**Course Abstract:**

The synapse is the fundamental element by which neurons transmit, receive and transform information in the brain. Synapses are functionally diverse, and a single neuron in the brain receives up to 10,000 synapses. Given the enormous complexity of the nervous system, how does a neuron integrate, encode and retrieve information? How is information processed beyond a single cell within the context of a neuronal circuit? Fundamental synaptic mechanisms underlie expression of higher-order brain functions, such as learning and memory, and cognition. Conversely, the disruption of synaptic processes contributes to the development of neurological disorders. In this course, students will learn to critically analyze the primary research literature to explore how synapses are studied and to understand how synapses integrate information to perform higher-order behavior. We will begin with the molecular composition of the synapse and will discuss how these components are altered to change the structure and function of individual synapses in response to experience, a process called ‘plasticity’. We will explore the diversity of synapses by examining excitatory and inhibitory synapses, focusing on distinct and common rules for plasticity, developmental origins of neuronal cell-types, and mechanisms that govern their integration into neural circuits. Finally, we will study mechanisms that contribute to the disruption of excitation-inhibition balance that lead to neuropsychiatric disorders, such as autism and schizophrenia. With this knowledge, students will visit the Drug Discovery Unit at Pfizer to learn about strategies for drug design and discovery to treat neuropsychiatric disorders. Students will also have the opportunity to visit an MIT laboratory where they will be introduced to cutting-edge experimental techniques, such as high-resolution two-photon imaging and electrophysiology, as well as a demonstration of optogenetics to optically control the activity of specific neural circuit elements. From this course, students will learn how to read, critique, summarize and present scientific results, and to understand advantages and disadvantages of various experimental approaches. By relying on classic and current scientific literature, students will gain an appreciation of both the progress and the challenges ahead in understanding the contributions of synapses in normal and diseased brains.