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Molecular Diffusion in Neurons: Theory and Experiment

Diffusion and transport of signaling molecules play a crucial role in neuronal function. For example, AMPA receptor trafficking in dendritic spines is emerging as a major mechanism for the expression of synaptic plasticity. The activation of AMPA or NMDA receptor requires a diffusion of neurotransmitter in the synaptic cleft, which in turn leads to  $\text{Ca}^{2+}$  entrance and subsequent diffusion-mediated  $\text{Ca}^{2+}$ -calmodulin signaling in the postsynaptic spines.

Molecular-level understanding of neuronal function therefore requires quantitative measurement and concurrent theoretical or computational analysis of molecular diffusion in neurons. In this one-day workshop, theoreticians and quantitative experimental biologists will discuss various aspects of molecular diffusion in neurons and talk about potential interactions between theory, computational modeling, and experiment. The topics include membrane protein diffusion, intra-cellular dynamics of ligand-receptor complex, protein trafficking and anomalous diffusion in dendrites, receptor trafficking in the dendrite spines, neurotransmitter diffusion in the synaptic cleft, and postsynaptic  $\text{Ca}^{2+}$ -CaM-CaMKII diffusion.

One of our participants, Dr. Kusumi (see below) will also give a talk at the main conference as an invited speaker. The title of his talk at the main conference is: Single-Molecule Tracking of Raft-Based Signal Transduction: A System of Digital Signal Transduction.

List of presenters

1. Dr. Akihiro Kusumi (Institute for Frontier Medical Sciences, Kyoto University): High-Speed Single-Molecule Tracking of Hop Diffusion and Signal Transfer Processes in the Plasma Membrane.
2. Dr. Tania Q. Vu (Department of Biomedical Engineering, Oregon Health and Science University): Tracking the intracellular Dynamics of Discrete Ligand-Receptor Complex in Neural Cells Using Quantum Dot Probes.
3. Dr. Erik De Schutter (University of Antwerp & Okinawa Institute of Science and Technology); Anomalous Intracellular Diffusion in Spiny Dendrites of Pyramidal Neurons and Purkinje Cells
4. Dr. Paul C. Bressloff (Department of Mathematics, University of Utah): Mathematical Models of Protein Trafficking in Dendrites.

5. Dr. Naveed Aslam & Dr. Harel Shouval (Department of Neurobiology and Anatomy, University of Texas Medical School at Houston): How Does Receptor Trafficking Affect Receptor Densities.

6. Yoshi Kubota (Department of Neurobiology and Anatomy, University of Texas Medical School at Houston): CaMKII Trafficking and Membrane Diffusion of Signaling Molecules in Dendritic Spines.

7. Dr. David Holcman (The Weizmann Institute of Science): The Degenerated Synaptic Cleft Geometry Strongly Controls Synaptic Transmission.