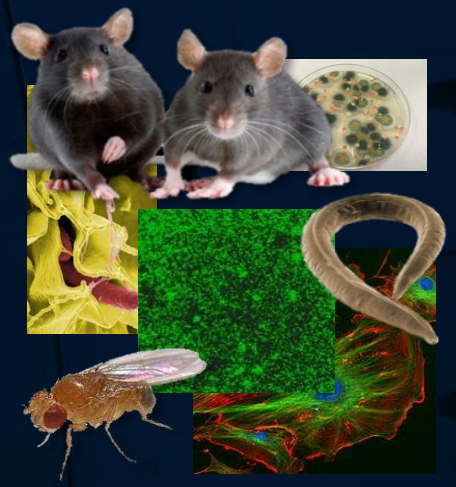
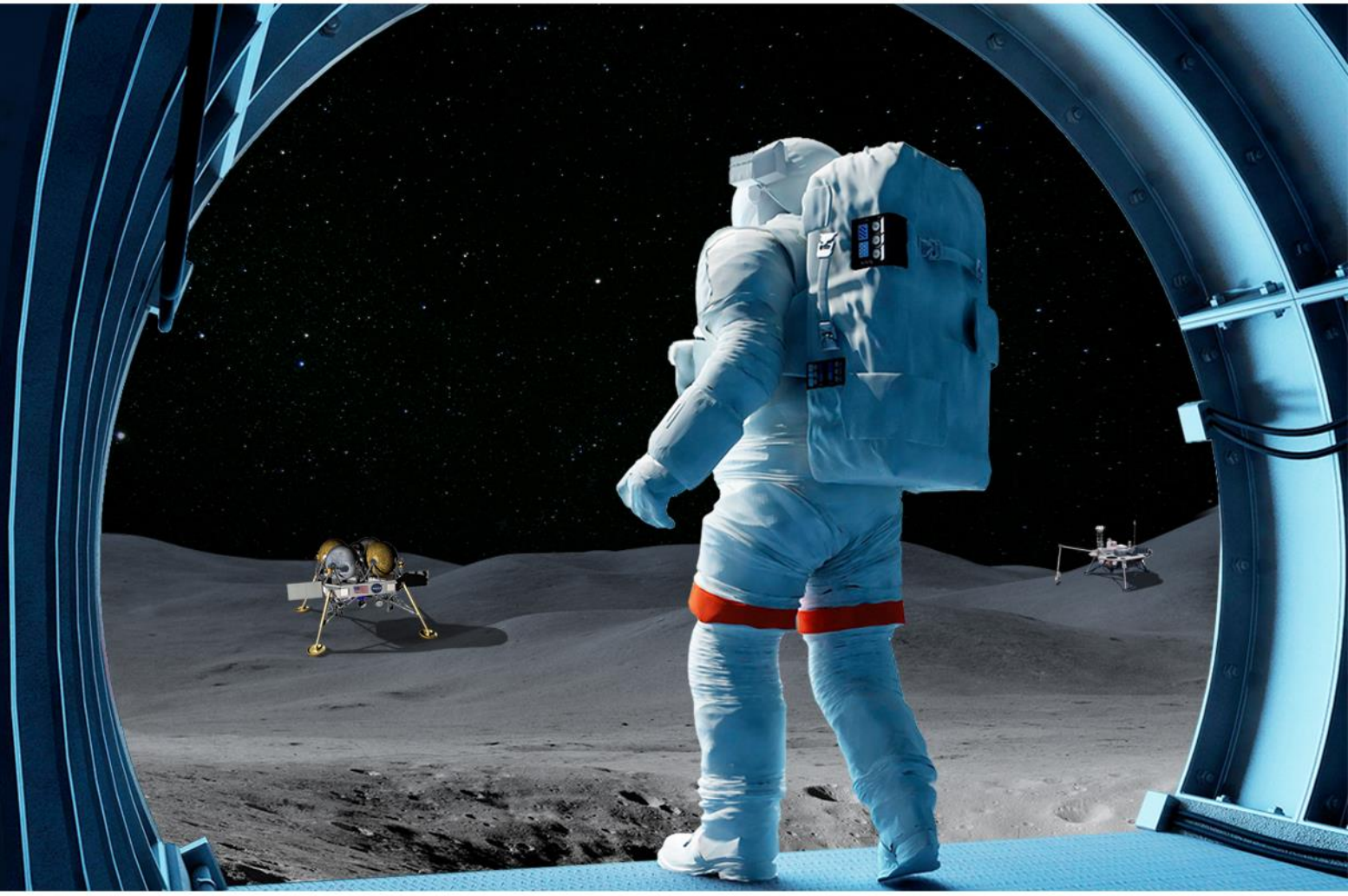
OP3 NASA JAXA Rodent Research Collaboration Opportunities

