



Neuroimmune Responses to Space Radiation

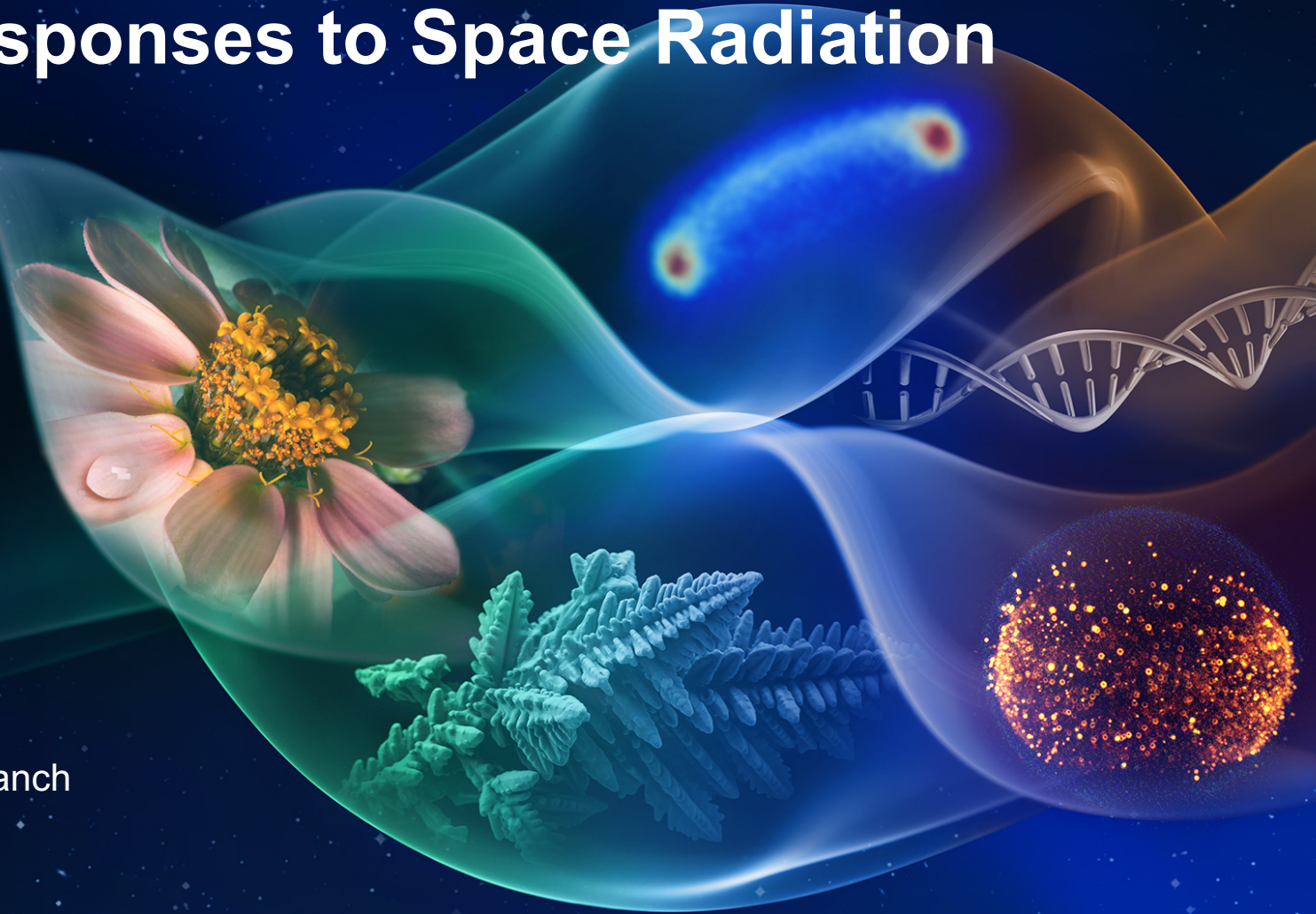


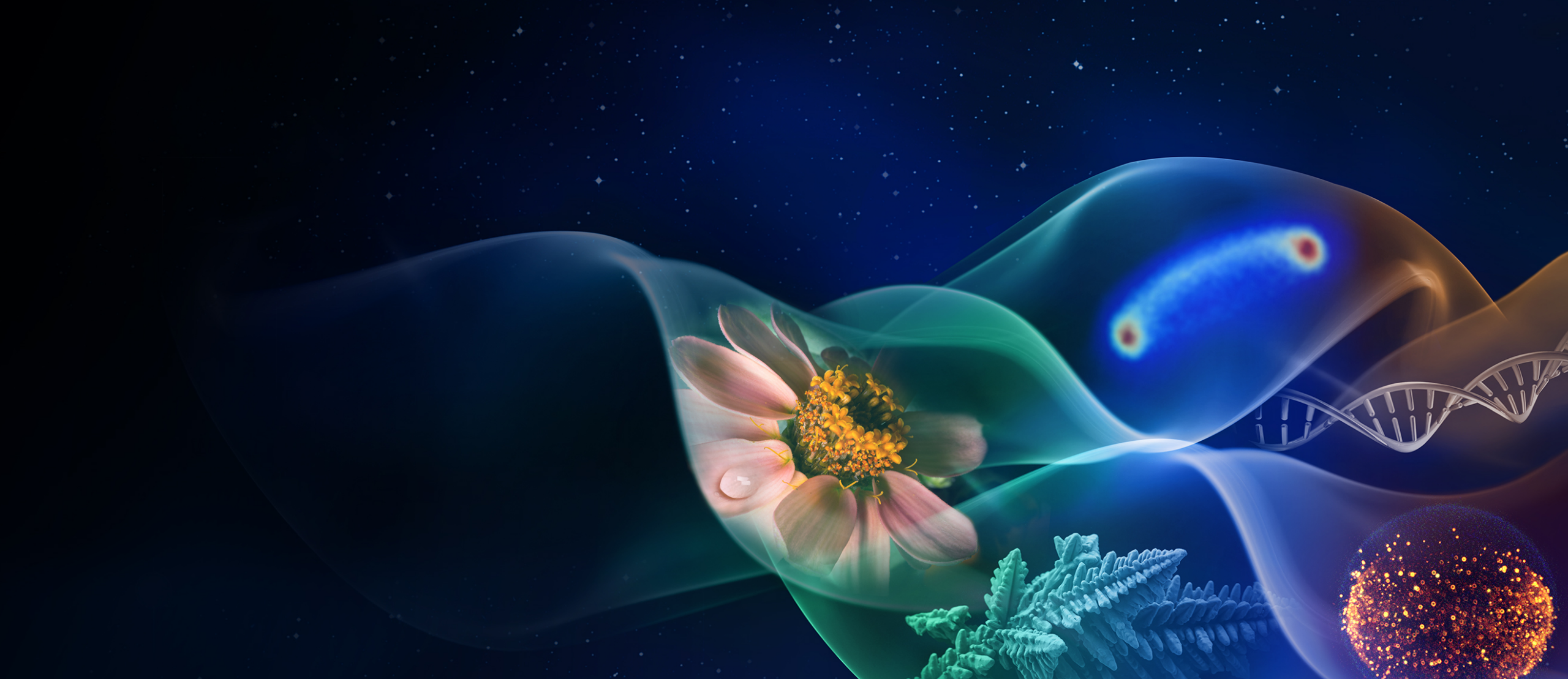
BPS

BIOLOGICAL AND
PHYSICAL SCIENCES

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NASA Ames Research Center
Space Biosciences Research Branch

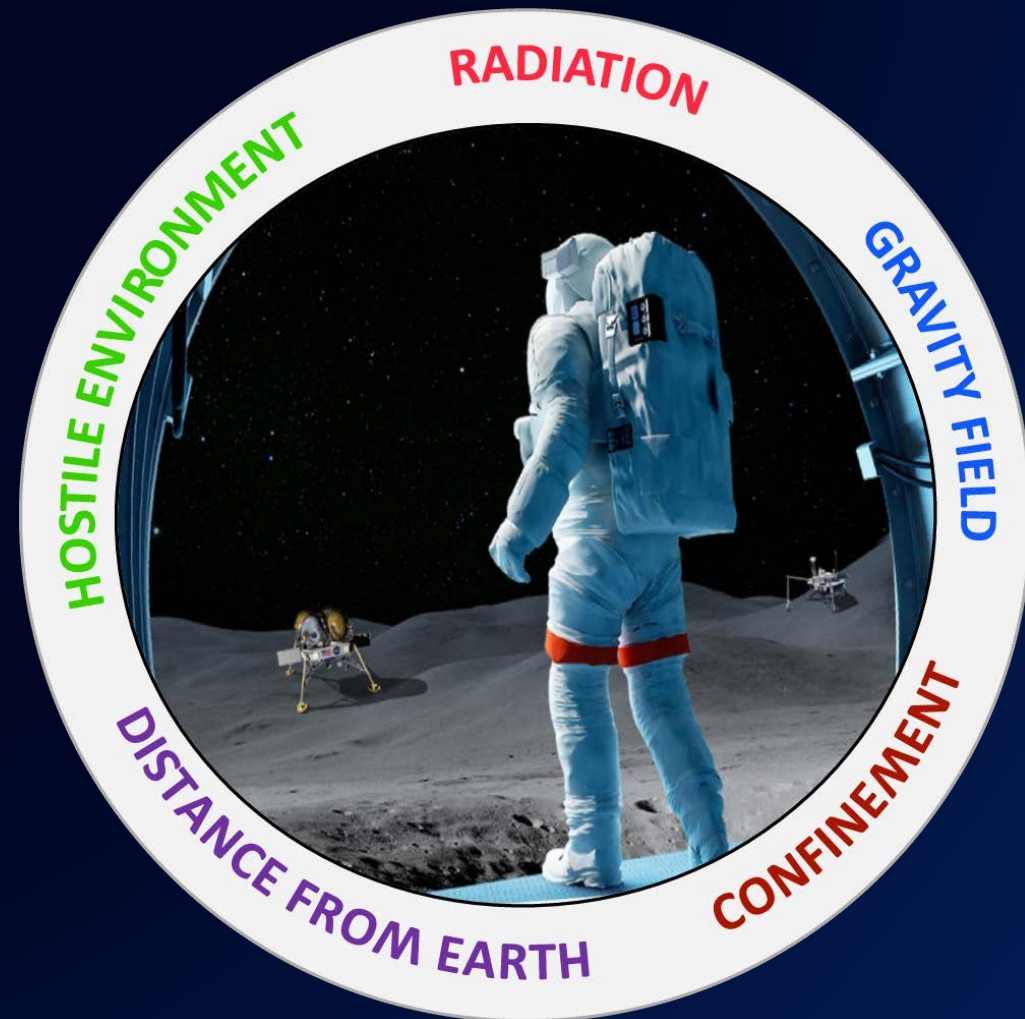
Space Life Sciences Seminar
Harvard University
12/04/20



