Application of Light Sensitive Opsin Proteins in the Control of Brain Activities

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Abstract

Introduction: Optogenetics combines optical and genetic methods to control the neural activities or other cellular functions rapidly and reversibly. Using genetic methods, specific cells or anatomical pathways can be sensitized to light through exogenous expression of microbial light activated opsin proteins. Using optical methods, opsin expressing cells can be rapidly and reversibly controlled by pulses of light from specific wavelength.

Methods: First of all, Optogenetics requires light-sensitive proteins, which can be naturally occurring or they can be chemically modified to become photosensitive. Secondly these light-sensitive proteins can be delivered to the target cells by transfection, viral transduction or the creation of transgenic animal lines. In third step, illumination can be temporally controlled using an ultra-fast shutter, fast switching of an LED or one-photon laser scanning microscopy. For in vivo applications, light sources coupled to optical fibers or miniaturized LEDs have been widely used. Finally the induced effect by illumination of the photosensitive protein needs to be measured in cells, tissue or organisms by electrodes, fluorescence-based biosensors or behavioural testing.

Discussion and Conclusion: This method represents millisecond-timescale control of neuronal spiking, as well as control of excitatory and inhibitory synaptic transmission. This technology makes it possible the use of light to alter neural processing at the level of single spikes and synaptic events, yielding a widely applicable tool for neuroscientists and biomedical engineers.

Keywords: Opsin, Brain, Optogenetic, Light sensitive protein, Neuromodulation, Neural activity

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