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Optogenetic approaches for the modulation of membrane excitability and synaptic plasticity

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Optogenetic approaches provide easy, low cost and precise experimental approaches to manipulate the cellular activities to investigate neurocircuitry and their functions. In this presentation, I will present 4 unpublished optogenetic approaches and tools developed within my research groups that can be used to study neurocircuitry function. The first approach is a co-expression strategy of 2 channelrhodopsins which can successfully suppress the blue-light induced excitation of red-shifted channelrhodopsin, achieving spectrally-narrow excitation of expressing neurons with red-light. This involves the modification of channelrhodopsin mutants to achieve matching kinetic of the 2 channelrhodopsins used. The second tool is a new mutant variant channelrhodopsin variant that can be manipulated by 3 wavelengths of light to achieve the subthreshold depolarization of expressing neurons. The third approach is our optogenetic tools that can simulate the activation of TrkB receptor by BDNF that permit the selective manipulation of different signaling pathways associated with endogenous BDNF signaling. Preliminary results have suggested differential effects on AMPA-type glutamate receptor membrane insertion when different signaling pathways are activated. The last tool is the optogenetic tool that can be used to disrupt the signal transduction mediated by GPCR-associated Gq that can lead to disruption of neurodevelopment, learning and behaviour of the expressing model organism.