National Aeronautics and Space Administration





Frances Donovan, Ph.D.
Space Biology Project, NASA Ames Research Center
JAXA Kibo Utilization Symposium
February 2019

Space Biology and Human Research

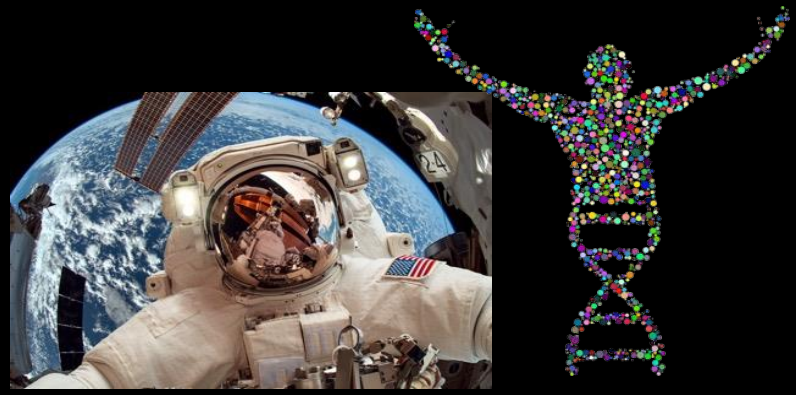
Supporting the exploration of space on the journey beyond LEO to places like the Moon and Mars

Mars
36 million mi
1/3 Earth's Gravity

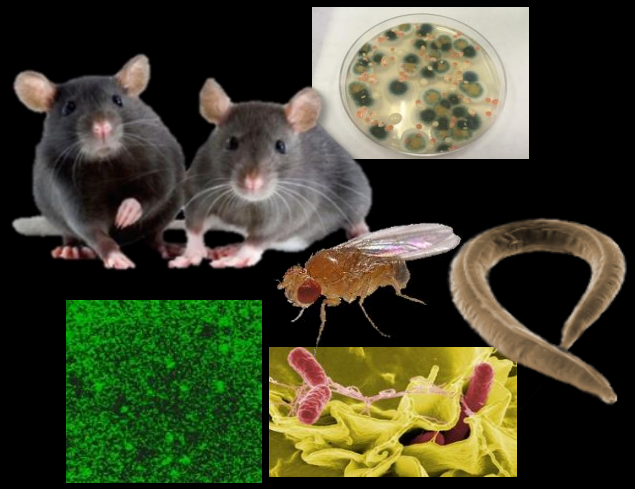
Moon
240000 mi
1/6 Earth's Gravity

ISS &
free flyers in LEO
180-300 mi
Microgravity

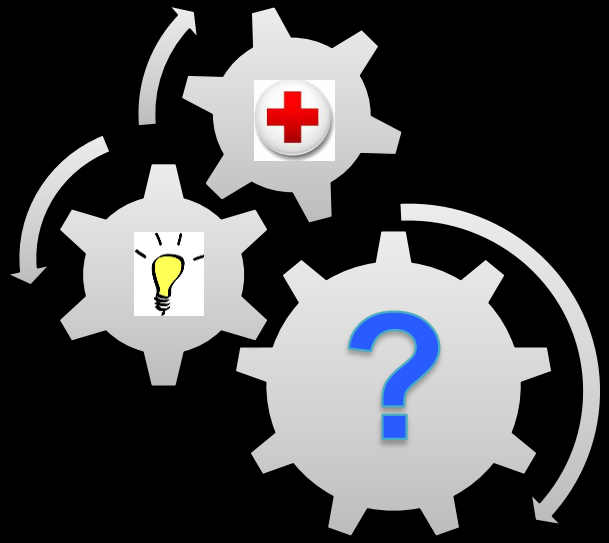
Integrated Approach to Space Life Sciences

