

Accelerating Space Life Sciences: Successes and Challenges of Biospecimen and Data Sharing

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Ryan T. Scott
Project Scientist, Ames Life Sciences Data Archive
NASA Ames Research Center, Moffett Field, CA

ryan.t.scott@nasa.gov



NASA Life Sciences Data Archive



- Archiving, Preservation, Accessibility of Spaceflight Research: *Biospecimens and Data*
- Contributes Towards Two of NASA's Strategic Goals:
 - Understanding Responses of Biological Systems to Spaceflight
 - Human Exploration in Deep Space, Including to the Surface of the Moon

LSDA Portal: <https://lsda.jsc.nasa.gov/>

Non-Human

Ames Research Center
Moffett Field, CA
(ALSDA)



Human

Johnson Space Center
Houston, TX



Plant

Kennedy Space Center
Cape Canaveral, FL





NASA Institutional Scientific Collection at Ames Research Center Ames Life Sciences Data Archive

NASA Institutional Scientific Collection (ISC) at ARC

Ames Life Sciences Data Archive (ALSDA)

- **~32,000 Non-Human Biospecimens**

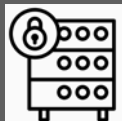
- Spaceflight and Ground Analog experiments
- Biospecimens Searchable (LSDA Website)
- Tissue Requests - ISC Biospecimen Sharing Program
- Metadata Retains Original Experimental Intent

- **Data and Descriptions from >800 Experiments**

- Flight and Ground-based PI Data
- HRP and Space Biology PI grants
- PI Data Submission Agreements with Timelines
- Data Searchable, Retrievable (LSDA Website)

Biospecimen Management

Secure Facilities, Database
Metadata: Conditions, Tissue Type, Descriptions, Species, Fixations, Chain of Custody Record, Telemetry
Storage: -80°C, -20°C, +4°C, Ambient
Features: Power Backup, Alarm System for Power Failure
24/7 Staff On-Call
SOPs and Work Instructions
ARC OCS Hosts ISC Advisory Board



Data Archived

Raw, Processed Data
Published Data
Audio & Visual Materials
PI & Project Data Sets
Biospecimen Metadata
Experimental Descriptions
Payload
Mission
Hardware
Personnel
Research Subject



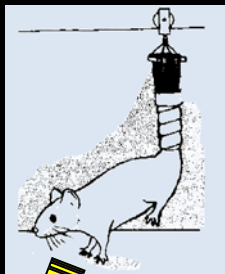


Biospecimen Collection and Data Collection



Space Flown

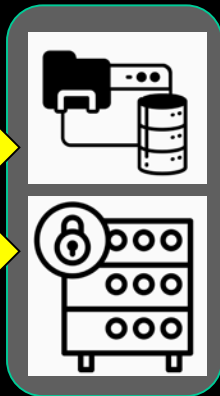
Ground Analogs



metadata

specimens

ARC-ISC

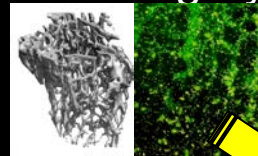


HRP and SB Primary Investigators Agree to Submit their Data

Raw Data from Assays



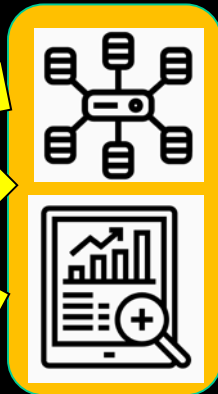
Data Imagery



Statistically Processed Data

Time (HR:MIN:SEC)	LRM	Max. Size
4:10:00.000	0.000000	0.000000
4:10:00.000	0.000000	0.000000
4:10:00.000	0.000000	0.000000
4:10:00.000	0.000000	0.000000
4:10:00.000	0.000000	0.000000
4:10:00.000	0.000000	0.000000
4:10:00.000	0.000000	0.000000
4:10:00.000	0.000000	0.000000
4:10:00.000	0.000000	0.000000
4:10:00.000	0.000000	0.000000

ALSDA



Publications





Scientific Importance of Archiving Data?



