

# Johns Hopkins Engineering

## **Methods in Neurobiology**

### Molecular Basis of Optogenetics

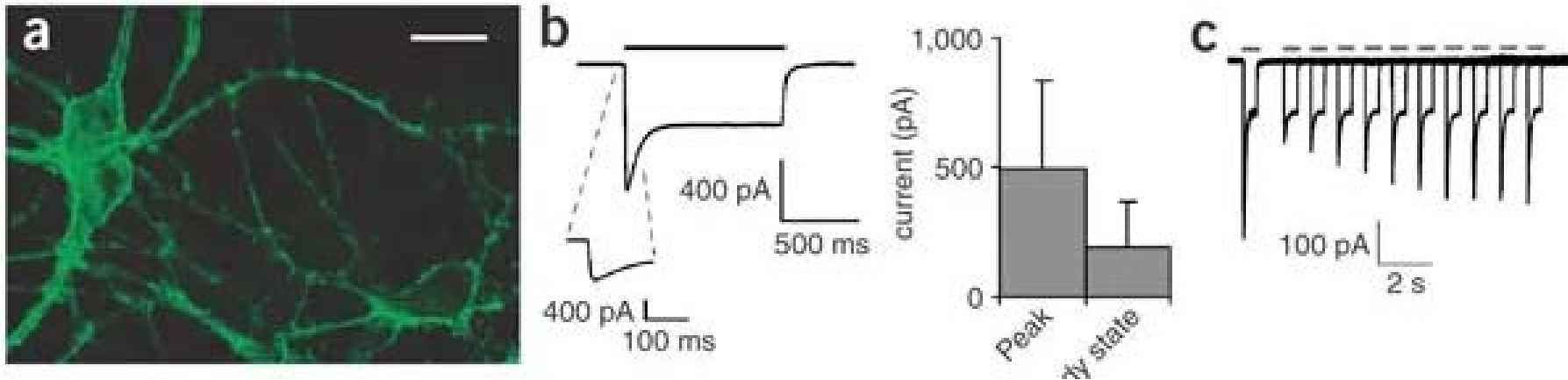


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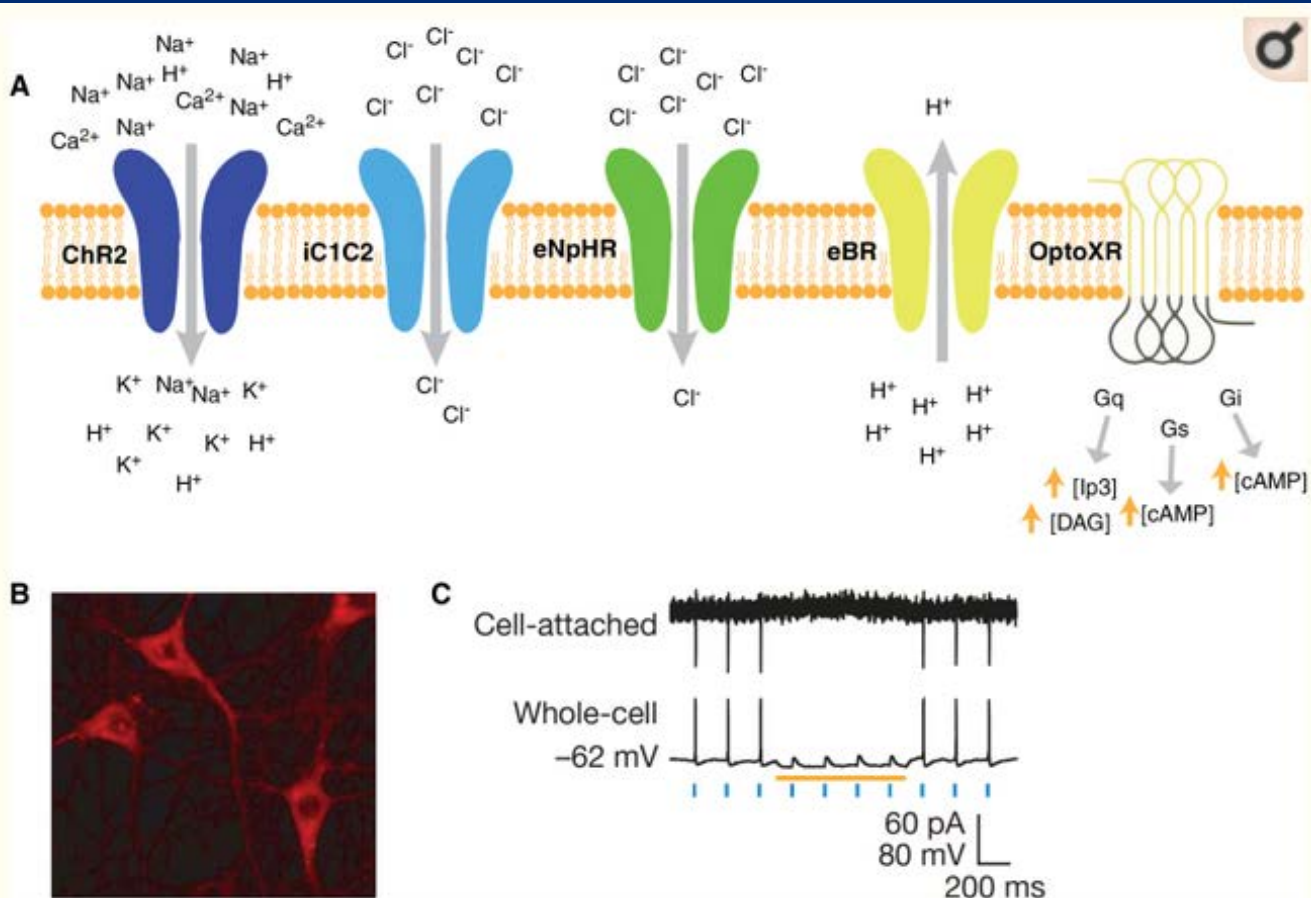
# What is Optogenetics?

