Discovery Through Biospecimen Sharing: The NASA Biological Institutional Scientific Collection (NBISC)

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OVERVIEW:

- The NASA Biological Institutional Scientific Collection (NBISC) hosts over 90,000 flight and ground analog biospecimens.
- Biospecimens are searchable and available for request through the NASA Life Sciences Portal (NLSP) public website.
- Goals:
  - maximize the scientific return of unique biospecimens from spaceflight investigations.
  - encourage broader participation of space biology-related research within the scientific research community.

WHAT TYPE OF BIOSPECIMENS AND DATA?

- Biospecimens from organisms flown on Shuttle, International Space Station and ground spaceflight-model experiments.
- Tissue types: musculoskeletal, neurosensory, reproductive, respiratory, circulatory, and digestive systems primarily from mice and rats.
- Samples are fixative dependent and are stored at -80°C, -20°C +4°C or ambient.
- Detailed metadata are available for all samples.
- Tissues have been used for a wide range of analyses, including histology, genomics, and transcriptomics.
- Future expansion will include a broad range of microbial isolates from spaceflight studies.

REQUESTING BIOSPECIMENS:

- Biospecimens are requested at the NASA Life Sciences Portal (NLSP) via an online biospecimen request.

- Availability of requested biospecimens are confirmed by NBISC and instructions relayed to the requestor for a short proposal submission.
- Proposals are assessed by merit, scientific significance, and innovation of proposed research.

KNOWLEDGE AND INSIGHTS GAINED THROUGH BIOSPECIMEN SHARING:

Brock University

- Muscle remodeling
- Calmodulin regulation
- Regulation of the sarco(endo)plasmic reticulum Ca^{2+}-ATPase (SERCA) pump
- Muscular dystrophy
- Spaceflight
- Aging, obesity, and diabetes

Characterizing SERCA Function in Murine Skeletal Muscles after 35–37 Days of Spaceflight

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In addition to the 187 RR-9 biospecimens awarded for this study, 12 biospecimens (female) from RR-1 were also used to support these findings.

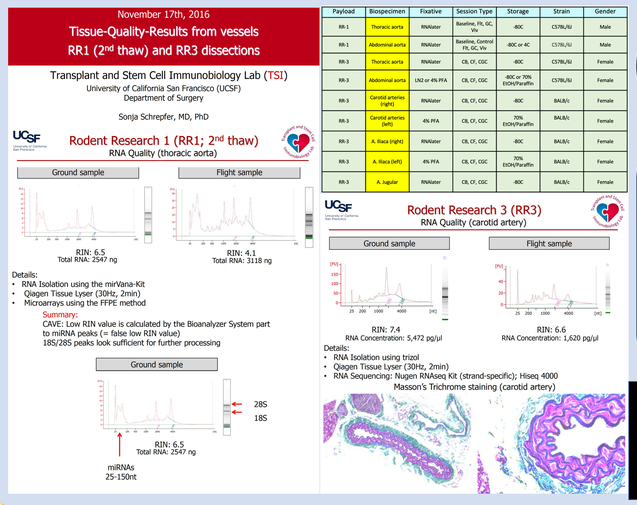
Conclusions

- Observed reductions in Ca2+ uptake and increases in reactive oxygen/nitrogen species (RONS) in the soleus.
- Found significant enhancements in Ca2+ uptake, a fast fiber type shift with increase MHC IIb and SERCA 1a, and no changes in RONS in the tibialis anterior.
- Determined future studies should further examine the role of biological sex on SERCA function and whether protecting SERCA function can resist the atrophy and weakness observed in the soleus muscles with spaceflight.

Payload	Biospecimen	Fixative	Session Type	Storage	Strain	Gender
RR-9	Soleus	LN2	Basal, CC1/FiVu CC2, Flt, Viv, GC	-80C	C57BL/6J	Male
RR-9	Femur	LN2 or RNAlater	Basal, CC1/FiVu CC2, Flt, Viv, GC	-80C or 4C	C57BL/6J	Male
RR-9	Tibialis anterior	LN2	Basal, CC1/FiVu CC2, Flt, Viv, GC	-80C	C57BL/6J	Male
RR-9	Tibia	LN2 or RNAlater	Basal, CC1/FiVu CC2, Flt, Viv, GC	-80C or 4C	C57BL/6J	Male

UC San Francisco

- Regenerative medicine
- Organ transplantation
- Vascular biology
- Cardiac biology
- Immunology
- Stem cell immunobiology
- Tissue preservation analysis



