

ALSDA AWG Update

National Aeronautics and
Space Administration



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ALSDA Project Scientist 
AWG Symposium 2022, Thursday, June 30, 2022
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Why Data Sharing for Lunar and Mars Missions?

Knowledge Discovery

Cell

Comprehensive Multi-omics Analysis Reveals Mitochondrial Stress as a Central Biological Hub for Spaceflight Impacts

Graphical Abstract

Article

Machine Learning Models to Predict Cognitive Impairment of Rodents Subjected to Space Radiation

DNA methylation dynamics associated with long-term isolation of simulated space travel

Article

Knowledge Network Embedding of Transcriptomic Data: Spaceflown Mice Uncover Signs and Symptoms Associated with Terrestrial Diseases

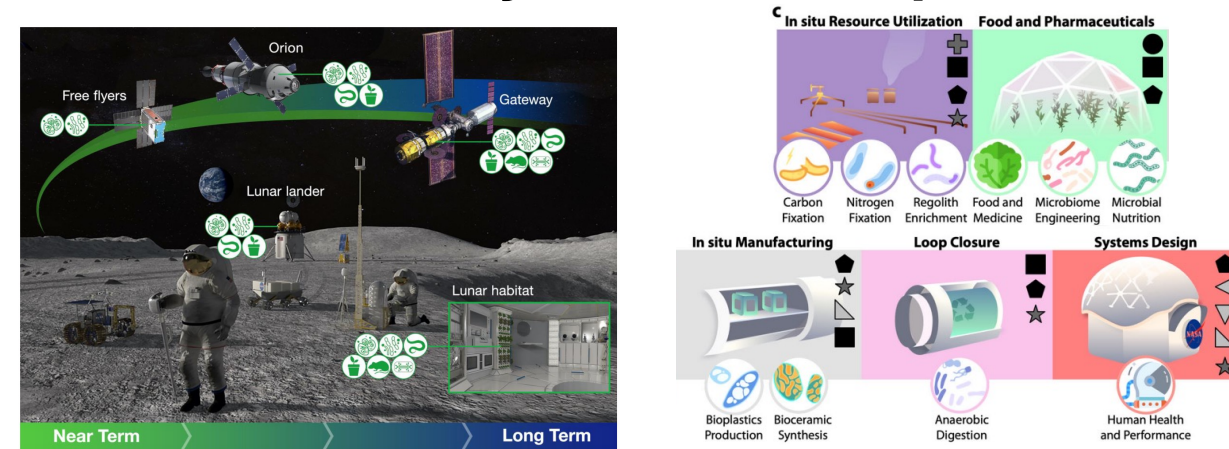
Bone health in spacefaring rodents and primates: systematic review and meta-analysis

Invariant Risk Minimisation for Cross-Organism Inference: Substituting Mouse Data for Human Data in Human Risk Factor Discovery

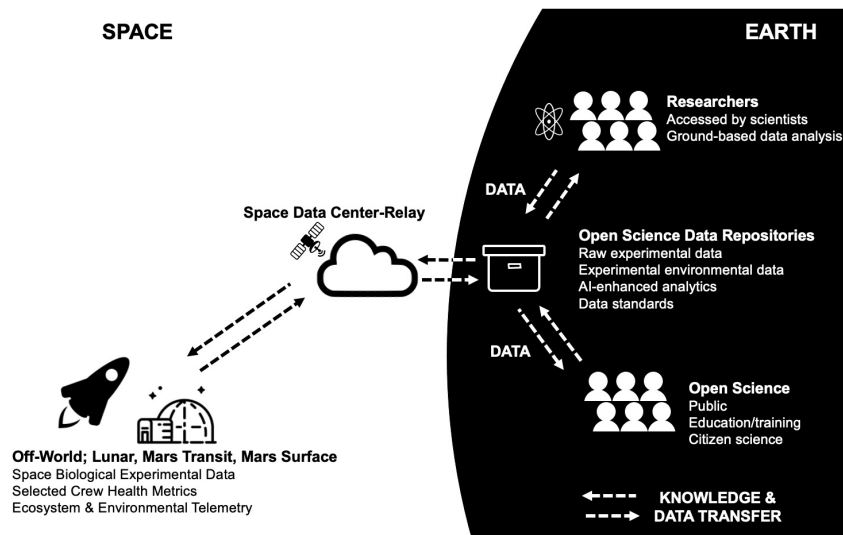
Odhran O'Donoghue, Paul Duckworth, Giuseppe Ughi, Linus Scheibenreif, Kia Khezeli, Adrienne Hoarfrost, Samuel Budd, Patrick Foley, Nicholas Chia, John Kalantari, Graham Mackintosh, Frank Soboczenski, Lauren Sanders

arXiv > cs > arXiv:2111.07348

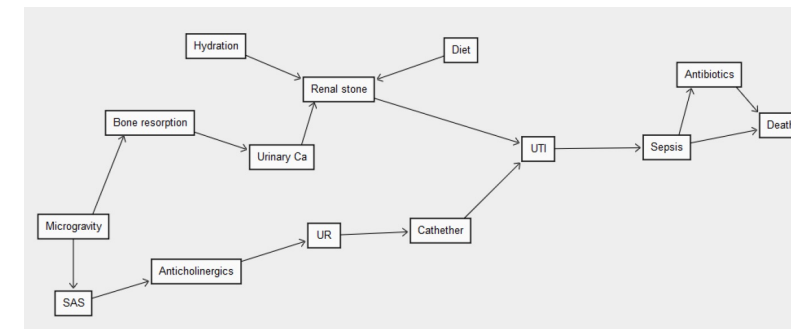
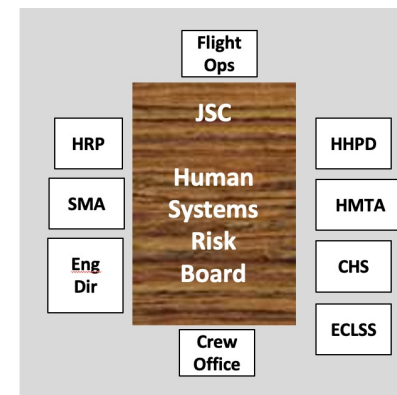
Novel Ecosystem Development



