

# Challenge Unveiling

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Spring CS175 2023 challenge is...

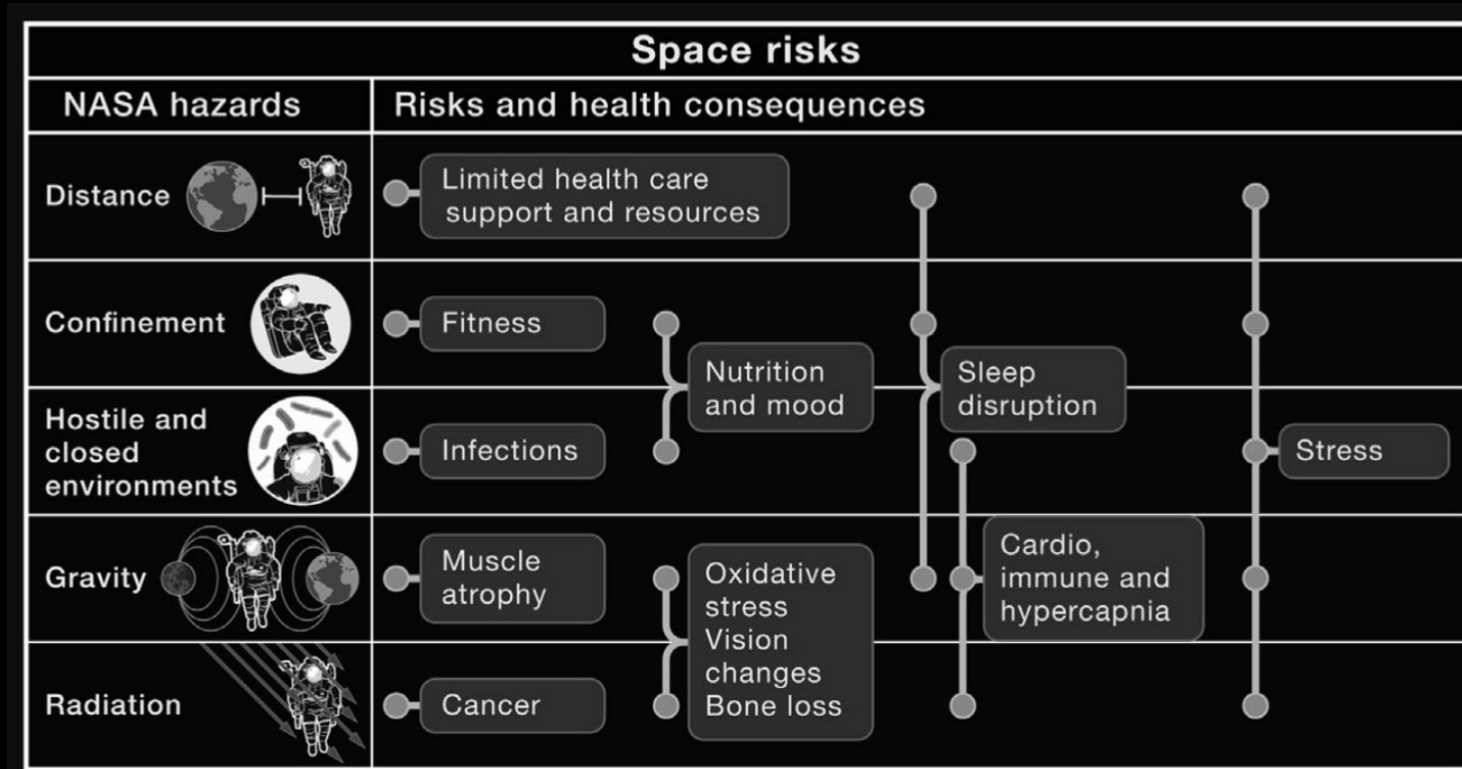
Spring CS175 2023 **challenge** is...



