

如何用光控制你的大腦

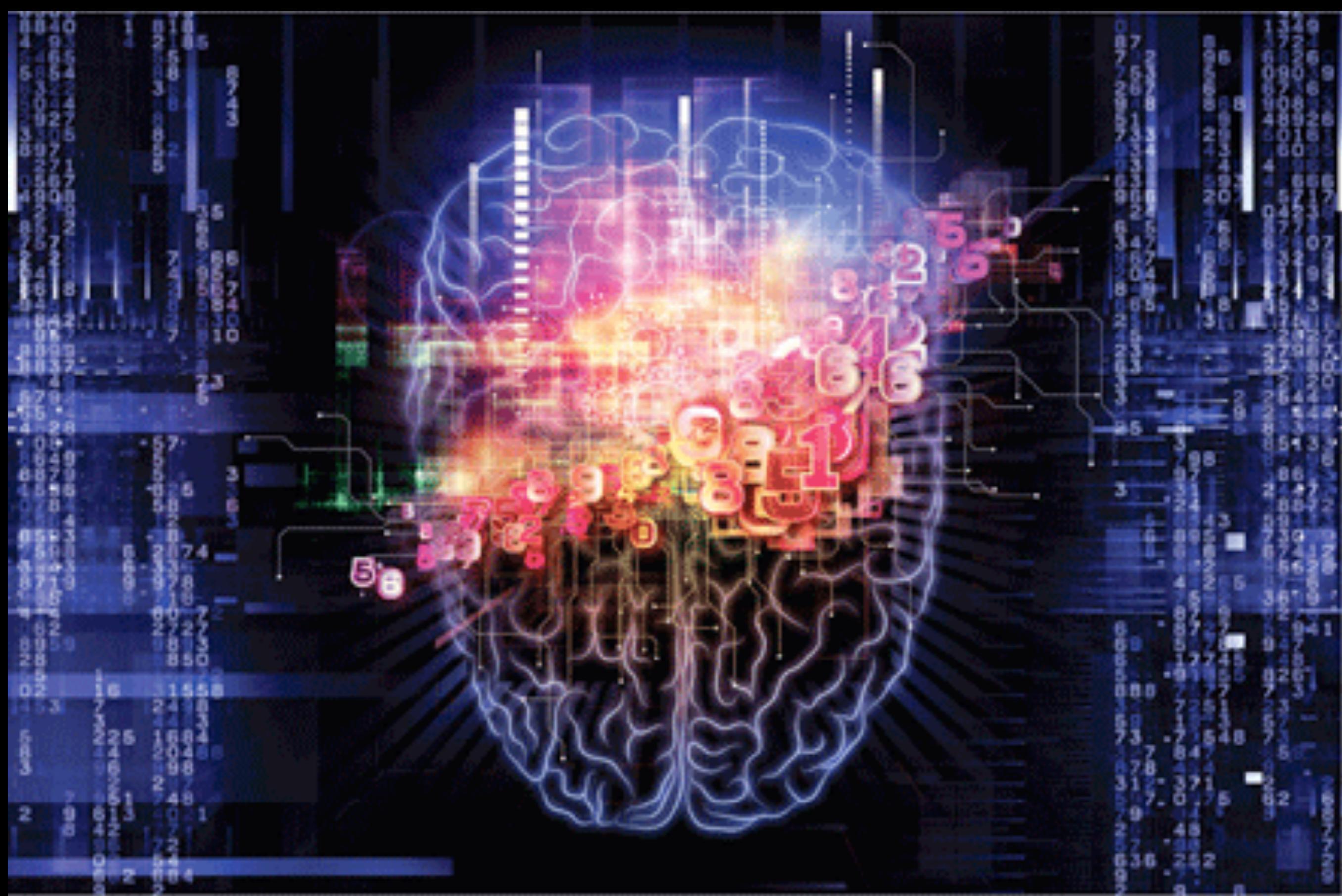
The Development and Application of Optogenetics in Neuroscience

Cheng-Chang Lien MD, PhD
Institute of Neuroscience, NYMU

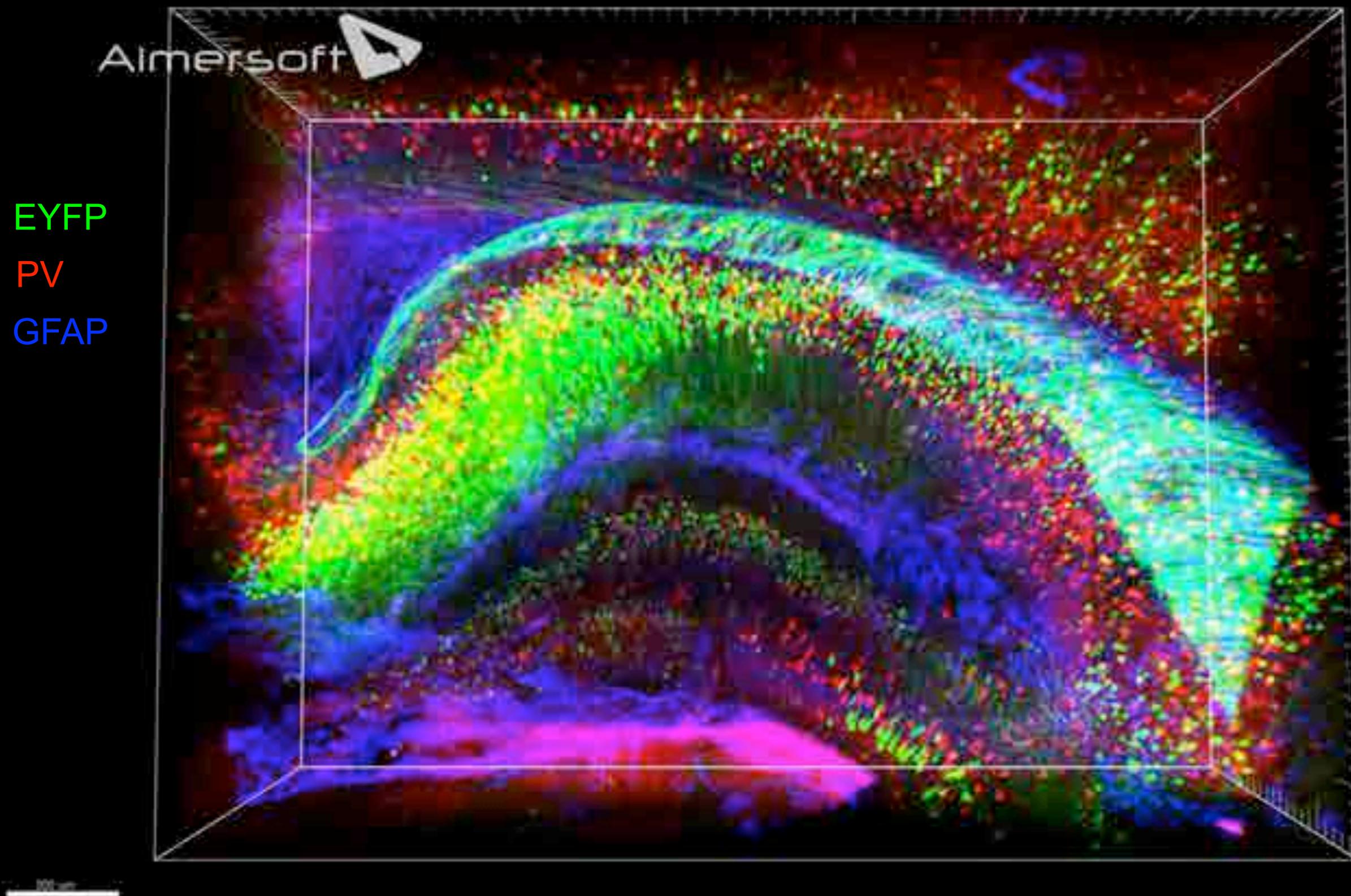
Speaker: Tsan-Ting Hsu, PhD student



The complexity of the brain



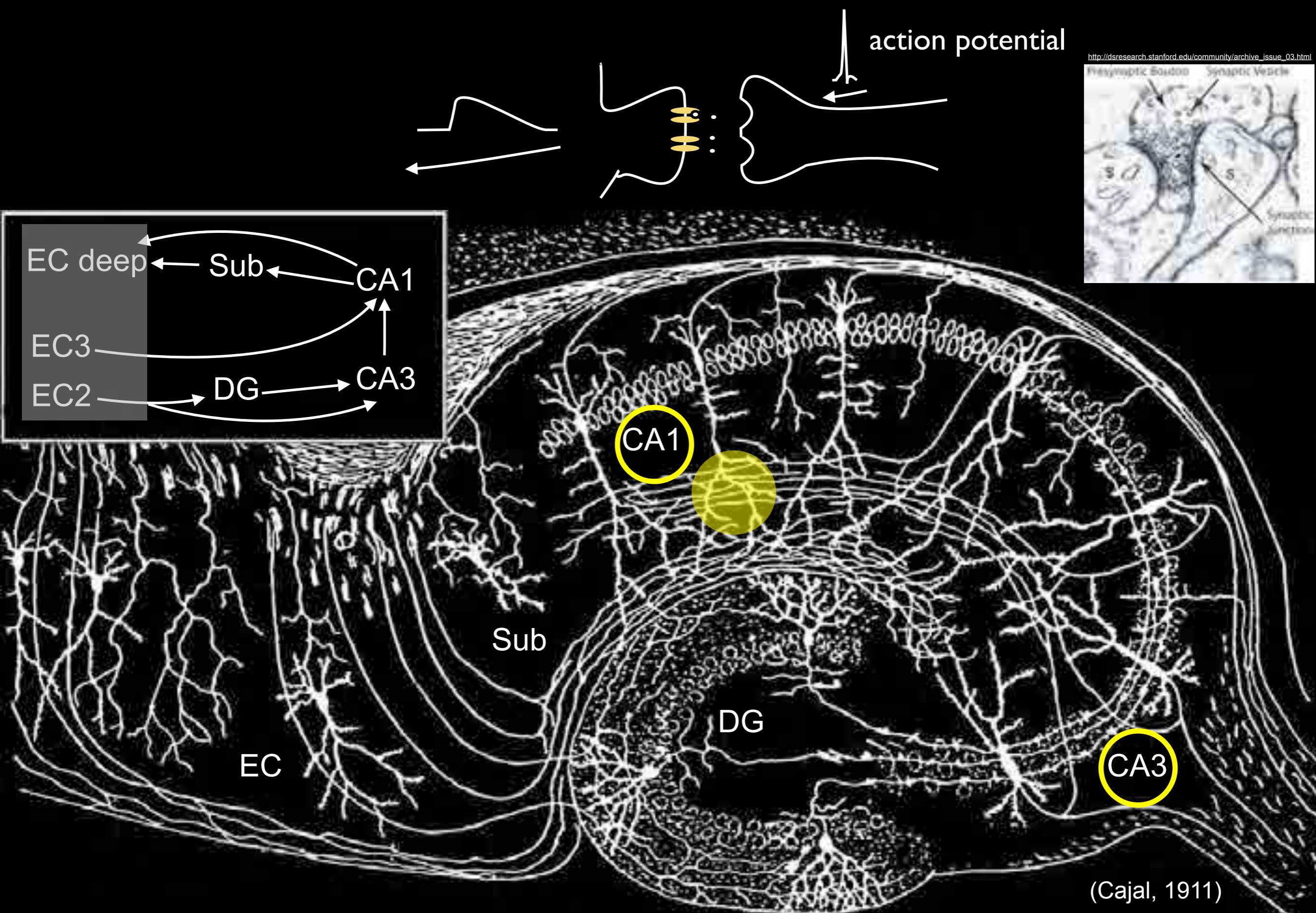
The complexity of the brain



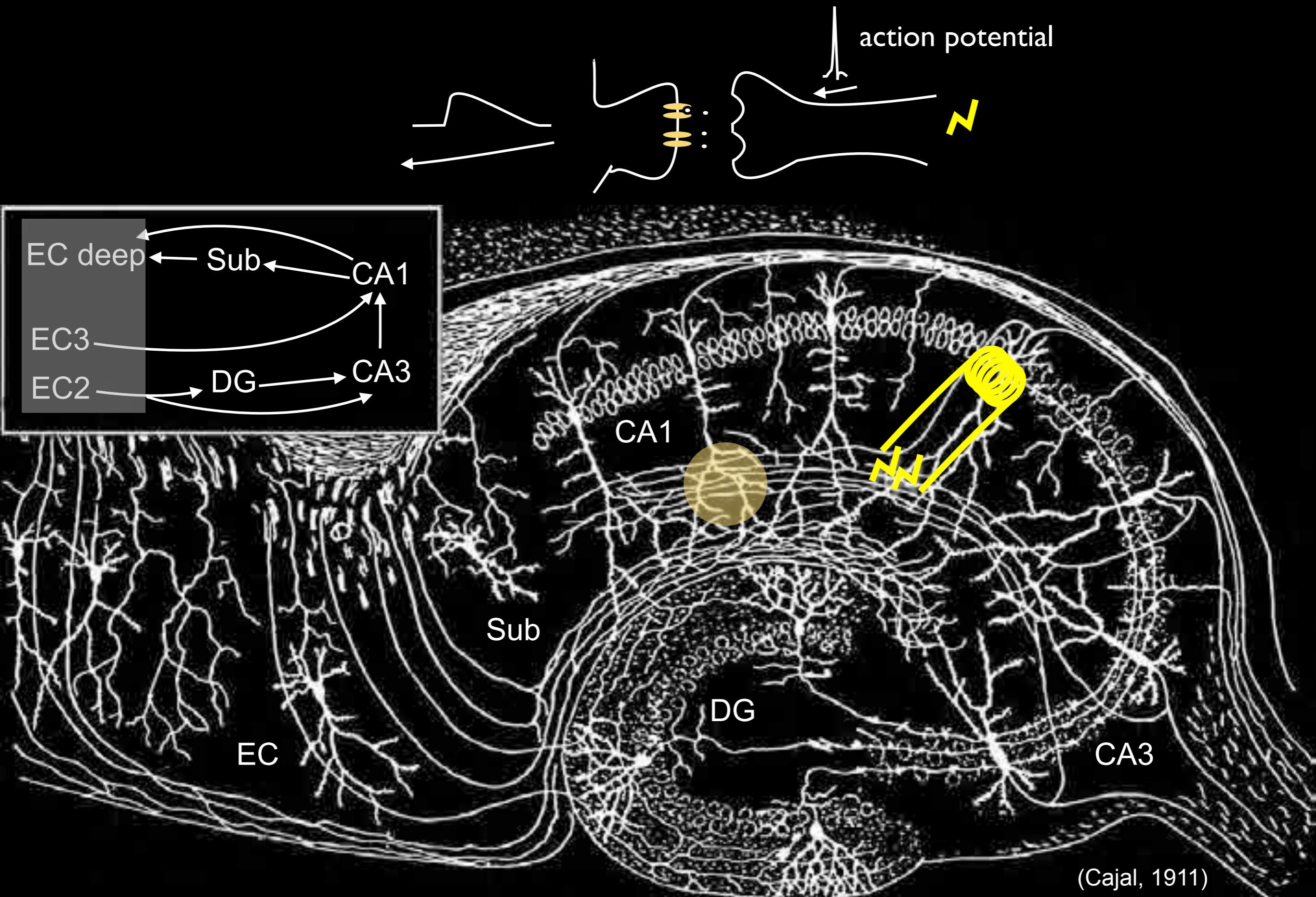
Thy1-EYFP mouse brain block

(Chung et al., 2013)

