National Aeronautics and Space Administration

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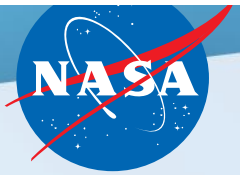

Human Research Program

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From Benchtop to Spaceflight Application: Translational Science Endeavors at NASA

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Human Research Program

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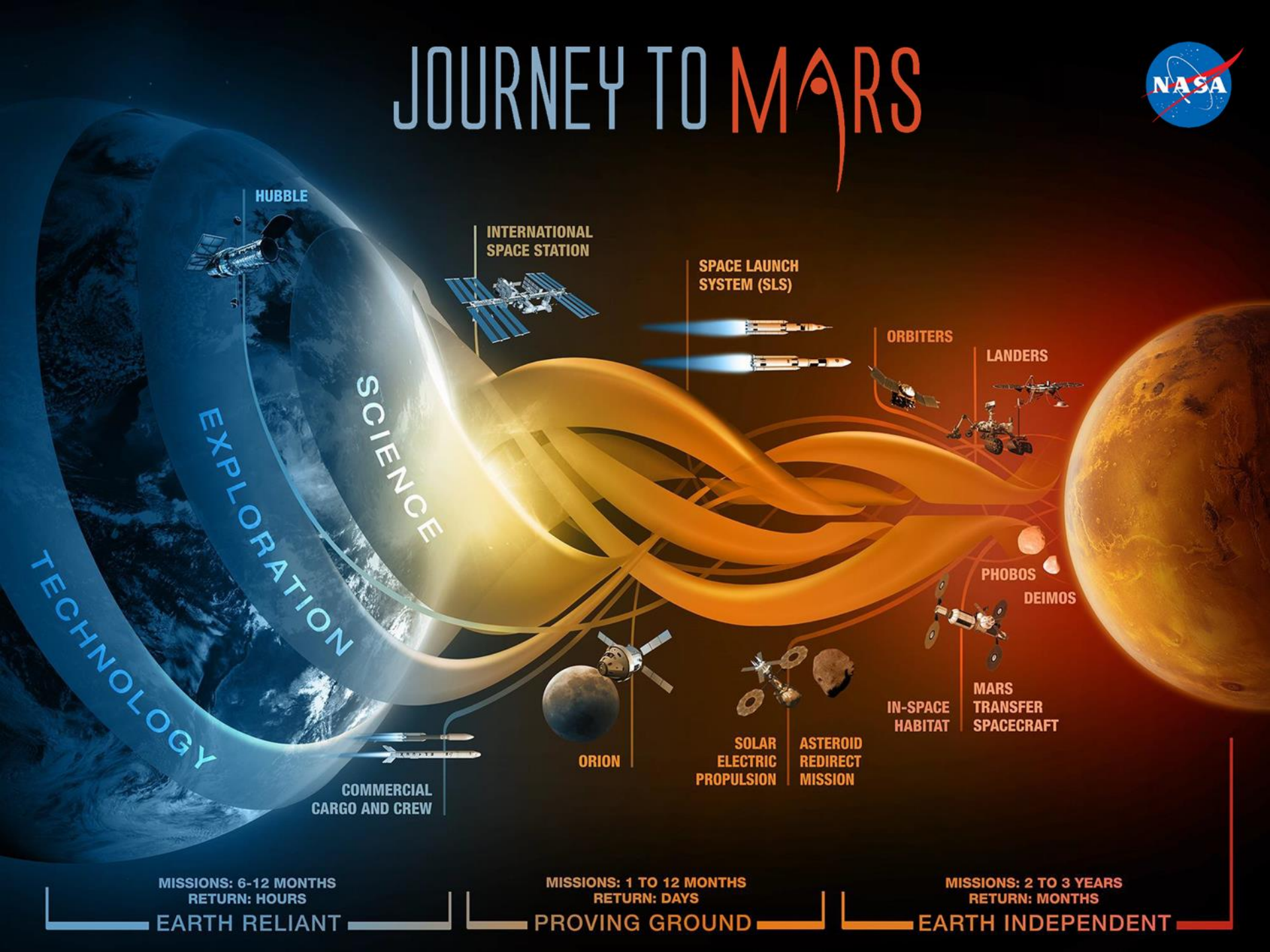
April 14, 2016

