

Optogenetics

Fundamentals and Opportunities on Single Photon CW Lasers (non MPE)

June 2014



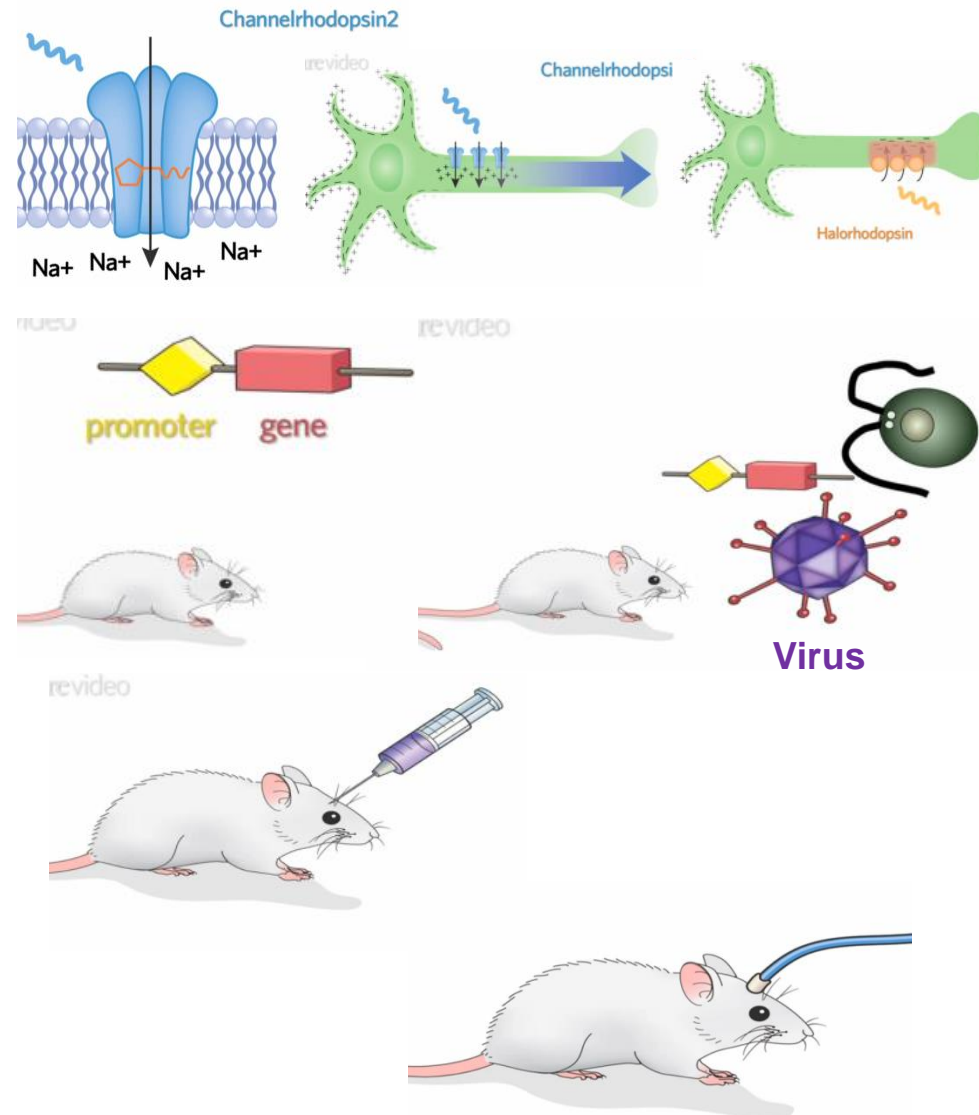
What is Optogenetics?

Optogenetics is the combination of genetics and optics to control well-defined events within specific cells of living tissue.

- Light-responsive proteins are allowing scientists to turn neurons on or off selectively with unprecedented precision.
- First ChR protein was isolated from a species of green algae in 2002.
- Key benefit is control over defined events within defined cell types at defined times. A level of precision that is most likely crucial to biological understanding even beyond neuroscience.
- Better than Electrophysiology as the electrical stimulation interferes with signals measured.
- ‘Optogenetic’ tools also hold clinical promise, with the potential for modulating activity of brain circuits involved in neurological disorders or restoring vision loss. (Source: <http://www.mpg.de/18011/Optogenetics>).

