Biological validation of a microgravity analog for bacteria and cell cultures

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With the future of long duration spaceflight missions looking to expand from the International Space Station (ISS) to deep space, it must be ensured that all critical systems, living and non-living, are thoroughly developed before humans begin the extended voyage. As we continue to unravel the effects of microgravity on cells, more questions arise on the molecular and cellular components and processes that sense and react to lowered gravity conditions. We have developed a microgravity analog that could simulate the effects of reduced gravity on cells and that could be maintained for a period of time long enough to observe and measure a wide variety of biological responses. On this instrument, the simulation of the effects of microgravity occurs when the samples rotate perpendicular to the gravity vector, moving in a very small circular path in the media that can be calculated based on Stoke's Law. Once this path is significantly smaller than the natural diffusive motion, the cells can be assumed to be experiencing "functional weightlessness". Here we present a new 2D clinostat design that operates under gravity and simulated microgravity conditions, simultaneously, and that is scalable to accommodate up to forty 2-mL liquid samples. This design was originally intended for bacterial studies that require a high number of replicates during multiple timepoints and it was mathematically and biologically validated using phenotypic and transcriptional endpoints on *Escherichia coli* K12 cultures.

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