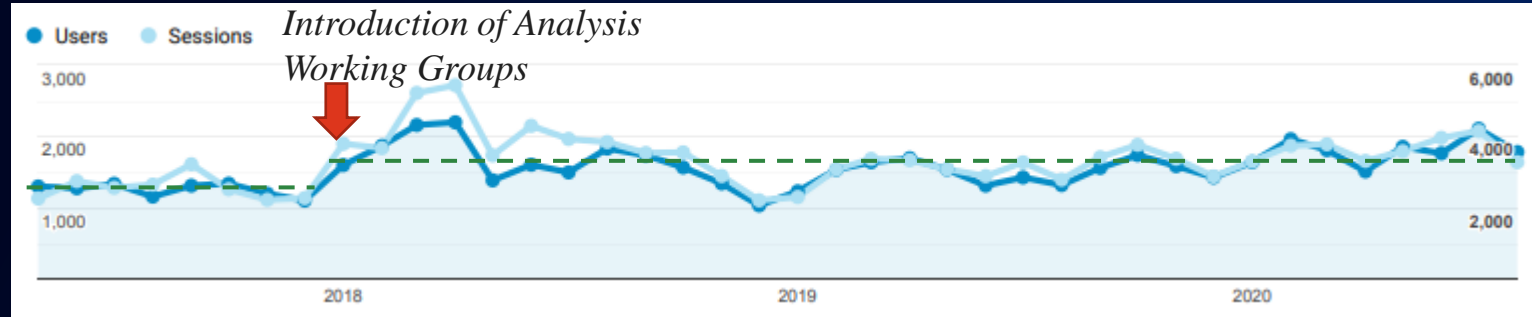
Usage: May 2017- Sept 2020

90

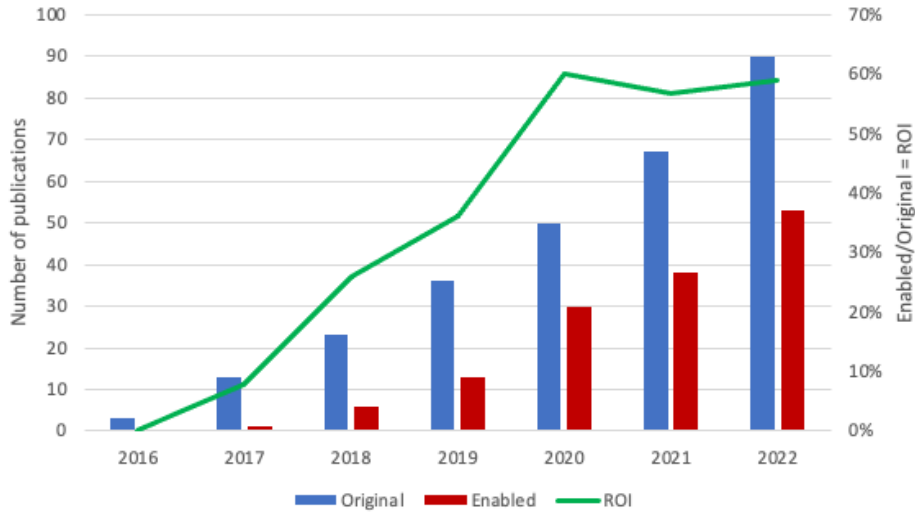
Original Publications linked to OSDR (GeneLab/ALSDA)

52

Publications Enabled by OSDR System, Data Sharing



ROI grows faster than publications linked to original



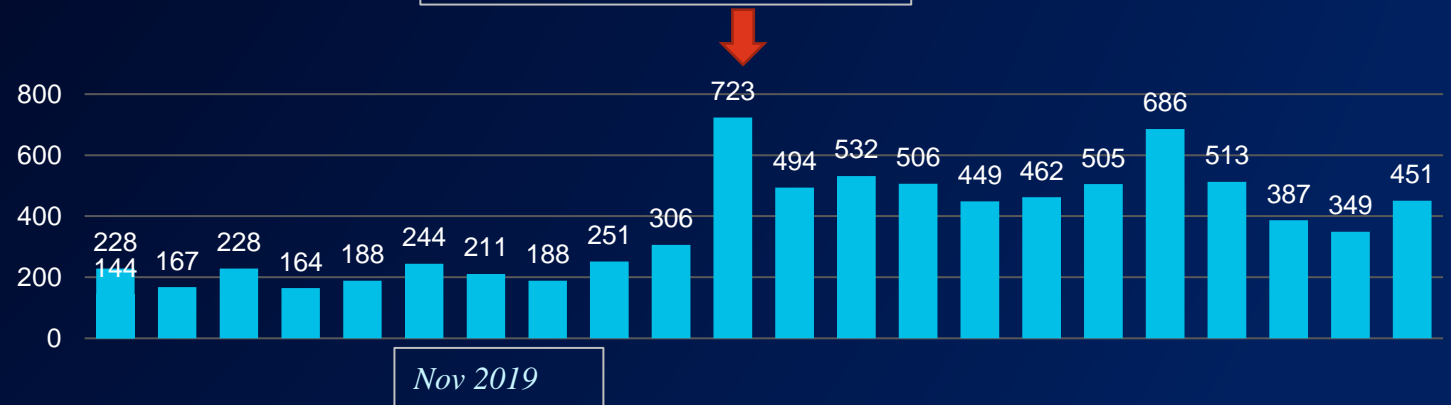
360

Avg Monthly Downloads

7189

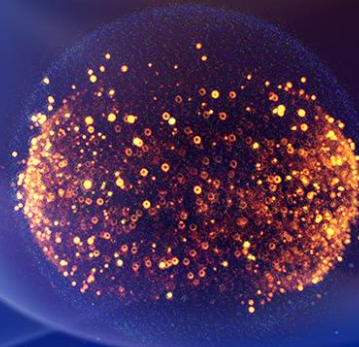
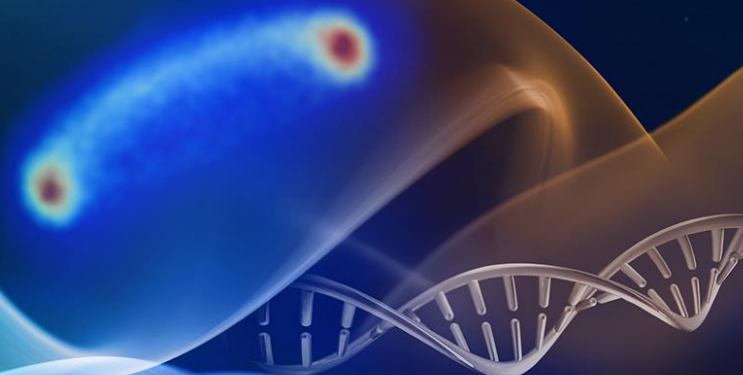
Total Study Downloads

Introduction of Processed Data and Visualization

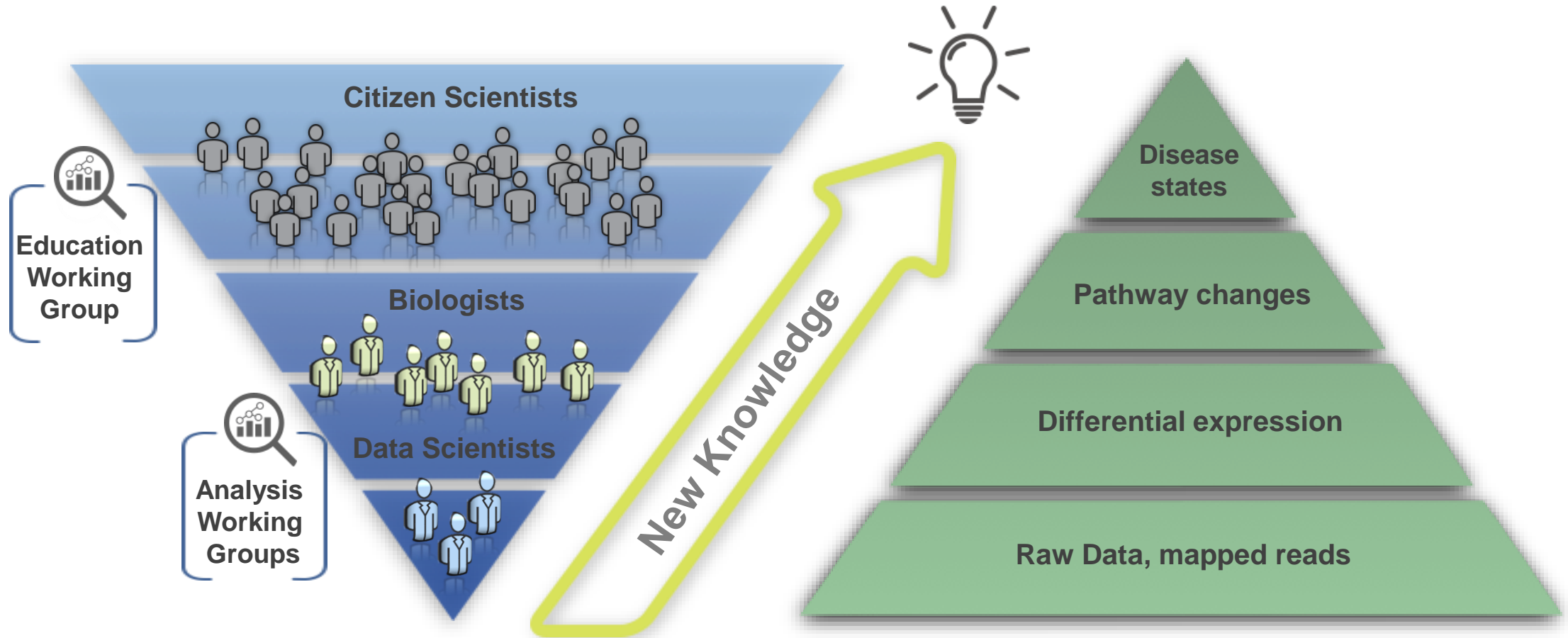


52 publications (13 publications produced by the AWGs) using data available in OSDR.

SCIENTIFIC COMMUNITY



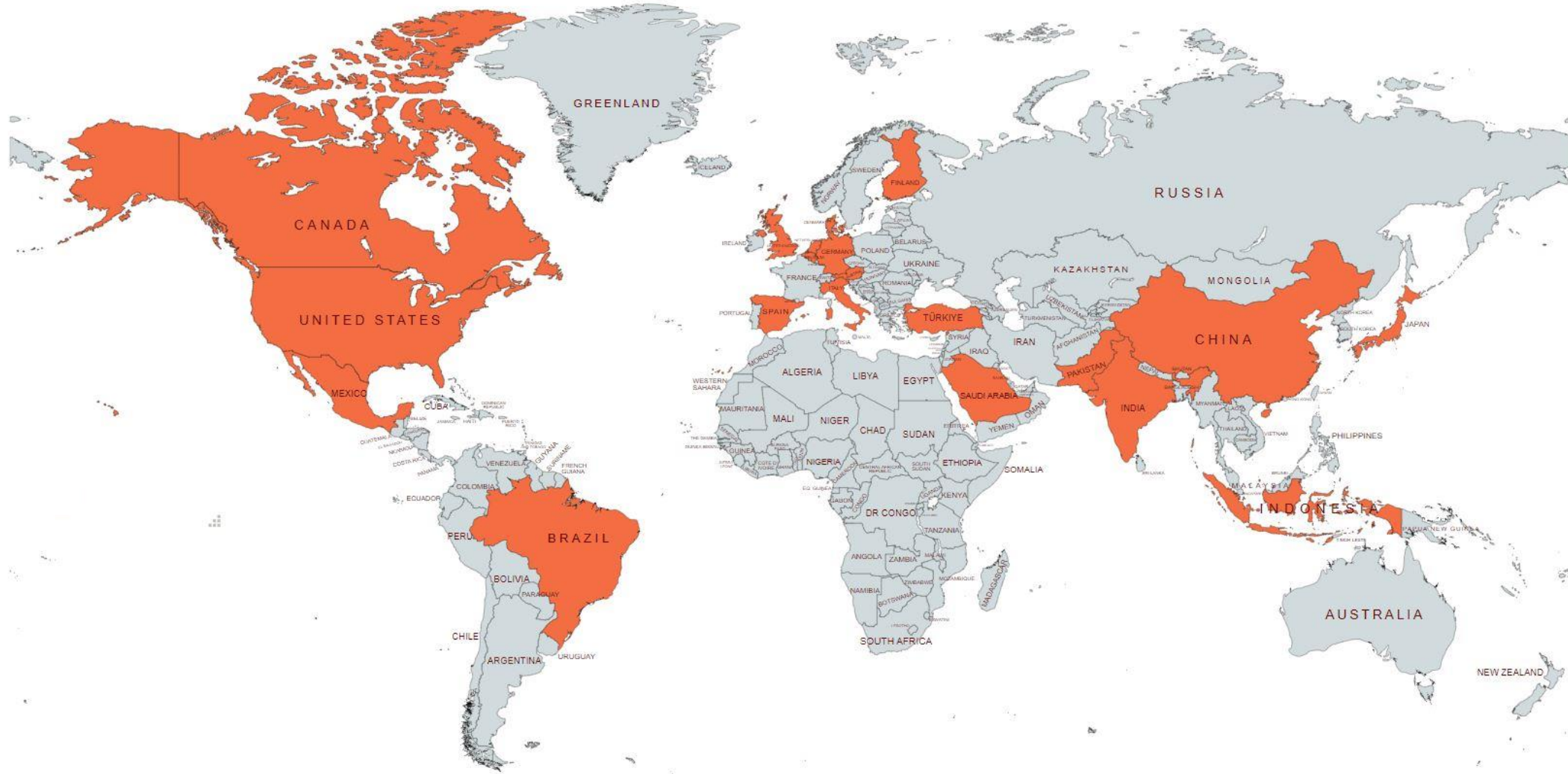
GeneLab Data Democratization



Making data accessible worldwide

Top 20 Countries Utilizing GeneLab:

- US 🇺🇸
- China 🇨🇳
- UK 🇬🇧
- India 🇮🇳
- Germany 🇩🇪
- Spain 🇪🇸
- Canada 🇨🇦
- Brazil 🇧🇷
- Japan 🇯🇵
- Netherlands 🇳🇱
- Turkey 🇹🇷
- Belgium 🇧🇪
- Indonesia 🇮🇩
- Italy 🇮🇹
- Mexico 🇲🇽
- Pakistan 🇵🇰
- Saudi Arabia 🇸🇦
- Austria 🇦🇹
- Denmark 🇩🇰
- Finland 🇫🇮



Open Science Analysis Working Groups

ANIMAL

104 members



Facilitates the use of omics in understanding basic mechanisms by which animals and constituent tissues and cells adapt to the spaceflight environment.

MULTI-OMICS

307 members



Interactions between the different omics to provide complete understanding of the entire system being studied.

MICROBES

98 members



Focuses on analyzing microbial datasets within GeneLab that includes gene-expression, proteomic, metabolomic and environmental metagenomic datasets.

PLANTS

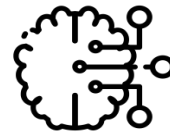
88 members



Share and discuss the latest developments in Astrobotany – the discipline of botany concerned with interactions between plant biology and space environment.

AI/ML

96 members



Focuses on developing data AI-readiness guidelines, algorithm and automation development, and developing ethical guidelines to increase trust and explainability surrounding AI in space biology.

ALSDA

138 members



Feedback on science data and metadata standards for physiological, phenotypic, and behavioral datasets to be reusable. Datasets span from raw to processed-results data, and across tabular, bioimaging, and video formats.

Consist of **500+ scientists** from multiple space agencies, international institutions, and industry. Scientists meet monthly with each group to provide feedback, develop standards, and analyze data.

We invite you to join - <https://genelab.nasa.gov/awg/join!>

Enabling our scientific community

MSI/HBCU
Educators

GL4U Direct Approach

MSI/HBCU
Students



Direct GL4U – Student Bootcamps:

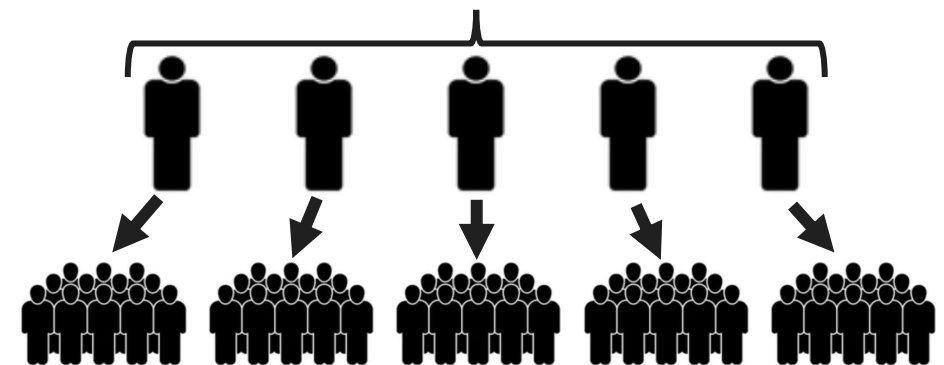
2021 – Space biology & RNAseq

- Virtual 1-week long bootcamp with 14 SJSU students
- Collaboration with USRA/SJSU; SJSU compute system
- Space biology- and RNAseq-specific lectures and hands-on instruction using Jupyter Notebooks (JNs)

2023 – Space biology & Amplicon Seq

- In-person 4-day bootcamp with 20-40 CSULA students
- Collaboration with JPL/CSULA; NSF ACCESS compute system
- Space biology- and Amplicon Seq-specific lectures and JNs

GL4U Indirect Approach



Indirect GL4U – Educator Bootcamps:

2022 – Space biology & RNAseq

- Virtual ~1.5-week long bootcamp
- Collaboration with JPL; SMCE compute system
- 6 professors and 4 graduate students from 4 HBCUs/MSIs
- Space biology- and RNAseq-specific lectures and hands-on instruction using JNs
- Resources to teach at home institution

Engaging with commercial entities: I4 Human Data into OSDR

INSPIRATION

a SpaceX Inspiration4 Spaceflight Omic and Medical Data Release

Data Location

Omic Data: ● Public (OSDR/GeneLab) ● Controlled Access (OSDR/GeneLab, TrialX)
 Clinical/Biomarker: ● Public (OSDR/ALSDA)

Samples	Assays	Raw Data	Flight Timeline										Descriptive Profile	Comparative Profile Differentials	Processed Data			
			L-92	L-44	L-3	FD1	FD2	FD3	R+1	R+45	R+82	R+194						
Blood	Whole Blood	Whole Genome Sequencing	●	●	●												●	
		Clonal Hematopoiesis	●	●	●													●
		Complete Blood Count (CBC)	●	●	●													●
	Serum	Direct RNA-seq	●	●	●													●
		Cytokine/Chemokine Biomarker Panel	●	●	●													●
		Cardiovascular Biomarker Panel	●	●	●													●
	PBMCs	Comprehensive Metabolic Panel	●	●	●													●
		Single-Nuclei RNA-seq	●	●	●													●
		Single-Nuclei ATAC-seq	●	●	●													●
	Plasma	Single-Cell TCR-seq	●	●	●													●
Single-Cell BCR-seq		●	●	●													●	
Proteomics		●	●	●													●	
EVPs	Metabolomics	●	●	●													●	
	eDNA	●	●	●													●	
	Proteomics	●	●	●													●	
Dried Blood Spot	Telomere qPCR	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
	Metagenome	●	●	●													●	
Oral Swabs	Metagenome	●	●	●													●	
	Metatranscriptome	●	●	●													●	
Nasal Swabs	Metagenome	●	●	●													●	
	Metatranscriptome	●	●	●													●	
Skin Biopsy	Spatially Resolved Transcriptomics	●	●	●													●	
	Metagenome	●	●	●													●	
Skin Biopsy	Metatranscriptome	●	●	●													●	
	Microbial Gene Expression	●	●	●													●	

Sample Type

Whole Blood	PBMC	Blood Plasma	Skin Swabs	Environmental	Skin Biopsy	Blood Serum
OSD-569 • RNA-Seq/longread • Epitranscriptomics • Complete Blood Count	OSD-579 • snRNA-seq • ATAC-seq • TCR/BCR Seq	OSD-571 • Proteomics • Metabolome • Mass Spec • cfDNA	OSD-572 • Metagenomics • Metatranscriptomics GeneLab	OSD-573 • Metagenomics • Metatranscriptomics GeneLab	OSD-574 • Spatial Transcriptomics • Metagenomics • Metatranscriptomics GeneLab	OSD-575 • Comprehensive Metabolic Panel • Cytokine Panel ALSDA

Assay Type

- OSDR able to ingest and properly curate all data for reuse

- Spring '23 Nature 'I4/JAXA/SB Package'
- Credit: Chris Mason's Lab; Overbey et al., 2023
- In Peer Review at *Nature*

- 3 New ALSDA Assay Metadata 'Configs'

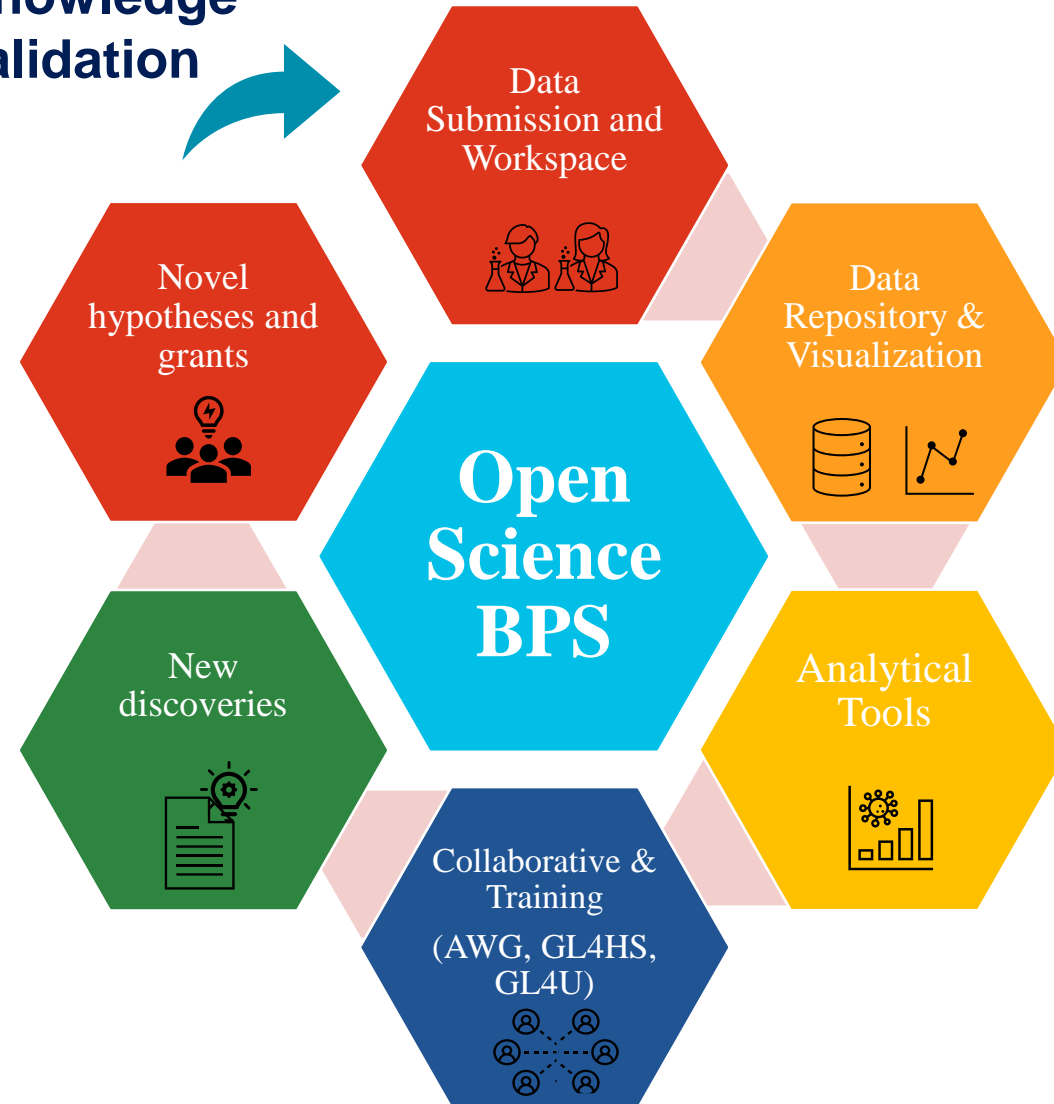
- Comprehensive Metabolic Panel (Spectrophotometry & Ion Selective Electrode)
- Complete Blood Count (Hematology Analyzer)
- Cytokine Panel (Multiplex)

OSDR OVERVIEW



Accessibility, Inclusivity, Transparency, Reproducibility

Knowledge
validation



OSDR Overview

CONTRIBUTE

My Dashboard (2462)

Search [] Sort []

All RDSA Studies Experiments

All Submitted In Curation In Review Req Signature Finalized Public Private

OSD-385: Persistence of Escherichia coli in the microbiomes of red Romaine lettuce (Lactuca sativa cv. 'Outredgeous')- does seed sanitization matter?