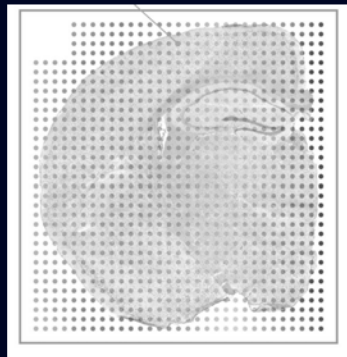


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Hazards of Space Exploration



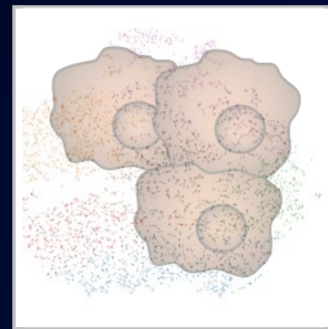
Spaceflight-Associated Changes in the Central Nervous System



Spatial
transcriptomics



CNS
sn-RNASeq

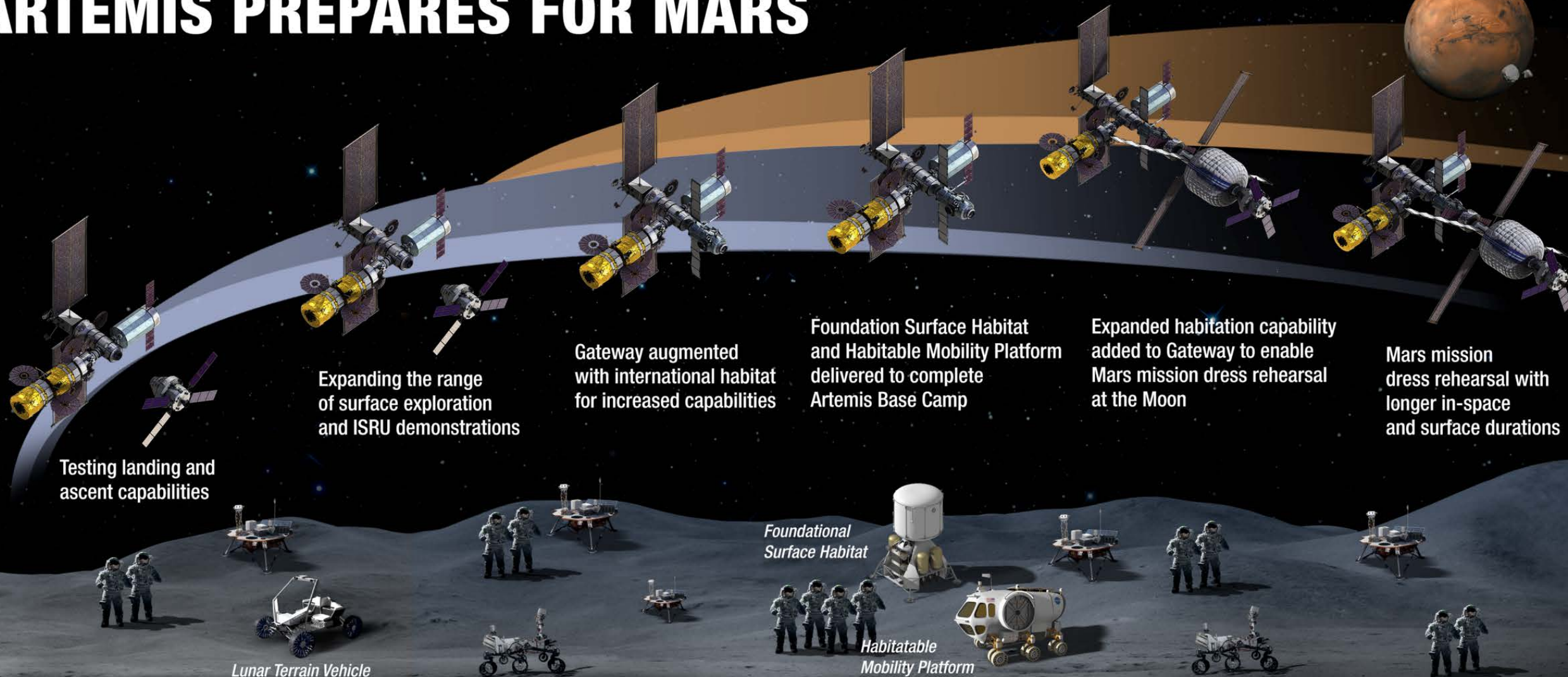


Immune
sc-RNASeq



*NASA GeneLab (RRRM-2)
Almeida/Juran (RR-10)*

ARTEMIS PREPARES FOR MARS



SUSTAINABLE LUNAR ORBIT STAGING CAPABILITY AND SURFACE EXPLORATION

MULTIPLE SCIENCE AND CARGO PAYLOADS | INTERNATIONAL PARTNERSHIP OPPORTUNITIES | TECHNOLOGY AND OPERATIONS DEMONSTRATIONS FOR MARS

Galactic Cosmic Rays:

