
Preface

Synapses are perennial and fruitful subjects for neuroscience, the study of their function and regulation lying at the interface of neurology, cell biology, psychology, and computational neuroscience.

Synapses are extraordinary signalling machines. Thousands of proteins precisely and uniquely organized within the submicron cubicle of each synapse govern neuronal communication and mediate nervous system plasticity in health and disease. Thus, one of the principle goals in neuroscience has long been to measure synaptic structure and protein organization and to monitor mechanisms of change at individual synapses in living cells.

Because synapses are very small, highly dynamic, and densely packed within light-scattering medium, this goal has remained elusive. However, recent advances in microscopy techniques have greatly improved our ability to measure protein arrangements and dynamics over nanometer distances in live cells. As synapses are regulated on this scale, they are one of the first areas where these new techniques are applied full force and are beginning to have a major impact in neurobiology.

This volume is dedicated to the nanoscale analysis of the molecular and structural organization and dynamics of synapses of the central nervous system, utilizing superresolution imaging (PALM and STED) and other advanced methods (single-particle tracking, FLIM, and EM tomography). Its aim is to share insights and enthusiasm for these nanoscale techniques, providing practical help and references to researchers, who want to use these powerful techniques to push the envelope on synapses.

The chapters are contributed by leading practitioners and innovators in synapse biology and optical method development, focusing on key aspects of the structural and molecular analysis of synapse organization and function, including: EM tomography of synapse ultrastructure, time-resolved electron microscopy, spt-PALM imaging of synaptic receptors, 3D STORM analysis of the PSD, PALM imaging of actin dynamics, time-resolved fluorescence anisotropy imaging of molecular diffusion, FLIM of second messenger synaptic signaling, probing molecular dynamics of synaptic components by FRAP, STORM imaging of the extracellular matrix, STED imaging deep inside acute brain slices.

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New Concepts and Opportunities

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