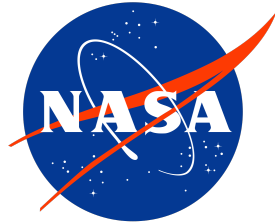


IMMUNE AND MICRORNA DIFFERENTIALS POST-SIMULATED DEEP SPACEFLIGHT



Immunology, Virtual, 2021
Amber M. Paul, PhD
Postdoctoral Fellow, NASA Ames Research Center
amber.m.paul@nasa.gov

iScience

CellPress
OPEN ACCESS

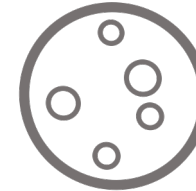


Article

Beyond Low-Earth Orbit: Characterizing Immune and microRNA Differentials following Simulated Deep Spaceflight Conditions in Mice

The Biology of Spaceflight

<https://www.cell.com/c/the-biology-of-spaceflight>



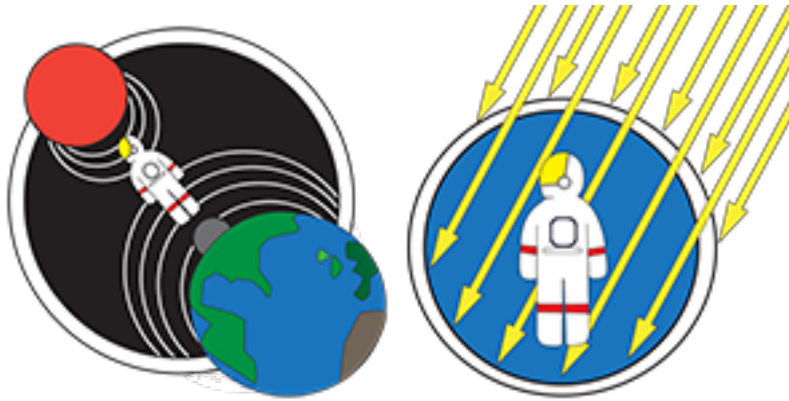
WHAT ARE THE STRESSORS OF SPACEFLIGHT?

Launch/landing (hypergravity >1g),

Flight (microgravity 0g),

Lunar (0.166g) and Mars (0.38g)

Altered Gravity Fields



Ionizing Radiation

Galactic cosmic rays (GCR)

Solar particle events (SPE)

Gamma Rays

X-rays

Behavioral

Physiological

Isolation



Moon and Mars adaptation

CO₂ elevation

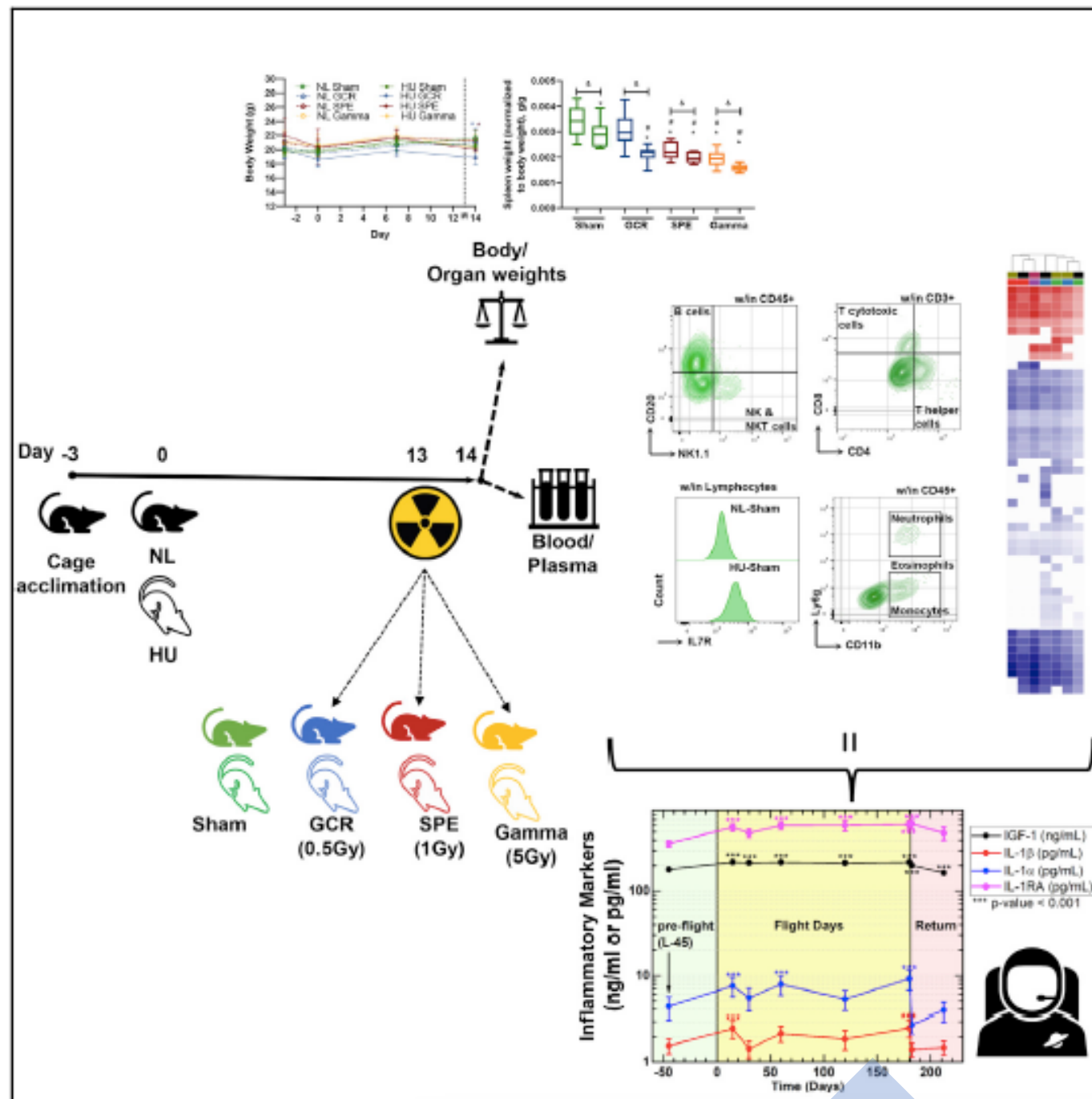
Enclosed/Hostile Environments



Distance

Pharmaceuticals for long durations,

Emergency medicine



IONIZING RADIATION

Ionizing radiation: Is an form of energy (i.e alpha/beta/gamma) that is released from unstable atoms during disintegration (radioactive decay).