~87% protons

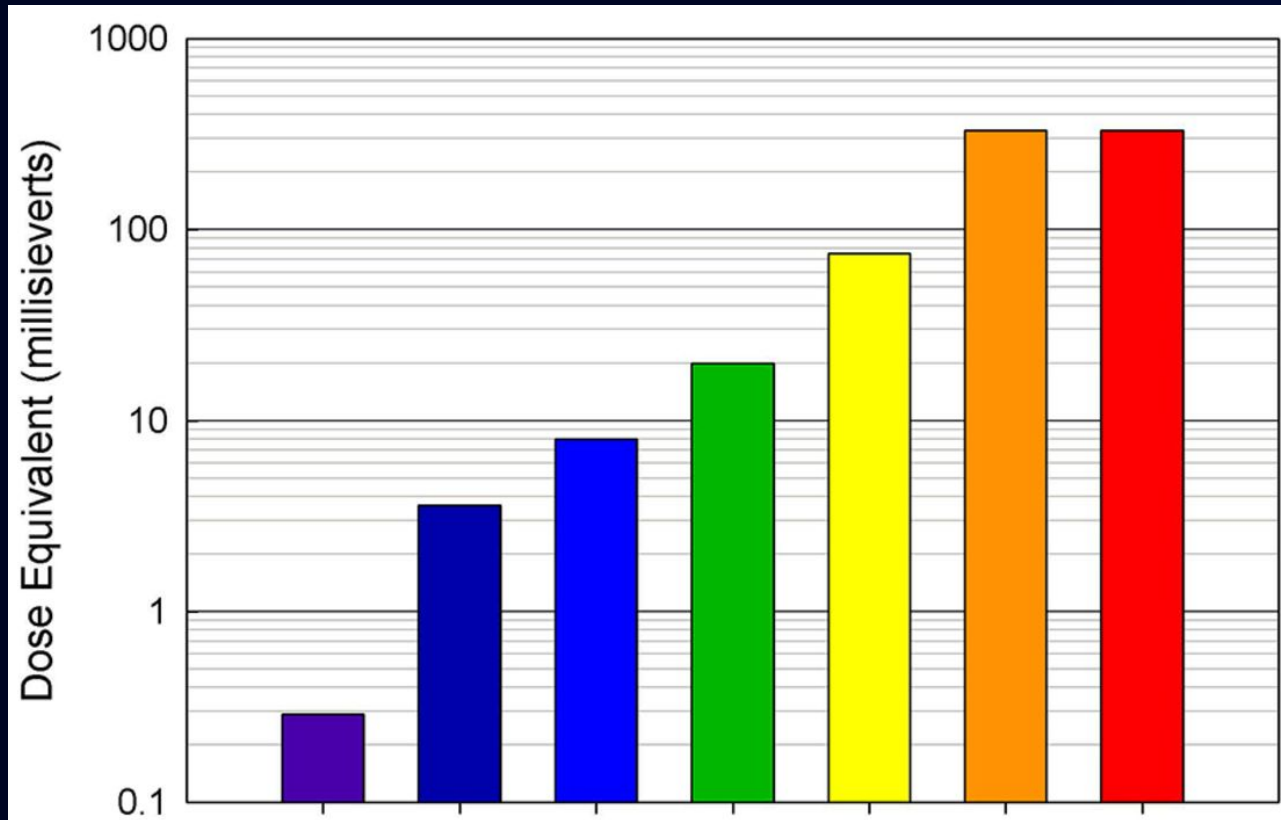
~12% ^4He

~1% high mass-charge particles through ^{56}Fe



Simulated at NASA Space Radiation Laboratory in Brookhaven National Lab

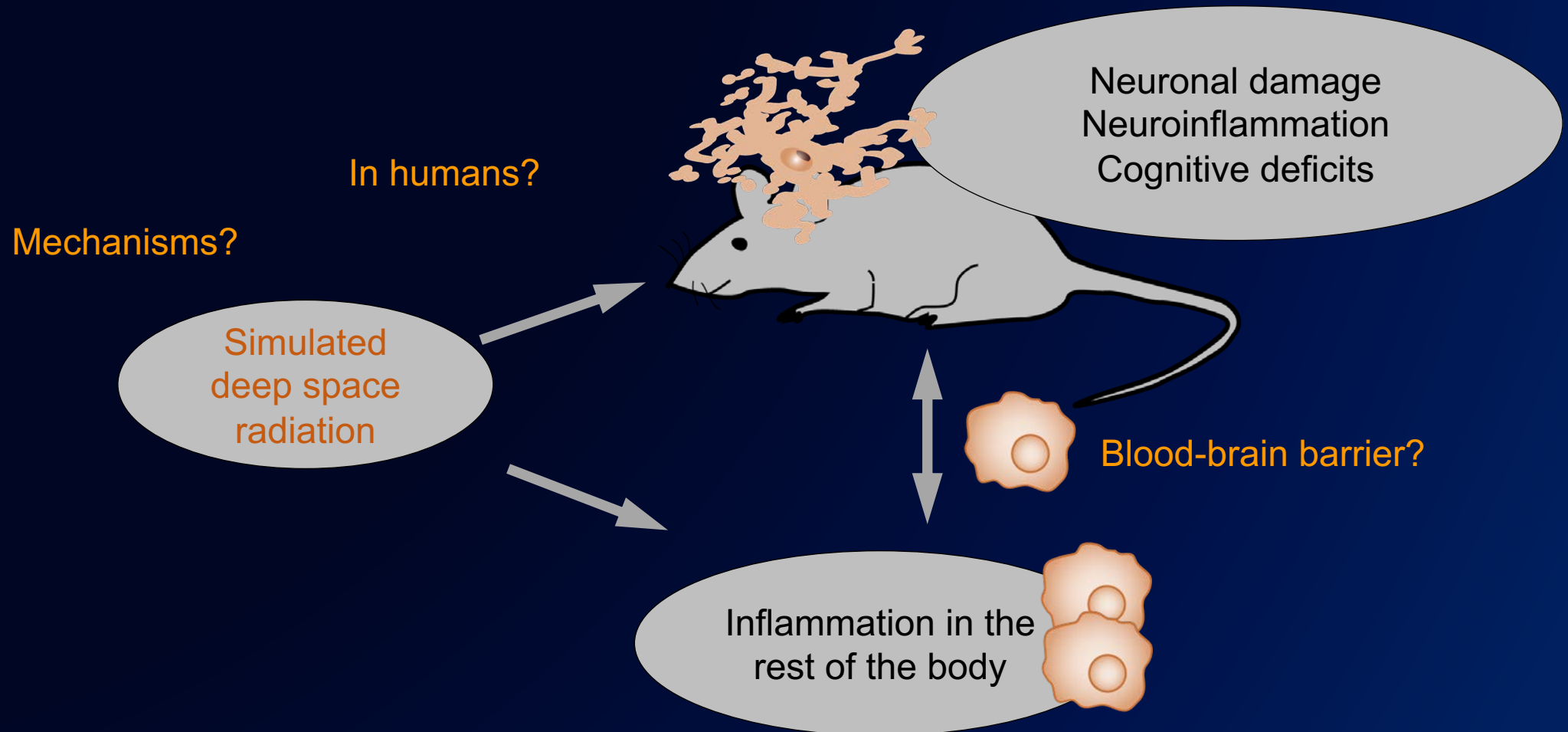
Ionizing Radiation Exposure In Space



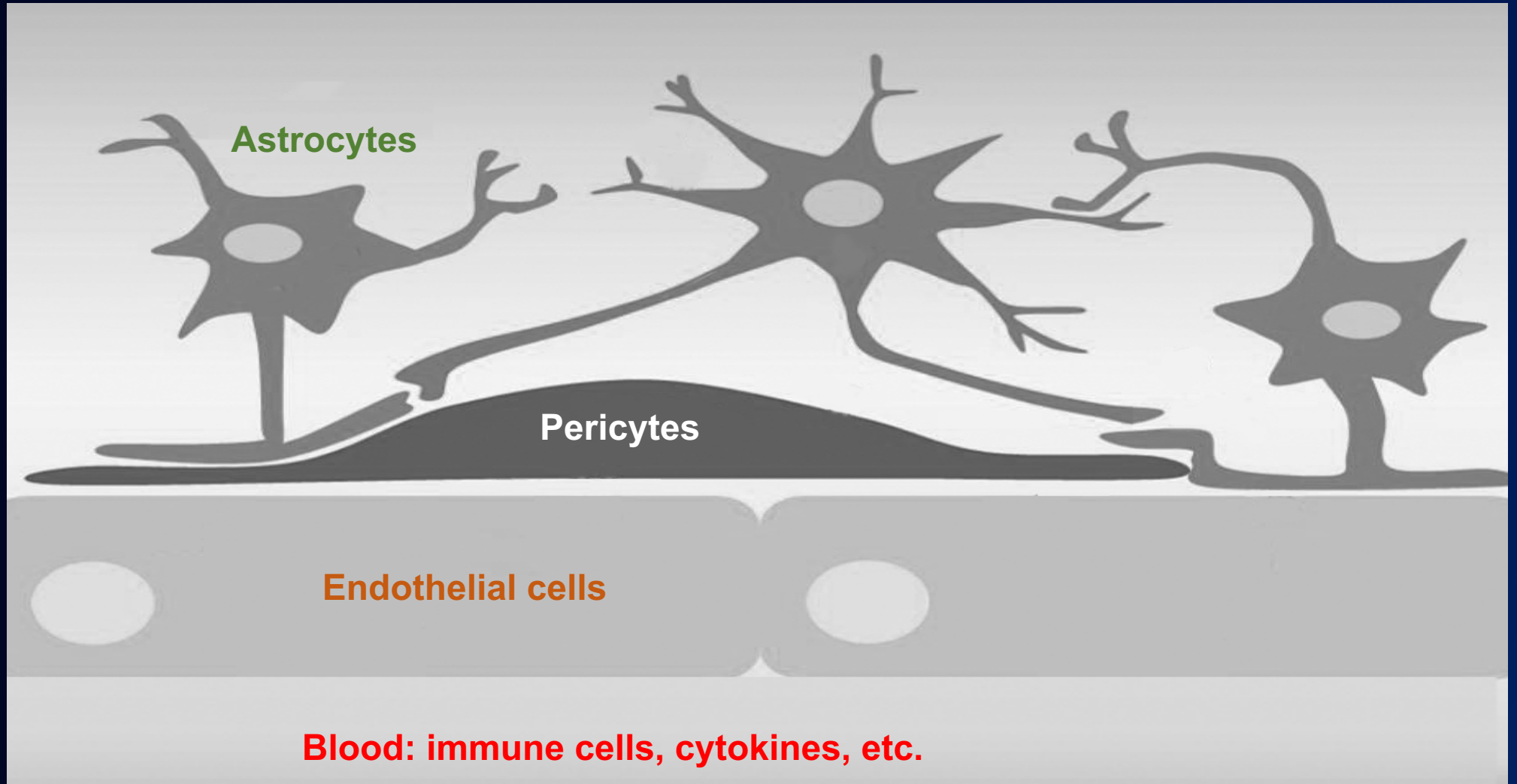
- Annual GCR at sea level
- US annual average
- Abdominal CT scan
- DOE rad. worker annual limit
- 6 months on ISS
- 180 day transit to Mars
- 500 days on Mars