Involve the World in Spaceflight

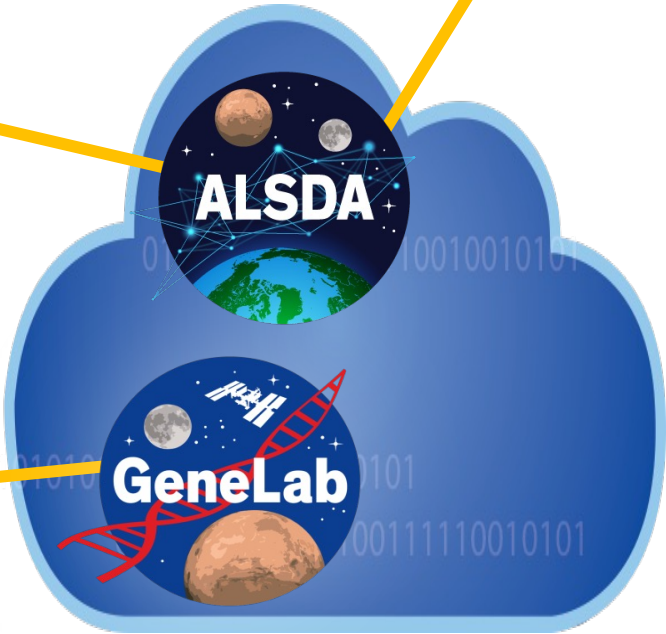
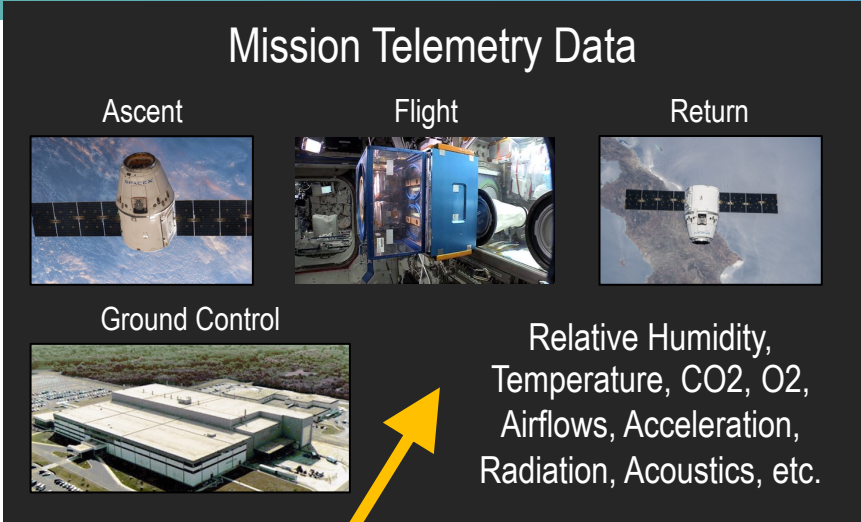
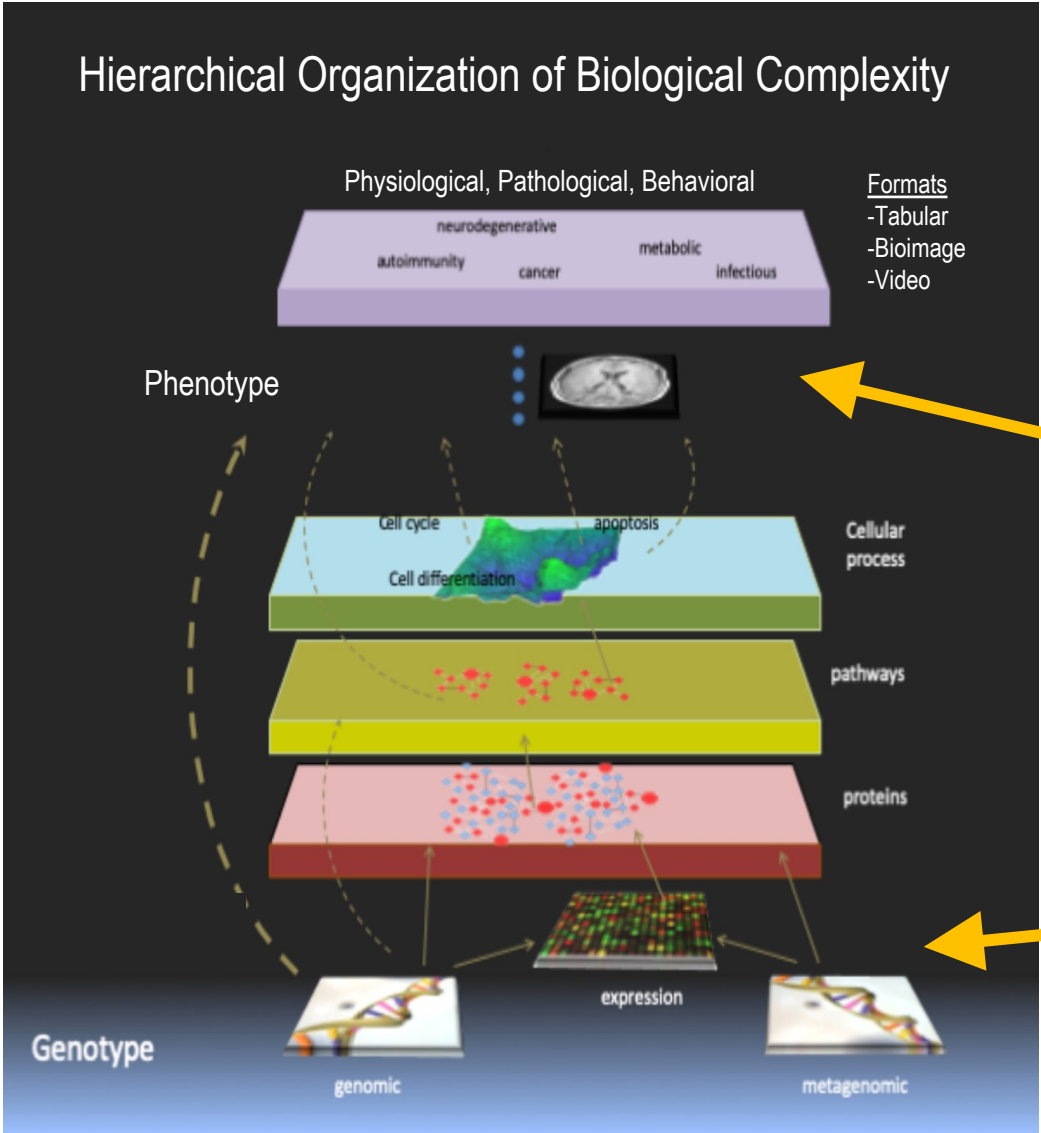


Support Human Health Risk Modeling



Directed Acyclical Graph Example: How does use of anticholinergics modify our total probability of death from sepsis after UTI?