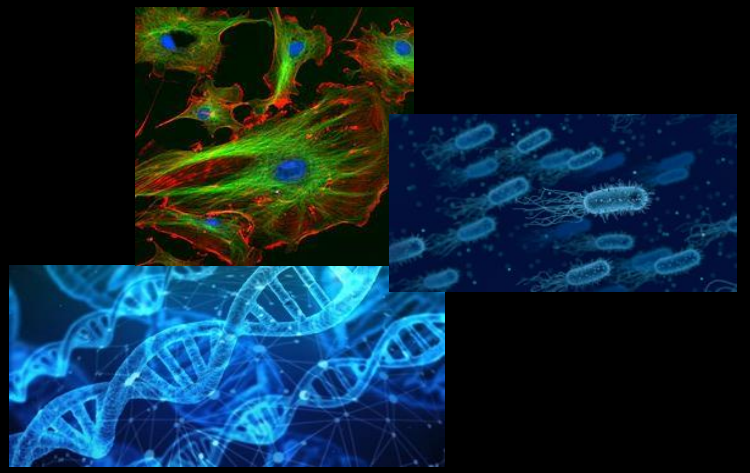


Human Biology and Health



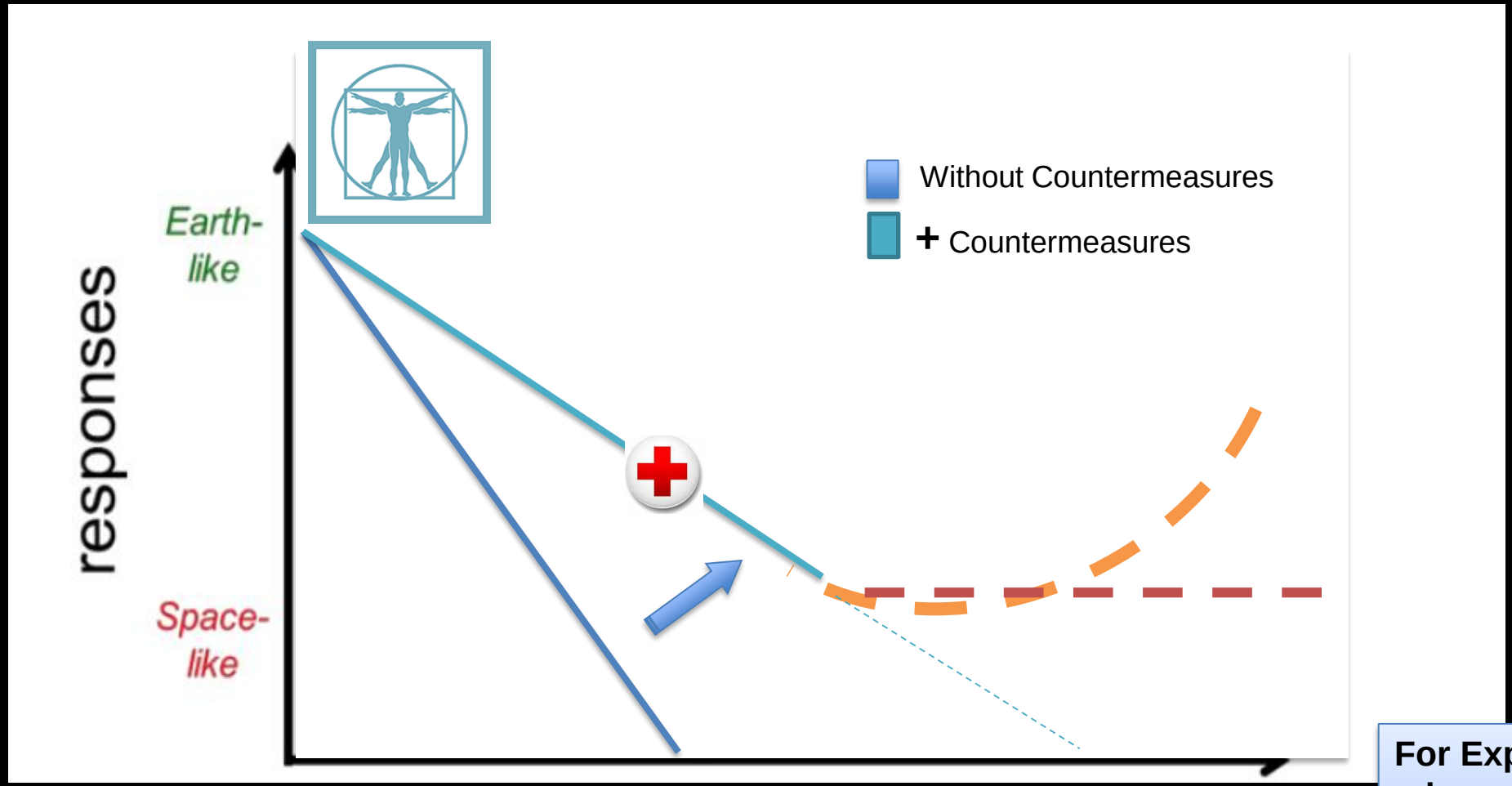
Integrated Biological and Physiological Systems





Fundamental Biological Systems and Biomolecules

Countermeasures: mitigate but do not reverse adverse effects.