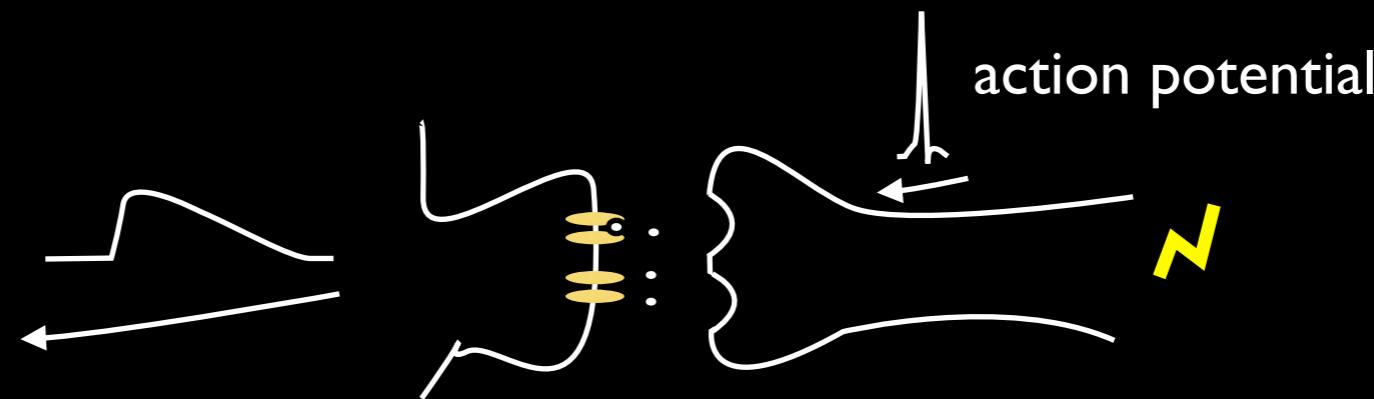
Hippocampal circuit



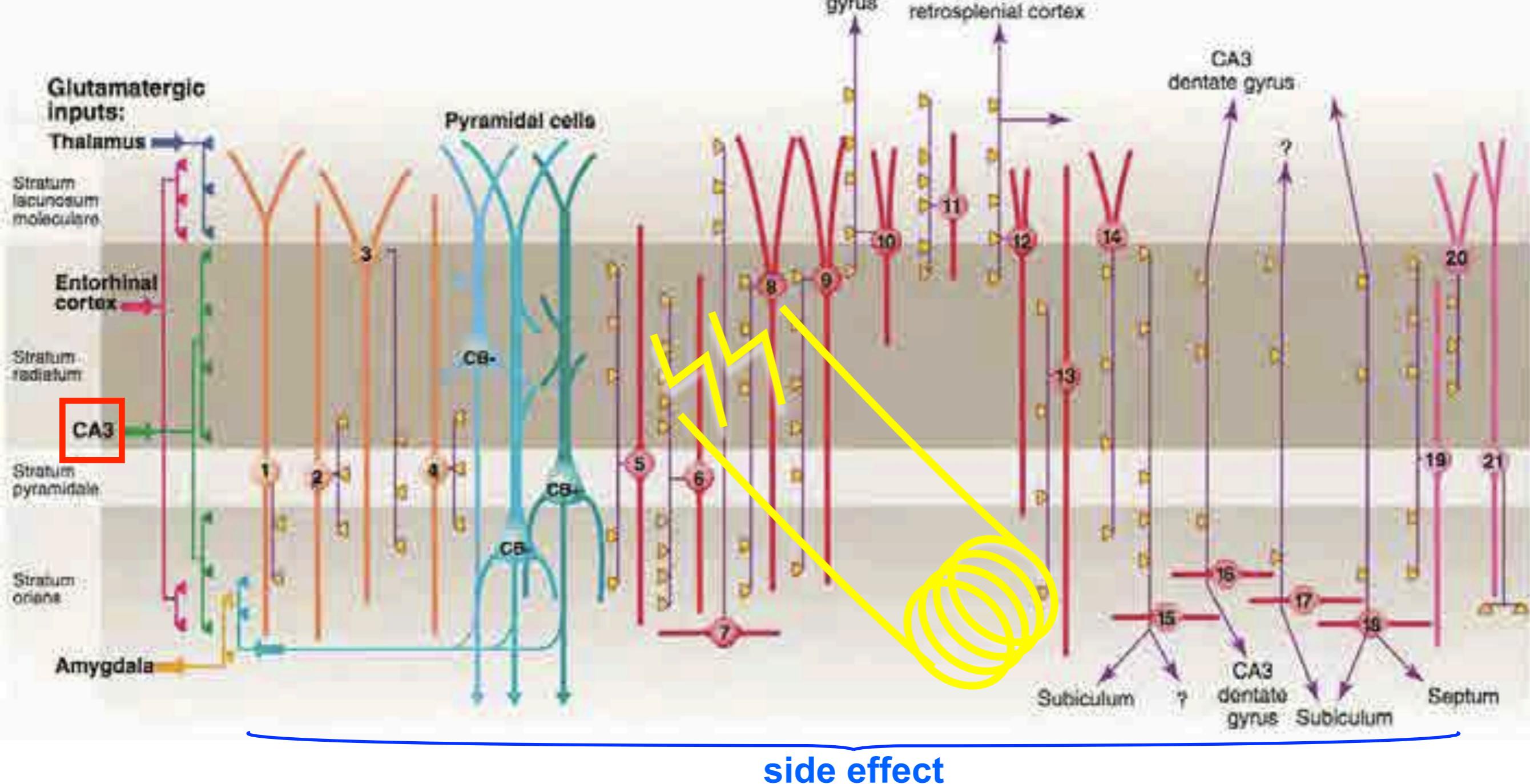
Hippocampal circuit

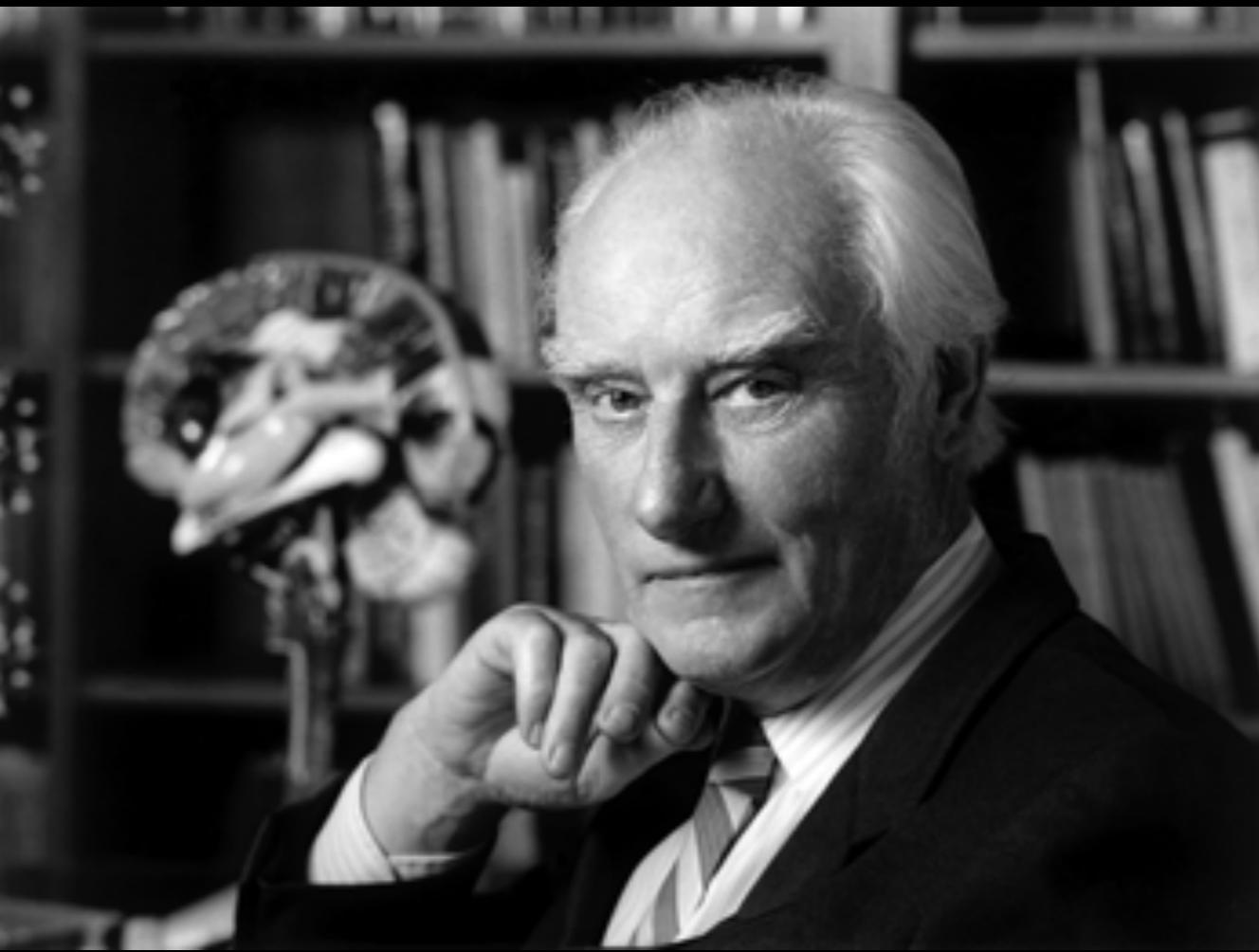


Hippocampal circuit



(Klausberger and Somogyi, 2008)



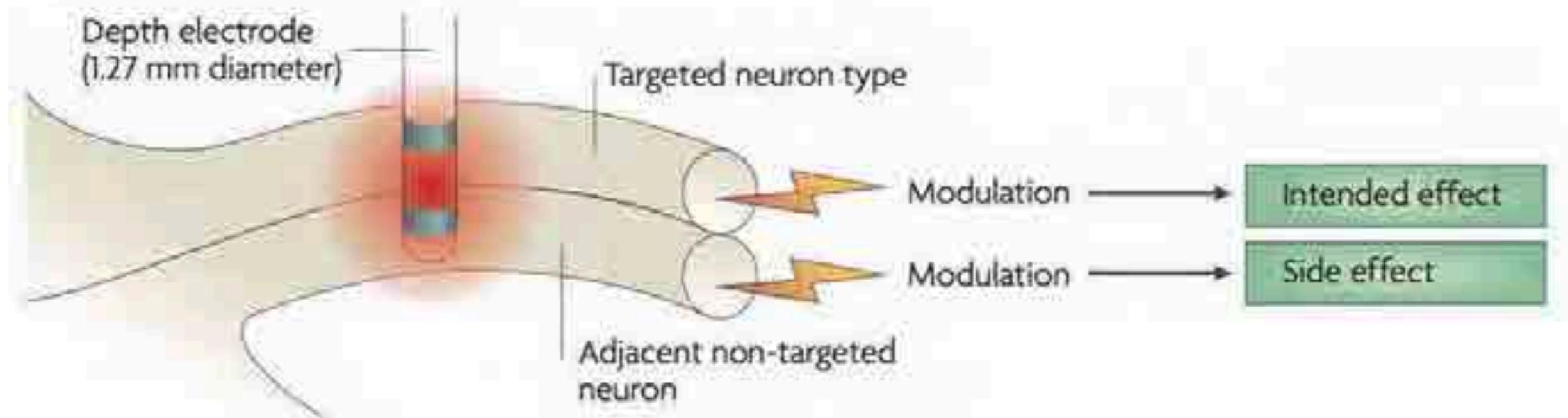


The major challenge facing neuroscience was the need to control one type of cell in the brain while leaving others unaltered.

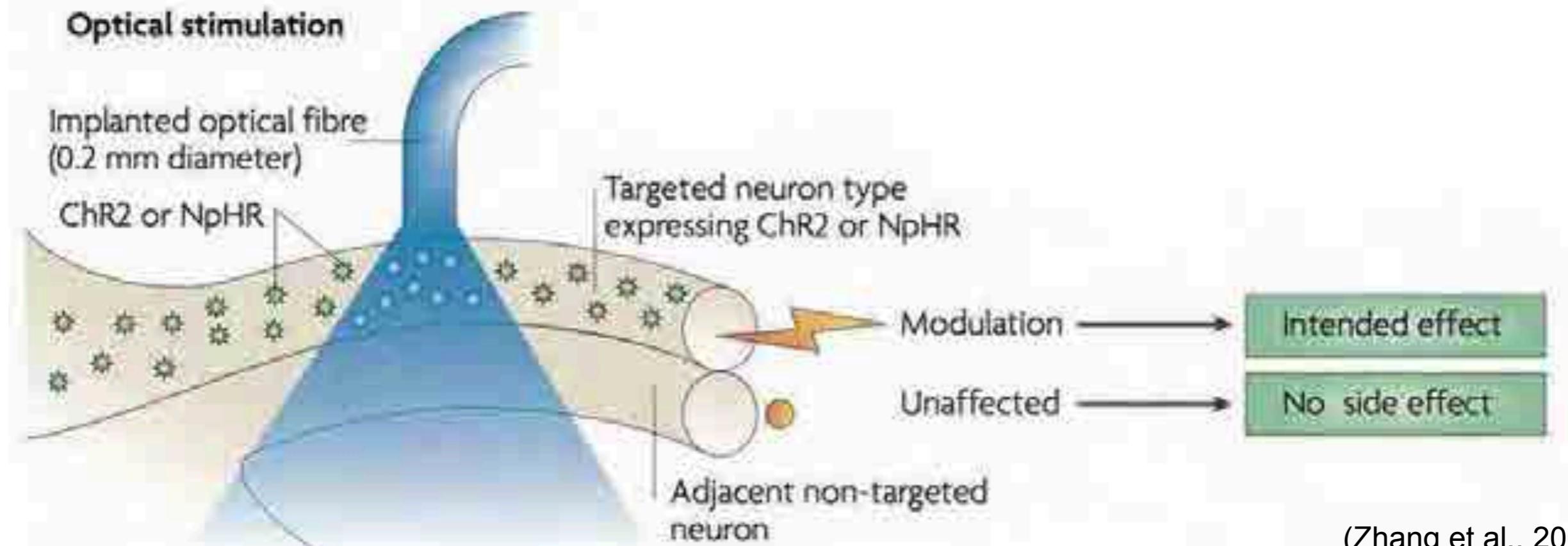
Nobel laureate Francis Crick (1979)

Controlling the brain with light

Electrical stimulation



Optical stimulation



(Zhang et al., 2007)

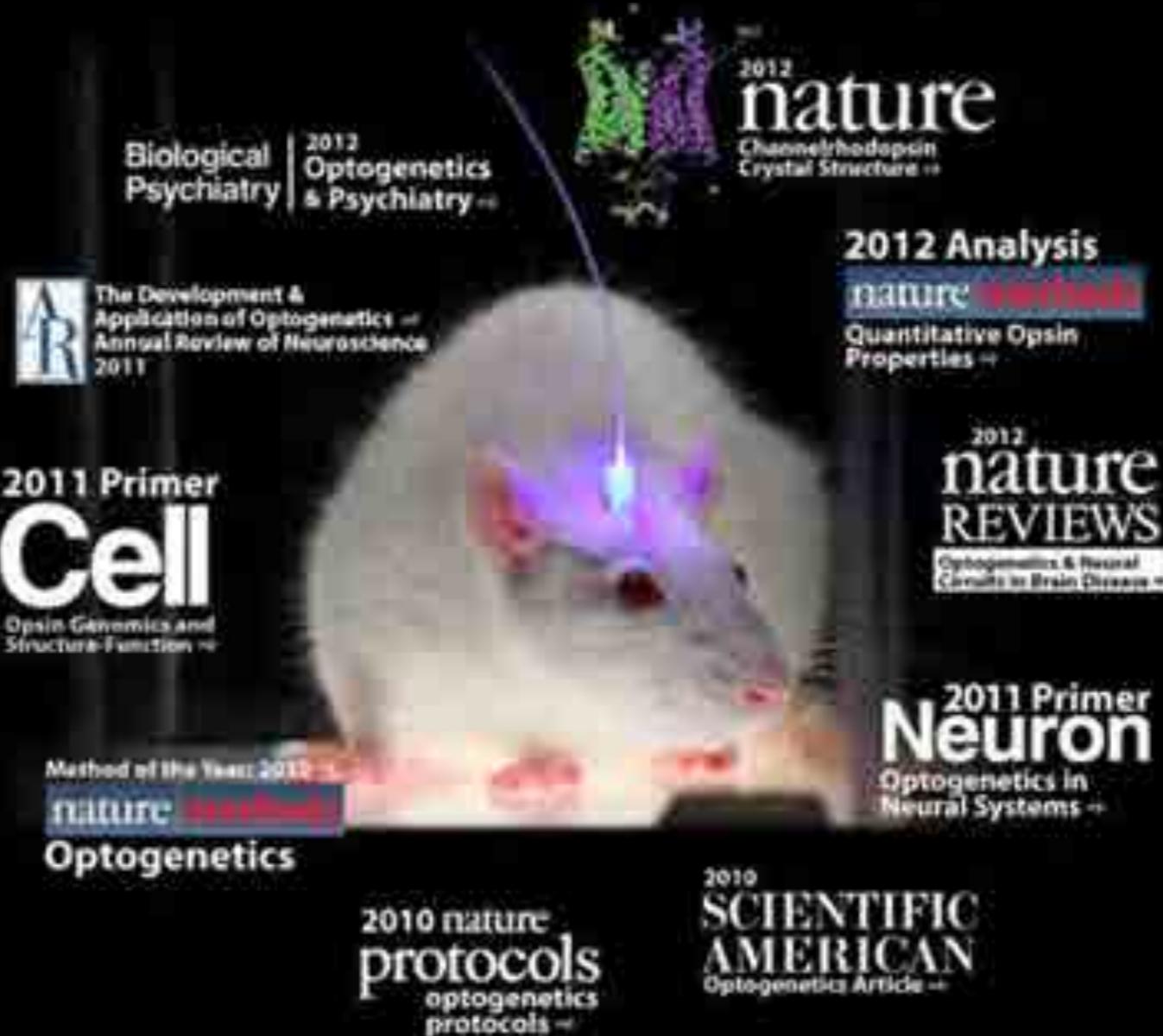
Controlling the brain with light



Karl Deisseroth

Edward S Boyden

Feng Zhang



Controlling the brain with light

Optogenetics Resource Center

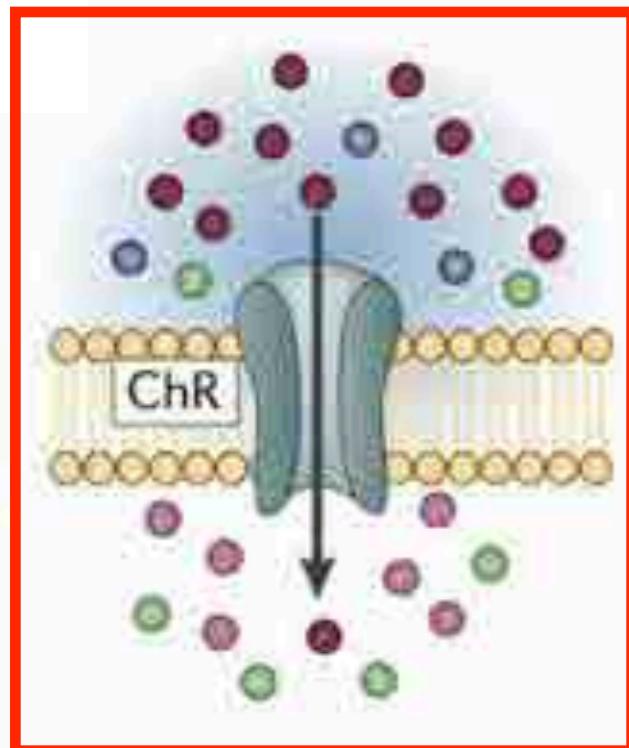
<http://www.stanford.edu/group/dlab/optogenetics/>

The image is a collage of various scientific publications and resources related to optogenetics, arranged around a central 3D rendering of a mouse brain. The publications include:

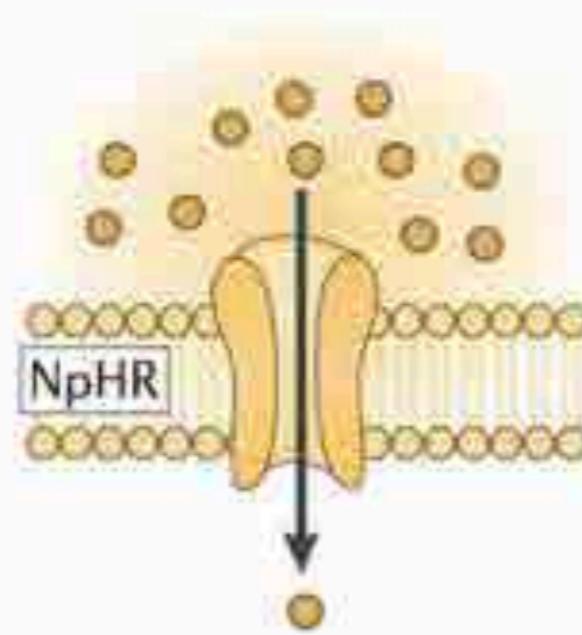
- OPTOGENETICS**: A vertical banner on the left.
- Biological Psychiatry**: An issue of Biological Psychiatry from 2012.
- Cell**: An issue of Cell from 2011, titled "Opson Genomics and Structure-Function".
- nature**: An issue of Nature from 2012, titled "Channelrhodopsin Crystal Structure".
- 2012 Analysis**: A section of the 2012 Nature issue.
- nature REVIEWS**: An issue of Nature Reviews from 2013, titled "Optogenetics & Neural Circuits in Brain Disease".
- Neuron**: An issue of Neuron from 2011, titled "Optogenetics in Neural Systems".
- SCIENTIFIC AMERICAN**: An issue of Scientific American from 2010, titled "Optogenetics Article".
- 2010 nature protocols**: An issue of Nature Protocols from 2010, titled "optogenetics protocols".
- Method of the Year 2010**: A section of the 2010 Nature issue.
- nature REVIEWS**: Another section of the 2010 Nature issue, titled "Quantitative Opson Properties".
- Sequence info**, **virus preparation**, **hardware**, **material request**, **references**, and **d-lab**: Links at the top of the page.
- Brain tissue light transmission calculator** and **Angeled Stereotax coordinate calculator (MatLab)**: Tools available on the site.
- Clarity Resource Site** and **Optogenetic courses**: Additional resources.