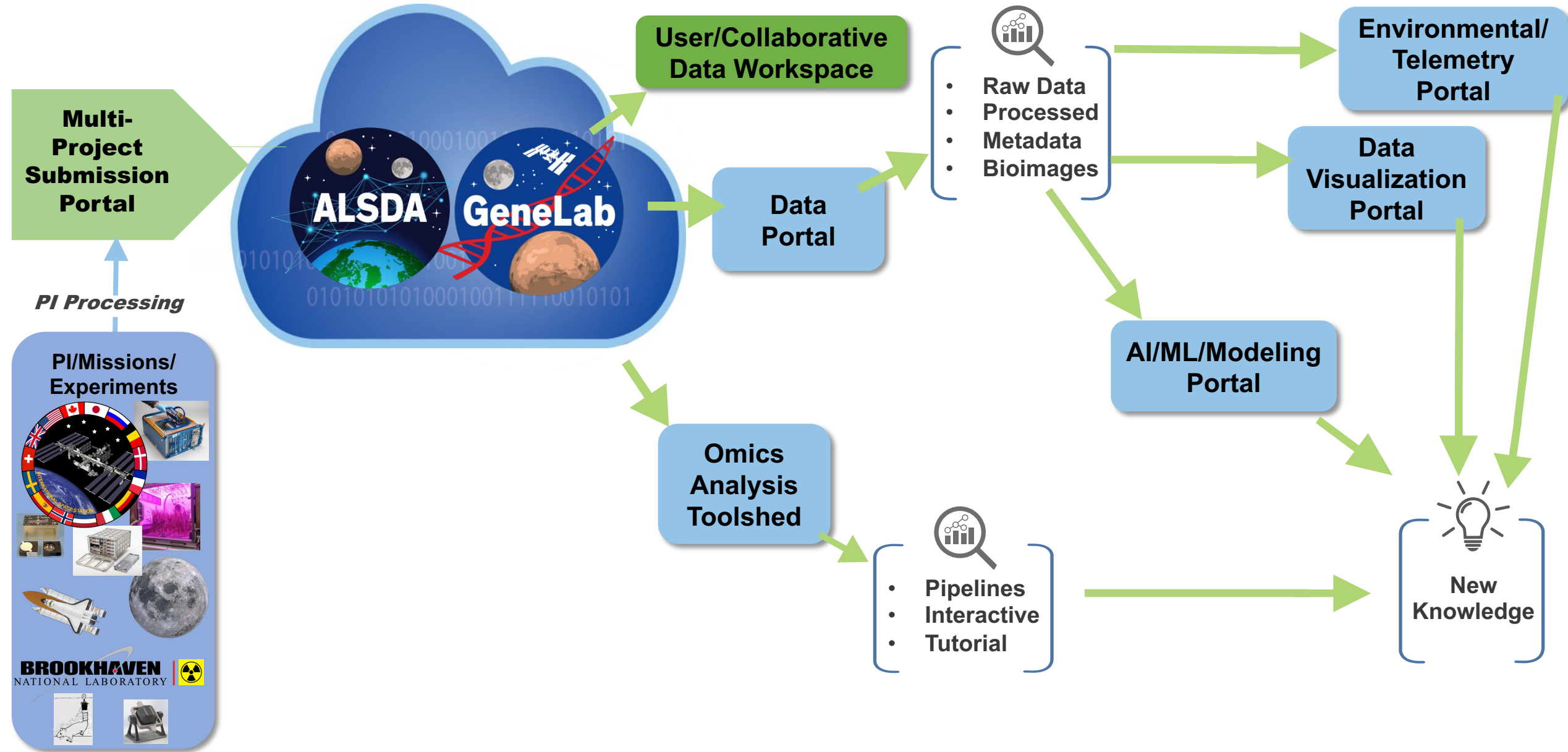
Importance of ALSDA Data Standardization



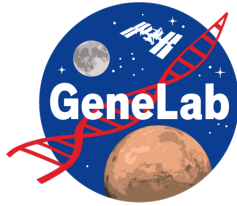
This Integration Enables Multi-Hierarchical, Multi-Modal Data Mining Together, for ***Many*** Computational-Informatic Approaches

(Image Credit: Sergio Baranzini, UCSF; Scott et al., 2021
<https://tinyurl.com/2j58nmn4>; Scott et al., 2020
<https://doi.org/10.1016/j.celrep.2020.108441>)

Open Science Data Repositories



What this means for Egress and Ingress of Data



Welcome to NASA GeneLab - the first comprehensive space-related omics database; users can upload, download, share, store, and analyze spaceflight and spaceflight-relevant data from experiments using model organisms.

Data Repository
Search and upload spaceflight datasets

Analyze Data
Perform large-scale analysis of biological omics data

Environmental Data
Radiation data collected during experiments conducted in space

Collaborative Workspace
Share, organize and store files

Submit Data
Have space-relevant data to submit to GeneLab?

Visualize Data
Interact with GeneLab processed data

Search Data

☐ All ☒ GeneLab ☐ NIH GEO ☐ EBI PRIDE ☐ ANL MG-FAST ☒ ALSDA

Search Filters (GeneLab Only)

Project Type Factors Organisms Assay Type

Show Only:

☐ Studies With Visualizations

Page 1 of 13 (Total Studies: 302) [Next >](#)

Studies Per Page: 25



Effects of Spaceflight on Bone Microarchitecture in the Axial and Appendicular Skeleton in Growing Ovariectomized Rats

Organisms	Factors	Assay Types	Release Date	Description
Rattus norvegicus	Spaceflight Ovariectomized Age	Radiography	25-Feb-2020	This study investigated the effects of a 14-day spaceflight on bone mass, density and microarchitecture in weight bearing (femur and humerus) and non-weight bearing (2nd lumbar vertebra and calvarium)...



