Space Science 101 – Non-Human Vertebrates and Invertebrates: Cells, Tissues, Systems

Why are cell and animal studies important to Space Research?

- Animals are research surrogates to humans and show many analogous biological responses to space
- Power of genetics: identify genes responsive to the space environment and mechanisms
- Statistical power: larger numbers of animals that can be flown for critical statistical analyses to tease out the multifactorial responses to the space environment
- Use of Earth-based analogs of microgravity and deep space radiation
- Open science sample sharing (ALSDA) and multi-omics data sharing (GeneLab) to greatly increase scientific return from unique and limited space-exposed specimens

Why is Space Research important to Animal Science?

- Provides a unique environment to study the impact and importance the fundamental force of nature, gravity, on biology
- Enables Identifying mechanisms and processes that govern and/or respond to gravity and radiation
- Enables characterizing of the extreme environment of space influences biology - important to advancing future human exploration, space tourism, and commercialization of space

Why is Animal Space Research is important to Earth?

- Spaceflight physiological effects have similar phenotypes to human disease and many changes associated with aging
- Spaceflight responses in cells, tissues, and integrated physiological systems occur in a compressed timeframe
- Data and findings from animal model investigations may lead to new biomarkers and targets for biomedical and pharmaceutical applications
- Availability of specimens from spaceflight for research focused on Earth benefits through open science sample sharing (ALSDA) and multi-omics data sharing (GeneLab)

Important Questions – what do we need to know about animal physiology to engage in long duration space exploration?

Topic A – What are the individual effects and combined effects of reduced gravity, space radiation exposure, and the space environment on physiological health and tissue structure and function?

Topic B – How does the spaceflight environment impact the communication between physiological systems?

Topic C – How does the space environment affect biology and adaptive processes during a single life span and over multiple generations and re-adaptation upon return to Earth?

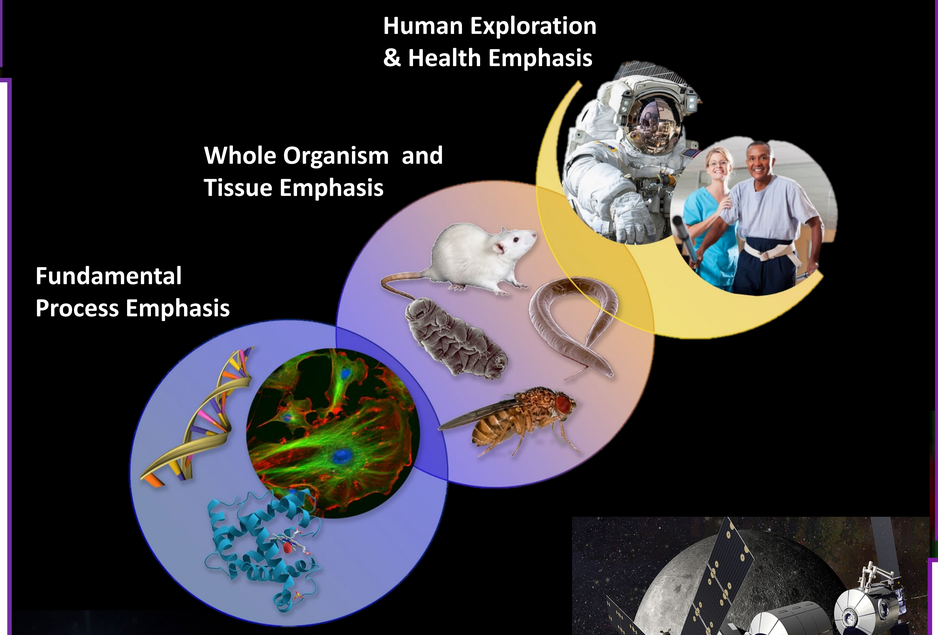
Topic D – What are the epigenetic changes and gene expression responses and the associated mechanisms that are influenced by gravitational changes, space radiation, and the space environment?