Optogenetic Tool Family

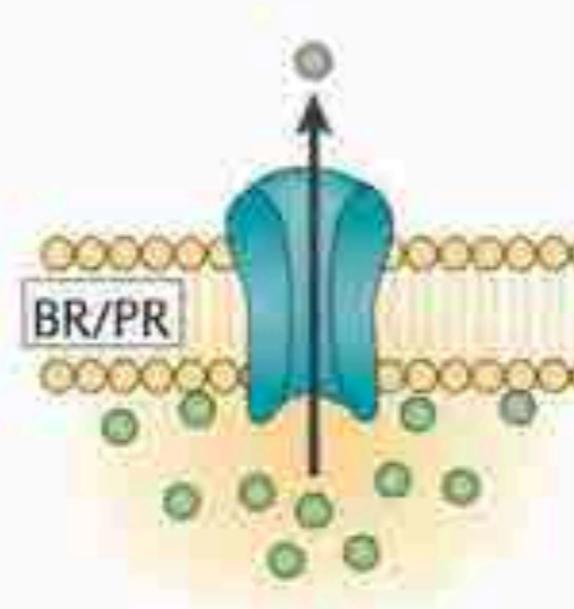
depolarization



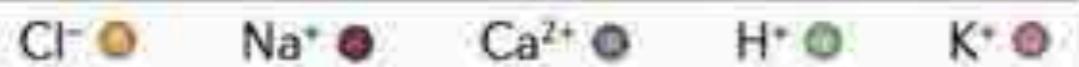
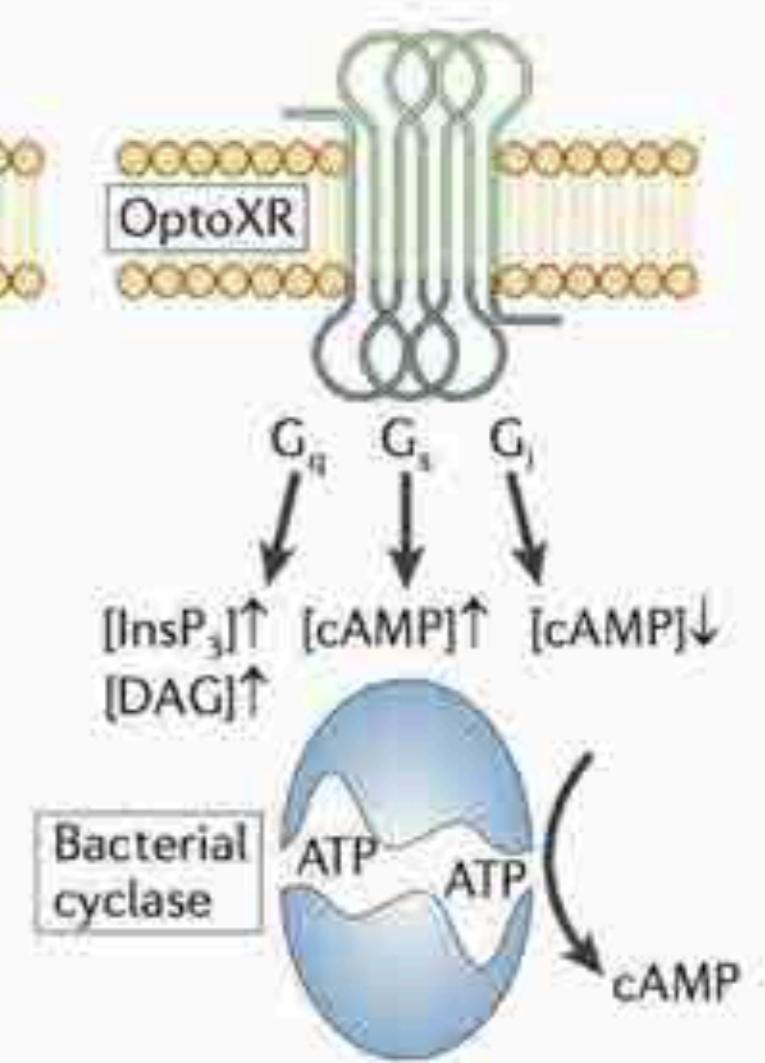
hyperpolarization



depolarization



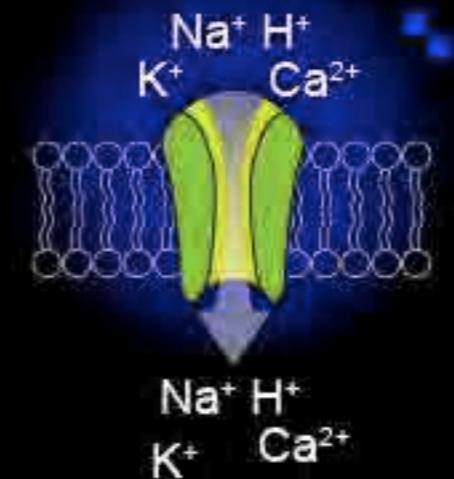
signaling



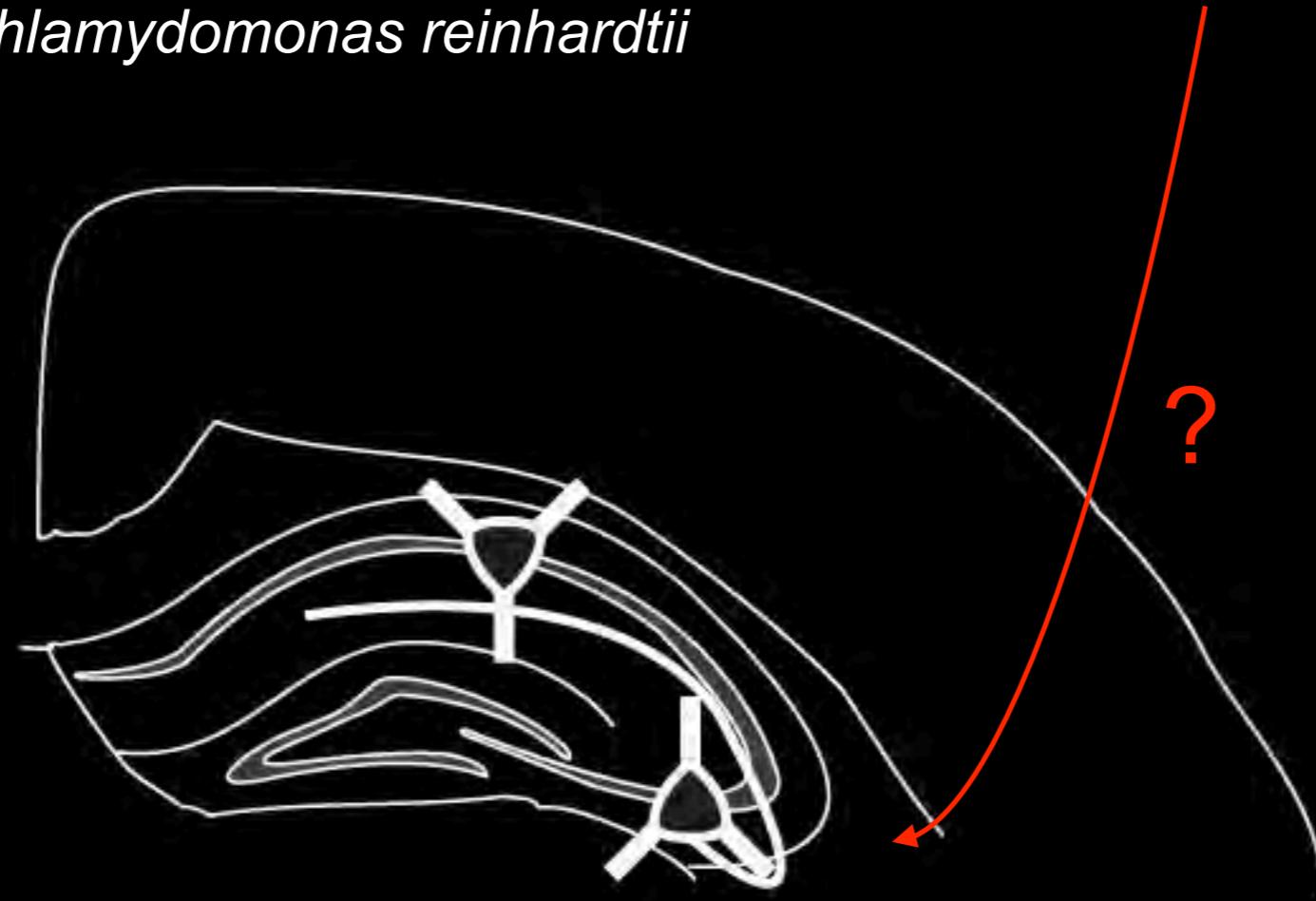
Channelrhodopsin-2 (ChR2) expression on specific neural populations



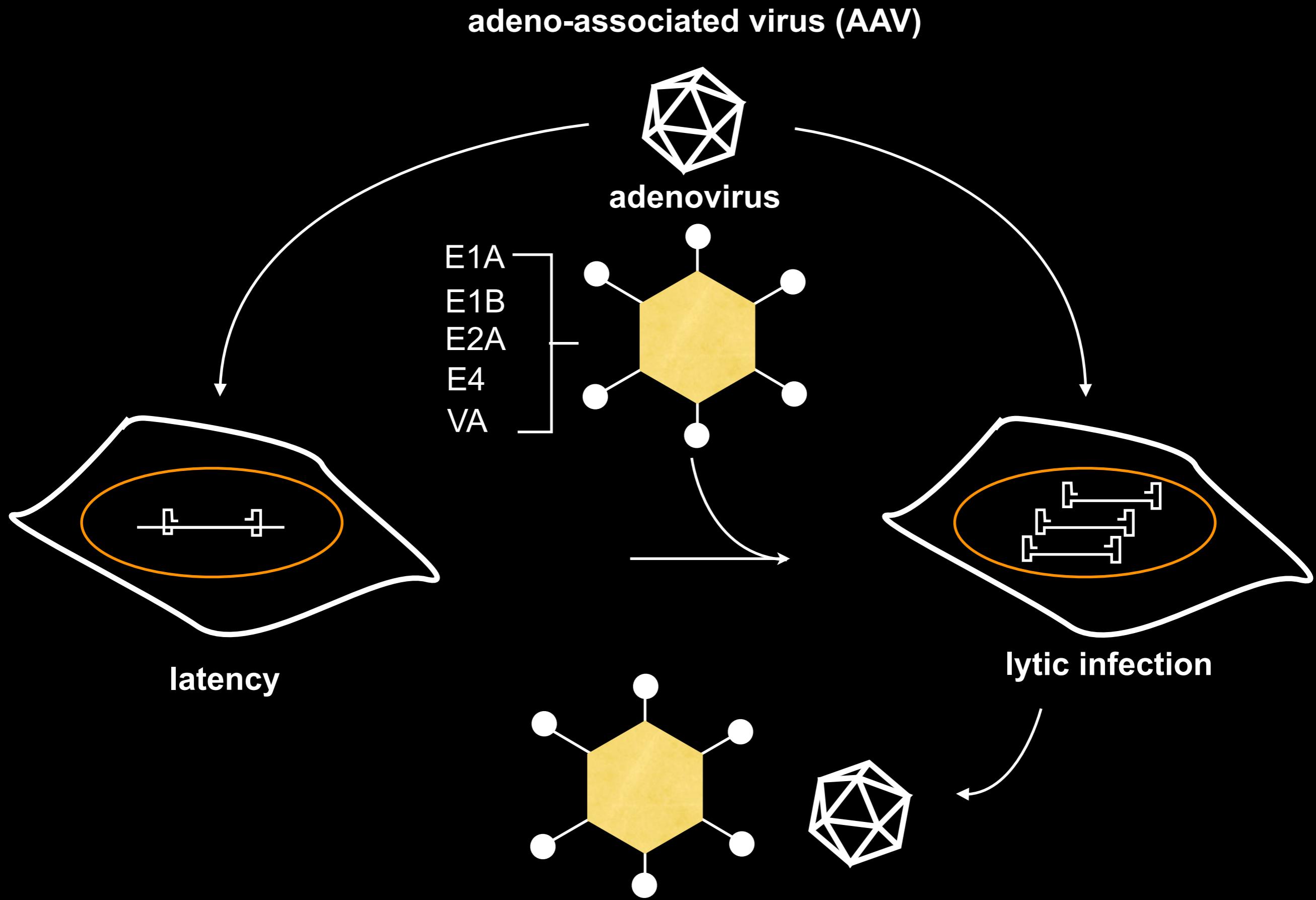
channelrhodopsin-2



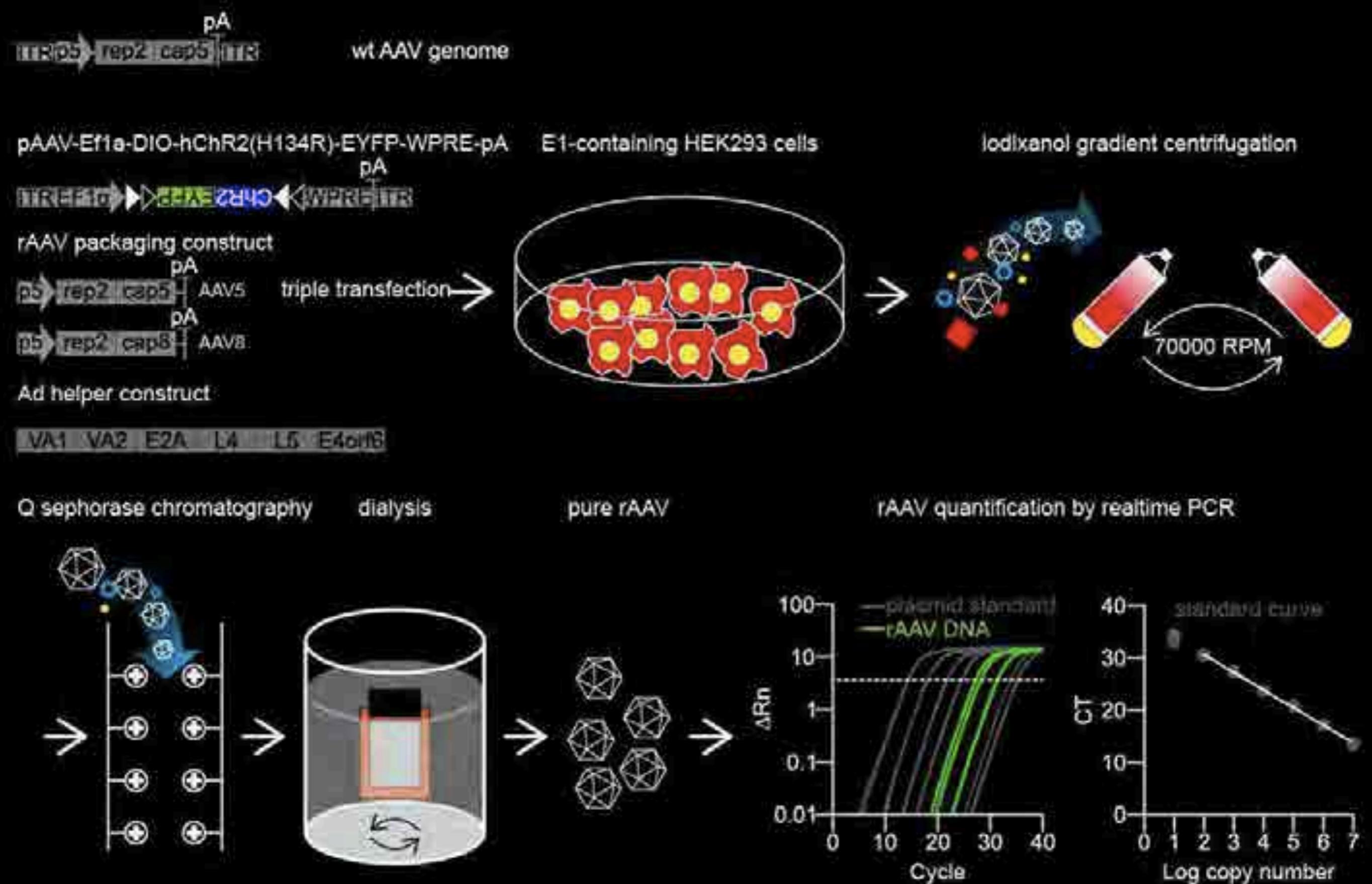
Chlamydomonas reinhardtii



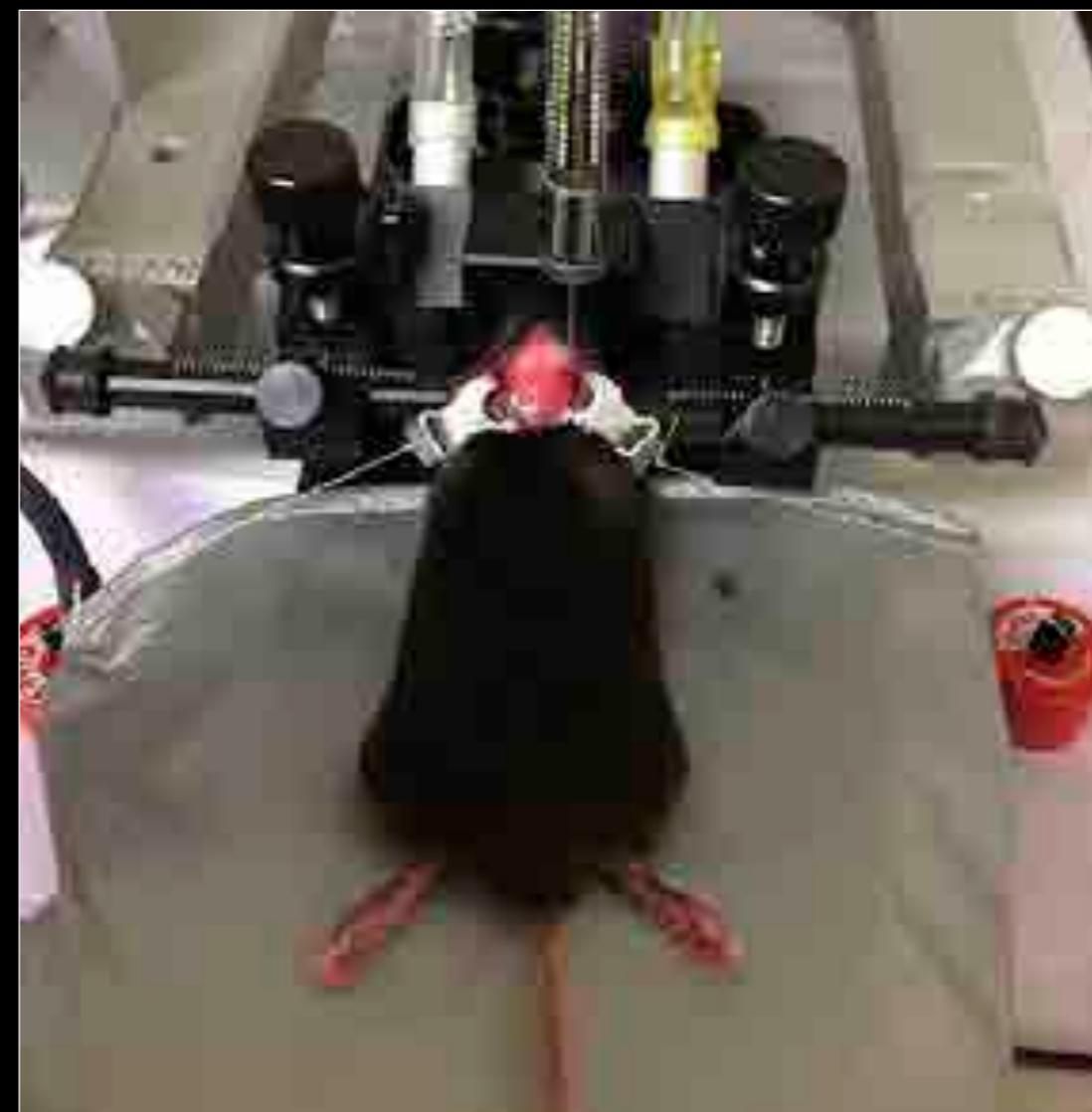
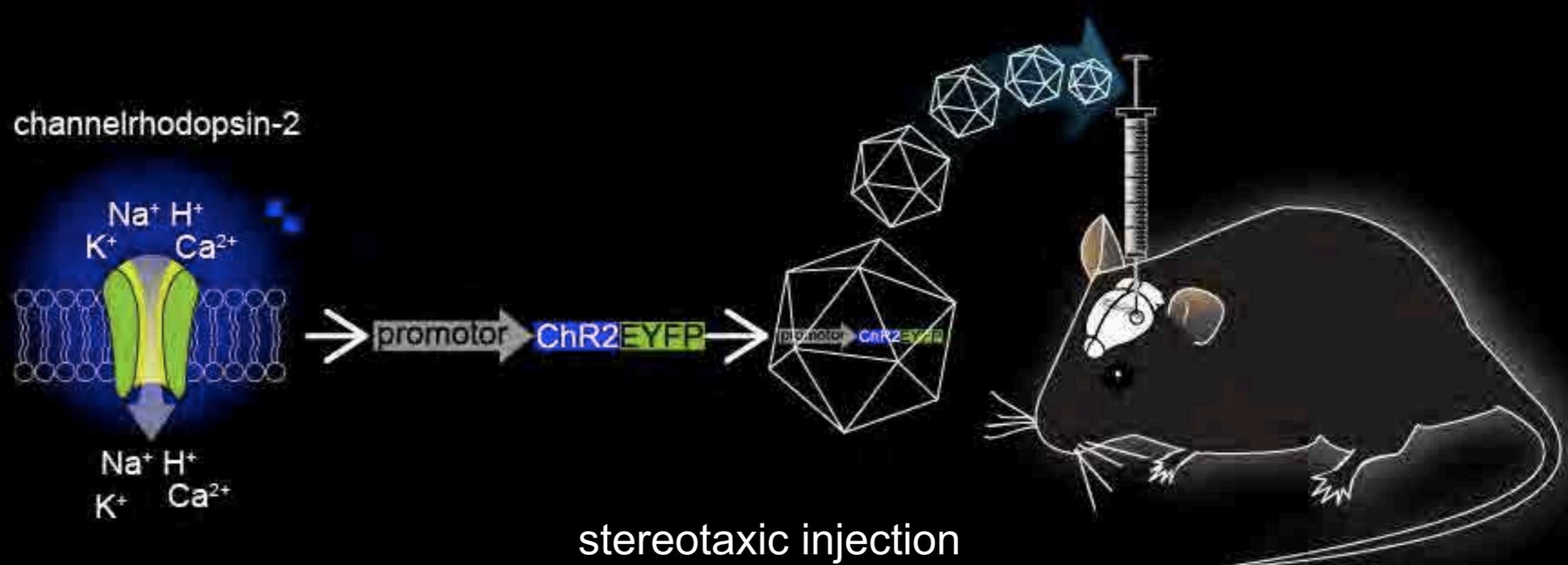
Channelrhodopsin-2 (ChR2) expression on specific neural populations