Alternative splicing regulates the physiological adaptation of the mouse hind limb postural and phasic muscles to microgravity

Organisms	Factors	Assay Types	Release Date	Description
Mus musculus	Spaceflight Tissue	transcription profiling	25-Jun-2021	We sought to comprehensively elucidate the transcriptomic underpinnings of microgravity-induced muscle phenotypes in mice by evaluating both differential gene expression (DGE) and changes in alternati...

Description Samples **Assays** Protocols Files Study Validations

+ Add Assay

Histone Modification Profile

Novel Object Recognition

Micro-computed tomography

Transcription Factor Binding Site Identification

Post-Transcriptional Modification Profiling

Histomorphometry

Protein Identification

Protein-Protein Interaction Detection

Western Blot

Copy Number Variation Profiling

Ultrasonography

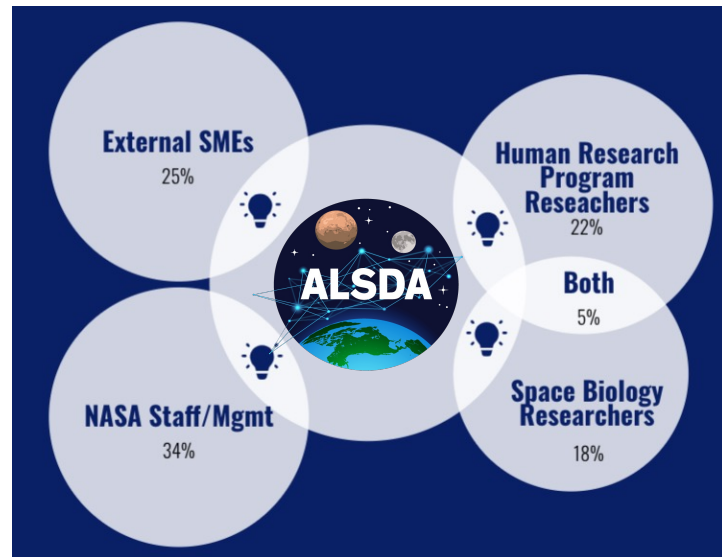
**Adding
Phenotypic
ALSDA
Assays to
Portal**

Cancel

Open Science Community and the ALSDA AWG

ALSDA Analysis Working Group:

- 8 Meetings
- ~100 Members
- ~30-55/Meeting



Assay Metadata Configurations	Drafted	AWG Covered	Deployed	Dataset Using
Bone Microstructure (MicroCT)	✓	09/08/21	✓	✓
Behavior (Novel Object Recognition)	✓	09/08/21	✓	✓
Molecular/Cellular Imaging (Lt/Fluor Microscopy)	✓	09/08/21	✓	
Flow Cytometry (Flow Cytometry)	✓	09/08/21	✓	✓
Behavior (Elevated Plus Maze)	✓	12/08/21	✓	✓
Behavior (Open Field)	✓	12/08/21	✓	
Behavior (Gait)	✓	12/08/21	✓	
Protein Analysis (Western Blot/Immunoblot)	✓	12/08/21	✓	✓
Calcium Uptake (Spectrofluorometry)	✓	12/08/21	✓	✓
Behavior (Barnes Maze)	✓	12/08/21	✓	
Osteocellular (Histomorphometry)	✓	02/16/22	✓	✓
Mechanical Test (3pt-Bend)	✓	02/16/22	✓	
Intra-Ocular Pressure (Rebound Tonometry)	✓			
Blood Analysis (Serum Metabolites)				
Echocardiogram (Ultrasonography)	✓	03/09/22	✓	✓
ELISA (ELISA)	✓	03/09/22	✓	
Behavior (Radial Arm; Water Maze)	✓	03/09/22	✓	✓
Behavior (3-Chamber Social Interaction)	✓	03/09/22	✓	✓
Behavior (Attentional Set-Shifting)	✓	06/01/22	✓	
Behavior (Unconstrained Cognitive Flexibility)	✓	06/02/22	✓	
Behavior (Morris; Water Maze)				
Muscle Physiology (Muscle Fiber Typing)				
In Vivo Bone (pQCT)	✓			
Mineral Density and Composition (DXA)				
Behavior (Object in Place)				
Behavior (Novel Location)				
Electron Microscopy (Scanning)				
Electron Microscopy (Transmission)				
Neurophysiology (Electrophysiological Recordings)				
Physiology (Blood Pressure)				
Physiology (Pulse Oximetry)				
Metabolites (HPLC with ECD)				
Cardiovascular Imaging (MRI)				
Neuroimaging (MRI)				
Eye Microstructure (microCT)				
Grip Force (Force Transducer)				
Behavior (Spatial Novelty Y Maze)				
Behavior (Tail Suspension Test)				
Behavior (Startle Test)				
Behavior (Prepulse Inhibition)				
Behavior (Contextual Fear Conditioning)				
Behavior (Rotarod)				
Behavior (Wire Hang)				
Behavior (Escher Staircase Track)				

