



Space Medicine Introduction



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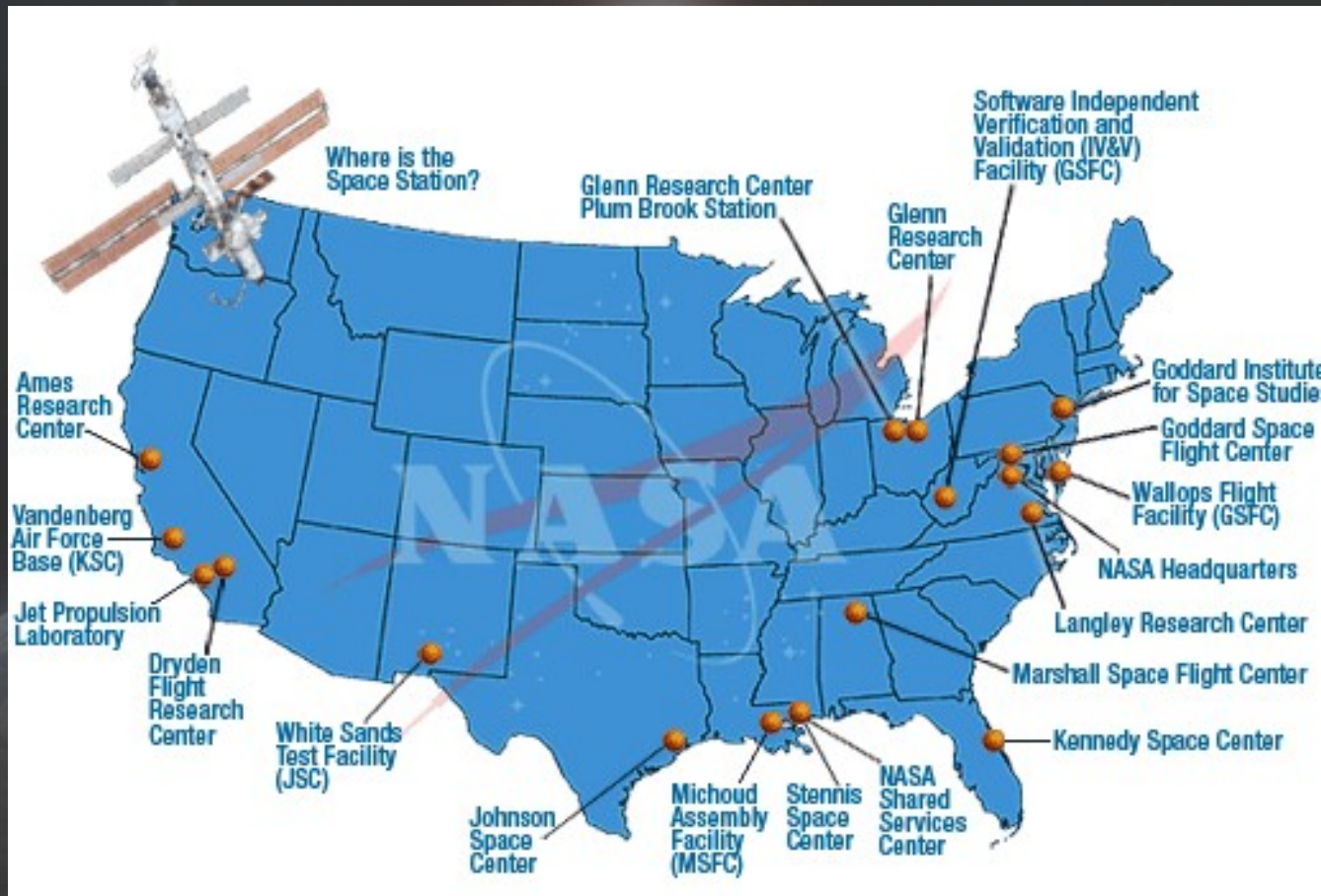
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NASA Centers





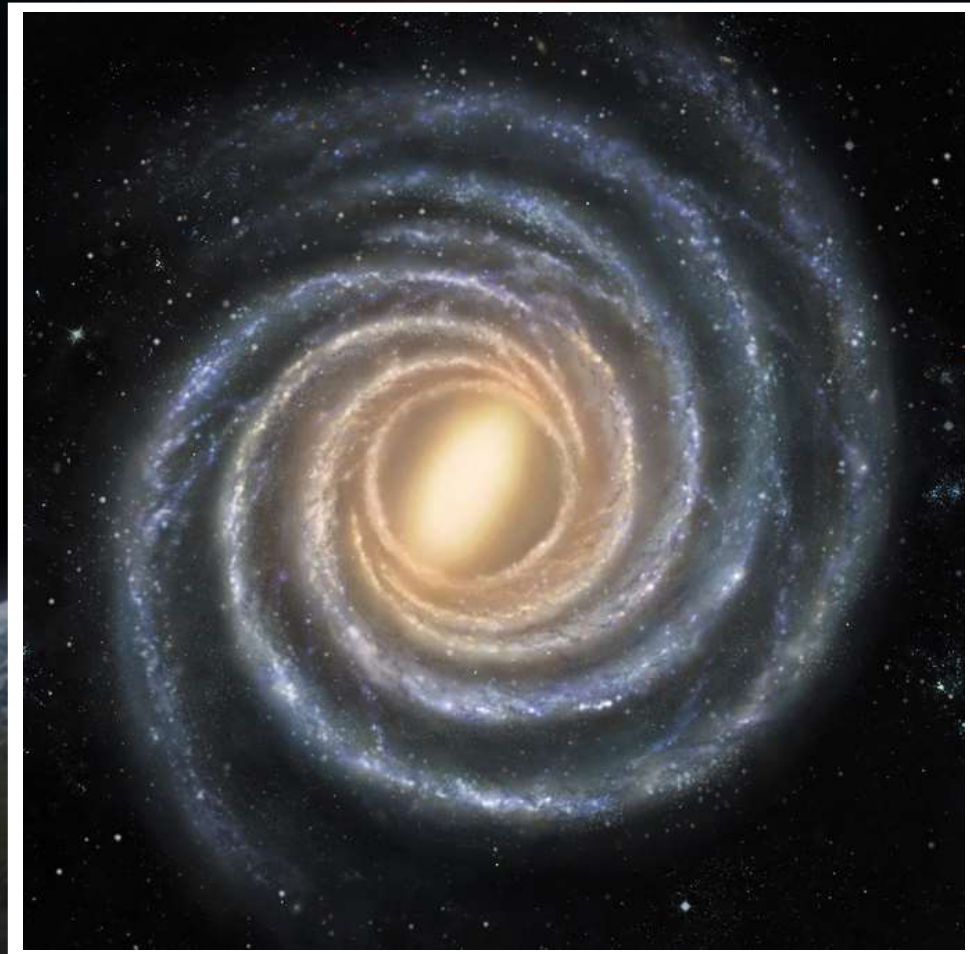
Why Should Physicians Care About Space?



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Why Should Air Force Flight Surgeons Care About Space?



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Why Should Air Force Flight Surgeons Care About Space?



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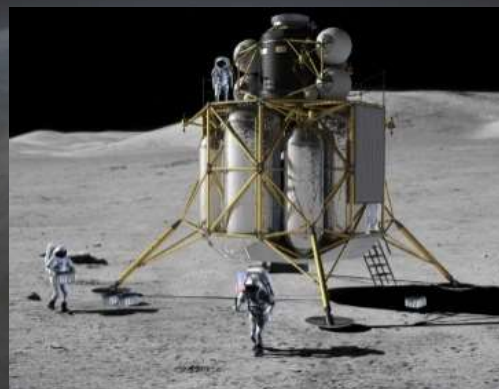
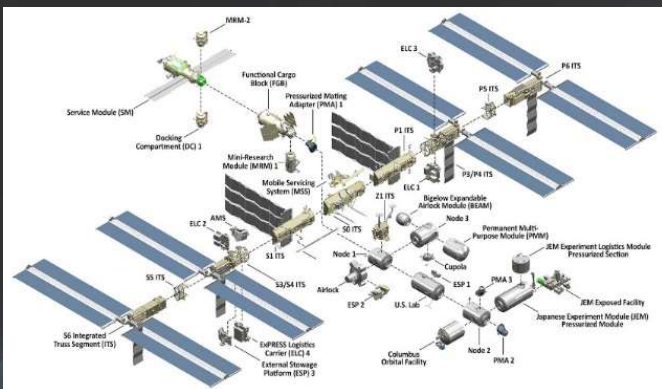
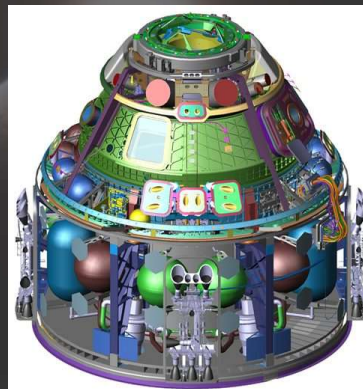


Return to the Moon





What is new and different in Space Medicine?



