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Translational Research Institute for Space Health (TRISH)

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Broad Institute Announcement

Overview Information

The Translational Research Institute for Space Health (TRISH), hereafter generally referred to as "we, us, our, or TRISH" is an applied space health research institute that funds disruptive, high-impact scientific studies and technologies to equip astronauts for deep space exploration. Founded on October 1, 2016, TRISH works in partnership with NASA's Human Research Program (HRP) through Cooperative Agreement NNX16AO69A. Led by Baylor College of Medicine's Center for Space Medicine, TRISH's consortium leverages partnerships with Caltech and Massachusetts Institute of Technology (MIT). More details on TRISH, its mission and funding opportunities can be found on our website. Join TRISH's Orbit Rendezvous to stay connected with TRISH's community.

TRISH relentlessly pursues and funds novel research to deliver high-impact scientific and technological solutions that advance space health and help humans thrive wherever they explore, in space or on Earth. Since its inception, TRISH has funded 178 innovative projects involving 101 organizations across 30 states, with international participation spanning 12 countries, demonstrating the breadth and impact of space health research globally. As an institute dedicated to promoting space health discoveries and technologies, TRISH is accelerating research that will benefit all people with a future in deep space and here on Earth.

To achieve this vision, TRISH employs a deliberate, tiered approach to research investment. TRISH utilizes multiple procurement mechanisms, from academic partnerships to early-stage biotech to mature technology companies, that enable us to match funding mechanisms to the maturity level of the challenge, ensuring innovations progress efficiently from laboratory validation through operational spaceflight deployment. This breadth allows us to award research funding to approach a problem in the most efficient way possible. In this Broad Institute Announcement, we will outline the TRISH science initiatives that govern the areas of interest for scientific research investment. This document does not include any specific solicitations for proposals but is a resource for those interested in proposing to TRISH to understand our vision. This is a living document that may be updated as necessary by TRISH. For open TRISH solicitations please refer to the following sites: https://www.bcm.edu/academic-centers/space-medicine/translational-research-institute/funding, Grant Research Integrated Dashboard (bcm.edu), NSPIRES - NASA Research Opportunities Online (nasaprs.com).

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Science ENterprise to INform Exploration Limits (SENTINEL)

NASA's Artemis missions will place astronauts in lunar orbit and on the lunar surface where they will experience deep space exposure on par with the Apollo missions. As the mission profiles progress, the Artemis exposure durations will far exceed the prior Apollo experience. Therefore, it is imperative that the space life science community has the tools to study the effects of long-duration and deep space exposure and test ways to prevent and mitigate its potential negative effects. The upcoming Artemis missions provide an unprecedented opportunity to understand the risks of deep space exploration as well as approaches to managing those risks.

The Science ENterprise to INform Exploration Limits (SENTINEL) initiative is TRISH's foundational effort to advance automated tissue chip technology for deep space exploration. SENTINEL funds development of standardized, autonomous microphysiological systems (MPS), also called tissue chips, that integrate in-line sensing and in-situ analysis capabilities to generate real-time data without requiring human intervention or sample return to Earth. This technology addresses a critical knowledge gap of understanding how human tissues respond to deep space radiation and microgravity, informing both countermeasure development and personalized medicine approaches for long-duration missions. Traditional approaches to characterizing deep space risks, which rely on ground analogs or ISS research with post-mission Earth-side analysis, offer limited and incomplete translatability. SENTINEL's automated tissue chips overcome this limitation by enabling time-course, dose-response, and mechanistic studies while systems remain in space, with data transmitted in real-time. This approach delivers actionable insights far faster than conventional methods and enables adaptive countermeasure testing during actual deep space exposure on future missions.

SENTINEL's MPS approach can be deployed as single-organ systems for focused mechanistic studies, or as multi-organ systems that model complex physiological interactions. Notably, SENTINEL chips can be deployed independently of astronauts, enabling continuous deep space research without crew time burden. Data extraction is possible in-flight, eliminating the need to physically return samples to Earth, representing a shift in how we conduct space biology research. Successful research and technology development in this area would improve the capability to test the effects of the realistic, deep space radiation environment on a tissue as well as the impacts of medications or other interventions. In addition, these systems are also being matured and validated with the goal of facilitating personalized and precision medicine. One can imagine the day when physicians can use cells acquired from a patient to diagnose and test treatments on that individual's engineered tissues and organs before ever having to introduce more risk to the patient. This is also the vision for space explorers given the remote, hostile, and austere environment in which they live and work that requires certainty and disciplined risk management. This approach during the Artemis missions and emerging commercial spaceflight opportunities will allow the MPS payloads to experience deep space exposures similar to those anticipated for exploration class missions and return data throughout the deep space exposure. Thus, these MPS would enable researchers to conduct time-course, mechanistic and countermeasure development studies while the MPS remain in space.