For Exploration Missions we need adverse effects to plateau or countermeasures recover the human from the effects of spaceflight

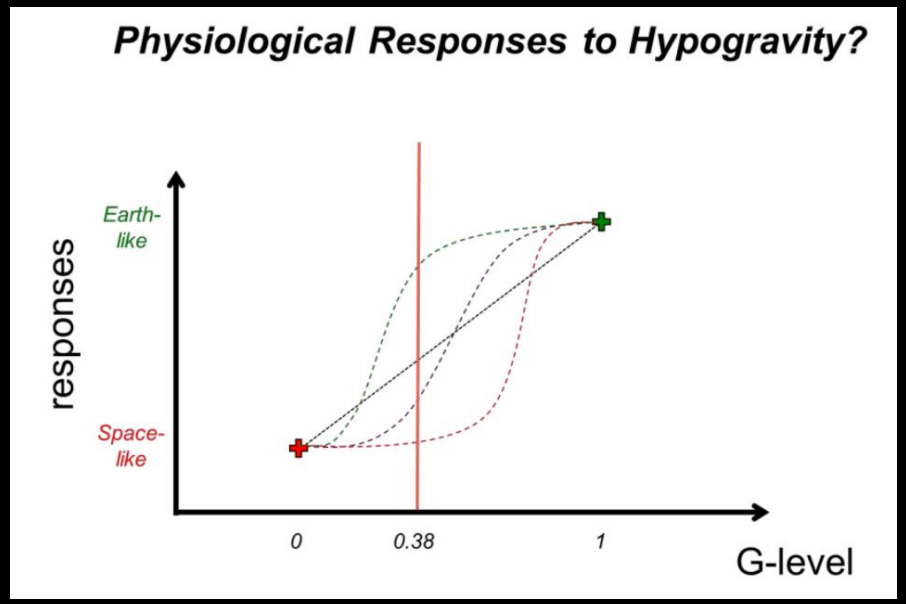
Gravity: response to 0*g*, Lunar and Martian *g*, and Artificial Gravity as a countermeasure

9.8 m/s^2 (1xg)

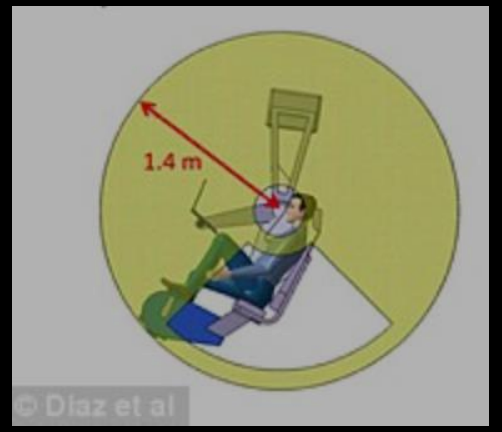
~ 9.8 $x10^{-6}$ m/s^2 (microgravity)

1.6 m/s^2 (1/6 x g)

3.7 m/s^2 (3/8xg)



- underlying **mechanisms**
- impacts of **prolonged exposure** followed by **return/re-acclimation** to gravity
- discrete **thresholds** of gravity level
- **continuous** gravity exposure vs. **intermittent** exposures
- combined effect of **space radiation** plus changes in gravity

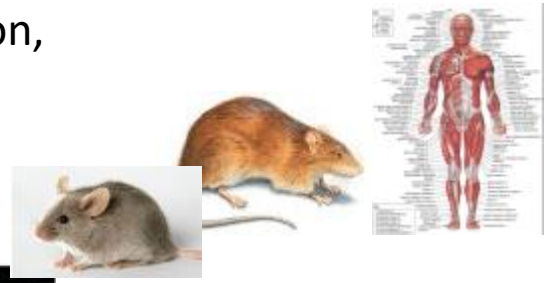


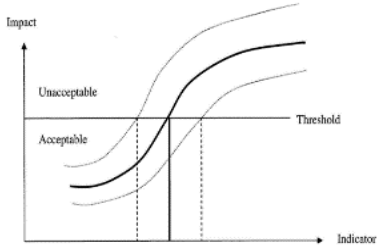
Artificial Gravity?