Effects: Removes electrons from atoms creating ions → damages cells

Cosmic Radiation: gamma and X-rays (photons), galactic cosmic rays (GCR), and solar particle events (SPE) (primarily high energy charged particles, alpha/beta particles) that originate from the sun, stars, and supernovas.

On Earth (US): generally protected from comic radiation (magnetosphere) = 0.33mSv/yr; rad worker = 50mSv/yr

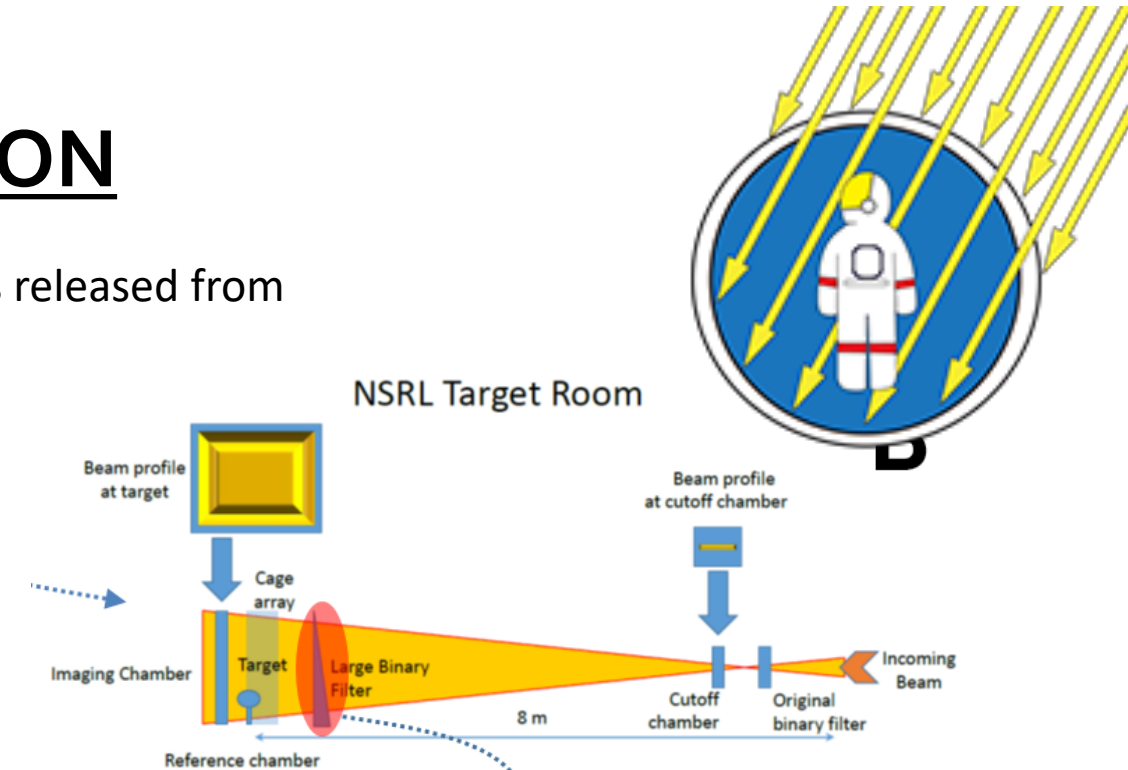
On ISS: 100-200 mSv/yr

Predicted on deep spaceflight: ~350mSv/yr

(Afshinneko et al., 2020)

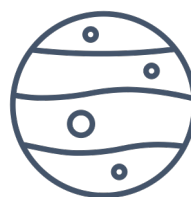
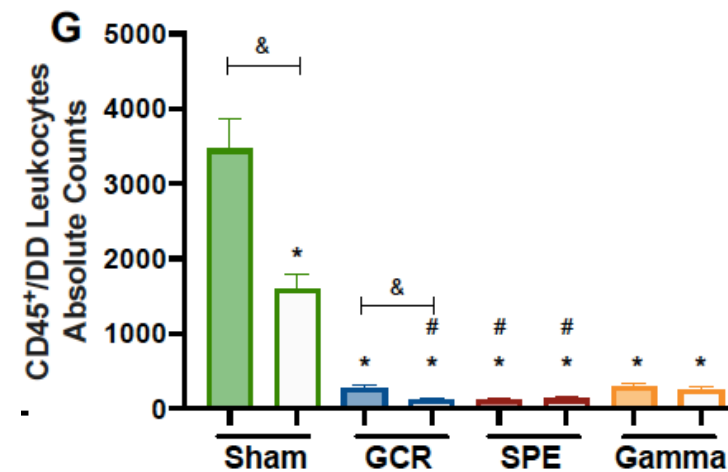
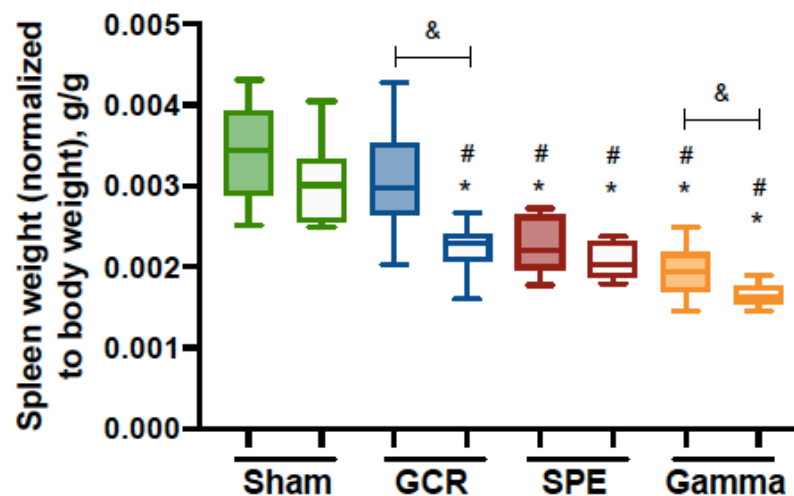
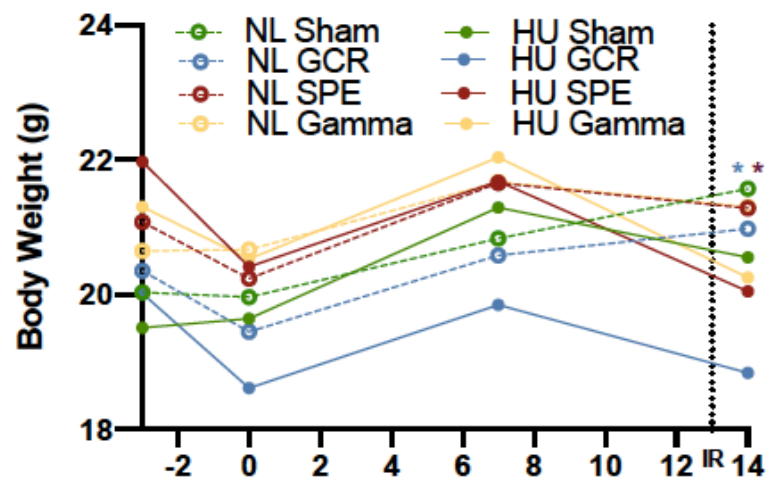


