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

Abstract

A central, long-standing goal of the astrobiology program that holds promise for both major scientific discoveries and exciting the general public is to understand life in outer space and on other celestial bodies. One strategy towards achieving this goal is to determine the potential for terrestrial microbial life to adapt and evolve in space environments. Identifying the limits of terrestrial life in space and the accompanying molecular adaptations is a prerequisite for developing predictions and hypotheses about life on other worlds. The ability of microorganisms to survive in a wide range of conditions encountered in space would support the hypothesis that terrestrial life might not be a local planetary phenomenon, but instead could expand its evolutionary trajectory beyond its planet of origin. This would, in turn, support the notion that terrestrial life may not be unique and similar life forms might exist elsewhere in the Universe.

In order to facilitate studies on the impact of the space environment on biological systems, we have developed GEMM (Gene Expression Measurement Module) - an automated, miniaturized, integrated fluidic system for in-situ measurements of gene expressions in bacterial samples. The project has been funded through the ASTID program. The GEMM instrument is capable of (1) lysing bacterial cell walls, (2) extracting and purifying RNA released from cells, (3) hybridizing it to probes attached to a microarray and (4) providing electrochemical readout, all in a microfluidics cartridge. Its first application on a nanosatellite platform is to cultivate and measure gene expression of the photosynthetic bacterium *Synechococcus elongatus*, a cyanobacterium known for its metabolic diversity and resilience to adverse conditions, under light and dark cycles exposed to polar orbit for a period of 6 months. The integration and end-to-end technology validation of this instrument will be discussed. In particular, results demonstrating that the instrument properly measures gene expression after cellular lysis, nucleic acid extraction, its purification, and hybridization to an electrochemical array will be presented and compared to commercial microarray analysis. Finally, a proposed version of GEMM that is capable of handing both microbial and tissue samples on the International Space Station will be briefly reviewed.