OIST SEMINAR

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DATE: **Thursday, January 19, 2017**

TIME: **15:00 – 16:00**

VENUE: **Seminar Room C700, Level C, Lab 3**

Synaptic plasticity and spine interactions revealed by calcium dynamics in striatal spiny projection neurons

Abstract:

The striatum is a major site of learning and memory for goal directed actions and habit formation. Spiny projection neurons (SPNs) of the striatum integrate cortical, thalamic, and dopaminergic input to learn critical associations. One mechanism used by SPNs for learning and memory storage is calcium dependent synaptic plasticity; however, the characteristics of calcium dynamics that control synaptic plasticity are unclear. Furthermore, though repeated synaptic stimulation produce synaptic plasticity calcium in response to spatially and temporally distributed synaptic input has not been characterized.

To investigate calcium dynamics in response to diverse synaptic stimulation patterns, we developed a multi-compartment SPN model with a branching dendritic structure and explicit spines. Our model uniquely implements sophisticated calcium dynamics including multiple buffers, pumps, and diffusion, as well as AMPAR desensitization. We tuned the model to several types of experimental data including electrical response to injected current, calcium imaging of action potentials and synaptic inputs, and the generation of plateau potentials by closely aligned synaptic stimulation of distal dendritic spines.

We demonstrate that a calcium-based weight change rule (plasticity rule) correctly predicts the plasticity outcome for multiple frequency dependent and spike-timing dependent stimulation protocols. Our results confirm a supralinear calcium elevation in spines active during a plateau potential when stimulating distal spines on a single tertiary dendritic branch, and reveal that non-stimulated, neighboring spines exhibit a significantly lower calcium elevation. When stimulating clusters of distal spines on neighboring branches, we find a small reduction in the number of spines per branch required to evoke a plateau potential, indicating limited interaction between neighboring branches. When clusters of synaptic inputs are stimulated sequentially, the spine calcium elevation of the second set of spines is greater than that of the first set. Overall our results show that spine calcium exhibits spine specificity and the spine calcium response is sensitive to the temporal order of stimulation.

Collectively, these results suggest that the model can be used to investigate synaptic integration in response to in vivo like inputs and the altered synaptic plasticity in response to drugs of abuse.