

Microfluidics in cell culture and gene therapy

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Recent development in microfluidic technologies, such as organ-on-a-chip, droplet microfluidics and high-throughput screening are revealing the potential of these platforms to address challenges related drug and gene delivery, due to the small volume of samples used, short processing time, and improved process control. The first part of the talk is focus on the author's research in the field of microfluidic platforms for drug screening: a cell culture model –“constrained spheroids”, a perfusion system for drug screening-“Incubator on a chip”, and “animal” testing on chip – “Fish on chips”. The second part of the talk will present the use of microfluidic hydrodynamic flow focusing to enable an accurate control of self-assembling nanoparticles with a special focus on DNA compaction. Two approaches will be illustrated. The first method is based on rapid change of solvent quality. As a result, a rapid change of solvent quality takes place in the central stream, and the surfactant-bound DNA molecules undergo a fast coil-globule transition. By adjusting the concentrations of DNA and surfactant, fine-tuning of the nanoparticle size – down to a hydrodynamic diameter of 70nm with a polydispersity index below 0.2 – can be achieved with good reproducibility. The second method relied on the controlled diffusive mixing of surfactant and DNA solutions through a water stream of tunable width. Using this method the smallest nanoparticles achieved were about 30 nm in hydrodynamic diameter, meaning that most of them contained a single DNAmolecule (<2 kbp). Due to the consistent 'batch-to-batch' results, the well-controlled nanoparticle size, the current microfluidic methods can be successfully used for gene therapy applications as well as for the synthesis of tailored soft nanoparticles.



Ciprian Iliescu holds a PhD in Mechanical Technology, Politehnica University of Bucharest (1999) and Habilitation in Chemical Engineering. He is ERA Chair holder and Founding Director of the eBio-hub - Center of Excellence in Bioengineering at National University of Science and Technology Politehnica Bucharest. Dr. Iliescu was PI for numerous national and international grants (budget >5 mil Euro). His main research interest is bioengineering (microfluidic cell culture, on-chip self-assembled nanoparticles, liquid biopsy, microphysiological systems, point-of-care testing, and transdermal drug delivery). He has 30+ years of research and industrial experience, including 18 in Singapore (at Nanyang Technological University, Institute of Bioengineering and Nanotechnology -IBN- and National University of Singapore). He setup several labs (IBN BioMEMS cleanroom, Micro and Nanofluidics lab at IMT Bucharest, and eBio-hub at NUSTPB). Dr. Iliescu has published in top journals, including Science Translational Medicine, Biomaterials, Trends in Analytical Chemistry, Chemistry of Materials, Sensors and Actuators B: Chemical, Analytical Chemistry and Lab on a Chip. He holds two US and EU patents and one Romanian patent and is “Member of Honour” of the Academy of Romanian Scientists.