Public Release Date 19-Apr-2024

Lead Investigator oikhodada

SUMMARY

Seed sanitization via chemical processes removes/reduces microbes from the external surfaces of the seed and thereby could have an impact on the plants, health or productivity. To determine the impact of seed sanitization on the plants, microbiome and pathogen persistence, sanitized and unsanitized seeds from two leafy green crops, red Romaine lettuce (*Lactuca sativa* cv. 'Outredgeous'), and Mizuna mustard (*Brassica rapa* var. japonica) were exposed to *Escherichia coli* and grown in controlled environment growth chambers simulating environmental conditions aboard the International Space Station. Plants were harvested at four intervals from 7 days post-germination to maturity. The bacterial communities of leaf and root were investigated using the 16S rRNA sequencing while quantitative polymerase chain reaction (qPCR) and heterotrophic plate counts were used to reveal the persistence of *E. coli*. *E. coli* persisted for longer periods of time in plants from sanitized versus unsanitized seeds and was identified in root tissue more frequently than in leaf tissue. 16S rRNA sequencing showed dynamic changes in the abundance of members of the phylum Proteobacteria, Firmicutes, and Bacteroidetes in leaf and root samples of both leafy crops. We observed minimal changes in the microbial diversity of lettuce or Mizuna leaf tissue with time or between sanitized and unsanitized seeds. Beta-diversity showed that time had more of an influence on all samples versus the *E. coli* treatment. Our results indicated that the seed surface sanitization a requirement for sending seeds to space influences the microbiome. Insight into the changes in the crop microbiomes could lead to healthier plants and safer food supplementation.

+ Create New Version | View in OSDR | Set to Private

LEARN

File Edit View Run Kernel Git Tabs Settings

Filter files by name []

Name Last Modified

- Bootcamp... 4 months ago
- Bootcamp... 4 months ago
- Content_2 5 days ago
- efs 4 months ago
- GLDS-104 4 months ago
- ost-found 10 months ago
- myown_Ns 4 months ago
- SolarSystem 4 months ago
- align_multi... 27 minutes ago
- count_mul... 27 minutes ago
- example.csv a month ago
- example.txt a month ago
- FLT_Rep1... 27 minutes ago
- FLT_Rep1... 27 minutes ago
- infer_exp... 27 minutes ago
- R_Intro_J... a month ago
- raw_multiq... 27 minutes ago

```
## Save your volcano plot
ggsave(file.path(DGE_plots, 'GLDS-104_volcano_DGE.png'), width = 6.5, height = 8.5, dpi = 300)
```

FLT versus GC
EnhancedVolcano

● N5 ● Log2FC ● Adj. p-value ● Adj. p-value & Log2

total = 21880 variables

Gene labels: Gm5532, Cntfr, Ucnl3d, Lrrs52, Cdk11, Fam51a, Arrb2, Dhrs91, Wnt9b, Krt17

Simple | 0 | R [conda env:gl4u-r] | Idle | Mem: 4.09 / 4.00 GB | Mode: Command | Ln 2, Col 25 | RNAseq_DGE_JN_06-2022.ipynb

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Search Datasets [] Sort By: Release Date

Items per page: 25 | 1 - 25 of 448 | < > >>

OSD-385 Persistence of *Escherichia coli* in the microbiomes of red Romaine lettuce (*Lactuca sativa* cv. 'Outredgeous')- does seed sanitization matter?

Organisms: Factors Assay Types Release Date Description

Microbiota Treatment Seed Sanitization Assay Amplicon Sequencing 19-Apr-2024 Seed sanitization via chemical processes removes/reduces microbes from the external surfaces of the seed and thereby could have an impact on the plants, health or productivity. To determine the impact...

Highlights: cgen

OSD-580 Transcriptional profiling of heart tissue from mice flown on the RRRM-2 mission

Organisms: Factors Assay Types Release Date Description

Mus musculus Spaceflight Age Euthanasia Location transcription profiling 03-Jan-2024 In the Rodent Research Reference Mission (RRRM-2), forty female C57BL/6N-Tac mice were flown on the International Space Station to assess differences in outcomes due to age, twenty 12-week-old and ten...

Highlights: cgen

OSD-576 Transcriptional profiling of tibialis anterior muscle from mice flown on the RR-23 mission

Organisms: Factors Assay Types Release Date Description

Mus musculus Spaceflight transcription profiling 12-Dec-2023 The objective of the Rodent Research-23 mission (RR-23) was to better understand the effects of spaceflight on the eyes, specifically on the structure and function of the arteries, veins, and lymphatic...

Highlights: cgen

OSD-575 Ionizing radiation induces transgenerational effects of DNA methylation in zebrafish

Organisms: Factors Assay Types Release Date Description

Zebrafish DNA methylation assay 12-Dec-2023 Ionizing radiation is known to cause DNA damage, yet the mechanisms...

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NASA Open Science for Life in Space

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Explore

Number of studies: 294

Filter

Assay technology type

- DNA microarray 149
- RNA Sequencing (RNA-Seq) 134
- nucleotide sequencing 75
- mass spectrometry 35
- microarray 9

Organism

- rodent 143
- bacteria 97
- fungus 79
- human 63
- plant 60

Tissue

- root 22
- liver 9
- leaf 8
- whole organism 6
- spleen 4

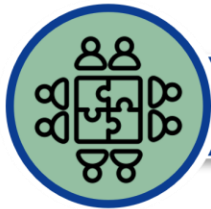
Factor

- spaceflight 191
- ionizing radiation 107
- time 69

Show 10 entries

GLDS-#	Title	Assay	Organism	Tissue	Factor
GLDS-1	Expression data from drosophila melanogaster	DNA microarray	Drosophila melanogaster	whole organism	infection, radiation, spaceflight
GLDS-4	Microarray Analysis of Space-flown Murine Thymus Tissue	DNA microarray	Mus musculus	thymus	spaceflight
GLDS-19	Transcription profiling of rat to study the effect of hindlimb unloading on healing of medial collateral ligaments 3 weeks after injury	DNA microarray	Rattus norvegicus	Medial collateral ligament	hindlimb unloading, treatment
GLDS-21	Effects of spaceflight on murine skeletal muscle gene expression	DNA microarray	Mus musculus	call muscle, gastrocnemius	spaceflight
GLDS-25	STS-135 Liver Transcriptomics	DNA microarray	Mus musculus	liver	spaceflight
GLDS-26	Microbiomes of the Shuttle Particles Collected from the International Space Station and Spacecraft Assembly Facilities	amplicon sequencing assay	cellular organisms	Cells	sample location, spaceflight
GLDS-27	Transcription of the spaceflight transcriptome of four commonly used model organisms	RNA Sequencing (RNA-Seq)	Arabidopsis thaliana	Seedlings	ecotype, spaceflight

Visualize Study



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DATA SUBMISSION: ADD, EDIT, SAVE, SUBMIT

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[Submitted](#)
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[Req Signature](#)
[Finalized](#)
[Public](#)
[Private](#)

OSD-385 : Persistence of Escherichia coli in the microbiomes of red Romaine lettuce (*Lactuca sativa* cv. 'Outredgeous')- does seed sanitization matter?

Status Public Release Date 19-Apr-2024

Principal Investigator ckhodada

SUMMARY

Seed sanitization via chemical processes removes/reduces microbes from the external surfaces of the seed and thereby could have an impact on the plants,health or productivity. To determine the impact of seed sanitization on the plants,microbiome and pathogen persistence, sanitized and unsanitized seeds from two leafy green crops, red Romaine lettuce (*Lactuca sativa* cv. ,Outredgeous,) and mizuna mustard (*Brassica rapa* var. japonica) were exposed to Escherichia coli and grown in controlled environment growth chambers simulating environmental conditions aboard the International Space Station. Plants were harvested at four intervals from 7 days post-germination to maturity. The bacterial communities of leaf and root were investigated using the 16S rRNA sequencing while quantitative polymerase chain reaction (qPCR) and heterotrophic plate counts were used to reveal the persistence of E. coli. E. coli persisted for longer periods of time in plants from sanitized versus unsanitized seeds and was identified in root tissue more frequently than in leaf tissue. 16S rRNA sequencing showed dynamic changes in the abundance of members of the phylum Proteobacteria, Firmicutes, and Bacteroidetes in leaf and root samples of both leafy crops. We observed minimal changes in the microbial diversity of lettuce or mizuna leaf tissue with time or between sanitized and unsanitized seeds. Beta-diversity showed that time had more of an influence on all samples versus the E. coli treatment. Our results indicated that the seed surface sanitization a requirement for sending seeds to space influences the microbiome. Insight into the changes in the crop microbiomes could lead to healthier plants and safer food supplementation.

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[View in OSDR](#)
[Set to Private](#)

Enhancing Data Submission Portal

Improved submission automation and “self-service” use

Data Repository Explore **Submission Portal Contribute**

General Search Filters

Data Source

- GeneLab
- ALSDA
- NIH GEO
- EBI PRIDE
- ANL MG-RAST

Data Type

- Study
- Experiment

Open Science Data Repository Search

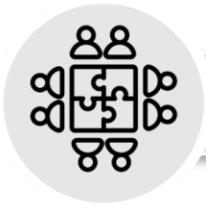
Search Datasets

Persistence of Escherichia coli in the microbiomes of red R

Organisms	Factors	Assay Types
Microbiota	Treatment Seed Sanitization Tissue	Amplicon Sequencing

Select Measurement

- Amplicon Sequencing ← Omics Assay
- Behavior
- Bone biomechanical measurement ← Phenotypic/Behavioral/Physiologic Assays
- Bone Microstructure ← Phenotypic/Behavioral/Physiologic Assays
- Calcium Uptake ← Phenotypic/Behavioral/Physiologic Assays
- Chromatin Accessibility
- clinical chemistry analysis
- Complete Blood Count
- Comprehensive Metabolic Panel
- copy number variation profiling ← Omics Assay



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[Persistence of Escherichia coli in the microbiomes of red Romaine lettuce \(Lactuca sativa cv. 'Outredgeous'\)- does seed sanitization matter?](#)

Organisms	Factors	Assay Types	Release Date	Description
Microbiota	Treatment Seed Sanitization Tissue	Amplicon Sequencing	19-Apr-2024	Seed sanitization via chemical processes removes/reduces microbes from the external surfaces of the seed and thereby could have an impact on the plants health or productivity. To determine the impact ...

OSD-385 **Study** Highlights: *cgene*

[Transcriptional profiling of heart tissue from mice flown on the RRRM-2 mission](#)

Organisms	Factors	Assay Types	Release Date	Description
Mus musculus	Spaceflight Age Euthanasia Location	transcription profiling	03-Jan-2024	In the Rodent Research Reference Mission (RRRM-2), forty female C57BL/6NTac mice were flown on the International Space Station. To assess differences in outcomes due to age, twenty 12 week-old and twe...

OSD-580 **Study** Highlights: *cgene*

[Transcriptional profiling of tibialis anterior muscle from mice flown on the RR-23 mission](#)

Organisms	Factors	Assay Types	Release Date	Description
Mus musculus	Spaceflight	transcription profiling	12-Dec-2023	The objective of the Rodent Research-23 mission (RR-23) was to better understand the effects of spaceflight on the eyes, specifically on the structure and function of the arteries, veins, and lymphati...

OSD-576 **Study** Highlights: *cgene*

[Ionizing radiation induces transgenerational effects of DNA methylation in zebrafish](#)

Organisms	Factors	Assay Types	Release Date	Description
				Ionizing radiation is known to cause DNA damage, yet the mechanisms

General Search Filters

Data Source

- GeneLab
- ALSDA
- NIH GEO
- EBI PRIDE
- ANL MG-RAST

Data Type

- Study
- Experiment
- Subject
- Biospecimen
- Payload

[Show more](#)

Study Search Filters

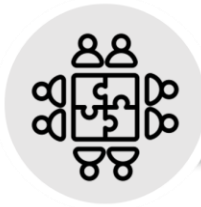
Project Type

- Ground
- Spaceflight
- High Altitude

Assay Type

- Amplicon Sequencing Assay
- Bisulfite Sequencing
- ChIP-Seq
- Behavior (Gait)
- Gel Electrophoresis

[Show more](#)



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OMICS ANALYSIS TRAINING

File Edit View Run Kernel Git Tabs Settings Help

RNAseq_fastq_to_counts_... RNAseq_DGE_JN_06-2022... Unix_Intro_JN_06-2022.ipyn

Filter files by name

Name

- Bootcamp_content
- Bootcamp_content2
- Content_2
- efs
- GLDS-104
- lost+found
- myown_JNs
- SolarSystem
- align_multiqc.html
- count_multiqc.html
- example.csv
- example.txt
- FLT_Rep1_R1_raw_fastqc.html
- FLT_Rep1_R2_raw_fastqc.html
- infer_exp_multiqc.html
- R_Intro_JN_06-2022.ipynb
- raw_multiqc.html
- RNAseq_DGE_JN_06-2022_wl...
- RNAseq_DGE_JN_06-2022.ipynb
- RNAseq_fastq_to_counts_JN_...
- Saturn.txt
- trimmed_multiqc.html
- Unix_Intro_JN_06-2022.ipynb

Plot the principal components of our unnormalized data:

Next, we'll plot the first 2 PCs against each other, since they explain the majority of the variance in the dataset.

In this first plot, we'll label all samples so we can see where each sample falls on the plot (Note: This can help us detect potential outliers):

```
[22]: autoplot(PCA_raw, data=sampleTable, colour='condition',
              label=TRUE, label.size=5, size=4, alpha=1) + theme_classic(base_size = 16)
```

condition

- FLT
- GC

Let's save your PCA plot with all samples labeled to your PCA directory defined in [Step 1a](#) above using the `ggsave()` function.

Note: You can adjust the width, height, and dpi of the saved plot until you're satisfied with how the PCA plot looks.

```
[ ]: ggsave(file.path(pca_dir, 'GLDS-104_PCA_raw_wlabels.png'), width = 8.5, height = 6, dpi = 300)
```

Simple 0 4 R [conda env:gl4u-r] | Idle Mem: 1.38 / 4.00 GB Mode: Command Ln 1, Col 1 RNAseq_DGE_JN_06-2022.ipynb



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MULTI-STUDY DATA VISUALIZATION PORTAL

GeneLab Visualization

OSD-47&OSD-137&OSD-168&OSD-242&OSD-245

Study details

Download DGE table

Home

PCA

Volcano

Pair plot Group 1

Pair plot Group 2

Heatmap

DGE

GSEA

Group Selection

Group 1: Ground Control

Group 2: Space Flight

Modify groups

OSD-47&OSD-137&OSD-168&OSD-242&OSD-245 Heatmap

Clustering method: UPGMA

Cluster rows

Cluster columns

Log2 data transformation

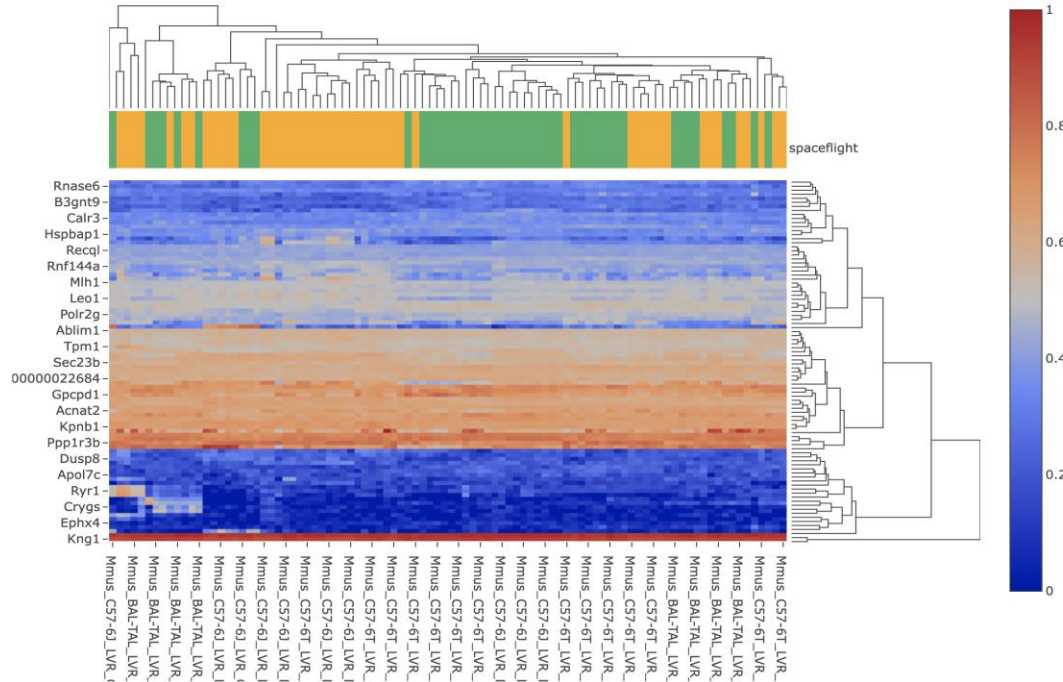
Filter genes with Adj p val < 0.05

Filter genes with |Log2 FC| > 1

Scale data between 0 - 1

Update

● Ground Control
● Space Flight



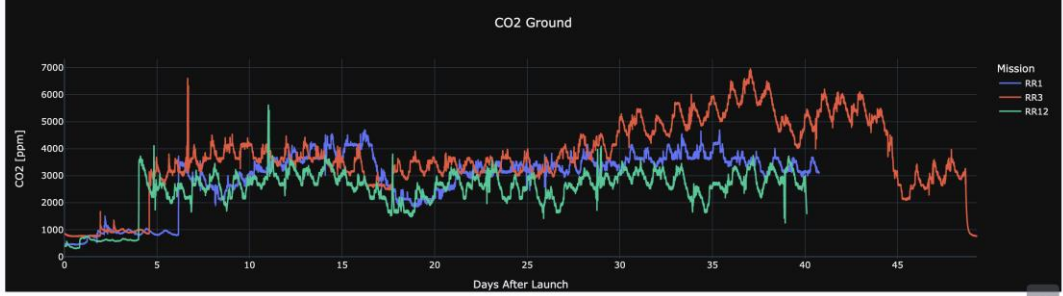
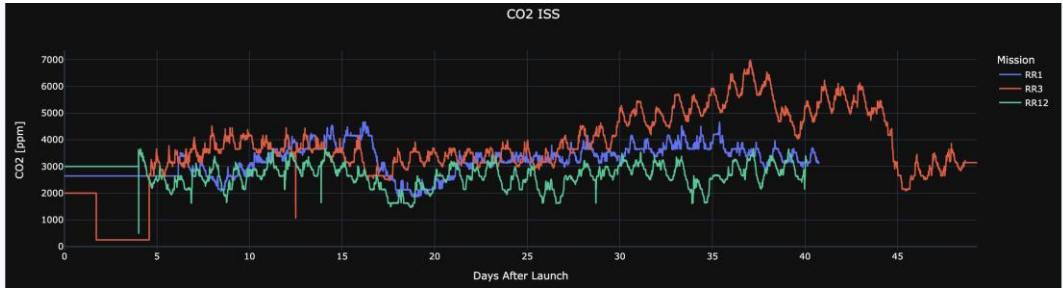
Data has been log2 transformed and scaled between 0 and 1

Only showing genes with Adjusted P value < 0.05 for (Ground Control)v(Space Flight)

Environmental Data App Dashboard

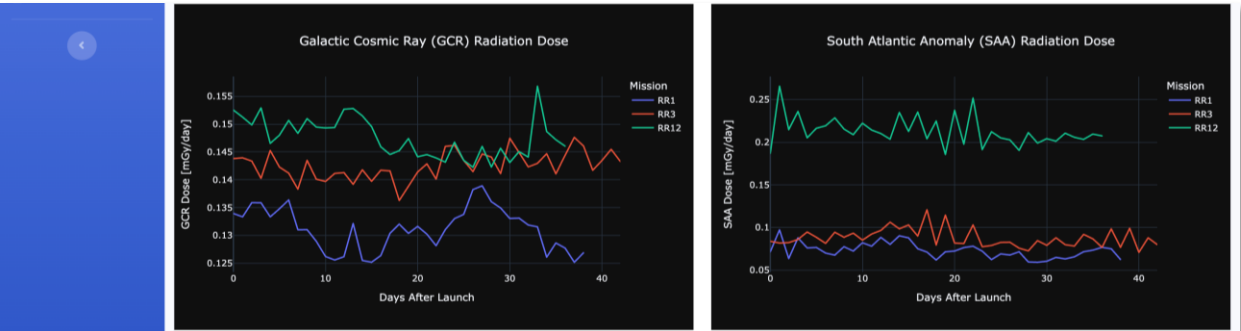
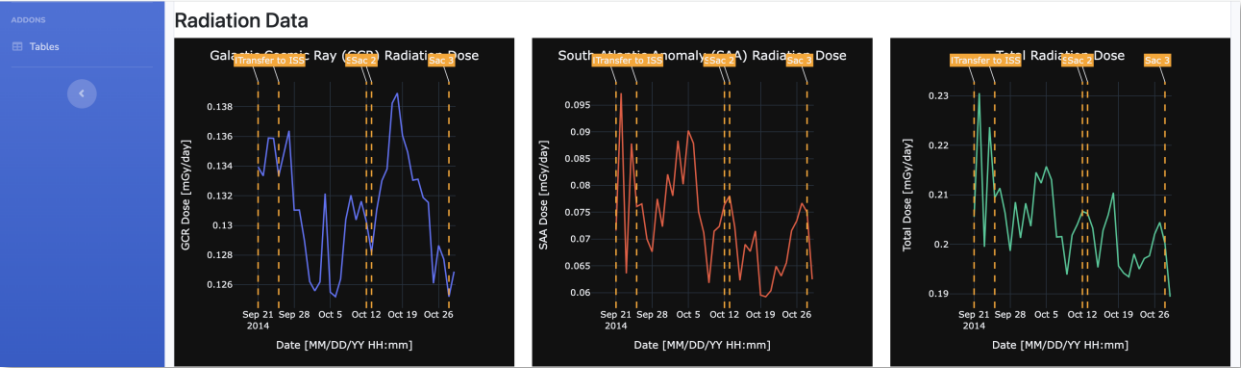
Rodent Research 1 (SpaceX-4) Generate Report

Mission Description
 This important first mission in NASA's rodent research project launched in 2014. It proved that the hardware system was effective and safe to use in space, and that critical research operations could be carried out by the space station crew. This first study showed that mice transported on the SpaceX Dragon capsule, then living in the habitat on the space station for a month, were both healthy and active. Rodent Research-1 also included a CASIS commercial research investigation dedicated to the study of muscle loss, or atrophy.

