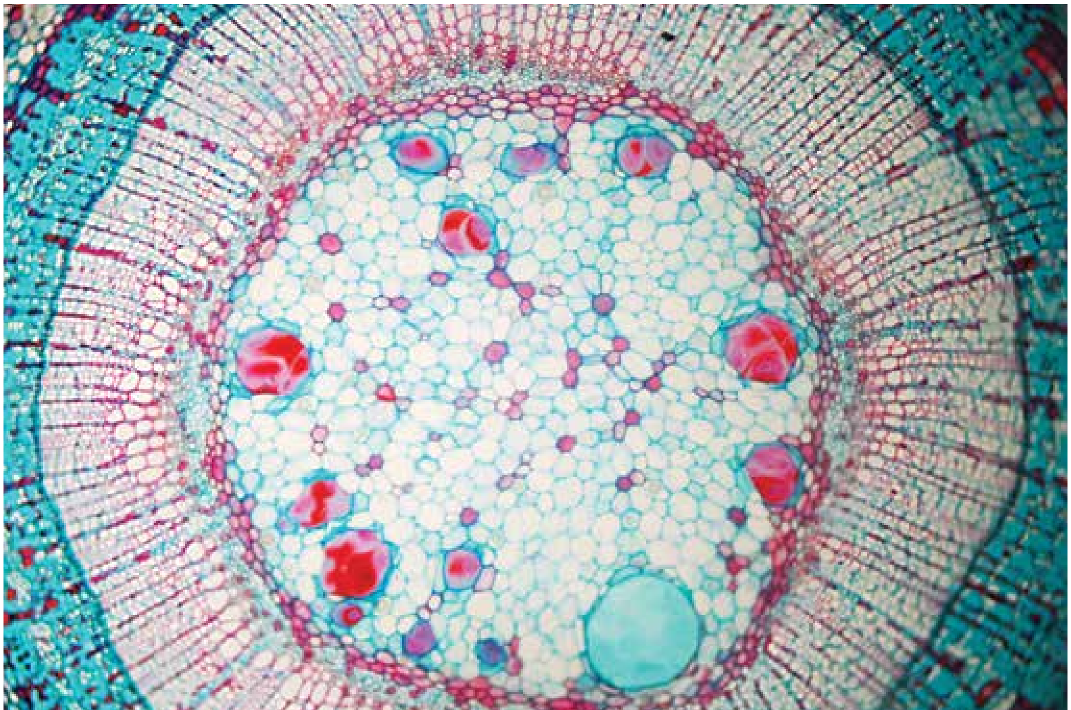
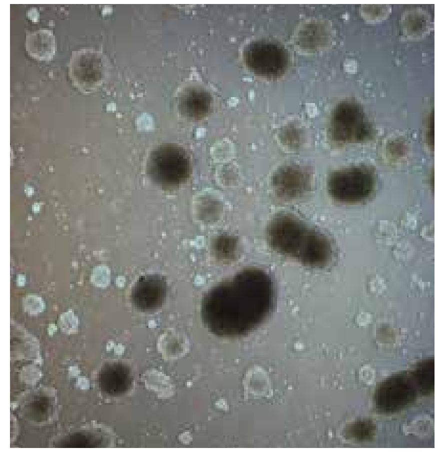


Microgravity induces a vast array of changes in organisms.

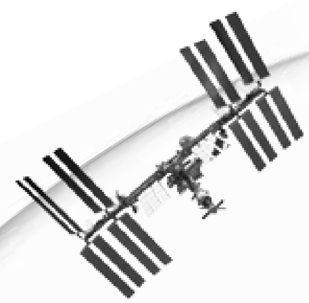
The International Space Station U.S. National Laboratory provides an extraordinary research platform for experiments in the biological and medical sciences. Microgravity induces a vast array of changes in organisms ranging from bacteria to humans, including global alterations in gene expression and three-dimensional aggregation of cells into tissue-like architecture. Moreover, studies of astronauts reveal a variety of spaceflight-induced health conditions, many of which may serve as models of ground-based ailments such as aging and trauma. Research into these and other effects of the space environment may advance pharmaceutical development and augment Earth-based studies in basic and human biology.



