



Enabling Space Biological Knowledge

Discovery Through Image and Video Data Sharing

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Background and Overview

Increased biomedical risks associated with deep space crewed missions (cis-Lunar, Mars transit/surface) require development of health countermeasures, novel ecosystem support, risk modeling, and fundamental space biological knowledge discovery. Molecular-omics, physiological-phenotypic-behavioral, and environmental-radiation telemetry data from space biological and health studies are needed for reuse by scientists to address these tasks. The data as well as space-relevant biospecimens are being made more findable, accessible, interoperable, and reusable through NASA's Open Science Data Repository (OSDR). This new OSDR umbrella grouping includes NASA GeneLab, the NASA Ames Life Sciences Data Archive (ALSDA), and the NASA Biological Institutional Scientific Collection.

The OSDR system design appropriately handles metadata and processed-tabular results from ALSDA studies collected from space experiments. But raw and processed ALSDA bioimage and video datasets require an expansion of OSDR's data architecture to handle ingestion, curation, and egress. The academic-industry bioimaging field saw a scientific renaissance in the past several years through leveraging open-source software, international collaborations, machine learning, and other open science/programming approaches. As crewed missions and more biological experiments are on the deep space horizon, OSDR is embracing data stewardship through listening to feedback from subject matter experts and designing an expanded architecture which is appropriate for NASA's goals to enable analysis and reuse of bioimaging and video data for the public science community.

Open Science Data Repository

Integrate and analyze data across:

- 1) Hazards (e.g., microgravity, radiation, isolation)
- 2) Missions and experiments (e.g., ISS, Space Shuttle, NASA Space Radiation Laboratory)
- 3) Species (e.g., human, rodent, microbe, plant/crops)
- 4) Assays (e.g., omics, molecular, phenotypic-physiological, environmental telemetry [O₂, CO₂, RH, radiation, acoustics, acceleration, temperature])
- 5) Formats (e.g., tabular, images, video)



859

Experiments

400

Studies

780

Datasets

45

Species

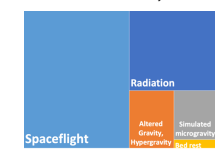
>20

Assays

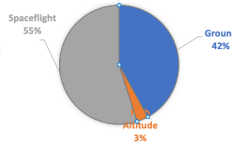
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Data

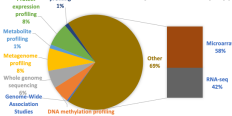
Amount of Datasets by Factor



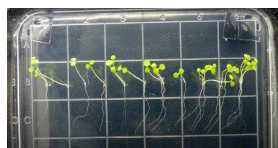
Percent by Location



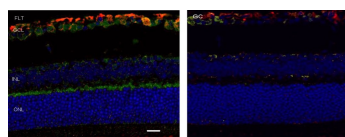
Percent by Omics Assay Type



Examples of OSDR Space Biological Imaging & Video



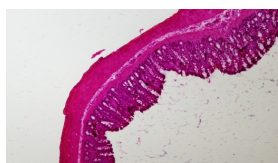
Arabidopsis Growth; from ISS/CARA



Flight vs Ground Control of Mouse Retina; from ISS/RR-9



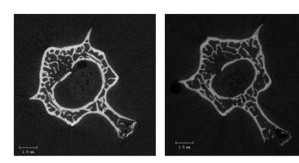
Mouse Retina; from Shuttle/STS-133



Rat Small Intestine H&E Stained; from Shuttle/STS-56



Arabidopsis Growth; Lunar Regolith from Apollo 11, 12, 17



Ground Control vs Flight of Mouse Lumbar Vertebrae; from Shuttle/STS-62

Planned Architecture for Bioimaging & Video Data

Investigation & Sample Metadata	Assay/Modality Metadata	File & Format Conversions	Raw, Processed, Results, and Analysis	Visualization, Downloading
Essential metadata for methods/materials to support quantification, reuse, reproducibility Ensure data and metadata are maximally: 1. Open-Access 2. Findable 3. Accessible 4. Interoperable 5. Reusable isa-tools.org	Assay metadata parameters, based on domain norms. Ontology selection for interoperability	162 formats. OME-TIFF format; NGFF. Pixels, openness, utility, export, multiple images, pyramid (multiple resolutions)	Raw, processed, and image results accessible through API	Image viewer for users. Option, but not required to download locally. Zarr is backend ability for chunked data accession

Current and Future OSDR/ALSDA Bioimage and Video Assays

Current:

- Histology, ultrasonography, video of fruit fly behavior, morphometric photography, immunohistochemistry, micro-computed tomography, video from ISS rodent experiments

Upcoming:

- Dual-energy X-ray absorptiometry, magnetic resonance imaging, atomic force microscopy, confocal microscopy, video from rodent behavioral assays, peripheral quantitative computed tomography, funduscopy, optical coherence tomography, video of Caenorhabditis elegans, video of mammalian tissue mechanics, video of plant growth, etc.

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- NASA Space Biology Program, NASA Human Research Program
- Image Credits
- Biological images from OSDR/ALSDA datasets or permission given to author
- Some images created using a subscription to BioRender.com

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