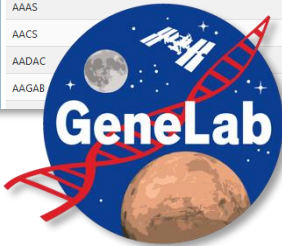
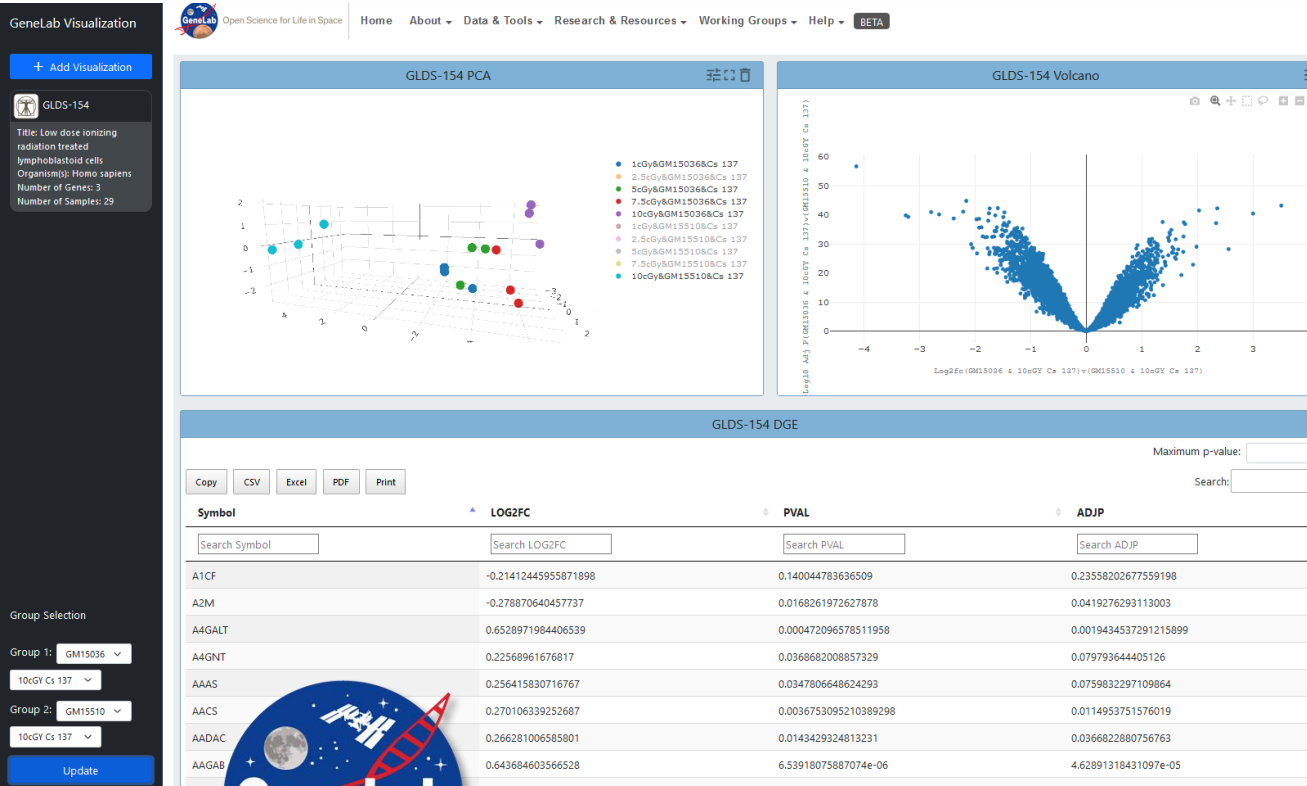


Copyright © EDA Dashboard 2022

Environmental Data App



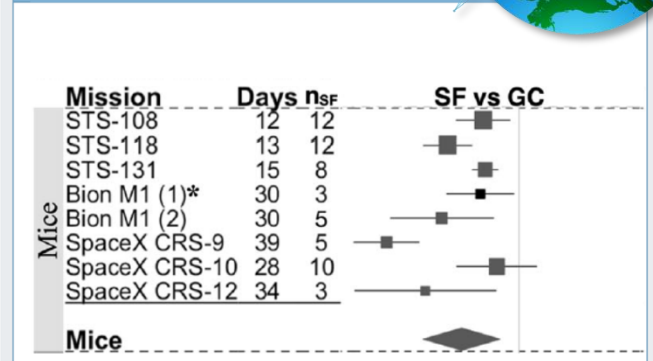
Science Data Viz Tools: GeneLab & ALSDA In Unison



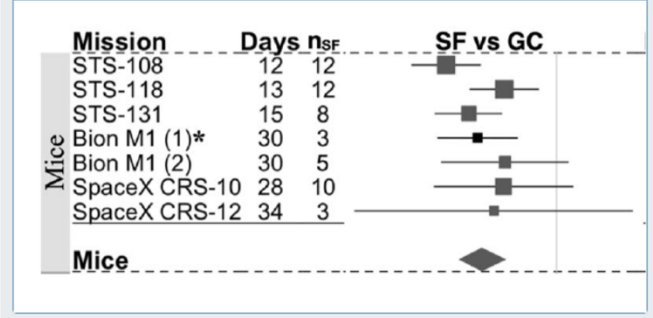
ALSDA Visualization

- LSDS-110**
 Mission: STS-108
 Tissue: Femur (D)
- LSDS-115**
 Mission: STS-118
 Tissue: Femur (M)
- LSDS-117**
 Mission: STS-131
 Tissue: Femur (M)
- LSDS-89**
 Mission: Bion M1 (1)
 Tissue: Femur (M,D)

TRABECULAR BV/TV – FOREST PLOT

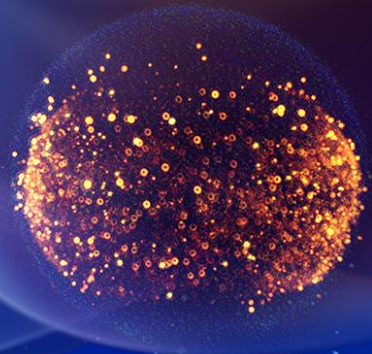
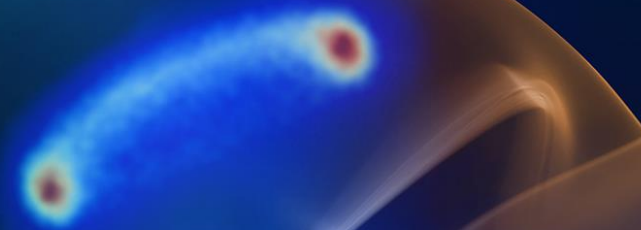
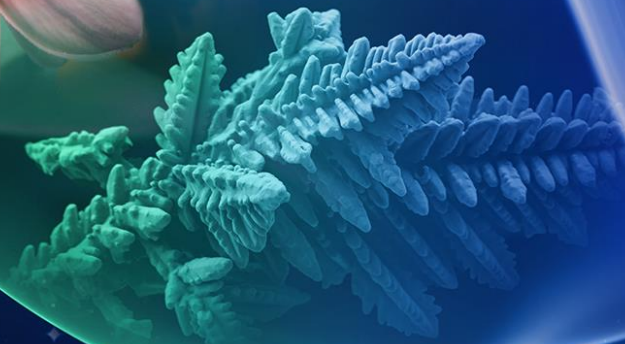


TRABECULAR THICKNESS – FOREST PLOT

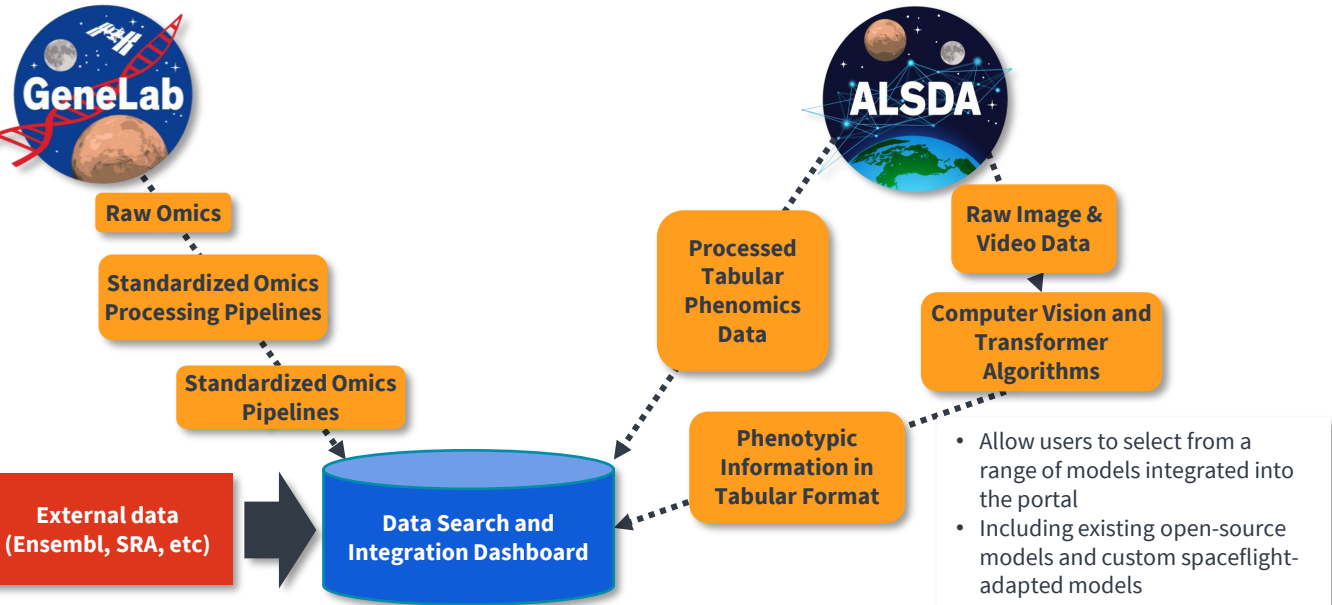


(Credit: NASA GeneLab; Fu et al., 2021, PMID: 34075059; PI: Svetlana Komarova)

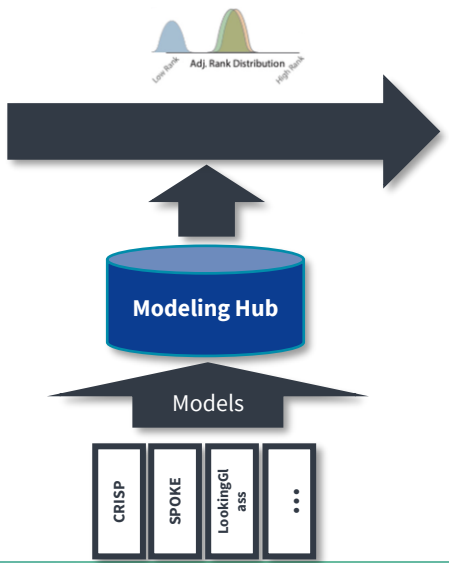
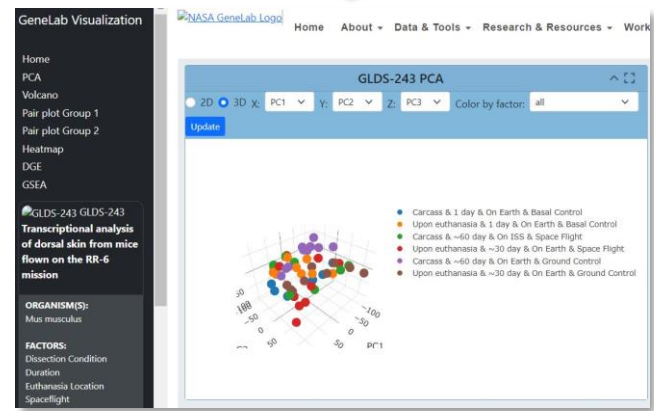
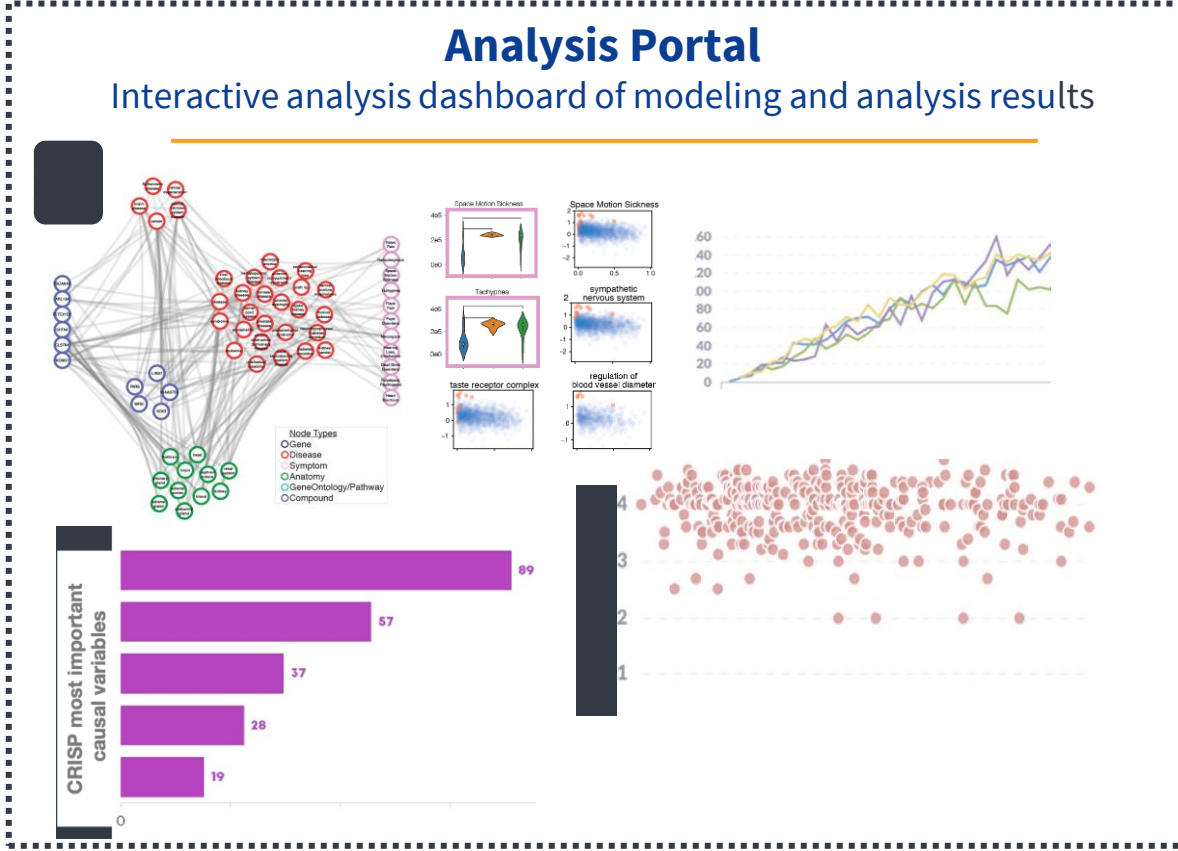
NEXT ERA OF DATA



Future: Streamlined Data Integration, Multimodal, Multihierarchical



- Allow users to select from a range of models integrated into the portal
- Including existing open-source models and custom spaceflight-adapted models

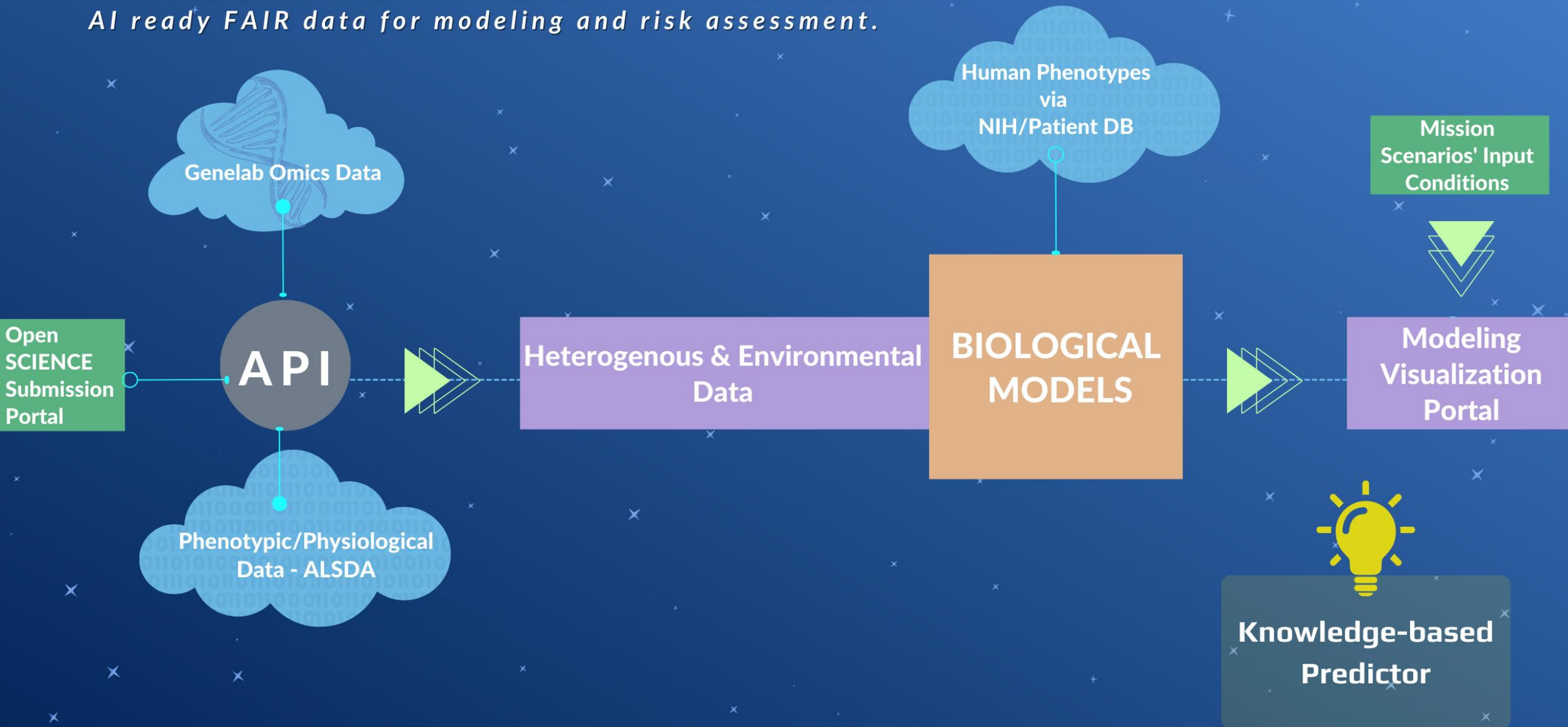


New Modeling Hub

Automated pipelines for a suite of machine learning, knowledge graph, modeling tools

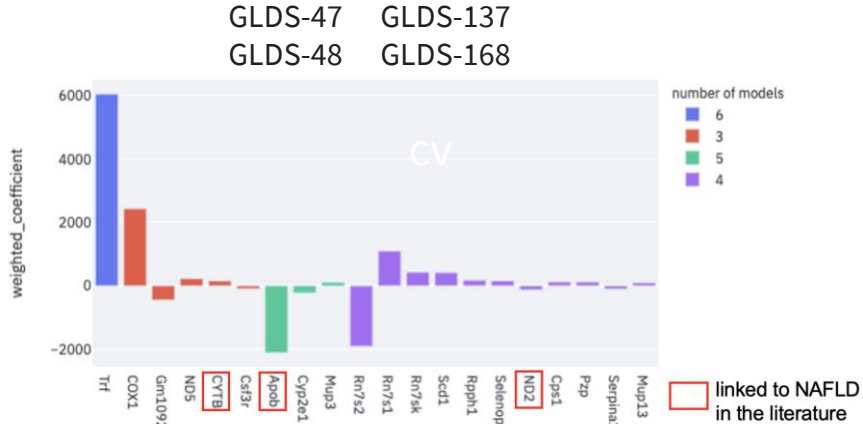
DATA REUSE EXAMPLE: DATA MODELING

All ready FAIR data for modeling and risk assessment.



AI for Life in Space

Genes with a causal relationship to **liver disease** phenotype in spaceflown rodents



A novel paradigm for generating human-relevant biomedical insights from observational datasets with limited size by leveraging and augmenting with animal model data

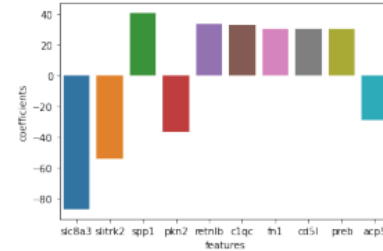


Figure 1: Top-10 IRM features according to feature coefficients with all human and mice gamma-radiation data.

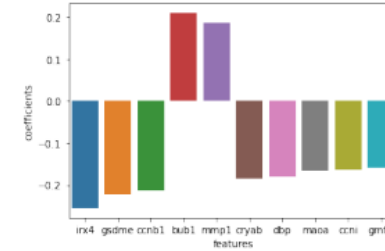
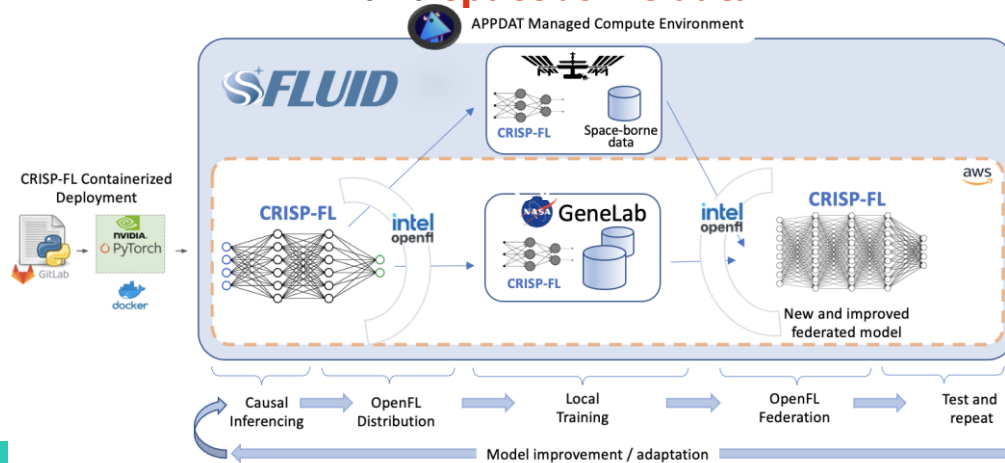


Figure 2: Top-10 IRM features according to feature coefficients with all human and mice heavy-ion radiation data.