SENTINEL is transitioning from foundational technology development and automation engineering toward applied dose-response studies and countermeasure validation. Upcoming solicitations will prioritize standardization frameworks, multi-tissue integration approaches, and radiation biology mechanistic studies that create a transferable knowledge base applicable to both spaceflight and terrestrial drug discovery. The long-term vision extends to precision medicine: pre-mission deployment of personalized tissue chips derived from individual astronaut cells into the space environment to predict and optimize risk mitigation strategies tailored to that crew member's unique physiology. This approach transforms space medicine from a one-size-fits-all model to individualized countermeasure planning. The end goal of the SENTINEL initiative is to provide the space life science research community and ultimately NASA space medicine with effective and reliable tools to preserve astronauts' health span and ensure a performance-ready state during and after the mission.

Topics or Focus Areas of Interest

Automated Tissue Chips

The development of autonomous MPS systems that do not require human tending. TRISH has funded one project in this area titled "Creating non-human tended microphysiological systems" (Principal Investigators: Dr. Gordana Vunjak-Novakovic and Dr. Sharon Gerecht) to develop this autonomous platform. This effort will enable studies to be conducted on uncrewed missions or those with limited crew time. Once autonomous capabilities are engineered, and a platform developed, the vision would be to integrate any tissue of interest into the platform for testing in concert with others.

Automated Analysis in Tissue Chips

The development of automated in-line sensing and in-situ analysis capabilities that can be broadly applied to various types of MPS systems. These capabilities would eliminate the need for a human in the loop analysis and sample return by only transmitting data back to Earth.

Countermeasure Development and Testing

Following the successful development of the first two topics/focus areas listed above it will become important to use this platform to test countermeasures to well understood spaceflight risks that might be useful to space travelers in the future.

Human and Environmental Research Matrix for Exploration of Space (HERMES)

The Human and Environmental Research Matrix for Exploration of Space (HERMES) initiative solves a critical operational problem by ensuring continuity of care across multiple spaceflight vehicles operated by different commercial providers. HERMES enables seamless health data integration and accessibility, allowing space and ground-based medical teams to monitor crew status, respond to emergencies, and adapt research in real-time, all regardless of which spacecraft the astronaut occupies. NASA's Artemis architecture and the emerging commercial spaceflight ecosystem both depend on multi-vehicle architectures where astronauts transition frequently between spacecraft from different operators. Without standardized data infrastructure, critical health information becomes fragmented across incompatible systems. Continuity of access to health and performance data is key for safeguarding the astronaut, assessing immediate health and performance risks, and making informed and timely decisions. The HERMES initiative involves the development of a data acquisition, data ingestion, data management, and data usability framework to support network infrastructure, biomedical peripherals, and end users of the collected data.

HERMES will be developed in phases that started with the initial Human and Environmental Research Matrix for Exploration of Space (HERMES) solicitation to design and build the networking infrastructure to facilitate the movement, storage, and distribution of biomedical data from source to user. The HERMES funding opportunity solicited for the predominantly software-based, semi-autonomous platform that seamlessly intakes, manages, and moves biomedical data gathered for research and clinical purposes and enables the data to follow the astronaut to any spaceflight venues they visit, whether that be a spacecraft or any other future space destination.

The envisioned platform, when fully completed, will allow continuity across missions and space vehicle operators as astronauts adapt to new space environments. By aggregating medical, research, environmental, and mission data together and having it follow the crewmember, all the necessary data is aggregated in proximity to the astronaut and available to develop and test autonomous medical systems of the future and allow more seamless remote medical care until autonomy is established.

Topics or Focus Areas of Interest

Human and Environmental Research Matrix for Exploration of Space (HERMES)

TRISH selected two companies to undertake the initial development of HERMES, TrialX and Ejenta. Both companies independently developed a robust, scalable, and interoperable network platform that can be used in different spaceflight vehicles that will enable usability and access to a spaceflight participant's data by algorithmic users, human users on Earth (including clinicians), researchers and the individual themselves.

Develop Artificial Intelligence (AI) and machine learning (ML) Tools

Develop and validate artificial intelligence and machine learning models that interpret real-time HERMES data streams to identify early biomarkers of health concerns, enabling predictive alerts to crew and ground-based medical teams. These tools are especially critical for long-duration missions where communication delays prevent instantaneous consultation, requiring semi-autonomous decision support. This approach will be especially helpful when astronauts are far from Earth and communication delays exist.

Advance Remote Medical Tools

Advance medical technology tools and sensors that can easily integrate into the HERMES system. Multi-use tools are of great interest. Small footprint, low burden tools (low mass, power, volume, and training needs) that are capable of producing clinical quality data for diagnostic and therapeutic capabilities.

