Space Medicine Introduction

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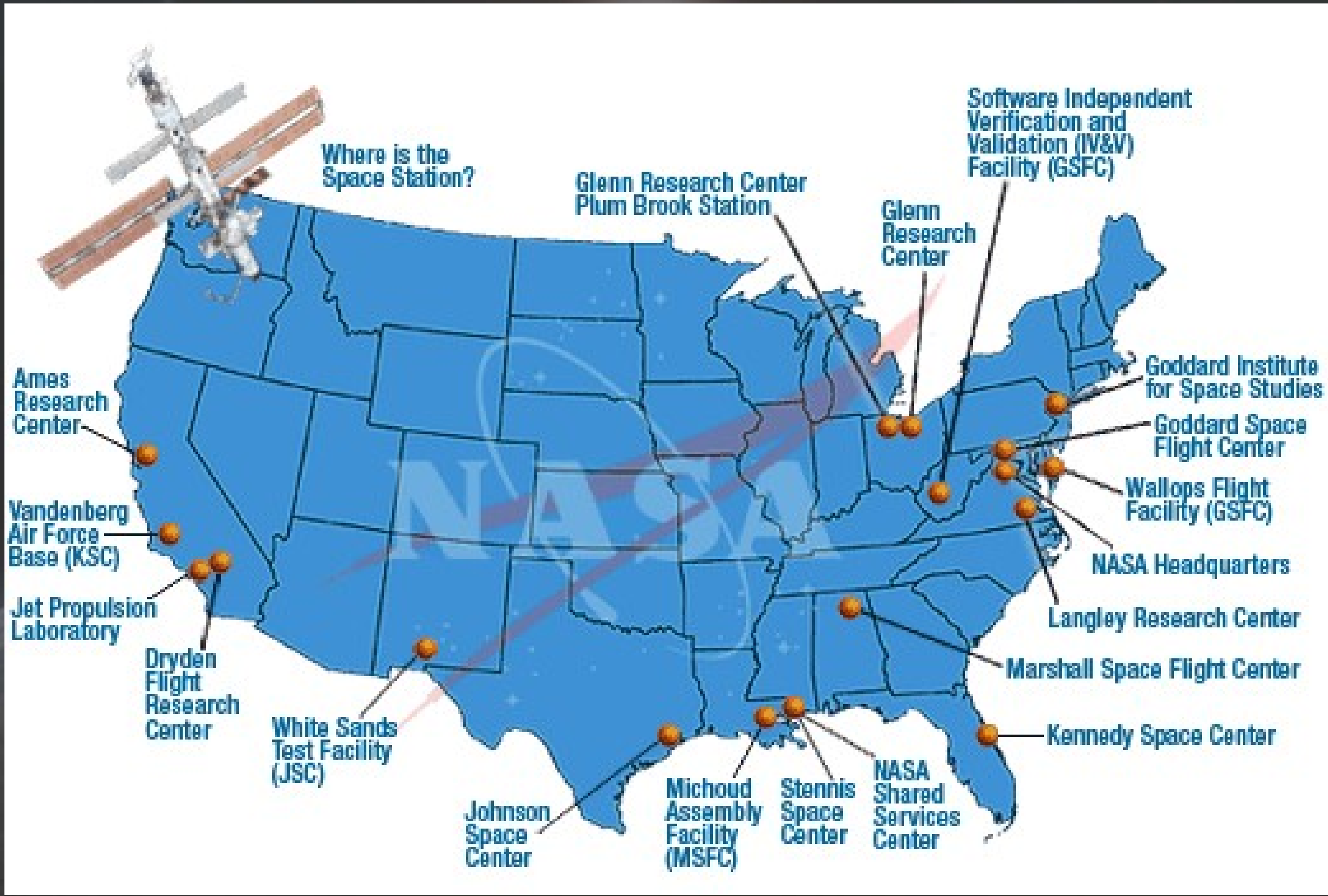
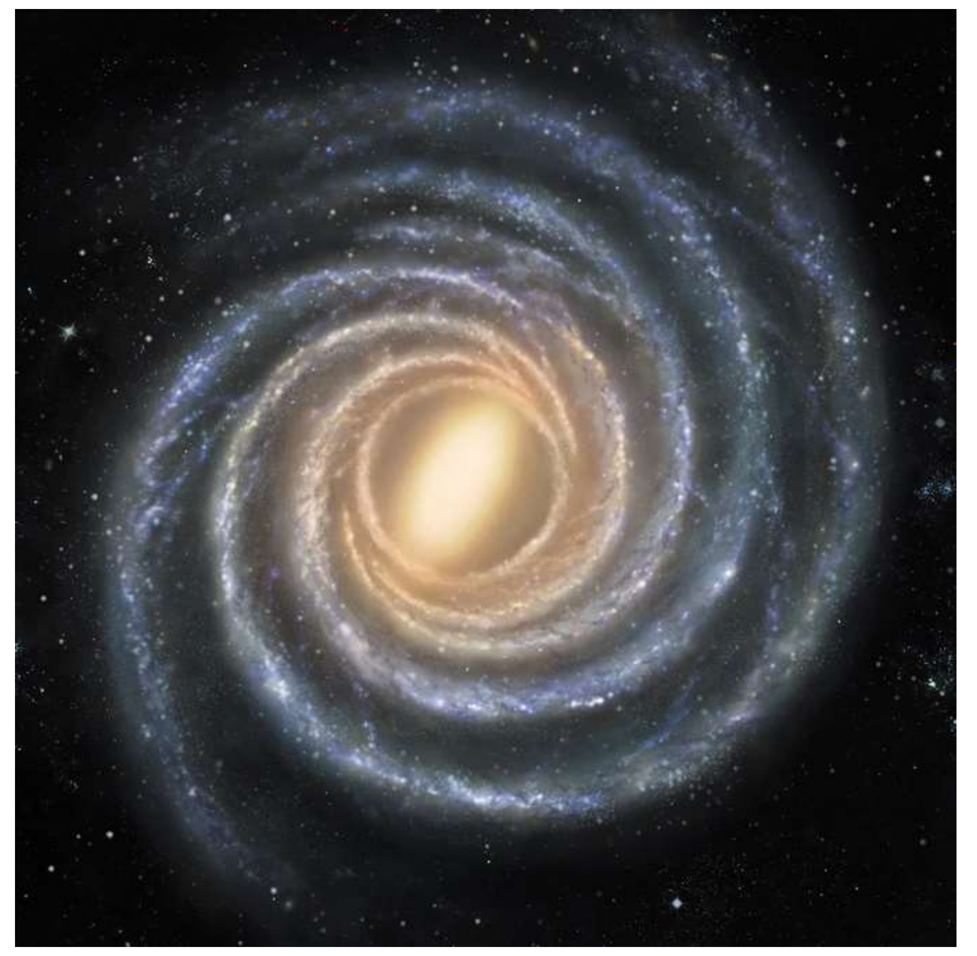
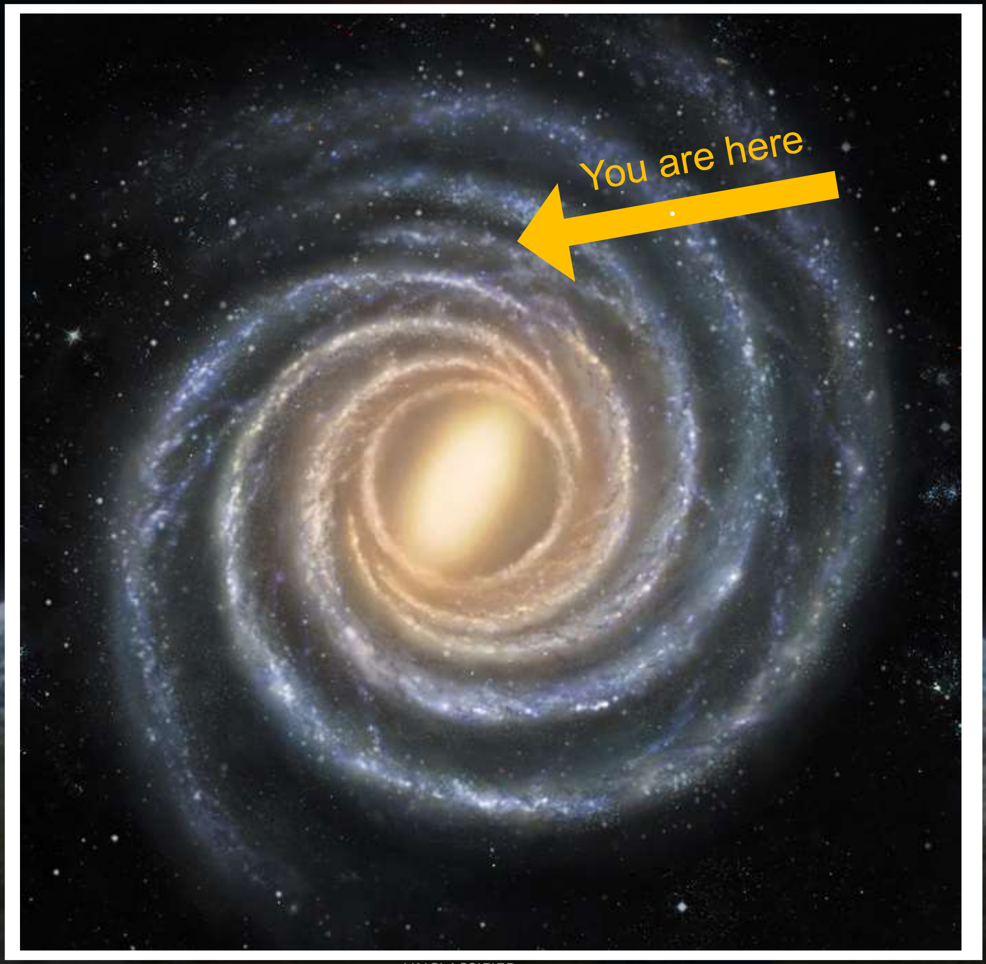


Why Should Physicians Care About Space?