GATEWAY

An exploration and science outpost in orbit around the Moon

Power and Propulsion Element: Provides communications, attitude control, and orbit control and thruster capabilities for the Gateway.

ESPRIT: Service module including additional propulsion thrusters and enhanced life support and communication capabilities.

Utilization Element: Small pressurized volume for additional habitation capability.

Logistics and Utilization: Large delivery of consumables and equipment. Modules may include an additional utilization volume.

Habitation Modules: Pressurized volumes with environmental control and life support. For scientific and exploration, work storage and distribution.

Robotic Arm: Manipulator arm to berth and unlash external payloads.

Airlock: Enables crew egress, potential to accommodate docking elements.

Sample Return Vehicle: A service module capable of delivering and retrieving payloads from the lunar surface to the Gateway.

Gateway Compared to the International Space Station: The International Space Station is a permanently crewed research platform that has 11 modules and is the size of a football field. The Gateway is a much smaller, more compact platform for exploring and conducting human activities like the ISS around the Moon.

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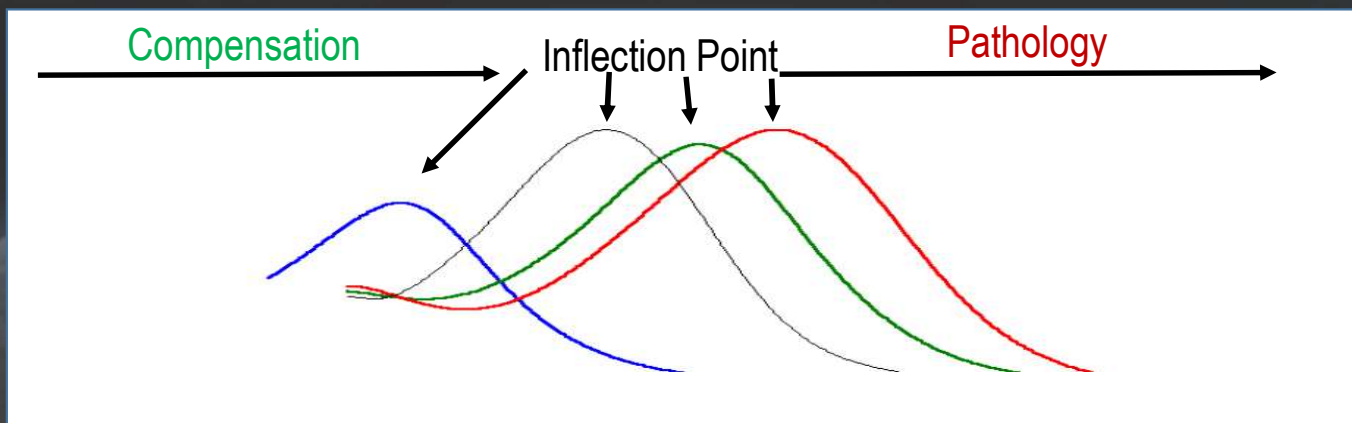


Write This Down



Homeostasis

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





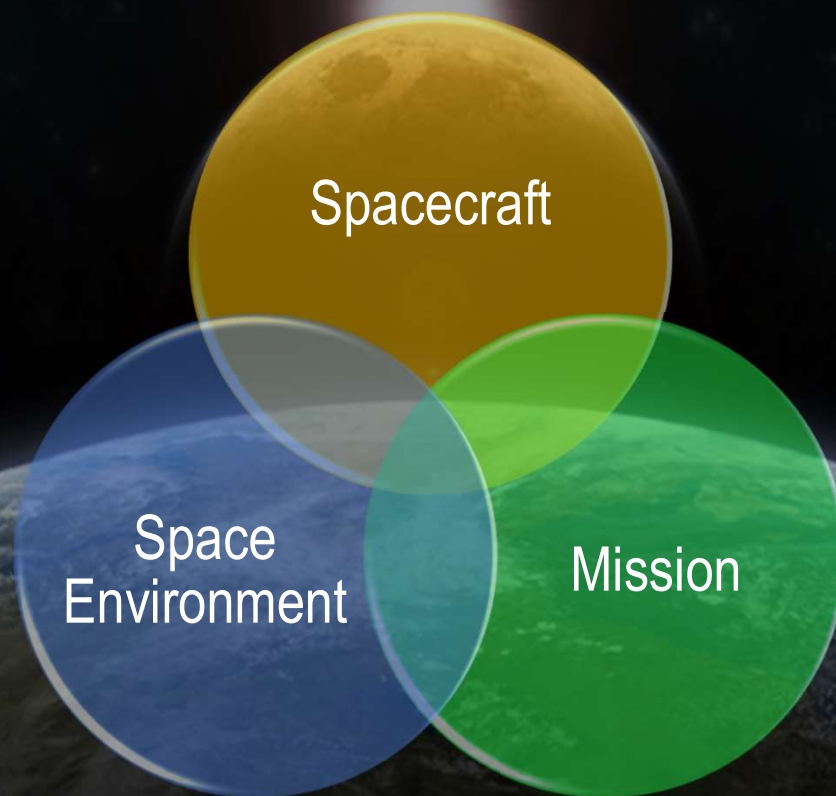
What do NASA Flight Surgeons do?



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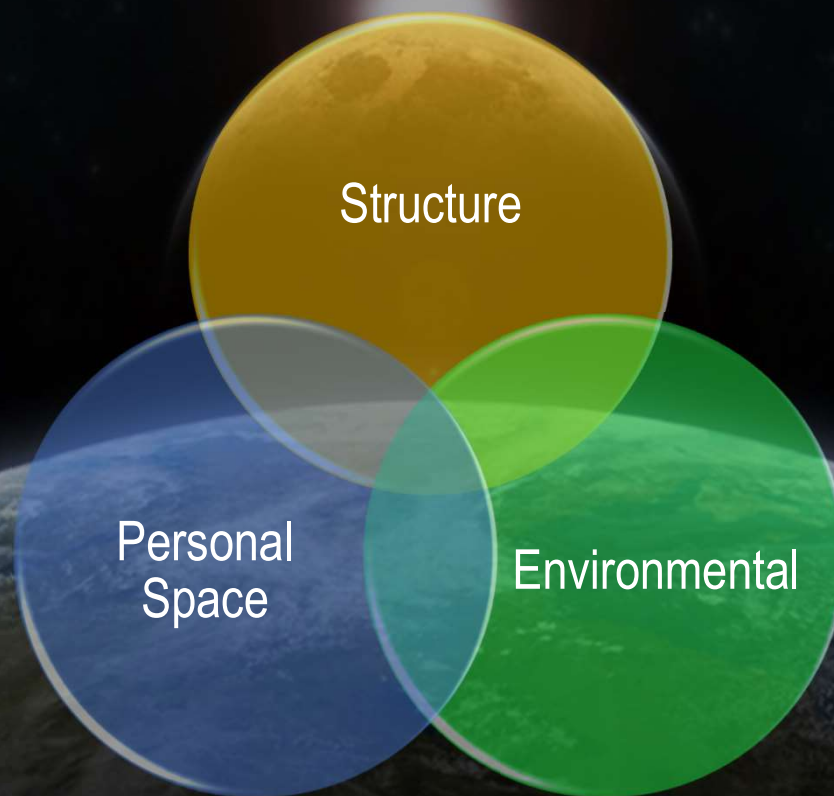
Hazards of Spaceflight