Cancer, cardiovascular/immune/tissue degeneration, CNS risk

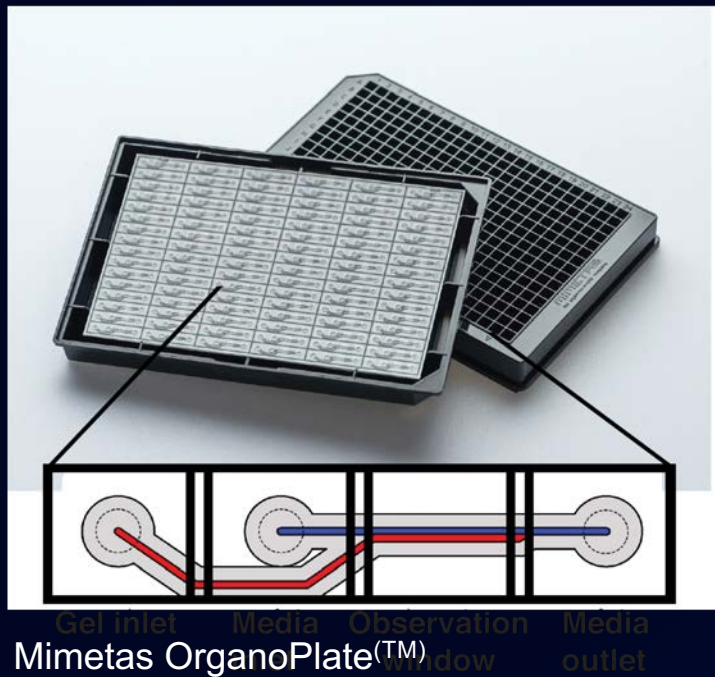
Central Nervous System Responses to Simulated Deep Space Radiation



Blood-Brain Barrier

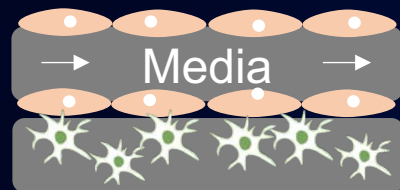


High-throughput 3D Human Neurovascular Model: OrganoPlates



2-lane plate setup

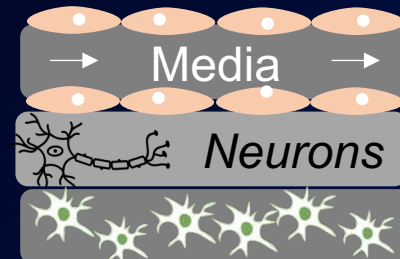
Endothelial cells



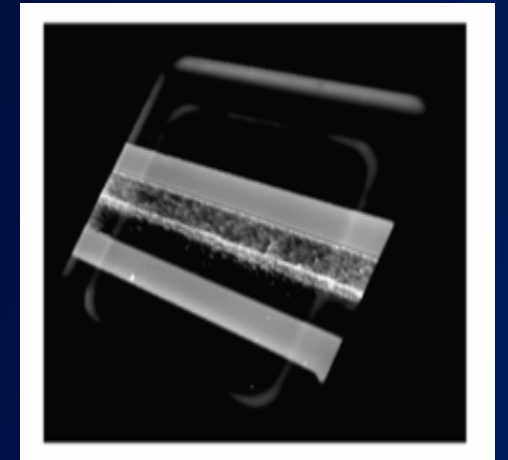
Astrocytes

3-lane plate setup

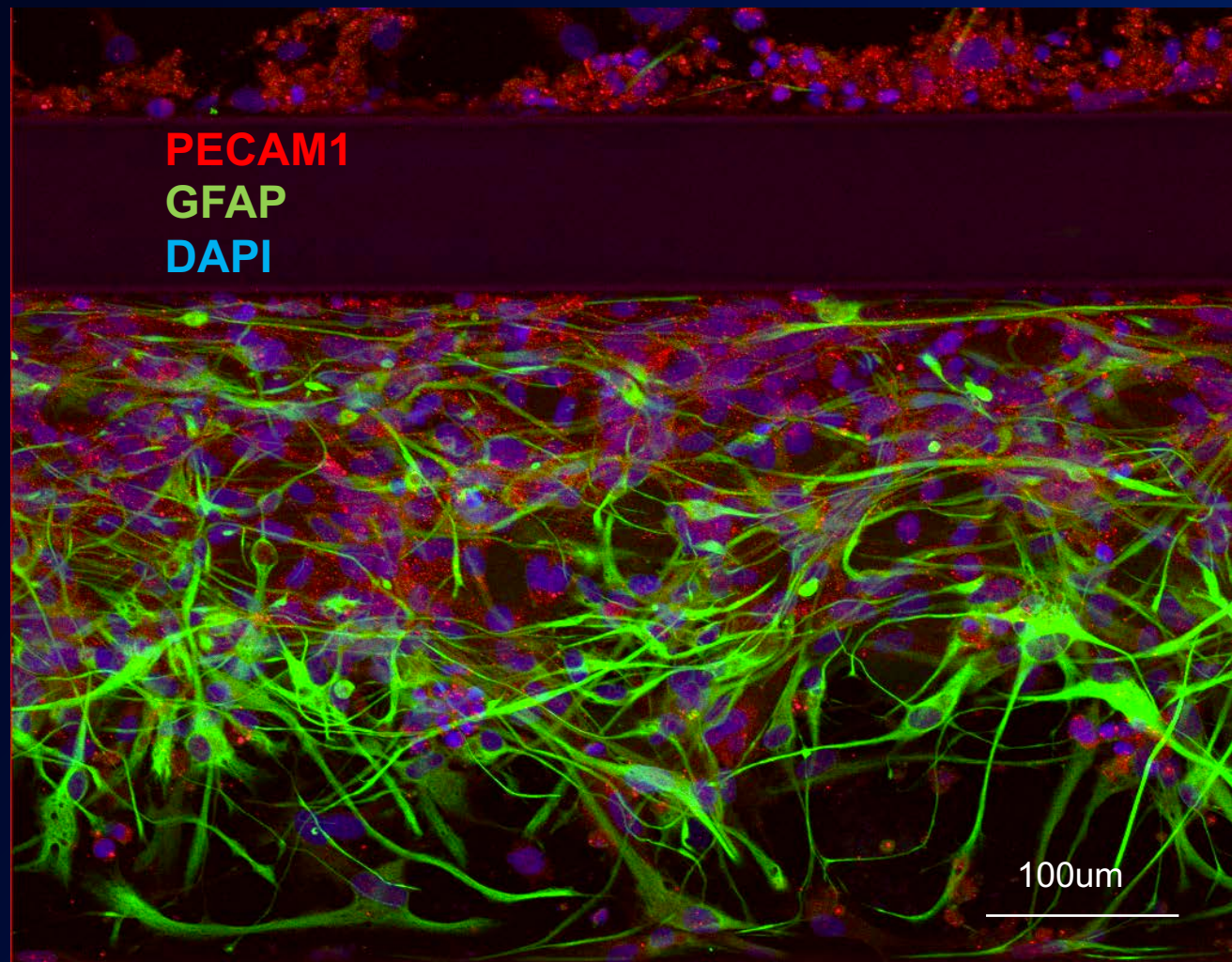
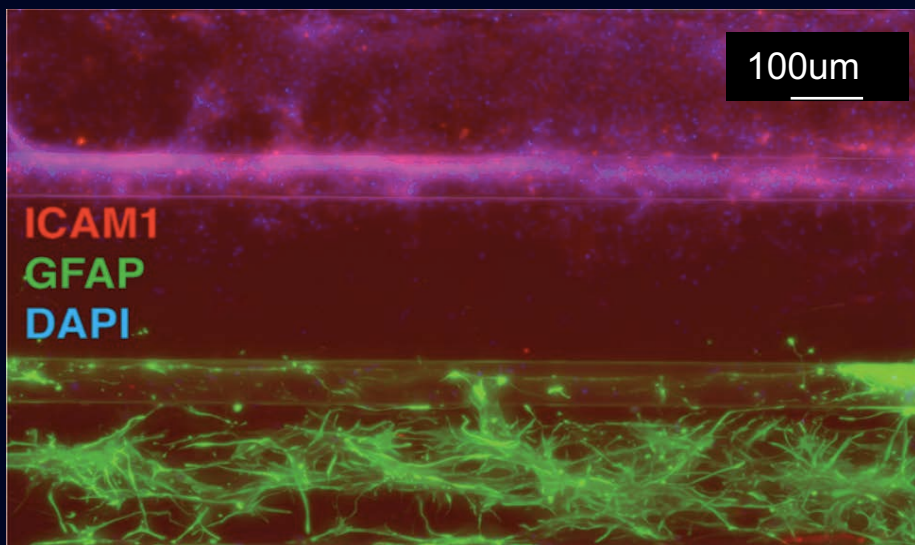
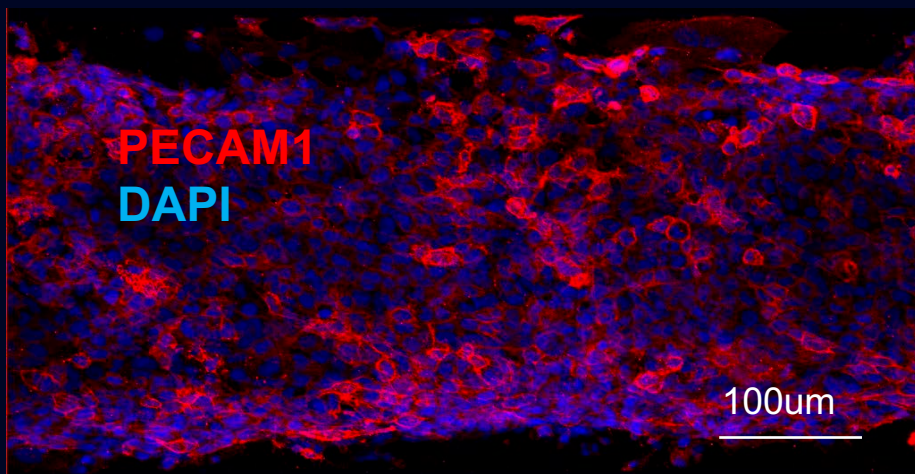
Endothelial cells