humanresearch.jsc.nasa.gov

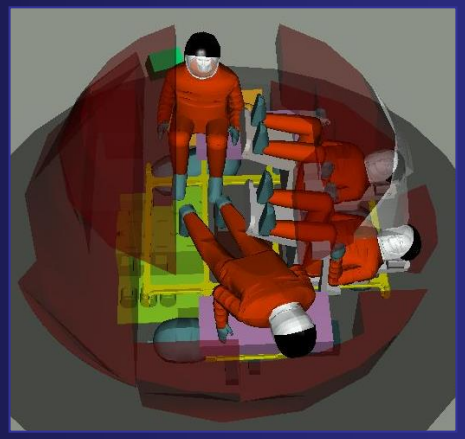
JOURNEY TO MARS



Human Research Program

- The Human Research Program (HRP) focuses on applied research
- Program goals
  - Perform research necessary to understand and reduce spaceflight human health and performance risks in support of exploration
  - Enable development of human spaceflight medical and human performance standards
  - Develop and validate technologies that serve to characterize and reduce medical risks associated with human spaceflight

Clay Anderson centrifuges Nutrition blood samples during Increment 15



Seat layout for contingency EVA

Example of a study on the effects of center of gravity on performance

An Applied Research Program

Components of HRP

- HRP is composed of six Elements
  - Behavioral Health and Performance
    - *Individual and interpersonal*
  - Exploration Medical Capability
    - *Medical care for missions*
  - Human Health Countermeasures
    - *Physiology*
  - ISS Medical Project
    - *Infrastructure for flight experiments*
  - Space Human Factors and Habitability
    - *Interfaces between humans and vehicles/habitats*
  - Space Radiation
    - *Radiation exposure and biological effects*
- HRP funds the National Space Biomedical Research Institute (NSBRI) through a cooperative agreement to pursue research that complements the HRP portfolio

Sunita Williams inserting blood samples into the Minus Eighty Degree Laboratory Freezer

Nutrition SMO

Human Response to Spaceflight

Astronauts experience a spectrum of adaptations in flight and post flight

Exposures:

Launch & Landing Loads

Microgravity

Closed Environment (air and water)

Confined Habitat

Radiation Exposure

Balance disorders
Cardiovascular deconditioning
Decreased immune function
Muscle atrophy
Bone loss

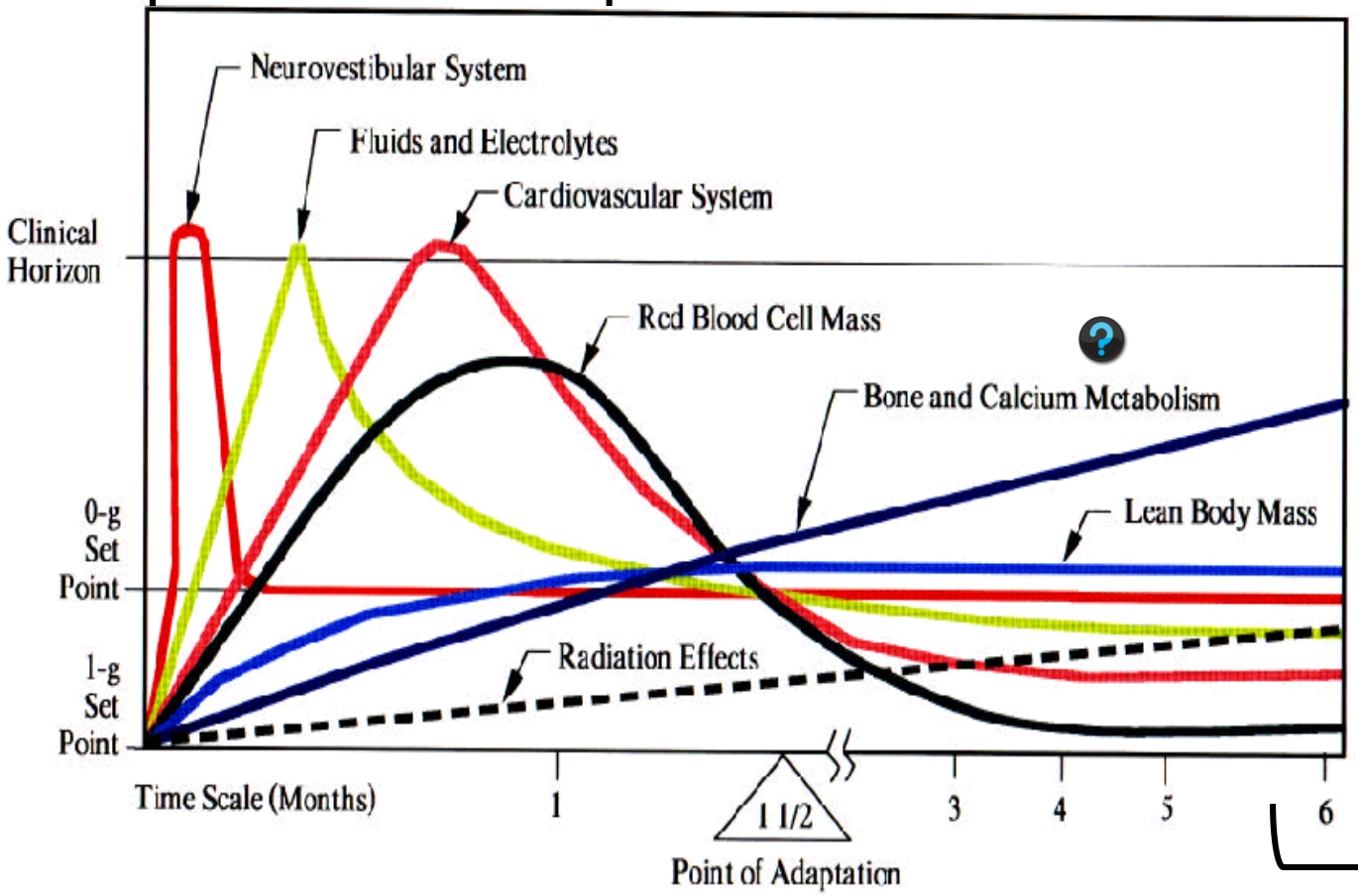
- Neurovestibular
- Cardiovascular
- Skeletal
- Muscular
- Immunological
- Nutritional
- Behavioral