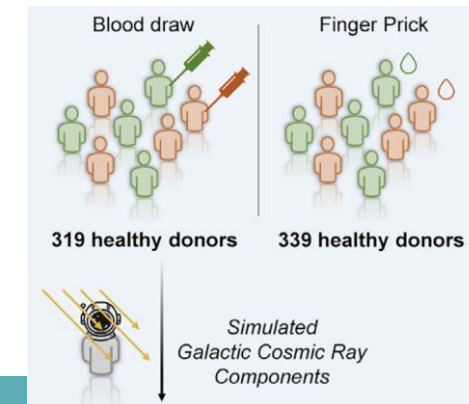
2021 FDL Astronaut Challenge



Federated causal inference between **Earth data** and **spaceborne data**

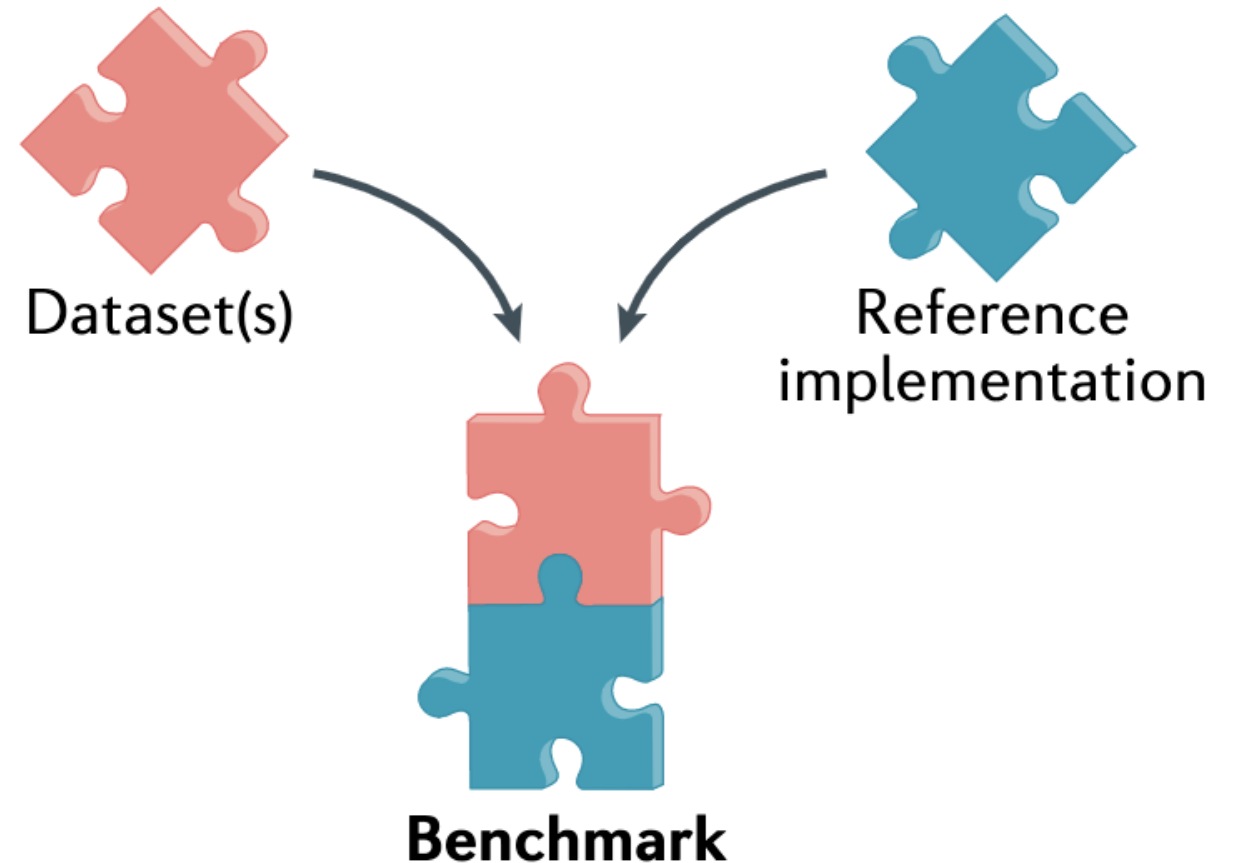


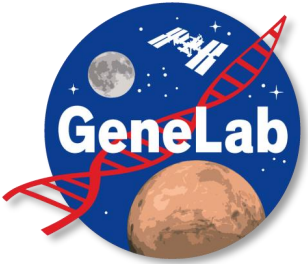
Genetic variants with a causal relationship to **DNA damage** and **radiation sensitivity** in human irradiated immune cells



Benchmark Datasets for Space Biology

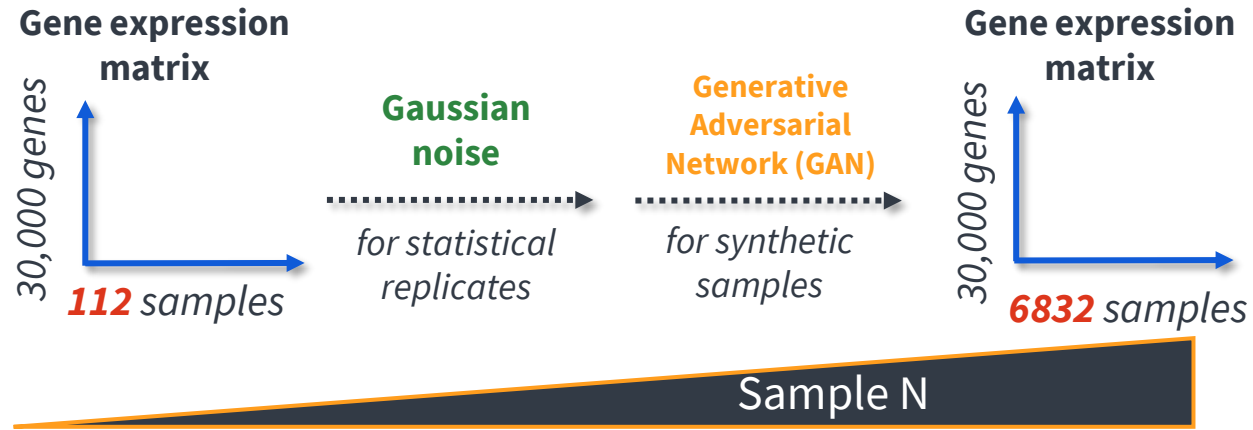
- **Scientific ML benchmarking**—Best ML algorithm for this problem
- **Application benchmarking**—Algorithm performance
- **System benchmarking**—Hardware and software architecture



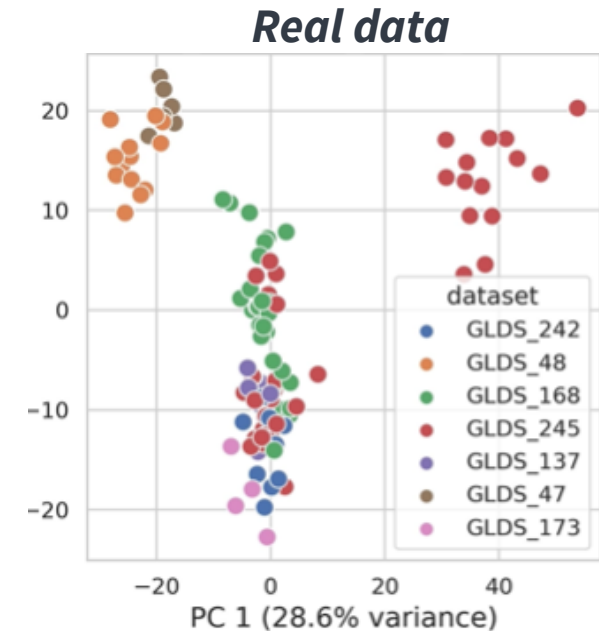
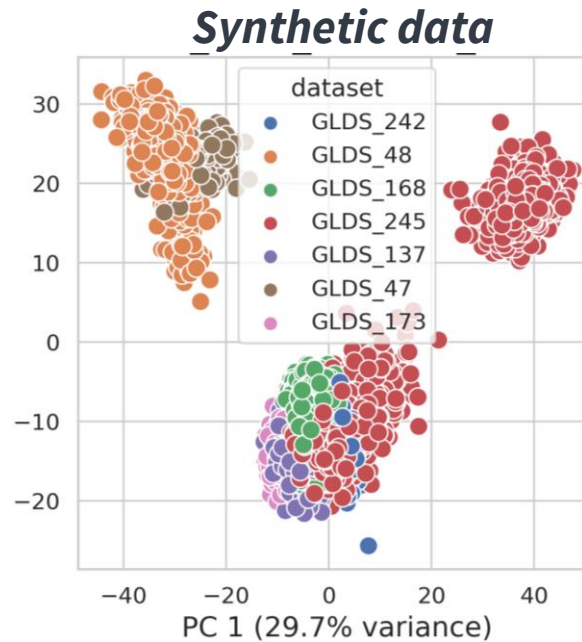


RNA sequencing benchmark dataset

Scientific motivation: *Effects of spaceflight on mouse liver health*



GeneLab Data Set	Tissue	Spaceflight Mission
47	liver	RR1 CASIS
48	liver	RR1 NASA
168	liver	RR1 NASA RR3 CASIS
137	liver	RR3 CASIS
173	liver	STS-135
242	liver	RR9
245	liver	RR6





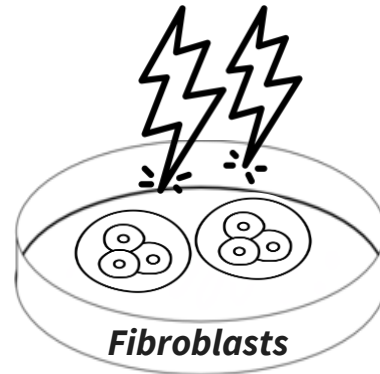
Fluorescence microscopy benchmark dataset

Scientific motivation: simulated space radiation causes cellular DNA damage

15 mouse strains



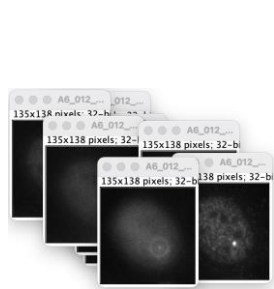
Simulated galactic cosmic rays



- 53PB1+ immunocytochemistry
- High-throughput imaging
- Automated quantification of 53 PB1+ radiation-induced foci

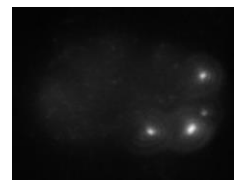
Penninckx et al. *Radiation Research* 2019

AI readiness pipeline:



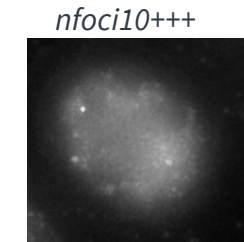
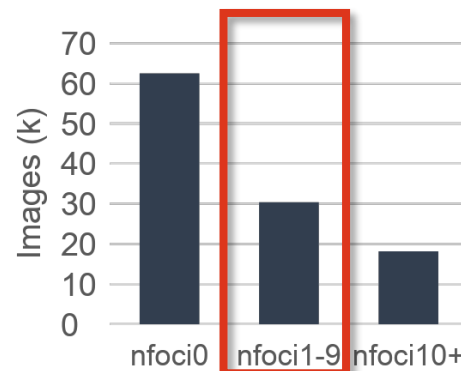
Raw Dataset ($n = 94,193$):
32-bit Z stacks (9 indices)

DIP lib
maximum intensity projection
16-bit conversion



Max Intensity Dataset ($n=94,193$):
16-bit single-index TIFFs

automatically estimated nfoci

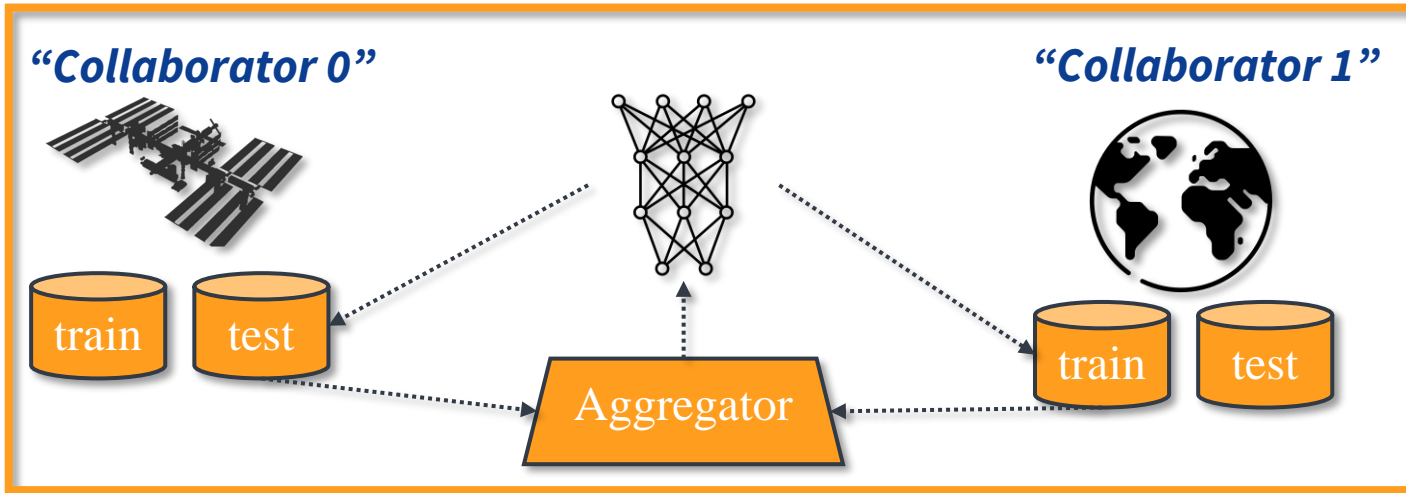


Labels:

- *nfoci* (number of 53BP1+ DNA damage foci)
- Radiation (X-ray, ^{56}Fe ...)

Federated AI/ML Analysis for Data Generated In-Flight

FLUID Federated Learning Architecture (FLUID)



- **Federated learning** allows training a global model on physically separated datasets.
- **FLUID architecture** is baselined on the Space-Borne Computer 2 (SBC2) using CRISP causal inference machine learning
- **Future implementations** can use any AI/ML model

Contents lists available at ScienceDirect

Life Sciences in Space Research

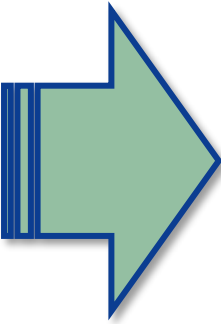
journal homepage: www.elsevier.com/locate/lssr

ELSEVIER

Effects of low-dose oxygen ions and protons on cardiac function and structure in male C57BL/6J mice

John W Seawright^{a,1}, Vijayalakshmi Sridharan^{a,1}, Reid D Landes^b, Maohua Cao^a, Preeti Singh^a, Igor Koturbash^c, Xiao-Wen Mao^d, Isabelle R Miousse^{c,e}, Sharda P Singh^f, Gregory A Nelson^d, Martin Hauer-Jensen^a, Marjan Boerma^{a,*}

Check for updates

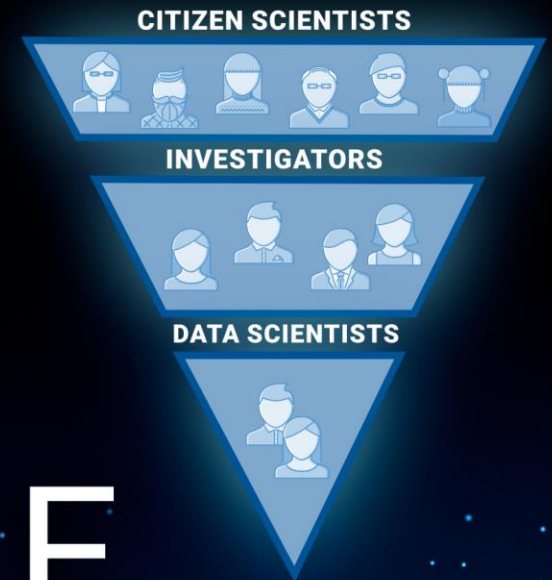


- ### Use Case: Radiation exposed rodent cardiac dataset
- Diversity of data to investigate for causality:*
- Ultrasound (cardiac output, stroke volume)
 - Doppler (heart rate, velocity)
 - Histology (IHC; Apoptosis, myofiber necrosis, interstitial fibrosis, microvascular damage)
 - ELISA & Immunoblot (mast cell impacts, protein alterations)

TISSUE REPOSITORY



SCIENTIFIC COMMUNITY



OPEN SCIENCE

DATA REPOSITORY



GENELAB
OMICS

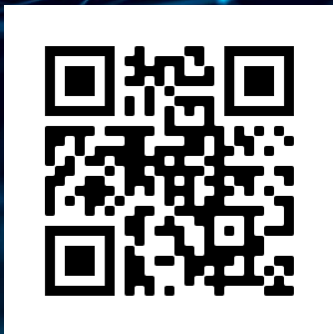
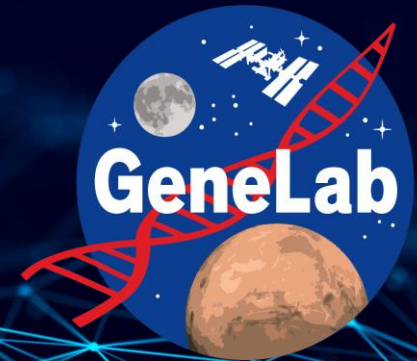
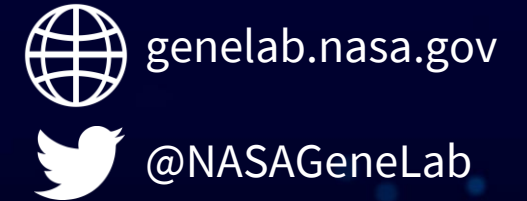
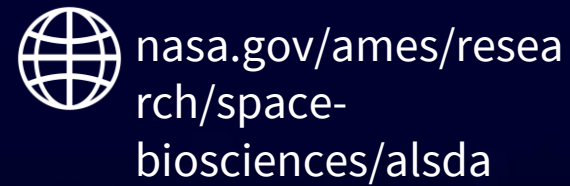
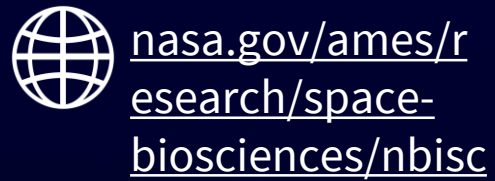
+

ALSDA
PHENOTYPIC

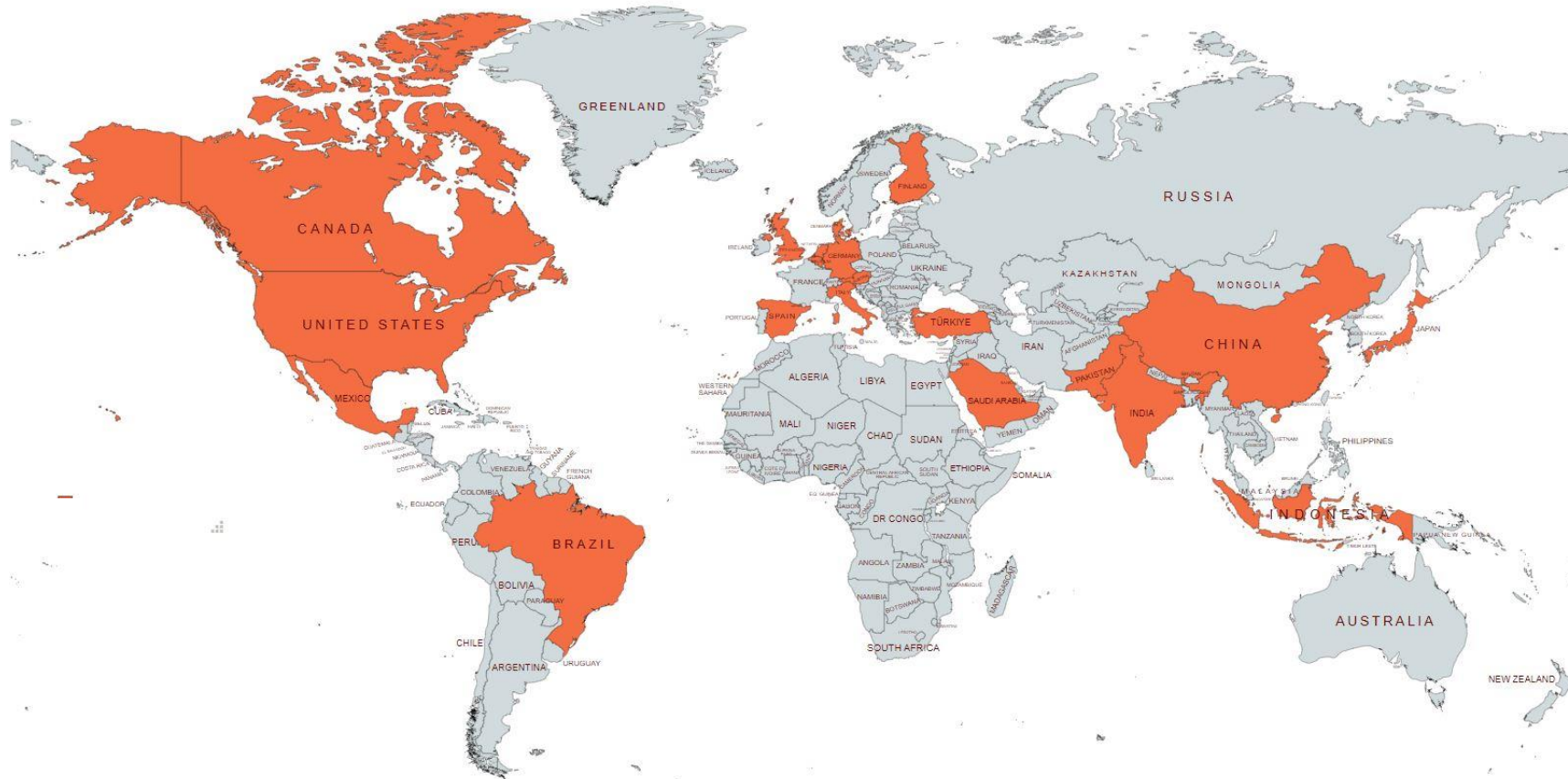


THANK YOU!

Open Science for Life in Space projects are funded by the Biological and Physical Sciences Division



Making data accessible worldwide



Top 20 Countries Utilizing GeneLab:

- US 🇺🇸 China 🇨🇳 UK 🇬🇧 India 🇮🇳 Germany 🇩🇪 Spain 🇪🇸 Canada 🇨🇦 Brazil 🇧🇷 Japan 🇯🇵 Netherlands 🇳🇱
- Turkey 🇹🇷 Belgium 🇧🇪 Indonesia 🇮🇩 Italy 🇮🇹 Mexico 🇲🇽 Pakistan 🇵🇰 Saudi Arabia 🇸🇦 Austria 🇦🇹 Denmark 🇩🇰 Finland 🇫🇮

Open Science Analysis Working Groups

Facilitates the use of omics in understanding basic mechanisms by which animals and constituent tissues and cells adapt to the spaceflight environment.

Animal

104 Members



Interactions between the different omics to provide complete understanding of the entire system being studied.

Multi-Omics

307 Members



Focuses on analyzing microbial datasets within GeneLab that includes gene-expression, proteomic, metabolomic and environmental metagenomic datasets.

Microbe

98 Members



Share and discuss the latest developments in Astrobotany – the discipline of botany concerned with interactions between plant biology and space environment.

Plant

88 Members



Feedback on science data and metadata standards for physiological, phenotypic, and behavioral datasets. Datasets span from raw to processed-results data, and across tabular, bioimaging, and video formats.