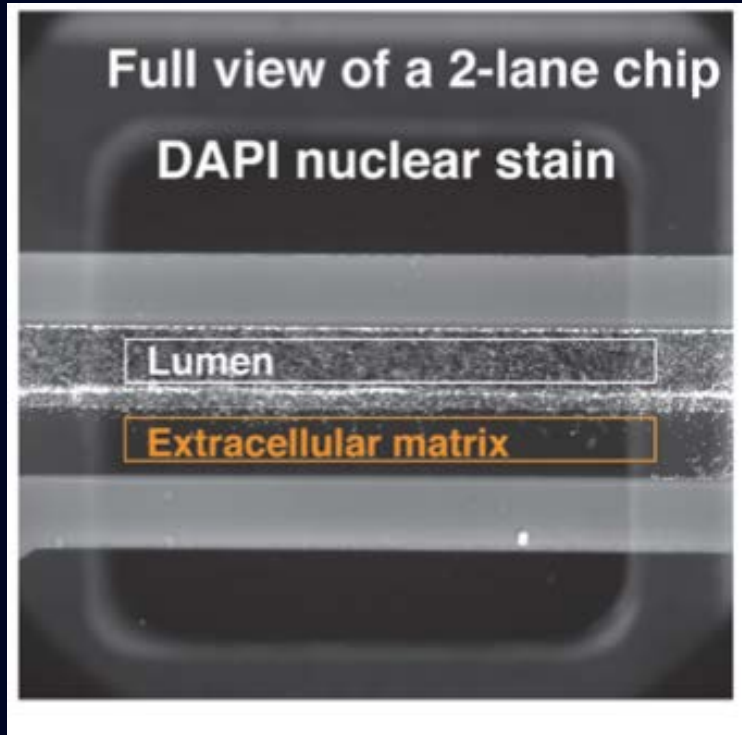
Astrocytes



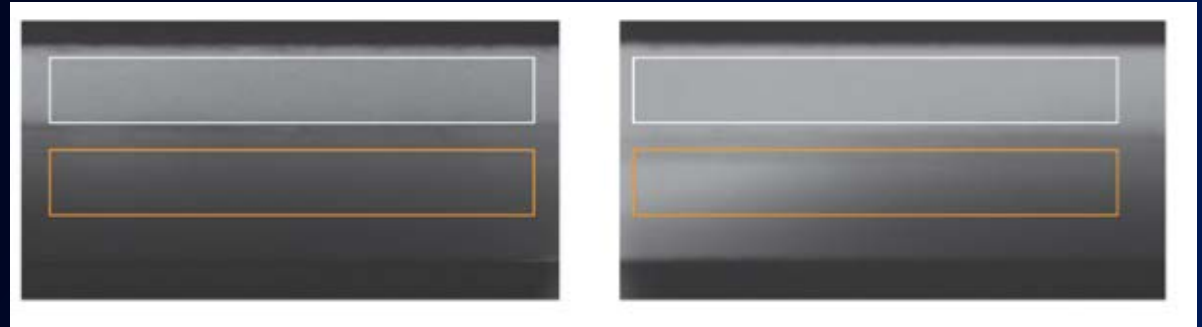
OrganoPlates



Quantifying Responses to Ionizing Radiation



Relative fluorescence of dye in
extracellular matrix channel / lumen channel

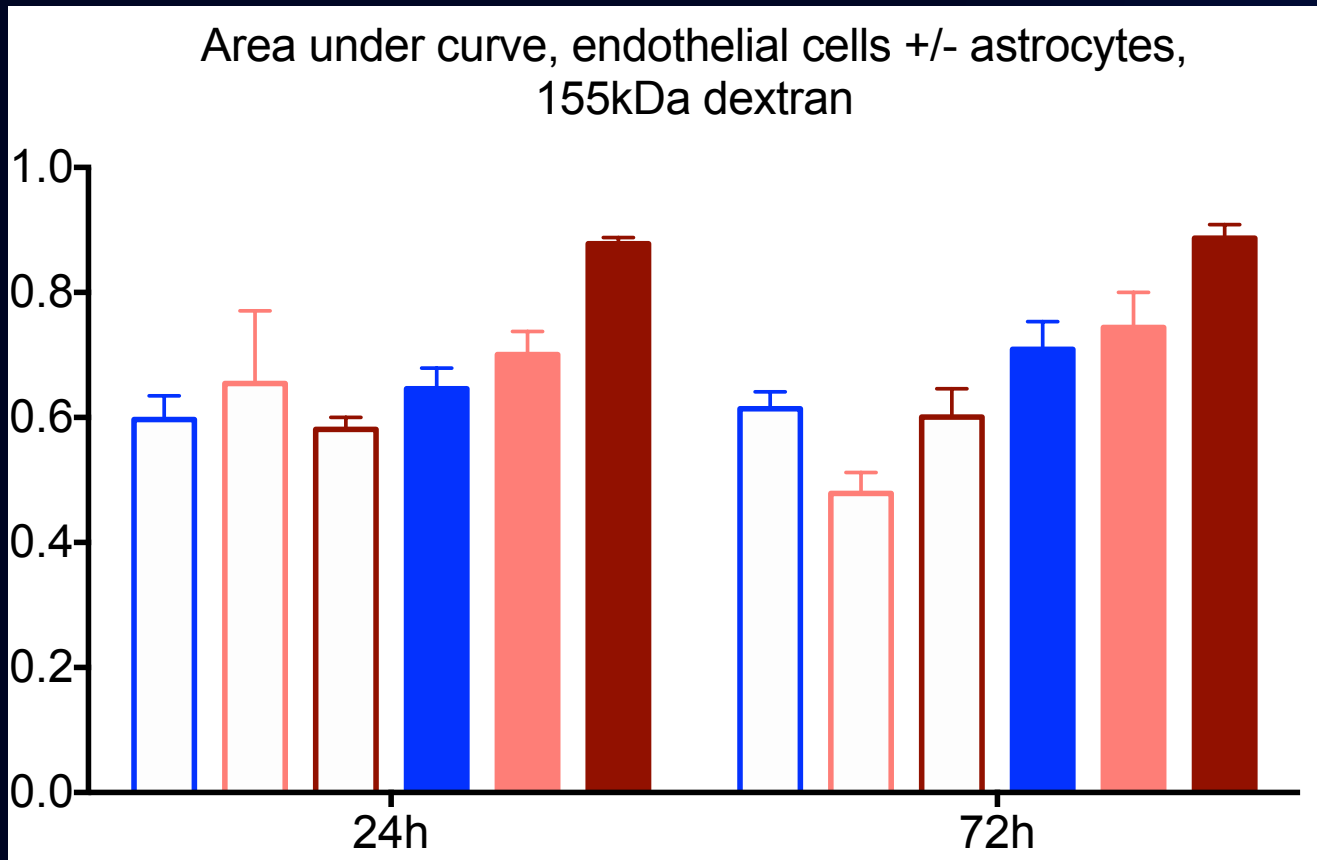


Non-leaky barrier

Leaky barrier

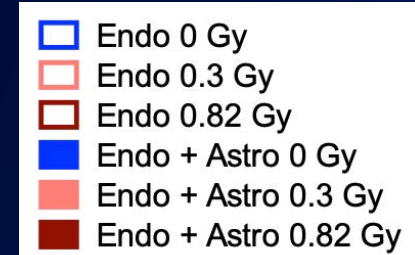
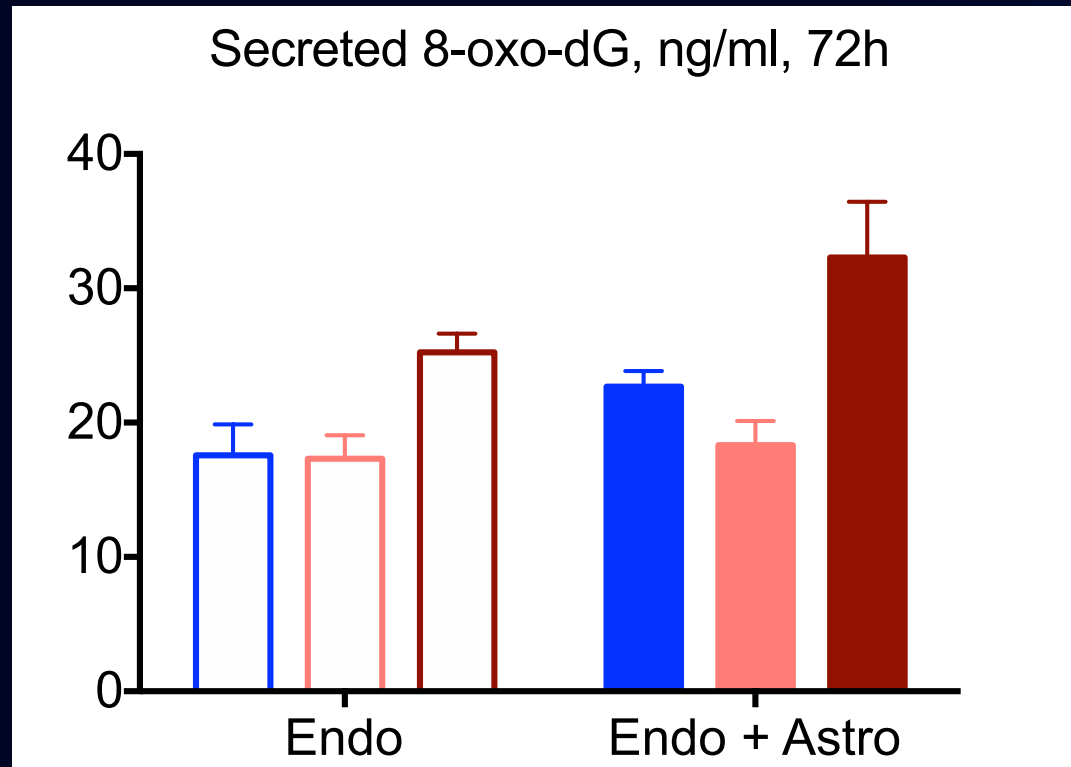
- Blood-brain barrier permeability and morphology
- Cellular damage
- Oxidative stress and cytokine production

