CIMIT Center for Integration of Medicine & Innovative Technology

Wellman Center for Photomedicine

Massachusetts Institute of Technology

April 20, 2010
Massachusetts General Hospital, Richard B. Simches Research Center, Room 3110
185 Cambridge Street, Boston
4:00 – 6:00PM

Lester Wolfe Workshop in Laser Biomedicine
Optogenetics - Probing the Brain with Light

This Lester-Wolfe Workshop covers a relatively new, but already a high-impact field called Optogenetics. It is concerned with the use of genetically encoded light-sensitive proteins like channel rhodopsins and high-speed optical methods for probing and controlling specifically targeted neurons within intact neural circuits. Light can be delivered at will to switch on or off specific groups of neurons thus providing answers to fundamental questions in neurobiology.

Welcome: *John A. Parrish, MD, CIMIT Executive Director, japarrish@partners.org*

Moderator: Michael Hamblin, PhD, Associate Professor, Department of Dermatology, Harvard Medical School, Principal Investigator, Wellman Center for Photomedicine, Massachusetts General Hospital, mhamblin@partners.org

Controlling Brain Circuits with Light
Speaker: Edward S. Boyden, PhD, Benesse Career Development Professor, MIT Media Lab, Assistant Professor, Biological Engineering and Brain and Cognitive Sciences and Leader of the Synthetic Neurobiology Group, Massachusetts Institute of Technology, esb@media.mit.edu

Over the last several years, Ed Boyden's group at MIT has developed a rapidly expanding suite of genetically-encoded reagents that enable powerful neural activation and silencing in response to pulses of light. In order to enable these tools to be used for systematic analysis of the causal contribution of specific cell types, pathways, and brain regions to neural computations, behaviors, and pathologies, they have begun to develop hardware to enable neural circuits to be perturbed in a three-dimensional fashion, and for the network-wide impact to be measured using tools such as novel electrodes and fMRI. Boyden will explore how these tools can be used to enable systematic analysis of neural circuit functions, exploring the properties of neural circuits that mediate emotion, sensation, and movement, and that play roles in neurological and psychiatric disorders. He will also discuss the translational potential of such tools to potentially enable novel ultraprecise neuromodulation therapies.

Engineering Light-gated Neurotransmitter Receptors

Speaker: Stephanie Szobota, PhD, Postdoc, Department of Molecular and Cell Biology, University of California, Berkeley, szobota@newton.berkeley.edu

At the molecular level, the interactions between neurons are largely governed by neurotransmitters, such as glutamate and acetylcholine. Stephanie Szobota's lab has developed a method that enables precise optical control over the activity of neurotransmitter receptors, so that they can be activated or silenced using brief pulses of light at specific wavelengths. These receptors are genetically engineered to bind a photoswitchable neurotransmitter, such as glutamate coupled to the photoisomerizable molecule azobenzene. Thus, the receptors can be genetically targeted to neurons of interest, where they are activated either by native neurotransmitter, or by light. This optical approach has temporal and spatial precision that is unmatched by traditional pharmacological or electrical manipulations, and enables remote, non-invasive control of single synapses, individual neurons, neural circuits, and animal behavior.

A New View of Neocortical Function: Integration of Optogenetic Control with High-resolution fMRI

Speaker: Itamar Kahn, PhD, Post-doctoral Associate, Howard Hughes Medical Institute, Harvard University; Visiting Post-doctoral Fellow, McGovern Institute for Brain Research, Massachusetts Institute of Technology, kahn@nmr.mgh.harvard.edu

Magnetic resonance imaging (MRI) methods allow us to simultaneously measure the function of multiple brain systems. In humans we can characterize the functional organization and specialization, and compare the system between health and disease. In animal models we can dissect the circuits underlying these dynamics. Itamar Kahn will describe new tools his lab is developing that combine functional MRI with optical control of specific neural populations in the brain. He will present results from experiments mapping system dynamics locally and across distal functional components and at a resolution that allows detection of differences among small clusters of neurons. He will also discuss prospects for this approach in studying the microcircuit as well as large-scale brain dynamics.

The Lester Wolfe Workshop in Laser Biomedicine is sponsored by the G. R. Harrison Spectroscopy Laboratory, MIT; MGH Wellman Center for Photomedicine; Harvard—MIT Division of Health Sciences and Technology; and CIMIT (Center for Integration of Medicine and Innovative Technology).

Lester Wolfe Biography

Lester Wolfe was an inventor with a special interest in optics and photography. He died in 1983 at the age of 86. He was a benefactor of MIT, and his will provided funds "for fellowships for studies in molecular biology and for research using optical methods in the investigation of the structure and properties of matter." Lester was born in Boston in 1897 to a family of modest means. He enrolled at MIT as physics undergraduate and graduated in the class of 1919 -- well before the advent of quantum mechanics, the atomic bomb or lasers! During World War I he served in the armed forces as an inventor, and received a commendation for design of the "fuel quantity gauge", which used a radioactive source to measure the supply of fuel stored in the wings of an airplane. After the war he became active in industry, and he made his fortune in the field of containerized shipping between the United States and Japan. He became an expert in pre-Colombian art and technology, and a collector in this field and several others. Toward the end of his life Lester became interested in furthering research in biology and medicine as well as in the area that he loved most, optics. That is how he developed an interest in the research projects of the Spectroscopy Laboratory.

The Lester Wolfe Workshop in Laser Biomedicine is a series of talks dedicated to a particular aspect in biomedical optics. The panel of speakers of the Workshop is chosen from expert researchers in academia, medical profession and industry. Held twice a year, the Lester Wolfe Workshop is sponsored by the George R. Harrison Spectroscopy Laboratory, MGH Wellman Center for Photomedicine, Harvard—MIT Division of Health Sciences and Technology, and CIMIT (Center for Integration of Medicine and Innovative Technology). Information obtained from the MIT Spectroscopy Website: http://web.mit.edu/spectroscopy/events/wolfe.html.