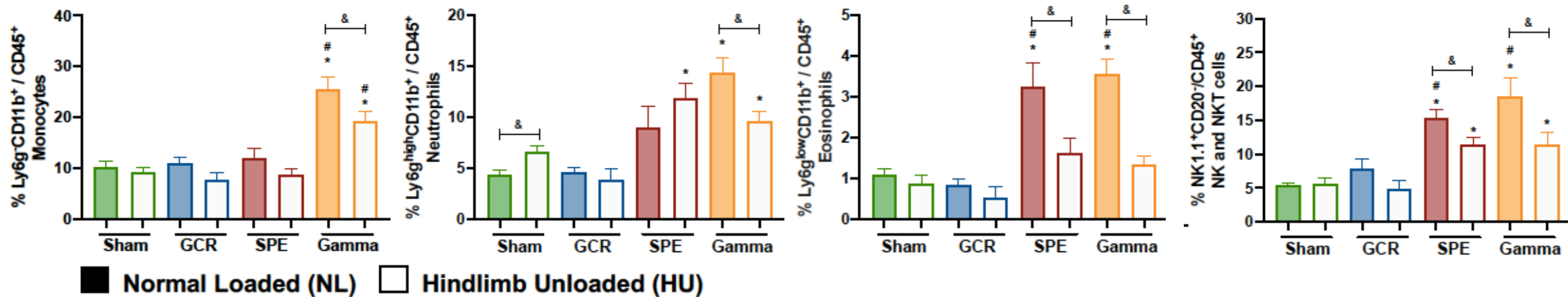
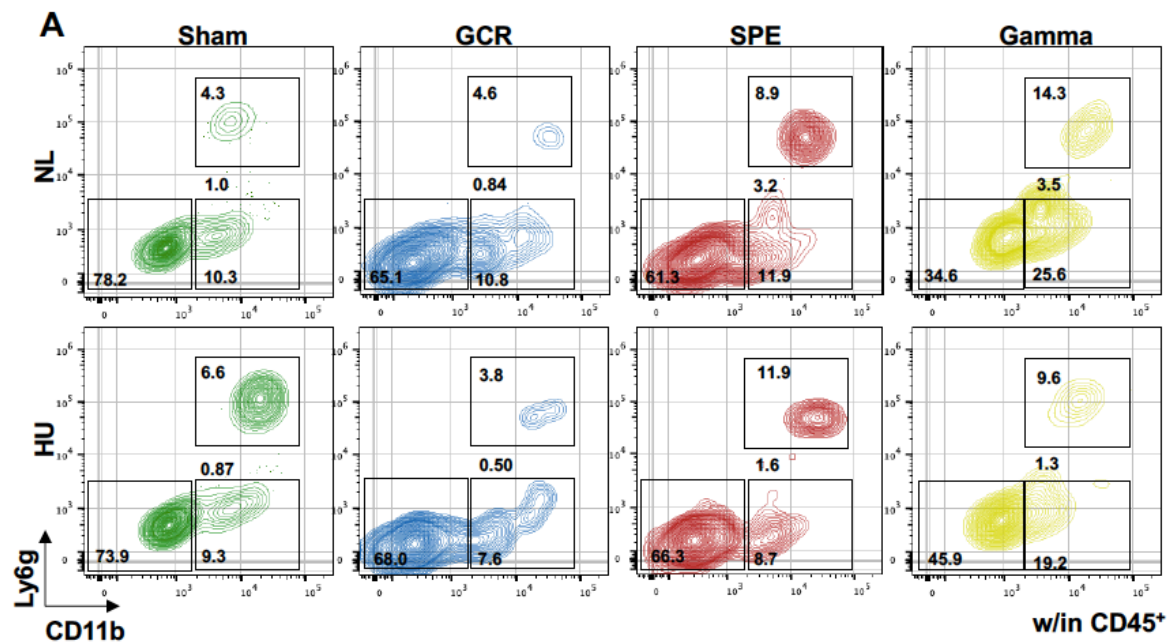
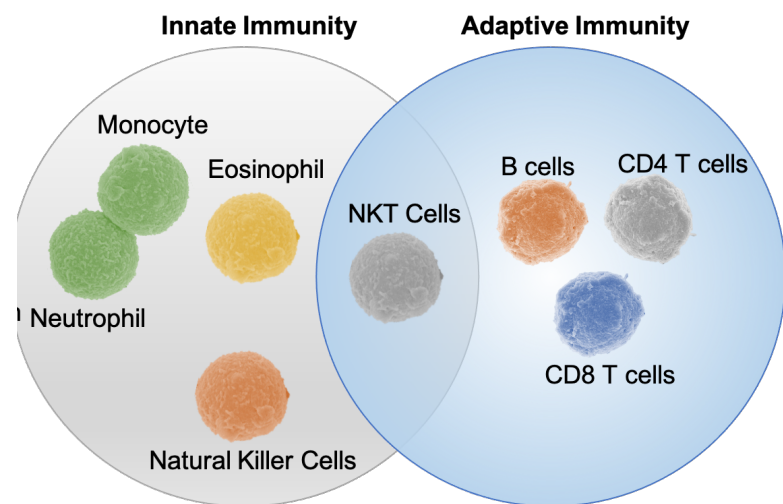
Gamma irradiators