ALSDA Assay Metadata, Image, Outcome Measure Configuration for microCT	Micro-Computed Tomography (microCT; µCT)
File Folders will contain: Study Metadata File, µCT Assay .log file	Measurement: Bone Microstructure
Supporting Literature: ALSDA Assay Metadata Configuration for Western Blot/Immunoblot	Western Blot / Immunoblot
File Folders will contain: Study Metadata File, Assay Results (Outputs; .txt files raw values), Western Blot Assay Raw Images and Stained Images	Measurement: Protein Quantification
Supporting Literature: ALSDA Assay Metadata, Setup, Outcome Measure	Barnes Maze
File Folders will contain: Study Metadata File, Processed Data Outcomes File, Image of Barnes Maze, Image of Aversion device, Image of the Room, Raw Training Session Video, Raw Test Session Video	Measurement: Behavior
Supporting Literature: ALSDA Assay Metadata, Setup, Outcome Measure	Gait
File Folders will contain: Study Metadata File, Processed Data Outcomes File, Image of Barnes Maze, Image of Aversion device, Image of the Room, Raw Training Session Video, Raw Test Session Video	Measurement: Behavior
Supporting Literature: ALSDA Assay Metadata, Setup, Outcome Measure	Open Field
File Folders will contain: Study Metadata File, Processed Data Outcomes File, Image of Barnes Maze, Image of Aversion device, Image of the Room, Raw Training Session Video, Raw Test Session Video	Measurement: Behavior
Supporting Literature: ALSDA Assay Metadata, Setup, Outcome Measure	Microscopy
File Folders will contain: Study Metadata File, Processed Data Outcomes File, Image of Barnes Maze, Image of Aversion device, Image of the Room, Raw Training Session Video, Raw Test Session Video	Measurement: Molecular/Cellular Imaging
Supporting Literature: ALSDA Assay Metadata, Setup, Outcome Measure	Elevated Plus Maze (EPM)
File Folders will contain: Study Metadata File, Processed Data Outcomes File, Image of Barnes Maze, Image of Aversion device, Image of the Room, Raw Training Session Video, Raw Test Session Video	Measurement: Behavior
Supporting Literature: ALSDA Assay Metadata, Setup, Outcome Measure	COGNITIVE ASSAY ARRANGEMENT
File Folders will contain: Study Metadata File, Processed Data Outcomes File, Image of Barnes Maze, Image of Aversion device, Image of the Room, Raw Training Session Video, Raw Test Session Video	PHYSICAL ENVIRONMENT

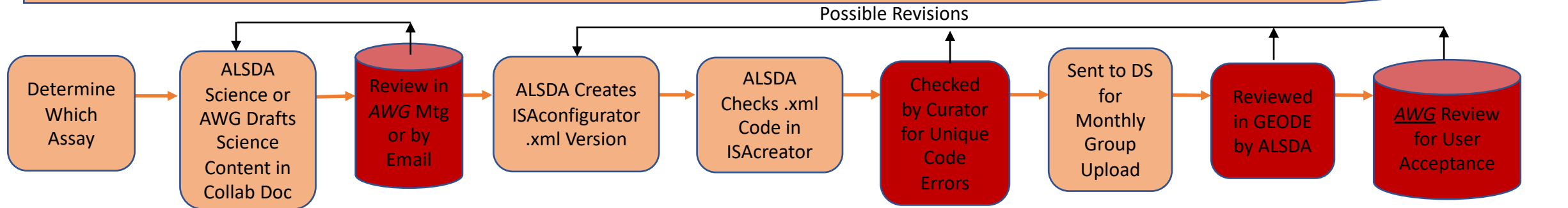
ALSDA AWG Accomplishments:

- ~20 Assay Metadata Configurations
- Submitted Data for Curation to Use Configs
- Mission Telemetry Feedback
- AI-Readiness & Data-Results Template Feedback

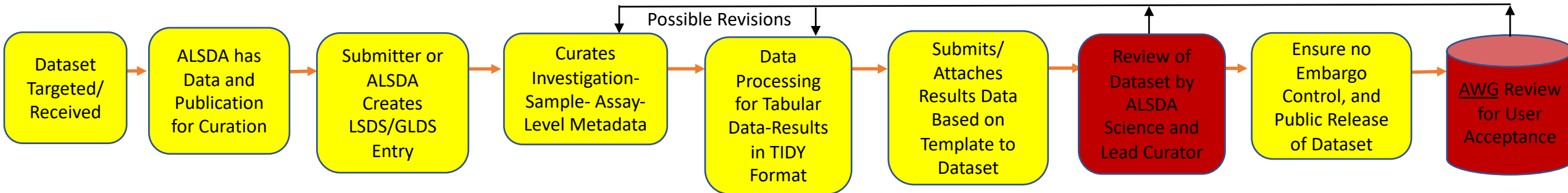
Email to learn more and join!
arc-dl-alsda@mail.nasa.gov

ALSDA Science and Data Workflows

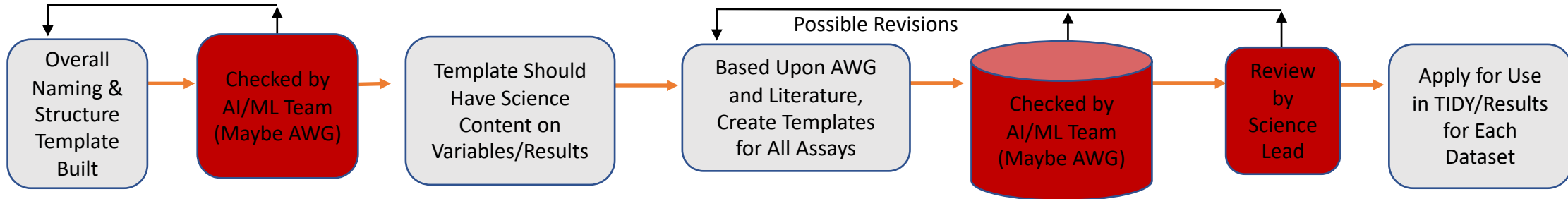
Assay Metadata Configurations



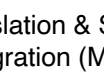
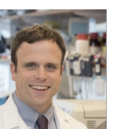
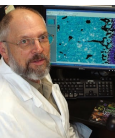
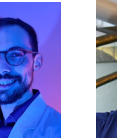
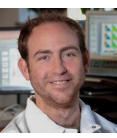
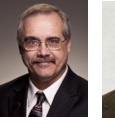
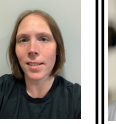
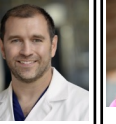
Dataset Curation



Tabular Data-Results Templates



Kudos: A Portion of AWG Members (Contributed Data, Config Feedback, etc.)

