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LAB-ON-CHIP PLATFORMS FOR SPACE BIOLOGY APPLICATIONS

Abstract

The influence of space conditions onto biomedical samples, especially in the context of microgravity and radiation, has been the subject of intensive scientific investigation in recent times [1]. Several astrobiological studies have been conducted to date to touch the problem of microbials' growth, metabolism or mutation in both simulated and space-based environments [1]. ISS infrastructure provides the facilities to ensure biomedical research in space, however, long waiting time, and limited experiment control must have opened the way towards novel and more remotely-controlled solutions, i.e. CubeSat type bio-nanosatellites. As the limited space and small energy demand are required for such space-based experimentation, microfluidics and MEMS (Micro-Electro-Mechanical-System) tools have appeared to be reliable and relatively low-cost technical means. As the potential application of analytical devices for space research covers many scientific areas - cell cultivation, gene expression, tissue engineering, drug delivery or protein crystallization, the need for different lab-on-chip instrumentation, meeting the demands of space conditions is of high consideration now. In this paper, the universal microfluidic platform for long-term cultivation of different biological objects and drug resistivity study on the selected cancer cell lines is presented. The lab-on-chip devices of various geometries have been fabricated utilizing glass micromachining techniques to achieve dedicated and biocompatible solutions ensuring cultivation of human cancer cells and microscopic fungi. Technology employed for the fabrication of the structures was studied thoroughly and tested in terms of mechanical durability to verify the possible shock/vibration resistance successfully. The culturing system including miniaturized micropump, culturing buffer falcon and dedicated micropump

controller was developed to provide "life-support" for the cultured objects. The performance of the lab-on-chip platform was validated biologically by using the selected fungi species (F. culmorum, C. macrocarpum, P. expansum) and cancer cell lines (e.g. SKOV-3, HaCaT, A-375). The experimentation was performed both in terrestrial laboratories and in simulated microgravity conditions utilizing RPM (Random Position Machine) and RWV (Rotary Wall Vessel). Interestingly, an increased mycelium growth of the fungi was observed in RWV comparing to the control assay. On the contrary, decreased viability of the cancer cell lines was noticed during the 96 hours of RPM simulated microgravity tests [2]. Recently, our major attention is focused on the drug resistivity research and possible, increased chemotherapeutic response of the cancer cells in microgravity environments, towards novel anti-cancer therapies and drugs of increased penetration. [1] D. Robson, et al., Acta Astronautica 2022, https://doi.org/10.1016/j.actaastro.2021.11.017
[2] D. Przystupski, et al., Cancers 2021, https://doi.org/10.3390/cancers13030402