**Millisecond-timescale, genetically targeted optical control of neural activity.**

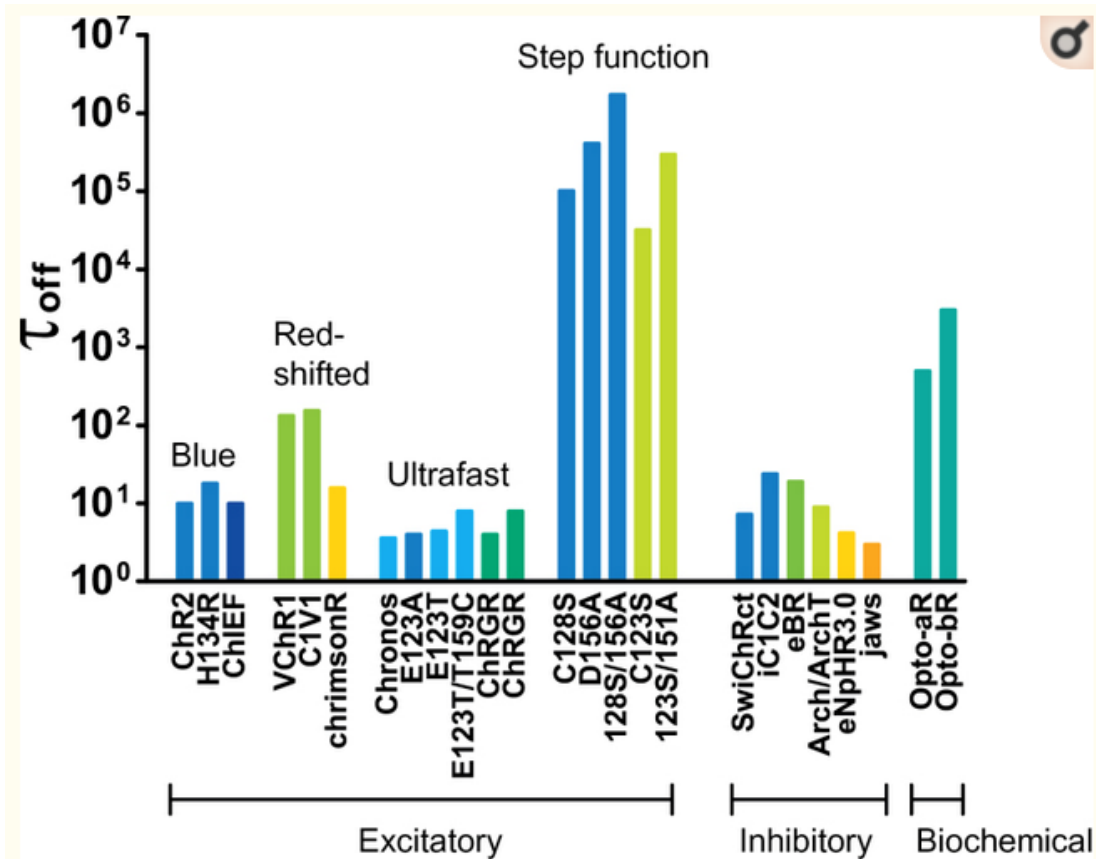
Boyden ES, Zhang F, Bamberg E, Nagel G, Deisseroth K. (2005) Nat Neurosci 8:1263–1268.