Why Should Air Force Flight Surgeons Care About Space?

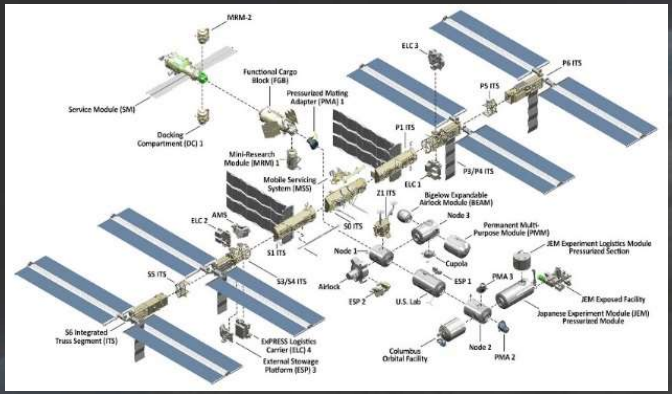


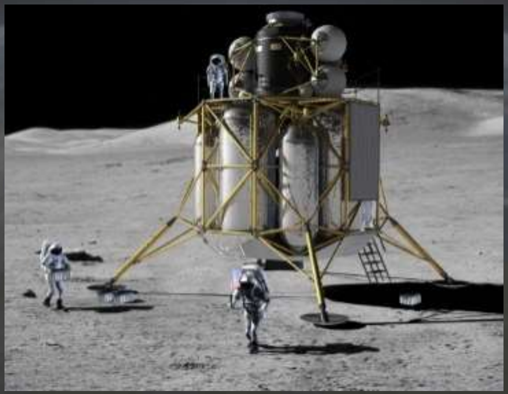
Why Should Air Force Flight Surgeons Care About Space?

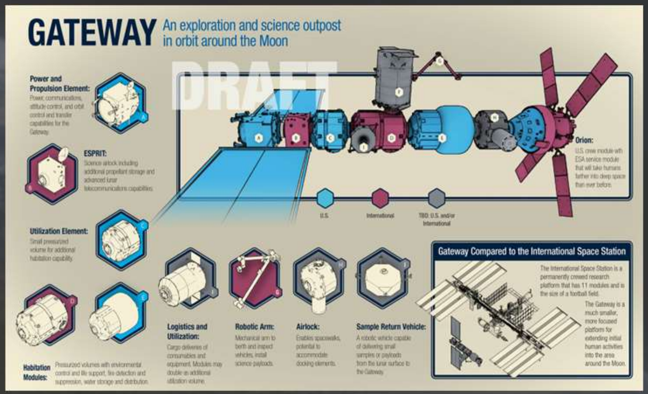


Return to the Moon

What is new and different in Space Medicine?



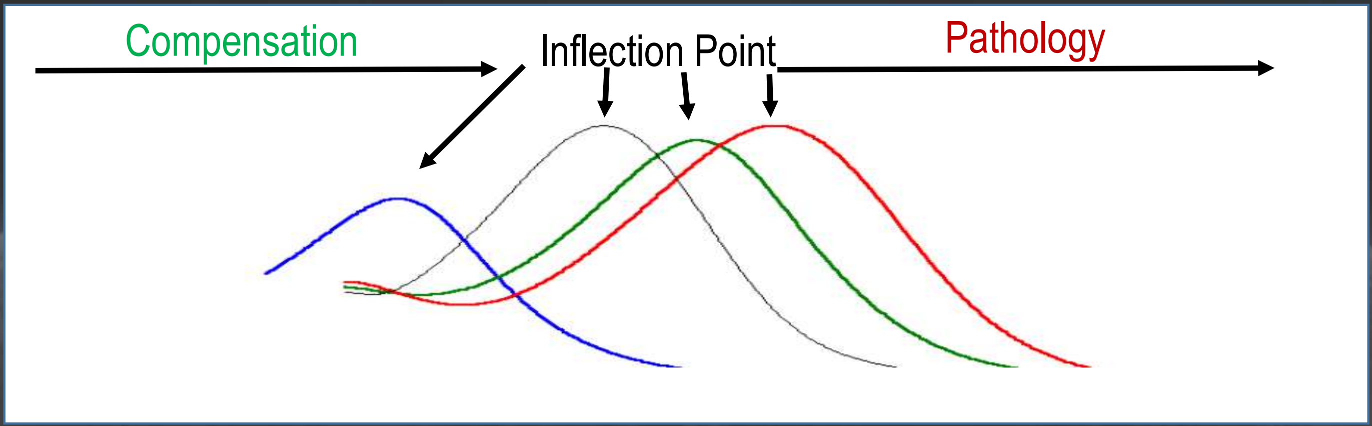




Write This Down

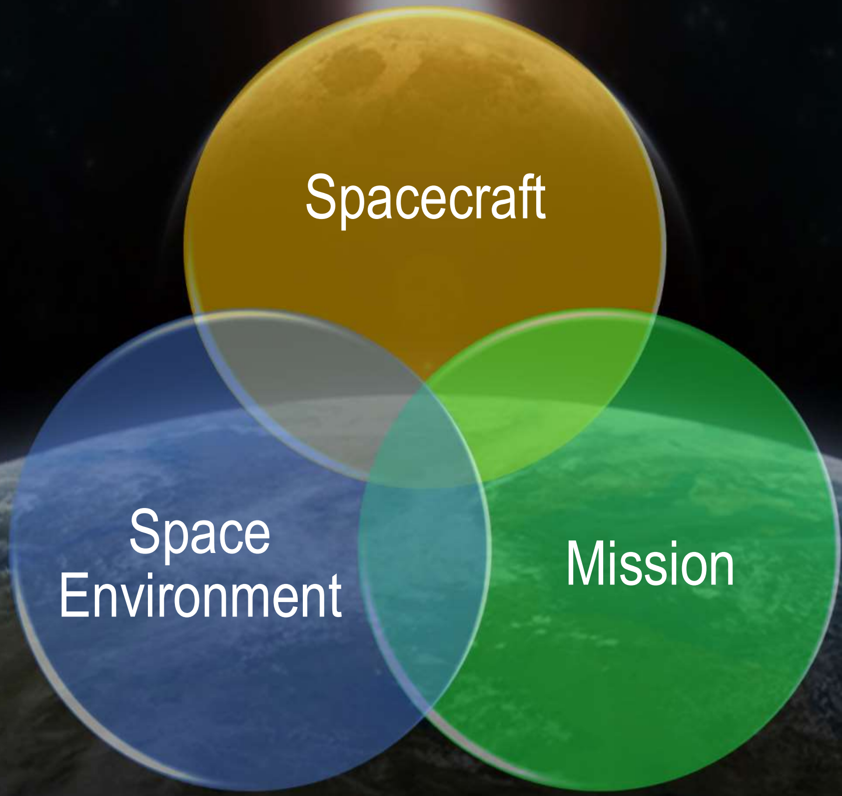
Homeostasis

The human body will *always* try to reach homeostasis with its environment, including microgravity

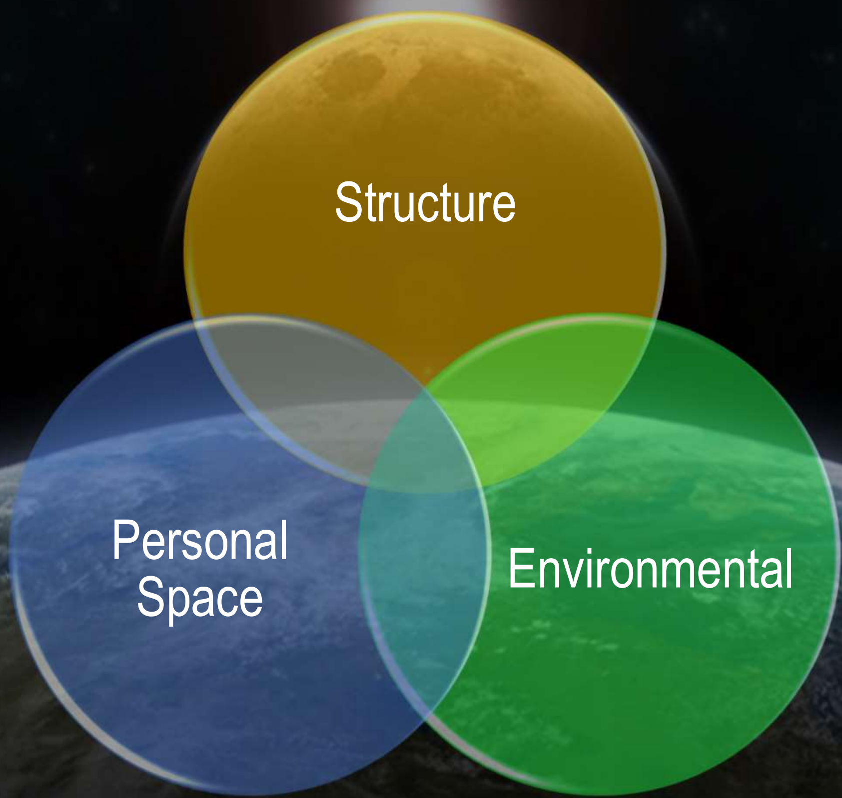


What do NASA Flight Surgeons do?