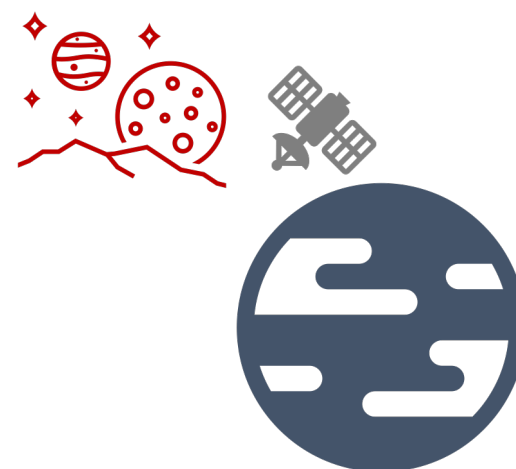
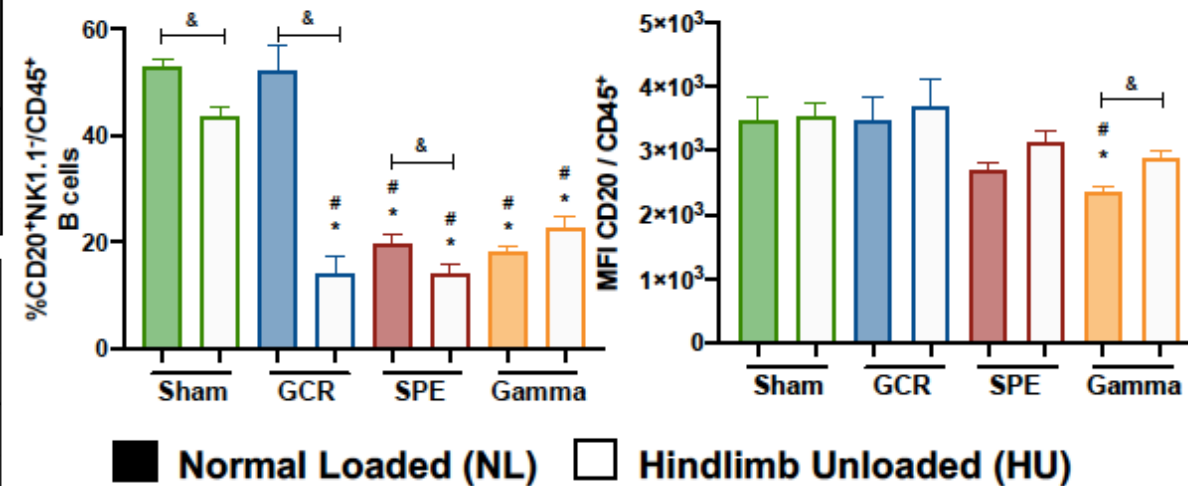
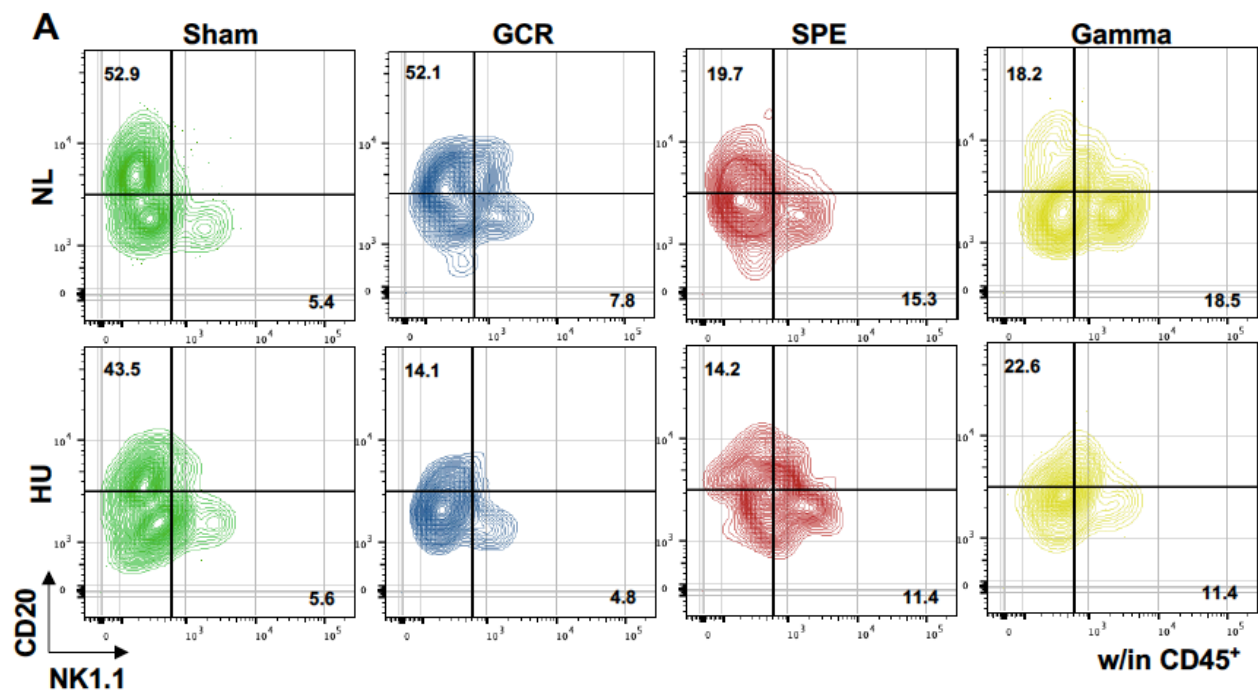