**Astronaut Health!**

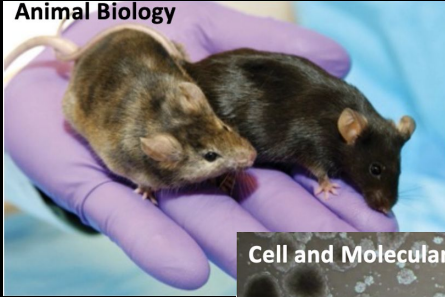
OpenAI: Dall-E Generated

**Exposure** to spaceflight is associated with a set of **health impacts** due to **5** key “stressors:”

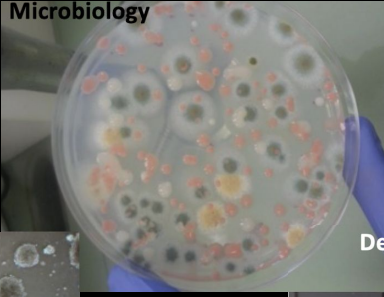


How might we leverage **artificial intelligence** to help us understand spaceflight-induced biological **changes**?

Animal Biology



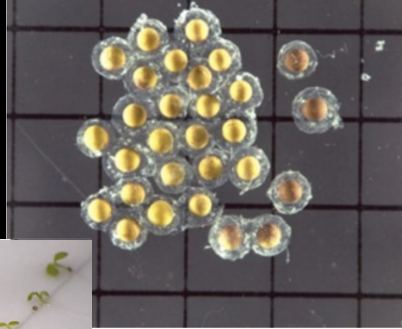
Microbiology



Cell and Molecular Biology



Developmental, Reproductive,  
and Evolutionary Biology

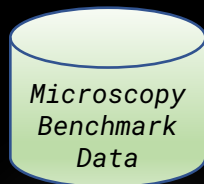
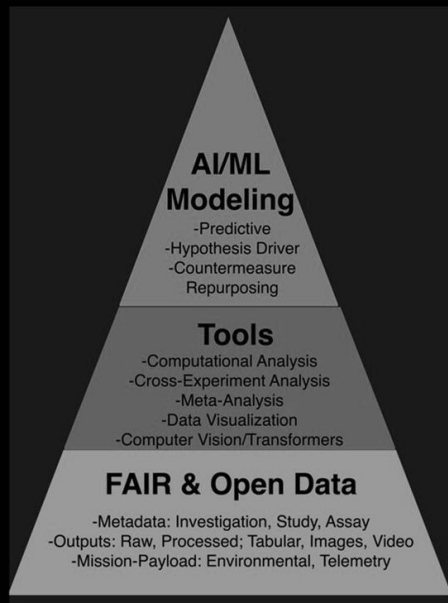


Plant Biology

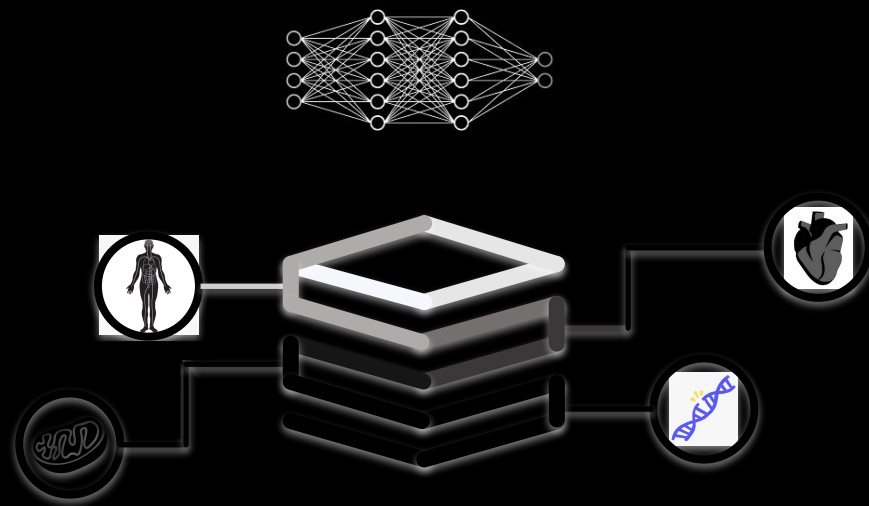


# AI for Life in Space

Leveraging ML methods to model space biology data from the NASA Open Science Data Repository: **how might we** use **NASA GeneLab** data to better understand the complex effects of spaceflight on living systems across hierarchical biological levels?