Hazards of Spaceflight



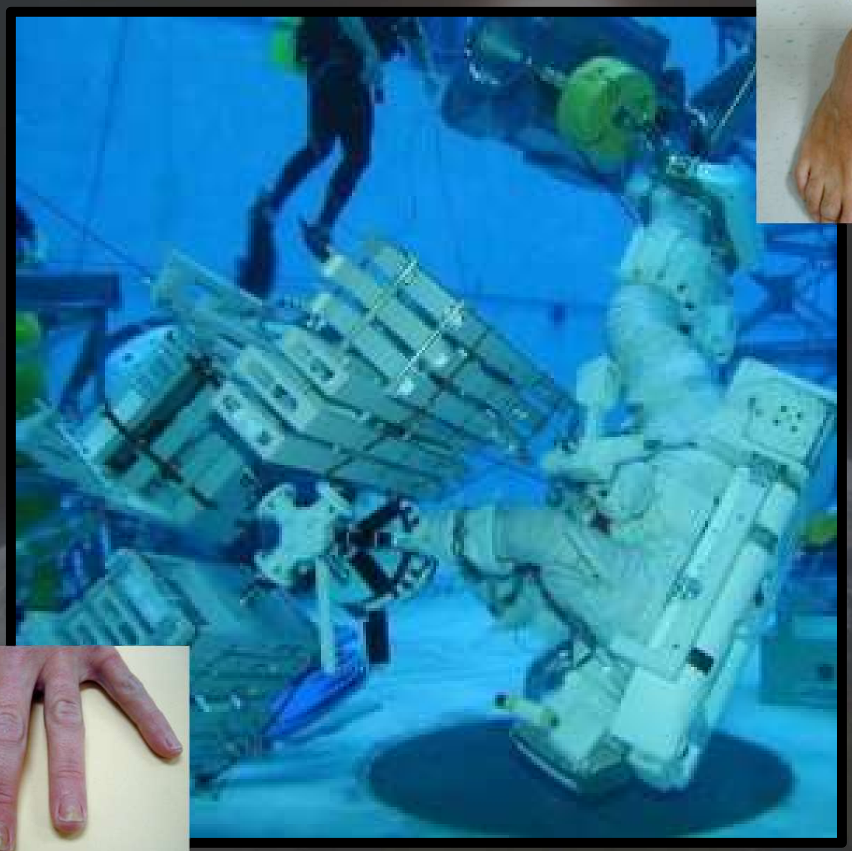
Hazards of Spacecraft



Spacecraft

Structure

- Training



Spacecraft

Structure

- Launch

Spacecraft

Structure and Personal Space

Spacecraft

Environmental

- Exposures
- Habitability

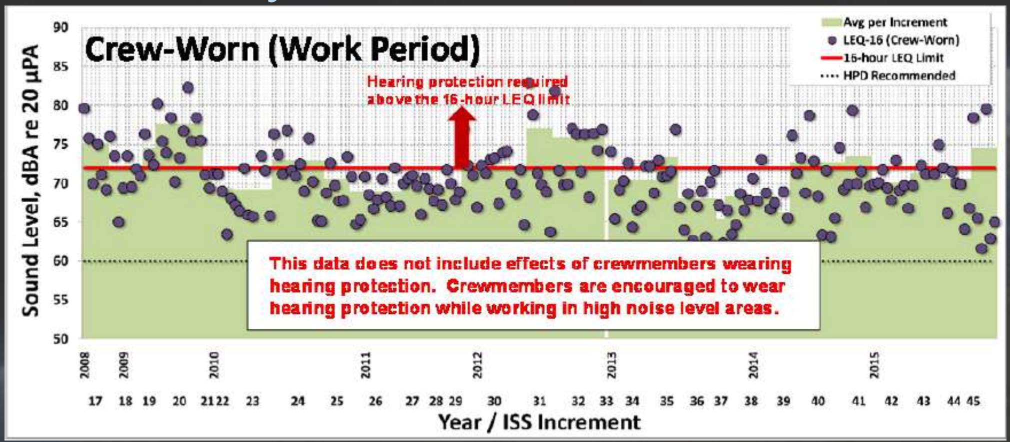
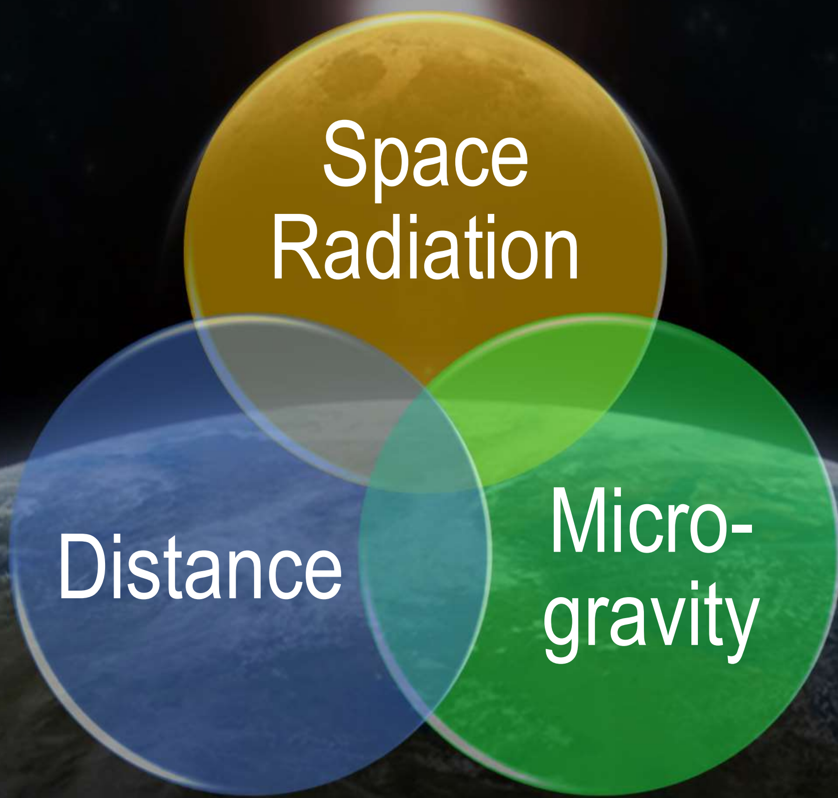


Figure 3. Bacterial Colonies (smooth)

Figure 4. Fungal Colonies (fuzzy)

Hazards of Environment

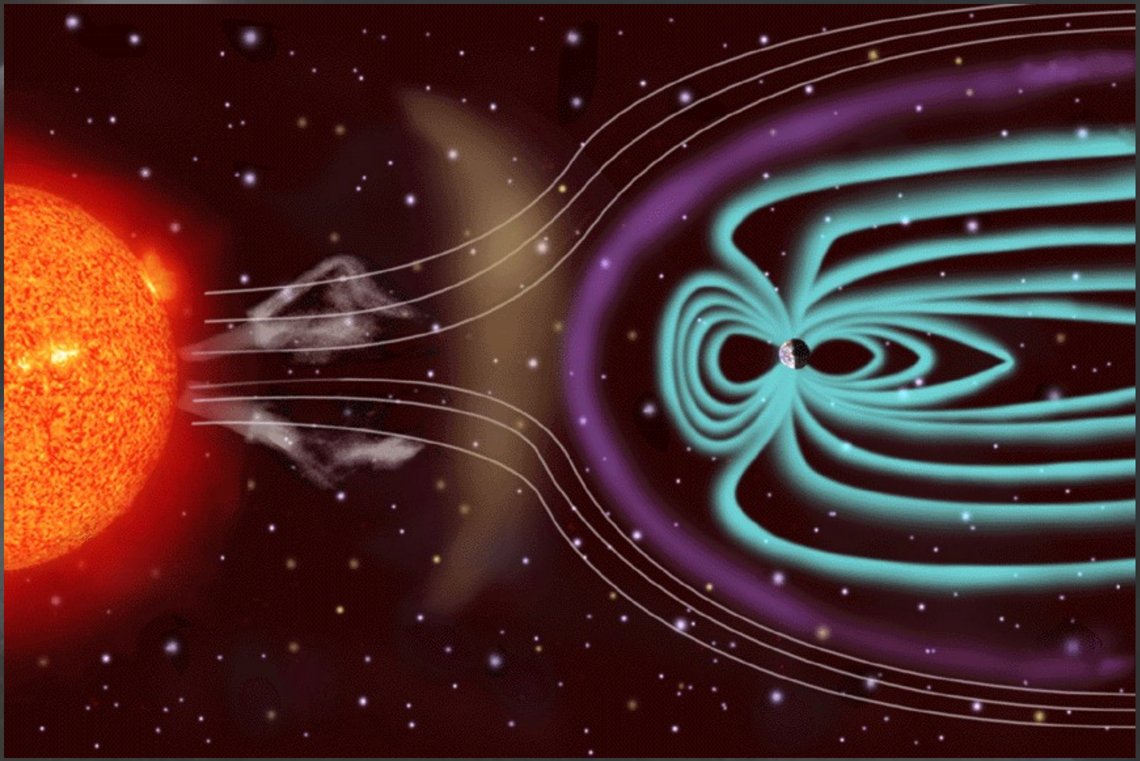


Space Environment

Space Radiation

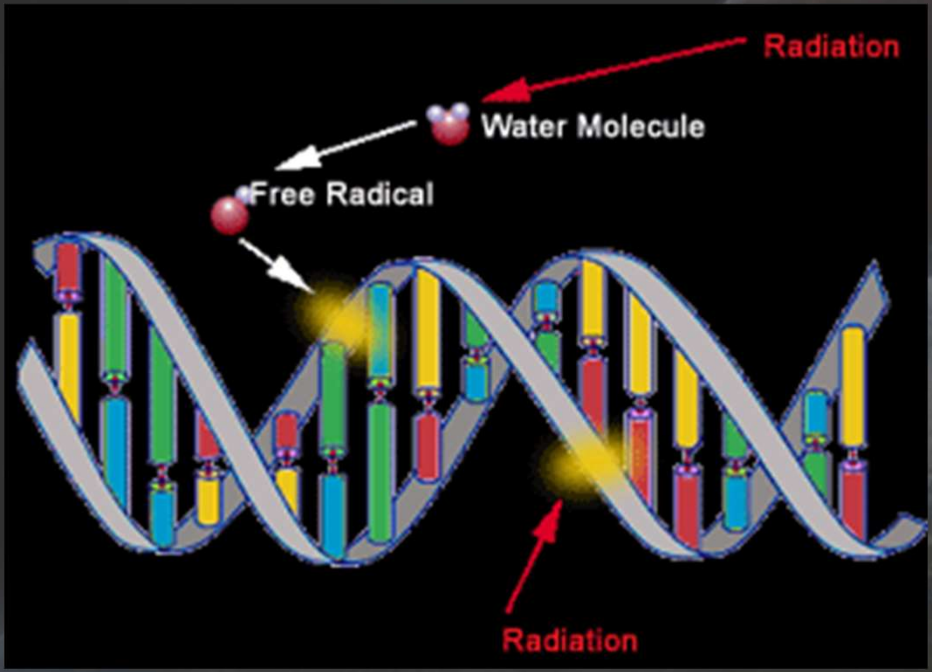
- Three main sources
  - Galactic cosmic radiation (GCR)