ALSDA

138 Members



Focuses on developing data AI-readiness guidelines, algorithm and automation development, and developing ethical guidelines to increase trust and explainability surrounding AI in space biology.

AI/ML

96 Members



Consist of **500+ scientists** from multiple space agencies, international institutions, and industry. Scientists meet monthly with each group to provide feedback, develop standards, and analyze data.

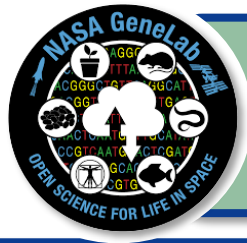
We invite you to join - <https://genelab.nasa.gov/awg/join!>

Training the Next Generation of Scientists



GeneLab for High Schools (GL4HS):

A four-week intensive training summer program for rising high school juniors and seniors to learn bioinformatics and computational biology methods and techniques to analyze space omics data.
Learn more and apply at: <https://www.nasa.gov/ames/genelab-for-high-schools>



GeneLab for Colleges/Universities (GL4U):

For educators and students to learn how analyze omics data using GeneLab standard pipelines and space-relevant data

Access to course materials: <https://github.com/nasa/GeneLab-Training/tree/main/GL4U>



Space Life Sciences Training Program (SLSTP):

Provides undergraduate students entering their junior or senior years, and entering graduate students, with professional experience in space life science disciplines.

Learn more and apply at: <https://www.nasa.gov/ames/research/space-life-sciences-training-program>



Spaceflight Technology, Applications, and Research (STAR):

Annual course for PIs, senior research scientists, and postdoctoral scholars and aims to facilitate their entry to space biology and preparation for conducting spaceflight experiments using NASA and commercial platforms.

Applications open until May 30th: <https://science.nasa.gov/biological-physical/programs/star>

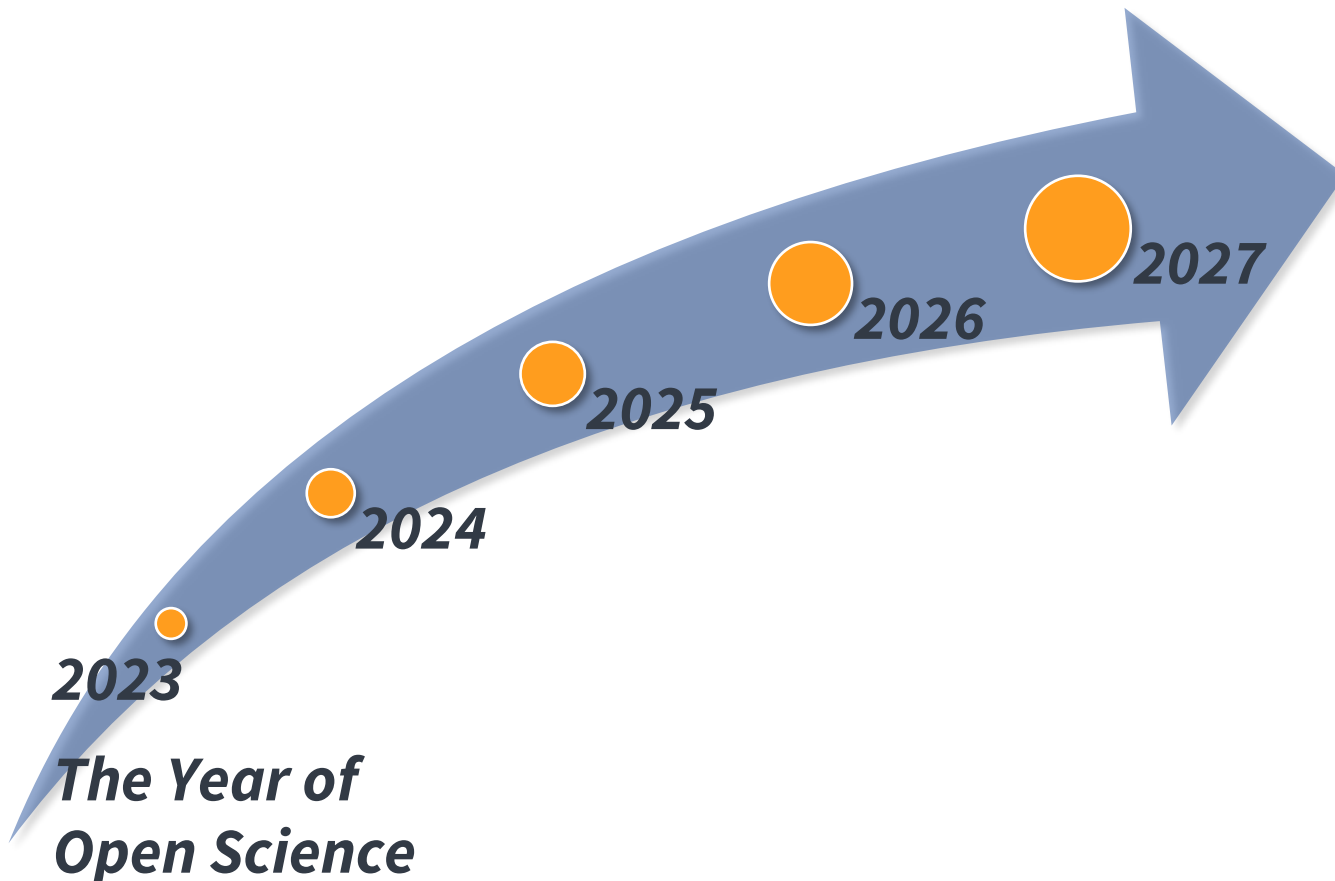


NASA Postdoctoral Program:

If you're an early-career or senior scientist, apply to the NASA Postdoctoral Program to help pursue NASA's mission and experience the world's most diverse technology and expertise.

Leading the Path to Open-Source Science

*Transform to Open Science (TOPS) is a \$40 million
5-year NASA Science Mission Directorate mission*



Objectives—

- Increase understanding and adoption of open science
- Accelerate major scientific discoveries
- Broaden participation by historically underrepresented communities

Goals for 2027—

- 20K earn Open Science Badge
- 5+ major discoveries
- Increase participation of underrepresented groups 2X

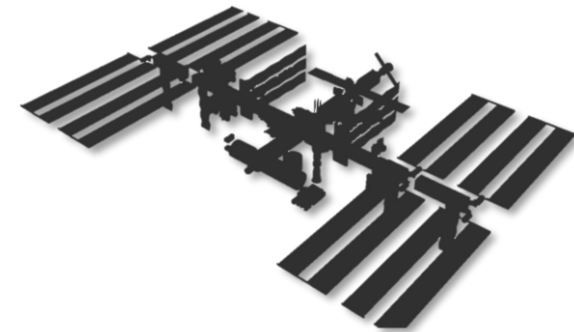
Proprietary Data

Currently all published data is openly accessible worldwide. GeneLab/ALSDA has a mechanism in place for standardized data curation and account-based access. This capability can be expanded in the future for:



Astronaut/Human space-relevant data

- Develop a controlled access data portal
- Create an automatic data access request workflow
- Scientists will be able to translate their findings from model organisms to human outcomes



Commercial LEO Destinations

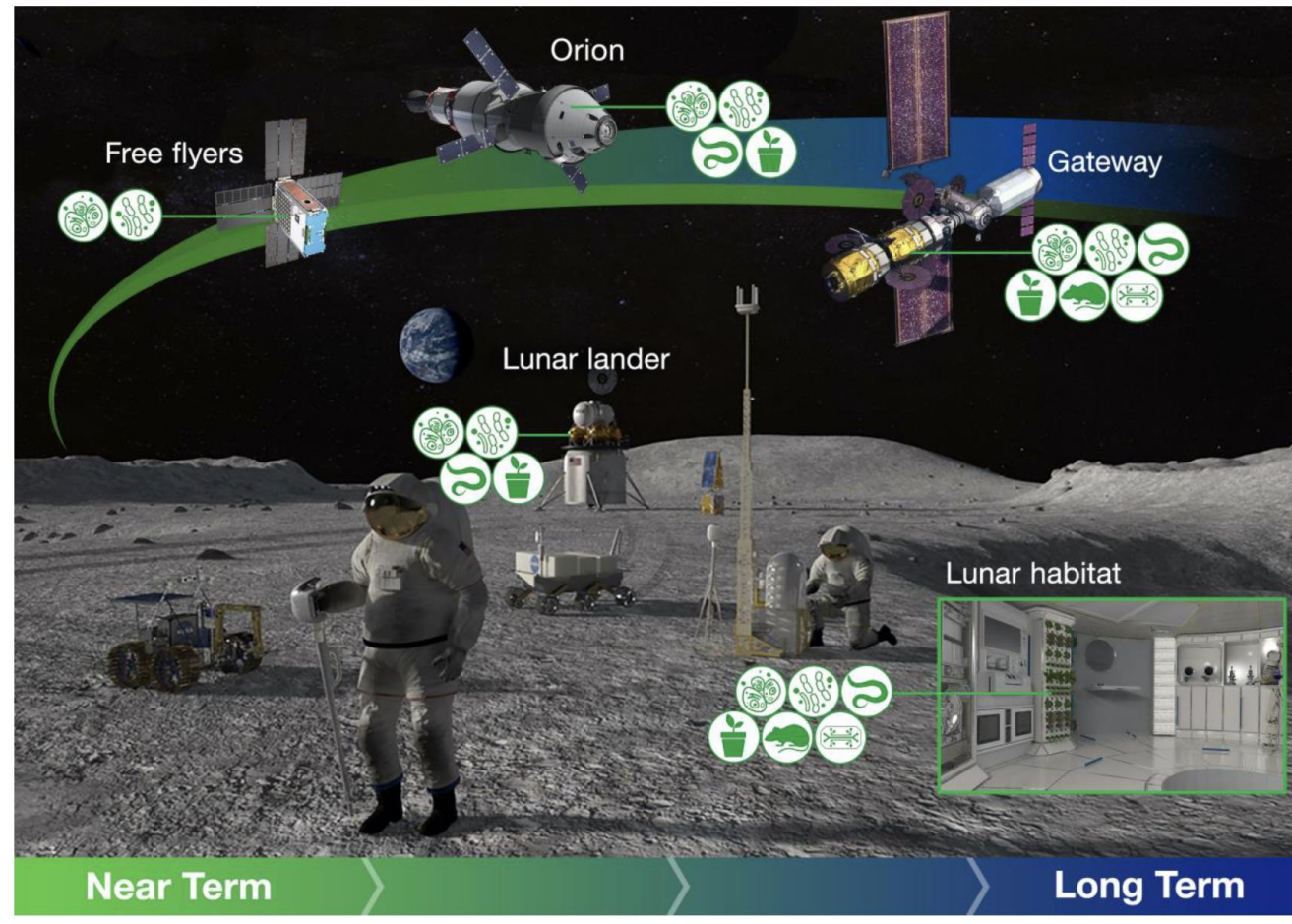
- Develop a controlled access data portal and an automatic data access request workflow for “closed” data
- Enable access to all spaceflight research a centralized data repository

Data should be as open as possible, as
closed as necessary.

Metadata can always be open.

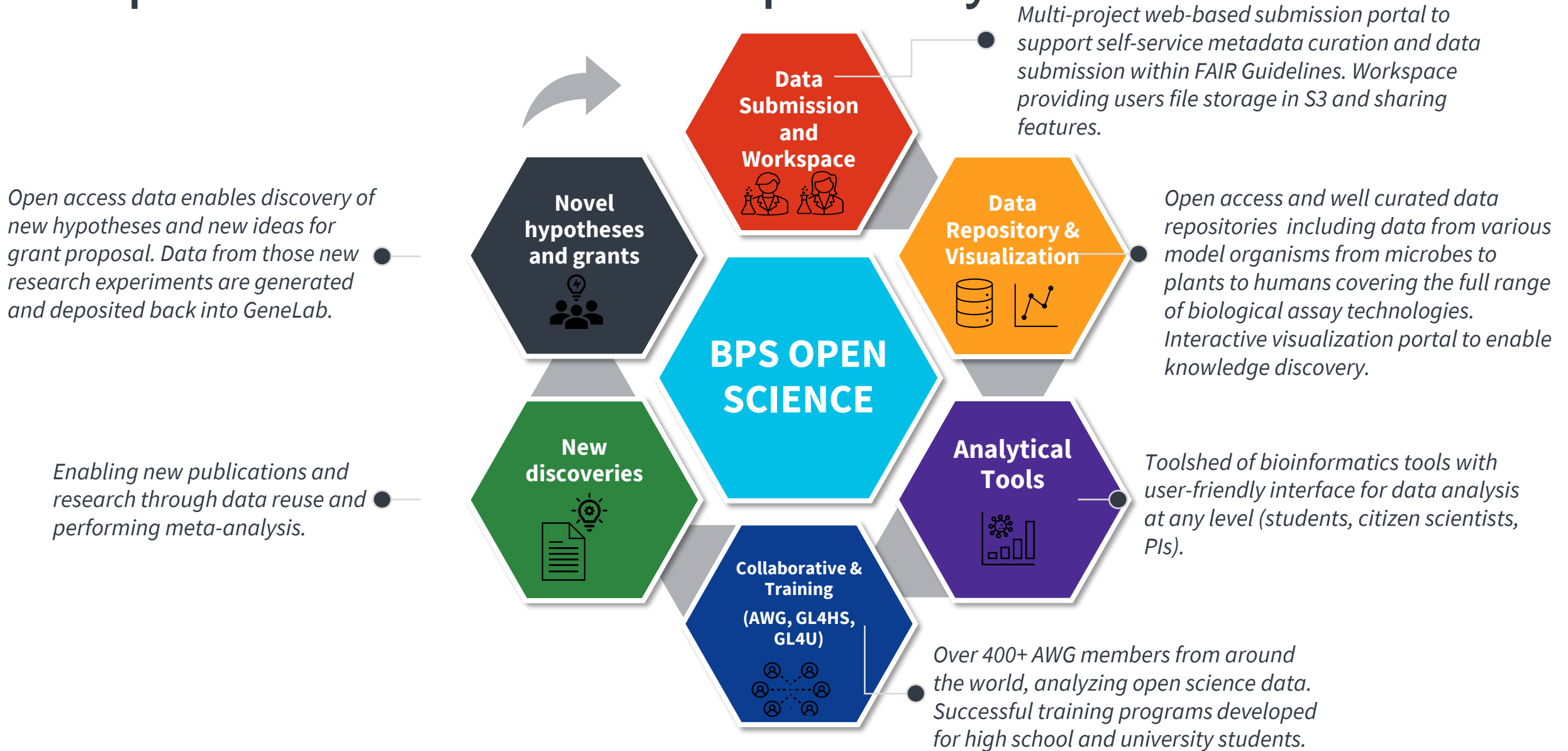
-Shelly Stall, TEM April 2020

Beyond Low Earth Orbit

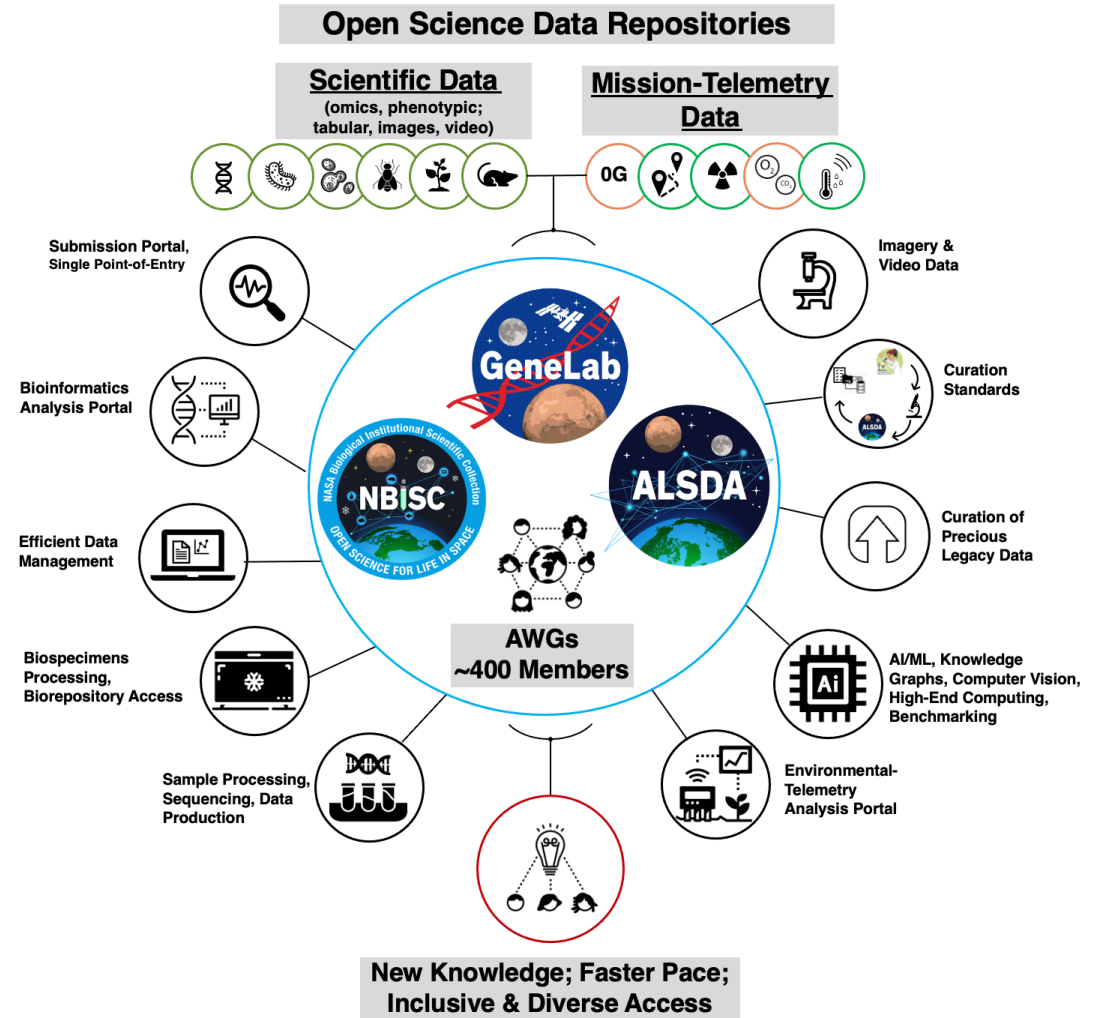
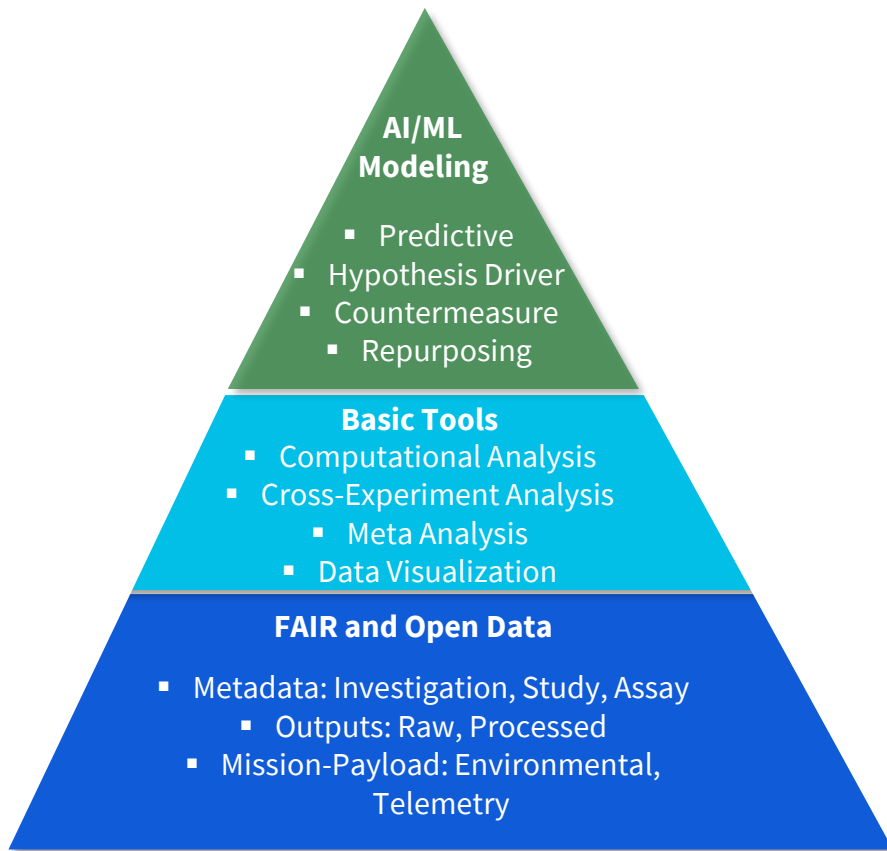


With limited sample return for various platforms, we are preparing new metadata templates and data streams to host and publish data from future lunar experiments and beyond.