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Hazards of Spacecraft



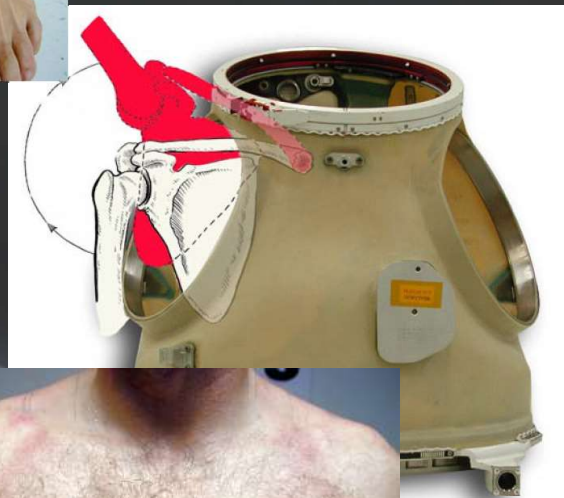
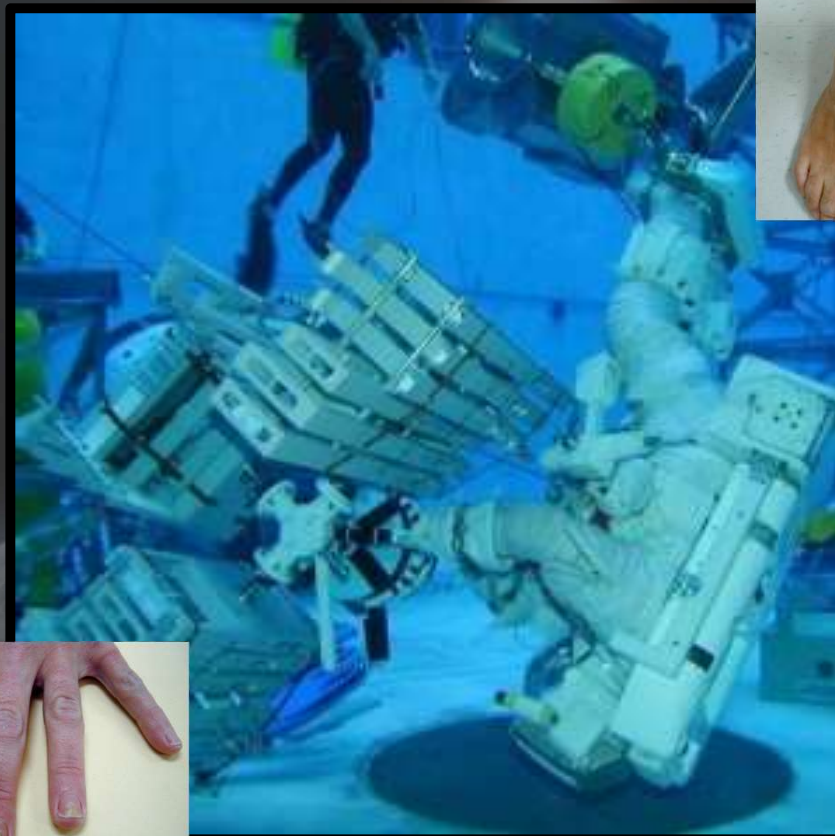
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Spacecraft



Structure
• Training



stricted
motion.

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Spacecraft



Structure

- Launch





Spacecraft



Structure and Personal Space





Spacecraft



Environmental

- Exposures
- Habitability

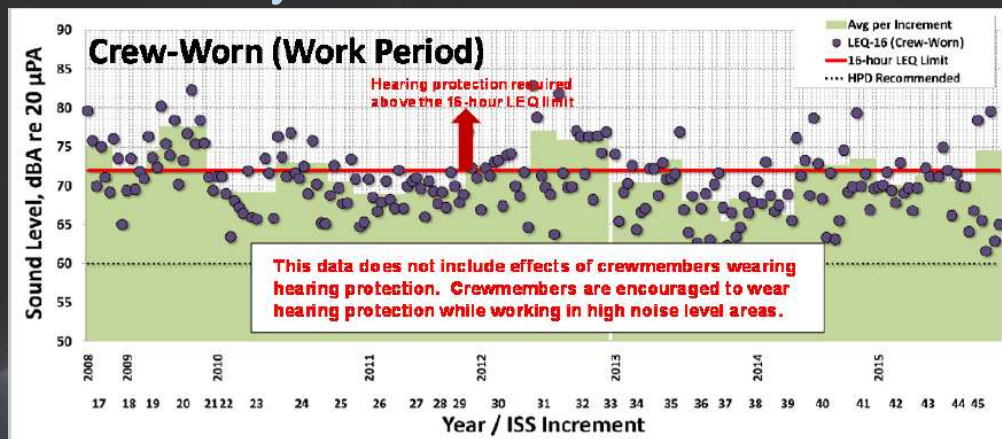


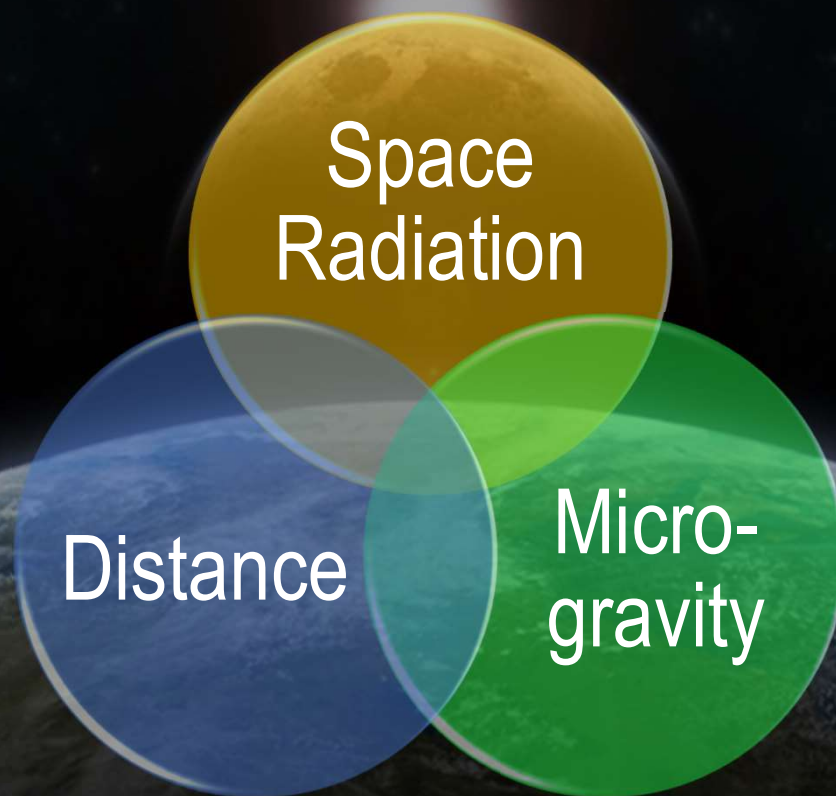
Figure 3. Bacterial Colonies (smooth)



Figure 4. Fungal Colonies (fuzzy)



Hazards of Environment



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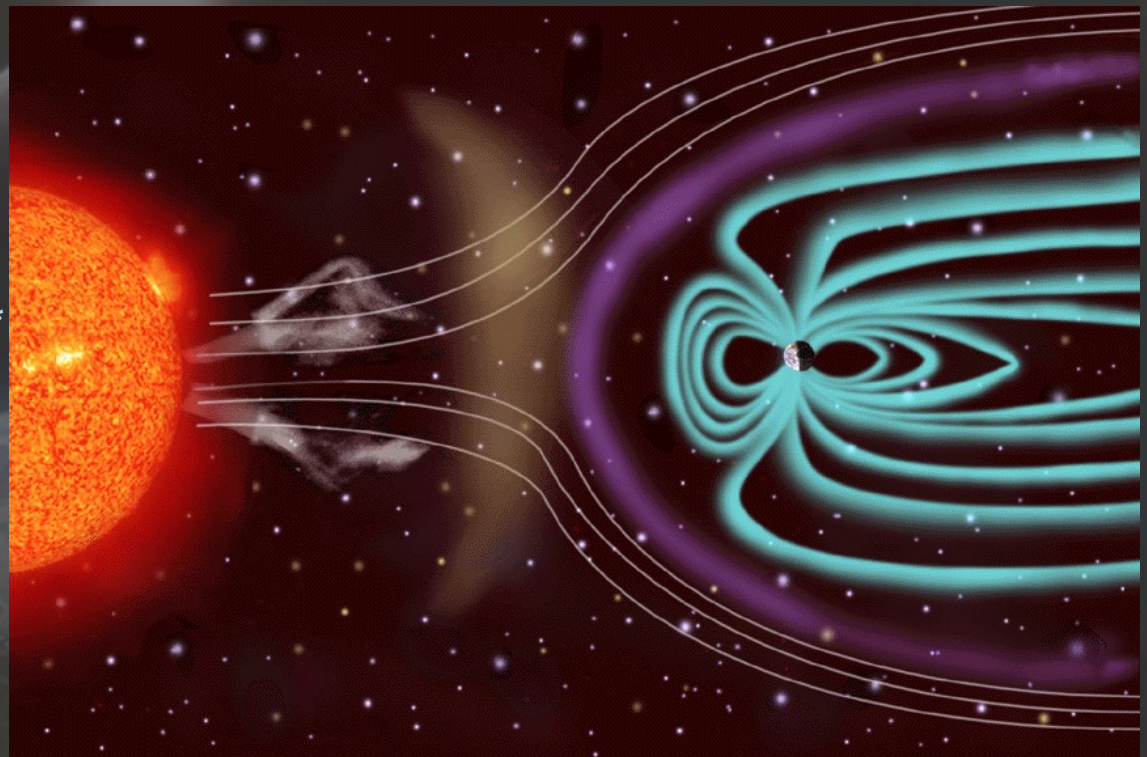


Space Environment



Space Radiation

- Three main sources
 - Galactic cosmic radiation (GCR)
 - **biggest threat to deep space missions**
 - Trapped Radiation
 - Solar particle events (SPE)