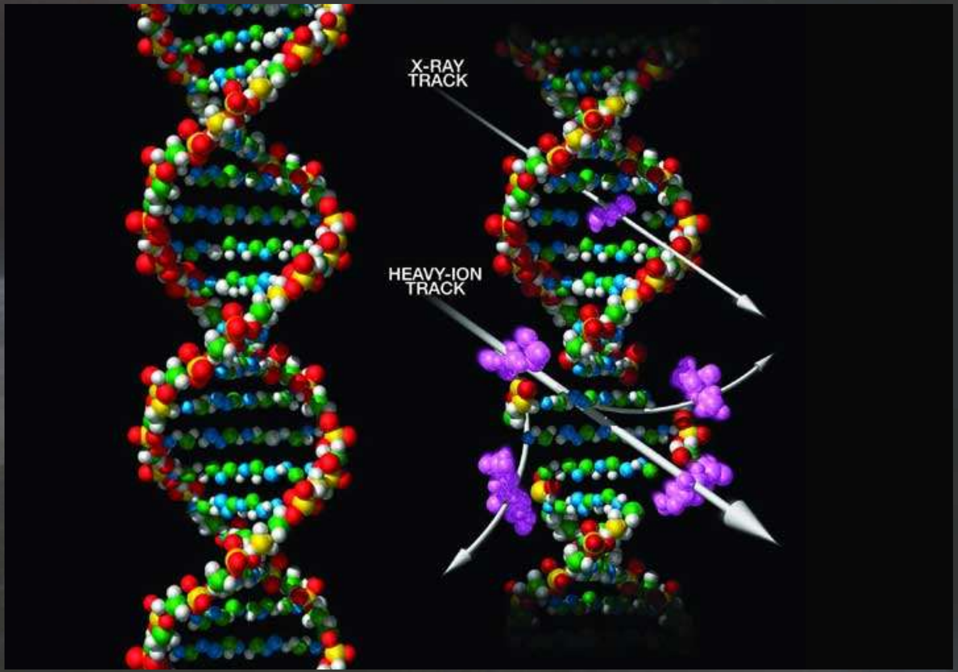
    biggest threat to deep space missions
  - Trapped Radiation
  - Solar particle events (SPE)



