National Aeronautics and Space Administration

WetLab-2

Real-time Quantitative PCR tools for the International Space Station National Laboratory

NASAfacts

Studies that characterize how spaceflight affects the gene expression of cells, microbes and tissues are key to helping researchers to better understand how life is affected by or adapts to spaceflight. Gene expression data helps reveal the molecular and cellular mechanisms involved with spaceflight-induced conditions such as bone and muscle loss, impaired immunity, and increased microbial virulence. Knowledge of these mechanisms can be applied towards developing countermeasures for protecting human health during long-term space missions and also for treating diseases on Earth.

WetLab-2 is a research platform for conducting real-time quantitative gene expression analysis aboard the International Space Station. The system enables spaceflight genomic studies involving a wide variety of biospecimen types in the unique microgravity environment of space.

Until now, isolation of RNA and DNA from space-flown biospecimens and subsequent gene expression analyses had to be conducted postflight—after living cultures or frozen or chemically fixed samples were returned to Earth from the space station. However, postflight analysis is limited for several reasons. First, changes in gene expression can be transient, changing over a timescale of minutes. The

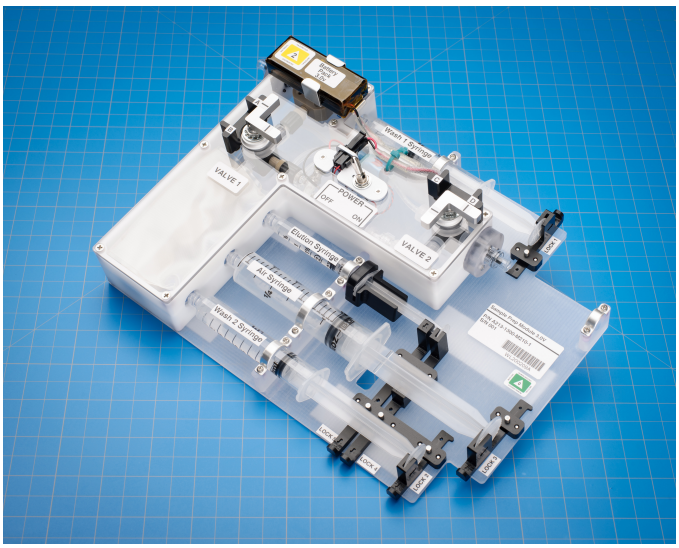
The Wetlab-2 system includes a Cepheid SmartCycler instrument that can perform up to 16 PCR reactions in parallel. Image credit: NASA / Dominic Hart

PCR reaction tube with a specialized cap that facilitates liquid handling operations and containment in micro-gravity. Image credit: NASA / Dominic Hart

delay between sampling a culture in space and analyzing that sample on Earth can range from days to months, and RNA may degrade during this period of time, even in fixed or frozen samples. Second, living organisms that return to Earth may quickly readapt to terrestrial conditions. Third, forces exerted on samples during reentry and return to Earth may affect results. Lastly, follow up experiments designed in response to post-flight results must wait for a new flight opportunity to be tested.

WetLab-2 has solved these problems by allowing investigators to obtain real-time genomic data from samples processed and analyzed during spaceflight. The system was validated in 2016 during the SpaceX CRS-8 mission to the space station.

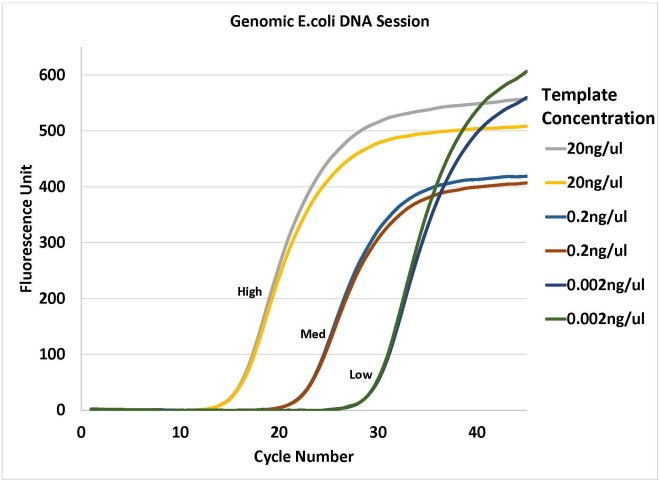
Wetlab-2 enables traditional uses of quantitative PCR, such as measuring gene transcription or rapid detection of gene targets that indicate infectious disease, cell stress, changes in cell cycle, growth and development, and/or genetic abnormality. Applications range from fundamental biology investigations to commercial drug discovery efforts. WetLab-2 also may be used for real-time analysis of air, surface, water, or clinical



Sample Prep Module (SPM). Image Credit: NASA / Dominic Hart

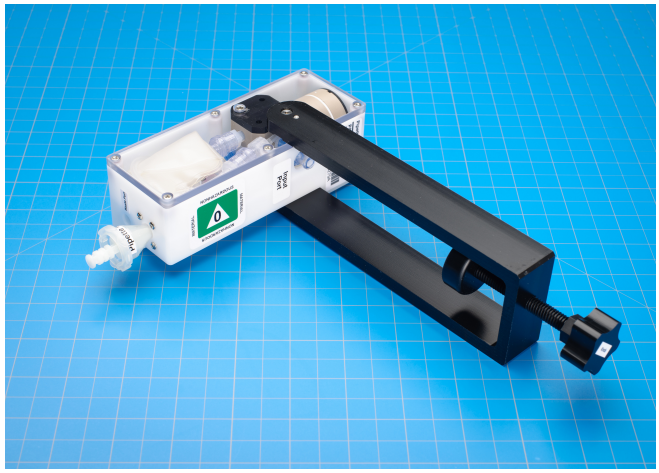
samples to monitor environmental conditions and crew health. It can also be used to validate terrestrial analyses of samples returned from the space station by providing quantitative gene expression benchmarking prior to sample return to Earth.

The system consists of a commercial quantitative PCR instrument (Cepheid SmartCycler), and a sample preparation system. The sample preparation system is configured to allow astronaut crew—working in microgravity—to isolate RNA and DNA from samples of cell cultures or tissues for RTqPCR analysis using the SmartCycler. The sample preparation system also could be adapted to prepare samples for other uses, such as in flight gene sequencing or for sample return.



Representative Data. Image Credit: NASA / Dominic Hart

The Sample Preparation System includes: a sample transfer tool that provides containment for biospecimens retrieved by astronaut crew working in a weightless environment. The sample processing module that is designed to lyse cells and extract RNA; the pipette loading device that removes air bubbles from fluids and transfers liquid samples into PCR reaction tubes; and PCR reaction tubes that are pre-loaded with stabilized lyophilized reagents.



RNA Sample De-bubbler and Pipette Loading Device. Image Credit: NASA / Dominic Hart

The SmartCycler can perform up to 16 quantitative PCR reactions in parallel, using up to four optical channels to measure fluorescence. The average time to deliver results is less than four hours.

WetLab-2 was developed at NASA's Ames Research Center by the Engineering Directorate under the leadership of the Ames International Space Station Utilization Office. Science direction is provided by the Space Biosciences Division at Ames and the Space Life and Physical Sciences Division at NASA Headquarters. Project funding is provided by the International Space Station Program at NASA's Johnson Space Center, Houston.

For more information, visit:
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