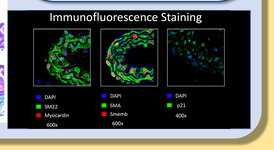
Payload	Biospecimen	Fixative	Session Type	Storage	Strain	Gender
RR-1	Thoracic aorta	RNAlater	Baseline, Flt, GC, Viv	-80C	C57BL/6J	Male
RR-1	Abdominal aorta	RNAlater	Baseline, Control Flt, GC, Viv	-80C or 4C	C57BL/6J	Male
RR-3	Thoracic aorta	RNAlater	CB, CF, CGC	-80C	C57BL/6J	Female
RR-3	Abdominal aorta	LN2 or 4% PFA	CB, CF, CGC	-80C or 70% EtOH/Paraffin	C57BL/6J	Female
RR-3	Carotid arteries (right)	RNAlater	CB, CF, CGC	-80C	BALB/c	Female
RR-3	Carotid arteries (left)	4% PFA	CB, CF, CGC	70% EtOH/Paraffin	BALB/c	Female
RR-3	A. Iliaca (right)	RNAlater	CB, CF, CGC	-80C	BALB/c	Female
RR-3	A. Iliaca (left)	4% PFA	CB, CF, CGC	70% EtOH/Paraffin	BALB/c	Female
RR-3	A. Jugular	RNAlater	CB, CF, CGC	-80C	BALB/c	Female

Biospecimens (200) awarded from Rodent Research 1 and 3 to validate preservation methods on various mice blood vessels

Summary RR1 and RR3

The quality of frozen tissue is suitable for:

- RNA Sequencing
- Microarray analysis
- Histopathology
- Immunofluorescence staining (when using prescribed preservation methods)



Georgia St. University
Florida St. University
Loma Linda University

- Genomics
- Microcirculation
- Cardiovascular biology/physiology
- Vasodilation
- Mitochondrial apoptosis
- Characterizing effects of spaceflight on eyes and brain

OXFORD

Precision Clinical Medicine, 4(2), 2021, 93–108

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Research Article

RESEARCH ARTICLE

Spaceflight decelerates the epigenetic clock orchestrated with a global alteration in DNA methylome and transcriptome in the mouse retina

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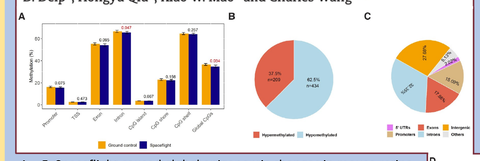
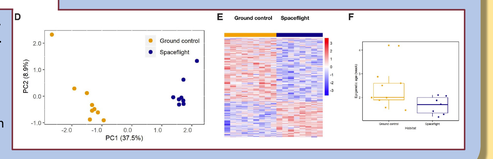


Payload	Biospecimen	Fixative	Session Type	Storage	Strain	Gender
RR-1	Eye	RNAlater	Baseline, Flt, GC, Viv	-80C	C57BL/6J	Female

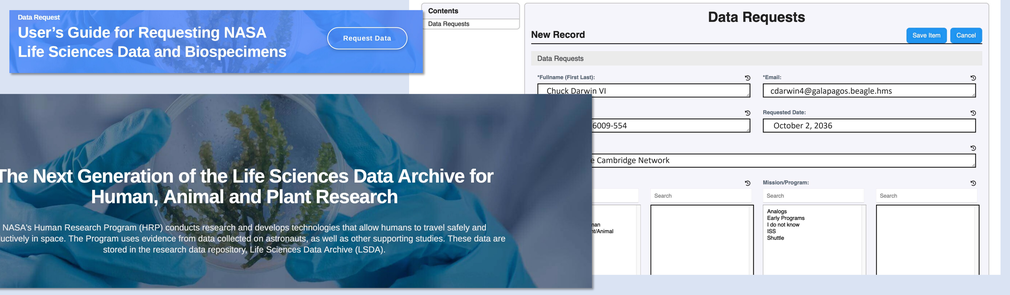
Conclusions

- Results indicate that spaceflight decelerated the retinal epigenetic clock.
- The study demonstrated that spaceflight impacts the retina at the epigenomic and transcriptomic levels.
- Hypothesized the above changes could be involved in the etiology of eye-related disorders among astronauts.

A – F: Spaceflight caused global epigenomic changes in mouse retina. (A) Genome-wide CpG methylation status at various genome regions. (B) and (C) Characteristics of significant differentially methylated CpGs (DMCs, methylation change > 10% and P ≤ 0.05). (D) Principal component analysis (PCA) based on the spaceflight induced DMCs. The beta values of all differentially methylated CpGs were used for PCA computation and no filtering was applied. (E) HCA plots based on DMCs. (F) Epigenetic ages calculated using Stubb's age estimator based on retinal methylomes.



NASA LIFE SCIENCES PORTAL



PLANNING, COORDINATION AND DATA COLLECTION:

- Preparations by the NASA Space Biology Biospecimen Sharing Program (BSP) begin approximately one year before an experiment start date or scheduled mission launch.

- Tissue list and internal sharing is established among PI's, PI Self-Forming BSP Team, International Partners, GeneLab, and BSP.
- Preservation options and dissection flow are carefully planned and executed to preserve tissue integrity and collection efficiency.
- Approximately 50 metadata details are recorded and assigned for each tissue collected.
- Metadata fields are standardized to accommodate data across multiple projects.

MORE ABOUT NBISC:

- NBISC is part of the Open Science initiative at NASA. This includes NASA GeneLab and the Ames Life Sciences Data Archive.
- This NASA Open Science initiative enables scientists to find, access, and reuse spaceflight data and samples to further understand how fundamental building blocks of life adapt to spaceflight.

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