Biomimetic Microsystems for Studying Functionalities of Stem Cell Derived Neuronal and Cardiac Cells

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Abstract

Stem cells are cells which can proliferate – make a copy of themselves, and differentiate – make new cell types. Traditionally, stem cells have been received from embryo (embryonic stem cells) or from a bone marrow, fat, tendon tissue of an adult individual. In 2006, first results on pluripotent stem cells derived from skin cells were published. This revolutionized the field, as now it became possible to obtain cells for example as skin biopsies from individuals, "clear the memory of the cells" such that they become stem cells and the differentiate the stem cells to different cell types. Thus, these so called induced pluripotent stem cells (iPS cells) allow the production of various cell types which have the genotype of an individual.

The iPS technology provides huge possibilities to investigate for example the mechanisms of genetic diseases, as patient and disease specific cells can now be produced. However, in order to induce the disease conditions and observe the disease mechanisms, the cell scientists need new methods, tools and equipment, i.e. collaboration with engineers.

In our research, we are developing microrobotic, micromechatronic and microfluidic technologies which facilitate long-term cultivation, enhanced cellular functionalities, controlled disease induction, and multimodal monitoring and analysis of cellular properties and responses.

In this talk, general trends in in-vitro cell assays and their applications are described. Our research on microfluidic cell perfusion and gas supply, electromechanical cell stimulation and measurement, and biochemical cell stimulation using novel microrobotic cell injection are discussed. The application examples include our recent advances in inducing electrical properties of human neuronal cells and mechanical properties human cardiac cells.

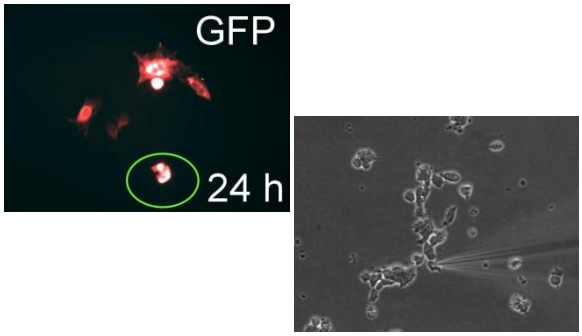

Figure 1: Microrobotic injection of neuronal cell line cells.

Figure 2: Modular micromechatronic and microfluidic environment for stimulating cardiac cells.

Biography

Pasi Kallio (IEEE S'95-M'03) is a Professor of Automation Engineering at Tampere University of Technology (TUT), Tampere, Finland. He received his M.S. degree in electrical engineering and the D.Tech. degree in automation from TUT in 1994 and in 2002, respectively. Currently, he heads Micro- and Nanosystems Research Group in the Department of Automation Science and Engineering. Prof. Kallio's main research interests include microrobotics and microfluidics, and their application in the development of automatic systems for cell manipulation, living cell cultivation and medical diagnostics.