

Specified Neuronal Differentiation and Neuronal Learning

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This summer, the undergraduates in Ron Weiss' lab are working on a project involving the specified differentiation of neurons and genetically engineered neuronal networks for the 2008 iGEM (international Genetically Engineered Machines) competition. The first part of our project is an endeavor to create a bi-stable switch, similar to the RS-Latch logic gate, using only genetically engineered neuronal cells. By inducing engineered excitatory or inhibitory synapses of our choice to form and specifically secrete and respond to various neurotransmitters we are able to dictate the physical and genetic design of our latch. The second part of our project involves the reinforced learning of neural networks. We aim to create a neural network that can be "taught" the correct answer. We plan to do this by reinforcing synapses that allow for the 'correct' response by inducing long term potentiation (LTP), a process associated with memory formation and maintenance. We will induce LTP by over-expressing the protein, PKM-zeta (Protein Kinase Zeta) which through a positive feedback circuit strengthens the synaptic connection and is necessary and sufficient for LTP maintenance. Conversely we plan to reinforce the wrong answers by restricting long-term potentiation and inducing long-term depression. We accomplish this by repressing PKM-zeta. We will create physical connections between the neurons in one of two ways. We are experimenting with the use of optical tweezers to trap particles using YaG lasers and have created a preliminary optical tweezers set-up in our lab. Optical tweezers allow us to move cells to specific locations. The other way to physically pattern cells is to use a lithography system similar to the system used in semiconductor fabrication. In our system we plate adhesion proteins in desired geometric patterns.