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INFORMATION CIRCULAR: IMMUNE SYSTEM IN SPACE.

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While it has been shown that decades of astronauts and cosmonauts suffer from immune disorders both during and after spaceflight, the underlying causes are still poorly understood, due in part to the fact that there are so many variables to consider when investigating the human immune system in a complex environment.

Immune system alterations have been previously characterized as essentially a postflight phenomenon, in animal studies or using terrestrial modeled microgravity or in-flight cell culture. The immune system is a complex weaving of biological structures and processes.

The immune response is affected by the spatial radiation, either solar or cosmic, which can not be contained entirely by the structure of the ship, stress, neuroendocrine response, changes in the pattern of sleep and exposure to the contaminants themselves Inside the ship. Studies have shown in microgravity there are immune system modifications. This may create an environment where, in some crew members, rashes, unusual allergies and latent virus reactivation may present themselves.

Invertebrates have become popular models for studying human disease because they are cheap, highly amenable to experimental manipulation, and have innate immune systems with a high genetic similarity to humans. Fruit flies (Drosophila melanogaster) have been shown to experience a dramatic shift in immune gene expression following spaceflight, but are still able to fight off infections when exposed to bacteria.

Extended exposure to radiation and microgravity in space has been linked to astronauts developing chronic diseases upon returning to Earth.

Data generated early in NASA's Integrated Immune study indicated that the distribution of immune cells in the blood of crew members aboard the space station is relatively unchanged during flight. However, they also revealed that some cell function is significantly lower than normal, or depressed, and some cell activity is heightened. In a sense, the immune systems of crew members are confused.

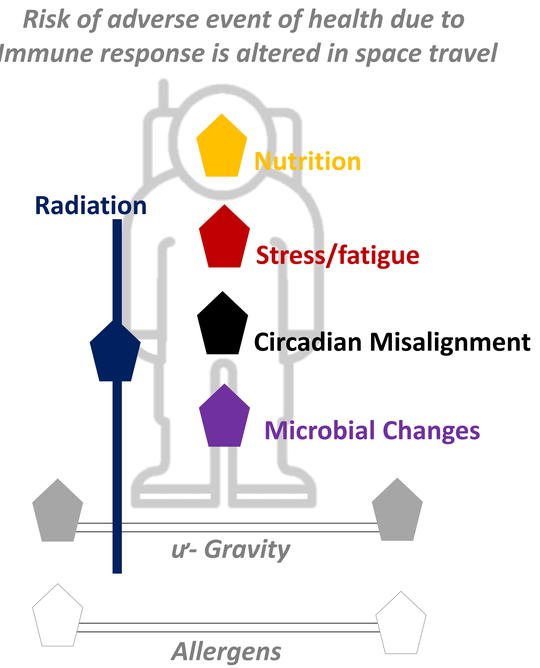
Researchers are also finding latent viruses are reactivating, but do not cause sickness in crew members. Evidence of viral 'shedding', virus DNA present in otherwise healthy individuals, has been found in crew member blood, urine and saliva samples. This can happen anytime the immune system is weakened in microgravity or even in stressful situations on Earth.

The reactivation of latent herpesviruses, including Epstein–Barr virus (EBV), cytomegalovirus (CMV), and varicella zoster virus (VZV), has been well documented in astronauts participating in short-duration spaceflight.

The reactivation of latent herpesviruses in astronauts was recently found to correlate with altered immunity. Should immune alterations persist for the duration of a human Mars mission, it could elevate specific clinical risks to crewmembers including infectious disease, allergies and hypersensitivities, autoimmunity, altered wound healing, and the consequences of persistent latent herpes virus reactivation.

Expedition 30 crew members Dan Burbank and Andre Kuiper perform blood draws for the Integrated Immune investigation. Data collected during the Functional Immune study will build upon findings from this investigation.
Credits: NASA

Astronaut Doug Wheelock collecting saliva sample during spaceflight operations. Image - **Credits: NASA**



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The Gram-negative pathogen Serratia marcescens has been shown to potentially cause significant infections in humans and in insect models on Earth. Our recent findings also showed that S. marcescens shows an increase in virulence after a short period of growth in the spaceflight environment, which raises initiatives to find the correlation between space environment and the increased virulence. Because we know that the health of astronauts is immunocompromised in space, it is possible that the combination of increased bacterial virulence and the weakened immune system will cause astronauts to be more susceptible to chronic diseases in extended spaceflight.

