【Seminar】 Dynamic nanoscale organization of AMPAR control short and long term synaptic plasticity

Date-Time
Wednesday, April 8, 2026 - 11:00 to 12:00

Location Seminar room C210, Ctr Bldg

Description

Title: Dynamic nanoscale organization of AMPAR control short and long term synaptic plasticity

Speaker: Prof. Daniel Choquet
Research director at the CNRS

Bordeaux Imaging Center (Director)
Neuroscience Cluster of Excellence, Bordeaux University (Director)

Member of the National Academy

Website:
https://www.iins.u-bordeaux.fr/en/teams/56854-dynamic-organization-and-function-of-synapses/

Summary:

The spatio-temporal organization of neurotransmitter receptors in the postsynaptic membrane is a fundamental determinant of synaptic transmission and thus information processing by the brain. Ionotropic AMPA glutamate receptors (AMPAR) mediate fast excitatory synaptic transmission in the central nervous system. Using a combination of high resolution single molecule superresolution imaging and tracking techniques, we have established that AMPARs are not all stable in the synapse as thought initially, but in large part undergo continuous entry and exit to and from the post-synaptic density through lateral diffusion. The other fraction of AMPAR are highly concentrated inside synapses into a few clusters of around seventy nanometers. These results have opened the new possibility that glutamatergic synaptic transmission is controlled by the regulation at the nanometer scale of the position and composition of these highly concentrated nanodomains. The dynamic exchange of AMPAR within the PSD and between synaptic and extrasynaptic sites is highly regulated by neuronal activity. Using methods to exogenously control AMPAR surface diffusion, we have demonstrated that AMPAR activity-dependent diffusion-trapping from extrasynaptic to synaptic sites directly controls the establishment of long term synaptic plasticity. We have also demonstrated that AMPAR conformation

strongly impacts their mobility, desensitized receptors being more mobile than naïve ones. This property likely explains how post-synaptic AMPAR receptor mobility can regulate short term synaptic plasticity, a feature previously ascribed to pre-synaptic mechanisms. We will also present a series of new experiments that decipher the respective contributions of transmitter release, AMPAR desensitization and surface diffusion in the control of high frequency dependent short term plasticity. Our data indicate that AMPAR surface diffusion is not only important for the expression of synaptic potentiation but also for frequency dependent information processing by synapses.

Short Bio:

Daniel Choquet trained as an engineer at Ecole Centrale (1984) and earned a PhD in neuroscience at the Pasteur Institute, studying ion channels in lymphocytes. After joining the CNRS in 1988 and completing a postdoc at Duke University with Michael Sheetz on integrin–cytoskeletal linkages, he moved to Bordeaux in 1996 to develop high-resolution imaging approaches to study neurotransmitter receptor trafficking. He founded the Institute for Interdisciplinary Neuroscience and the Bordeaux Imaging Center. His work focuses on how the nanoscale organization of synapses shapes function and plasticity, combining advanced imaging, cell biology, protein engineering, and physiology. Recently, his research has examined pre- and post-synaptic mechanisms underlying synaptic plasticity and their alteration in neurodevelopmental disorders. He is a member of the French Academy and has received three ERC Advanced Grants.

Short abstract

The spatial and temporal organization of AMPA receptors in the postsynaptic membrane is a key determinant of synaptic transmission and brain information processing. Contrary to the earlier static view, super-resolution imaging shows that many AMPARs continuously exchange in and out of synapses via lateral diffusion, while another fraction is confined within ~70 nm nanodomains. This dynamic distribution is tightly regulated by neuronal activity, and activity-dependent diffusion-trapping of receptors into synapses directly drives long-term synaptic plasticity. Moreover, receptor mobility—modulated by conformational state and desensitization—contributes not only to synaptic potentiation but also to short-term, frequency-dependent information processing.