Space Station

Research & Technology

Crews & Expeditions
International Cooperation
Launches & Landings
Ground Facilities
Images & Videos
Space to Ground
Facts & Figures
News & Media Resources
All NASA Missions

International Space Station

T-Cell Activation in Aging (T-Cell Act in Aging) - 10.01.14

Overview | Description | Applications | Operations | Results | Publications | Imagery

ISS Science for Everyone

Science Objectives for Everyone

T-Cell Activation in Aging (T-Cell Act in Aging) seeks the cause of a depression in the human immune system while in microgravity. T-cells, a type of white blood cell, have surface chemical receptors that must trigger together to activate the body's immune system properly. Isolated T-cells are flown to ISS and then return for analysis to determine changes in gene response on the ground to determine the role of microgravity on the immune system.

Science Results for Everyone

Information Pending

The following content was provided by Millie Hughes-Fulford, Ph.D., and is maintained in a database by the ISS Program Science Office.

Experiment Details

OpNom T-Cell Act In Aging

Principal Investigator(s)

- Millie Hughes-Fulford, Ph.D., University of California, San Francisco, CA, United States

Co-Investigator(s)/Collaborator(s)

Information Pending

Developer(s)

National Institutes of Health (NIH), Bethesda, MD, United States

University of California, San Francisco (UCSF), San Francisco, CA, United States

Northern California Institute for Research and Education (NCIRE), San Francisco, CA, United States

Sponsoring Space Agency

National Aeronautics and Space Administration (NASA)

Sponsoring Organization

National Laboratory - National Institute on Aging

Research Benefits

Earth Benefits, Scientific Discovery, Space Exploration

ISS Expedition Duration
March 2014 - March 2015

Expeditions Assigned
39/40,41/42

Previous ISS Missions
Information Pending

^ back to top

Experiment Description

Research Overview

- The National Institute on Aging (NIA) and NASA are cooperating to facilitate cellular and molecular biology research in space for a better understanding of human physiology and human health on Earth.
- Crewmembers have lowered immunity to infections during or after space flight.
- The long-term goal of T-Cell Activation in Aging (T-Cell Act in Aging) is to discover the molecular basis of suppression of T-cells in space flight.
- The correlation between the natural reduction in immune function that occurs over time in the elderly population and space flight-associated immune function repression observed in astronauts is analyzed.
- Another objective of T-Cell Act in Aging is to identify altered mRNA expression in the lowered activity of T-cells in microgravity as compared to 1g onboard controls. Recently, the Hughes-Fulford Laboratory discovered an altered microRNA (miRNA) expression in microgravity and now hypothesize that altered miRNAs expression may provide new information on the impaired immune response in astronauts and the elderly. A major goal of this experiment is to elucidate the function of miRNA in immunosuppression.

Description

Over 50% of the Apollo astronauts had bacterial or viral infections during flight, or within 1 week of landing. Apollo 7 marked humanity's first experience with space flight infection when all three crewmembers contracted head colds during their mission. On Apollo 13, one astronaut contracted an infection which rarely causes disease unless the person suffers from immune suppression. As a result, NASA implemented a preflight quarantine program that subsequently reduced the number of reported infections to one Apollo astronaut. To this day, the preflight quarantine program is still actively used in both the US and in the Russian programs.

Experiments from Skylab and Shuttle have confirmed that T-cells have a suppressed immune response (in vivo and in vitro) with lower T-cell proliferation/activation, lower IL-2 synthesis and severely reduced IL-2R expression (RNA and Protein); these blunted immune responses are also seen in the immunosuppressed elderly. Recent ISS data shows T-cell activation and selected gene expression is decreased in microgravity when compared to onboard 1g controls.

The change in the immune function of the elderly occurs over a long period of time and results in a significantly reduced ability to combat infection and disease. However, the root cause of these changes is poorly understood. The same types of changes in immune response occur in healthy crewmembers during microgravity exposure. The microgravity-influenced changes in immune cells were found to occur rapidly at the molecular level, which means microgravity provided an excellent platform to investigate immune functional changes that normally occur over a very long period of time. A critical step in the immune response to infection is the activation of the T-cell. Recent space flight studies of T-cell function in rodent and isolated T-cells led to the discovery that T-cell activation was suppressed under the microgravity condition and left to the identification of candidate molecular regulatory

factors that may be involved in loss of immune response. T-Cell Activation in Aging (T-Cell Act in Aging) also studies other critical aspects of T-cell activation by examining the production of very early cytokines and their receptors.