Simulated Deep Space Radiation Increases Blood-Brain Barrier Permeability



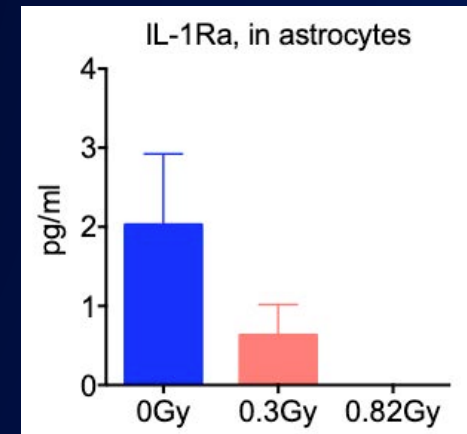
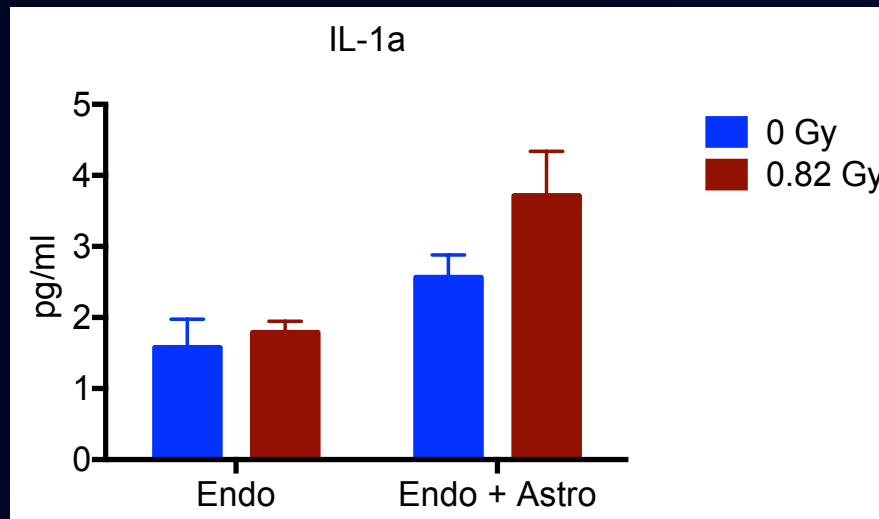
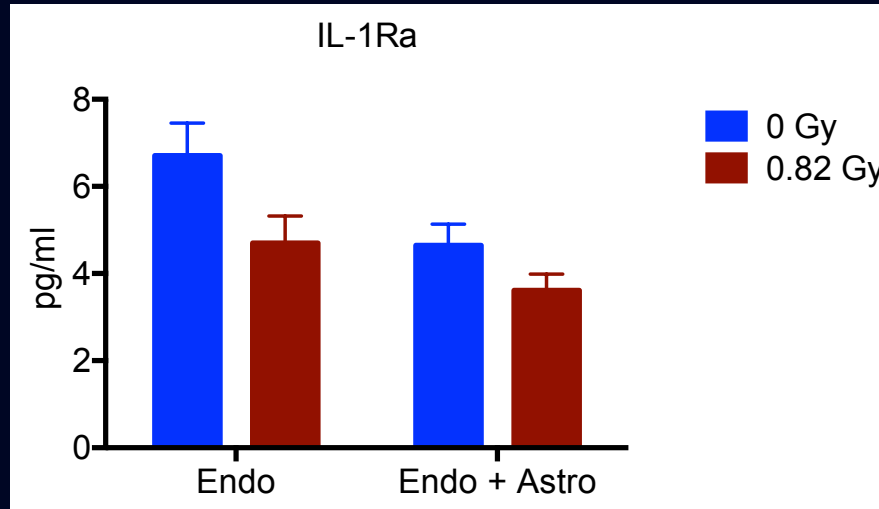
**...but only when
astrocytes are
present!**

Simulated Deep Space Radiation Increases Oxidative Stress



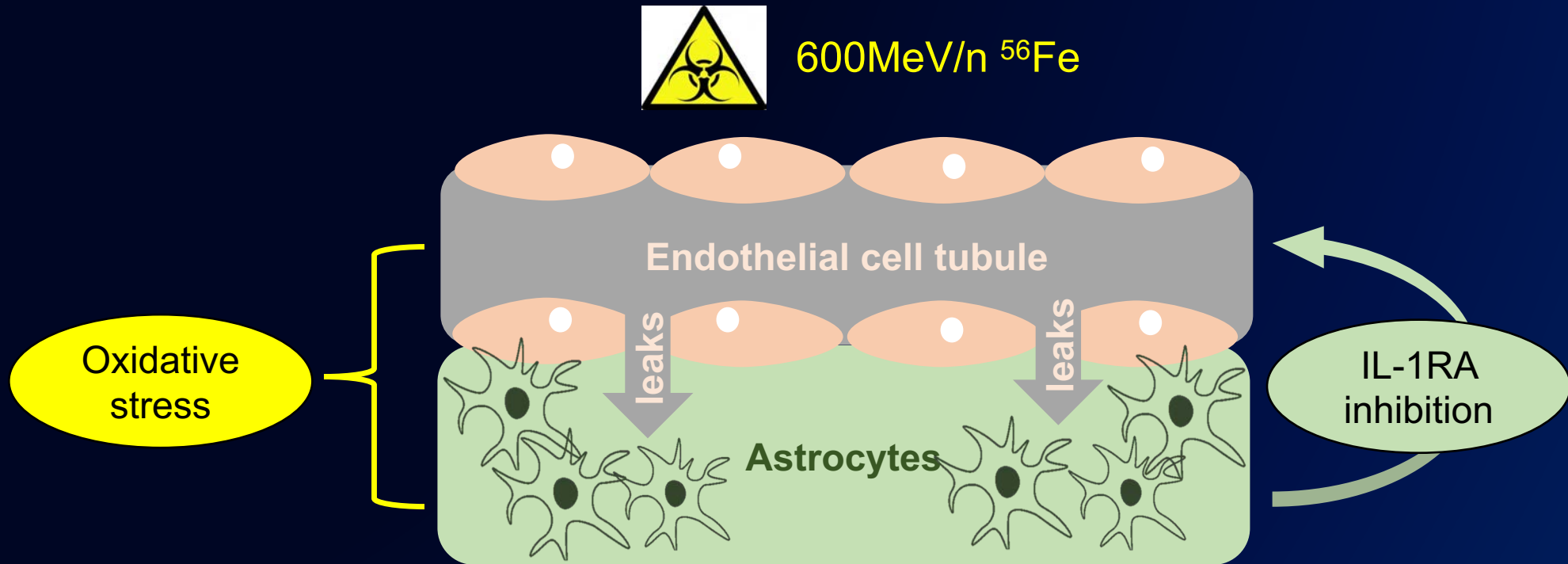
**...especially
when astrocytes
are present!**

Simulated Deep Space Radiation Changes IL-1RA Associated Cytokine Expression

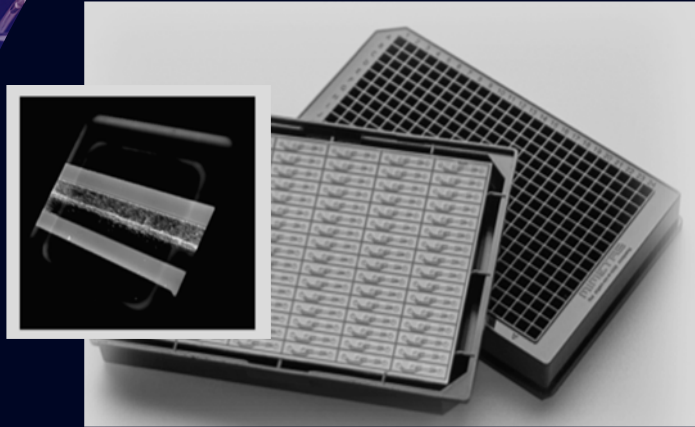


**...especially
when astrocytes
are present!**

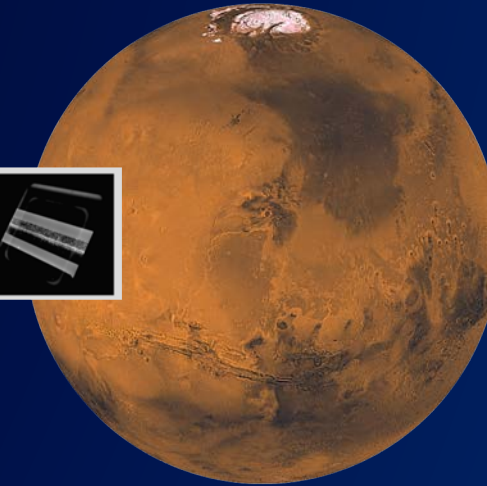
Human Neurovascular Responses to Simulated Deep Space Radiation



