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Biology in Space (7)

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GENE EXPRESSION MEASUREMENT MODULE (GEMM)- THE DOOR TO HIGH-THROUGHPUT IN-SITU ANALYSES OF BIOLOGICAL SYSTEMS IN SPACE.

Abstract

To date, high-throughput in-situ analyses of biological material from experiments carried out on the International Space Station (ISS) can be performed only after returning samples to Earth. This limits our ability to conduct efficient, hypothesis-driven research, save astronauts' time, and reduce requirements for down-mass. In order to eliminate these barriers to biological research on the ISS we are developing GEMM (Gene Expression Measurement Module) - an automated, miniaturized, integrated fluidic system for in-situ measurements of gene expressions in bacterial and tissue samples. The instrument is based on a GEMM that is being developed for deployment on nanosatellites. The integration and end-to-end technology validation of the latter instrument, scheduled for completion later this year, will be discussed.

Measurements of gene expression with the aid of GEMM will help us understand adaptation of terrestrial life to conditions beyond the planet of origin, identify deleterious effects of the space environment on a wide range of organisms, develop effective countermeasures against these effects, determine metabolic basis of microbial pathogenicity and drug resistance, test our ability to sustain and grow in space organisms that can be used for life support and in-situ resource utilization during long-duration space exploration, and monitor both the spacecraft environment and crew health. These and other applications hold significant potential for discoveries in space biology, biotechnology and medicine.

The ISS version of the GEMM, the size of which is approximately 12X12X7 inches, will be capable of (1) lysing bacterial cell walls, (2) extracting and purifying RNA released from cells, (3) hybridizing it on a microarray and (4) providing readout of hybridization signal. The GEMM will consist of a self-contained, disposable microfluidic cartridge and a companion, processing instrument that automatically controls all the processes on the cartridge and scans the resulting hybridized array. The key aspects of the instrument are its versatility, simplicity of use and modest costs of experiments. The universal, disposable cartridge will contain all the reagents and consumables for sample processing and microarray hybridization. To install the cartridge, a crew member will simply slide the GEMM processing unit out and inserts the cartridge into the instrument. This design allows for carrying out multiple experiments conducted by different investigators. Furthermore, the modularity of the system enables the use of the sample preparation system, which performs cell or tissue lysis and nucleic acid extraction/purification, for other downstream applications onboard the ISS, such as Polymerase Chain Reaction instrument in Wetlab2.