1. Enables New Scientific Discoveries

- Allows Data Integration for *Interdisciplinary* Research Approach (Goswami Clément Hargens Roma et al. 2013)
 - Mathematical Modeling, Meta-Analyses, Data Mining
- Data Analytics, Visualization, Machine Learning: Further Analyses



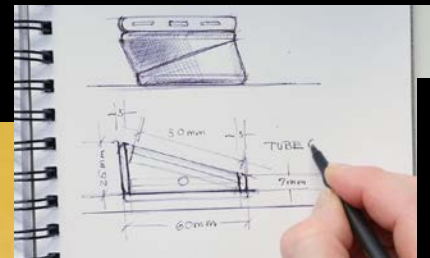
2. Enables Translation of Life Sciences Research to Human Challenges of Spaceflight

3. Enables New Spaceflight Hardware/Platform Development

4. Ensures Reproducibility

5. Ensures Transparency

6. Enables Learning and Education



STEM Activities
Grades K-2 and 3-5



NASA & Peanuts
50 Year Anniversary



Scientific Importance of Biospecimens?



1. Enables Research to Answer Spaceflight Basic Science Knowledge Gaps

- Awarding Tissues to Researchers Allows Investigation of How Living Systems Are Influenced by Space Environment

2. Enables Translation of Life Sciences Research to Human Challenges of Spaceflight

3. Increases Scientific Return on Investment

4. Path for Publications for Early Career PIs

5. Broaden Scientific Community Participation

6. Collaborate Internationally

- Tissues, Science, Sharing, Joint Experiments

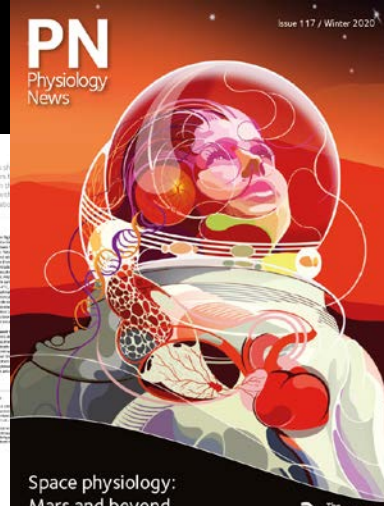
Previous Examples from ISC-BSP Tissue and Data Sharing

- Retina: Zanello et al. (2013)
- Gut Microbiome: Jiang et al. (2019)
- Spinal Cord: Ishihara et al. (2006)
- Thymus: Gridley et al. (2013)



Physiological discoveries abound within NASA samples

Observations from ten analyses of the space environment on factors associated with a robust effect on the microbiome during spaceflight, with implications for mammalian systems.





ISC Biospecimens Available: Stomach



Sample Tissue Matrix

Database List of Available Tissues

		2016	2014-17	2017	2018	2017	2017	2017	2017
		ISS Biological Research in Canister23	Hindimb Unloaded	ISS/JAXA Mouse Habitat Unit-2	ISS Rodent Research 7	ISS Rodent Research 9	ISS Rodent Research 6	ISS Rodent Research 5	ISS Rodent Research 4
System	Specimen Types	Bacteria	Rat	Mouse	Mouse	Mouse	Mouse	Mouse	Mouse
Circulatory	Blood, Heart, Lymph nodes, Spleen		X			X			
Digestive	Cecum, Colon, Duodenum, GI Tract, Ileum, Intestine, Jejunum, Pancreas, Stomach			X	X	X	X		X
Endocrine	Adrenal glands, Liver, Salivary glands, Thymus, Thyroid		X		X	X	X		

EX	Mis	Year	BIO ID	Species	Strain	Ind Variable	Duration	N	Sex	Age
MI2	STS-133	2011	5069	Mouse	BALB/c	Vivarium	13 days	10	F	~8 wks
MI2	STS-133	2011	5082	Mouse	BALB/c	Flight	13 days	6	F	~8 wks
MI2	STS-133	2011	5083	Mouse	BALB/c	Control (AEM)	13 days	10	F	~8 wks
MI2	STS-133	2011	5073	Mouse	BALB/c	Vivarium	13 days	6	F	~8 wks
MI2	STS-133	2011	5078	Mouse	BALB/c	Flight	13 days	10	F	~8 wks
MI2	STS-133	2011	5079	Mouse	BALB/c	Control (AEM)	13 days	10	F	~8 wks
RR1_BS_P	SpX-4	2014	5239	Mouse	C57BL/6J	Flight	35 days	8	F	~16 wks
RR1_BS_P	SpX-4	2014	5240	Mouse	C57BL/6J	Vivarium	35 days	8	F	~16 wks
RR1_BS_P	SpX-4	2014	5241	Mouse	C57BL/6J	Control (AEM)	35 days	9	F	~16 wks