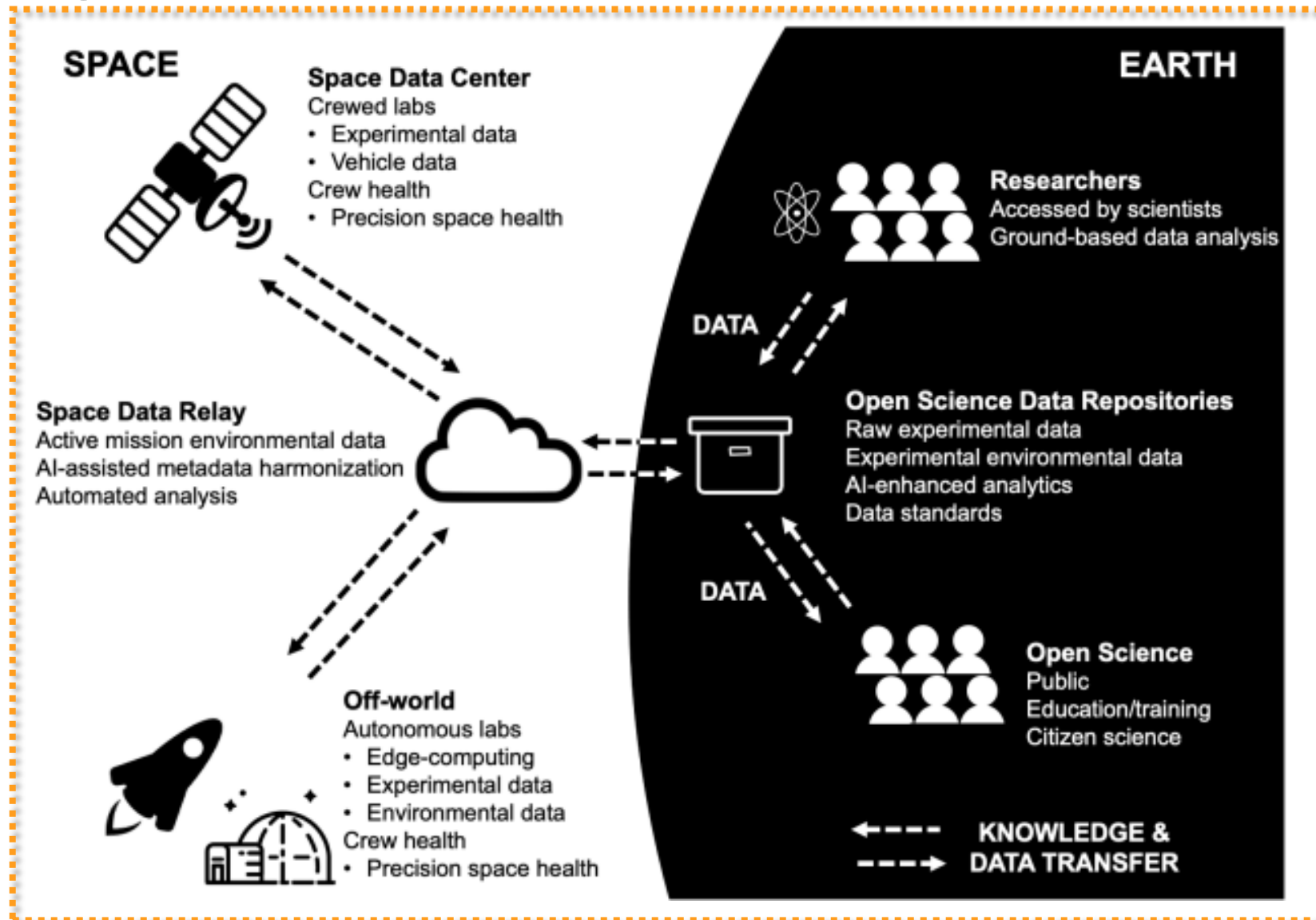
Open Science Data Repository



Big Picture for Open Science for Life in Space



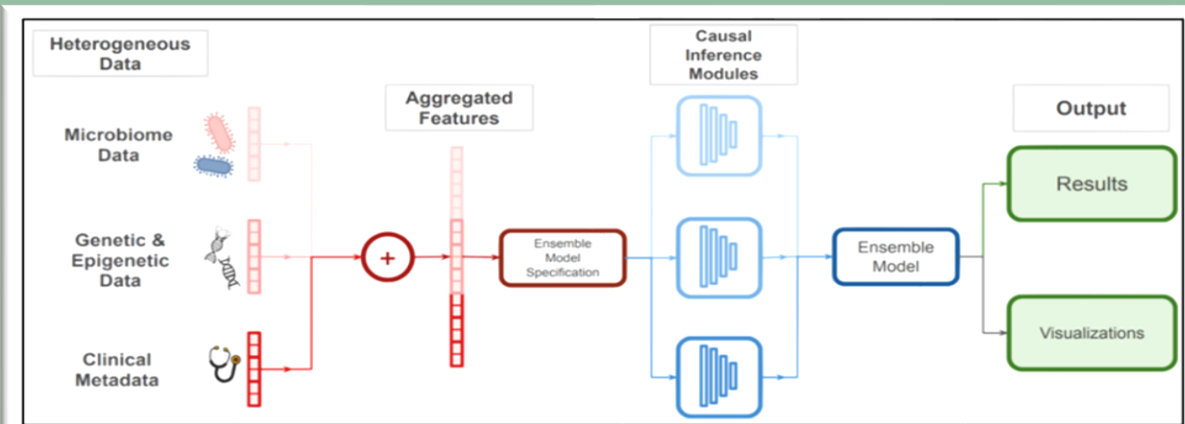
Knowledge and Data Transfer



AI/ML Analysis Re-using Data from Space



CRISP: Causal inference machine learning finds causal connections between biological features (e.g. genes) and targets (e.g. disease)



Generalizable to different data types with the ability to learn causal drivers of any feature within a dataset

Automated dimensionality reduction using machine learning selects the most important input variables for causal analysis

An ensemble of causal inference models "votes" on the selection of causal features

Use case:

Identifying genes with a causal relationship to NAFLD liver disease phenotype in spaceflown mouse liver

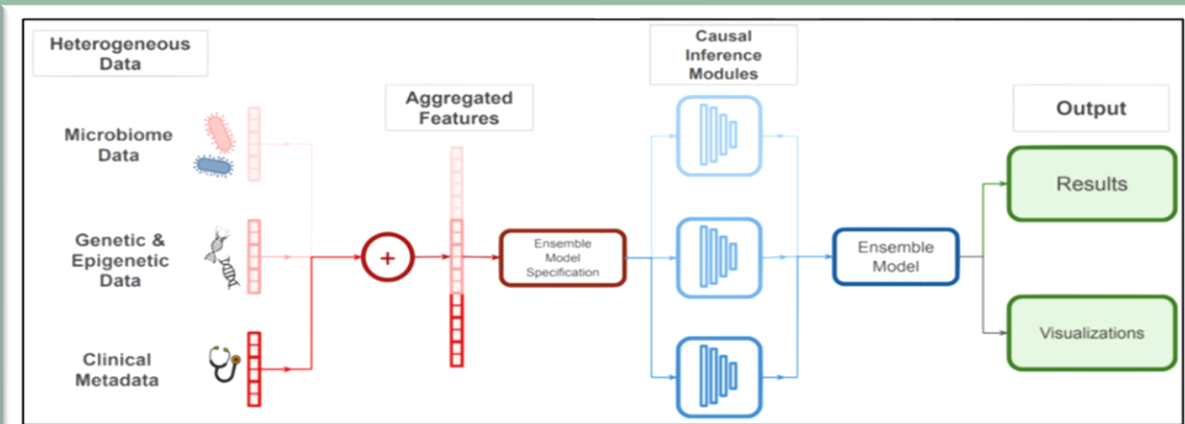
RNA-Seq and ORO values (NAFLD measure)				
	Flight	Ground	Basal	Vivarium
GLDS-47	3	3	3	0
GLDS-48	7	7	0	0
GLDS-137	6	6	6	0
GLDS-168	0	0	5	5
Total	16	16	14	5



AI/ML Analysis Re-using Data from Space



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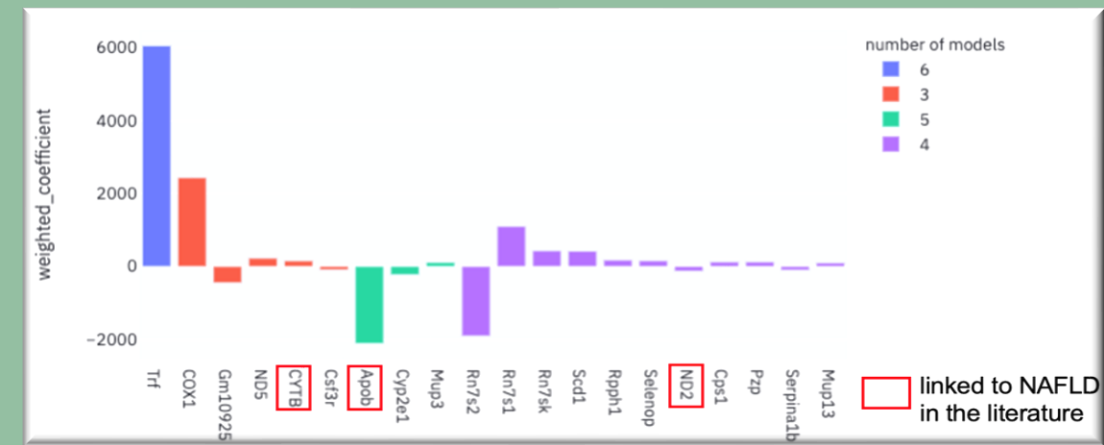
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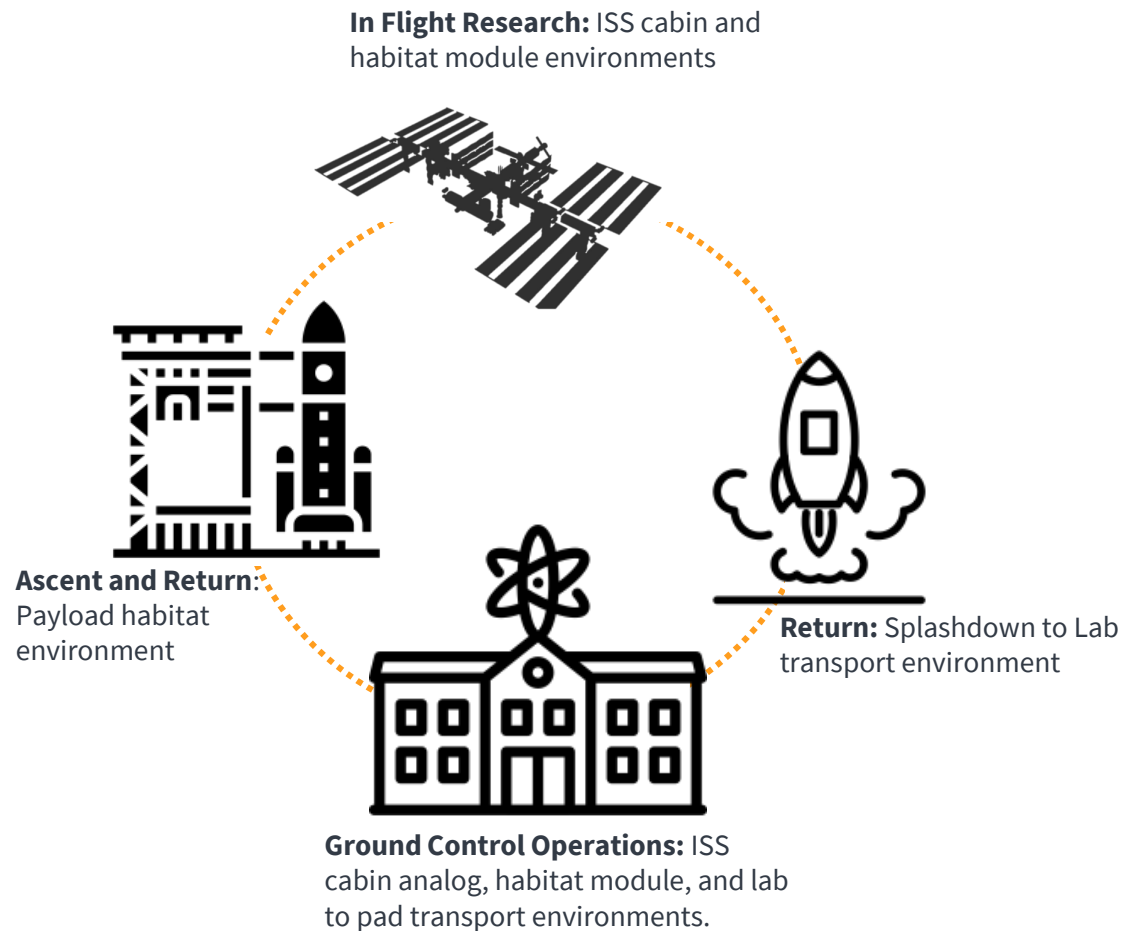
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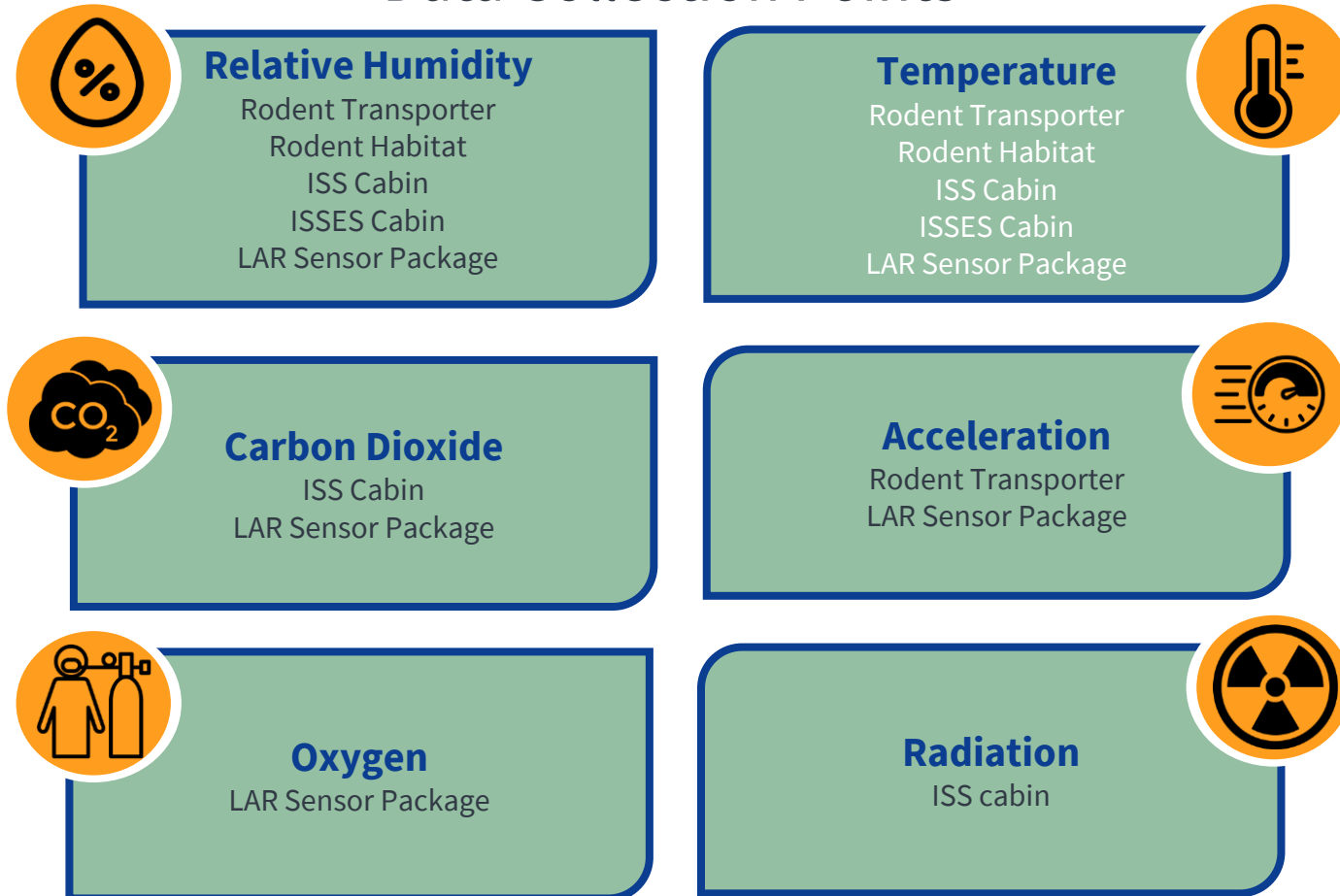


Rodent Research Mission Data

Developing a data processing pipeline for Mission, Vehicle, and Hardware data. A pipeline that allows data repositories to easily collect, process, and store mission data in both CSV and JSON formats.

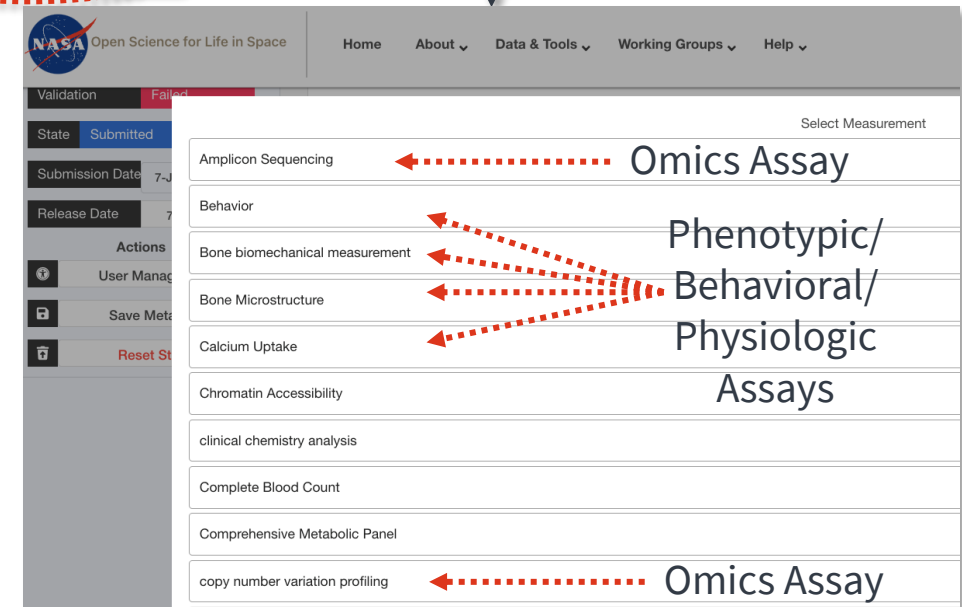
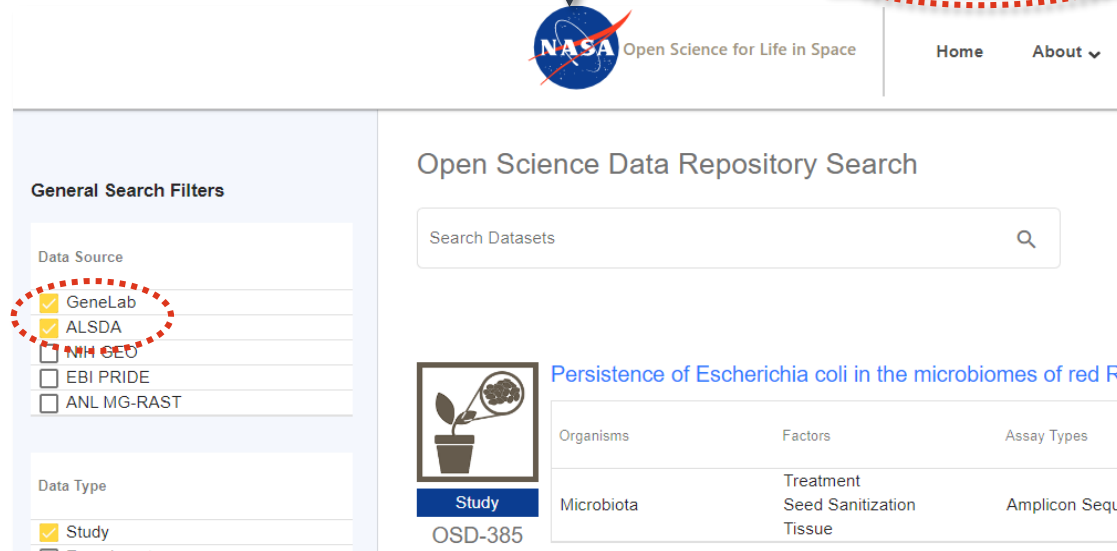
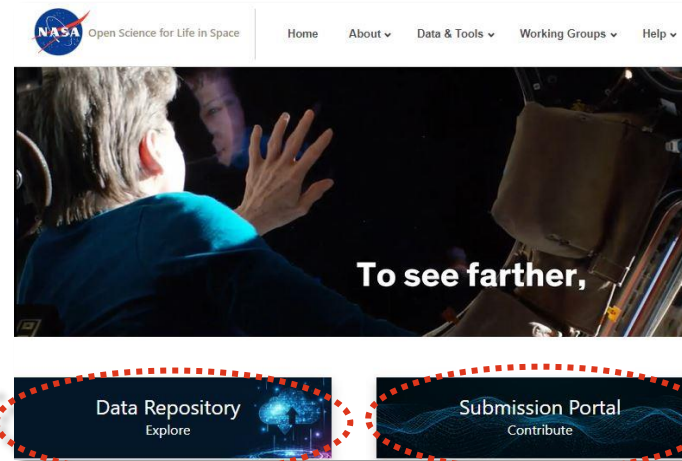
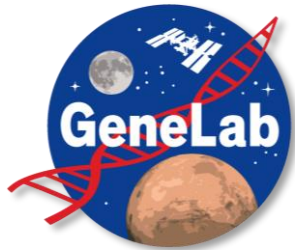


Data Collection Points

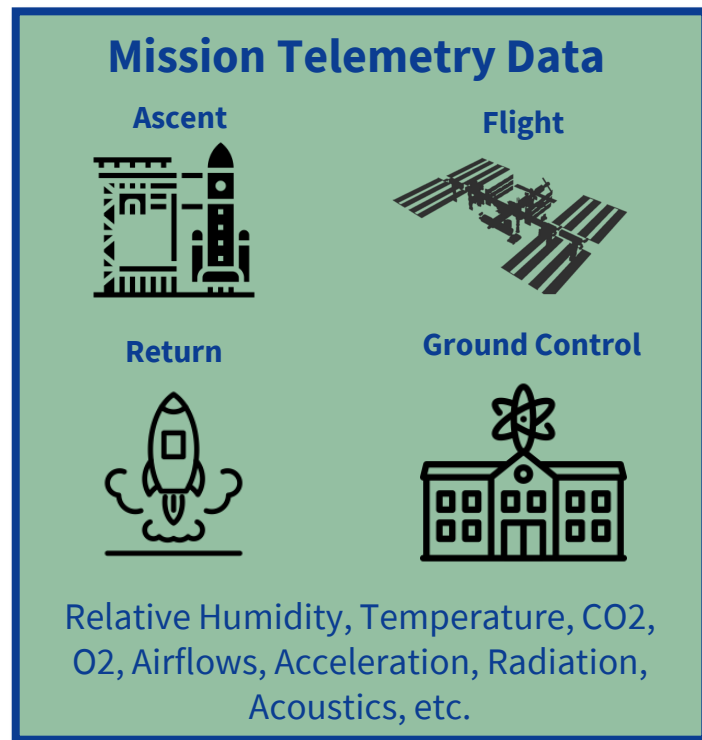


Enhancing Data Submission Portal

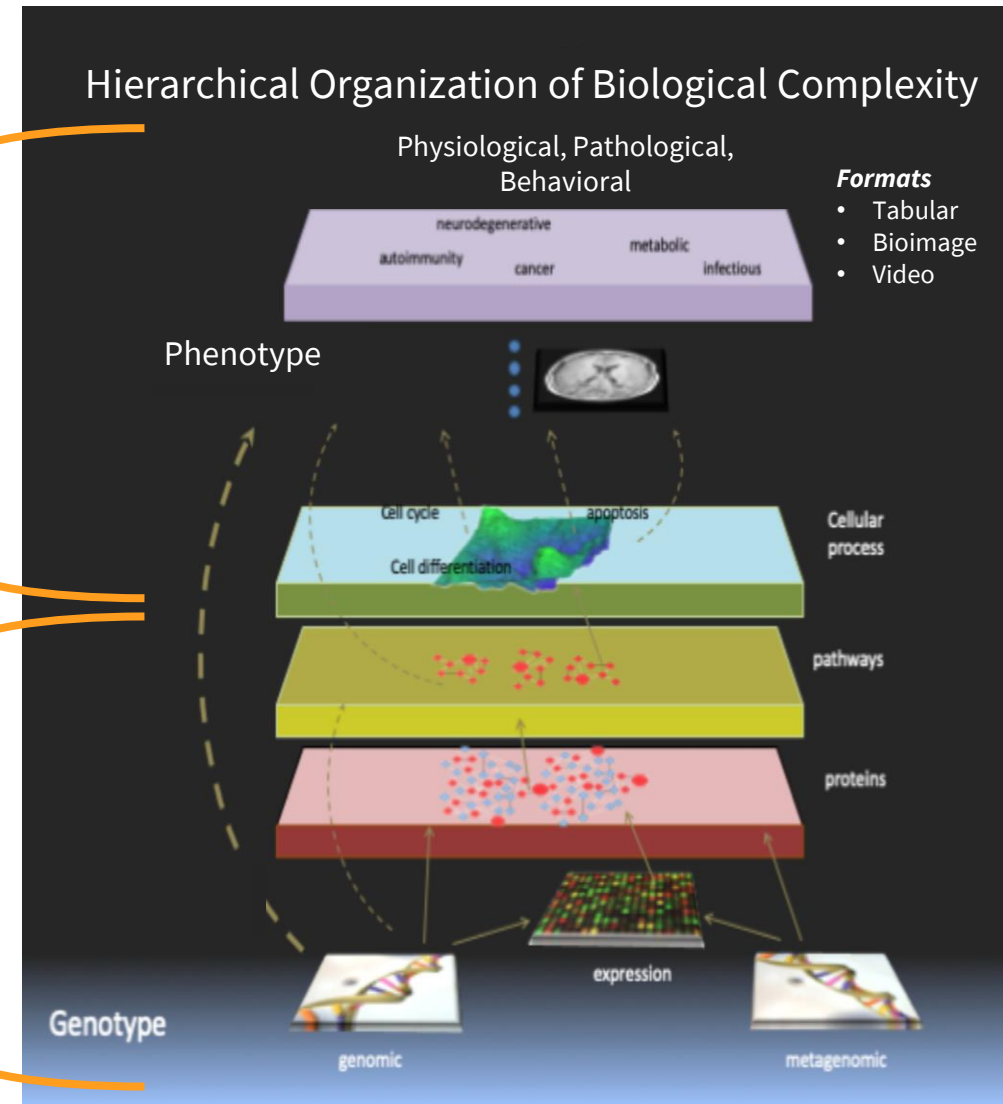
Improved submission automation and “self-service” use



Data Standardization and Integration



This Integration Enables Multi-Hierarchical, Multi-Modal Data Mining Together, for **Many** Computational-Informatic Approaches



Commercial and International Partners



Open access data in GeneLab, **accelerates the pace of scientific discovery** and thus **enables exploration and development of countermeasures** by using systems biology approaches to identify cross-species relevance, mechanisms, biomarkers and potential health risks for LEO and beyond LEO (Lunar and Mars Exploration).