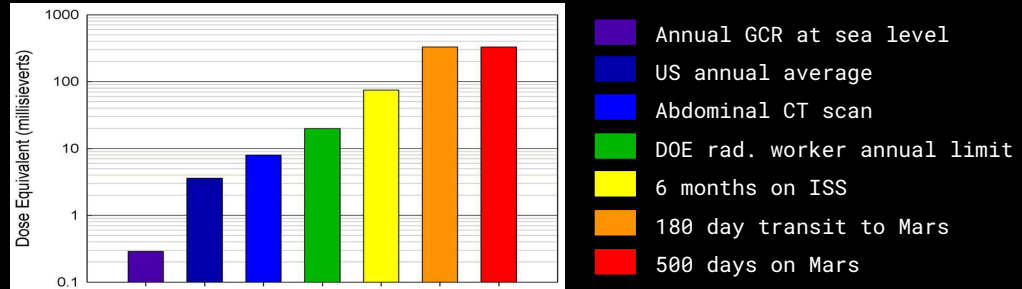
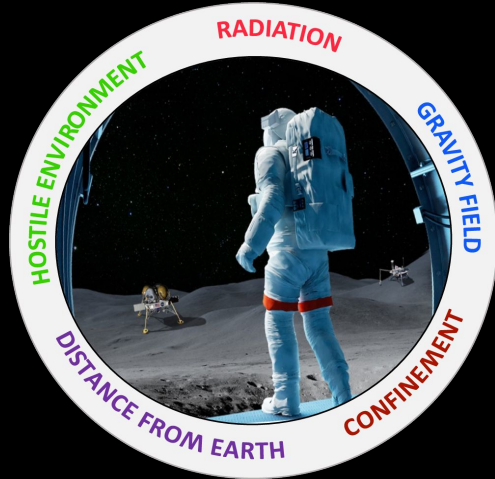
[osdr.nasa.gov](https://osdr.nasa.gov)



Can we **improve** upon traditional statistical methods of analysis?

L. Sanders (GeneLab)

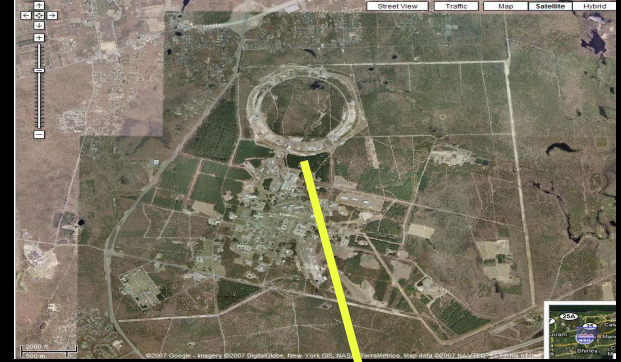
# Scientific Motivation: Space Radiation Risks



- Expected doses from ionizing radiation in space (galactic cosmic rays)
- Health hazards include:
  - **DNA** damage
  - Central **nervous** system effects
  - **Immune** system effects

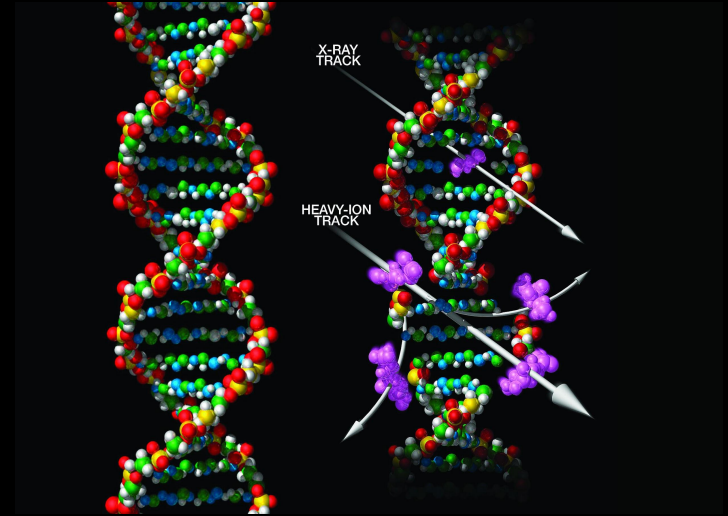
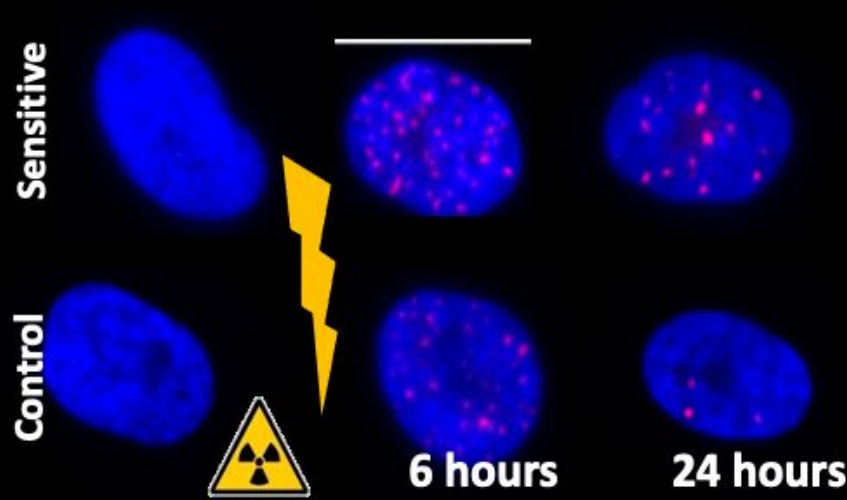
# Investigating deep space **radiation** on earth...