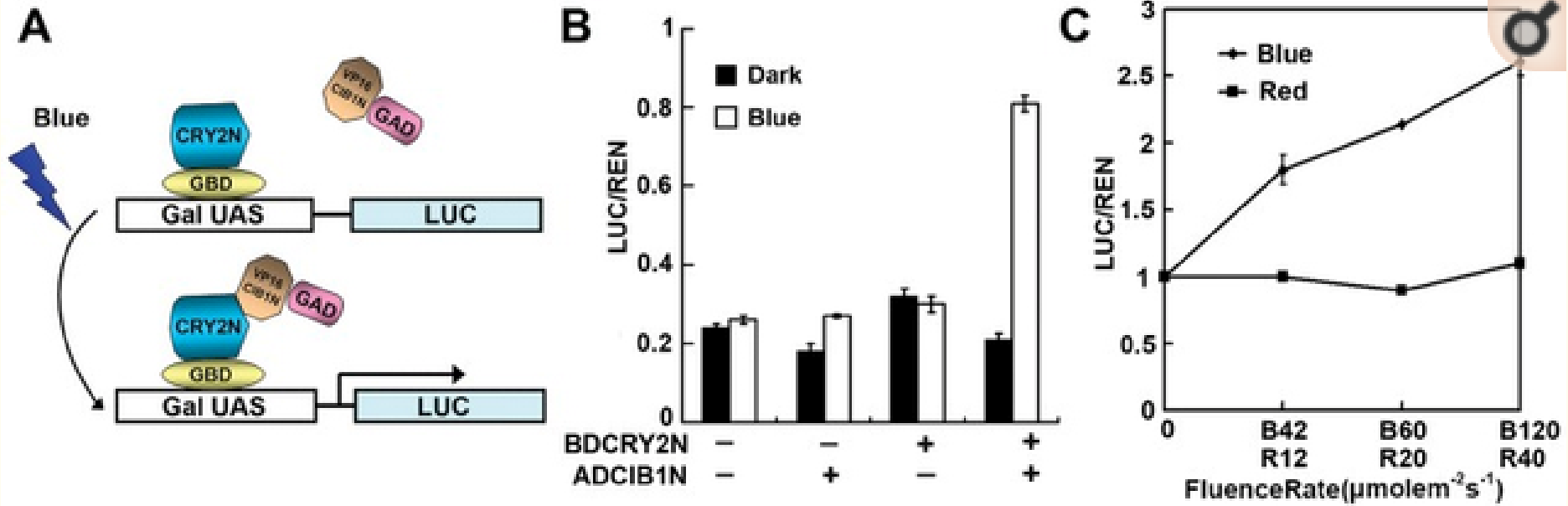
# Type of Opsins



# Example of Opsins Currently Available