To increase usability and accessibility, space biological research should be available through a common portal. It's important to work closely with our commercial and international partners to ensure data across agencies and platforms are harmonized and comparable. In addition, systems already developed can be utilize not duplicating efforts and costs for data sharing.

For example, **GeneLab already hosts datasets from multiple space agencies (ESA, JAXA, CSA) and from CASIS funded experiments.**

In order to continue maximizing the return of spaceflight experiments, **we encourage commercial and international partners to utilize the GeneLab and ALSDA Data Systems for their research data, both for open and proprietary data.**

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NASA Biological Institutional Scientific Collection

Space-Based Tests



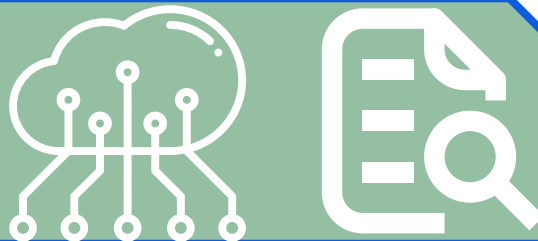
Ground Analogs

Results

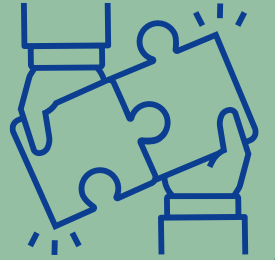
- 33 publications since 2011
- 53 tissue requests since 2016
- 41 GeneLab data sets

Metadata

Specimen



- Fills spaceflight knowledge gaps
- Increases scientific return
- Publications for early career PIs
- Broadens our scientific community
- International collaboration



35,000 Non-Human Biospecimens*

- Mouse, Rat, Quail, Microbial isolates (expected)
- Searchable catalog (LSDA Website)
- Requests via LSDA Biospecimen Request form

~50,000 Space Radiation Mouse Biospecimens

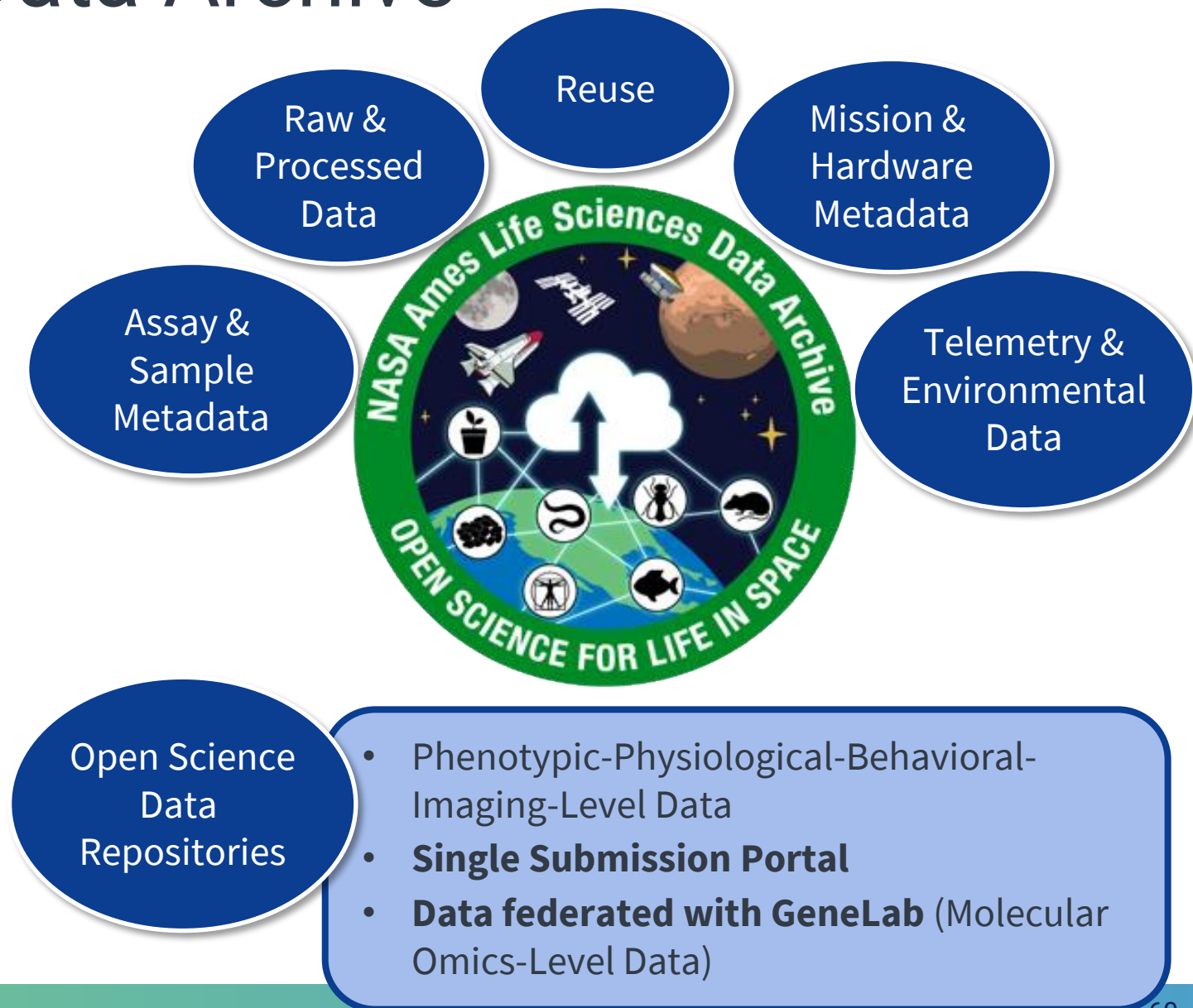
- Space Radiation Ground Analog
- Newly submitted, will be available soon

*Specimens mostly from Shuttle and ISS missions. Also stored are specimens from ground analog studies including centrifuge, hind-limb unloaded, and partial weight bearing.

Ames Life Science Data Archive

Data Sources

- **Past, Present, & Future Data:**
ISS, Shuttle, Bion, Hindlimb Unloading, Radiation-Exposed, Partial Weight Bearing, Rotating Wall Vessel, Clinostat, etc.
- **Basic & Applied Data:**
 μ Gravity, Radiation, Behavioral Countermeasure
- **Living Data Sources:**
Mouse, Rat, Drosophila, Yeast, Bacteria, etc.



Ames Life Science Data Archive

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433
Studies

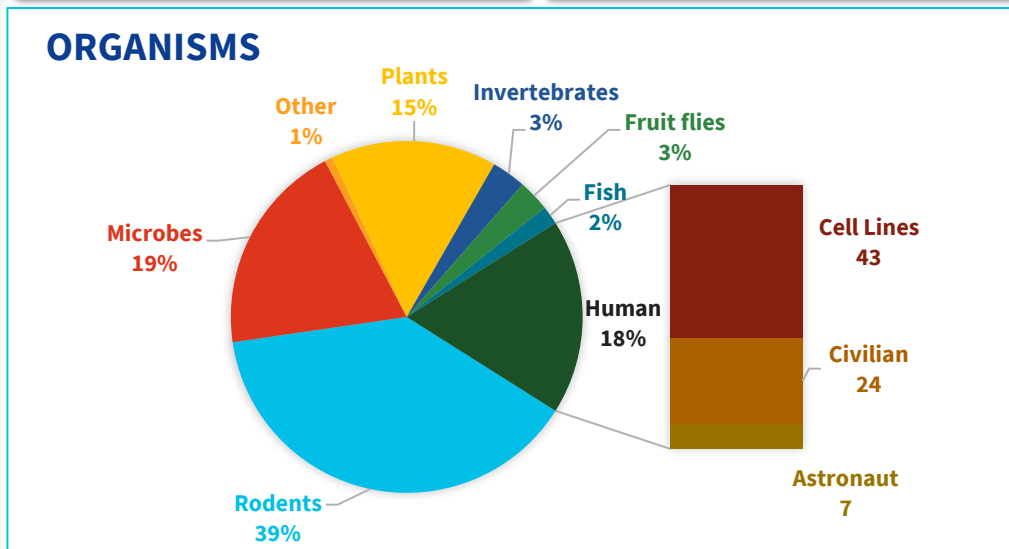
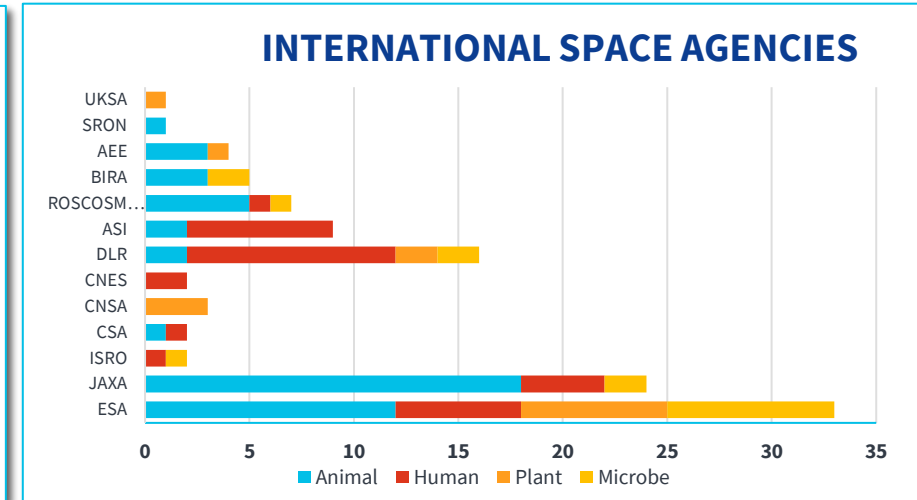
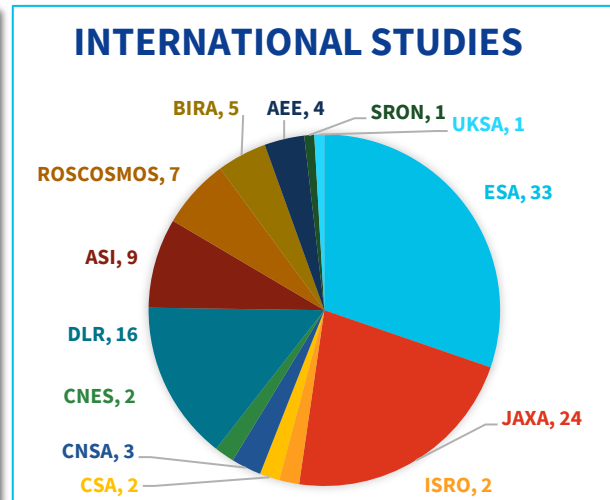
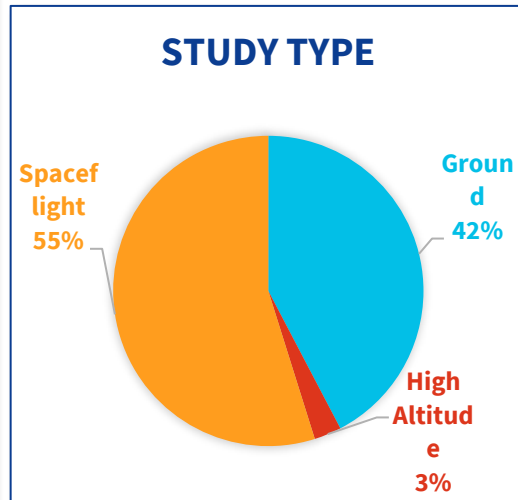
819
Datasets

45
Species

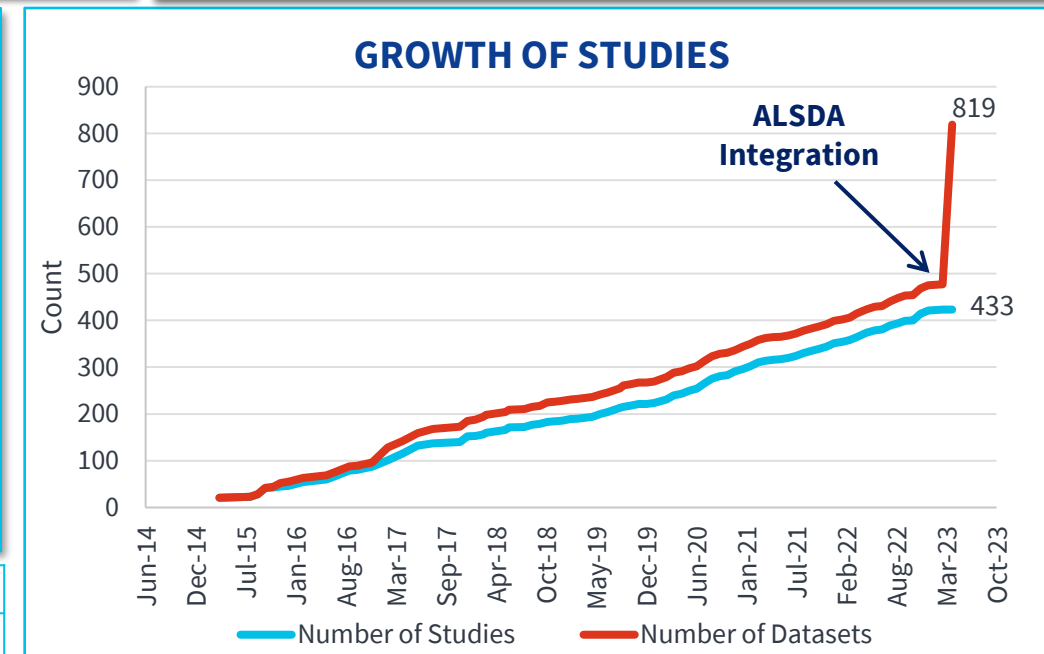
>25
Assays

>150TB
Data

OSDR Database (GeneLab and ALSDA)



Civilian and Astronaut	Bed Rest, Spaceflight, Mars simulation
Cell Lines	Radiation (Ground), Simulated uG, Spaceflight, Parabolic Flight



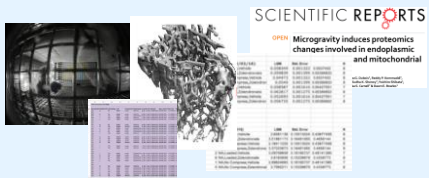
*Data originates from Gene Expression Omnibus (GEO) and EMBL's European Bioinformatics Institute (EMBL-EBI) repositories.



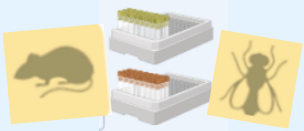
Collects, curate, and distributes data from NASA funded non-human life sciences investigations

Established in 1994

Raw & Processed Data



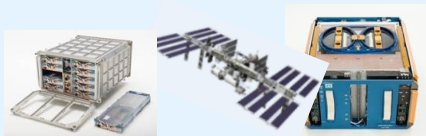
Assay & Sample Metadata



Environmental & Telemetry Data



Mission & Hardware Data



Open Science Data Repository

75 Grants

- Grant managed between 2010-2022

859 Experiments

- 1975 to 2022

356 Datasets (grouped)

- Datasets grouped based on legacy structure

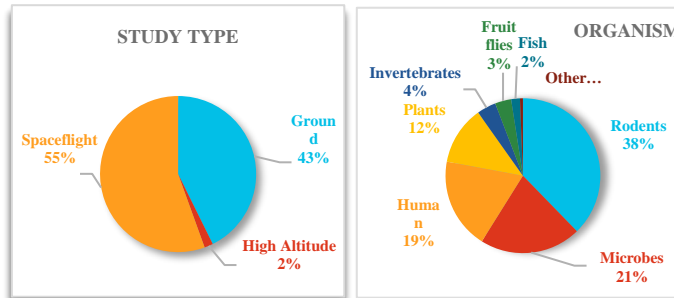
15 TB
300 cf Volume

- PI Data: 1.3 TB
- Mission Data: 2.7 TB
- Images/Video: 11 TB

433 Studies

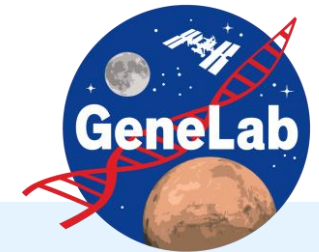
436 Datasets

45 Species



>10 Assays

>135 TB Volume



GeneLab, an open science **multi-omics** repository, covering transcriptomics, metagenomics, epigenomics, proteomics, and metabolomics. Studies comprise of data from **model organisms** including microbes, plants, fruit flies, rodents and humans.