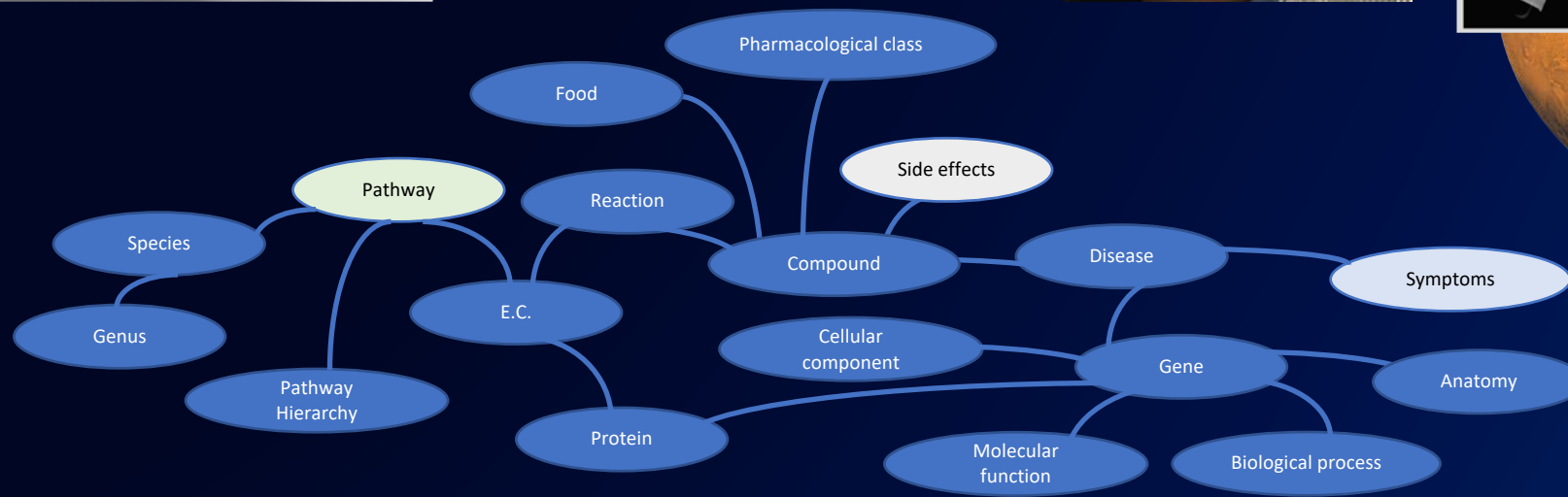
Next Steps in Neurovascular Model Development