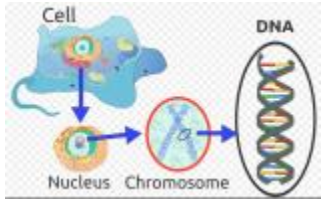
Gravity as A Continuum

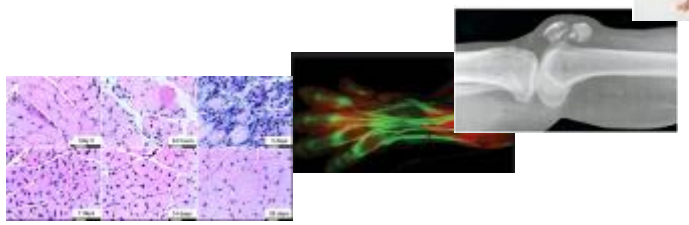
The Gravity Dose Response Curve: Threshold or Continuum?

- Gravity induces biological responses at the gene expression, cellular, systems and whole organism level
- The dose response curve of any of these responses is not fully characterized









- It is not known if responses are a continuum or are based on reaching thresholds
- Its is not known if responses require continuous or intermittent exposures
- It is not known if the sensitivity/dose response changes during development

Gravity as a Continuum ToolBox - ground & flight research on a variety of organisms to define dose response curve & adaptation mechanisms from 0 to >2+*g*

Ground-based Centrifuges

In-flight Centrifuges (EMCS, KUBIK, JAXA mouse centrifuge "MARS", Free-flyers)

Parabolic Flight

Ground-Based Fractional G Simulators (Clinostats, RPMs, HARVs, etc)

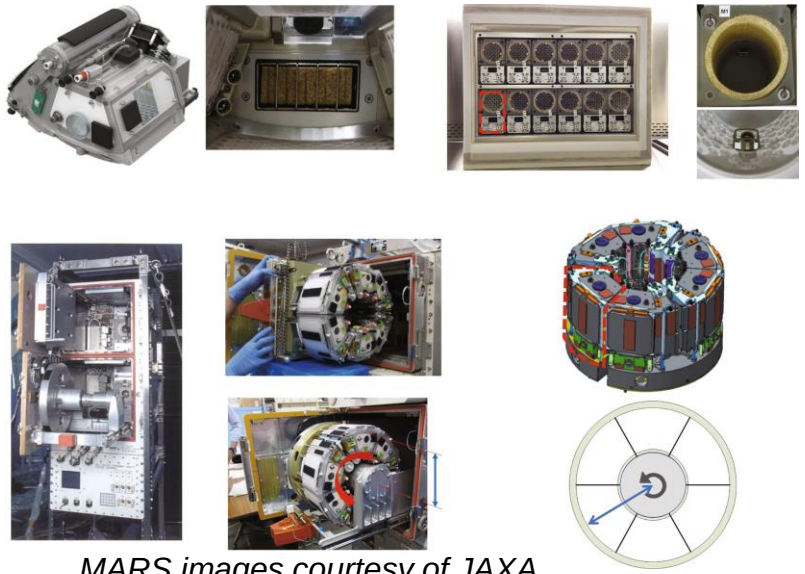
Partial Unloading in Animals and Humans

NASA negotiating for use of MARS facility to study partial *g*

NASA Research Opportunity for US investigators: new proposals to use the JAXA MARS facility

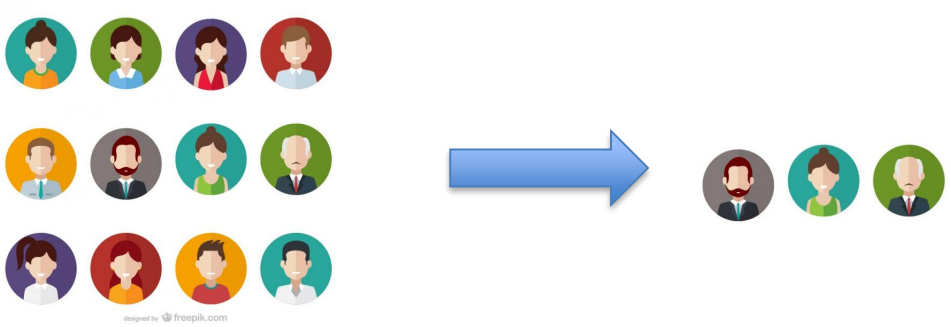
– Varying gravity level exposure using mouse

Micro *g, 1/6 g, 3/8g, other?*



MARS images courtesy of JAXA

Proposals were peer reviewed, and a team of three investigators were chosen to provide an integrated research proposal.