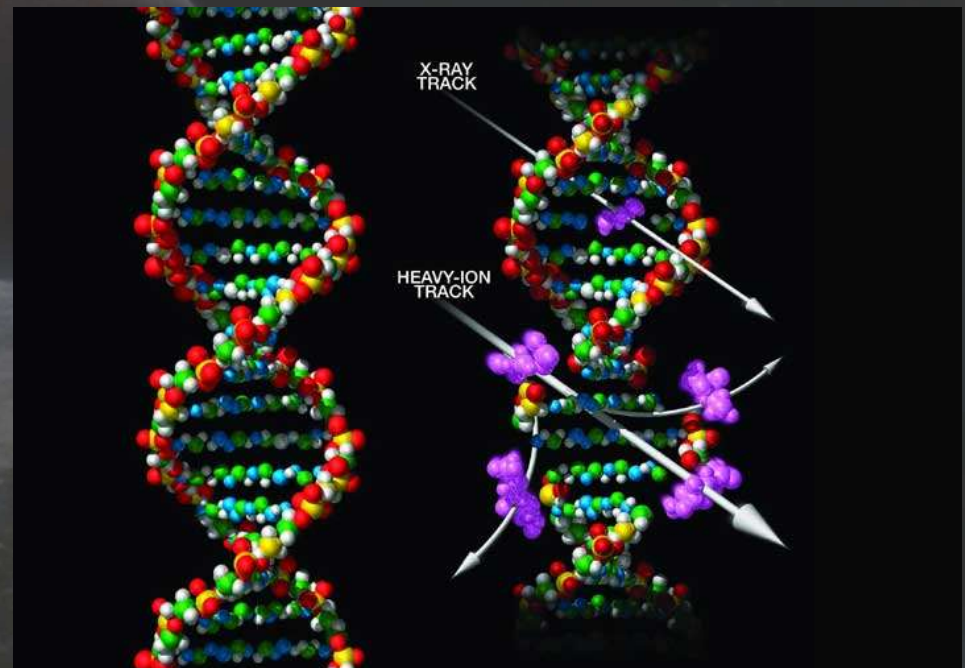
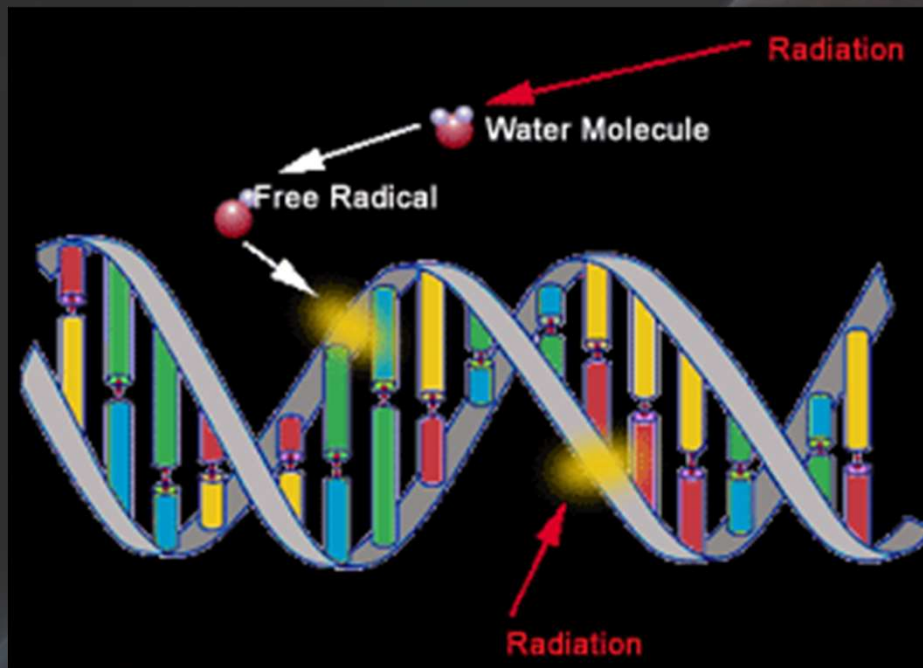