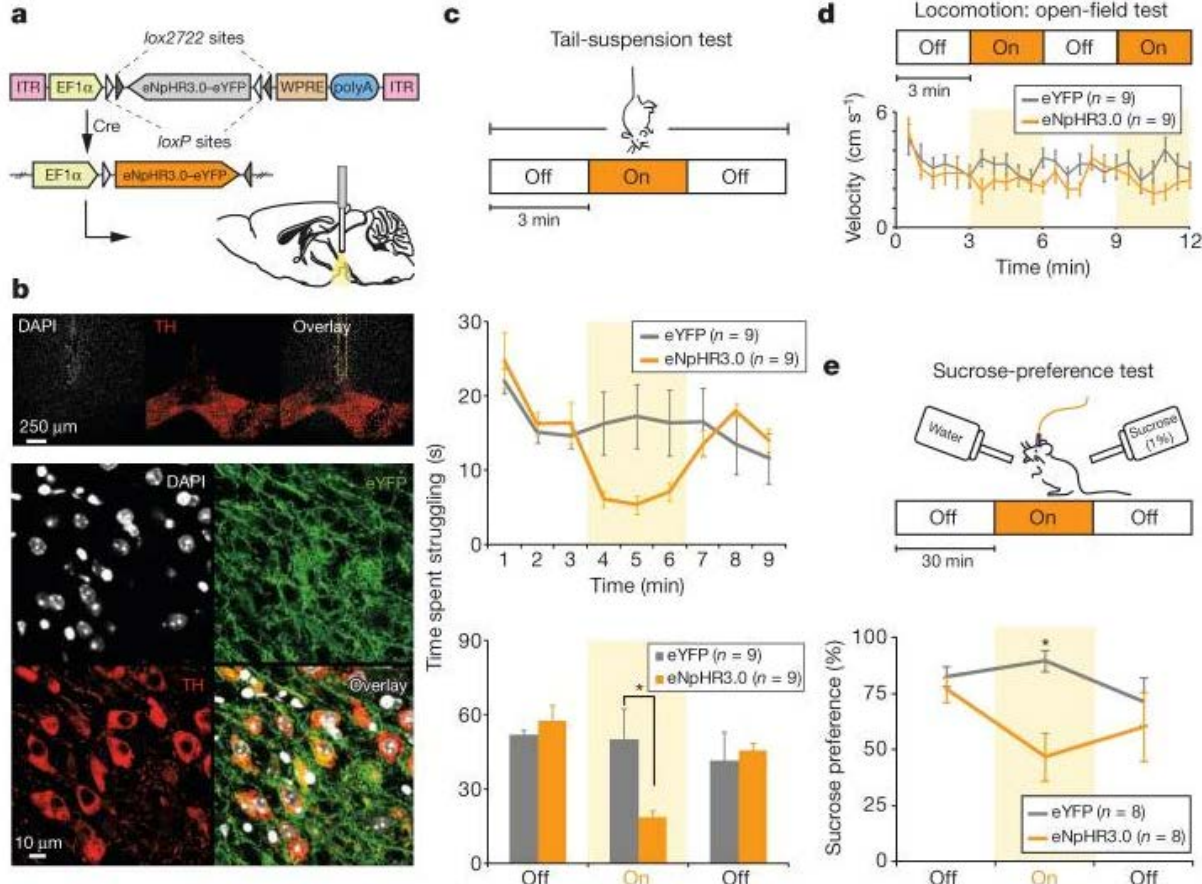
# More Optogenetic Actuators; Control Over Gene Transcription