NASA Rodent Research Habitat

- **NASA Rodent Habitat– ISS facility, micro g only. Up to 10 mice per unit, group housed**

Rodent Habitat, Transporter, and Access Unit

Image: Techshot

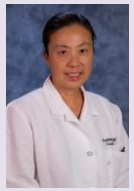
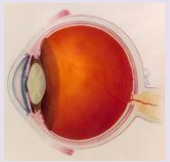
- **Data can be collected by DXA for body composition/bone density**
- **Body mass can be measured with Small Mass Measuring device**
- **Grip strength can be measured with Grip Strength device**
- **Euthanasia and dissection can be performed in the Glovebox**
- **Samples Frozen and returned to earth.**

Rodent Research Science on the ISS


2017 2018 2019 2020 2021 2022

RR-9: Effects of Spaceflight on Ocular Oxidative Stress and the Blood-Retinal Barrier, retinal vasculature/tissue remodeling, and hip/knee joints.


Dr. Delp
Florida State University

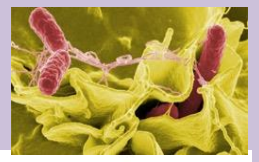



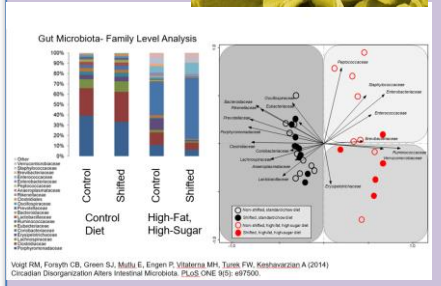
Dr. Mao
Loma Linda University


Dr. Willey
Wake Forest University

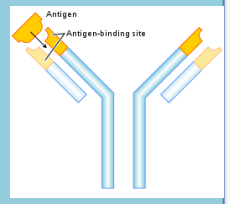
RR-7: Effects of Spaceflight on Gastrointestinal Microbiota in Mice: Mechanisms and Impact on Multi-System Physiology


Dr. Turek
Northwestern University

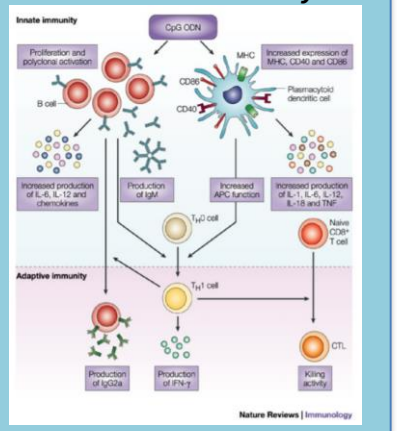





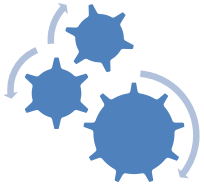
RR-12: Impact of Spaceflight on Primary and Secondary Antibody Responses

Dr. Pecaut
Loma Linda University



Future Areas of investigation:
Bone and Tissue Regeneration
Eye and Blood Brain Barrier
Free Radical generation and effects
Vascular and Reproductive Health



RR-11: Vascular Health in Space: MicroRNAs in Microgravity
Dr. Taylor
Texas Heart Institute

Role of P21/CDKN1a Pathway in Microgravity-Induced Bone Tissue Regenerative Arrest

Dr. Almeida
NASA Ames Research Center

Foundational In Vivo Experiments on Osteocyte Biology in Space

Dr. Robling
University of Indiana


Spaceflight Environment Induces Remodeling of Vascular Network and Glia-vascular Communication in Mouse Retina

Dr. Mao
Loma Linda University

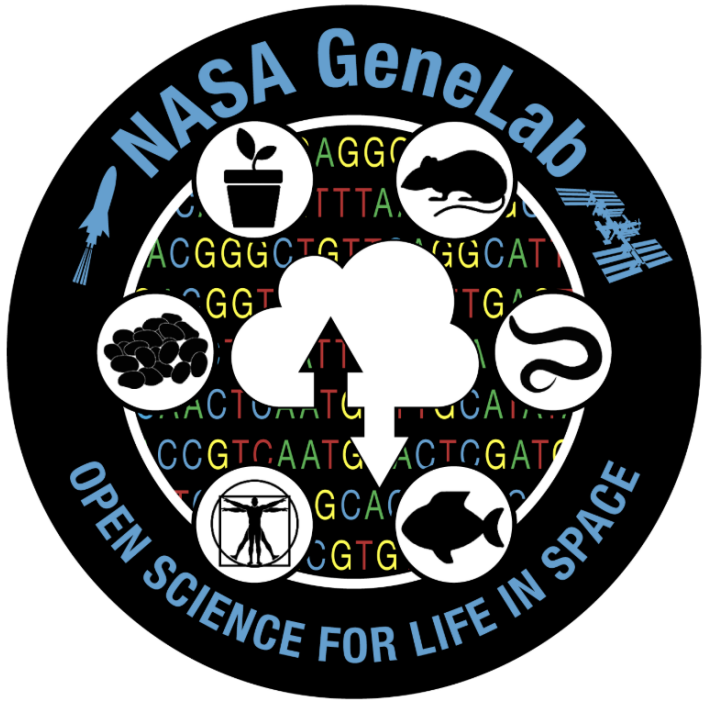
MORE INFO? See NASA TASK BOOK WEBSITE **https://taskbook.nasaprs.com**.