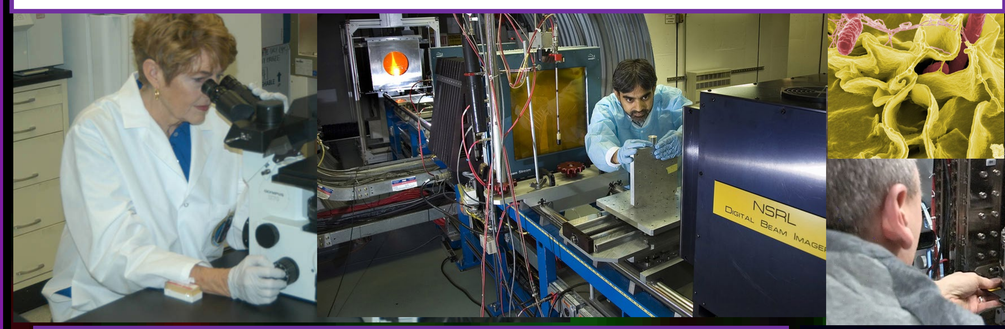
Topic E – Do biological processes respond to a threshold of gravity or through the continuum of gravity (i.e. 0xg to 1xg)?

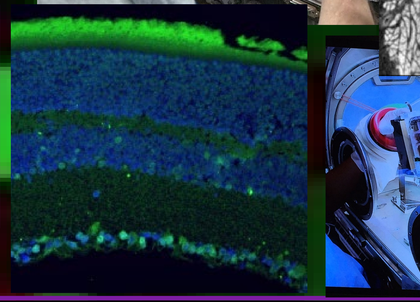
Topic F – How are the relationships between the circadian rhythm and tissue functions and biological processes affected by the space environment?

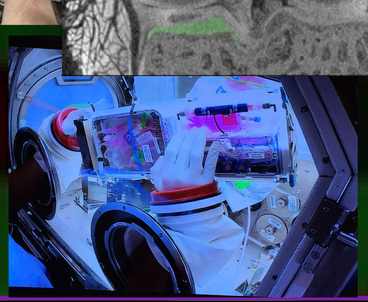
Topic G – How is the microbiome of the animal and its relationship to different physiological functions affected by the space environment?

Continuum of Animal Research to Understand Life in Space and on Earth









Selected Important Answers – what have we learned that could only be revealed in space?

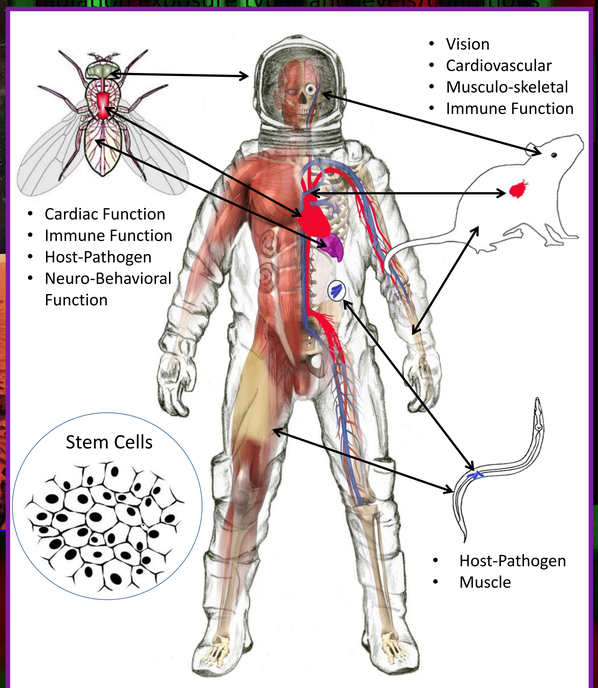
Animals – adapt to the new space environment but show physiological and morphological changes (e.g. muscle, bone, liver cardiovascular system)

Animals and Cultured Cells – show impaired innate and adaptive immune responses

Animals – show oxidative stress responses, which can initiate a cascade of cellular, molecular, and physiological changes

Cultured Cells – responses show changes in cytoskeleton architecture, gene expression, and their functional output

Animals and Cultured Cells – show species-specific and tissue-specific responses to radiation exposure types and levels/conditions



Representative examples of model organisms and systems that have human homologues

American Society for Gravitational and Space Research

Biological and Physical Sciences
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https://asgsr.org/SpaceScience101

Terms: ALSDA - ARC Life Science Data Archive – lsda.jsc.nasa.gov
GeneLab - genelab.nasa.gov