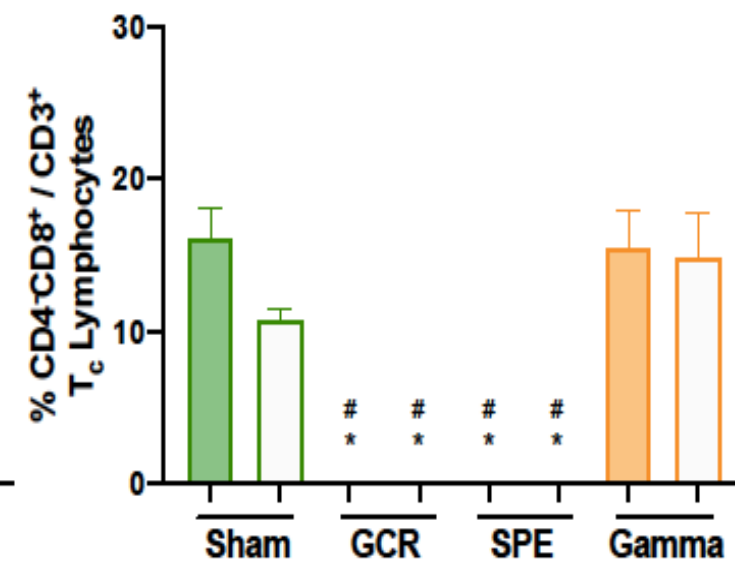
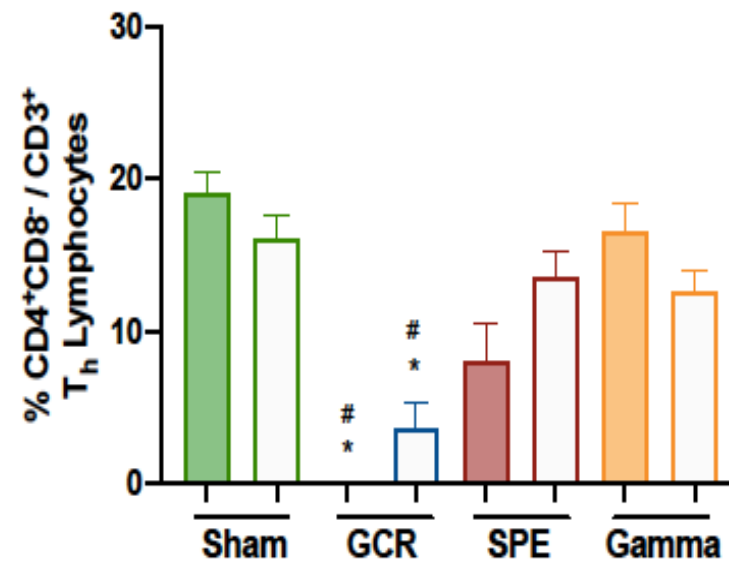
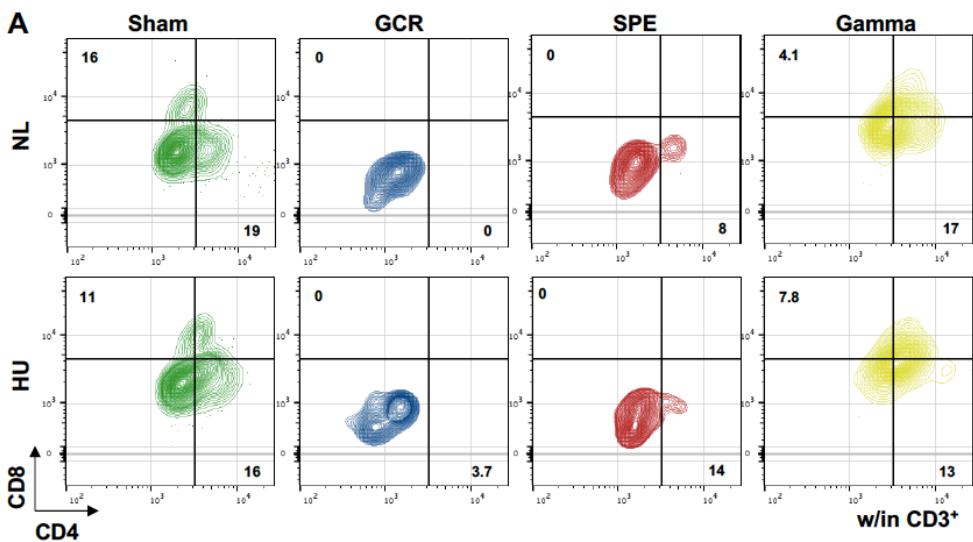
GCR and SPE
NSRL – BNL

■ Normal Loaded (NL) □ Hindlimb Unloaded (HU)

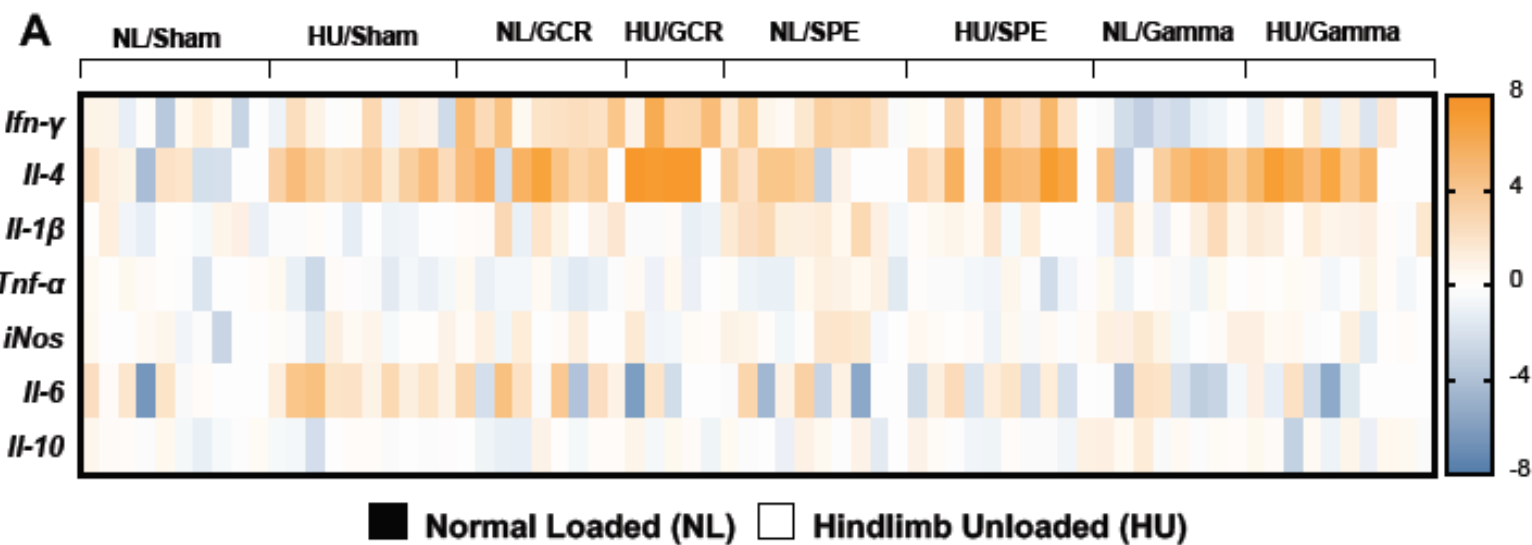
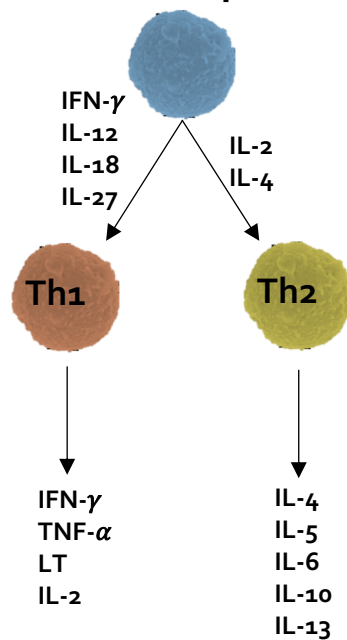