Space Environment



Space Radiation Mechanisms of Damage

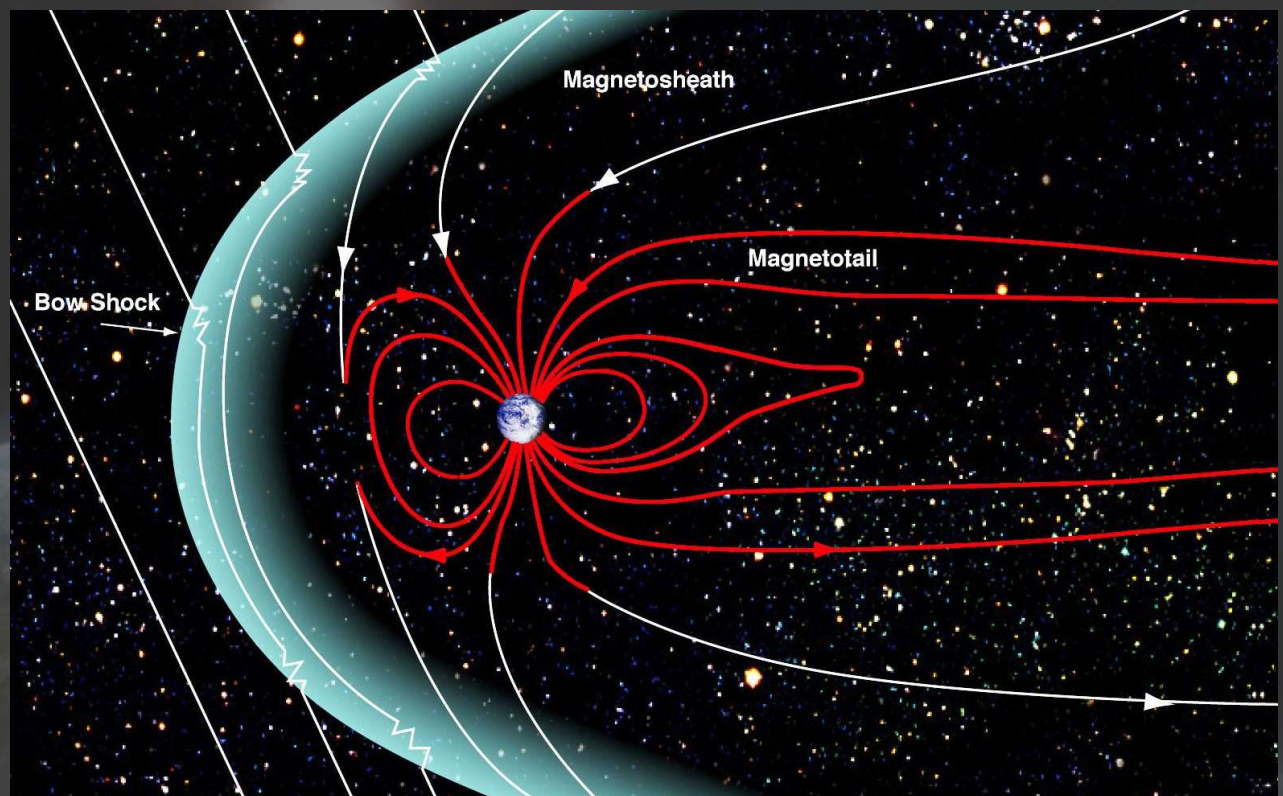




Space Environment



Magnetosphere



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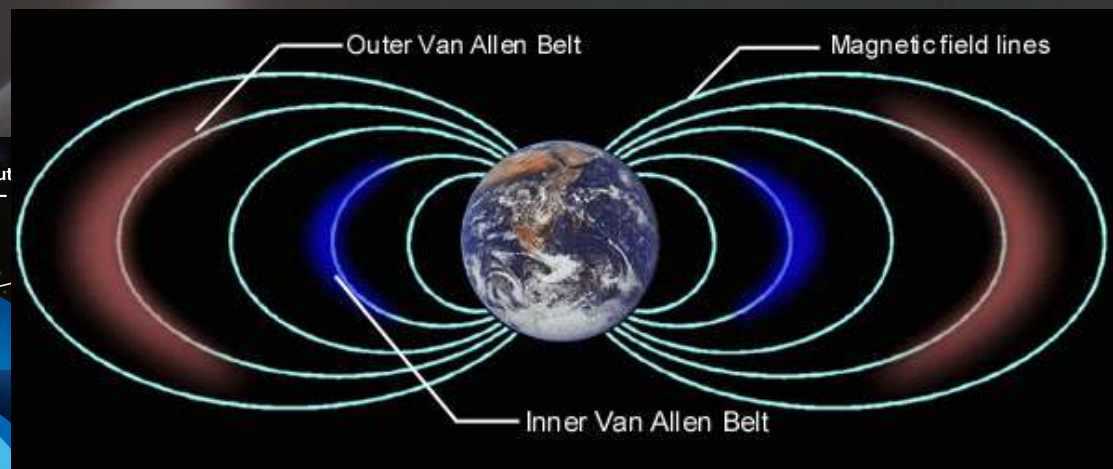
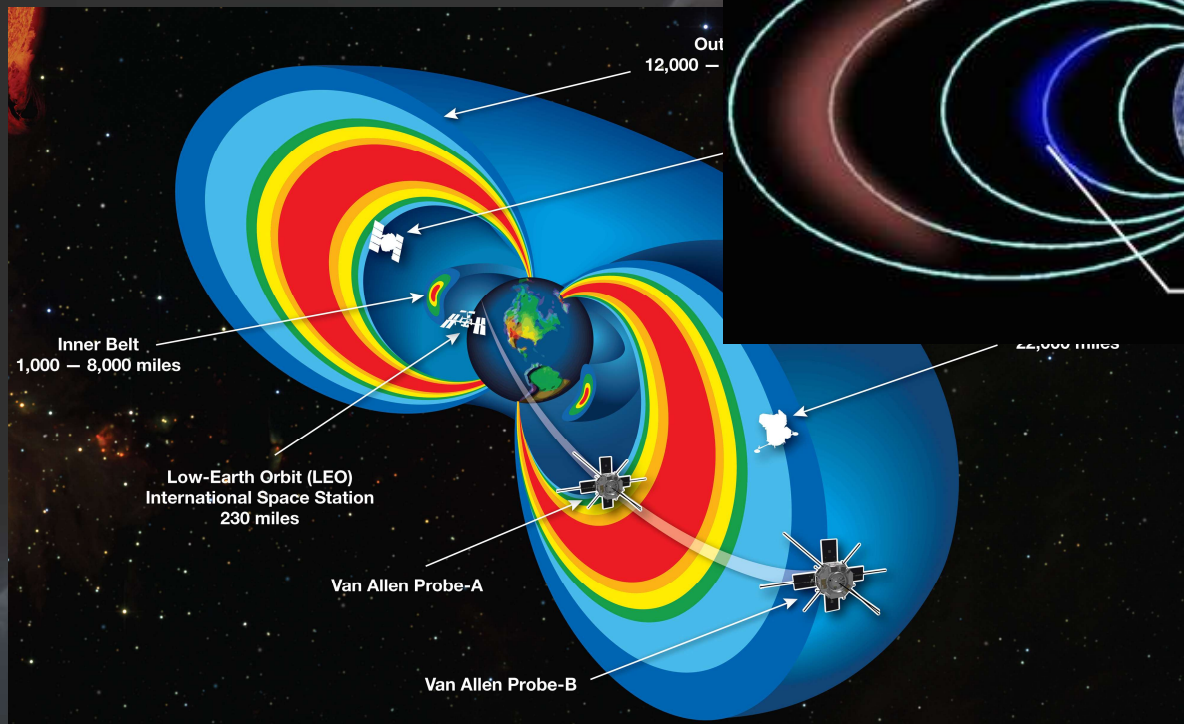
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Space Environment



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



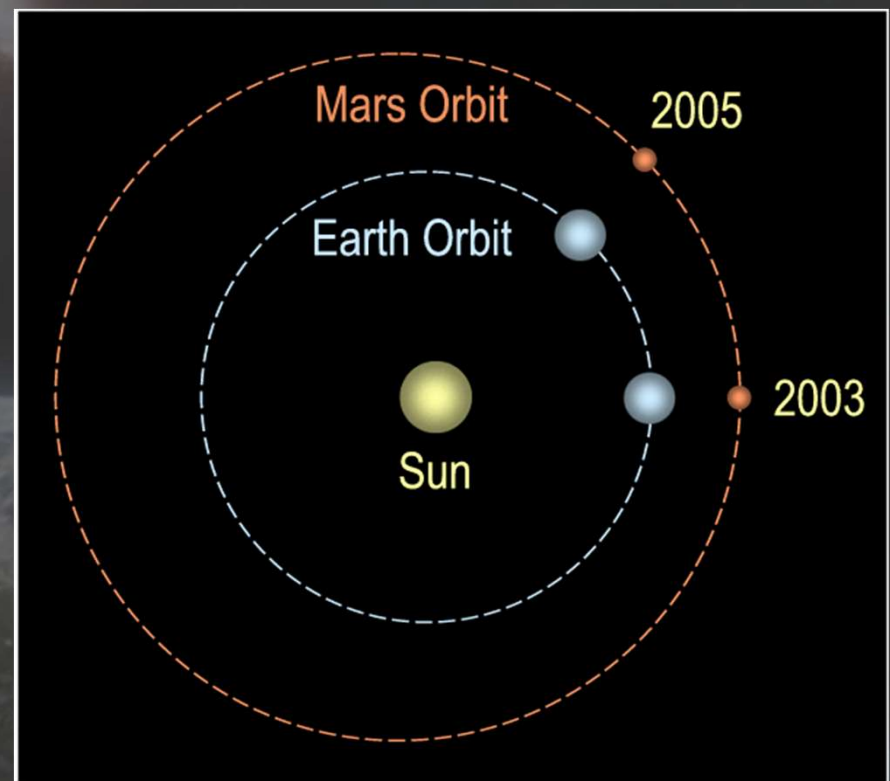


Space Environment



Distance

- Distance to the Moon ~ 238,854 miles
- Average distance to Mars ~ 142 million miles
(range 56 - 401 million miles)