Additional spaceflight experiments have also provided greater detailed information by investigating specific niches aboard spacecraft or using alternative methodologies beyond the culture-based isolation historically used.

Generally, the data indicate that the potable water, air, and surfaces to which the crew are exposed are free of obligate pathogens; however, opportunistic pathogens such as P. aeruginosa, Stenotrophomonas maltophilia, and S. aureus are not uncommon.

The primary post-infection countermeasure during spaceflight is the use of antibiotics; however, several spaceflight experiments have provided evidence suggesting alterations in antibiotic resistance when microorganisms are cultured during spaceflight.

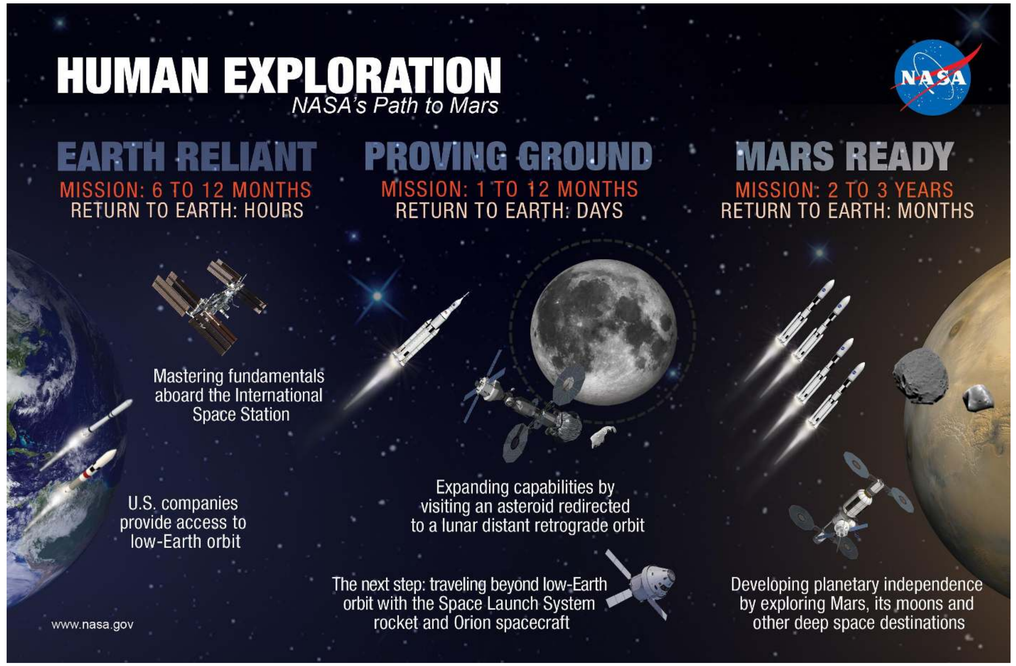
NASA astronaut Kate Rubins removes samples from the Minus Eighty-Degree Laboratory Freezer for ISS (MELFI). Blood, saliva and urine samples will be stored in MELFI until they can be transported back to Earth for analysis.
Credits: NASA

Investigations of immunity immediately after spaceflight may be confounded by the high-G reentry and stressors of readaptation to terrestrial gravity following prolonged deconditioning. Some studies have indicated that the function of various immune subpopulations may be depressed either following or during short-duration spaceflight.

Recommended Reading: NASA (Laurie J. Abadie, Charles W. Lloyd, Mark J. Shelhamer, NASA Human Research Program) - see link: https://www.nasa.gov/hrp/bodyinspace

Consult reports and evidence of human research of NASA "Human Research Roadmap":

- https://humanresearchroadmap.nasa.gov/explore/
- https://www.nasa.gov/content/study-reveals-immune-system-is-dazed-and-confused-during-spaceflight-u
- https://www.nasa.gov/mission_pages/station/research/news/functional_immune



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