Naïve CD4 T cell



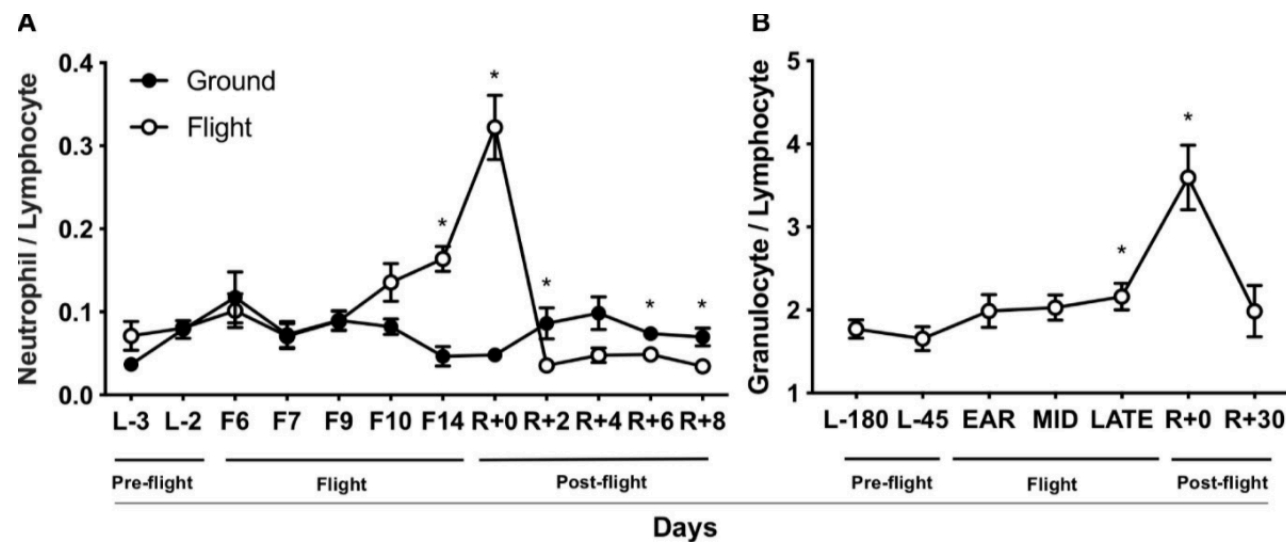
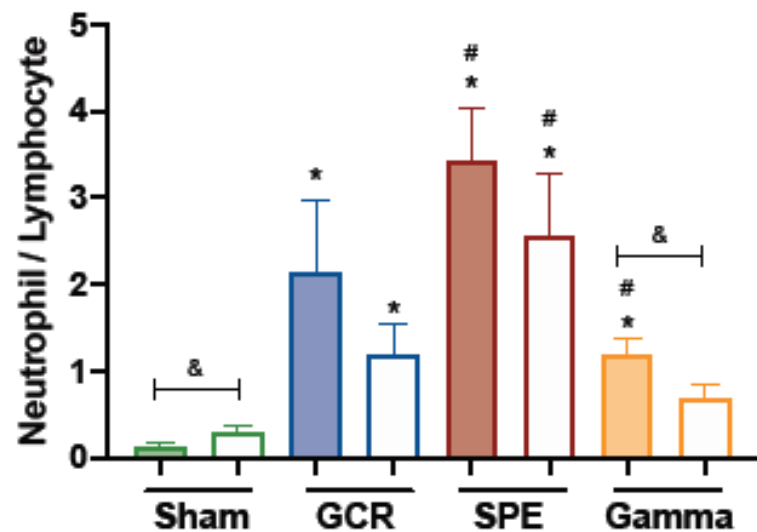
