

Nicotinic Acetylcholine Receptor Function in the Brain:

Role in Synaptic Excitability, Plasticity, and Disease

Nicotine is one of the most potent and prevalent neurotoxins in the environment; infant deaths have been linked to exposure *in utero*, and there are cognitive and behavioral disabilities in children exposed *in utero*, or to second hand smoke. However nicotine can enhance cognition in adults, and also appears to be neuroprotective in Parkinson's and perhaps Alzheimer's disease. Nicotine exerts its effect in the nervous system by acting on the nicotinic acetylcholine receptor channel (nAChR). The nAChRs are ligand-gated ion channels and are widely expressed throughout the brain and nervous system in general, where they are involved in a variety of brain functions including (but not limited to) development, learning and memory formation, and reward. Furthermore deficits in nAChR signaling are associated with neurodegenerative diseases, such as Alzheimer's (AD) and Parkinson's disease (PD). In the Ion Channel Physiology Group, we focus on understanding structure/function aspects of native and expressed nAChRs, and what role these receptors play in neural circuits, including the hippocampus, an important region for learning and memory. Using a multitude of electrophysiological and light and laser-based imaging techniques, we have recently shown the remarkable temporal precision of cholinergic functions in the hippocampus that induces synaptic plasticity, a cellular model of learning and memory. Our recent work provides a novel mechanism for information processing in cholinergic-dependent higher cognitive functions.