9-6-2012

Investigating Axonal Biology Using Microfluidic Devices

James Deyling
Cleveland State University, J.K.DEYLING@csuohio.edu

Brittany Kastan
Cleveland State University, B.KASTAN@csuohio.edu

Investigating Axonal Biology Using Microfluidic Devices

Fenn College of Engineering

Department of Biological, Geological and Environmental Sciences[a]
Department of Chemical and Biomedical Engineering[b]

Student Researchers: James K. Deyling [a] ; Brittany Kastan [b]

Faculty Advisor: Chandrasekhar Kothapalli, Ph.D

Abstract

During nervous system development, various diffusing biomolecules play a critical role in neurite outgrowth and guidance, resulting in the formation of a complex circuitry. However, the precise mechanism by which these molecules are spatio-temporally delivered to the growing tip of the neurites is unclear. To overcome the limitations of conventional *in vitro* cultures, we developed and implemented a sophisticated microfluidic platform to facilitate high-throughput screening, *in situ* imaging, enhanced reproducibility and quantification, and tight spatio-temporal control on biomolecule delivery and sensing. The device consists of a central chamber for cell seeding within 3D gel, flanked by two side (source and sink) channels for gradient generation. Quantification of gradients within the device using immunofluorescence detection of 10 kDa FITC-Dextran diffusion, and computational studies using COMSOL®, demonstrated the establishment of a steep biomolecular gradient across the 3D collagen-1 gel within 180 min, and stable up to 24 h. Cortical neurons derived from rat brain and seeded within 3D collagen gel exhibited excellent survival and neurite outgrowth under controlled gradients within the device, relative to controls. Overall, the results suggest to the utility of this device for studying neurobiology, tissue engineering and cell migration.