NEUROBIOLOGY ON A CHIP

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Cell culture technology is falling behind in the pace of progress. As animal and bacterial genomes and proteomes are being fully probed with DNA chips and a wide array of analytical techniques, a picture of cells with dauntingly complex inner workings is emerging. Yet cell culture methodology has remained basically unchanged for almost a century: it consists essentially of the immersion of a large population of cells in a homogeneous fluid medium. The traditiional approach is becoming increasingly expensive to scale up and cannot mimic the rich biochemical and biophysical complexity of the cellular microenvironment. This problem is particularly exacerbated when trying to study delicate cells during development, such as neurons or stem cells, which are extracted from the body at a stage of intensive gene expression changes and need long recovery times to recover from the insult of isolation.

Microtechnology offers the attractive possibility of modulating the microenvironment of single cells and, for the same price, obtain data at high throughput for a small cost. Microfluidic or "Lab on a Chip" devices, in particular, promise to play a key role for several reasons: 1) the dimensions of microchannels can be comparable to or smaller than a single cell; 2) the unique physicochemical behavior of liquids confined to microenvironments enables new strategies for delivering compounds to cells on a subcellular level; 3) the devices consume small quantities of precious/hazardous reagents (thus reducing cost of operation/disposal); and 4) they can be mass-produced in low-cost, portable units. Not surprisingly, in recent years there has been an eruption of microfluidic implementations of a variety of traditional molecular biology techniques. By comparison, the combination of microdevices with live cells, presenting the additional technological challenge of cellular maintenance and sub-cellular microscopy/analysis, is still in its infancy. In this talk, I will review the latest efforts of our laboratory in using microdevices to study various neural processes, such as neuromuscular synaptogenesis, axon guidance, and chemotaxis.

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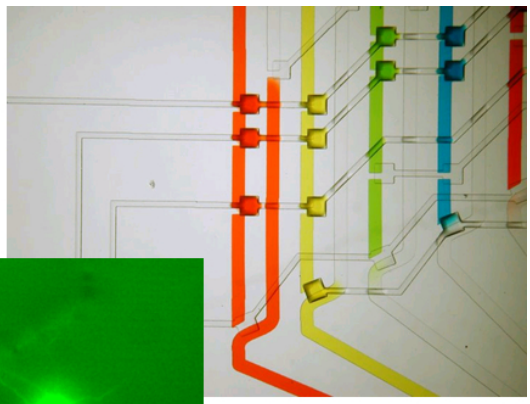

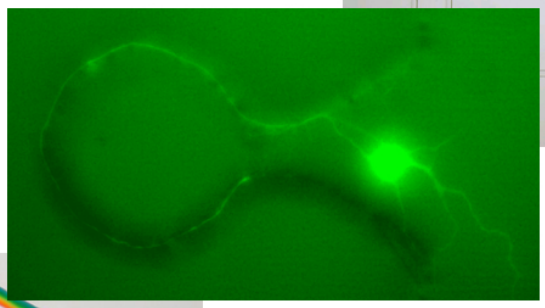

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Nanobioeurope2008 09-13 June, 2008 Barcelona-Spain