Enhancing eXploration Platforms and ANalog Definition (EXPAND)

TRISH's Enhancing eXploration Platforms and ANalog Definition (EXPAND) program represents a fundamental shift in space health research infrastructure through standardizing data collection, biosampling, and study design across commercial spaceflight operators, creating the first harmonized research ecosystem for private spaceflight. Initiated with the Inspiration4 mission in 2021, EXPAND now encompasses > 50 private spaceflight participants across 15 missions with four commercial partners (SpaceX, Axiom Space, Blue Origin, Space Adventures), with international participation spanning 12 countries and over 100 institutional collaborators. TRISH's EXPAND Program collects pre-, in-, and post-flight data from private spaceflight missions and houses it in a centralized database.

In 2023, TRISH continued to build upon this new program by (1) harmonizing NASA's Standard Measures and TRISH's Essential Measures, (2) supporting the SpaceX, Axiom Space, and Blue Origin commercial spaceflight missions, (3) developing a TRISH EXPAND Database in which to store all data from commercial spaceflights, (4) developing a Space Omics program and biobank in collaboration with Baylor College of Medicine's Human Genome Sequencing Center, and (5) establishing a Data Privacy and Release Board (DPRB).

EXPAND's analog component extends space health research to Earth via partnerships with extreme environment facilities, notably the Australian Antarctic Division. These analogs enable ground-based validation of countermeasures and technologies in conditions that closely approximate spaceflight stressors such as isolation, confinement, microgravity analogs like parabolic flights, and psychological demands. These analogs serve the dual purpose of both validating technologies before spaceflight deployment, and generating comparative data that demonstrates the translation of space health innovations to terrestrial applications in emergency medicine, remote medicine, and extreme environment performance. We see the EXPAND program as a testing ground for mature technologies that have proven themselves in earlier testing and are ready to be tested in analog and spaceflight environments. Successful technologies, countermeasures and other solutions developed through TRISH's initiatives as well as via other funding sources could be tested through the EXPAND program once they have proven themselves in a laboratory environment.

In future years TRISH plans to continue to grow its relationships with commercial spaceflight companies and offer EXPAND as a complement of scientific studies that can help to bring benefit not only to support future Artemis goals but also to enable better healthcare on Earth as well.

TRISH Essential Measures

TRISH Essential Measures represents a coordinated suite of standardized biomedical assessments designed for consistent deployment across all commercial spaceflight missions. Harmonization with NASA's Standard Measures ensures that comparative data from diverse crews, vehicles, and missions can be aggregated, analyzed, and leveraged for hypothesis-driven research without compatibility issues. This complement has been designed to maximize the collection of valuable information while minimizing the crew time and up-mass requirements. Given that all current commercial spaceflight missions are short in duration, these projects have been selected based on physiologic changes expected in missions less than one month. TRISH Essential Measures also collects data, samples, and medical data pre- and post-flight in addition to including environmental and mission data from the spacecraft. While this complement of research is designed to remain the same between missions and thus new studies to it will be rare, the data and samples collected will be stored in the EXPAND database and will be available for hypothesis driven research as reviewed by the DPRB, both described below.

Space Omics Project Assays

The Space Omics project leverages Baylor College of Medicine's Human Genome Sequencing Center to deploy CLIA-certified genomic, transcriptomic, and proteomic assays on commercial spaceflight missions. These omics datasets, integrated with physiological, environmental, and behavioral data through the EXPAND database, create a systems-level understanding of how spaceflight stressors alter human biology at the molecular level. This comprehensive molecular phenotyping enables identification of biomarkers for health risks, discovery of countermeasure targets, and understanding of individual variation in spaceflight response. All data collected for Space Omics will be stored in the TRISH EXPAND Database.

The EXPAND Database

TRISH's goal is to provide a state-of-the-art integrated medical, research, and environmental knowledge bank as well as a repository for biological samples. EXPAND captures research, medical data and biospecimens from all volunteering commercial spaceflight participants. Requests to use this data or acquire bio-samples for hypothesis driven research will be reviewed by the DPRB, described below, on a case-by-case basis.

Data Privacy and Release Board

The EXPAND Data Privacy and Release Board (DPRB) was established to ensure that spaceflight data and rare samples are used in the most appropriate way possible while maintaining the privacy of the spaceflight participants themselves. The DPRB has ten members with institutional and scientific discipline diversity to ensure a well-rounded board. The purpose of the DPRB is to review data and bio-sample requests made through the EXPAND data/sample request process.

Analogs

TRISH's analog strategy leverages extreme Earth environments as proving grounds for space health innovations. The partnership with Australia's Antarctic Division provides access to one of the world's most austere environments characterized by multi-month isolation, communication delays, limited medical resources, and intense psychological demands. Data from these studies also inform Earth-based applications in polar research, remote medicine, and emergency response. TRISH is expanding the analog portfolio to include additional extreme environment partners, recognizing that space health innovation serves human resilience across all extreme environments.