Optogenetics Basics

- In proteins such as Channelrhodopsin, light opens the channel for flux of positive ions into the cell. **Activate neuron.** Halorhodopsin does the inverse (negative ions). **Deactivate neuron.**
- Genetic engineering is necessary: Take the gene that encodes the protein and another piece of the DNA, the promoter, and put those into a virus.
- Inject the virus. Virus infects neurons and delivers the genes to express in the cell membrane. Light switches motion neurons.

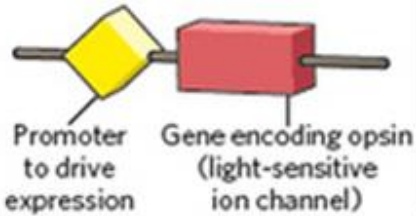


SIX STEPS TO OPTOGENETICS

With optogenetic techniques, researchers can modulate the activity of targeted neurons using light.

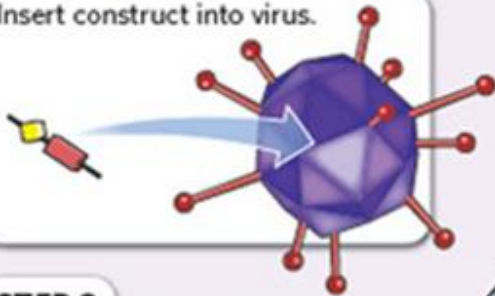
STEP 1

Piece together genetic construct.



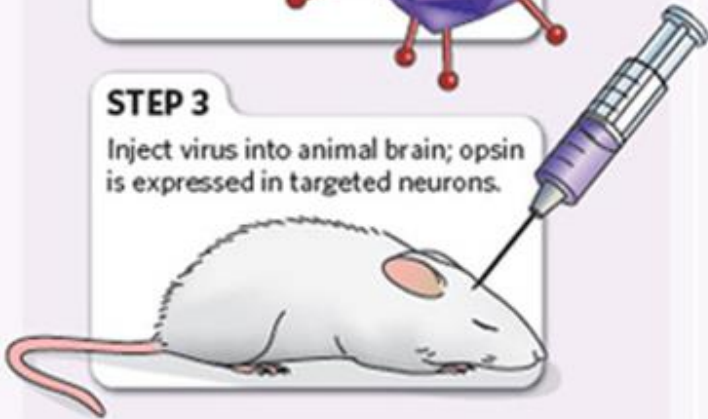
STEP 2

Insert construct into virus.



STEP 3

Inject virus into animal brain; opsin is expressed in targeted neurons.



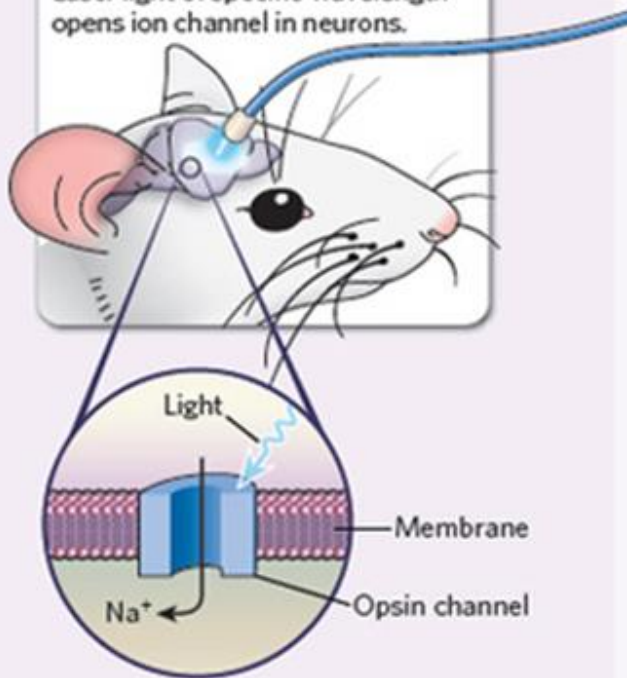
STEP 4

Insert 'optrode', fibre-optic cable plus electrode.



STEP 5

Laser light of specific wavelength opens ion channel in neurons.



In Vivo
- Living Animal