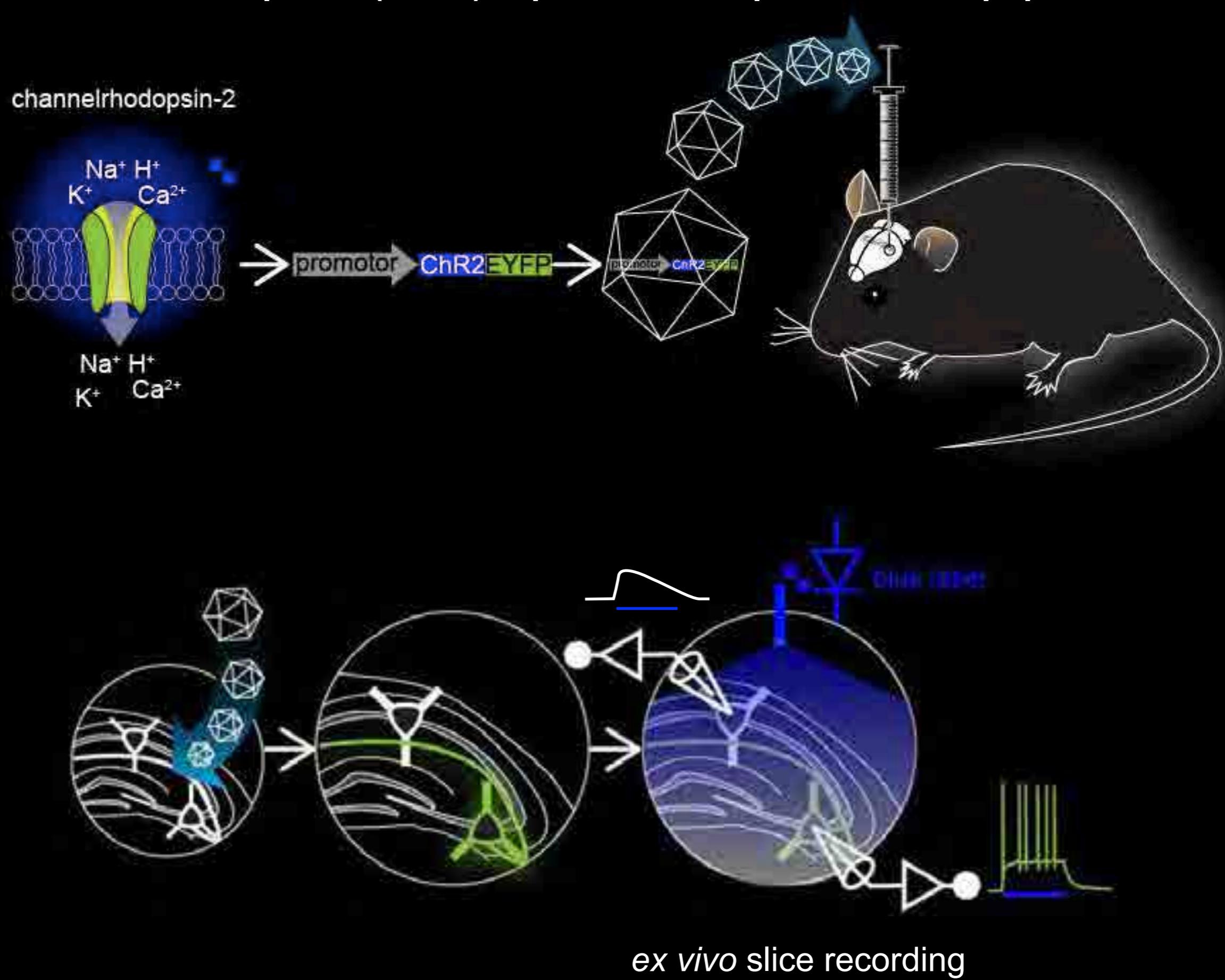
Channelrhodopsin-2 (ChR2) expression on specific neural populations



Channelrhodopsin-2 (ChR2) expression on specific neural populations

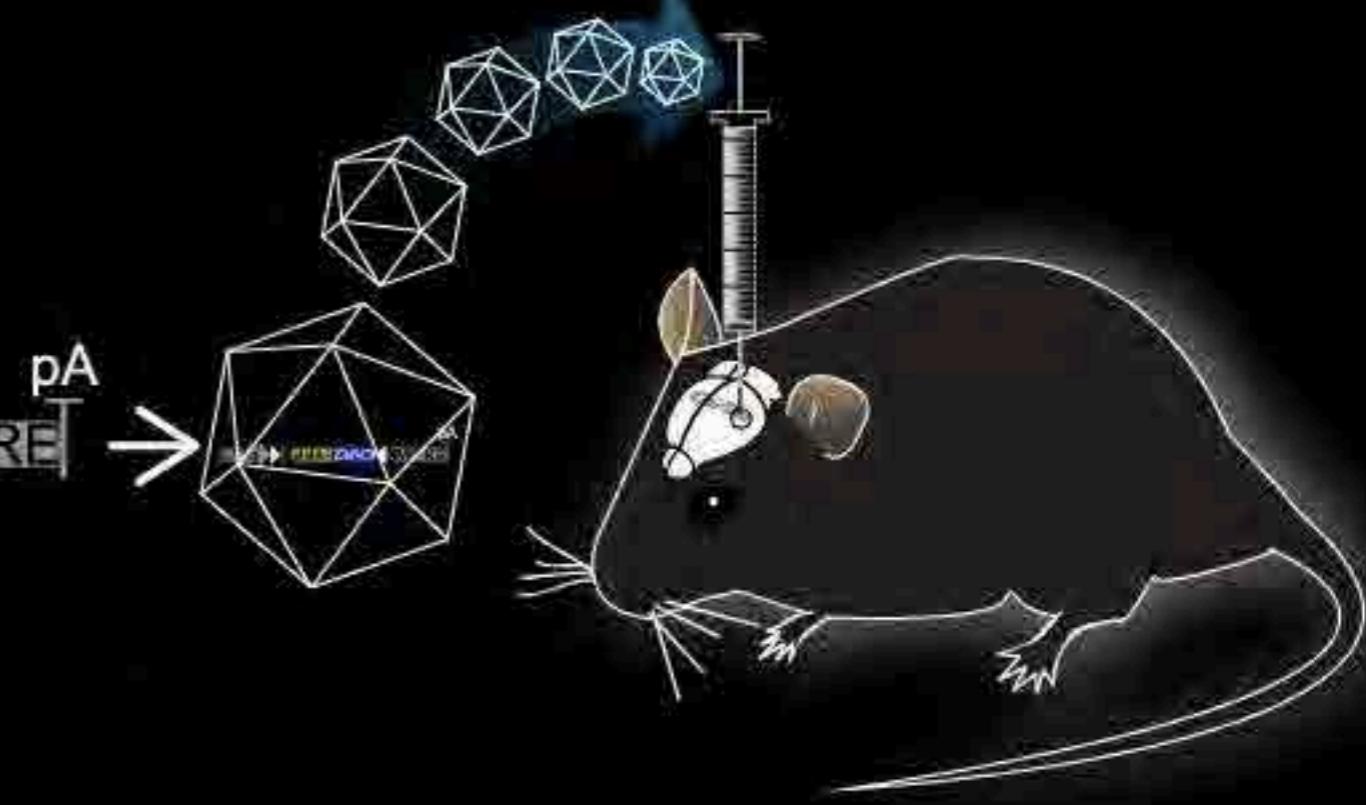
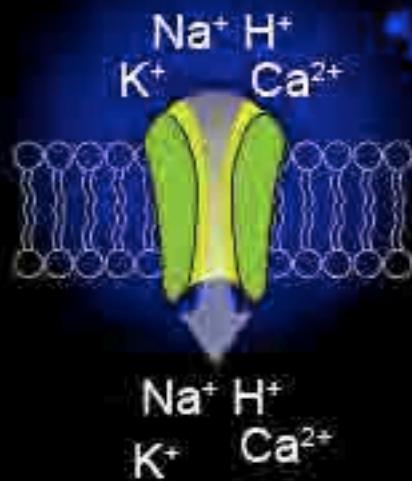


Channelrhodopsin-2 (ChR2) expression on specific neural populations

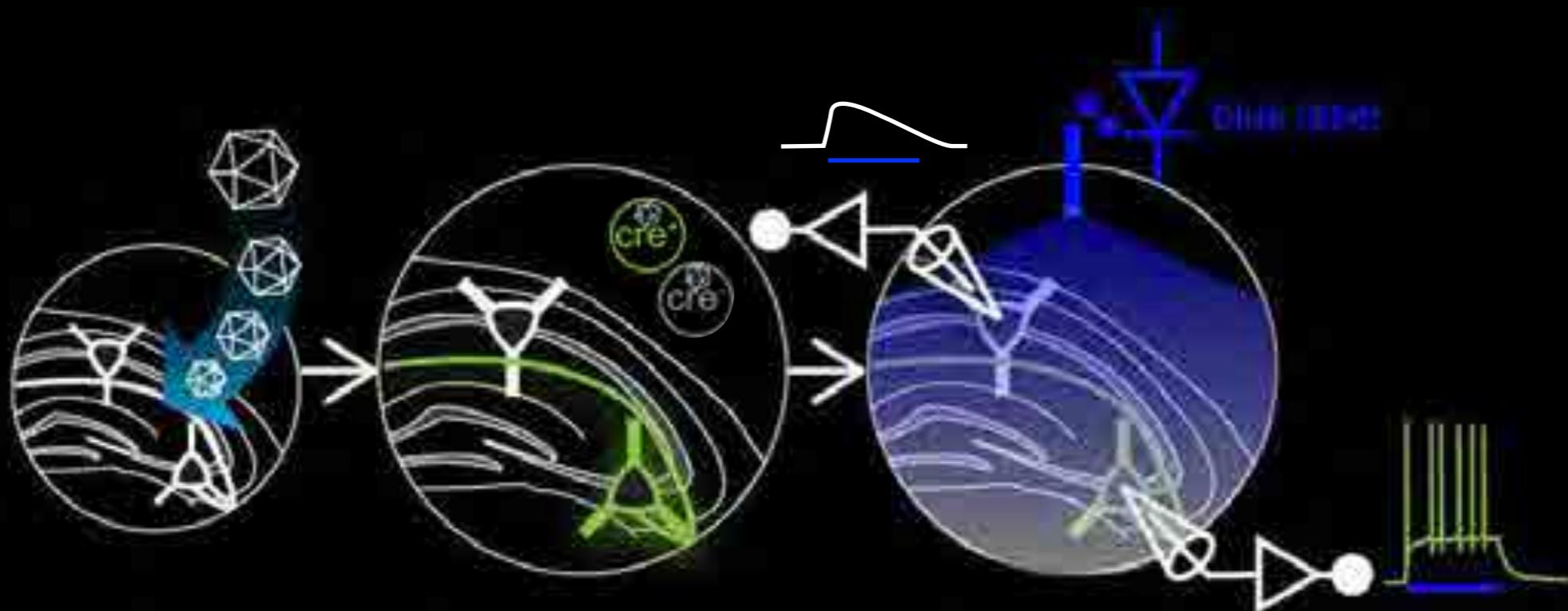


Channelrhodopsin-2 (ChR2) expression on specific neural populations

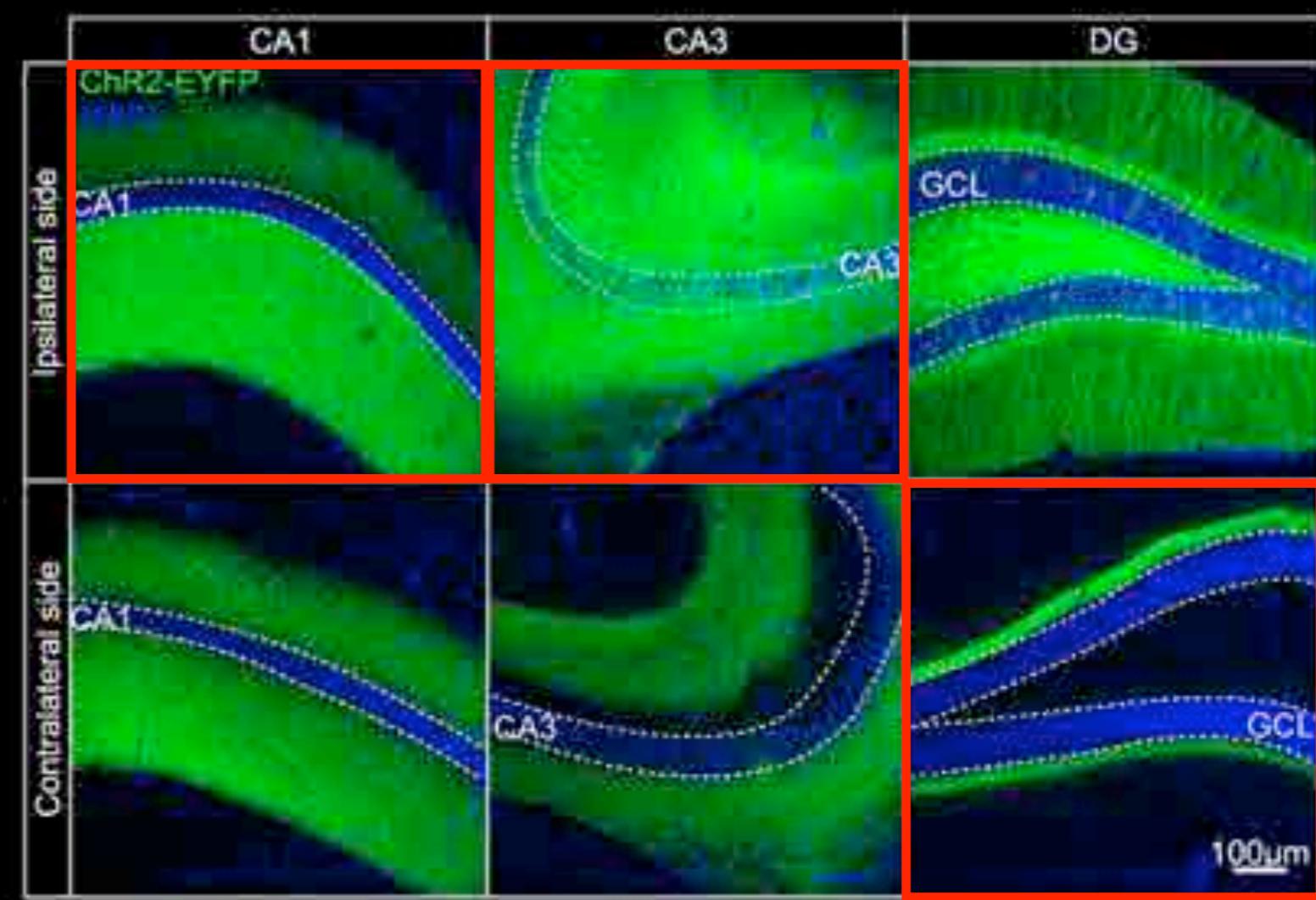
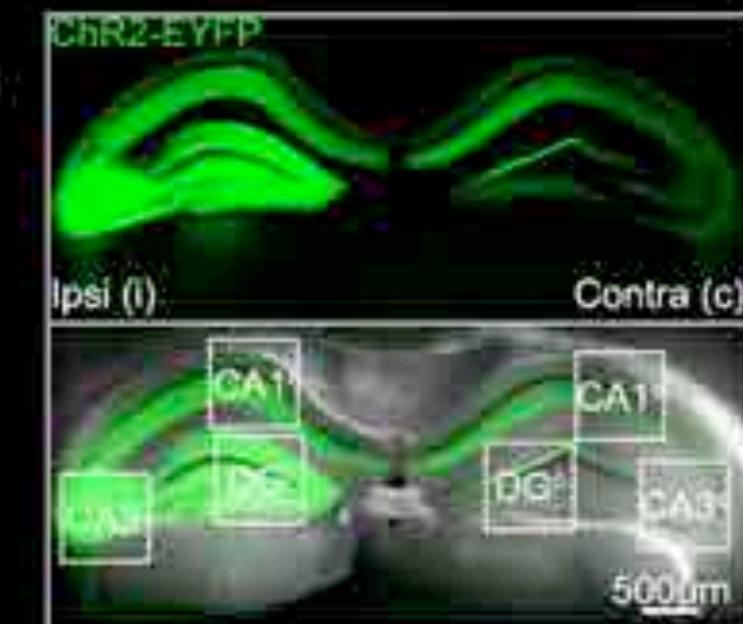
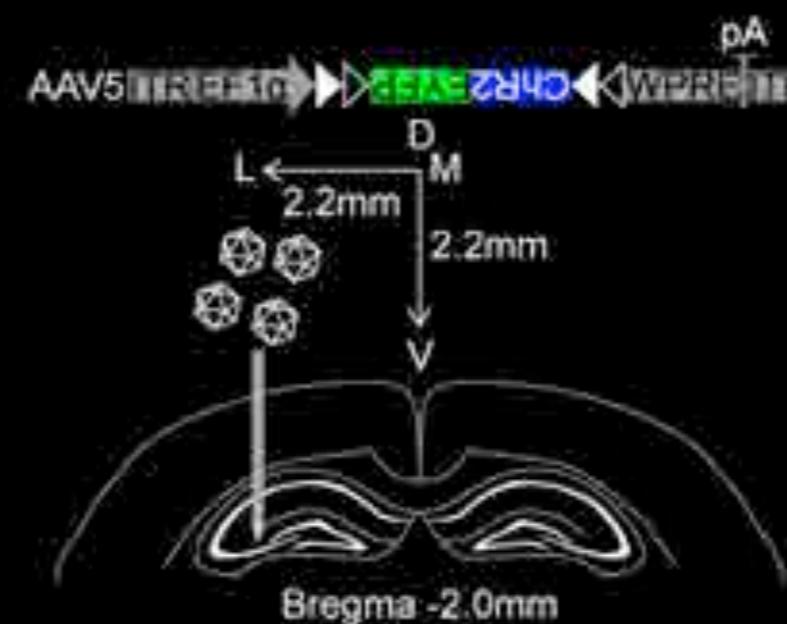
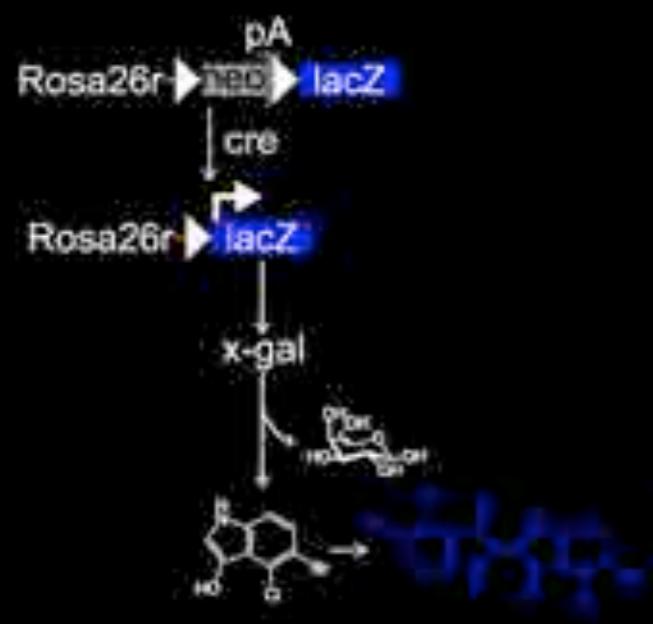
channelrhodopsin-2