Time Course of Physiological Changes During Weightlessness

This is notionally how the body adapts to Spaceflight, most notably microgravity

Note that there are acute and chronic processes at work

Still unclear if there are bimodal responses



A. Nicogossian et al, Space Physiology and Medicine

Therefore, the body has a process by which it readapts to gravity. These processes will have acute and chronic elements as well

Translational Science

- HRP is more aggressively taking a multidisciplinary approach to addressing the identified risks and characterizing new and emerging risks
- Challenges we face:
  - Human Variability is large and our ‘n’ is small
    - Translating between individuals (population data and case studies)
    - Translating between populations (astronaut-like test subjects: HDBR; ICC; ICE)
    - Translating between species (rodent models for mechanistic studies: additional complexity of analogs (HLU)
  - Time Course of exposure
    - Extrapolating to different durations: design reference missions
    - Characterizing exposures: Galactic Cosmic Rays versus Gamma and X-Ray
  - Technology push/pull
    - Transition to Operations Process: process improvement, risk reduction, new capability, etc.
    - Requires constant communication and engagement with our Primary Stakeholders

Countermeasures

Research

Operational

One-Year Missions and Twins Study

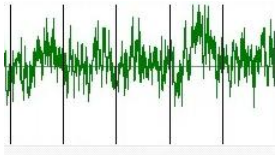
- Scott Kelly of NASA and Mikhail Kornienko of Roscosmos launched to the International Space Station on 27 March 2015 and returned on 1 March 2016, the longest space mission ever assigned to a NASA astronaut
- This one-year mission will show if observed physiological trends continue as before or if we are approaching any “cliffs” that will require new treatments while providing new insights
- Possibly five additional one-year missions
- The Twins Study (Scott and Mark Kelly) is NASA’s first foray into 21st-century omics research and will examine differential effects on homozygous twin astronauts associated with differences in exposure to spaceflight factors
- The Twins Study will examine
  - Genome, telomeres, epigenome
  - Transcriptome and epitranscriptome
  - Proteome
  - Metabolome
  - Physiology
  - Cognition
  - Microbiome

Mechanistic Understanding of Spaceflight-induced Visual Impairment and Intracranial Pressure

Risk statement - Given that it has been documented during and after spaceflight that astronauts have experienced abnormal changes to ocular structures such as optic disc edema; choroidal engorgement; choroidal folds; and optic nerve sheath distension, there is a possibility of space flight-induced altered blood flow in the eye and/or increased intracranial pressure adversely impacting astronaut health and performance, thereby leading to a mission impact and unfavorable long term health consequences.

ISS Fluid Shift study looking at fluid shifts,

ISS 1 Carbon Metabolism study looking at genetic mutations and relation to astronaut vision issues.



HRP funded rat study looking at fluid shifts, ICP, ocular changes and gene expression

GeneLab

Open Science for Exploration

Biospecimen sharing with Space Biology for Gene lab and looking at other physiological systems (bone, IVD, cardiovascular)

Thank you for listening!

Questions?