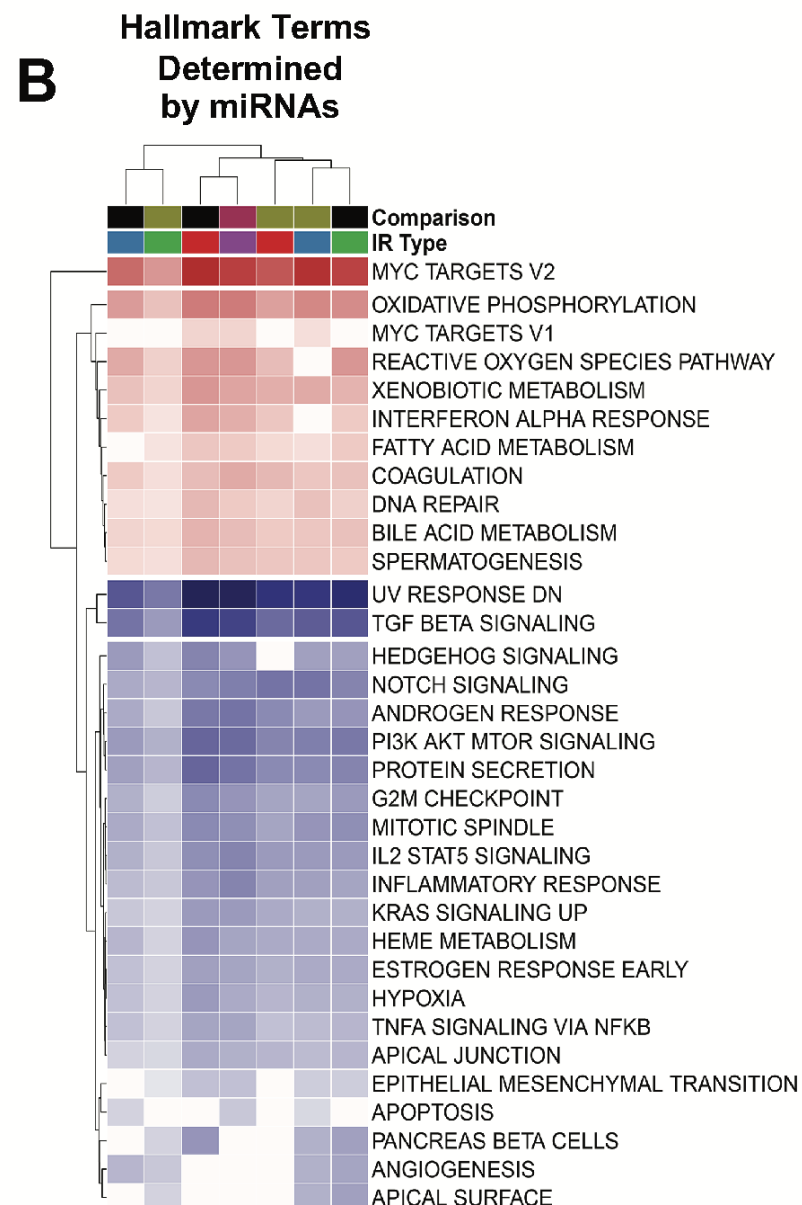
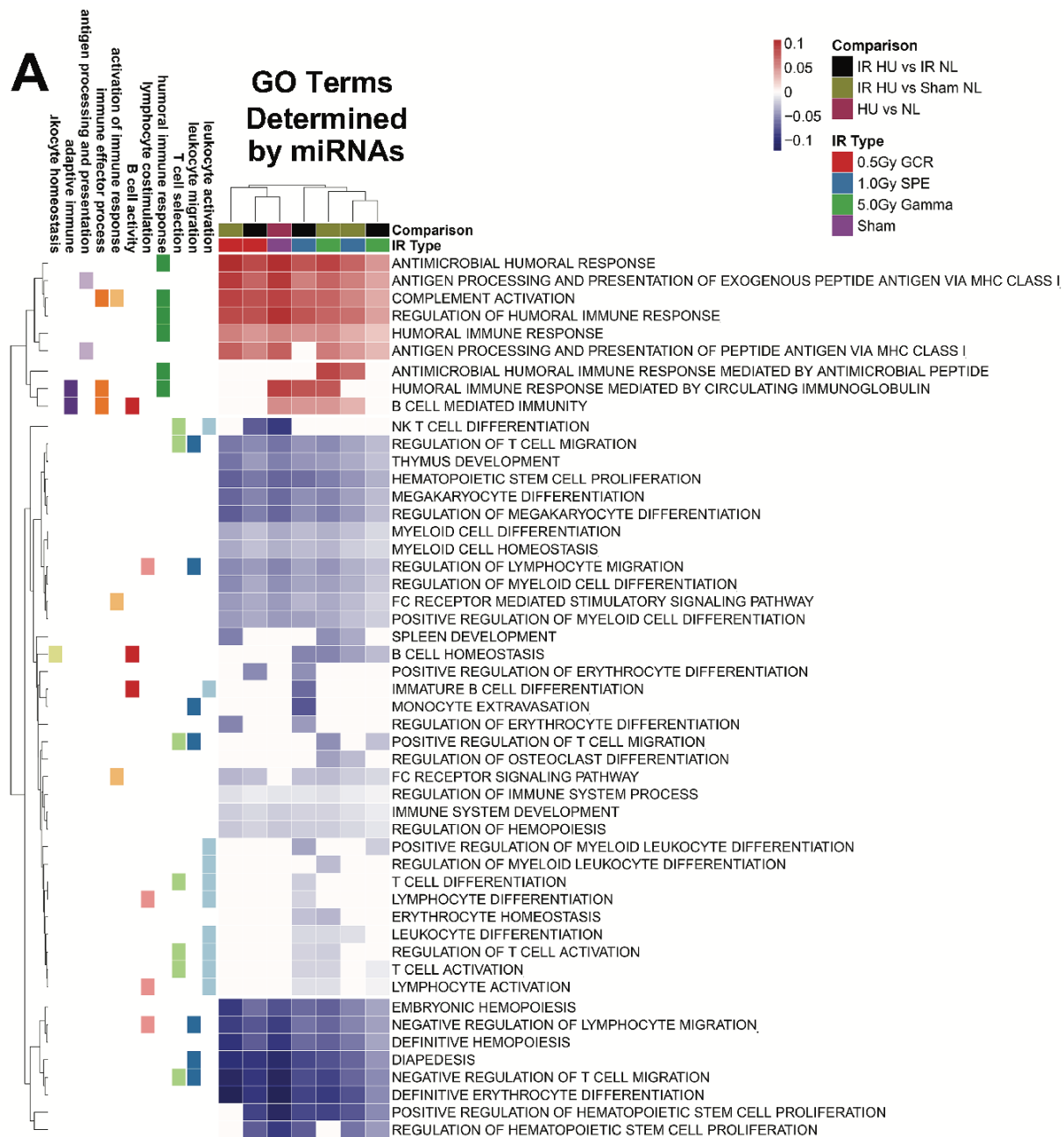
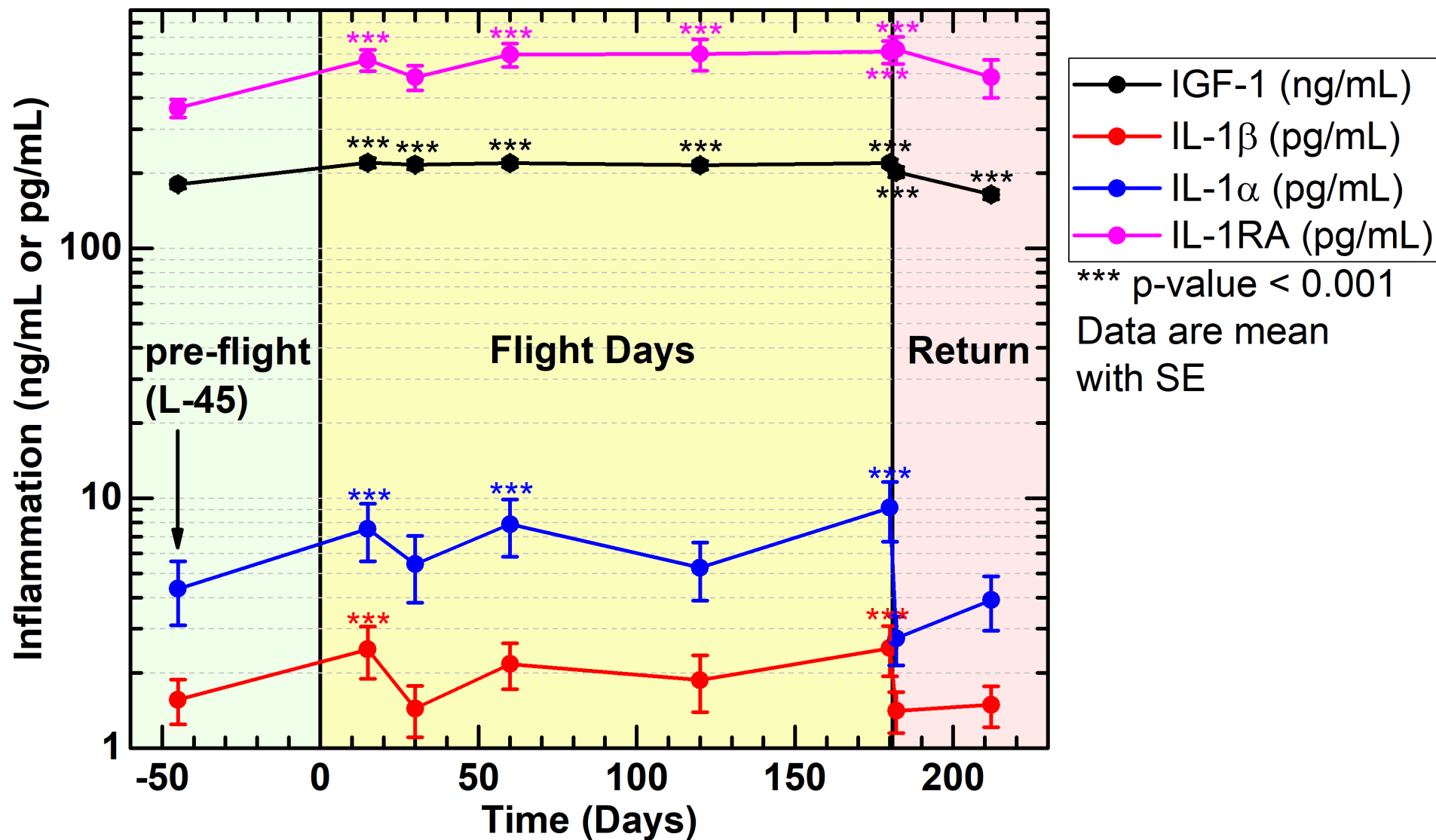