Space Environment

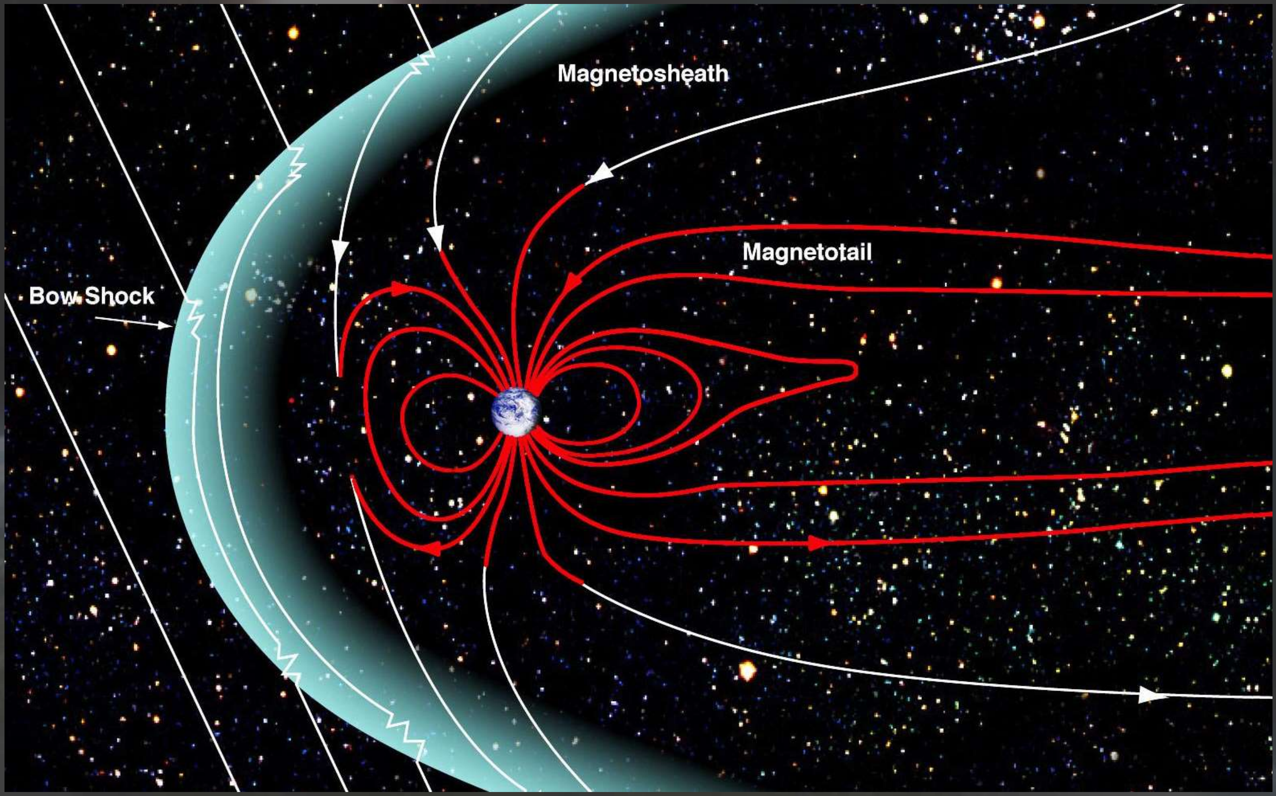
Space Radiation Mechanisms of Damage





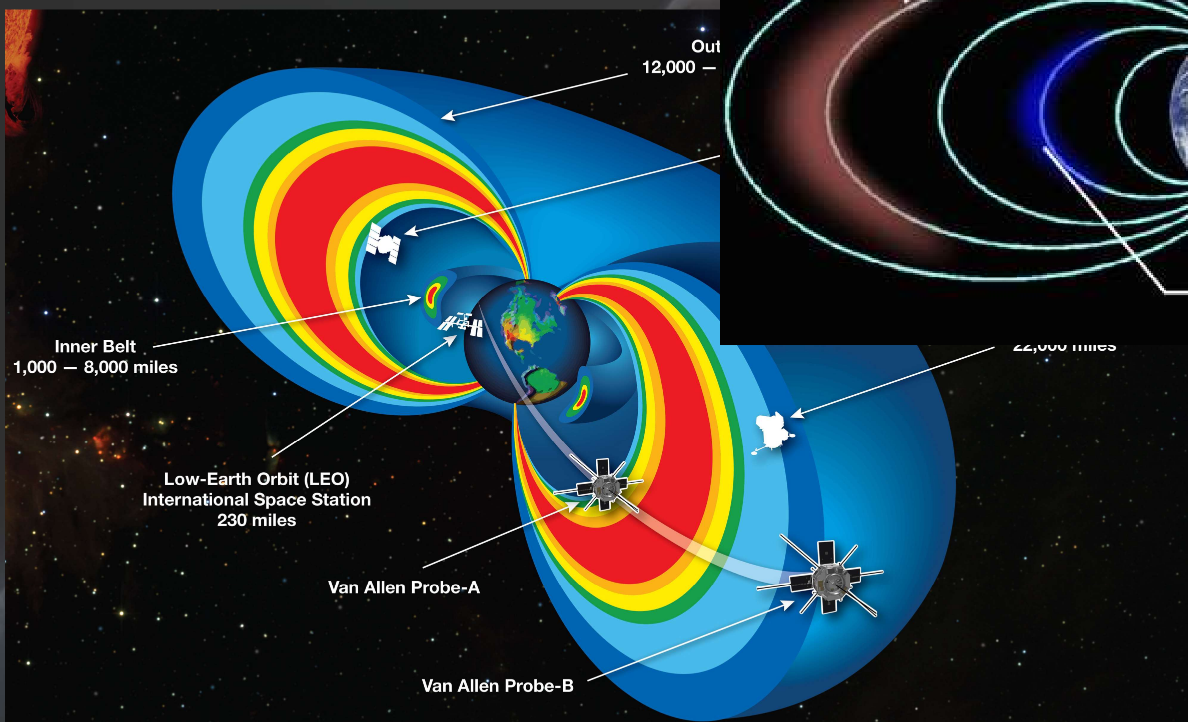
Space Environment

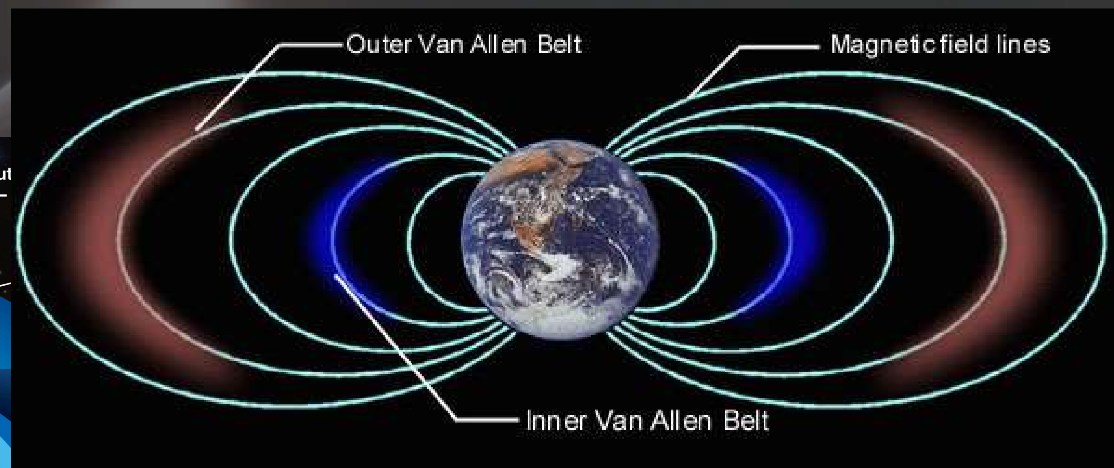
Magnetosphere



Space Environment

Van Allen Belts





Space Environment

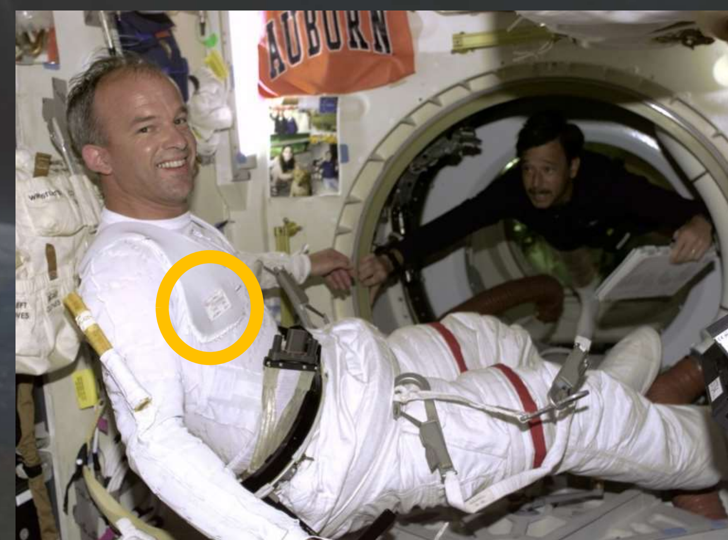
Radiation Exposure Career Limits – 600 mSv (60 rem)

	Typical Dose (rem)
Round-trip NY to London / Chest x-ray (1 film)	0.01
Natural background radiation per year	0.3
CT scan	3-10
Typical mission dose on ISS	**10-15**
Estimated dose for 3-yr Mars mission	100-150
Atomic bomb survivors	Up to 400
Human LD_{50}, no medical intervention	350-550
Human LD_{50}, with medical intervention	500-1000

Space Environment

Protection from Radiation

- **Time, Distance, Shielding**

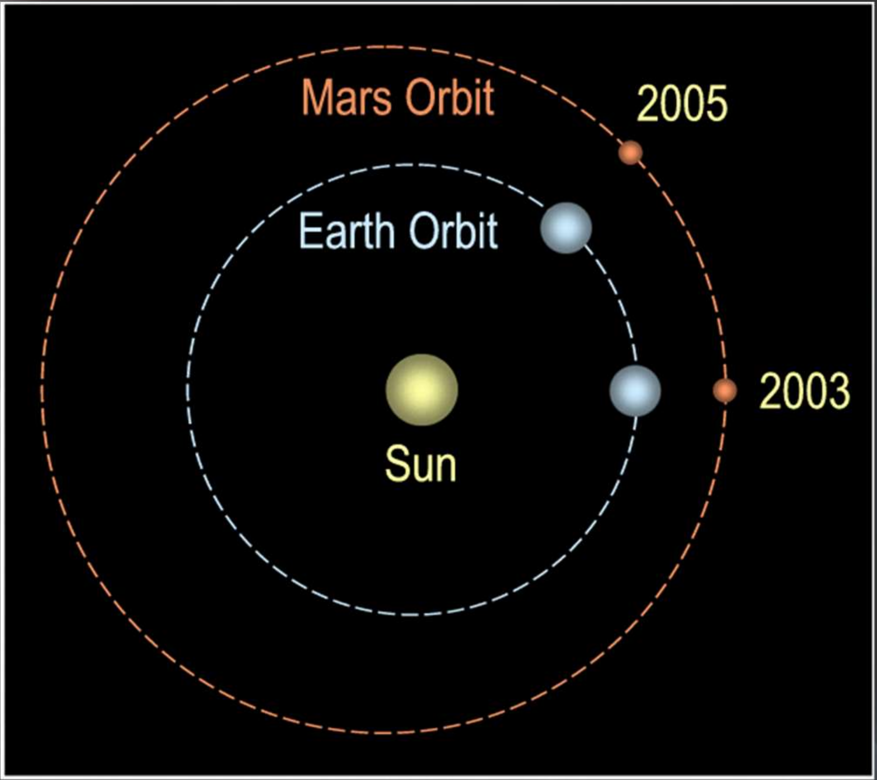


Space Environment

Distance

- Distance to the Moon ~ 238,854 miles
- Average distance to Mars ~ 142 million miles

  (range 56 - 401 million miles)



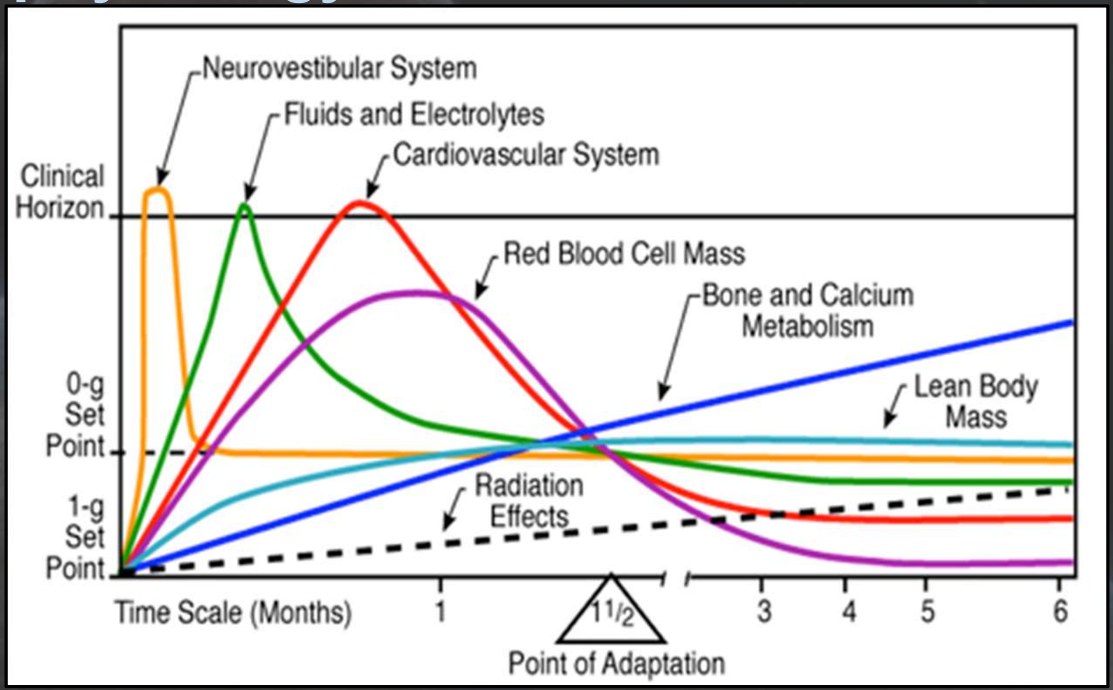
Space Environment

Microgravity

Space Environment

Microgravity - **Normal physiology, *abnormal* environment**

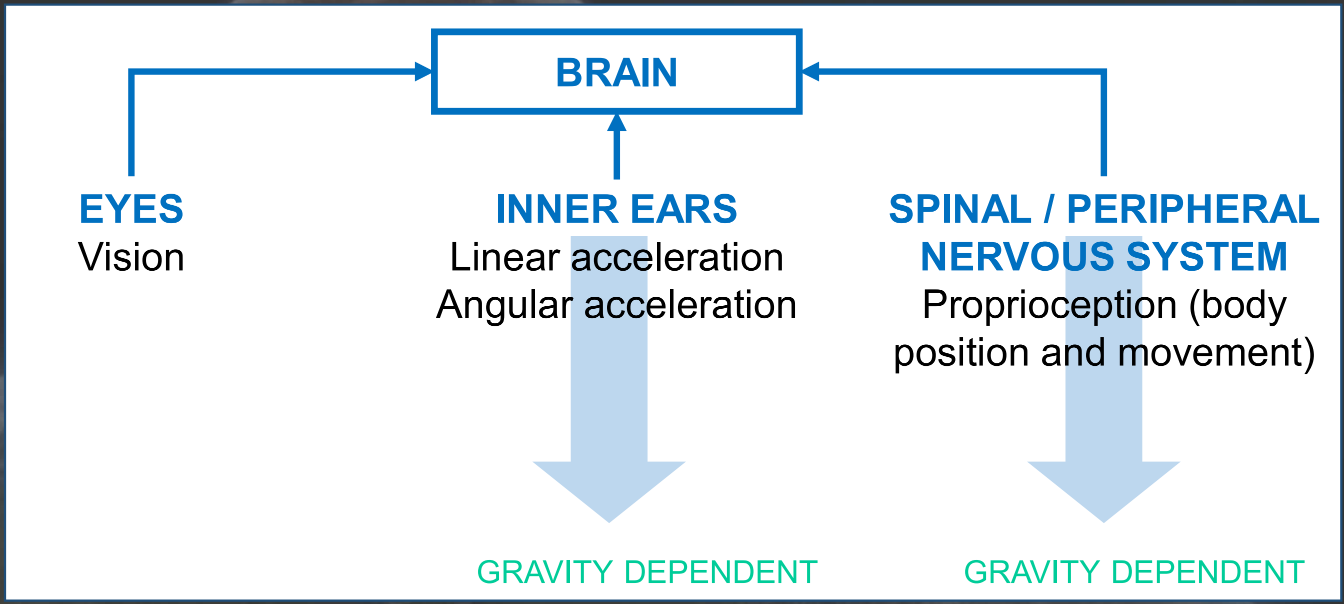
- Neurovestibular
- Cardiovascular
- Musculoskeletal
- SANS
- CO_2