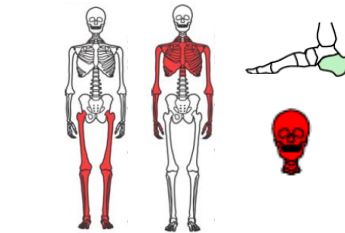
 Siddhita Mhatre 	 Janani Iyer 	 Josh Alwood	 Egle Cekanaviciute 	 Susanna Rosi 	 Amber Paul 	 Val Fajardo	 Jessica Braun 	 Alex Pattison 	 Andrew Wyrobek 	 Svetlana Komarova 	 Mattias Neset 	 Matt Gaidica 	 Upal Roy 	 Christopher Mason 	 Anthony Lau 	 Nate Szewczyk 	
 Greg Nelson 	 Vivien Mao	 Marie Mortreux	 Mary Bousse 	 Cynthia Lemere 	 Rich Britten 	 Jeffrey Willey 	 Sunny Narayanan 	 Mike Delp	 Russell Turner 	 Urszula Iwaniec	 Stephen Keegan 	 Fred Kiffer 	 Amelia Eisch 	 Marshall Porterfield 	 Richard Barker 	 Deepak Kulkarni 	 Dan Berrios
 Vinita Chauhan 	 Marjan Boerma	 Antiño Allen 	 Keith Siew 	 R I Anu 	 Mona Matar 	 Raj Prabhu 	 Jerry Myers 	 Saswati Das 	 David Zawieja 	 Walter Cromer	 Rob Reynolds 	 Rachel Shoop 	 Sara Jorgensen 	 Katherine Baxter 	 Erik Antonsen 	 Virginia Ferguson 	 Bernard Rabin 
	 San-huei Lai 	 Sylvain Costes	 Evelyn Wong	 Ryan Scott	 Danielle Lopez	 Samrawit Gebre	 Alan Wood	 Kira Rienecker	 Viktor Stolz 	 Lauren Sanders 	 Adrienne Hoarfrost	 April Ronca 	 Eduardo Almeida 	 Dawn Bowles 			

Thanks to ALL
ALSDA AWG
Members!

Meta-Analysis, Literature Mining, and Curating Legacy Datasets

Previous Bone Meta-Analysis

ARTICLE **OPEN** npj | Microgravity
A systematic review and meta-analysis of bone loss in space travelers
Mariya Stavnichuk^{1,2}, Nicholas Mikolajewicz^{2,3}, Tatsuya Corlett^{2,3}, Martin Morris^{2,4} and Svetlana V. Komarova^{1,2,3,5}



ARTICLE **OPEN** npj | Microgravity
Bone health in spacefaring rodents and primates: systematic review and meta-analysis
Jingyan Fu^{1,4}, Matthew Goldsmith^{1,2,4}, Sequoia D. Crooks¹, Sean F. Condon¹, Martin Morris^{2,3} and Svetlana V. Komarova^{1,2,5}

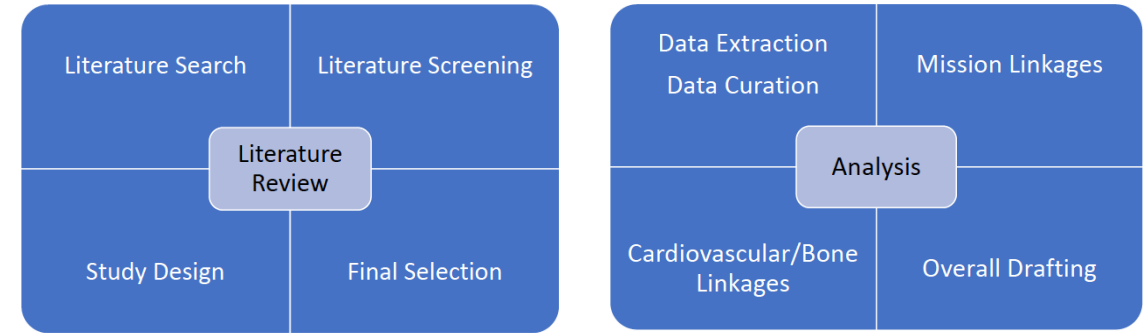


New Cardiovascular Project/Approach

Outcomes in Humans and Animals; Actual or Simulated Microgravity

Step 1) Organize knowledge & data changes in CV parameters

Step 2) Correlate CV outcomes w/additional organ interplay (e.g. bone)



Involvement

Various PIs, Labs, ALSDA AWG

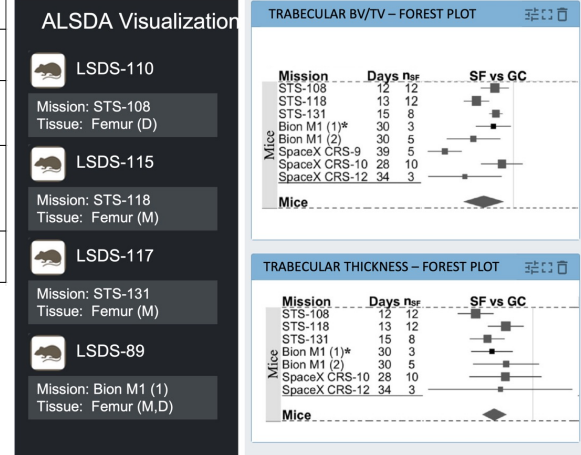
Drs. Susan Bloomfield, Michael Delp, Katherine Baxter, Nate Szewczyk, Russell Turner, Benjamin Levine, Jay Buckey, Marjan Boerma, Dawn Bowles, Bettina Willie, Saswati Das



ALSDA Data Curation

1st Author	GLDS	Configs needed	Bones	PI	Link	Mission/Payc
Berg-Johansen 2015	GLDS-471	mCT	caudal vertebrae 4	Alan Hargens	https://doi.org/10.1002/jor.23029	Bion M1
Jee 1983	GLDS-475	histology (light microscopy)	tibia, humerus	Webster Jee	https://doi.org/10.1152/ajpregu.1983.244.3.R3110	COSMOS 1129
Blaber 2013	GLDS-474	histology (light microscopy); mCT	ischium, femur	Eduardo Almeida	https://doi.org/10.1371/journal.pone.0061372	STS-131
Lloyd 2015	GLDS-472	histomorphometry, light micro, pQCT	tibia, humerus, lumbar 5, femur	Ted Bateman	https://doi.org/10.1016/j.bone.2015.08.021	STS-108
Zhang 2013	GLDS-486	mCT	calvaria	Alan Hargens	https://doi.org/10.1016/j.bone.2013.06.009	STS-131

- Demonstrate Value in Legacy Data
- Community Curation Approach
- More Data, More Reuse



~100 Students/Young Professionals

- Volunteered to obtain research experience
- Majority Underrepresented Background in STEM (e.g., First-Generation, Women, Minority, Disadvantaged Backgrounds, Disabilities, etc.).

