Lester Wolfe Workshop in Laser Biomedicine

Neural Imaging with Optics

Dynamic neural imaging is a growing field which is improving our understanding of neural structure and function from the level of single neurons to whole brain systems. This workshop will provide an introduction to this field and explore new optical methods for imaging changes in the brain.

Tuesday, April 13, 2004 4:00-6:00 PM
Wellman 1 Conference Room ** 50 Blossom Street, MGH Campus, Boston

Venkatesh N Murthy, Harvard University

Using Optical Microscopy to Study Synaptic Structure and Function

Individual neurons and the synaptic connections between them are elemental units of the nervous system. To decipher the operation of a specific neuronal circuit, it is necessary to uncover the activity of individual components as well as their connectivity. Optical microscopy provides an appropriate set of tools for this task. Enormous advances have recently been made in the design and delivery of fluorescent molecules that can selectively label individual neurons or their components. In parallel, advances in different forms of fluorescence microscopy, particularly laser scanning microscopy, have allowed imaging of neuronal structure and function in the living neural tissue. In this talk, Dr. Murthy will provide some background on these advances and present some studies from his laboratory on imaging synaptic structure and function.

Christopher Fang-Yen, MIT

Low Coherence Interferometry for Noninvasive Monitoring of Nerve Signals

Dr. Fang-Yen and his colleagues are developing new interferometric techniques for measuring very small motions and optical shifts in nerve cells and tissues which accompany nerve signaling. Such optical methods aim to allow long-term noninvasive imaging of neural signals without the addition of exogenous agents. A dual-beam low coherence fiber interferometer has been developed which can measure nanometer-scale motions of weakly reflecting cells and tissues at kilohertz bandwidths. Using this interferometer they have performed the first non-contact measurements of surface displacements in a nerve during the action potential. Dr. Fang-Yen will describe current efforts to measure analogous displacements in cultured rat hippocampal neurons. Methods for imaging multiple neurons simultaneously and possible in vivo applications will be discussed.

Ania Majewska, MIT

Two-photon Imaging of Synaptic Morphology in the Visual Cortex In Vivo

Dendritic spines are the postsynaptic elements of most excitatory synapses in the mammalian cortex. Their distinct morphology allows synapse-specific regulation by restricting biochemical signals for plasticity to active synapses. Because of their small size, however, dendritic spines have proved to be challenging experimental targets. Two-photon laser scanning microscopy has allowed the probing of these small structures in living brain tissue. The work of Dr. Majewska and her colleagues has focused on examining dynamic changes in spine morphology in the developing visual cortex in vivo under the influence of visual stimulation and deprivation. By examining these structures in the intact visual cortex over timescales of hours and days they have begun to discover the rules which govern changes in spine shape during development and during specific types of visual cues. These morphological changes should prove very important for synaptic function and rearrangement. Their long-term goal is to understand the relationship between plasticity, changes in connectivity and rapid changes in dendritic spine structure.