Three Challenges: Archive Modernization



- Manual Handling
- PI Data Submission
- Single Point Entry
- Biospecimen Quality
- Archive Credibility



Processes

- Data Importance
- Communication
- Outreach
- Collaboration
- Data Sharing
- Recognition



Culture



Technology

- Legacy System
- Cloud Storage
- Analytics
- Portal
- Infrastructure
- Prioritization



Next Steps

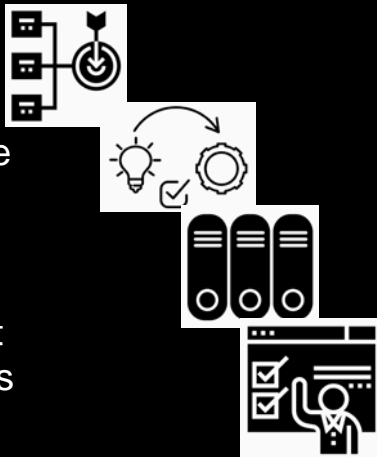
• Outreach science community

- Broad, Targeted, Local



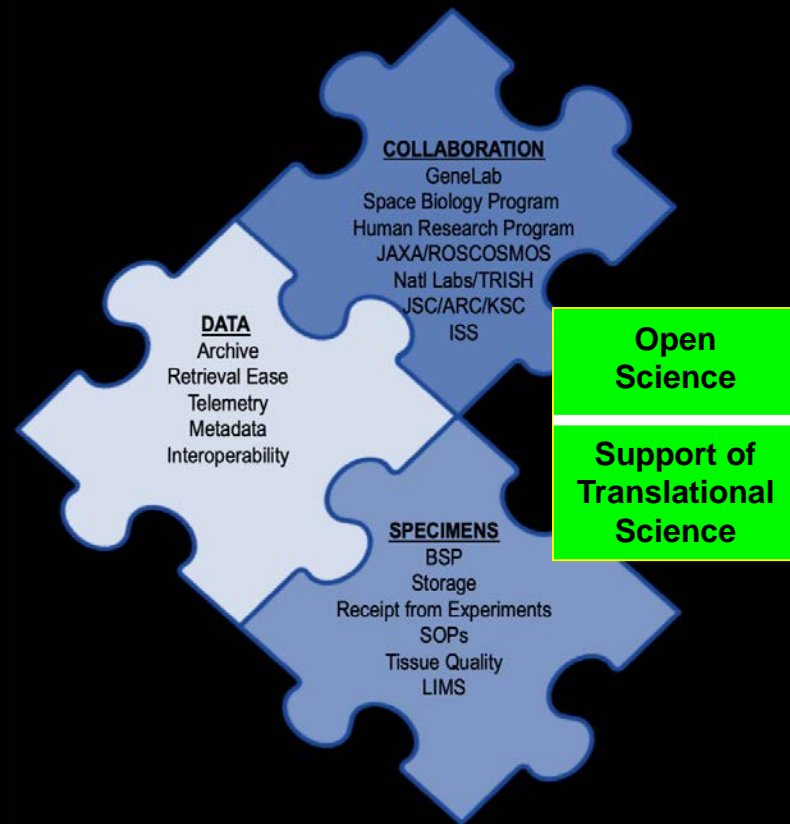
• Archive Modernization Plan

- Vision, Goals, Benefits
- Risks if Not Done
- Phased Implementation Timeline
- Deliverables, Roadmap
- Components of Architecture:
 - Technological Platforms
 - Infrastructure Development
 - Data Management Systems
 - Portal User Interface



• Data Sharing Technical Exchange @ARC 3/11-12

- Panel Discussions Across Projects, Programs, Centers, and NASA's Institutional Partners





Acknowledgements: A TEAM EFFORT



- Engineers
- Archivists
- Scientists
- Biologists
- Astronauts
- Safety Personnel
- Physicists
- Electricians
- Students
- Support Staff
- Astronomers
- Mathematicians
- Artists, Designers
 - Logistics
 - Educators
 - Public Support
- Trainers, Technicians
 - Historians
 - Informational Techs



Take a picture to
download the link for more
information

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<https://www.nasa.gov/ames/research/space-biosciences/isc-bsp>