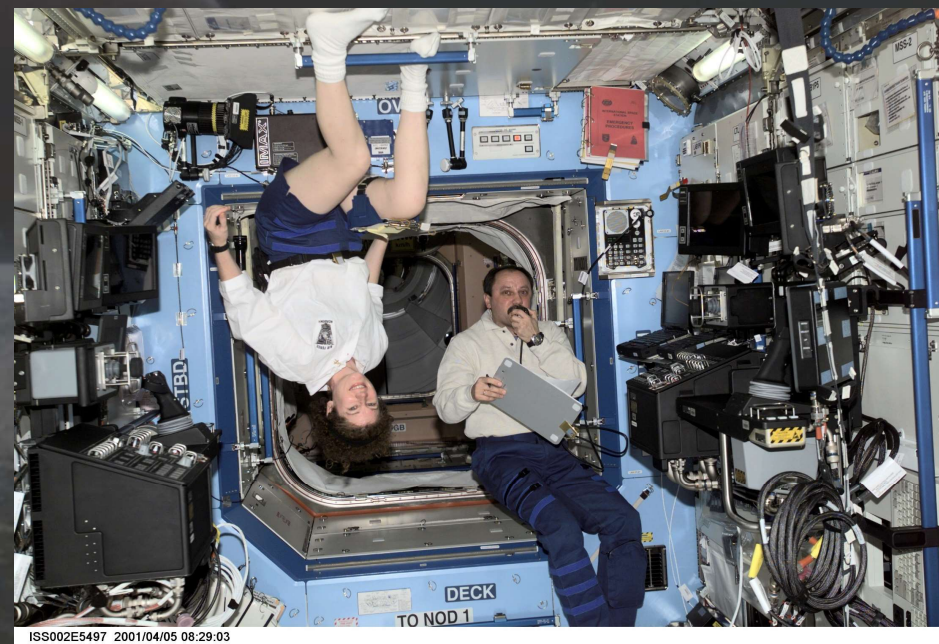




Space Environment



Microgravity



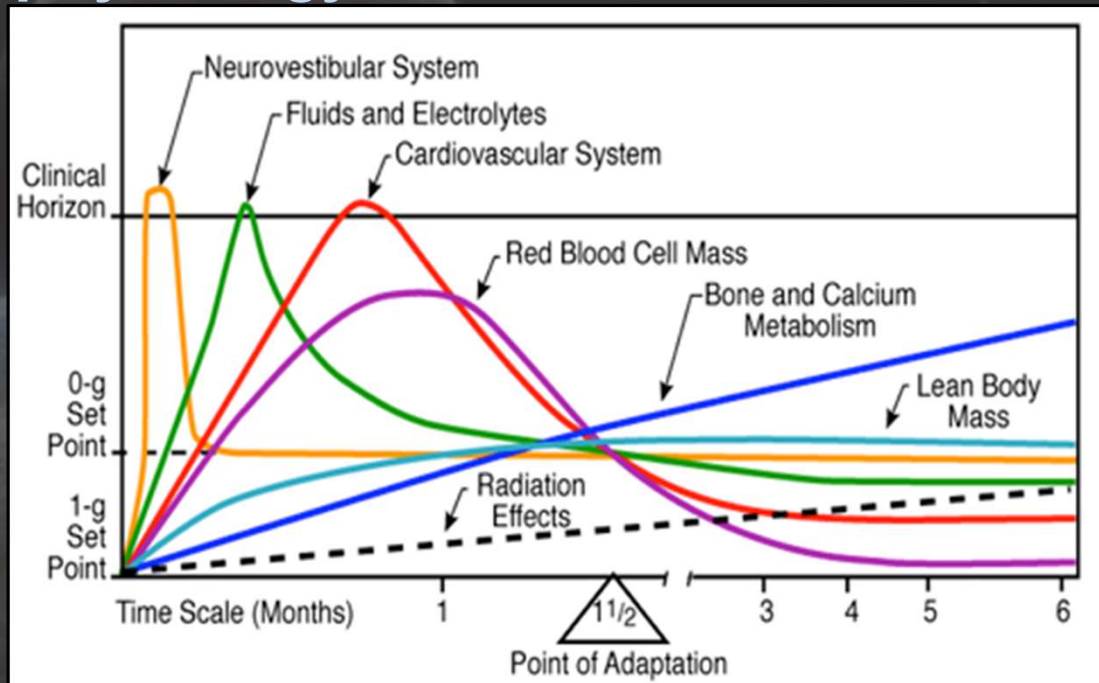


Space Environment



Microgravity - Normal physiology, *abnormal* environment

- Neurovestibular
- Cardiovascular
- Musculoskeletal
- SANS
- CO₂



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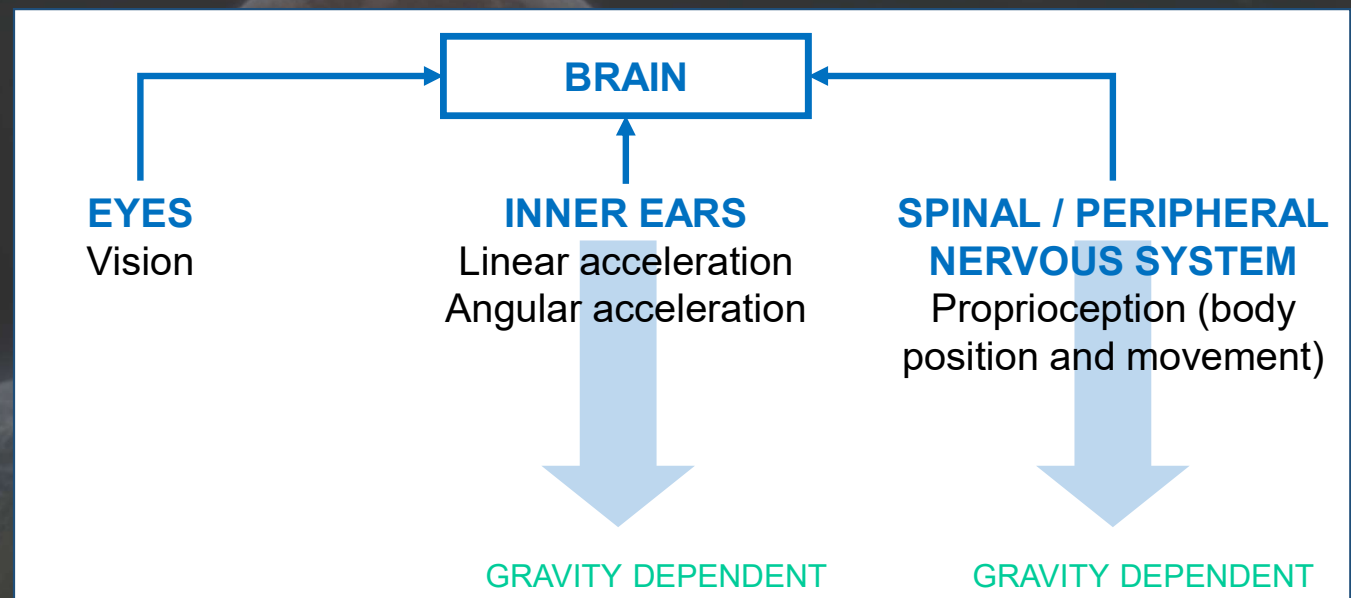


Space Environment



Microgravity

- Neurovestibular





Space Environment



Space Motion Sickness



79%

Treatments?



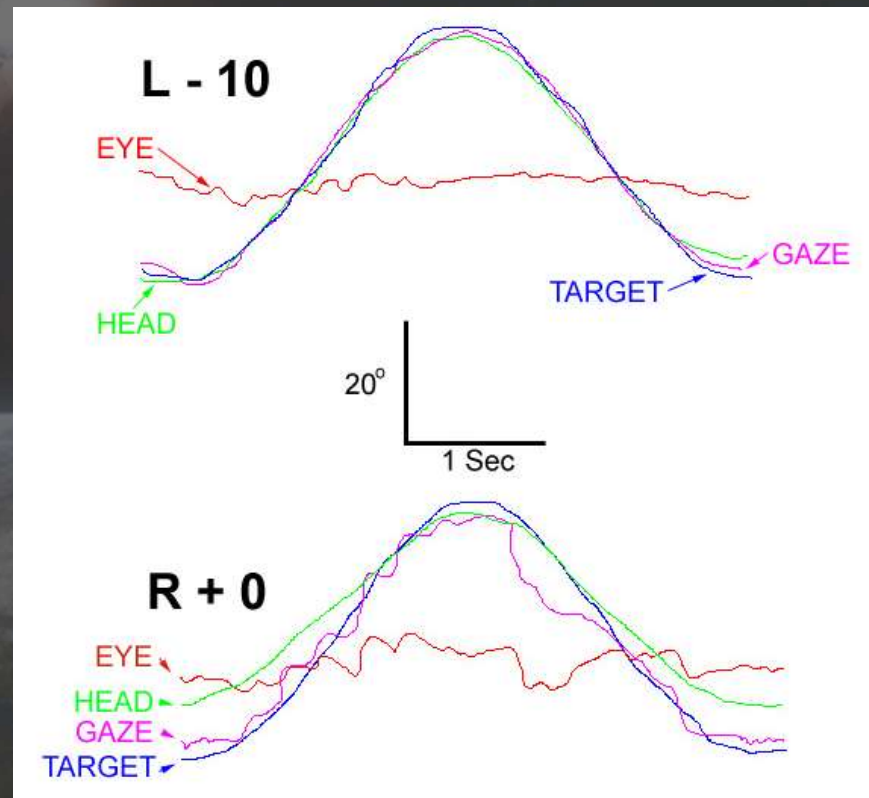


Space Environment



Microgravity

- Neurovestibular





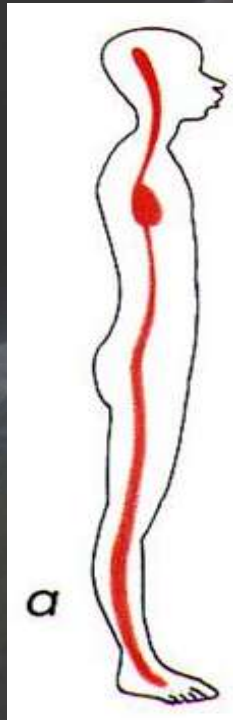
Space Environment



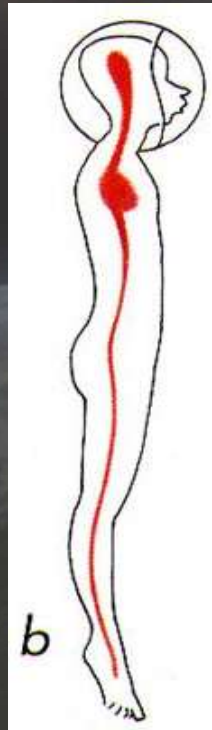
Microgravity

- Cardiovascular

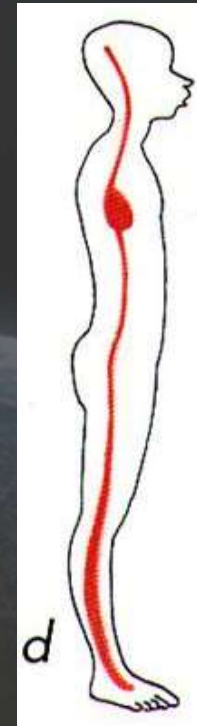
Earth



In Space Adaptation



Return



Lujan and White (1995)



Space Environment



Microgravity

- Cardiovascular



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Lujan and White (1995)