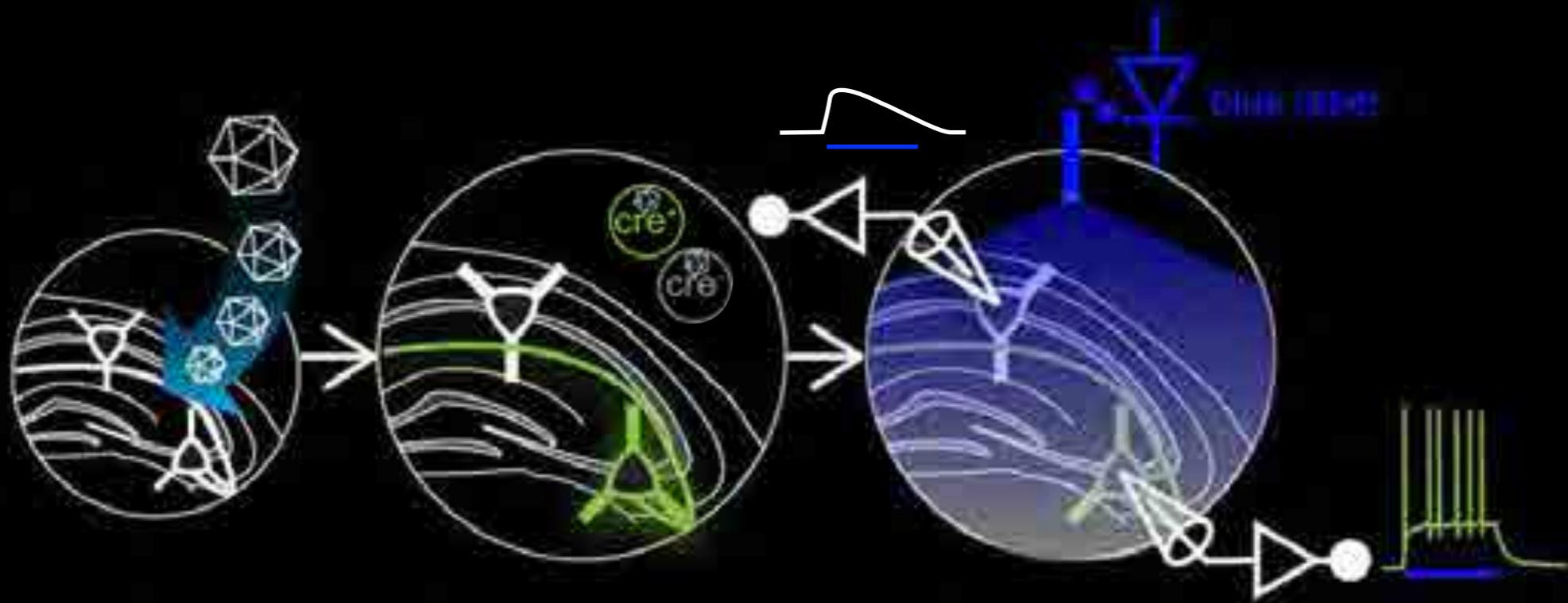


Cre driver mice

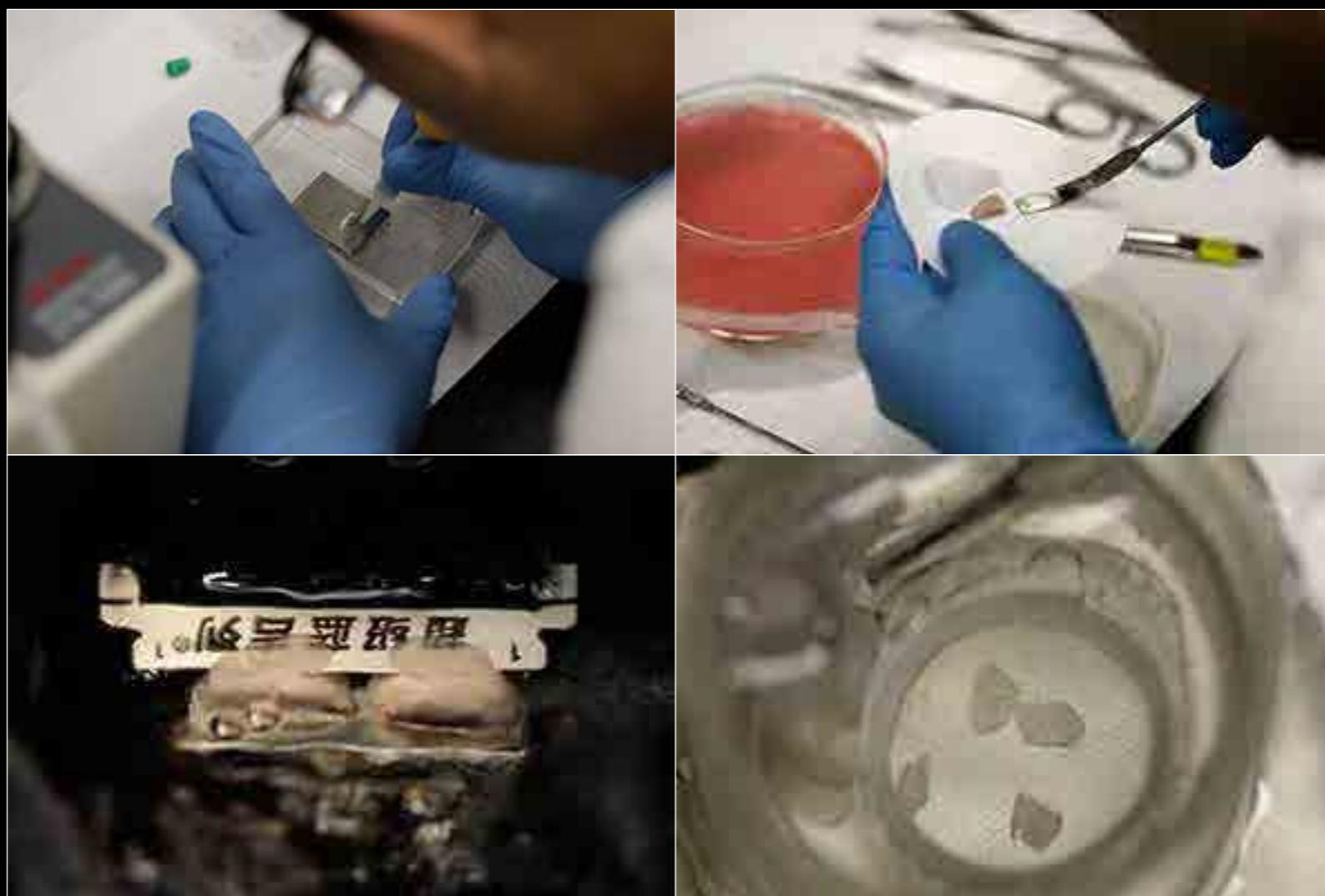


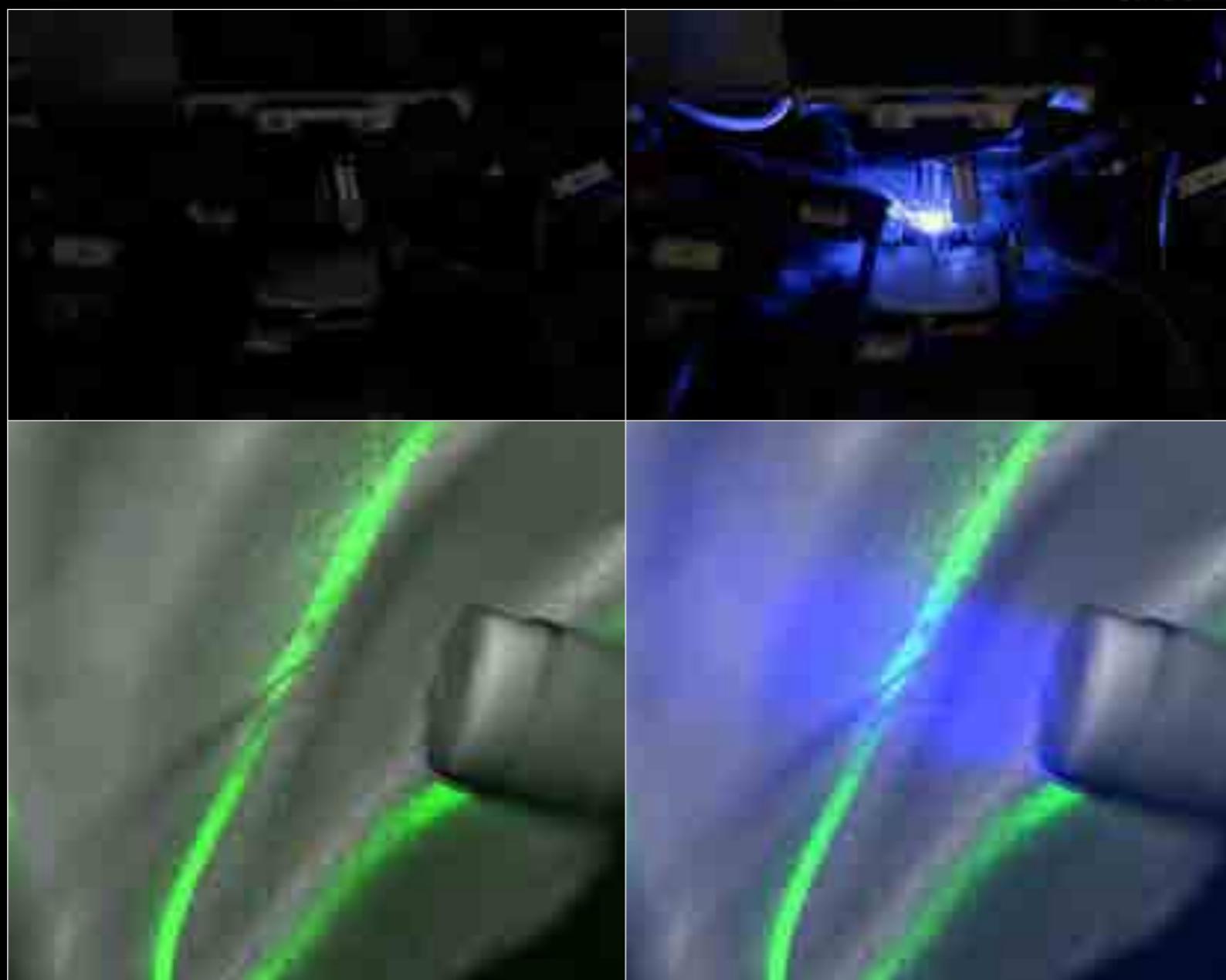
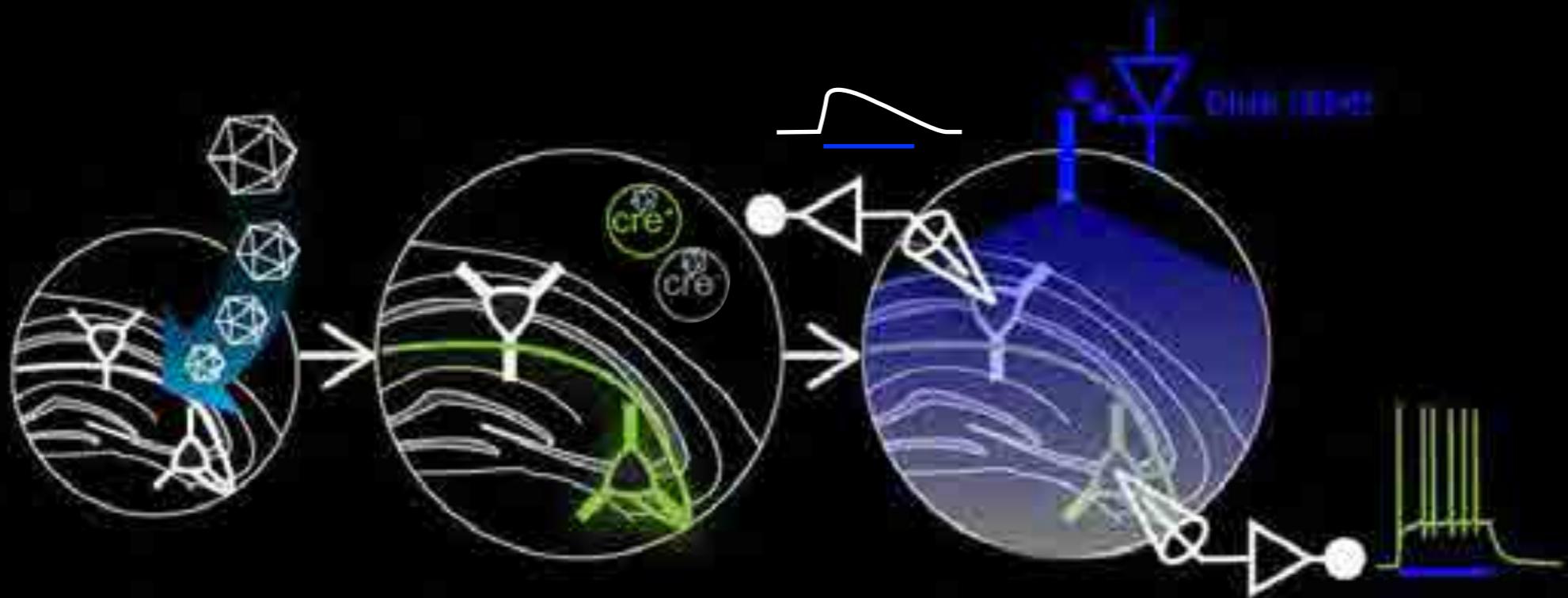
ChR2 expression on CA3, GC, Mossy cell afferents





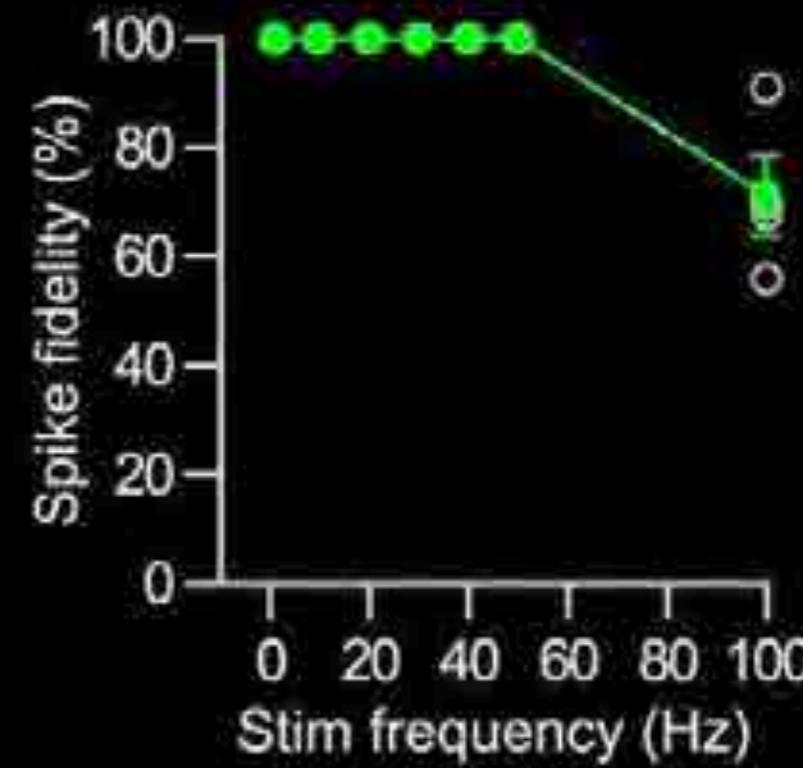
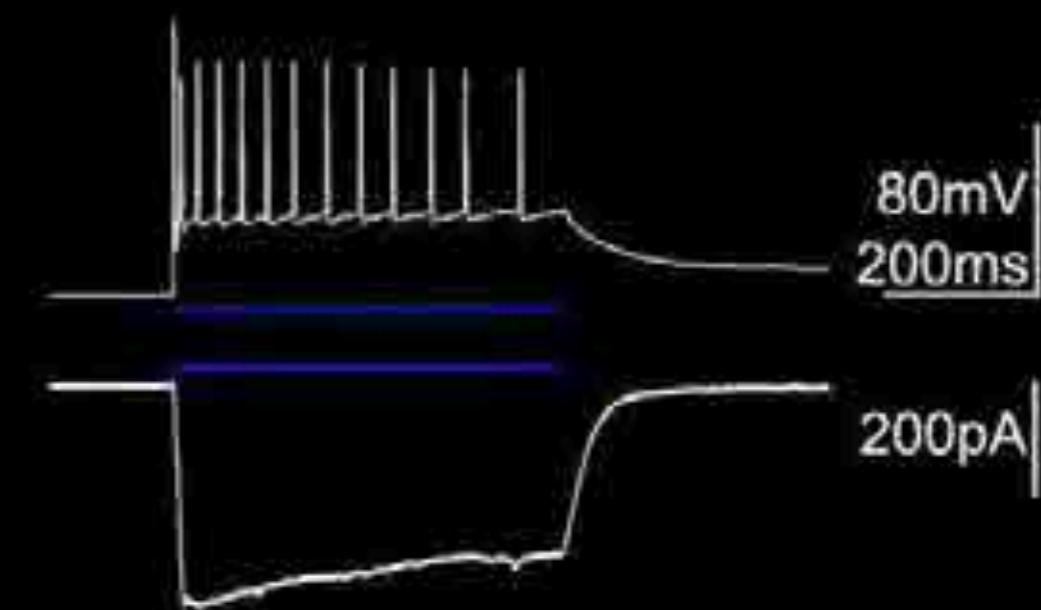
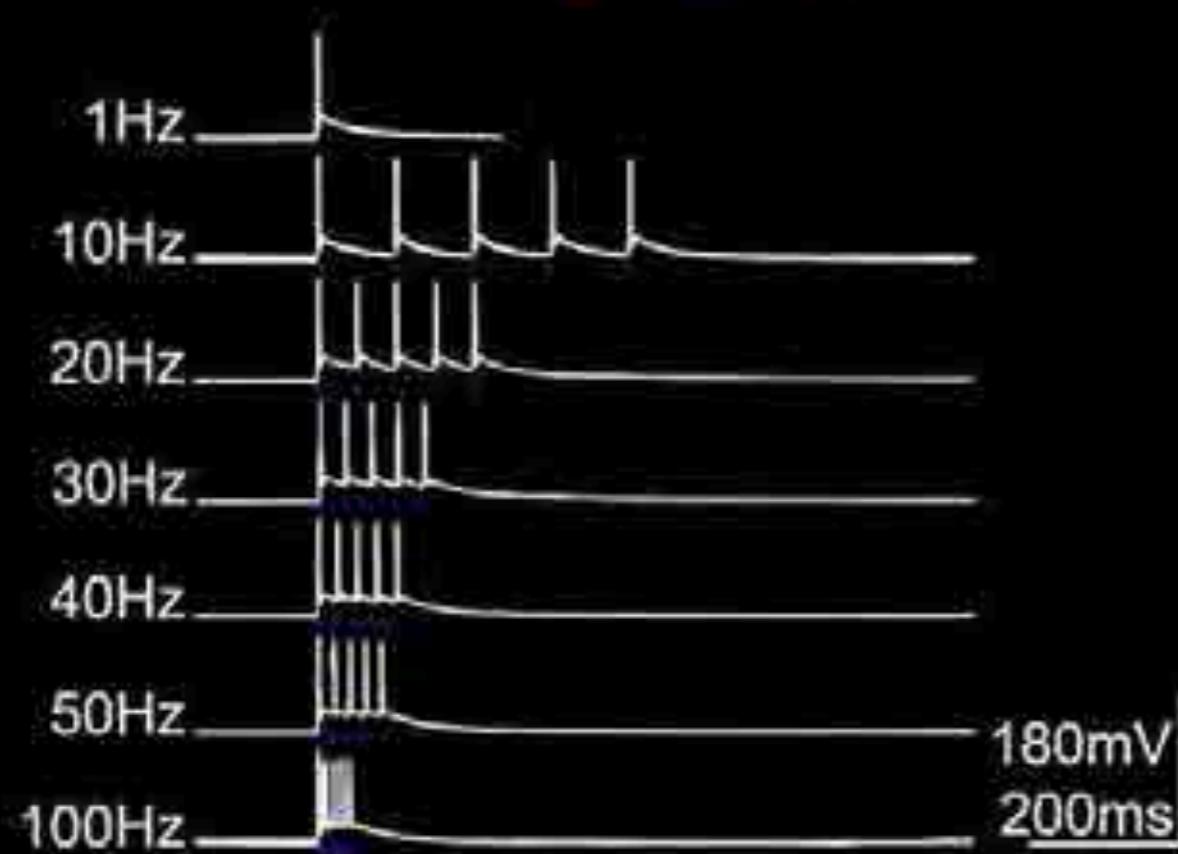
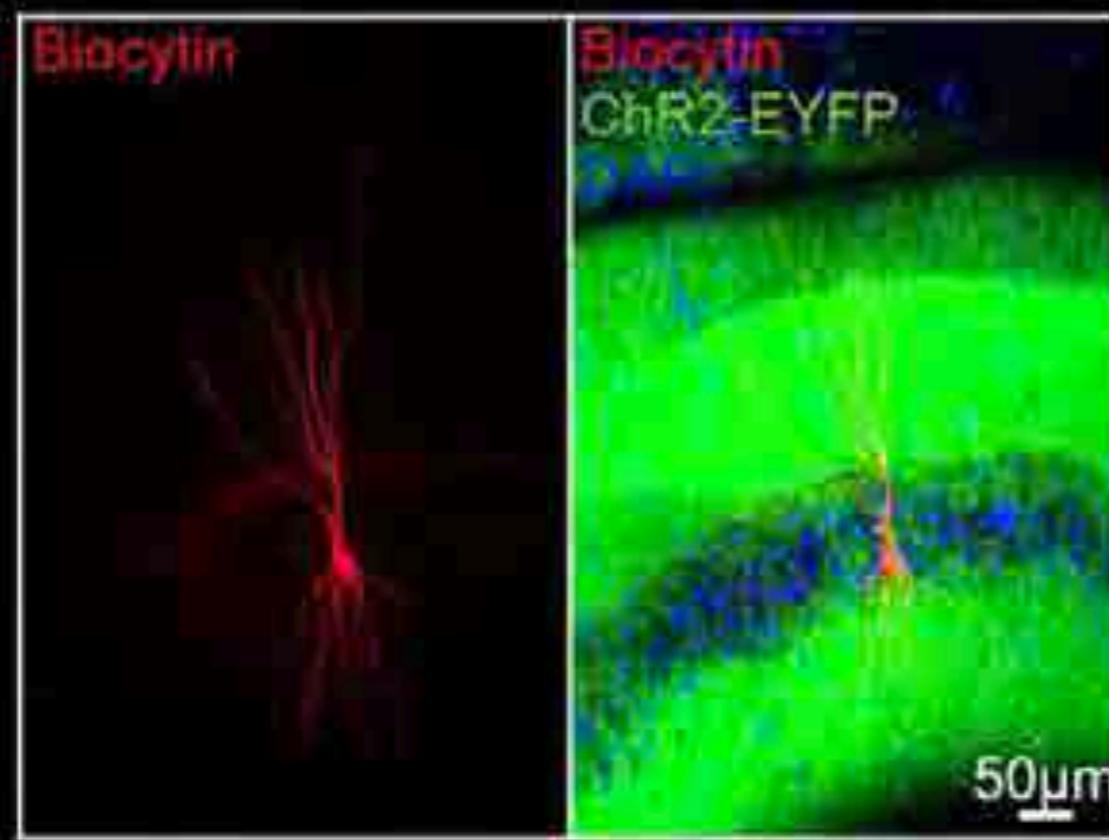
acute brain slice preparation





