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A SIMPLE LAB-ON-A-CHIP SYSTEM FOR MOLECULAR BIOLOGY RESEARCH IN
SPACEFLIGHT AND SPACEFLIGHT ANALOGUE ENVIRONMENTS**Abstract**

Biological experiments in spaceflight and spaceflight analogues are often constrained by environmental requirements of the cells or organisms being studied, available equipment for analysis, and size and weight limitations. We designed a simple lab-on-a-chip system that mitigates these challenges. This system uses a fluidics card that contains desiccated *Saccharomyces cerevisiae* cells, growth media, and a fixative agent for preserving nucleic acids. A finger actuated pump is used to inject growth media into wells containing the desiccated cells to initiate growth. When cells have grown to mid-log phase, an additional pump injects a fixative agent to preserve cells for downstream gene expression analysis by RNA sequencing. Check valves built into the chip prevent backflow of both fluids. We tested this system on a parabolic flight. Our system is small, light (about the size of a credit card), and can be made with less than \$100 USD of materials. Our system is also operationally advantageous. The desiccation protocol means that no laboratory or equipment is required on-site prior to or during flight, as cells can be prepared and desiccated months before flight and grown at ambient conditions. The simple finger actuated pumps reduce complexity of operation and can be used by individuals without training in sterile technique. Additionally, our system is autoclavable, which enables accessibility to laboratories without access to more expensive sterilization systems. While our system was designed for and tested on a parabolic flight, it could be adapted for experiments in spaceflight and other spaceflight analogues, such as low-earth orbit platforms, stratospheric balloons, or sounding rockets. It could also be adapted for experiments with other organisms or other molecular analyses.