SPACE LIFE SCIENCES SYMPOSIUM (A1)
Biology in Space (7)

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CURRENT TRENDS IN HIGH THROUGHPUT METHODS FOR IN-SITU SPACE RESEARCH.

Abstract

Over the last two decades high throughput methods have revolutionized the field of biology. The key components of this new approach are genomics, proteomics and metabolomics, collectively known as "omics". They are aimed at studying content and activity of the full complement of genes, proteins and metabolites, respectively, in an organism or a consortium of organisms. Even though "omics' approaches are relatively new, they are already widely used and have yielded many important insights to biology and medicine. In the half-century of space exploration multiple lines of evidence have accumulated to state with near-certainty that effects of space environments are not limited to a single gene or even a small number of genes, or a single subcellular component, but instead influence many genes and cell functions. This implies that they should be studied using global, integrative methods. This, in turn, means, that "omics" approaches are not only helpful, but are indispensible for space biology. To achieve the expected advances from "omics" technologies, the current paradigm of performing data analyses post-flight should change to include "omics" tools for *in situ* research. However, developing "omics" instruments for space applications remains a challenge even in the case of mature methods. Among contributing factors are the need for substantial miniaturization and automation, compatibility of all protocols and materials with conditions in space, safety issues and the requirements for low power and operation independent of the direction of the gravity vector. We will discuss which "omics" technologies are currently amenable to adaptations for space applications and how these adaptations can be achieved. We will review ongoing efforts aimed in this direction and discuss scientific benefits that they might bring. In this context, we will argue that, with sufficient commitment, at least some instruments for high-throughput measurements could be ready for deployment on-board spacecraft in the next 2-3 years. Once developed and deployed, "omics" tools can be used for a wide variety of high-value studies on biological systems ranging from microorganisms to humans that hold significant potential for discoveries in space biology, biotechnology, pharmacology and medicine.