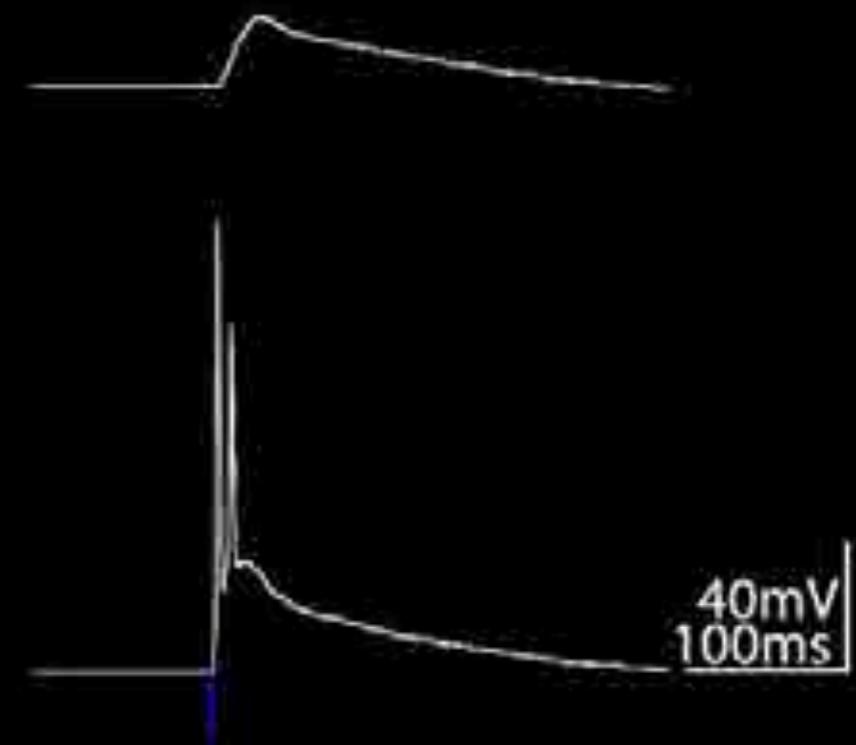
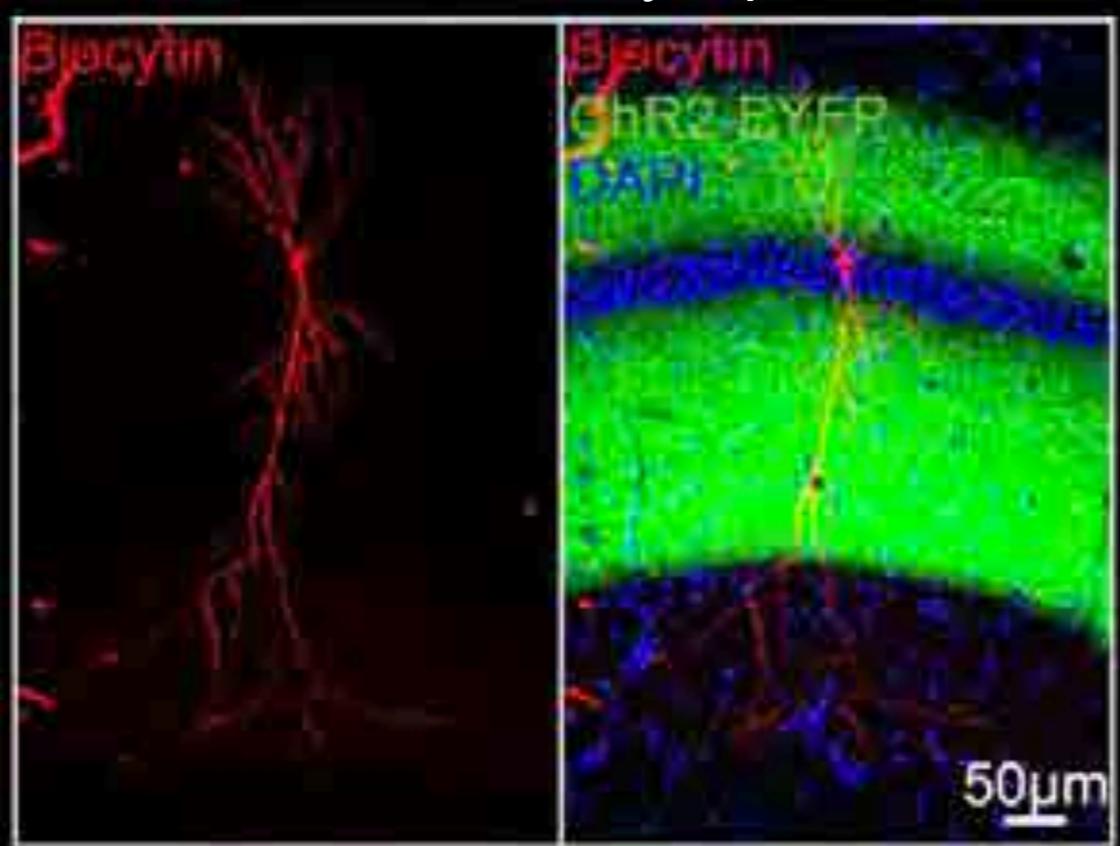
ChR2 expression on CA3, GC, Mossy cell afferents

ChR2-EYFP expressing CA3 neuron

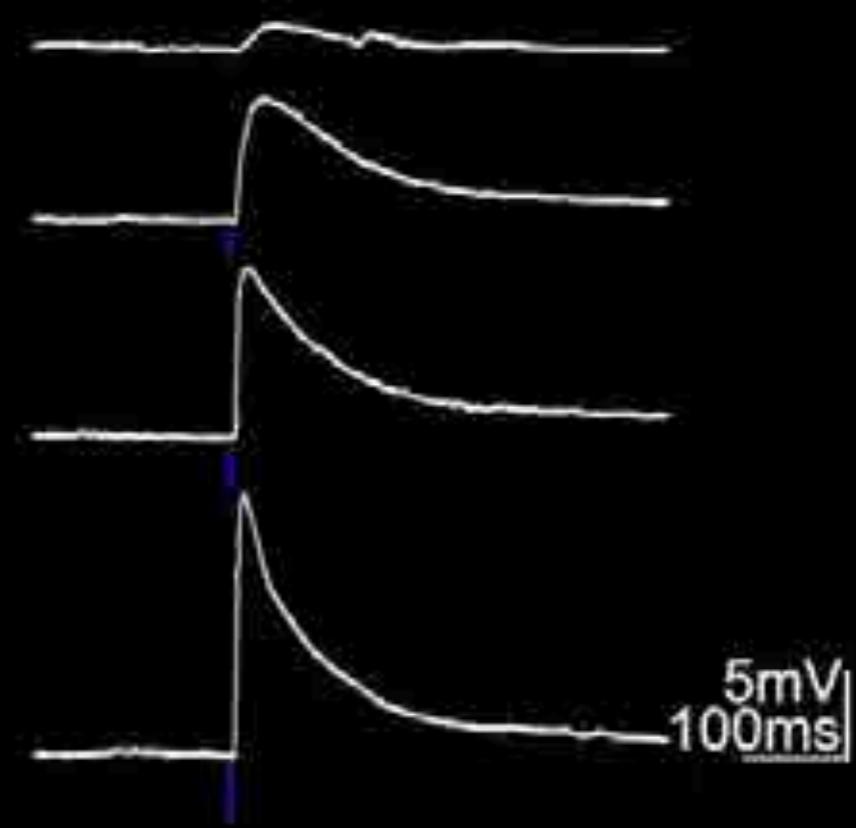
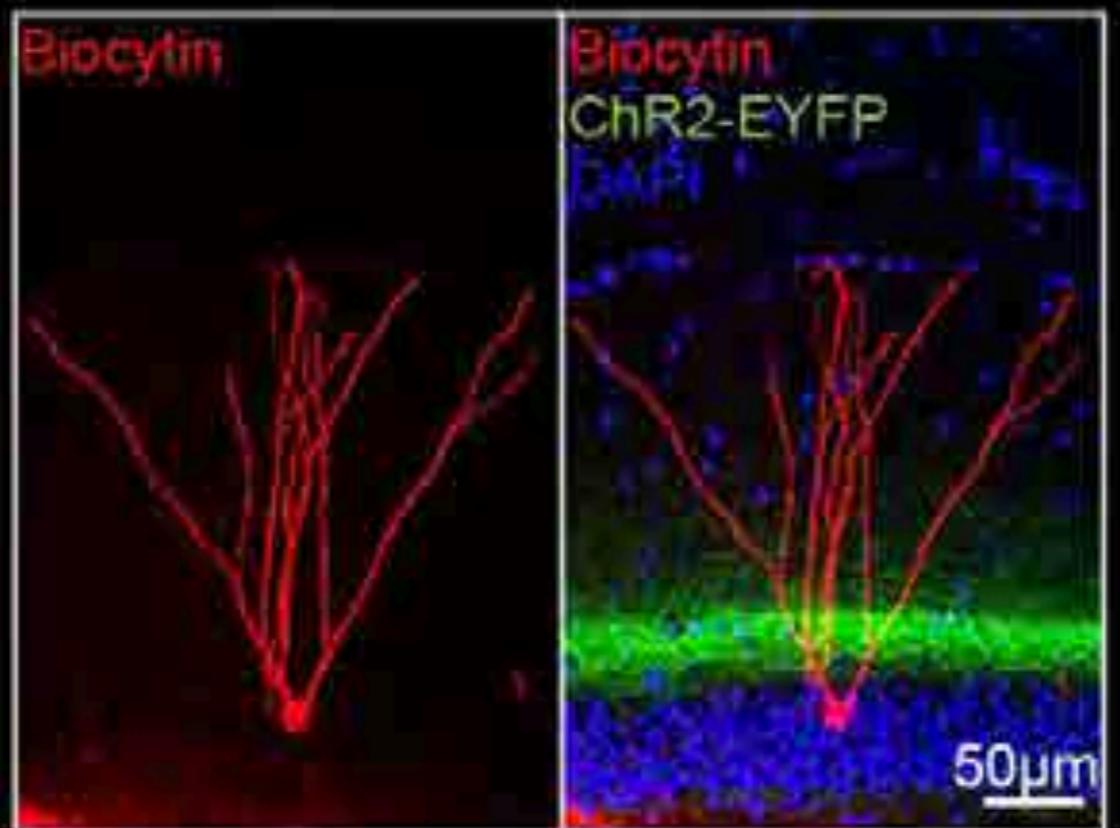


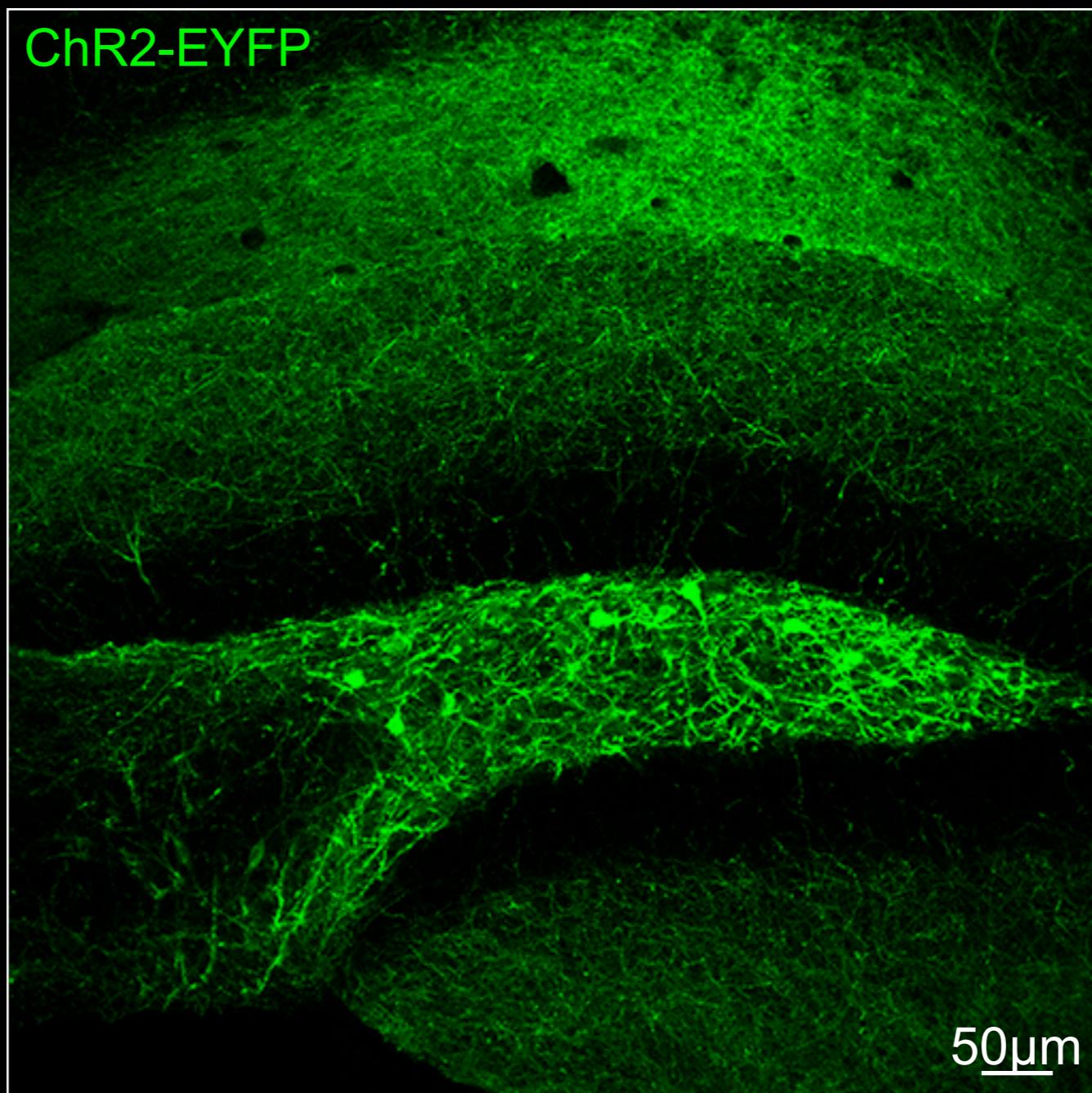
Optical stimulation of ChR2-EYFP expressing afferents