Personalized analysis:
iPSC-derived cells from a
specific subject

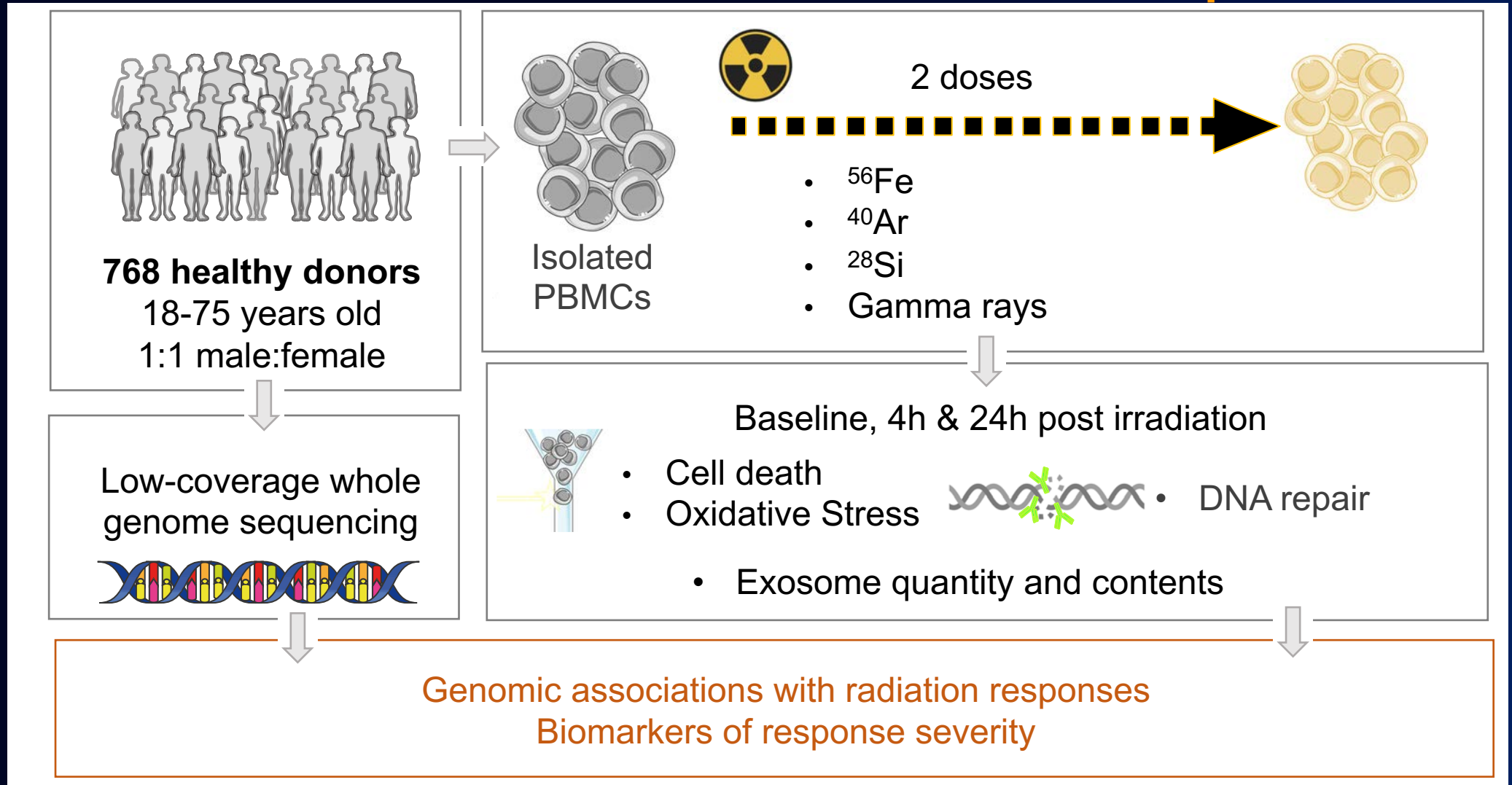


Payload
adaptation

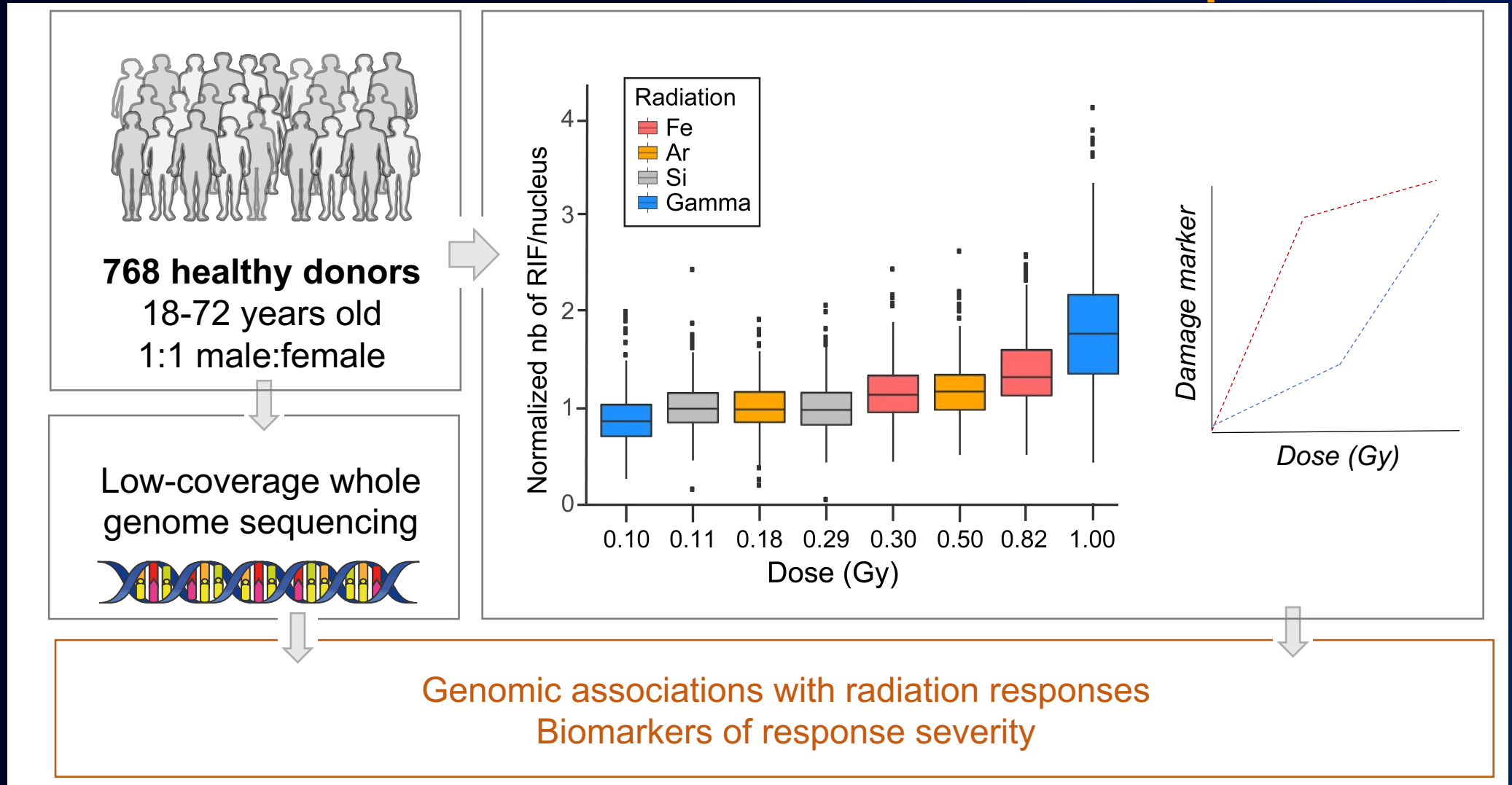


Drug repurposing

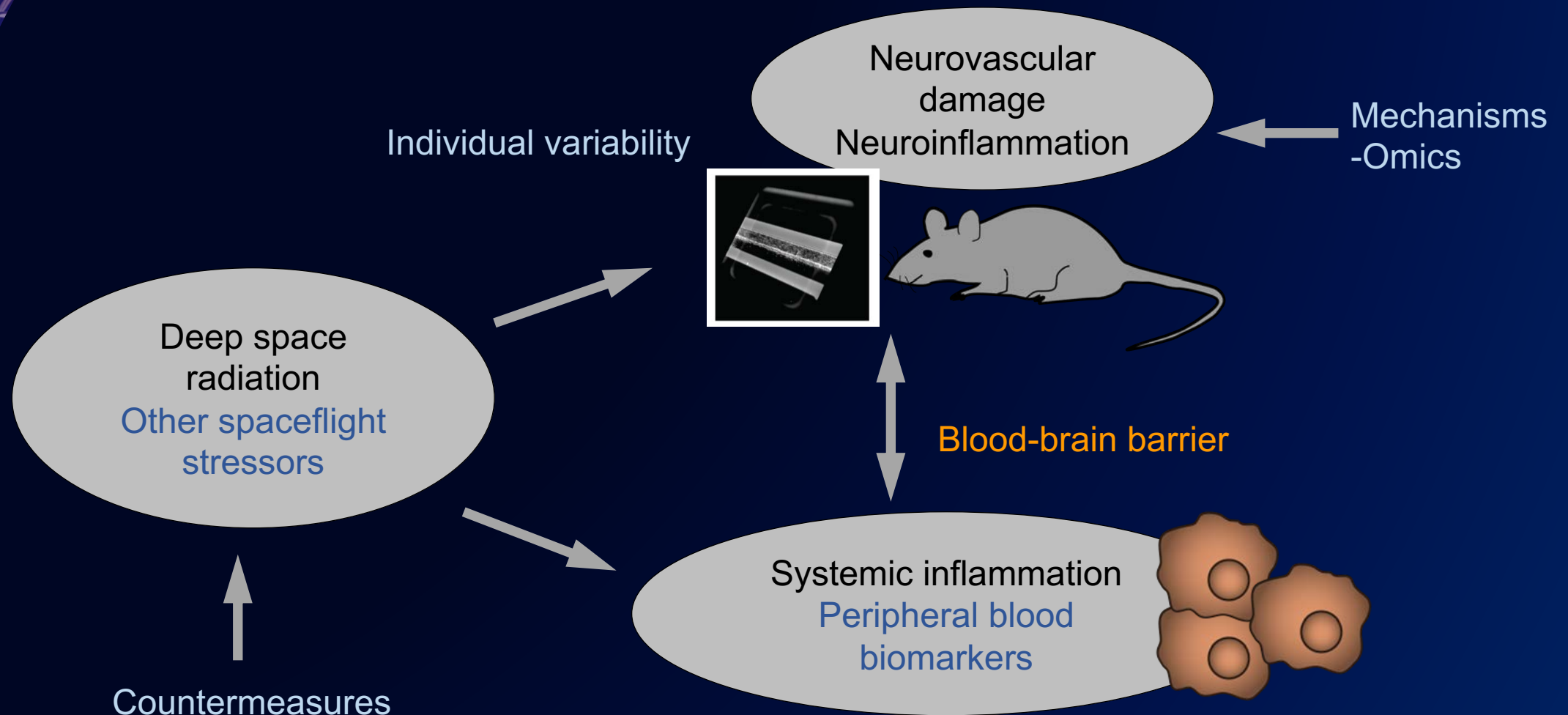
Human Variability and Genomic Associations with Radiation Responses

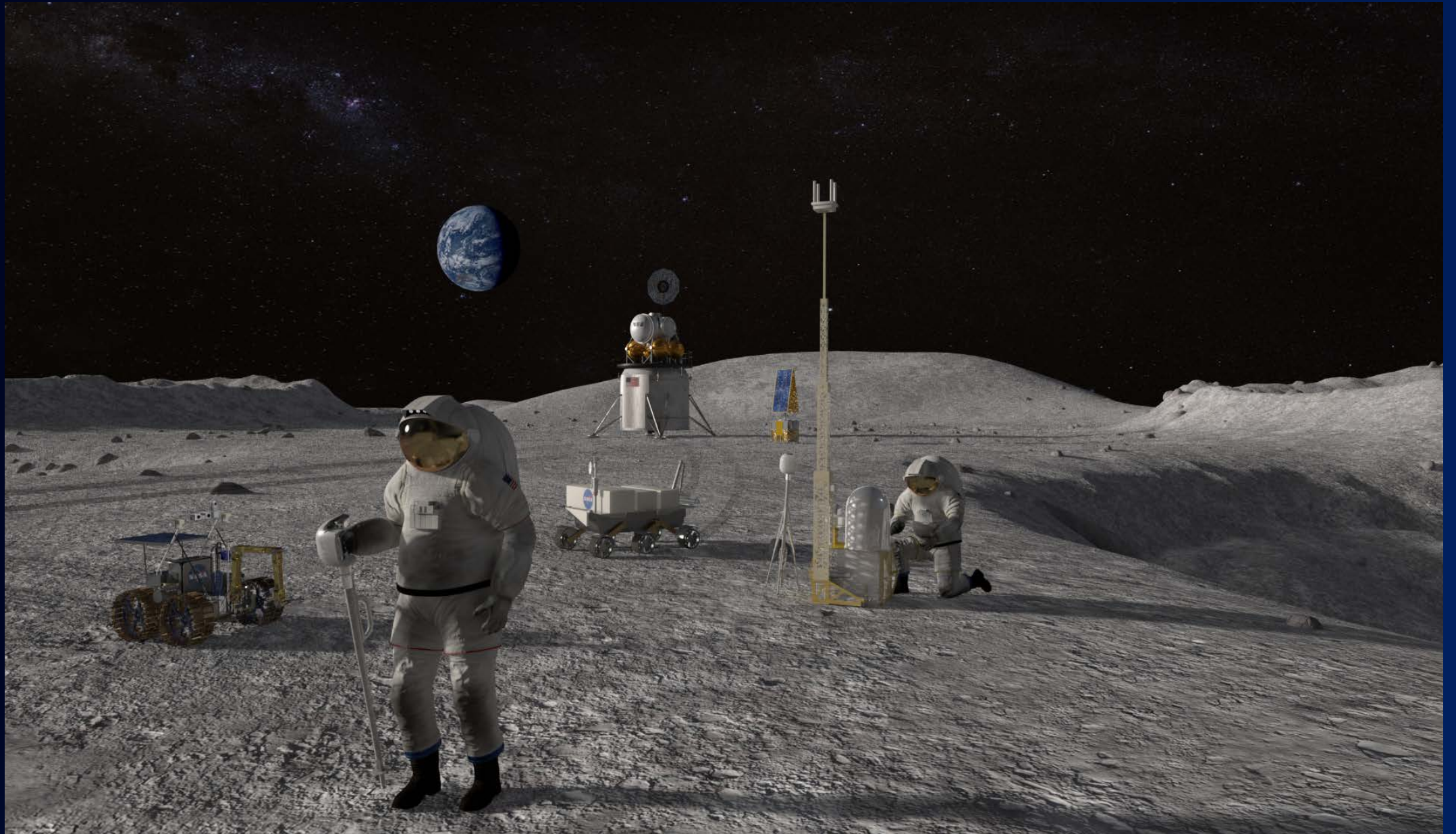


Human Variability and Genomic Associations with Radiation Responses



Neuroimmune Responses to Space Radiation





Acknowledgments



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NASA HRP
NASA Ames ARIA





TRISH Announcement Soliciting Postdoctoral Fellowship Applications



Committee on Biological and Physical Sciences in Space

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NASEM Decadal Study: contribute to white papers to shape the next decade of space biosciences!

Neuroimmune Responses to Space Radiation

