LAB-ON-CHIP PLATFORMS FOR CULTURING AND INVESTIGATION OF CELLS BIOLOGICAL POTENTIAL

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This paper presents the results on development of microfluidic lab-on-chip platforms which has been used for cell culturing and study of life potential of radically different microbiological objects [1-3]. The platform has been equipped with all the components, necessary to establish and maintain long-term cell cultures, and study their behavior in response to chemical, optical and thermal stimulations. The use of intelligent processing and analysis of the image sequence allowed for metrological parameterization of the cultures and determination of, among others, the population growth, mobility or the size and shape of the cells. The platform uses a family of glass lab-chips, which are fabricated from scratch and adapted for the specific research needs. The platform is also equipped with a temperature module, light source (e.g. programmable OLED matrix), CCD detectors and a flow control unit for liquid and gaseous media delivery.

The platform ensures long-term culturing of autotrophic and heterotrophic microorganisms, fungi, human cancer and normal cells, and animal oocytes. It allows to determine the vital parameters of both individual objects, and the whole population by means of computer-aided processing of time-lapse images.

A number of culturing experiments have been conducted on the platform to date, including, e.g. the maturation of porcine oocytes (IVM process) and the culturing of human cancer cells with the simultaneous studies on drug resistivity with both standard cytostatic drugs (e.g. cisplatin) and novel medications (e.g. curcumin), Fig. 1. In addition, the life potential of microscopic fungi and the chosen freshwater microorganisms (*Euglena gracilis*, *Euglena viridis*, *Lepadella patella*) based on phototaxis and chemotaxis phenomena has been investigated.

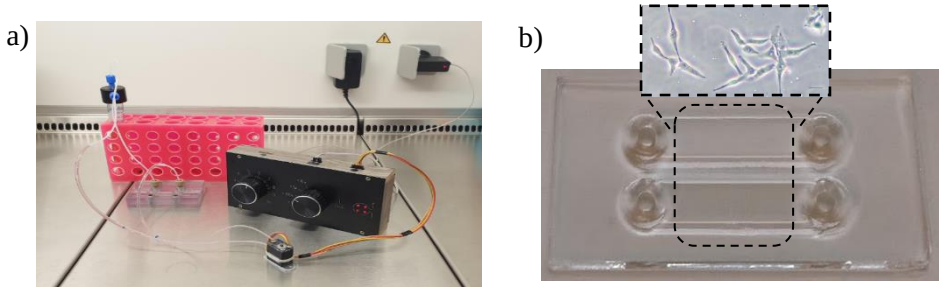

Fig 1. The lab-on-chip platform for culturing of human cancer cells (SKOV-3, UMUC-3, RT-112, HaCaT, A375, HAPAF-2): a) set-up, b) lab-chip.

An interesting direction for the further development of microfluidic lab-on-chip platforms is their use in widely understand astrobiological research. This is the new scientific trend, encompassing the investigation of biological samples growth in simulated or space-based microgravity on ISS (International Space Station) or with the use of small scale nanosatellites. A notable change in samples metabolism due to weightlessness state may have a significant future impact on the development of new oncological and antibiotic therapies, gene regulations or drugs with increased penetration.

[1] D. Przystupski, A. Górska, O. Michel, A. Podwin, et al., Testing Lab-on-a-Chip technology for culturing human melanoma cells under simulated microgravity. Cancers. 2021, vol. 13, nr 3, art. 402, s. 1-14.
[2] A. Podwin, et al., Lab-on-chip platform for culturing and dynamic evaluation of cells development. Micromachines. 2020, vol. 11, nr 2, art. 196, s. 1-11.
[3] A. Podwin, et al., A 3D printed membrane-based gas microflow regulator for on-chip cell culture. Applied Sciences. 2018, vol. 8, nr 4, art. 579, s. 1-9.