CA3-CA1 synapse



MC-GC synapse

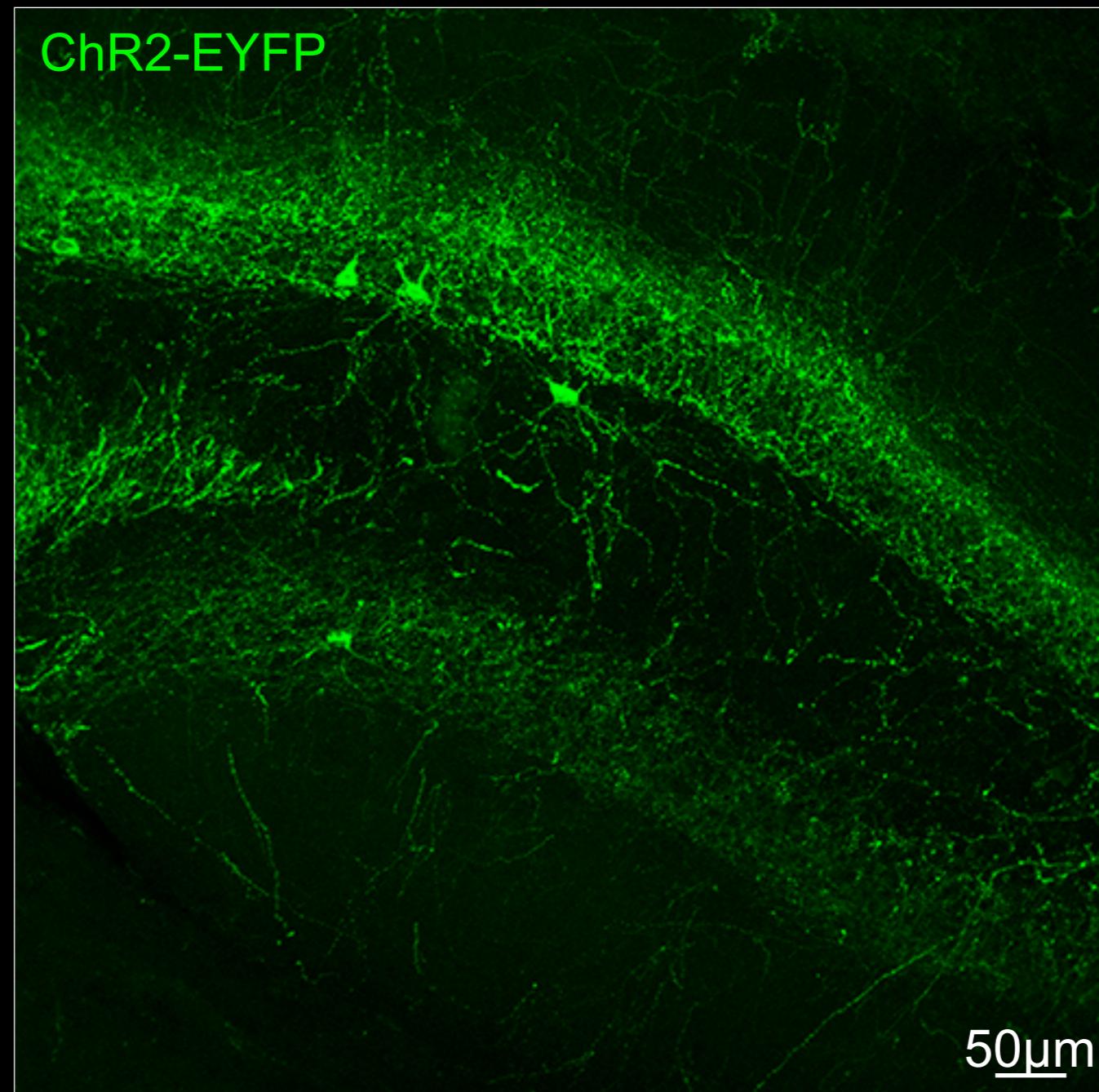




somatostatin-Cre mice

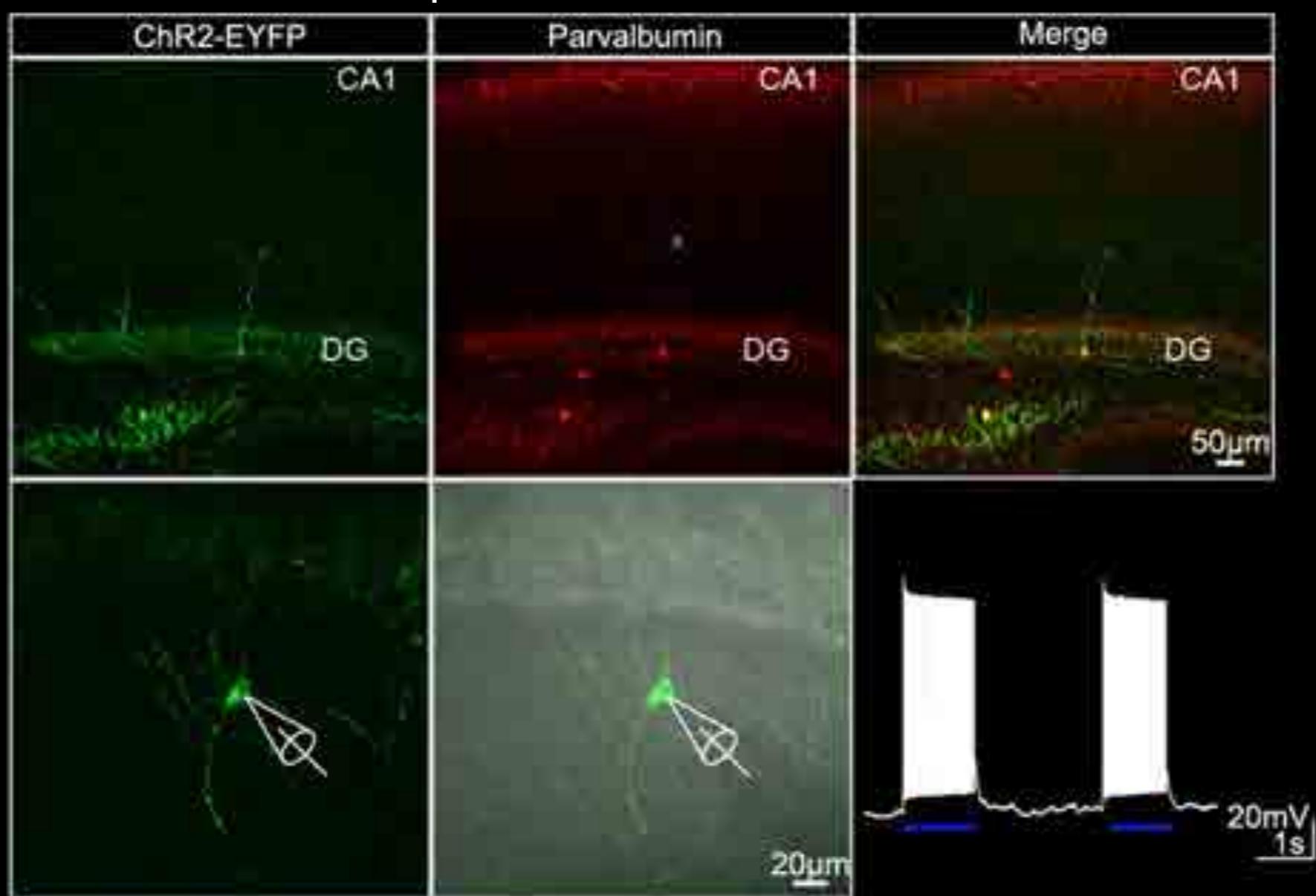


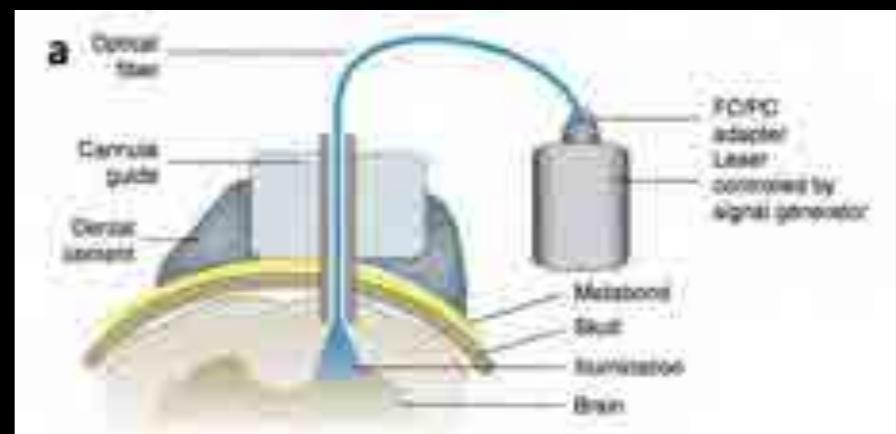
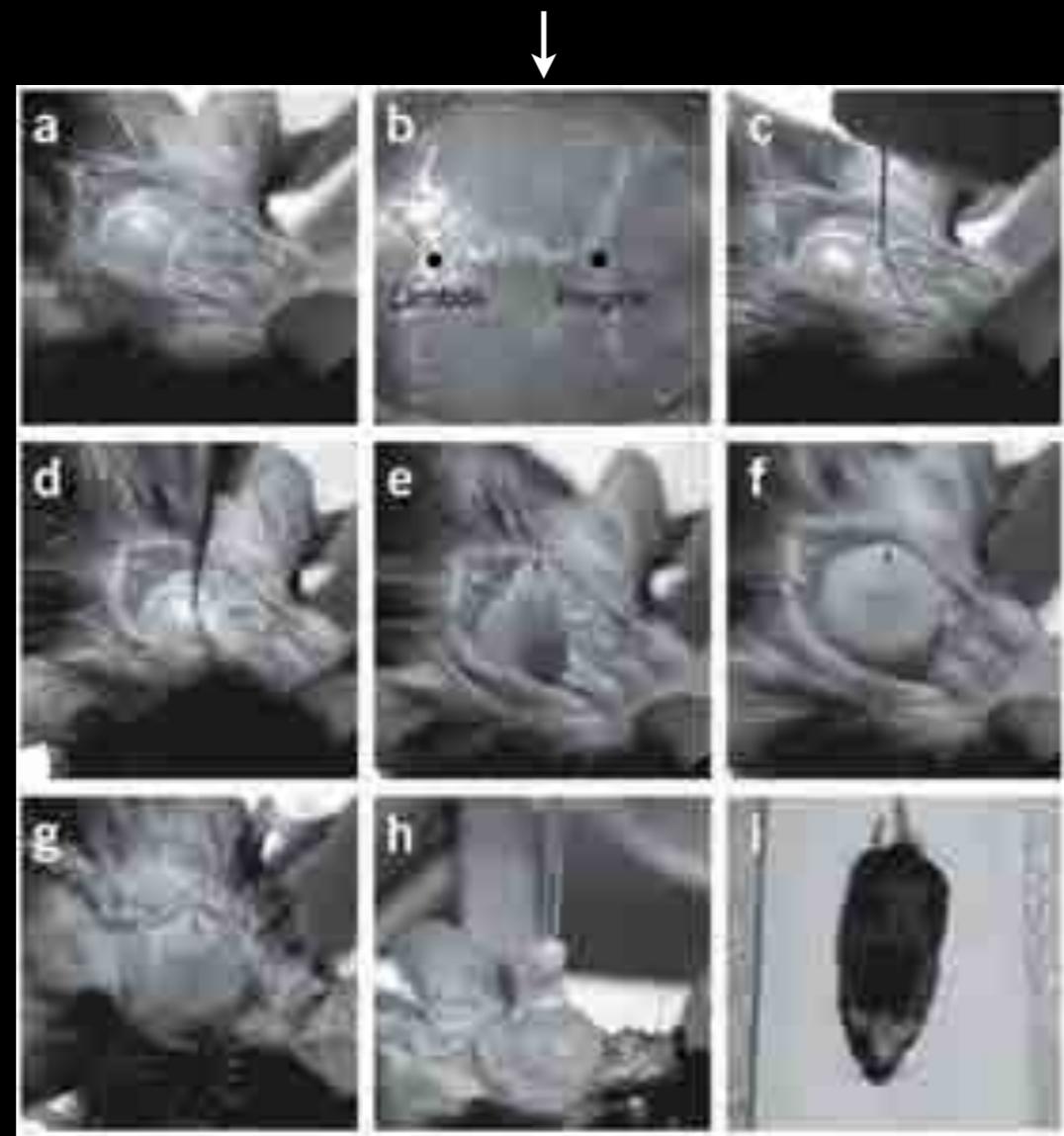
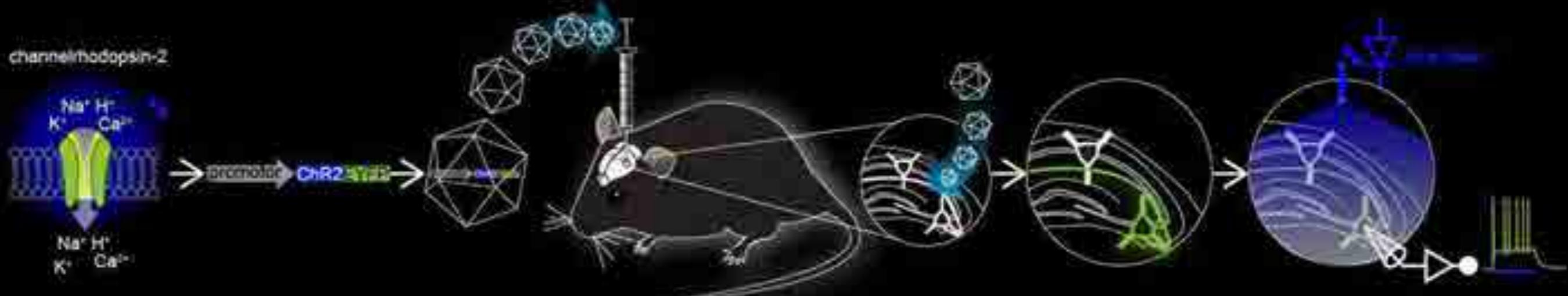
pavalbumin-Cre mice





