# Neurons growing in line

April 15 2010

In order to be able to understand complex organs such as the brain or the nervous system, simplified model systems are required. A group of German scientists led by the Frankfurt brain researcher Erin Schuman has successfully developed a novel method to grow cultured neurons in order to investigate basic mechanisms of memory. The researchers grew two separate populations of neurons in microfluidic platforms. These neurons extended their processes through tiny grooves, to meet each other and form synaptic connections. Perpendicular to the grooves, a perfusion channel was constructed that allows the researchers to manipulate very small populations of synapses with drugs or neurotransmitters. The chambers are amenable to imaging, allowing researchers to visualize the dynamics of synapses, the movement of molecules within the neurons.

Studying cultured neurons makes it possible to reduce the complex three-dimensional network in living organisms to two dimensions. However, even in the laboratory, cell growth is totally disorganized, which makes a systematic study difficult. Neurons consist of a nucleus whose signals are transmitted to adjacent cells through a long extension (axon). Shorter extensions (dendrites) absorb the incoming signals. While the stimulus transfer along the axon and dendrites occurs electrically, the contact points between two neurons, the synapses, are bridged by biochemical signals. To understand how synapses are formed and which neurotransmitters play a part in their formation is not only an interesting topic for brain research, but may also aid the development of new pharmaceutical agents.

After demonstrating that functional synapses were formed in the approximately 150 microgrooves of the chamber, the brain researchers developed the device further in order to be able to stimulate the synapses directly. Here, they made use of the fact that cultured dendrites have a characteristic length so that the contact points with the axons of the neighboring cell populations could develop in about the same compartment of the microgrooves. There, the group implemented another small perfusion channel pervading the relevant area perpendicular to the "neuronal channels". This supply channel enables a direct manipulation of the synapses via solute substances.

A further refinement of the test arrangement was reached by restricting the biochemically effective fluid in the supply channel from infiltrating the channels containing the nerve fibers. Schuman and her collaborators managed to do so by letting in a solution on both sides of the main stream shielding the main stream. The three parallel fluid streams have the additional advantage that the perfusate may be exactly dosed by varying the width of the middle stream.

Besides, the amount of the perfusate is also subject to increased temporal control: The supply can be turned on and off within one minute. It is thus possible to imitate the short duration signals that are the language of the nervous system.

Erin Schuman who relocated several months ago from the renowned California Institute of Technology (Caltech) to the Max Planck Institute for Brain Research in Frankfurt is interested in the function of synapses in the context of memory. How do synapses change during the storage of memory? And what happens during these processes at the molecular and cellular level? Years ago, her group discovered that dendrites can make the proteins required to change the functional capacity of synapses. The nucleus transcribes the required information as messenger RNA (mRNA), which is then sent out to the dendrites. When certain signals

arrive, the dendrites translate the mRNA into protein using ribosomes present in the dendrite.

Frankfurt is not only appealing to the native-born Californian because of the possibility to run the Max Planck Institute for Brain Research together with her husband, brain researcher Gilles Laurent (the other director is Wolf Singer). The cooperation with scientists of the excellence cluster "Macromolecular Complexes" at Goethe University with which Schuman is associated as "Principle Investigator" also promises many interesting collaborations, for example with the Paul-Ehrlich-Young Academics awardee Amparo Acker-Palmer or with the Heisenberg-Professor Alexander Gottschalk. With respect to the new building of the MPI for Brain Research, the mother of two daughters at the age of ten and seven already has a plan: "Many employees of the institute have children who come into contact with science already at an early age through their parents. We also want to make the new institute family-friendly. We hope to organize Science Saturdays for our kids to see how exciting it is to explore something on their own."

**More information:** Anne M Taylor, Ph.D.; Daniela C Dieterich, Ph.D.; Hiroshi T Ito; Erin M Schuman; Microfluidic local perfusion chambers for the visualization and manipulation of synapses, Neuron (2010), doi:10.1016/j.neuron.2010.03.022

Provided by Goethe University Frankfurt

provided for information purposes only.