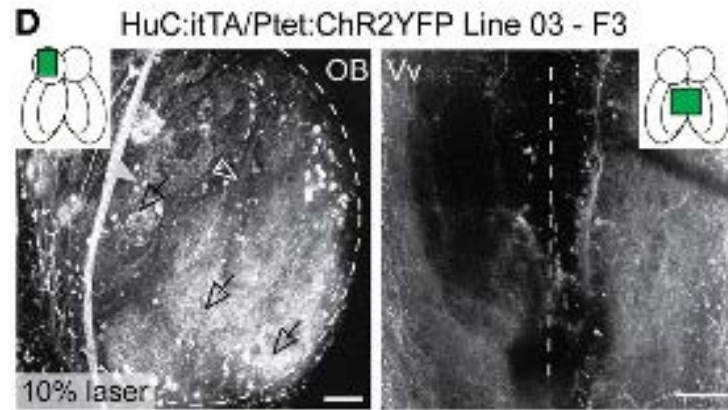
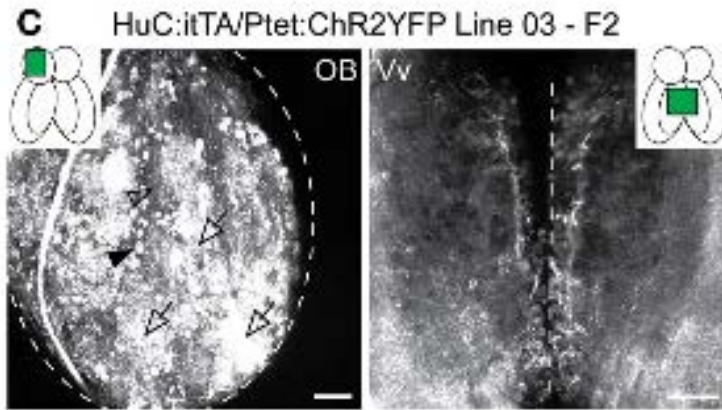
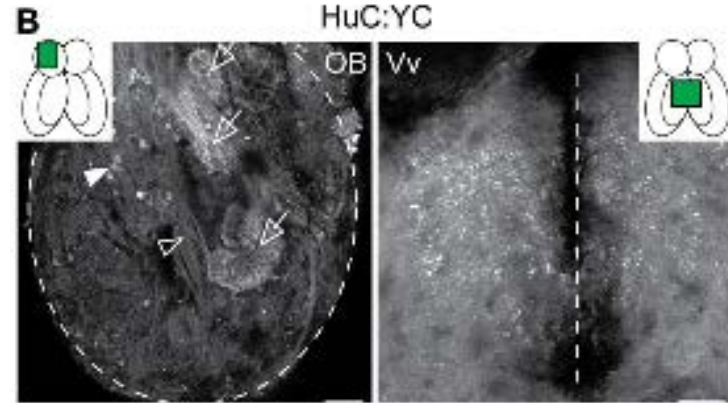
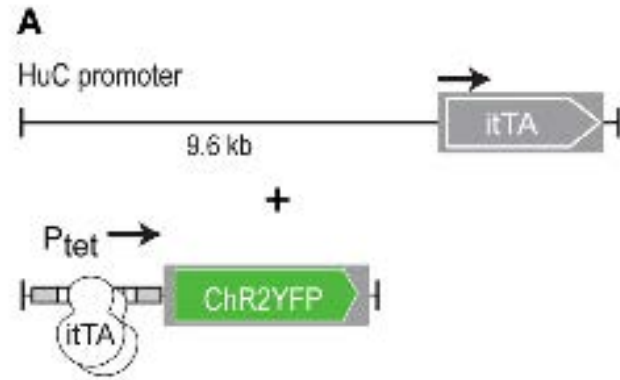
# Other Optogenetic Actuators

- **Light-control over transcription** (Optogenetic Control of Transcription in Zebrafish. Lin et al, PLoS 2012)
- **Protein translocation** (Light-induced nuclear export reveals rapid dynamics of epigenetic modifications. Kuhlman et al Nat. Chem. Biol. 2016)
- **Protein aggregation and dissociation** (Optogenetic protein clustering and signaling activation in mammalian cells. Schaffer et al Nat. Methods 2013; LOVTRAP: An Optogenetic System for Photoinduced Protein Dissociation. Hahn et al Nat. Methods 2016).
- **Protein binding and release** (Optobiology: optical control of biological processes via protein engineering. Lin et al Biochem. Soc. Trans. 2013; Optogenetic control of intracellular signaling pathways Cui et al Trends Biotechnol. 2015)