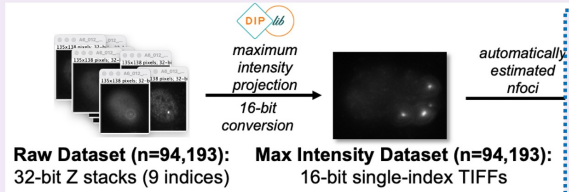
ALSDA Data Currently in Reuse

Benchmark Microscopy Dataset

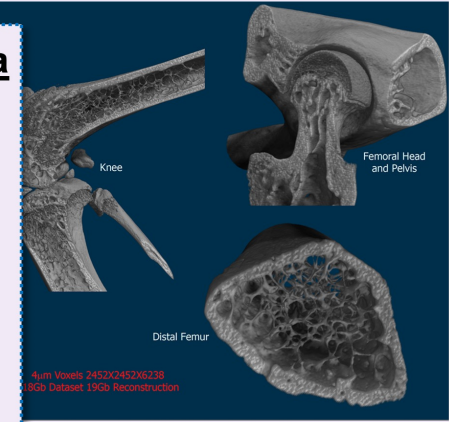
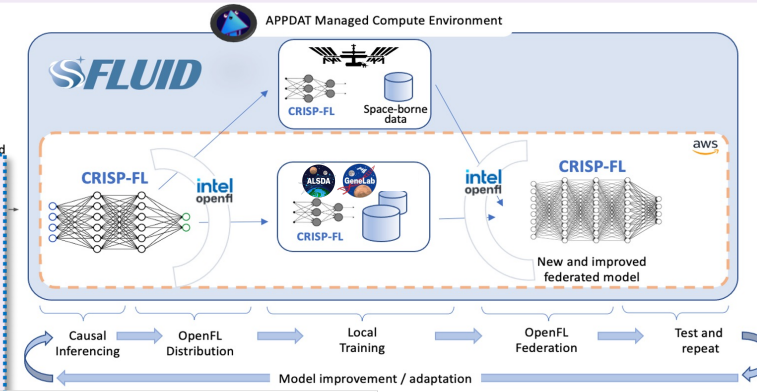
- Huge amounts of microscopy data in space biology, time consuming, manual annotate

Approach:

-Radiation exposure microscopy DNA damage dataset, distinct foci (PI: Costes)



Federated causal inference; Earth data and ISS spaceborne data



Genomic to Phenotypic: CRISP and Hepatic Dysfunction

-Transcriptomics, Histology; Four Spaceflown Rodent Liver Datasets

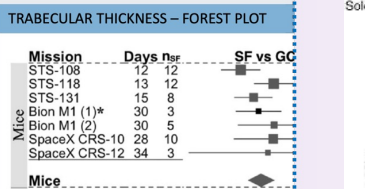
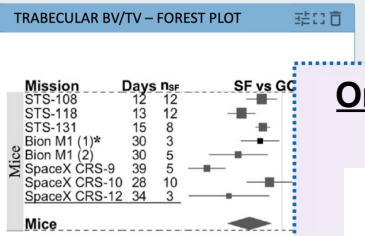
-Ensemble Learning; Causal Research and Inference Search Platform



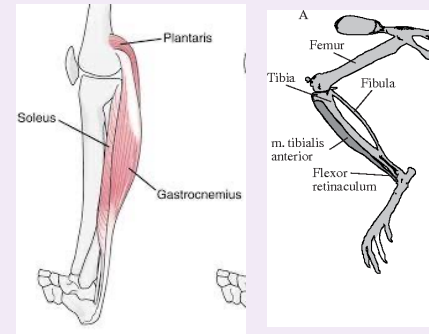
ALSDA Visualization

 LSDS-110

Mission: STS-108
Tissue: Femur (D)

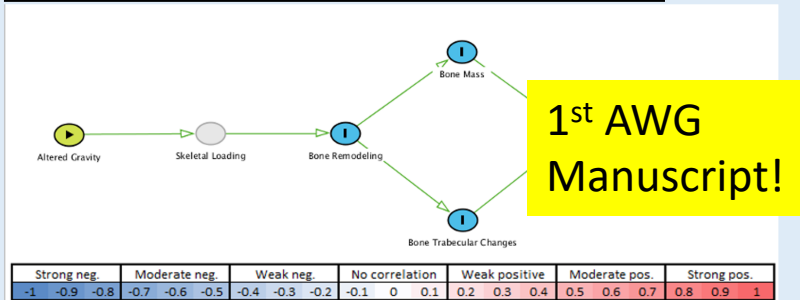
 LSDS-115

Omics and Phenomic Muscle Data using explainable xAI (Qlattice) to identify drivers of fast vs slow-twitch space muscle impacts