- Space radiation is composed of:
  - **solar** particle events (SPEs)
  - galactic **cosmic** rays (GCRs)
- Galactic Cosmic Rays:
  - ~87% **protons**
  - ~12% **4He**
  - ~1% high mass-energy particles through  **$^{56}\text{Fe}$**
- GCR particles are simulated at NASA Space Radiation Laboratory in Brookhaven National Lab
  - Particle accelerator for GCR simulation





# Exposure to radiation causes **DNA** damage to cells



- Visible through fluorescent imaging of DNA damage markers
- Radiation-induced foci (RIF) of DNA damage
- Heavy-ion tracks are visible as linear patterns of DNA damage foci

How might we study the effects of cosmic radiation on humans without putting people at risk?



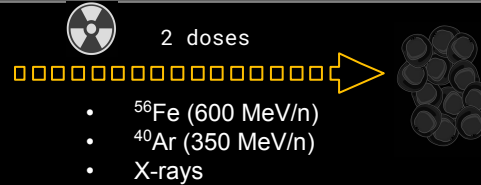
## Mighty Mice!

Mice are similar to humans:

- genetically
- physiologically

# Mouse cultured **fibroblast** dataset

5 inbred strains  
10 Collaborative Cross strains

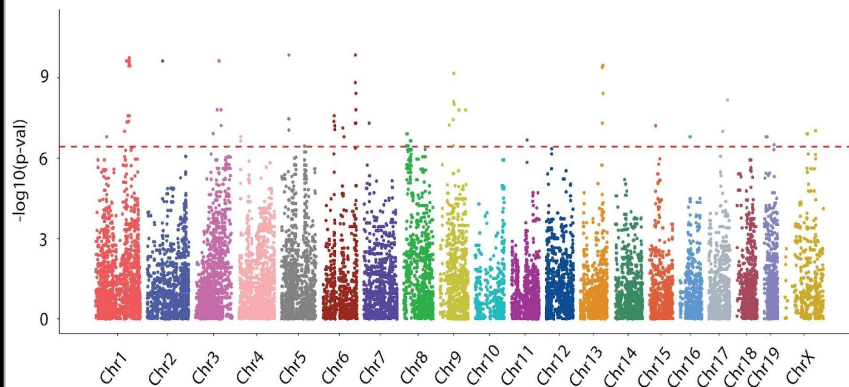


GWAS

4h & 24h post irradiation



DNA repair



We would like to utilize machine learning approaches to analyze the underlying patterns of DNA damage and repair in microscopy images

# Mouse **fibroblast** DNA damage benchmark dataset

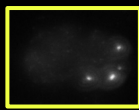


Raw Dataset (n=94,193):  
32-bit Z stacks (9 indices)



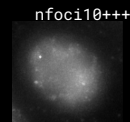
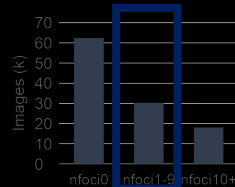
maximum intensity  
projection

16-bit conversion



Max Intensity Dataset  
(n=94,193):  
16-bit single-index  
TIFFs

automatically  
estimated nfoci



Label Types	Labels	Total images
Number of foci (nfoci)	0-20	93,488
Radiation Type	$^{56}\text{Fe}$ or X-ray	
Radiation Dose	Low and high dose	
Imaging Time Post-exposure	4, 24, 48 hours	

Registry of Open Data on AWS



BPS Microscopy  
Benchmark Dataset



We have lift-off!

