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Editorial

A New Era of Space Omics

Y. Hameda*

Department of Agriculture and Farmers Welfare, Visayas State University, Baybay City, Philippines

Corresponding Author
Y. Hameda
yeohameda@gmail.com

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1. Editorial

Omics technologies enable cost effective, high throughput analysis of living molecules. Innovative advances in genome sequencing, bioinformatics and analytics tools (e.g., mass spectrometry) as well as high output technologies have led to recent advances. These technologies provided crucial insights into biological processes and helped unravel the complexity of human diseases. We are entering a new era of human space exploration as both NASA and other international and private organizations plan to return to the moon and send the first humans to Mars. With these big plans, there is a demand to develop new and tougher international standards for space research. Astronauts around the world are experimenting with microgravity at the International Space Station (ISS). However, due to the lack of standard methods, it is difficult for external scientists to use data generated in their own research. To address this, the International Standards for Space Omics Processing (ISSOP) was established. ISSOP is an international consortium of scientists aimed at improving the standard guidelines among space biologists at the global level. In this blog, we will explore the challenges of spaceflight Omics and the benefits that this consortium will bring in preparing for the coming space life science era.

1.1. International Standards for Space Omics Processing

Omics technologies can produce a vast amount of data, and the proper extraction of scientific insights that can take action from these complex datasets can only take place with better standardization and communication internationally. Conducting biological research in space travel presents unique technical and biological challenges. To ensure its success, these challenges must be addressed specifically by the international space biology association. In response, ISSOP consortium was formed. Members include scientists who conduct space omics experiments funded by multiple space agencies in Japan (JAXA), Europe (including delegates from the European Space Agency (ESA) space omics topical team) and the United States (NASA). They specialize in the processing of space omics models, implementation of multi omics and systems biology approaches, and generalization of spaceflight metadata. The consortium was also briefed on the latest developments in government, industry and academia. Their goal is to develop, share and promote the sample processing standardization and metadata generalization of spaceflight omics experiments. This allows for better coordination of data and enhances knowledge.

1.2. Lessons Learned from Previous Space Omics Studies

The consortium recently published a series of 29 studies in the journal of cell. In the first publication, a new era for space life science: International standards for space omics processing, the authors address some of the unique technical and biological challenges at each stage of space omics experiments. Some of these challenges are summarized below:

Limitations in space, time, and finances: First, capability limits on orbital platforms limit the number of experimental replicas and variables. Second, crew time is exceptionally limited to experimental approaches in spaceflight. Third, it is difficult to repeat unsuccessful experiments experimental approaches in spaceflight. Third, it is difficult to repeat unsuccessful experiments due to logistic and financial constraints and wait longer compared to experiments on Earth.

Hardware and housing: Biological experiments in space are rarely performed using standard ground equipment. The ongoing challenge is to develop specialized hardware and housing technology that can operate in spaceflight conditions. Communication between academia, government and industry is crucial, as is developing and improving hardware designs.

Sample collection: There are often inconsistencies in how staff obtains samples for analysis due to time and financial constraints.

Sample care: Adequate preservation of specimens in the ISS is an ongoing challenge and barrier to capturing unchanged biological responses.

Data duration and distribution: The space omics community must create a database unique to the characteristics of the space omics data. NASA GeneLab's first comprehensive space omics database. Its goal is to optimize scientific revenue from spaceflight and ground simulation experiments. The repository currently contains more than 300 transcriptomic, epigenome, proteomics, metabolomics, and metagenomics datasets from space experiments on plants, animals, and microorganisms.

Data sharing: Sample partnership schemes must be used to maximize innovation and reproduction efficiency among researchers in the field of space omics. For example, sharing a simple bio bank and sample processing facility is ideal. Space omics sharing schemes have already been implemented in Japan and the United States.

1.3. Future Directions

ISSOP aims to provide concrete solutions to some of these challenges described in order to reduce confounding factors and promote harmonization and interoperability between space omics datasets. This in turn will increase the accuracy of space omics studies. In the future, ISSOP aim to develop space omics recommendations across individual omics assays. They also hope to create guidelines for promising molecular biology laboratory techniques. An important component of future experiments and project sharing will be digitization of sample handling using advanced robots. ISSOP can leverage lessons learned and develop an informed framework that can maximize scientific discovery while minimizing ethical problems that may arise. Standardization of space omics data through ISSOP could pave the way for cell space atlases and precision spaceflight medicine, which will improve the safety of humans traveling through space.

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