Space Environment

Microgravity

- Neurovestibular



Space Environment

Space Motion Sickness

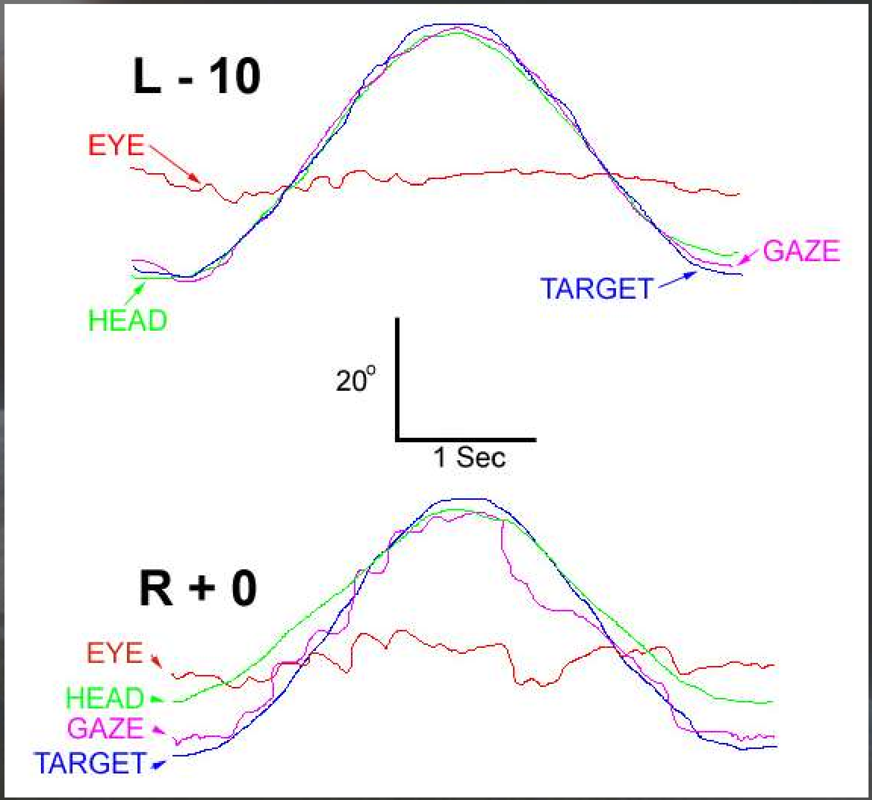
79%

Treatments?

Space Environment

Microgravity

- Neurovestibular



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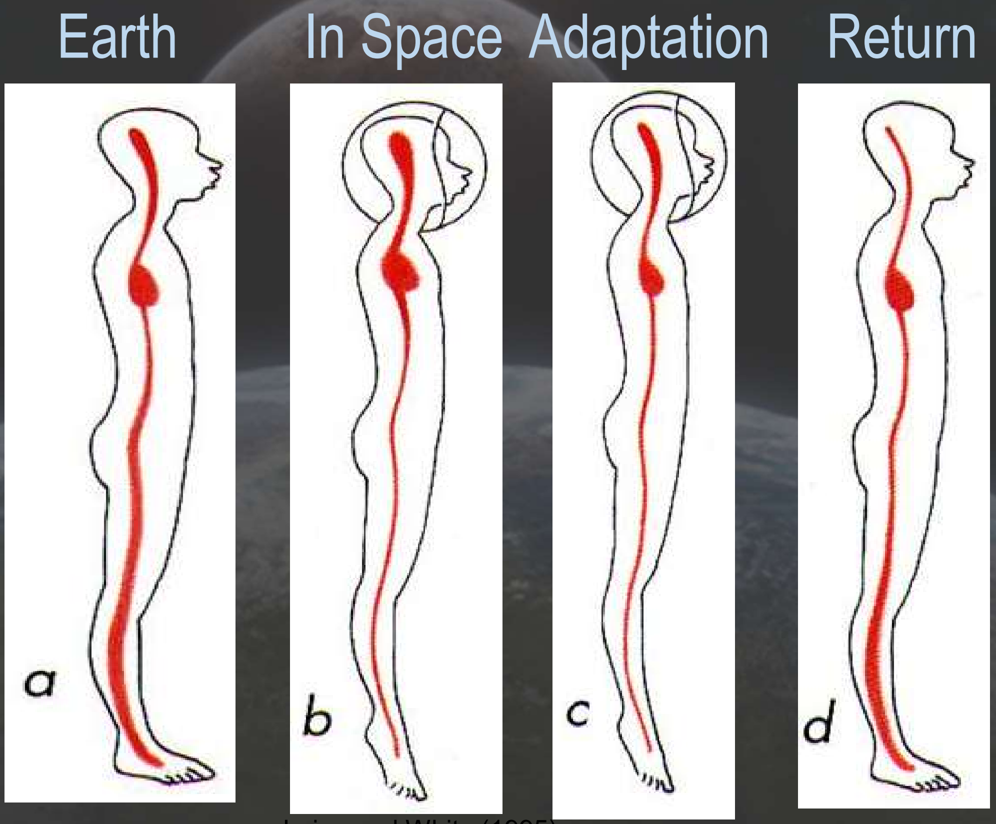
Space Environment

Microgravity

- Cardiovascular



Lujan and White (1995)

Space Environment

Microgravity

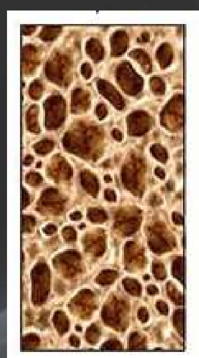
- Cardiovascular

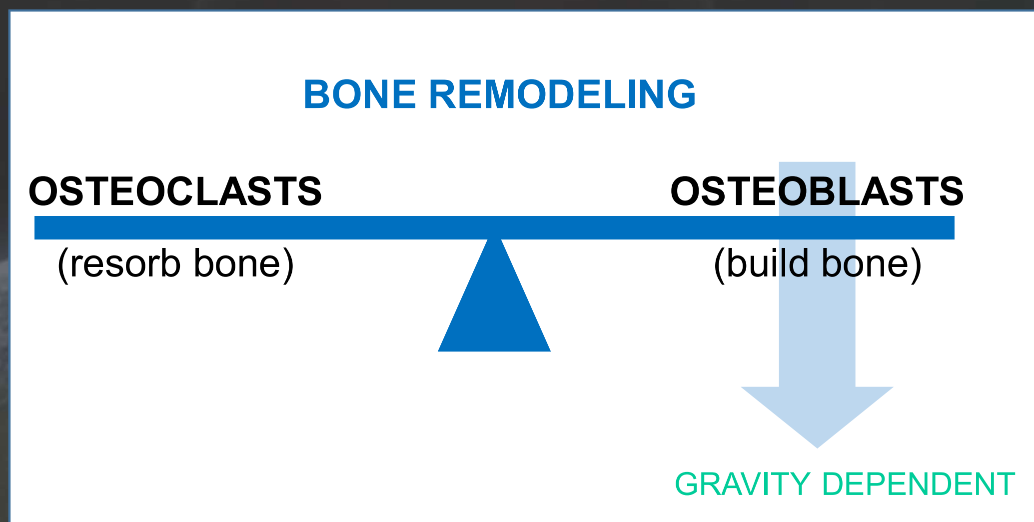
Lujan and White (1995)