Established in 2014



Data Repository

Raw and high-order data



Environmental Data



Collaborative Workspace



Analysis Platform



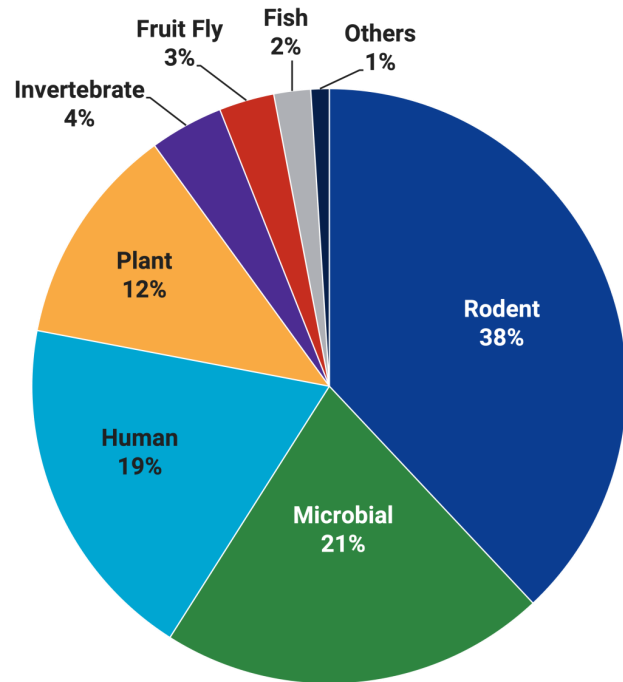
Visualization Portal



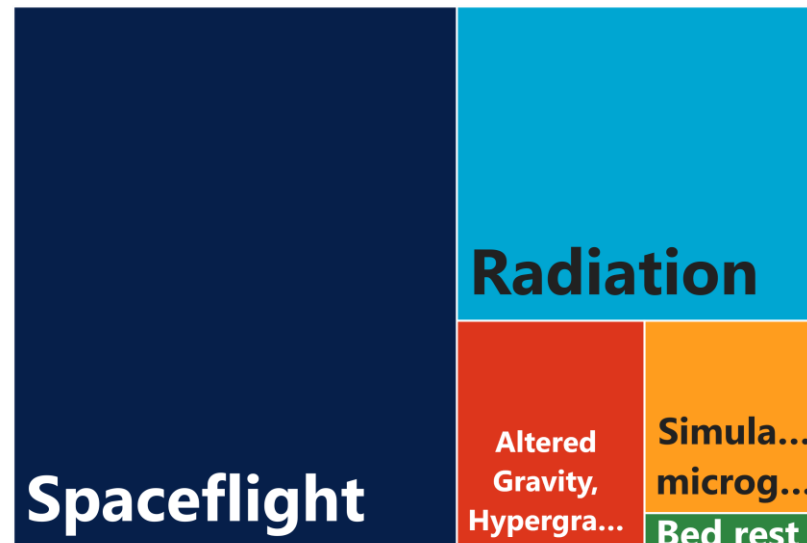
In-house Sequencing Facility

Available Information on OSDR

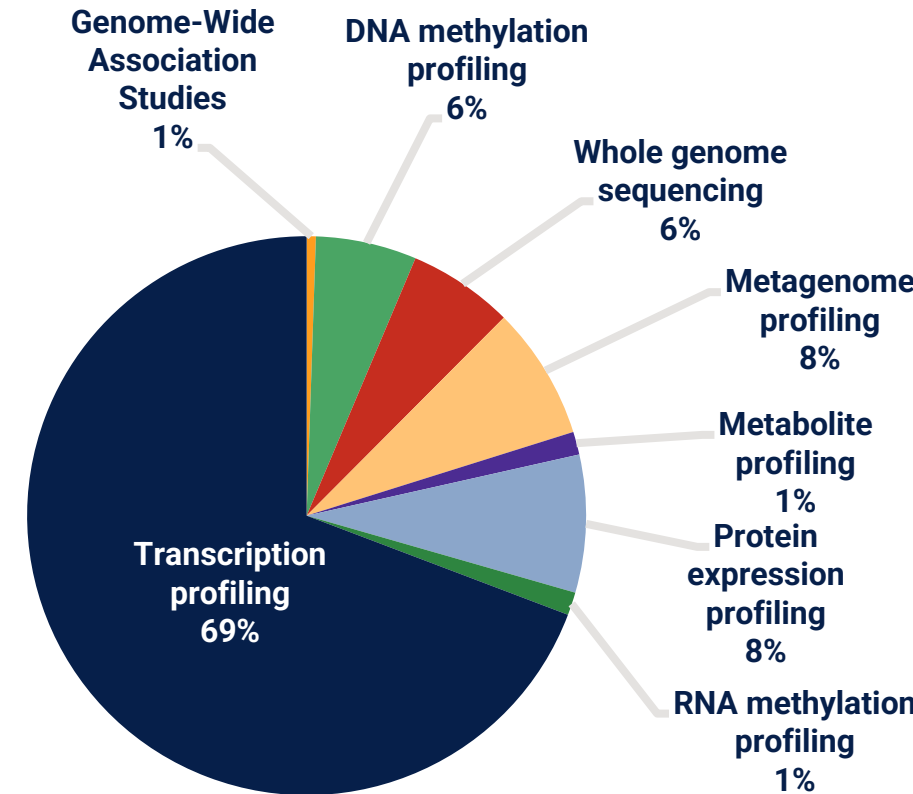
Organisms



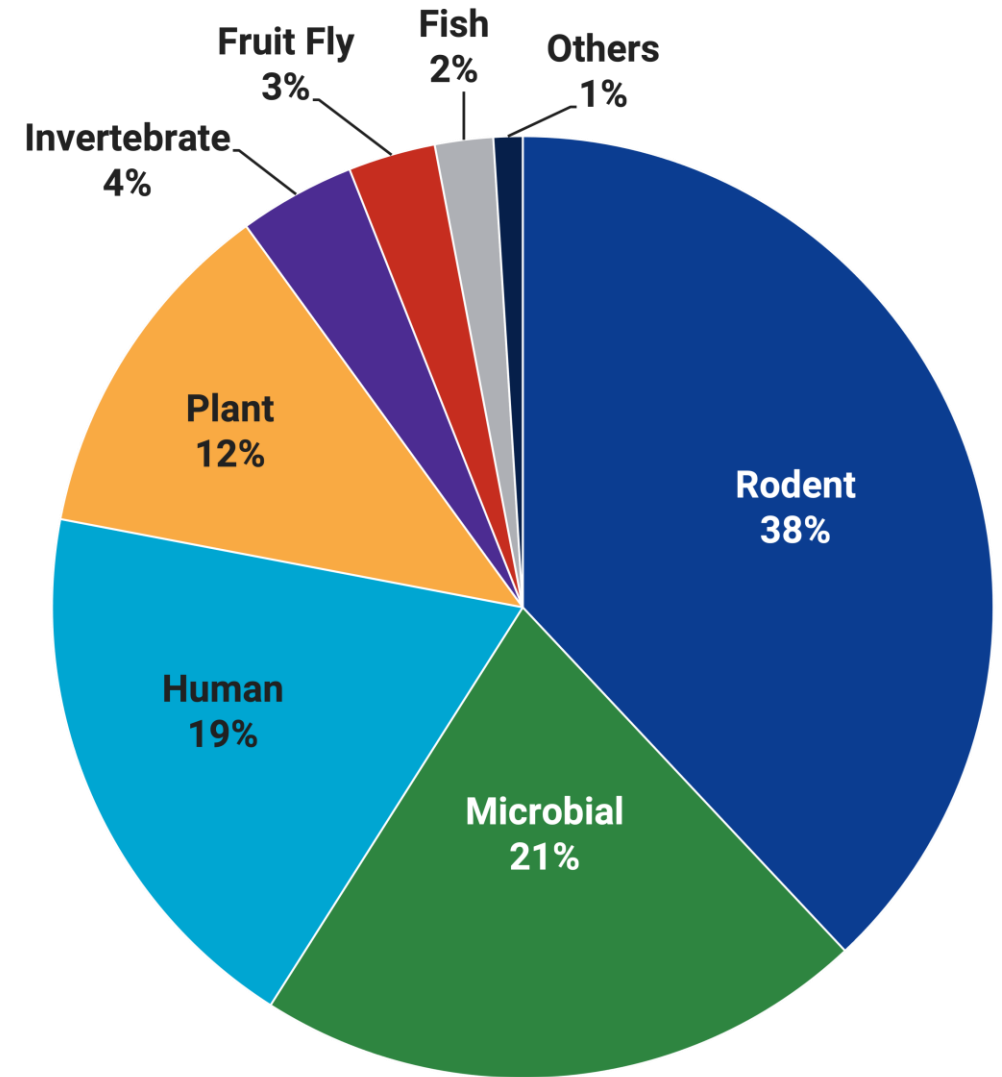
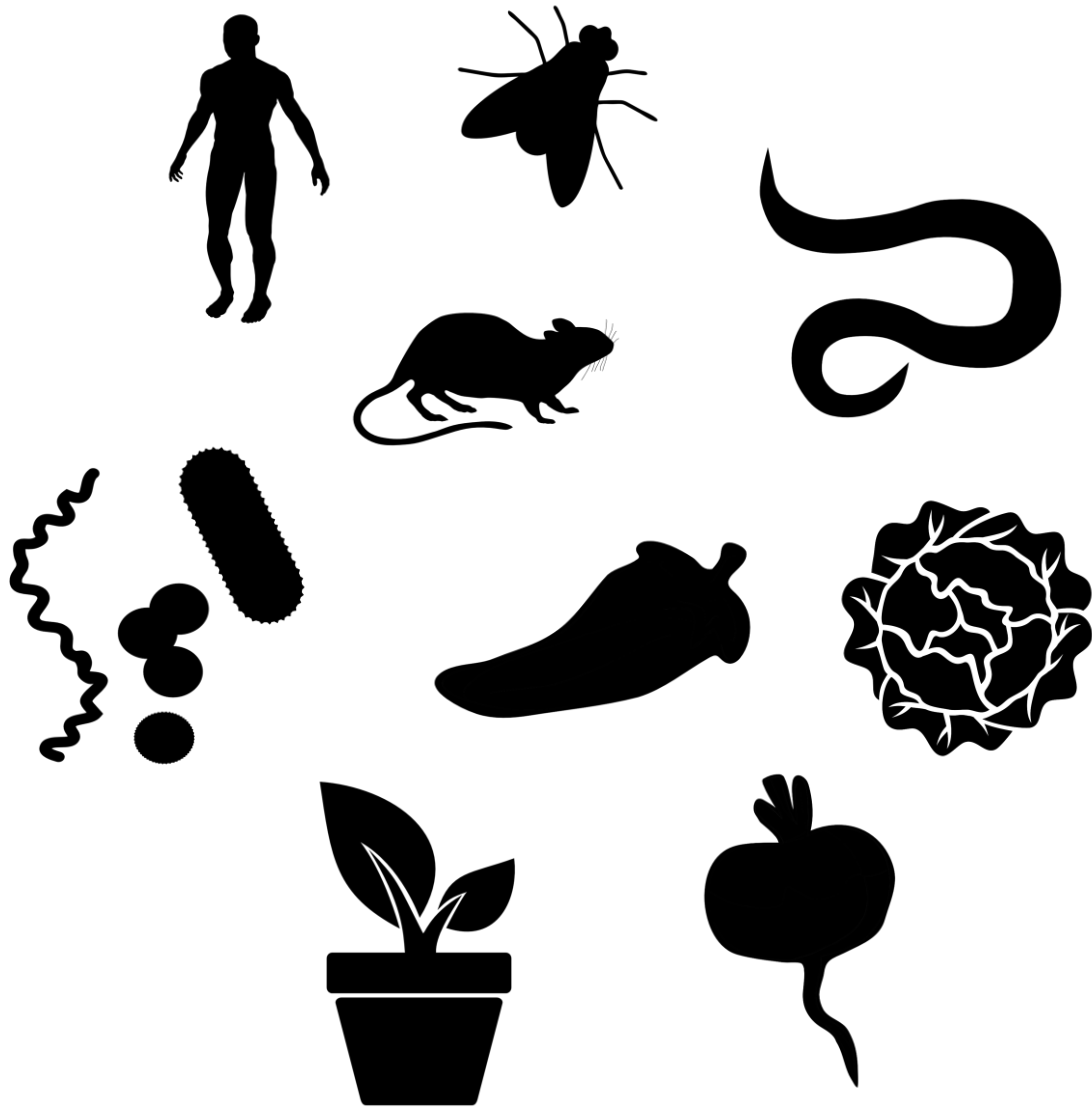
Primary Factors



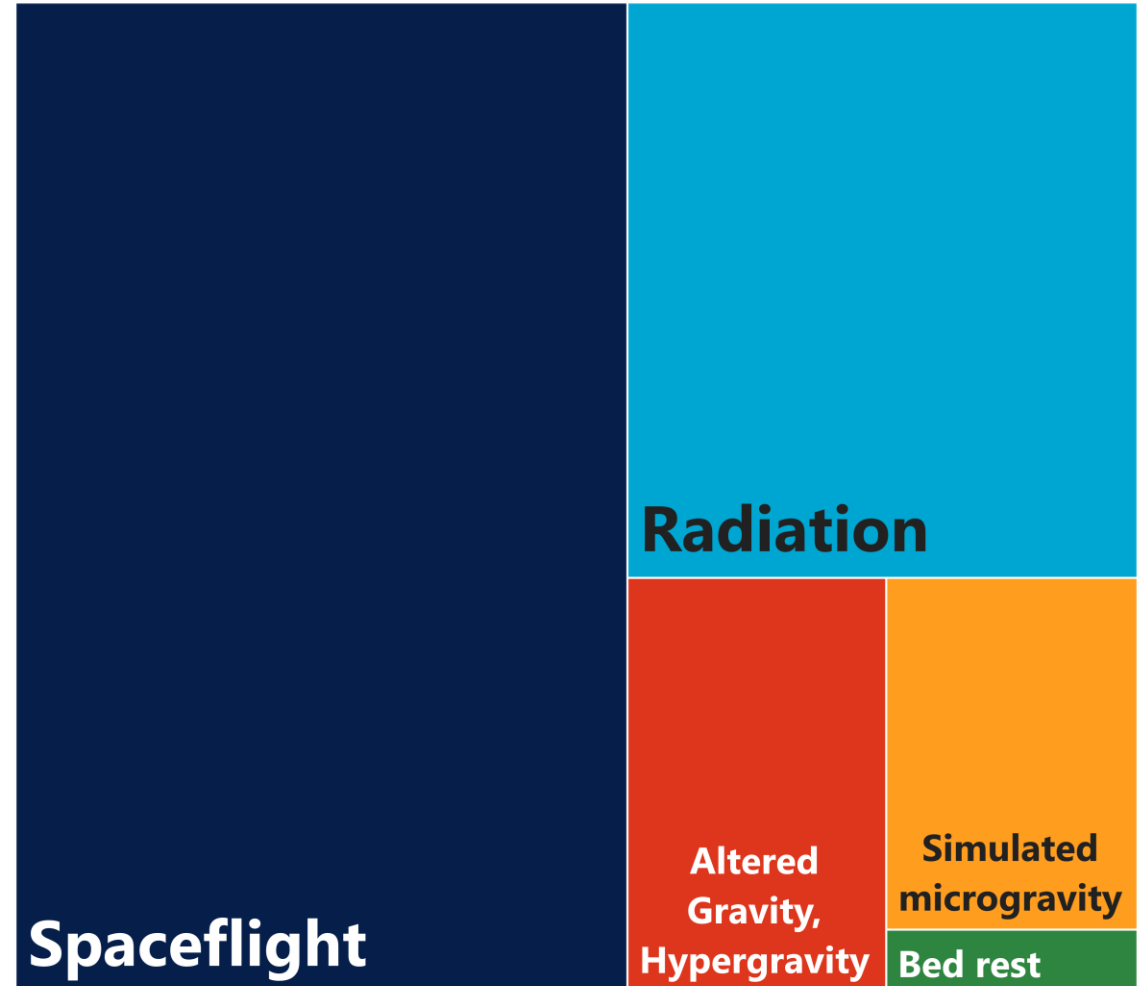
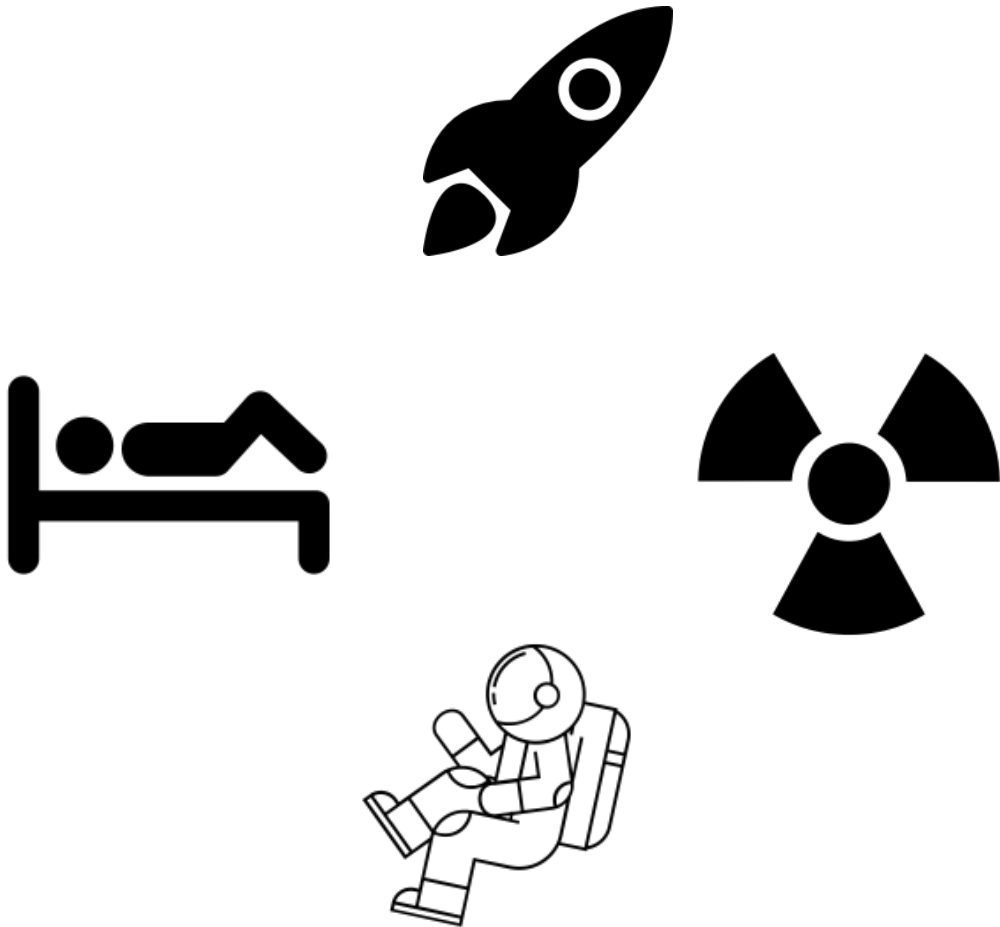
Assays



Model Organisms Found in OSDR

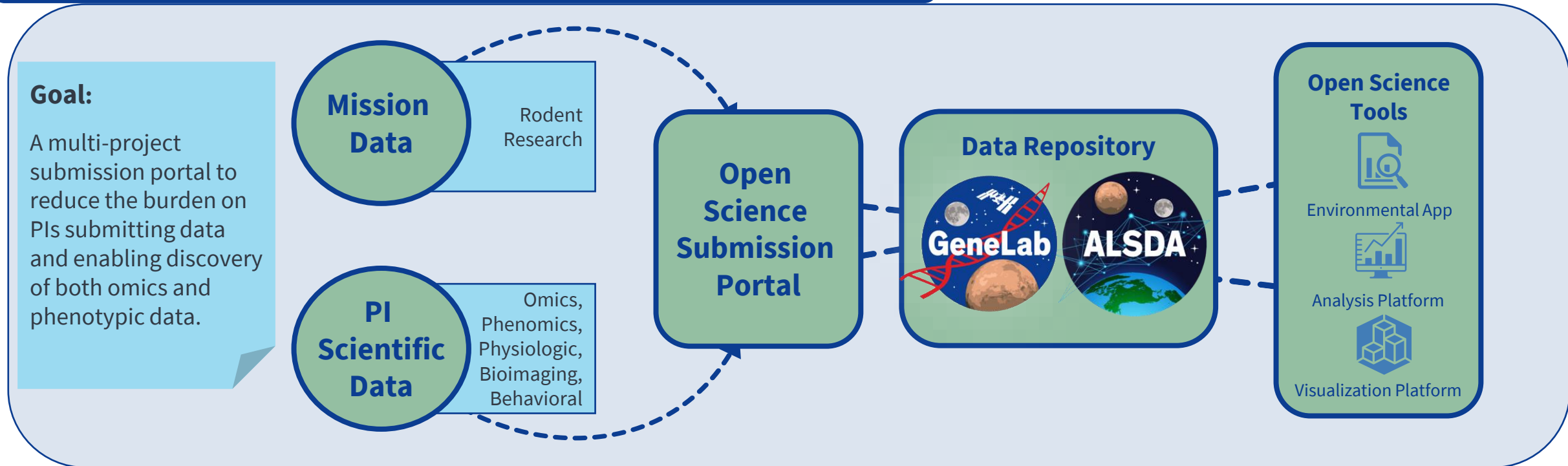


Primary Factors of Concern



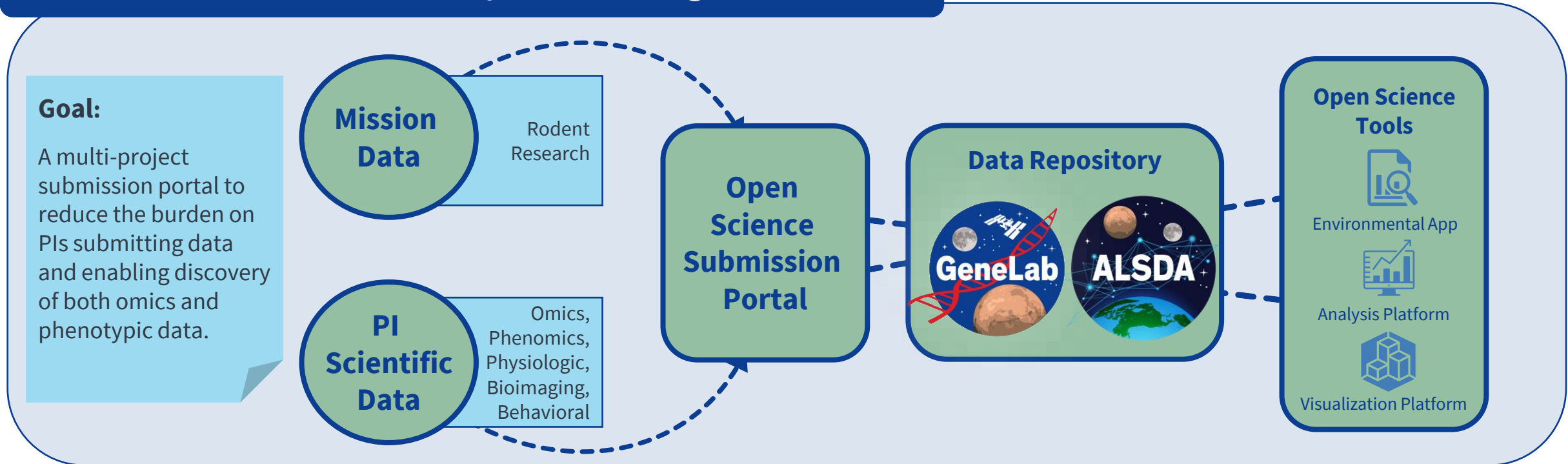
Biological Data Repository

ALSDA and GeneLab Data Systems Integration (2022)



Biological Data Repository

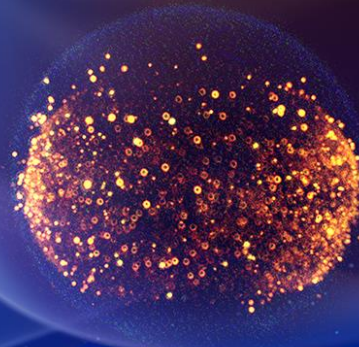
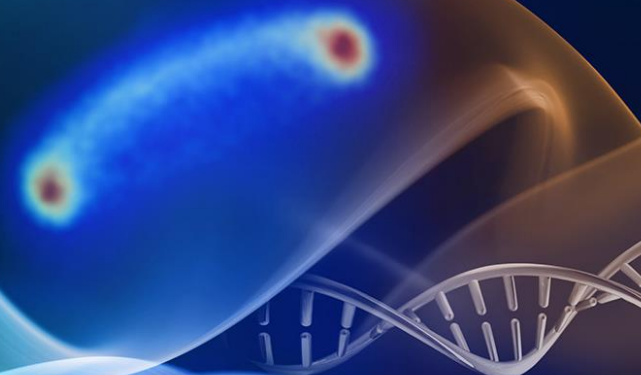
ALSDA and GeneLab Data Systems Integration (2022)



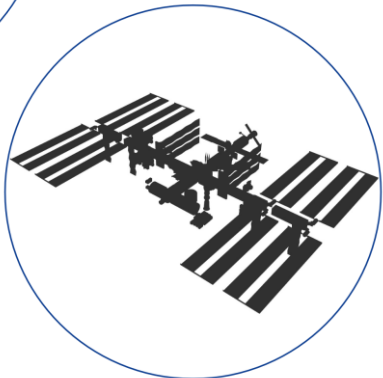
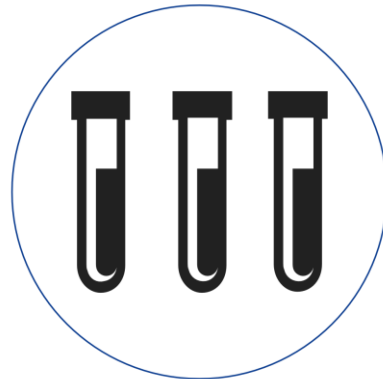
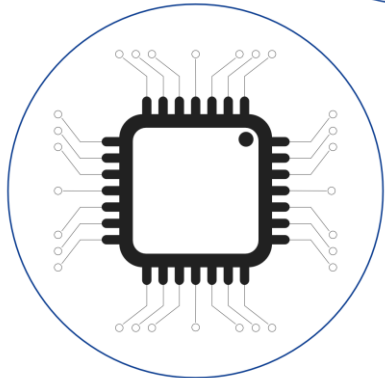
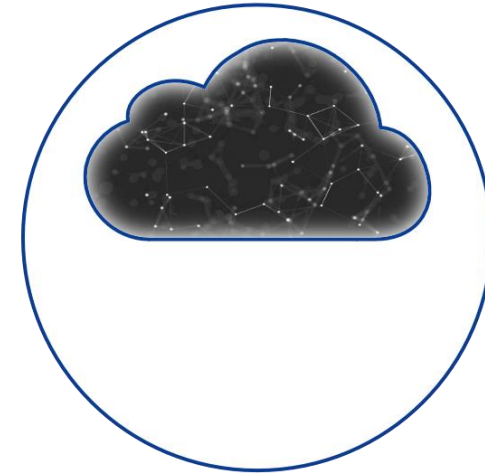
Analysis Working Group (AWG)

- 500+ members (multiple space agencies, international institutions, industry)
- Scientists meet monthly with each group for feedback and data analysis
- Five Groups: Animal, Microbes, Plants, Multi-Omics, & ALSDA
- Published 11 collaborative peer-reviewed papers to date

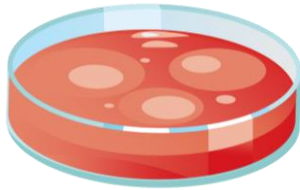
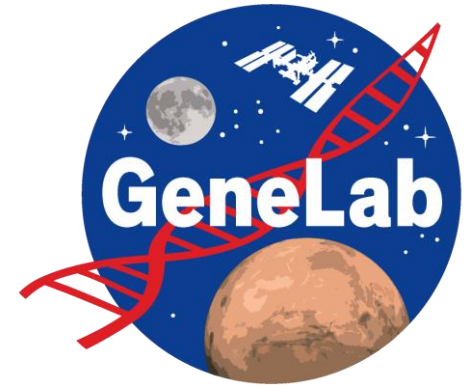
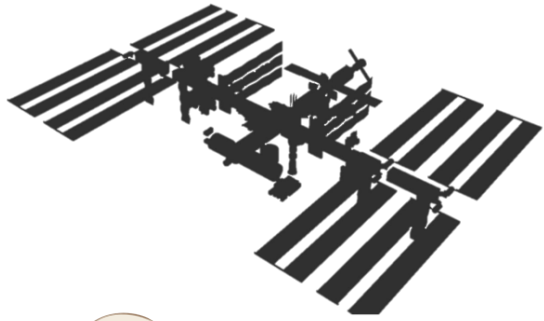
Slide Deck Supporting Materials



Open Science Figure - Image Elements



Misc. Image Elements



Details of the Deck

Theme Fonts

Titles and Headings: Roboto

Body Text: Source San Pro

Theme Colors

Find full color scheme here: <https://nasa.github.io/nasawds-site/components/colors/>

