

# 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](mailto: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**

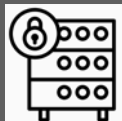
- Spaceflight and Ground Analog experiments
- Biospecimens Searchable (LSDA Website)
- Tissue Requests - ISC Biospecimen Sharing Program
- Metadata Retains Original Experimental Intent

- **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



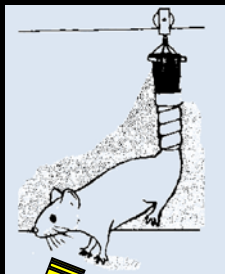


# Biospecimen Collection and Data Collection



## Space Flown

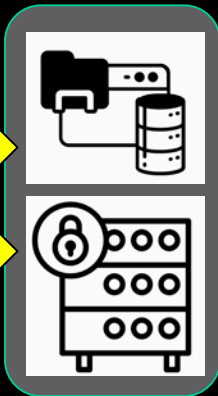
## Ground Analogs



metadata

specimens

## ARC-ISC

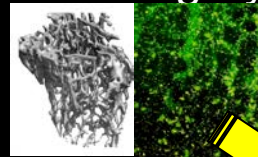


## HRP and SB Primary Investigators Agree to Submit their Data

## Raw Data from Assays



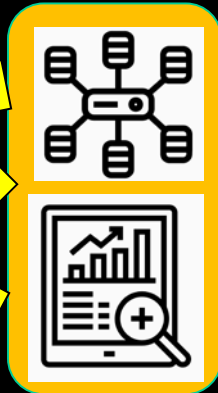
## Data Imagery



## Statistically Processed Data

Time (00:00:00)	LRM	Max. Area
0:00:00	0.000000	0.000000
0:00:05	0.000000	0.000000
0:00:10	0.000000	0.000000
0:00:15	0.000000	0.000000
0:00:20	0.000000	0.000000
0:00:25	0.000000	0.000000
0:00:30	0.000000	0.000000
0:00:35	0.000000	0.000000
0:00:40	0.000000	0.000000
0:00:45	0.000000	0.000000
0:00:50	0.000000	0.000000
0:00:55	0.000000	0.000000
0:01:00	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



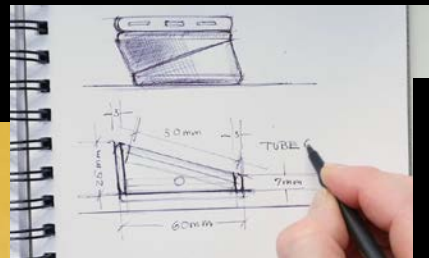
## 2. Enables Translation of Life Sciences Research to Human Challenges of Spaceflight

## 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

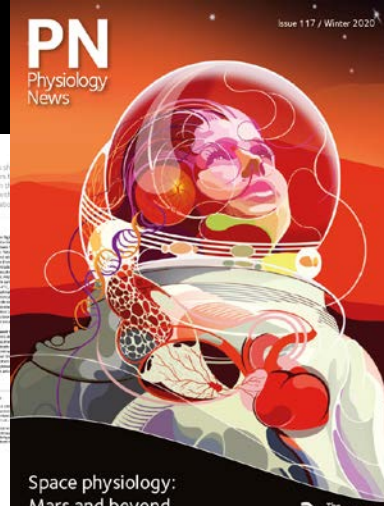
### Previous Examples from ISC-BSP Tissue and Data Sharing

- 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

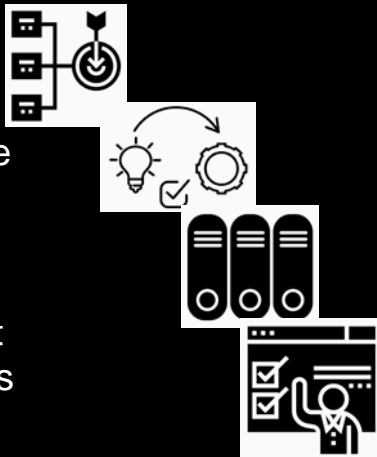
## • Outreach science community

- Broad, Targeted, Local



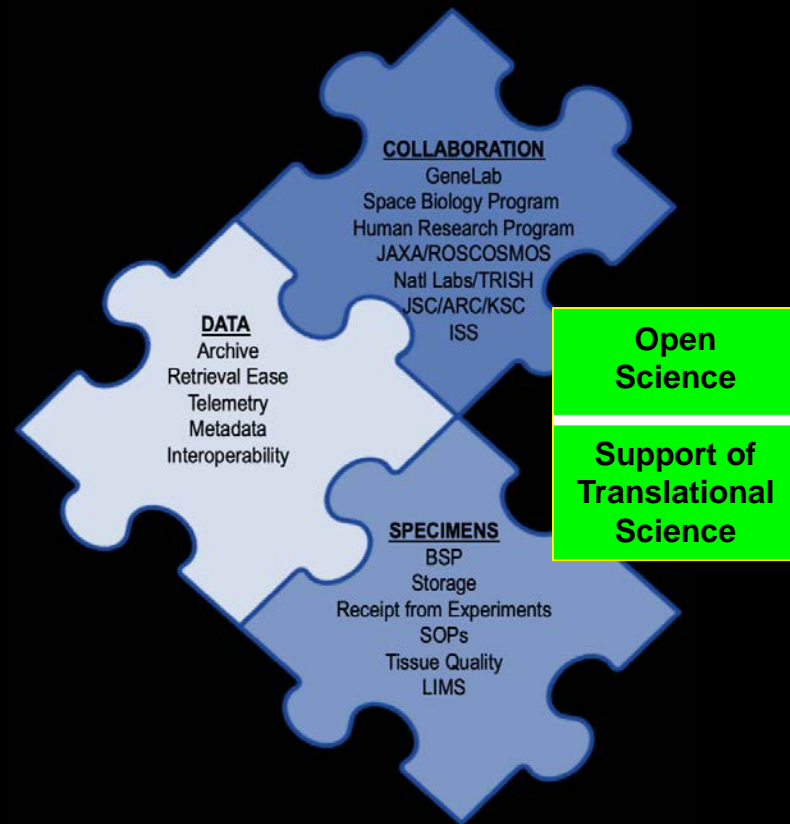
## • Archive Modernization Plan

- 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>