GeneLab Webpage: genelab.nasa.gov

GeneLab
Open Science for Life in Space

Home | About | Data & Tools | Research & Resources | Help

Keywords



Welcome to NASA GeneLab – the first comprehensive space-related omics database in which users can upload, download, share, store, and analyze spaceflight and corresponding model organism data.

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

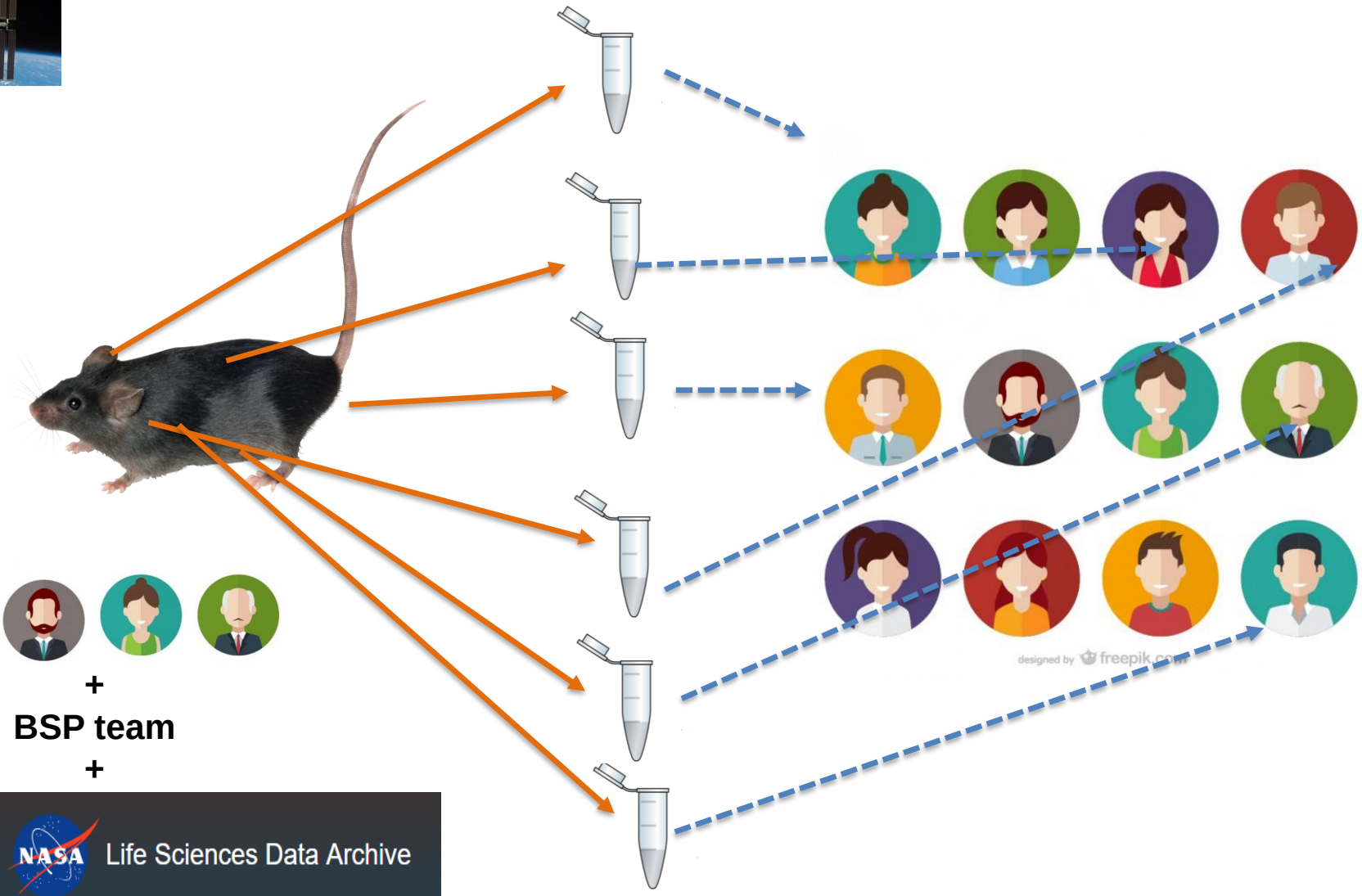
Collaborative Workspace
Share, organize and store files

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

Tutorials
New to GeneLab?