Image credit: Paul et al., 2020

■ Normal Loaded (NL) □ Hindlimb Unloaded (HU)



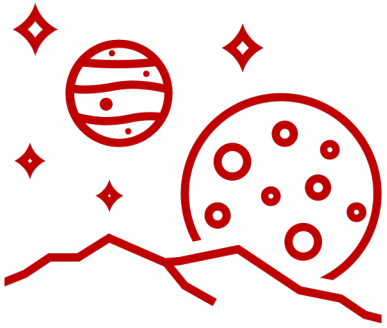




n = 59 crewmembers; 47 males, 12 females

Summary

Distinct immunoprofiles with each experimental condition



- HU alone induced inflammatory markers (i.e. elevated neutrophils, NLR, and IL-6)
- Astronauts experience mild inflammation in LEO (i.e. increased IL-1 family and GLR)

Simulated deep spaceflight resulted in:



- Minimal differences in innate immunity
- Reduced leukocytes (B, Tc, and Th lymphocytes) → contributes to impaired immune memory and function
- Preference for a Th₂ immune response → allergic-like immune responses → Astronauts experience rashes and allergies in LEO (Dunn et al., 2018 and Voorhies et al., 2019)

Left to right: Dr. Elizabeth Blaber, Margareth Cheng-Campbell, Dr. Amber Paul and Dr. Afshin Beheshti

Acknowledgements



Dr. Brian Crucian



Dr. Scott Smith



Dr. Sara Zwart



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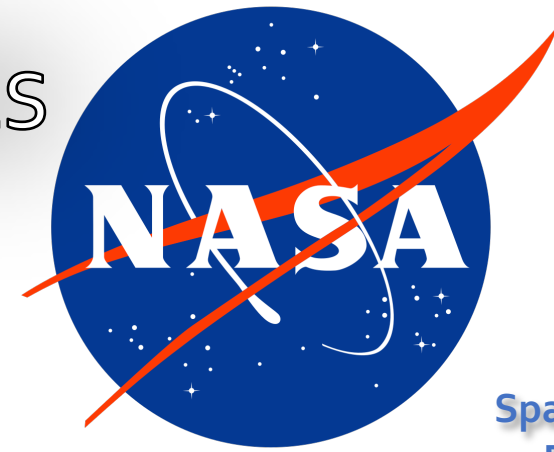
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Dr. Sulekha Anand



Dr. Robert Meller



NASA
Space Biology
Program



NASA Life
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NASA
Space Radiation
Laboratory (NSRL)



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