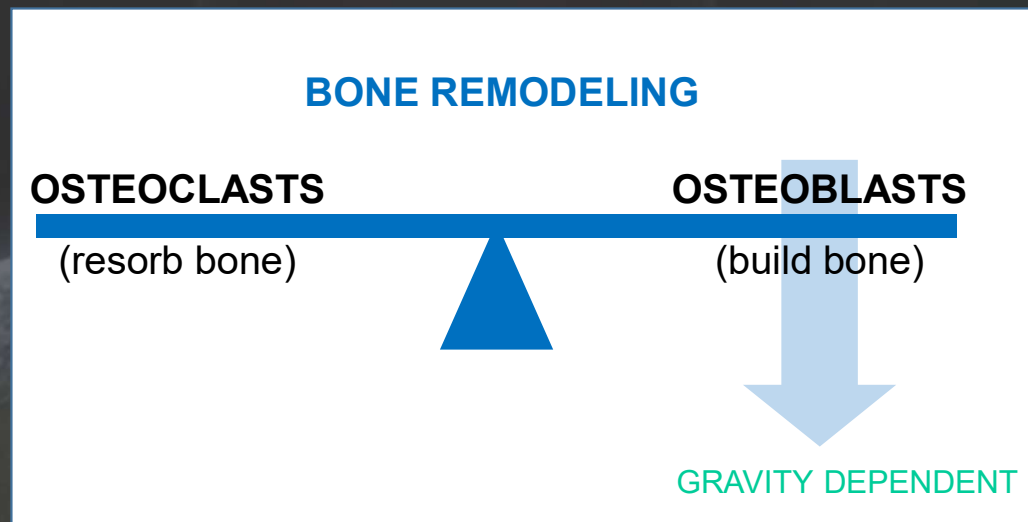


Space Environment



Microgravity

- Musculoskeletal



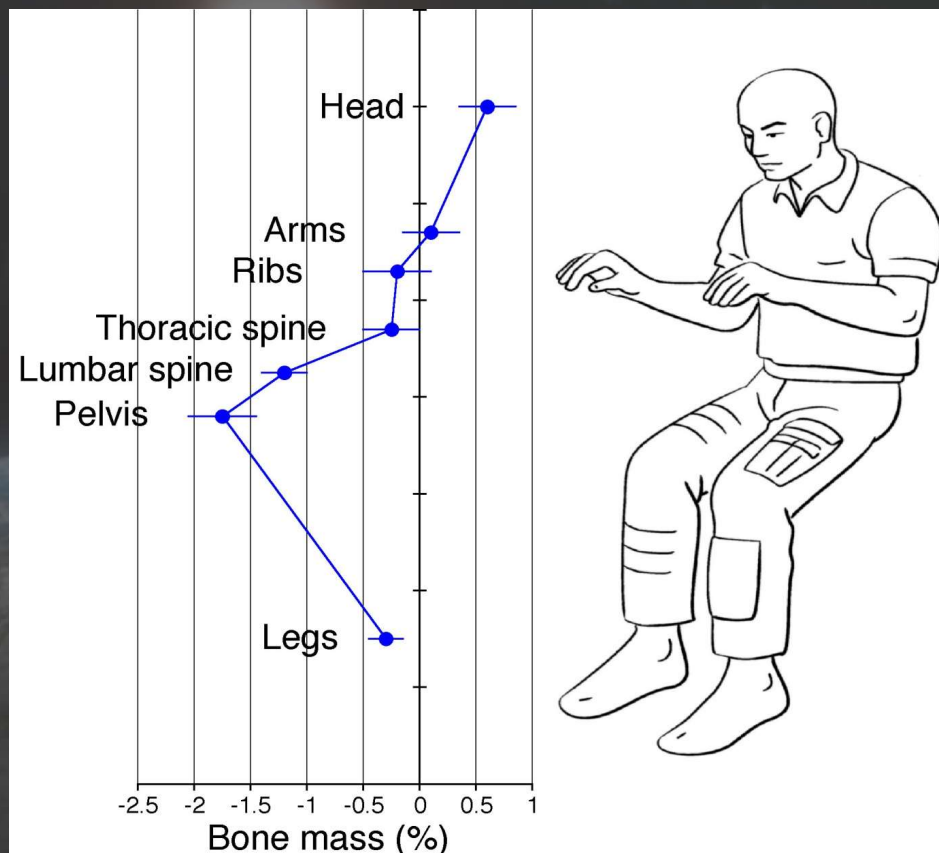


Space Environment



Microgravity

- Musculoskeletal Post-flight changes in bone density compared to preflight



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Space Environment



In-flight Countermeasures

T2
(Treadmill 2)



CEVIS
(Cycle Ergometer with
Vibration Isolation &
Stabilization)



ARED
(Advanced Resistive
Exercise Device)



Neurovestibular	✓		
Cardiovascular	✓	✓	
Musculoskeletal	✓	✓	✓

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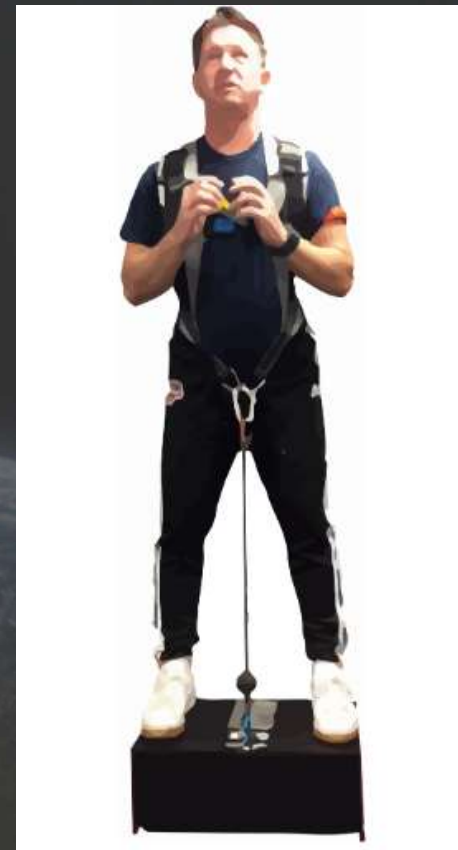


Space Environment



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?



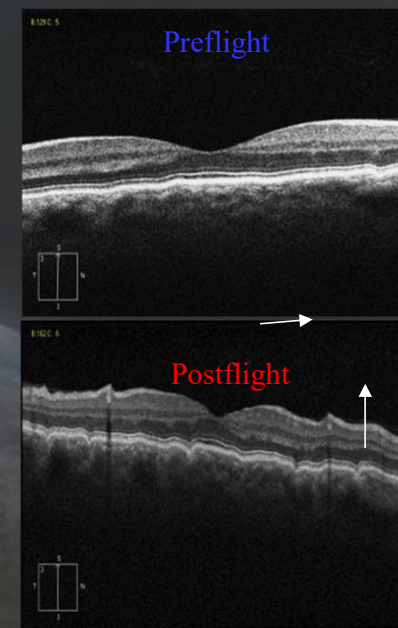
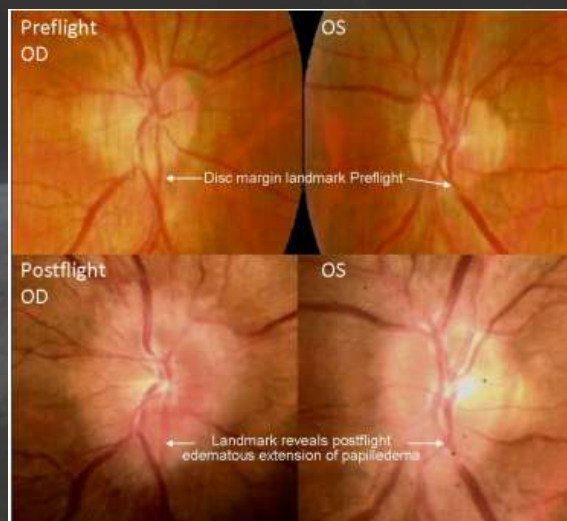
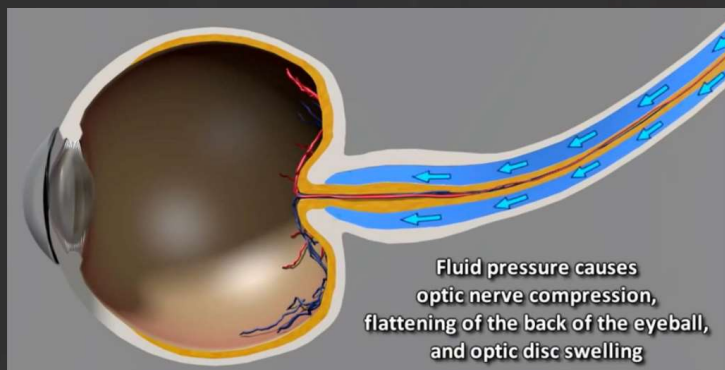


Space Environment



Microgravity

- Spaceflight Associated Neuro-ocular Syndrome (SANS)





Space Environment



Microgravity

- SANS

Decreased near visual acuity, distant vision intact

E	1	20/200
F P	2	20/100
T O Z	3	20/70
L P E D	4	20/50
P E C F D	5	20/40
E D F C Z P	6	20/30
P E L O P Z D	7	20/25
D E F F O T E C	8	20/20
L I S O D D Y T	9	
L E S L T E R	10	
A S T R O N A U T	11	