WATCH: NASA's new GeneLab video - Access and analyze unique genomics data from spaceflight

Biospecimen Sharing Program (BSP)- Maximizes Science obtained from Spaceflight Research



Biospecimen Sharing Program and Life Sciences Data Archive

Upcoming BSP Milestones	Date
RR-7 Flight and Ground Control dissections at Northwestern University, Evanston, Illinois. • 13 Tissue types will be collected.	January-February 2019
RR-12 Dissections at Kennedy Space Center. • Up to 29 Tissue types will be collected.	April 2019

https://lsda.jsc.nasa.gov

Picture: RR-9 PI and NASA Teams at KSC.

Picture: RR-7 PI and NASA Teams at KSC.

Summary and Future work

- **NASA would like to thank JAXA for this historic opportunity to collaboratively study effects of partial gravity exposures to a mammalian model.**

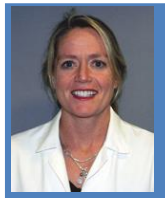
- **JAXA/NASA Biospecimen Sharing – an ongoing effort**
  - Exchange of rodent tissues from NASA Rodent Research experiments and tissues from JAXA MARS facility
  - NASA rodent missions are leading to bio banking of spaceflight tissues we hope will be useful to our international partners

This effort is supported by the Human Research Program, the Space Biology Program, and the ISS Research Integration Office under the Space Life Sciences Research Applications Program.

Thank you

BACK UP charts

NASA investigator team from Human Research and Space Biology Programs



HARVARD MEDICAL SCHOOL
Beth Israel Deaconess Medical Center

Mary Bouxsein, Ph.D.

UCDAVIS
Chronic Acceleration Research Unit

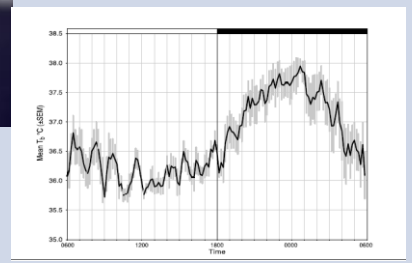
Charles Fuller, Ph.D.

Center for Sleep & Circadian Biology
NORTHWESTERN UNIVERSITY

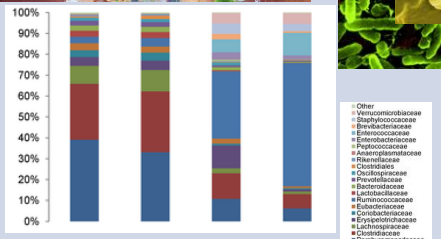
Martha Vitaterna, Ph.D.

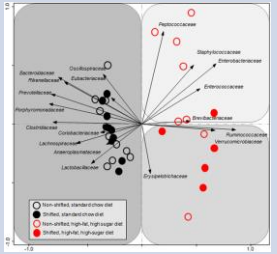
Bone, Neuromotor Performance and Muscle Function.

Circadian Rhythm



Microbiome





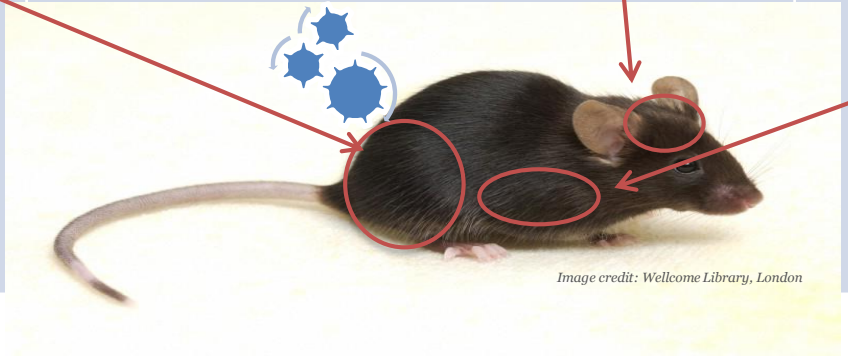


Image credit: Wellcome Library, London