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ELECTROPHYSIOLOGICAL RECORDING OF HUMAN NEURONAL NETWORKS DURING SUBORBITAL SPACEFLIGHT

Abstract

The use of microfluidic tissue-on-a-chip devices in conjunction with electrophysiology (EPHYS) techniques has become prominent in recent years to study cell-cell interactions critical to the understanding of cellular function in extreme environments, including spaceflight and microgravity. Current techniques are confined to invasive whole-cell recording at intermittent time points during spaceflight, limiting data acquisition and overall reduced insight on cell behavior. Currently, there exists no validated technology that offers continuous EPHYS recording and monitoring in physiological systems exposed to microgravity. In collaboration with imec and SpaceTango, we have developed an enclosed, automated research platform that enables continuous monitoring of electrically active human cell cultures during spaceflight. The Neuropixels probe system (imec) will be integrated for the first time within an engineered in-vitro neuronal tissue-on-a-chip model that facilitates the EPHYS recording of cells in response to extracellular electrical activity in the assembled neuronal tissue platform. Our goal is to study the EPHYS recordings and understand how exposure to microgravity affects cellular interaction within human tissue-on-a-chip systems in comparison to systems maintained under Earth's gravity. Results may be useful for dissecting the complexity of signals obtained from other tissue systems, such as cardiac or gastrointestinal, when exposed to microgravity. A commercially available Neuropixels probe and data collection system (imec) will be integrated into 3D neuronal tissue cultures maintained in a microfluidic device, from which measurements will be obtained for the duration of the suborbital flight. Glutamatergic Neurons reprogrammed from human induced pluripotent stem cells (iPSC) (Fujifilm CDI) representing a consistent, mature and electrically active neuronal cell source will be seeded within an alginate-Matrigel scaffold creating a high-quality human tissue model. Adequate cell culture environments, stabilization, and functionality of the system in flight will be facilitated via a CubeLab designed specifically for this system by SpaceTango. After the payload is returned, tissue platforms will be further processed to study resultant cell morphology and behavior via continued EPHSY measurements and end-point immunostaining, microscopic imaging, and RNA sequencing to detect gene alterations. Significant aberrations are not expected in the data acquired from the neuronal tissue platform aboard the suborbital flight (2 min). There may be evidence of altered cell morphology and function resulting from exposure to space-radiations. This study will yield valuable knowledge regarding physiological changes in human tissue-on-a-chip models due to spaceflight, as well as validate the use of this type of platform for more advanced research critical in potential human endeavors to space.