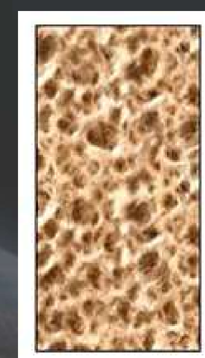
Space Environment

Microgravity

- Musculoskeletal





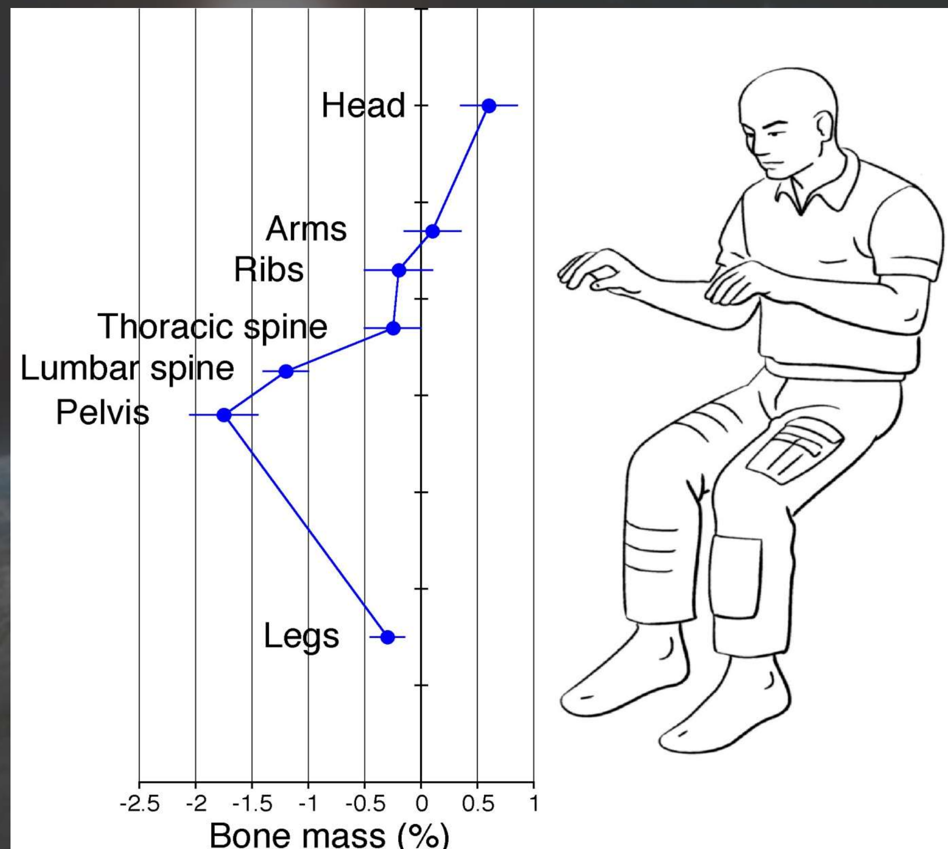


Space Environment

Microgravity

- Musculoskeletal

  Post-flight changes in bone density compared to preflight



Space Environment

In-flight Countermeasures

	T2 (Treadmill 2)	CEVIS (Cycle Ergometer with Vibration Isolation & Stabilization)	ARED (Advanced Resistive Exercise Device)
Neurovestibular	✓		
Cardiovascular	✓	✓	
Musculoskeletal	✓	✓	✓

UNCLASSIFIED

Space Environment

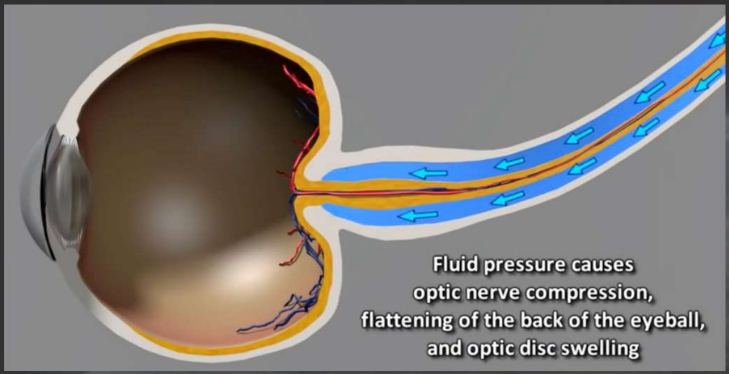
Future In-flight Countermeasures

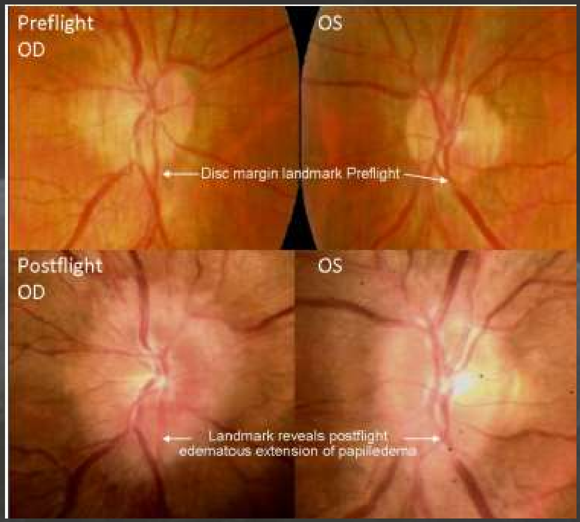
- Size of craft will affect space available for exercise equipment
- Optimal design would allow for multifunctional equipment
- Does this provide sufficient medical benefit?

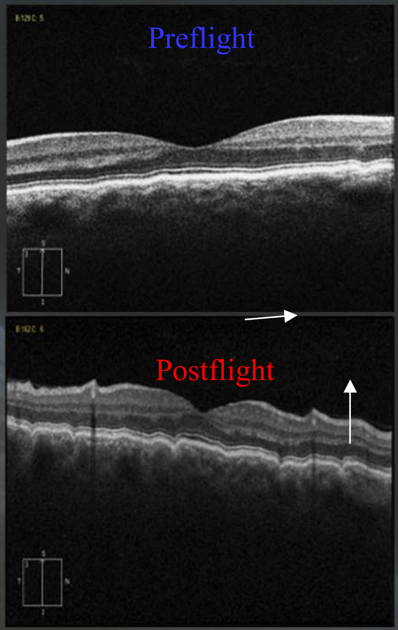
Space Environment

Microgravity

- Spaceflight Associated Neuro-ocular Syndrome (SANS)





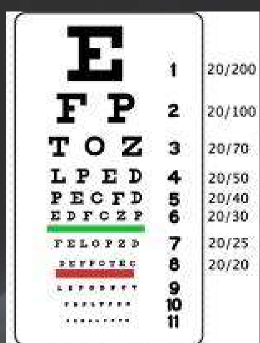


Space Environment

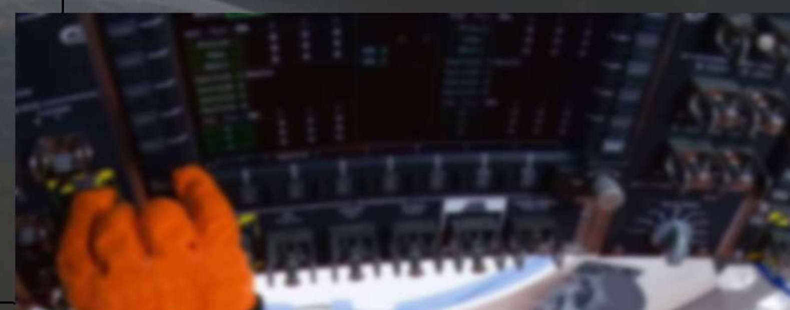
Microgravity

- SANS

  Decreased near visual acuity, distant vision intact



Design and Mission Impacts



Space Environment

Microgravity

- CO_2
  - Terrestrial partial pressure of CO_2: 0.39 mmHg
  - Hardware design based on original ISS Flight Rule limit for CO_2 of 7.6 mmHg
  - Flight Rule limit revised to 5.3 mmHg in 2008
  - Recently limit for 24-hr average was decreased to 3.0 mmHg
  - Current evidence would suggest that an operational limit between 0.5 and 2.0 mmHg