Features of space science

Effects of microgravity:

- Altered gene expression results in phenotypic consequence, including changes in cellular immune function and microbial growth and virulence.
- Cell cultures show altered processes of differentiation and cell communication, including increased pluripotency of stem cells.
- Tissue cultures grow in three dimensions.
- Changes in body systems result in bone loss, immuno-suppression, vision changes, viral reactivation and loss of skeletal muscle mass and strength, among other effects.



Easier in space:

- Some studies show growth of larger and more highly ordered crystals of proteins and large molecules (versus ground studies).

Novel in the space environment:

- The radiation environment in space includes high-energy protons and atomic nuclei of heavier elements.

Exploiting space-specific phenomena

- Use phenotypes of altered gene expression to study biological processes, such as virulence or protein and antibiotic production.
- Observe how cell cultures respond to space-related stressors and various altered processes.
- Complement traditional whole-genome sequencing and microarray technologies with new advances in metagenomics and techniques such as deep sequencing to examine microbial communities in space.
- Use 3-D tissue cultures to repeat ground-based studies of pharmaceutical effectiveness, necrosis and tissue growth techniques.
- Study microgravity-induced health conditions in animal models to inform the treatment of ailments such as osteoporosis, immunosuppression and shingles, as well as the prevention of age-induced physiological changes.
- Potentially crystallize proteins and large molecules for which ground-based crystallizations efforts have been unsuccessful.
- Obtain more detailed 3-D crystal structures of proteins and large molecules.
- Evaluate the varied capabilities of organisms and organic material to survive and mutate in space.

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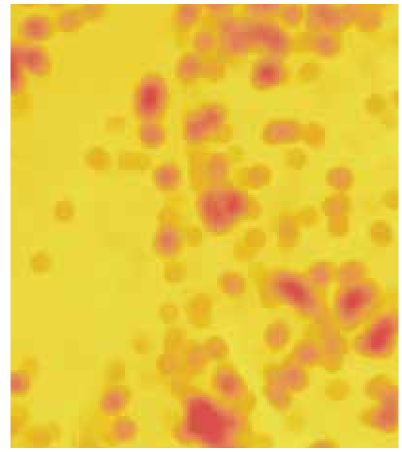
RESEARCHER'S FACT SHEET: *Biomedical Sciences*



ISS photos courtesy of NASA.

Relevance & potential market applications

- Novel pharmaceutical design/targets based on a better understanding of pathogenesis, as well as improved production methods and higher sensitivity and specificity of drugs.
- Development of viral vaccines and new drug treatments (e.g., for HIV, Parkinson's or heart disease).
- Elucidation of conserved molecular pathways, informing fields such as evolutionary biology, stress response and energy conservation.
- Elucidation of biological pathways and characteristics of cell interactions.
- Improved understanding of microbial populations, informing fields such as cell communication, quorum sensing, systems biology, and studies of biofilms and the microbiome.
- Increased translational relevance of studies on cell/tissue behavior and response to stimuli (such as pharmaceutical testing).
- Advanced tissue engineering and regeneration.
- Design of approaches to improve wound healing; for example, in combat settings.
- Advancements in therapeutic approaches to diseases on Earth and antiaging biology.
- Increased ability to use crystal structures to identify protein function and target sites for therapeutics.
- Improved understanding of organic material behavior in space, informing studies of the origin, evolution, distribution and future of life (e.g., prebiotic chemistry or whether life can be transferred between planets).

To learn more, contact CASIS: **info@iss-casis.org**

The Center for the Advancement of Science in Space (CASIS) manages the International Space Station U.S. National Laboratory, supporting space-based research that seeks to improve life on Earth. The National Lab is now open for use by the broad scientific community—and CASIS is the gateway to this powerful in-orbit research platform. For more information, visit **www.iss-casis.org**.

For information on specific experiments in space, including resulting publications and patents, scan the code to your left.