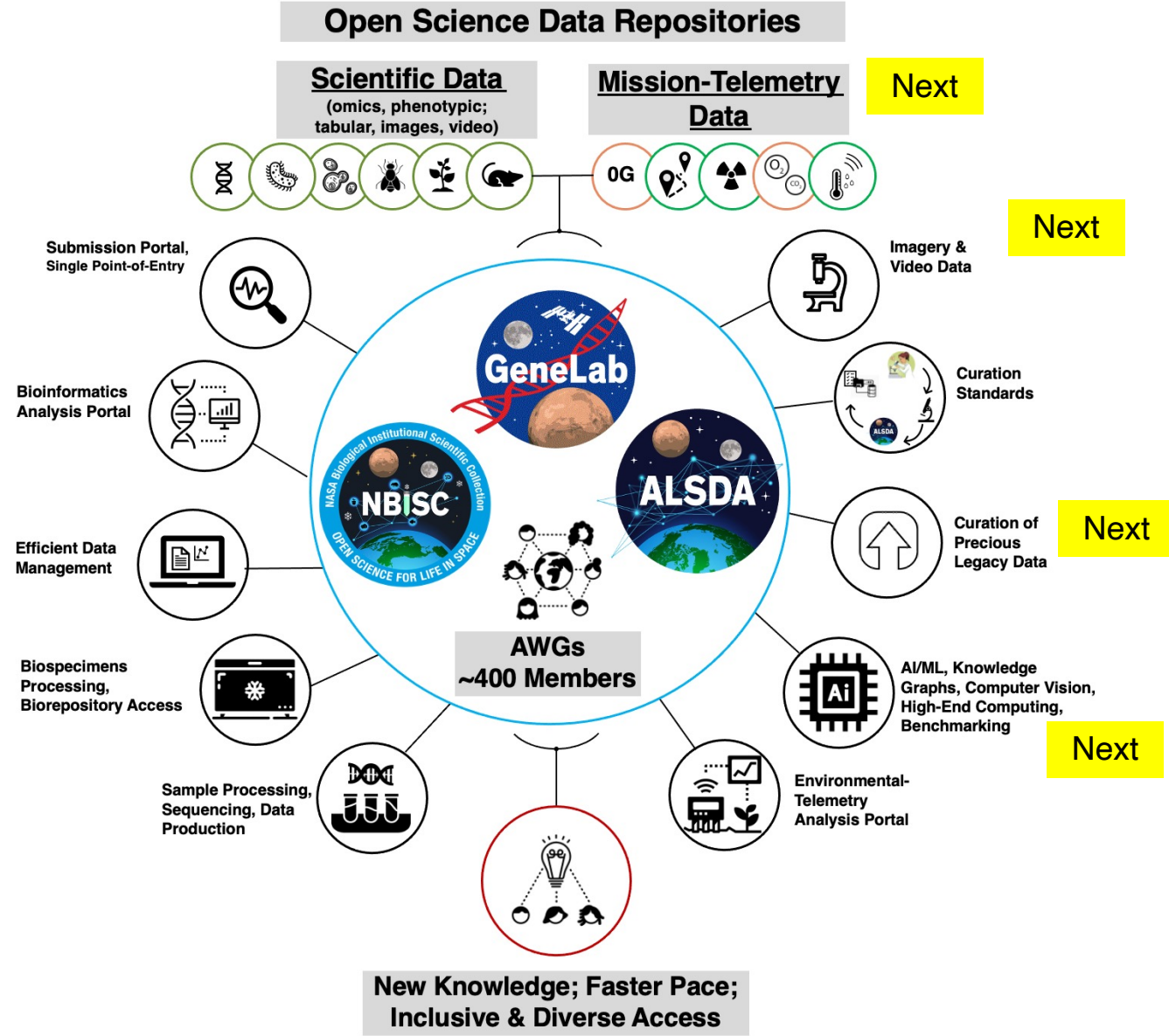
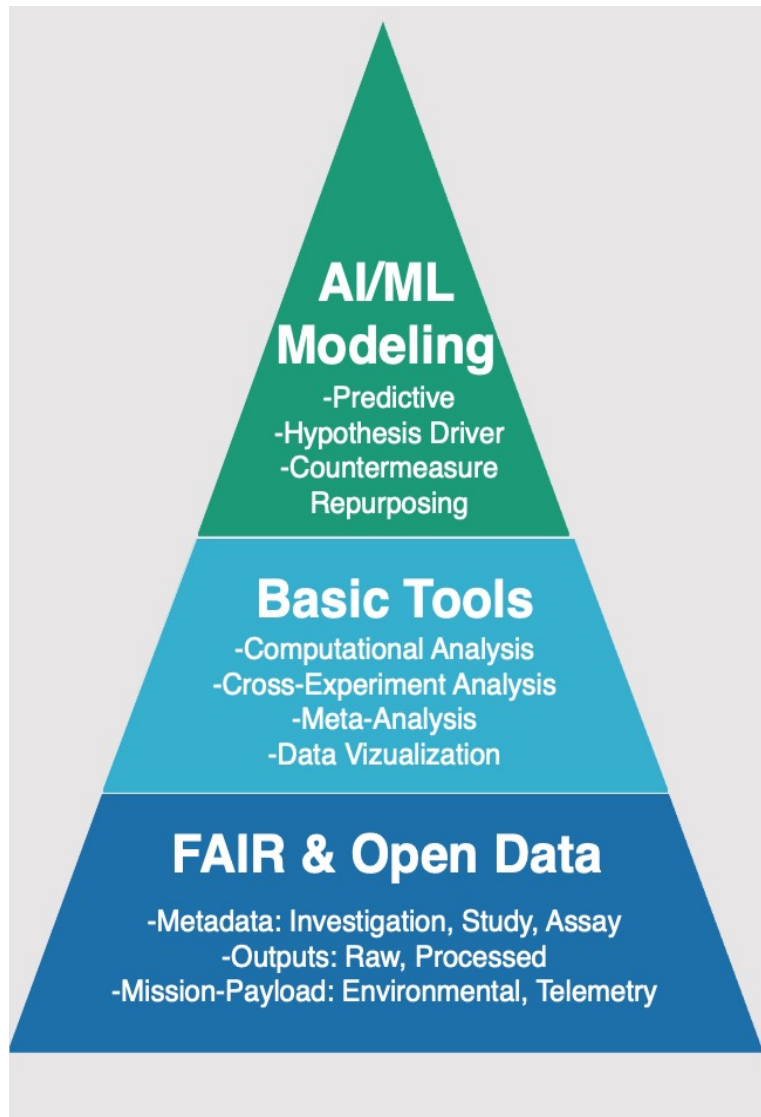


- Transcriptomics (RNA-seq)
- Methylation
- Proteomics
- Calcium uptake

Quantify Bone Risk: DAG Proof of Concept



Big Picture for Open Science for Life in Space



Think of Yourself as a Citizen of Time. All Space-Related Biological/Biomedical Data are PRECIOUS Current and Future National and International Resources

Keep This in Mind: Every Payload,
Every Ground Experiment

Data and Metadata
Stewardship from Start to
Submission is Crucial to
Make Data Maximally
Findable, Accessible,
Interoperable, Reusable

This Ensures:

- 1) Repeat Knowledge Discovery
- 2) Ecosystem Platform Development
- 3) Involvement of the World in Exploration & Discovery
- 4) Operational-Mission-Health Support