pavalbumin-Cre mice

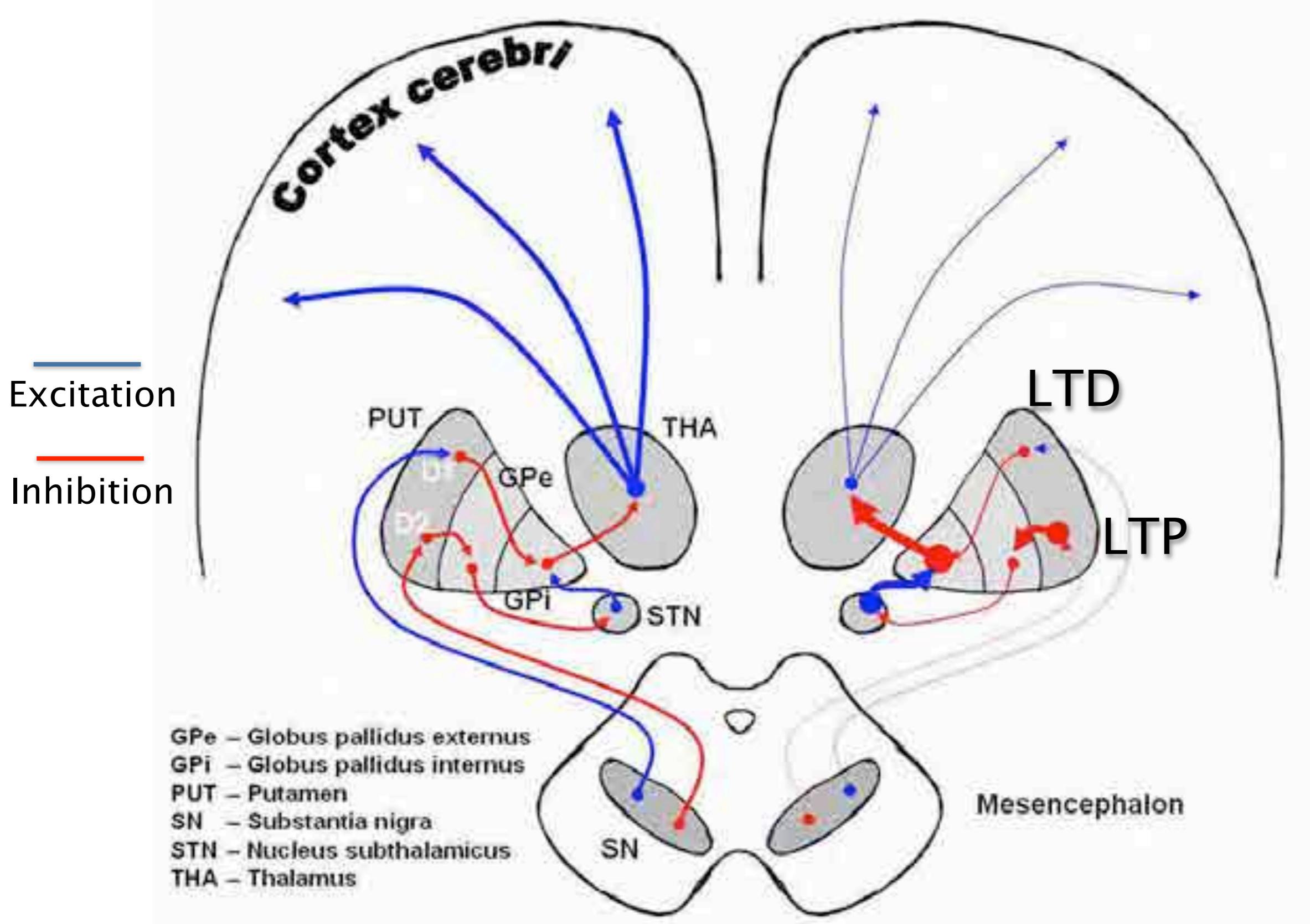




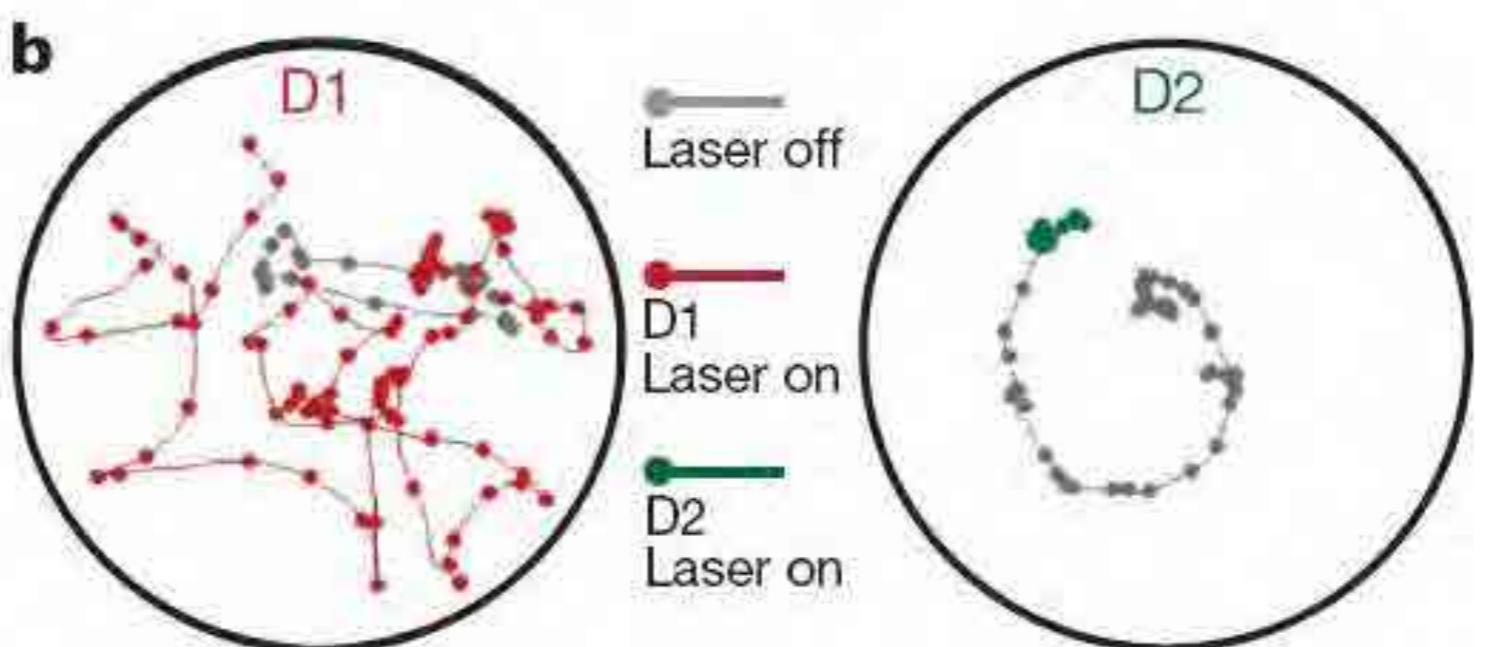
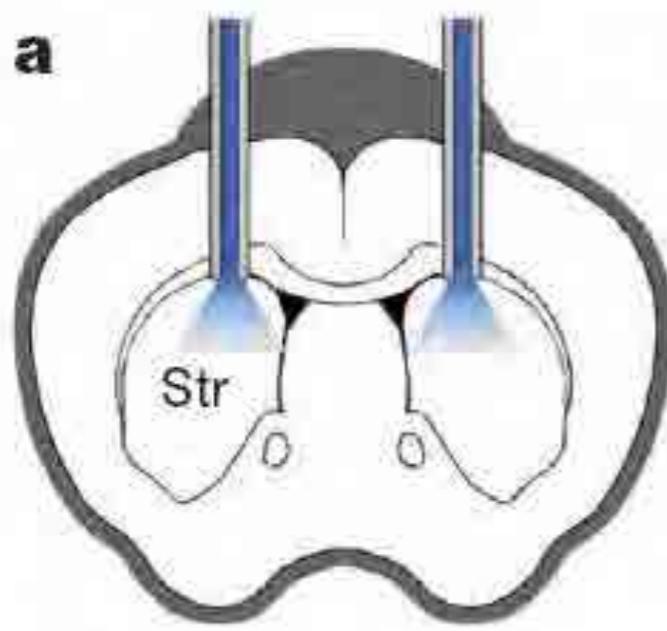
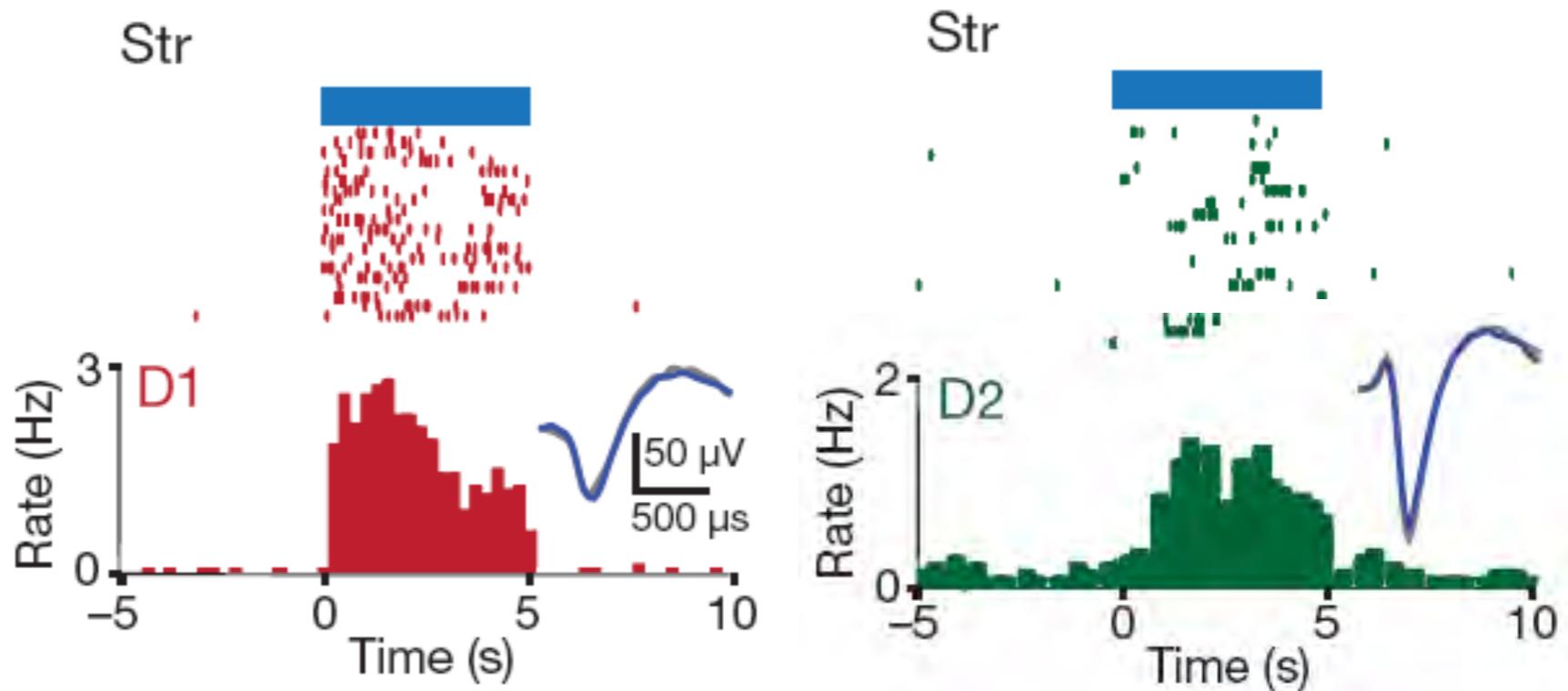
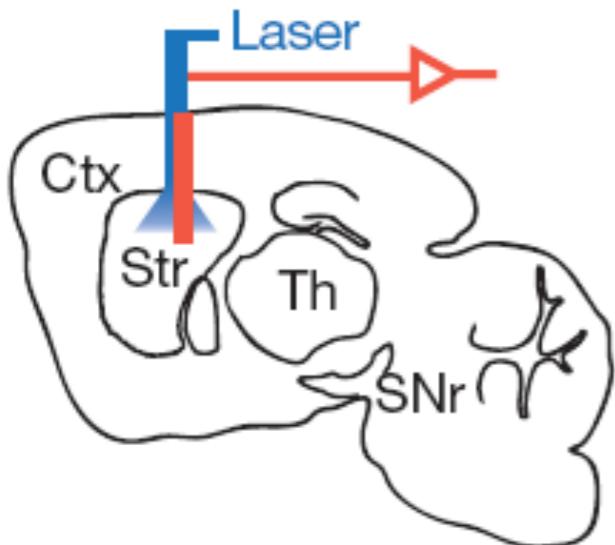
(Zhang et al., 2010)

In vivo optogenetics

Direct and indirect-loop



Optogenetics re-visits the theory



(Kravitz et al., 2010)

Bilateral stimulation of indirect pathway

Movie S2:
Bilateral illumination of indirect pathway

Kreitzer lab, 2010

Contextual fear memory



www.ChinaVisual.com 视觉中国



www.ChinaVisual.com 视觉中国

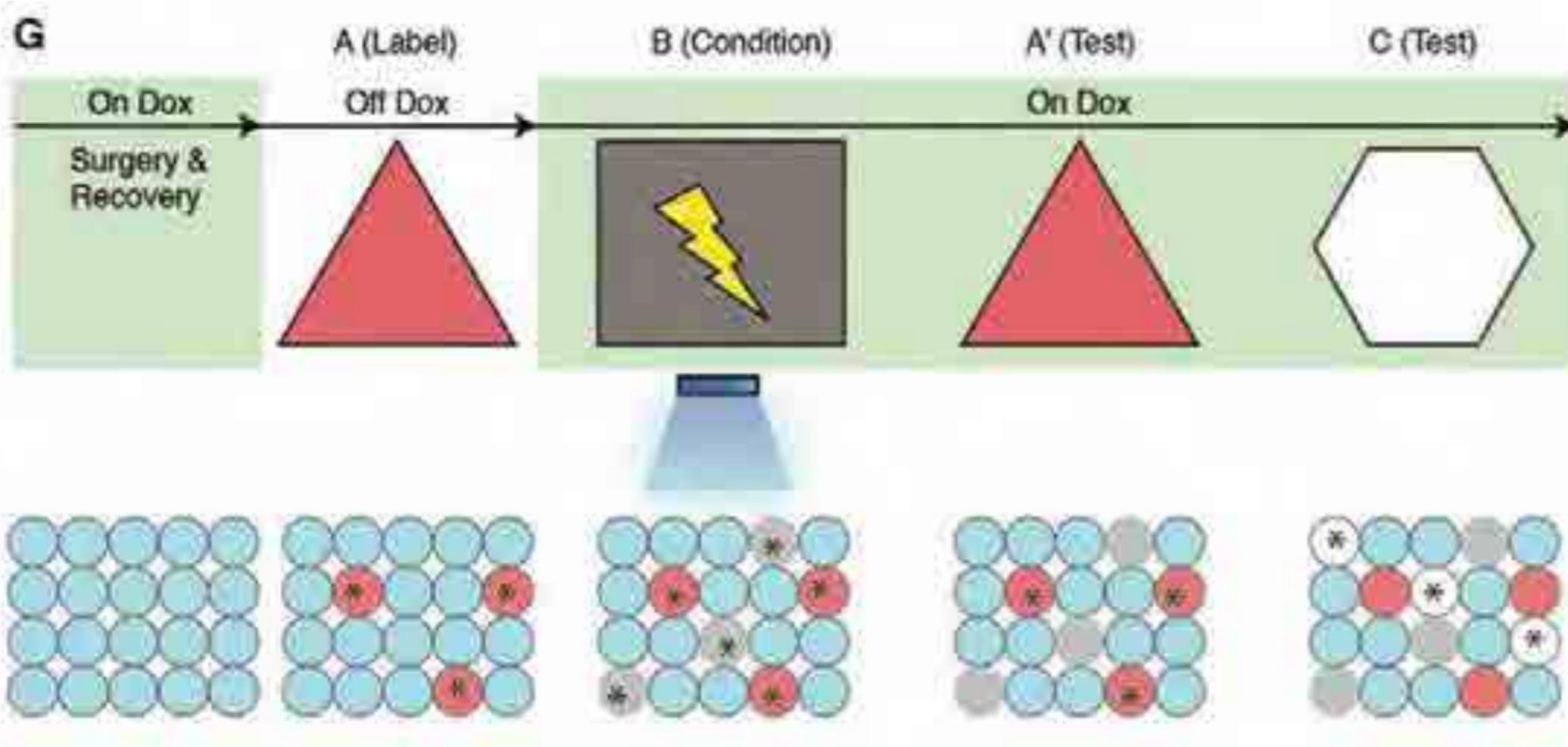
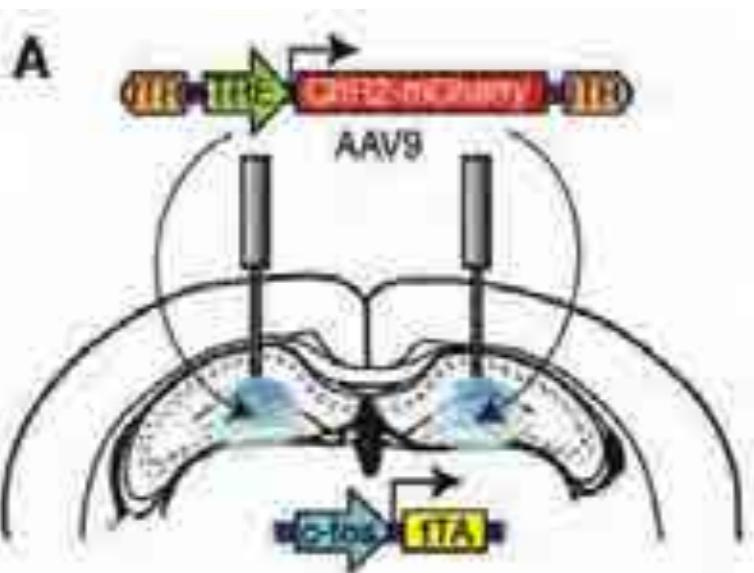
Contextual fear memory



Optogenetics

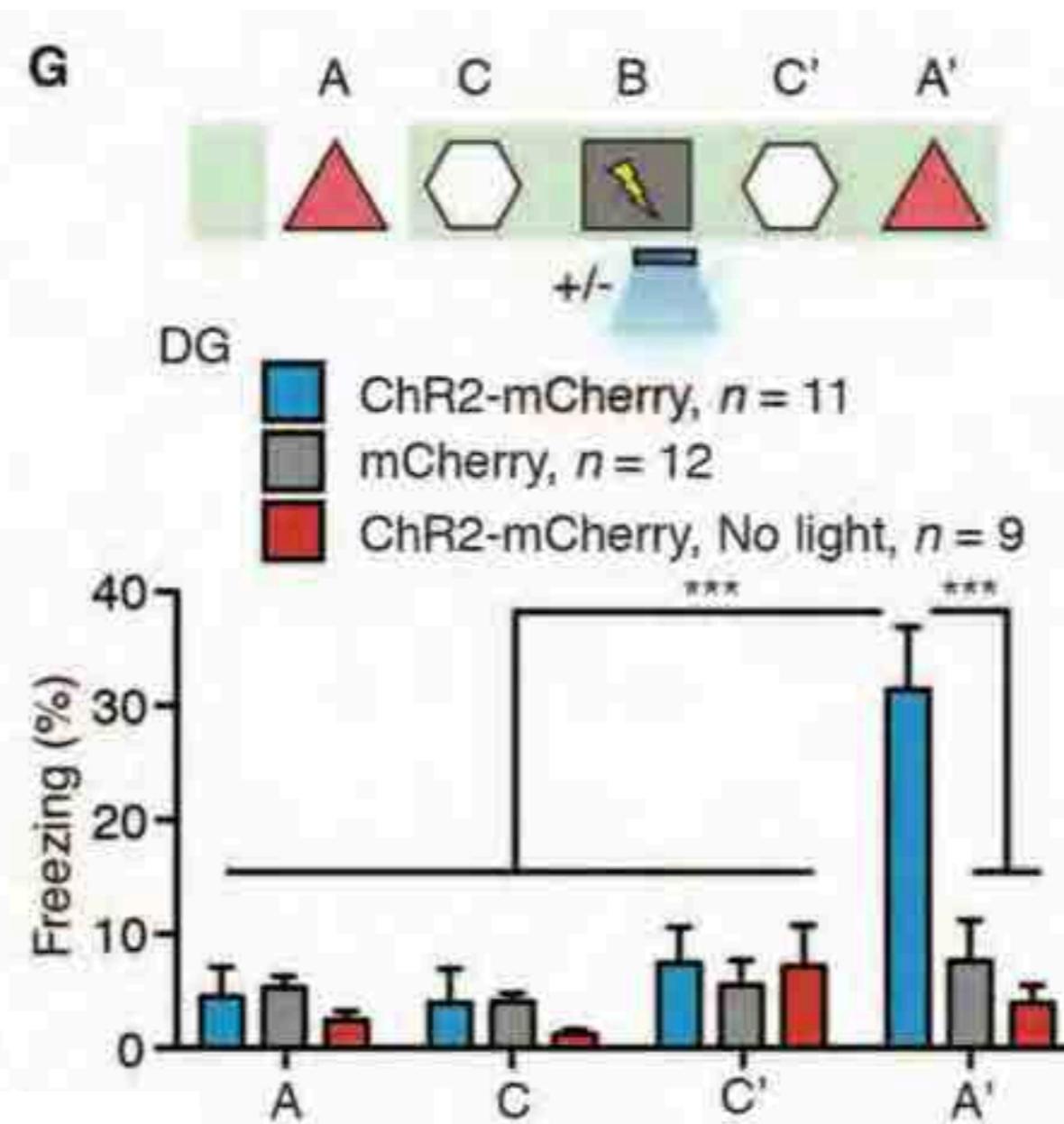
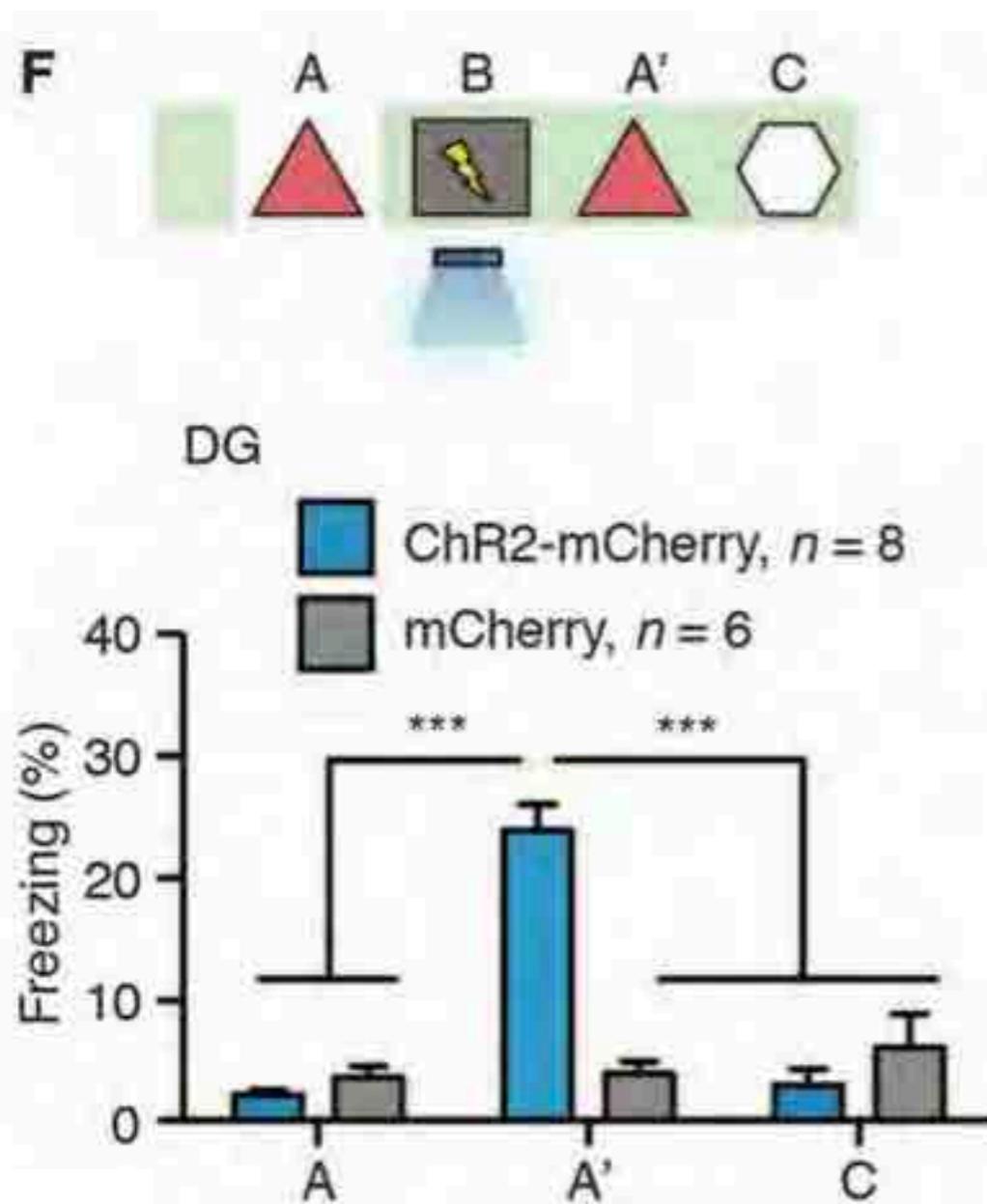


Creating a false memory in the hippocampus



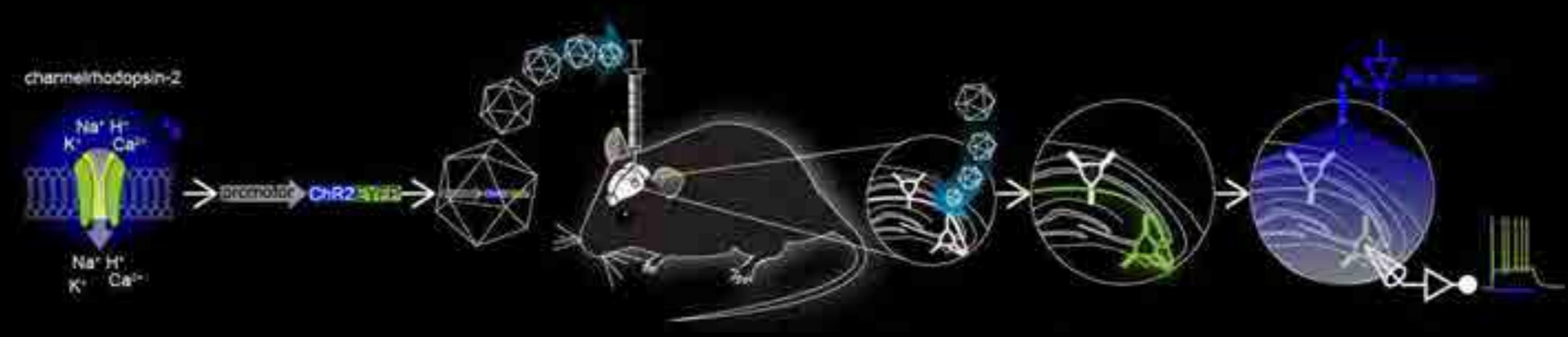
(Ramirez et al., 2013)

Creating a false memory in the hippocampus



(Ramirez et al., 2013)

Summary



virus generation stereotaxic generation

Optogenetics in brain slices

in vivo optogenetics



Thanks for your attention