Design and Mission Impacts





Space Environment



Microgravity

- CO₂
 - Terrestrial partial pressure of CO₂: 0.39 mmHg
 - Hardware design based on original ISS Flight Rule limit for CO₂ 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



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Mission



Limited Resources

- Medical Training and Assets





Mission



Crew Health Stabilization



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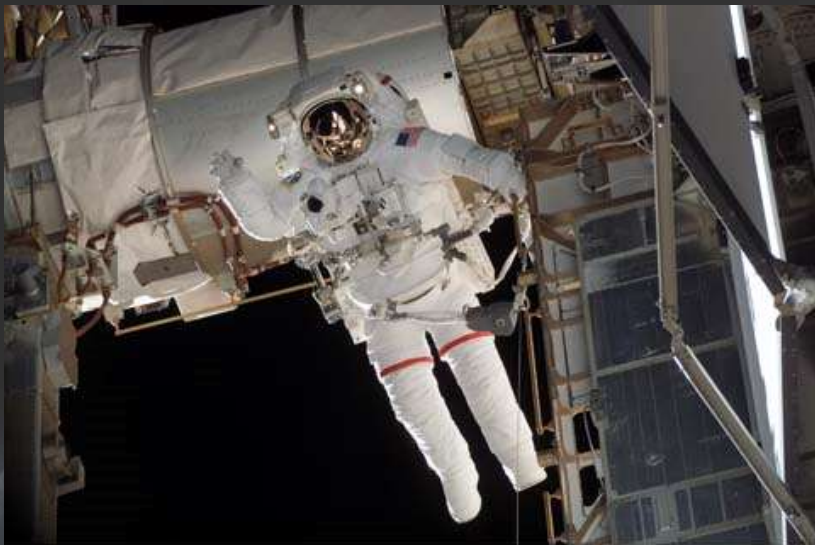


Mission



Physical Challenges

- EVA



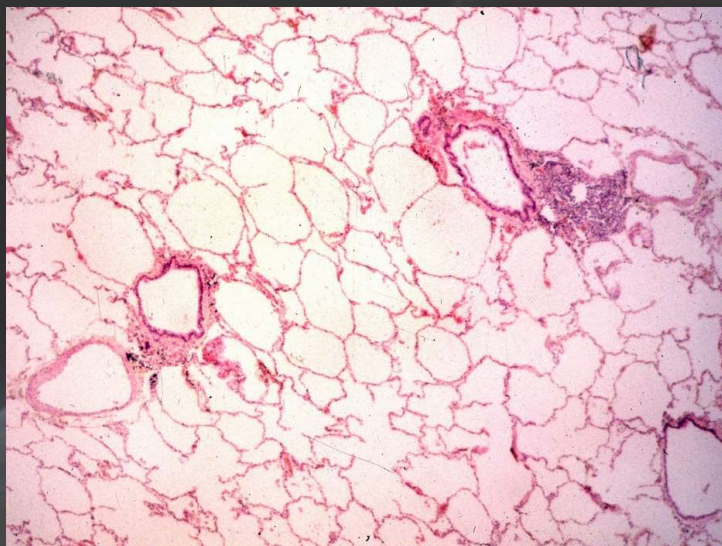


Mission

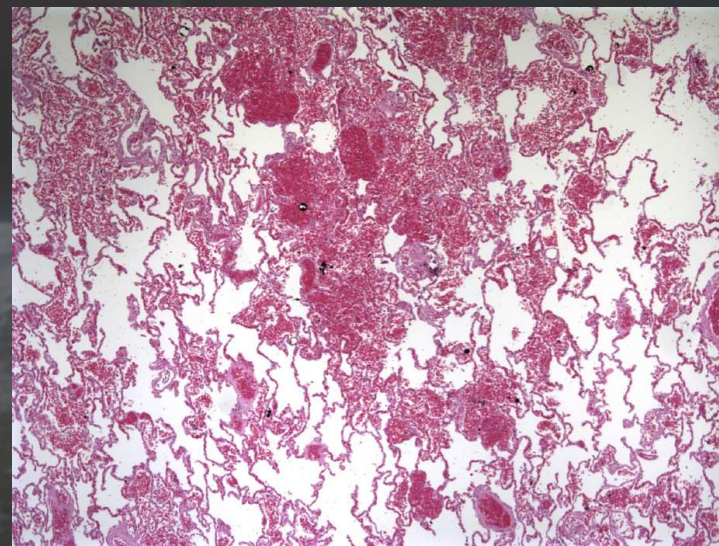


Physical Challenges

- DCS



NORMAL LUNG TISSUE



EBULLISM

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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



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Mission



Physical Challenges

- Return



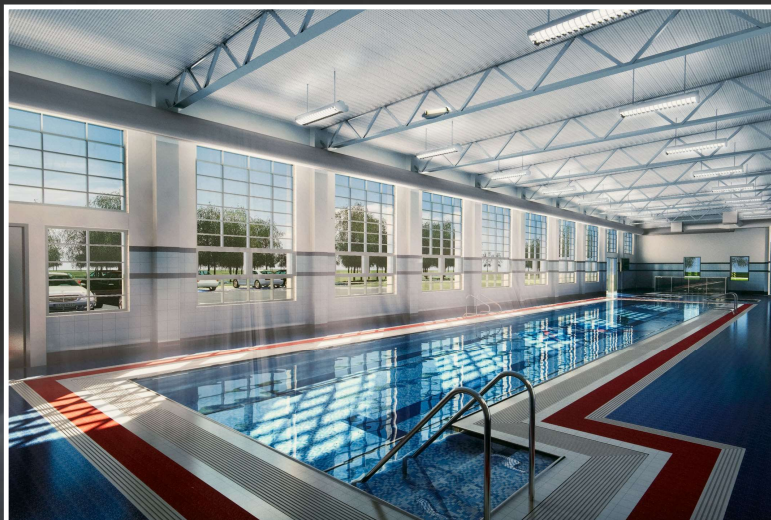


Mission



Physical Challenges

- Postflight



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Mission



Mental Challenges

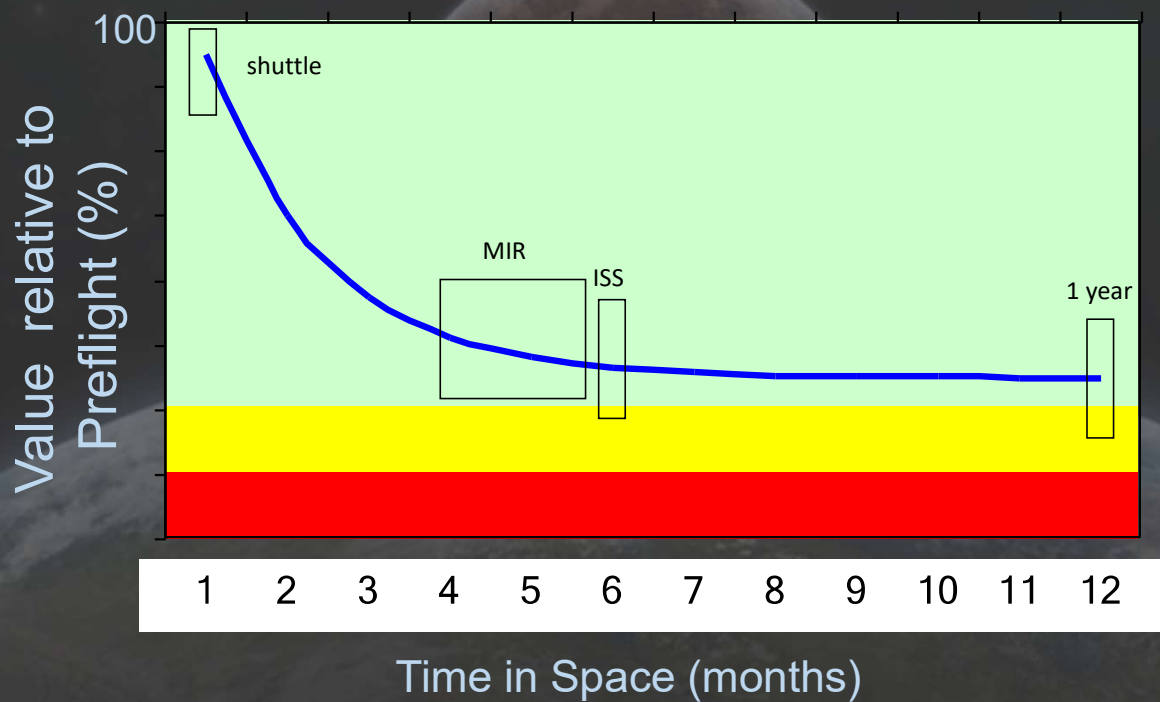
- Significant physical and psychosocial stressors



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Data Extrapolation





Space is Hard



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Summary



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



Questions?



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