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THE POTENTIAL ROLE OF BIOMEDICAL LAB-ON-CHIP FOR HUMAN SPACE EXPLORATION

Abstract

The altered gravity, ionizing radiation and other environmental factors in Space can affect human health, with potentially long-term consequences, especially after an extended exposure to these agents. For these reasons, and in view of the imminent manned missions to the Moon and then to Mars, global Space Agencies, such as ESA and NASA, are increasingly interested in developing technologies to use on site during space missions. Encouraging results from a previous study demonstrated the effectiveness of the proposed methodology, both in terms of analysis performance and innovation. In fact, SERS-sensing Lab on Chip systems could allow physiological measurements to be performed by means of high throughput analysis in real time and at low cost, where aptamers could be synthesized in situ and be modified according to on-board medical needs, making the proposed approach a highly promising and potentially effective solution for the space domain. The first development step involves the study and evaluation of new technologies and materials for chip preparation. The combination of Raman spectroscopy, in surface enhanced Raman scattering (SERS) mode, and the use of microfluidic devices is emerging as a suitable technology for an automated and reproducible measurement environment with high sensitivity and specificity. This method requires no sample manipulation, and allows the detection of single metabolites in complex matrices, in concentrations. In addition, the use of microfluidic systems will allow multiple samples to be tested in parallel, with reduced reagent volumes and analysis times compared to conventional methods, and automated processes. Characteristic of SERS is its ability to significantly amplify the Raman signal of target molecules. The required sensitivity is achieved by using metal nanostructures, such as silver or gold nanoparticles, or nano/micro-structured metal surfaces. The required selectivity, on the other hand, is achieved through the use of aptamers, single-stranded oligonucleotide probes (ssDNA or ssRNA), synthesized specifically for the target under investigation (proteins, carbohydrates, small molecules, toxins, etc.) by a process called SELEX (Sequential Evolution of Ligands by Exponential Enrichment). Through an iterative process, non-binding sequences are discarded and aptamers that bind to the proposed target are amplified. Aptamers have binding selectivities comparable to those of monoclonal antibodies, while avoiding animal sacrifice to obtain them. The aim of the paper is to propose a platform designed and preliminarily tested on Earth for early colon cancer screening, which could be updated to a "Space-version" to use as an effective system for the monitoring of the astronauts' health.