T-Cell Act in Aging aims to identify the gene expression pattern of the candidate molecular regulators under microgravity versus 1g conditions. It also hopes to identify the target genes of the candidate molecular regulators using bioinformatics analysis of gene array data and to also verify changes in expression of those target messages (qRTPCR) for the microgravity environment. T-Cell Act in aging also plans to analyze the protein synthesis of predicted target genes affected by T-cell activation under normal and altered gravity conditions. Lastly, this investigation intends to compare the expression of candidate molecular regulators and other genes found in the microgravity experiment to activated T-cells from the older population (over 65 years).

Scientist believe information gained from comparing flight and ground controls will provide further insight into understanding and identifying specific factors that may play a critical role in immune function loss during aging. The discoveries made from T-Cell Act in Aging may lead to the development of medical treatments used to maintain normal immune function throughout life on Earth and in space.

Aim: Determine the cause of immunosuppression in space flight.

Specific Goals:
1) Perform transcriptomics (gene array of human genome)

2) Identify molecular pathways that are dysregulated

3) Find new therapeutic targets for treating immune dysfunction

4) To compare data from gene arrays in spaceflight with normal and aging patients

5) Discover new potential therapeutic targets to treat immune disease

Parameters Measured:
1) Expression of all human genome using microarray (postflight analysis)

2) Expression of key genes (identified from microarray) using quantitative real-time rtPCR

3) Measure and determine microRNA small regulators regulate the changes in function

4) Analyze gene arrays to determine differences in normal conditions as well as space flight and aging populations

^ back to top

Applications

Space Applications

Maintaining the immune system is essential for crew health during long space missions, especially beyond Earth orbit where major medical facilities are out of reach. Results from T-Cell Act in Aging will help researchers develop better protective measures to prevent disease in flight crews.

Earth Applications

A clear understanding of how the immune system is activated or suppressed will help in treating a range of auto-immune diseases such as arthritis and diabetes, and in treating the natural decline of the immune system as people age.

^ back to top

Operations

Operational Requirements

1) A preflight laboratory is required at Kennedy Space Center for preparation and T-cell isolation from donor blood. T-cell isolation starts immediately after blood draw. The specimen and fixative are loaded into the Experimental Container (EC) system, followed by a check of the loaded hardware. After check, the EC is loaded into an ambient stowage bag and returned to the KSC cold stowage team.

2) A late prelaunch load into the capsule is required.

3) The experiment must be activated by insertion into the KUBIK incubator on the ISS by no later than 75 hours after launch date due to the limited life of the specimens. It is critical for the stowage bag containing the specimens to be easily identifiable by the ISS crew for quick identification during capsule unloading. For every hour over the activation time requirement, 5% of scientific data is lost due to specimen viability.

4) The PD meets the cold stowage team at a designated location near the docking port where the samples are handed over for return to the PI's laboratory.

Operational Protocols

1) Transfer experiment containers (ECs) from passive conditioned temperature stowage to KUBIK as follows:

a. Install ECs (10 each) into the +37°C prewarmed KUBIK incubator.
b. Place 6 ECs in the static rack and 4 ECs in the 1g onboard centrifuge.

2) Preincubation is set at 37°C ±1°C for 2.5 hours (minimum 1.5 hours, maximum 4 hours).

3) Add fixative to 2 ECs in the static rack at the end of the preincubation step (t=0; unactivated controls; the Crew depresses the plunger on the culture cassette to add the activator to the T-cell culture).

4) Transfer these ECs to cold stowage no later than 4.5 hours after the fixative is added.

5) Add activator to the remaining 8 ECs at the end of the pre-incubation step (the Crew depresses the plunger on the culture cassette to add the activator to the T-cell culture).

6) Incubate the activated ECs and then add fixative as follows (Crew depresses a second plunger to add fixative to the T-cell cultures).

a. Add fixative to 4 ECs (2 EC in the static rack, 2 ECs in the 1g onboard centrifuge) after 2 hours ± 10 minutes of incubation post activator addition.
b. Transfer to cold stowage.
c. Add fixative to 4 ECs (2 in microgravity, 2 in 1g) after 24 hours ±30 minutes of incubation post activator stowage.
d. Transfer to cold stowage.

7) Transfer samples to the refrigerated/frozen conditioned container and then transfer the container to SpaceX Dragon for decent stowage.

^ back to top

Results/More Information

Information Pending

^ back to top

Related Websites

Hughes-Fulford Laboratory

^ back to top

Imagery