Hazards of Mission

Mission

Limited Resources

- Medical Training and Assets

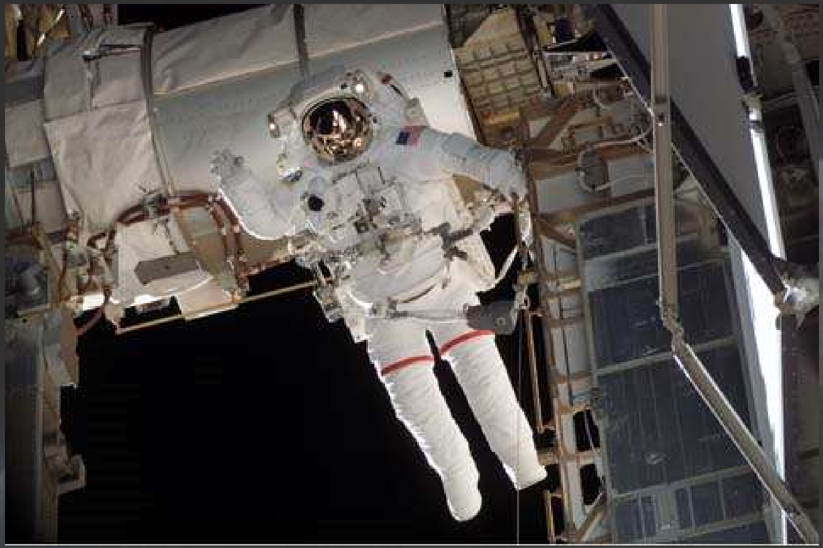
Mission

Crew Health Stabilization

Mission

Physical Challenges

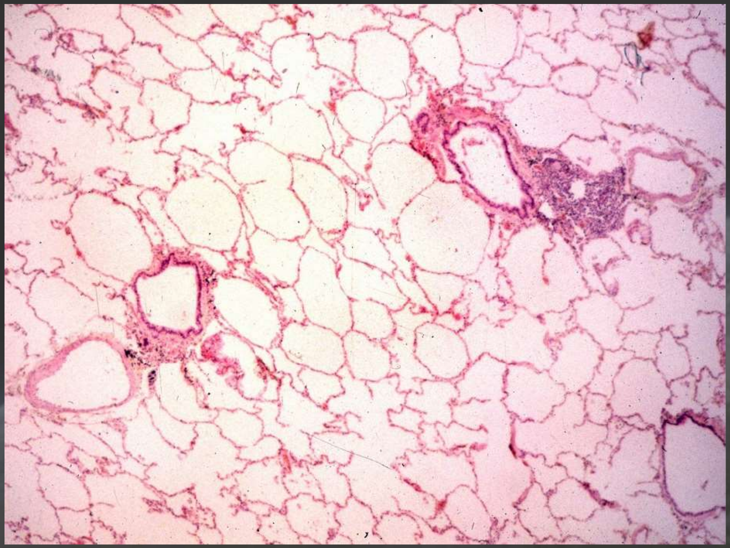
- EVA



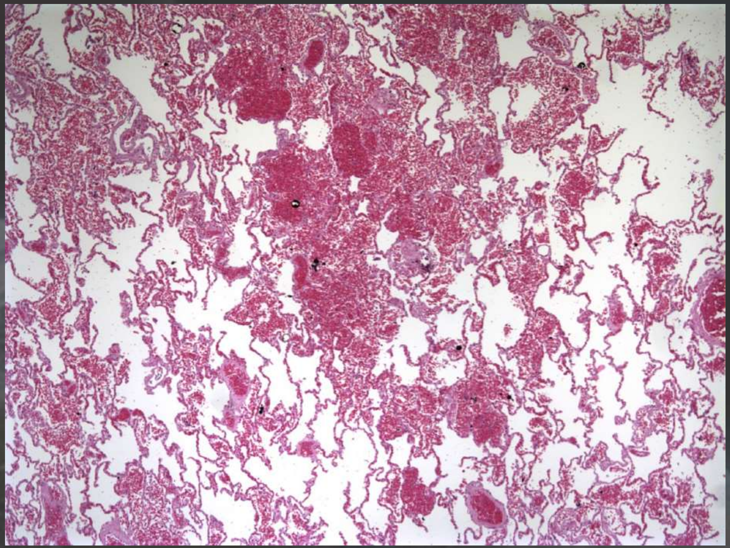
Mission

Physical Challenges

- DCS



NORMAL LUNG TISSUE



EBULLISM

Mission

Physical Challenges

- Suits

US EMU – 4.3 psi

Russian Orlan – 5.8 psi

Mission

Physical Challenges

- Suits

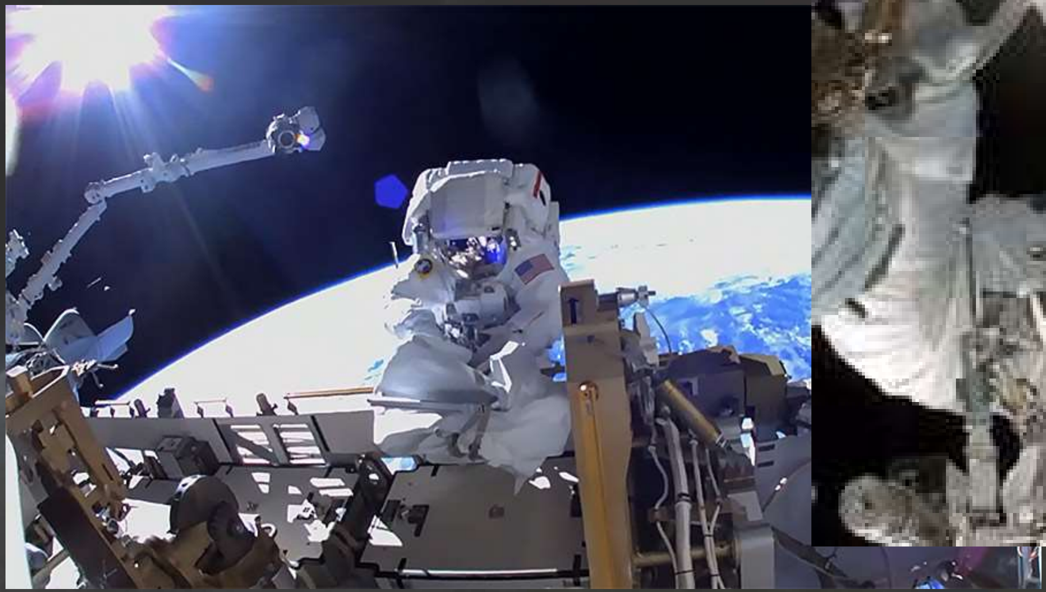
Figure 3. Largest crater found on the PMIA handrail was 1.85 mm diameter with 0.33-mm-high crater lips.

Figure 6. Mastracchio's left glove after STS-118 EVA #3.

Mission

Physical Challenges

•Light



Mission

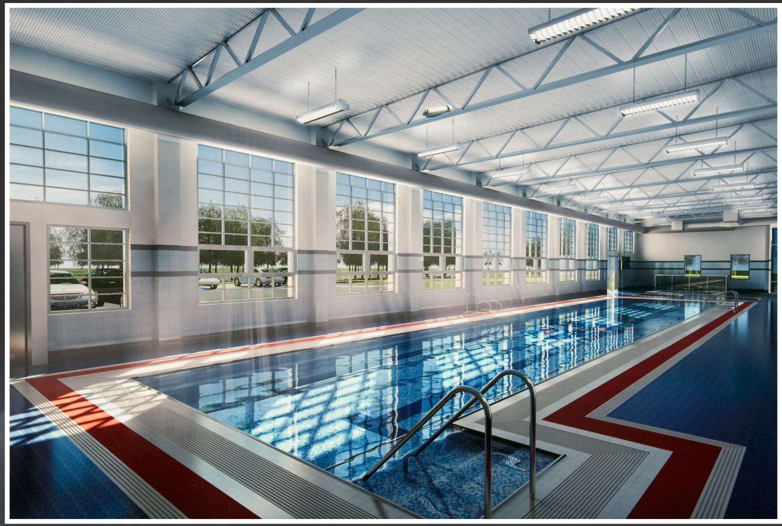
Physical Challenges

- Return

Mission

Physical Challenges

•Postflight



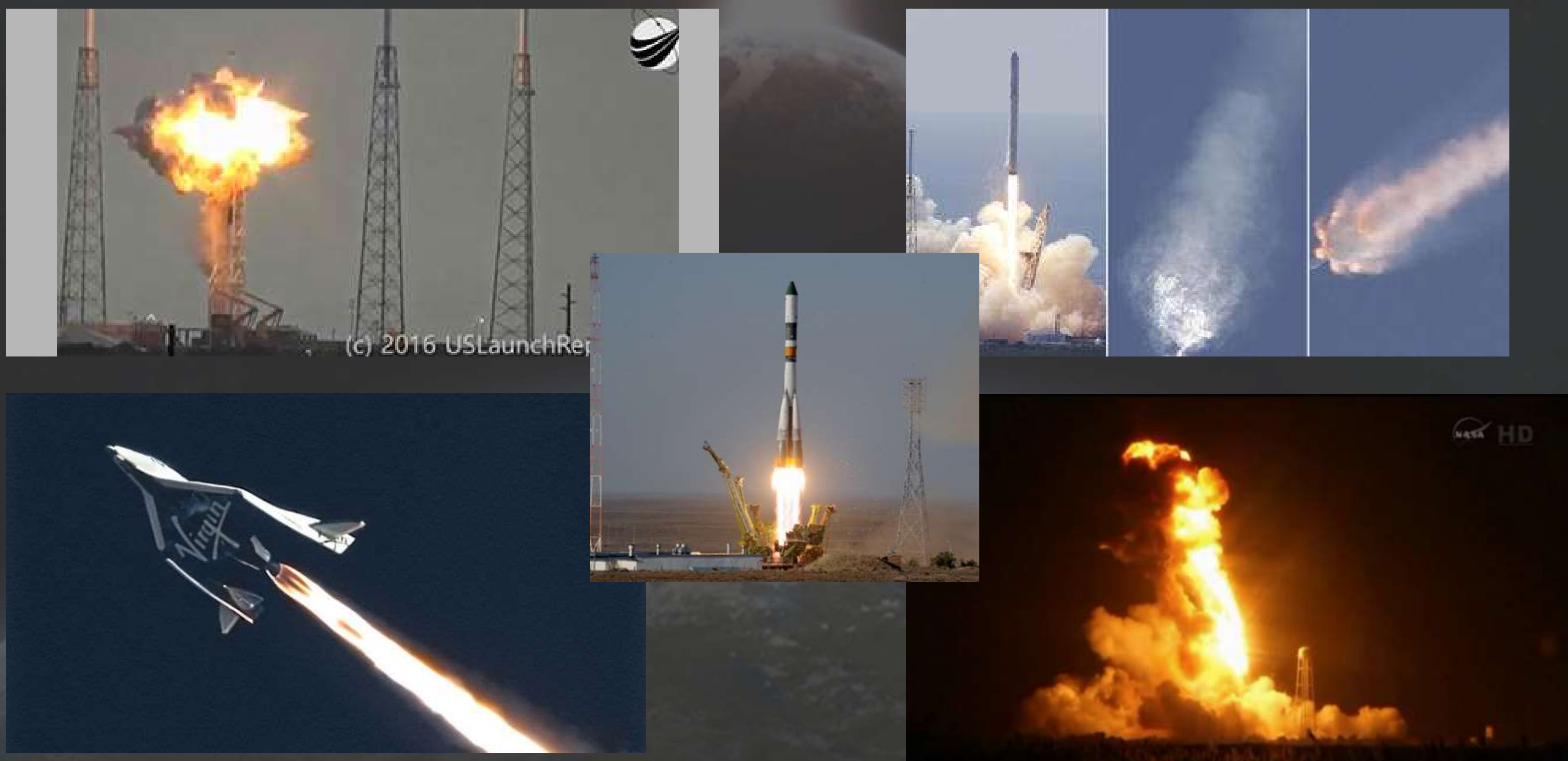
Mission

Mental Challenges

- Significant physical and psychosocial stressors

Data Extrapolation

Space is Hard



Summary

- Space is hard…but super cool
- Aerospace Medicine Specialists are uniquely positioned to understand the physiologic and operational challenges of extreme environments

Questions?