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Life and Microgravity Sciences on board ISS and beyond (Part II) (7)

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TRANSLATIONAL OMICS RESEARCH ON THE INTERNATIONAL SPACE STATION

Abstract

Sequencing of the human genome ushered a paradigm shift for life sciences, enabled by the advent of pioneering technologies to collectively characterize comprehensive sets of biomolecules at cellular, tissue, organ, and organismic levels in various domains, classified as omics. Research in the emerging field of omics is opening new possibilities for insight into biological processes, with translational applications in Earth and space biomedicine. These high-dimensional biology approaches are revolutionizing systems biology, facilitating development of personalized strategies. The International Space Station (ISS) is an extensive orbiting research laboratory advancing science and technology in a wide range of disciplines. Omics studies on ISS cover a broad array of areas, including genomics, epigenomics, transcriptomics, and proteomics. For example, OsteoOmics is a NASA investigation that compares genomics, signaling pathways, proteomics, and metabolomics of different types of bone cells in true versus modeled (via electromagnetic levitation) microgravity, aiming for more effective countermeasures and therapies. The JAXA Cell-Free Epigenome investigation (Genome and epigenome analysis of circulating free DNA- and RNA-based liquid biopsy) profiles genetic and epigenetic information in blood to assess tissue integrity and cellular status, which could be used to identify targets for drug development or biomarker candidates. Data from this study will be compared with data from the Mouse Epigenetics investigation. Cell Science-02 is a NASA investigation that uses a pan-omics approach (transcriptomics, genomics, proteomics, metabolomics, epigenomics) to examine biochemical mechanisms of wound healing toward growing complex tissues, which may help identify molecular circuits of therapeutic significance. Its results will be contrasted with those from the Rodent Research-4 bone tissue regeneration multi-omics study. Objectives of the ESA investigation InVitroBone include evaluating the effect of microgravity on epigenetic regulation of hMSC (human mesenchymal stem cells) through analysis of the methylome, which may provide insight into age-related bone loss. And Medical Proteomics is a JAXA study that applies proteomic methodologies to identify protein expression patterns related to osteopenia, which may benefit diagnosis and treatment of osteoporosis. Other ISS investigations involving omics include Twins Study, NASA's first foray into integrated human omics, and JAXA's Multi-Omics, which explores human microbial-metabolic coss-talk. In addition, NASA's GeneLab open science platform is providing coordinated genomics, proteomics, and metabolomics data, which could help find gene-based therapies, facilitate drug development, and create improved diagnostic tools, while advancing the field of genomics. Lastly, increased ISS capability for biomolecular analyses is opening a new era for omics research in space, with benefits for humanity.