# How to Deliver Opsins to Animal Models with Viral Vectors

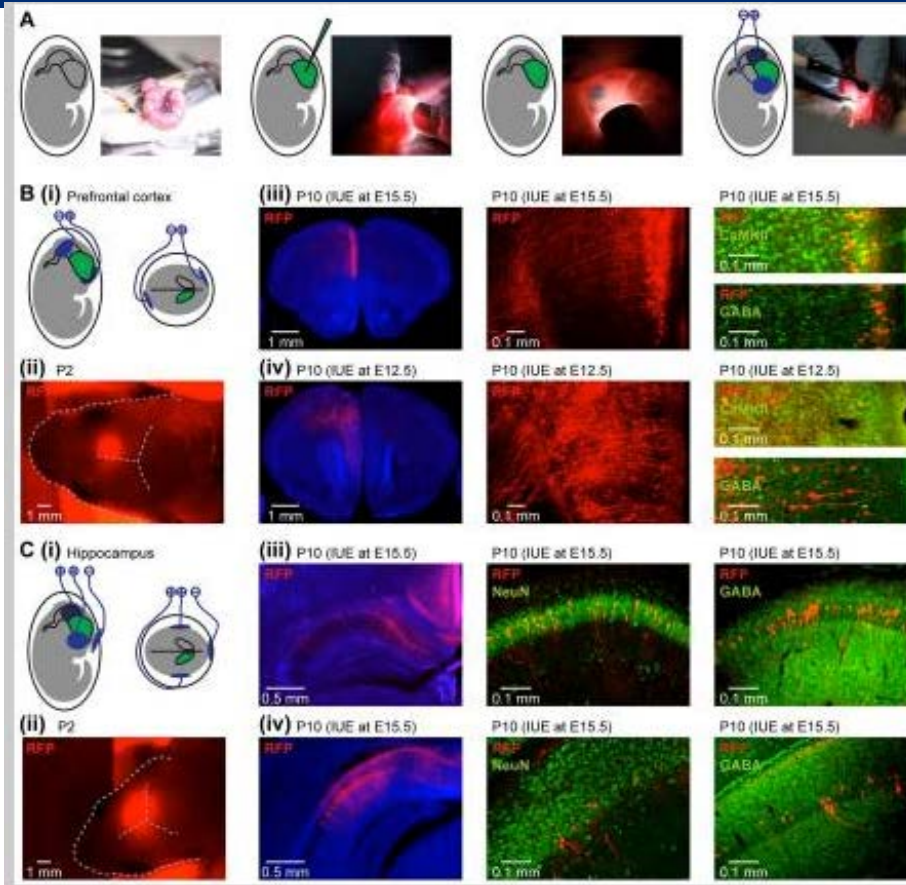


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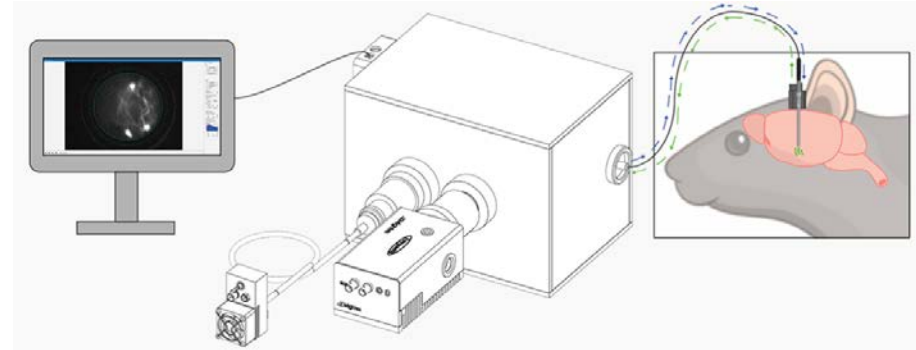




# Delivery of Opsins Using In Utero Electroporation



# Examples of microscopes for optogenetics



# References

Slide	Reference
2	Boyden, E., Zhang, F., Bamberg, E. <i>et al.</i> 2005 Millisecond-timescale, genetically targeted optical control of neural activity. <i>Nat Neurosci</i> <b>8</b> , 1263–1268.
3,4	Guru, A., Post, R.J., Ho, YY., Warden, M.R. 2015 Making Sense of Optogenetics. <i>Int J Neuropsychopharmacol.</i> 18(11): pyv079.
5	Liu, H., Gomez, G., Lin, S., Lin, S., Lin, C. 2012 Optogenetic Control of Transcription in Zebrafish. <i>PLoS One</i> 7(11): e50738.
7	Tye, K., Mirzabekov, J., Warden, M. <i>et al.</i> 2013 Dopamine neurons modulate neural encoding and expression of depression-related behaviour. <i>Nature</i> 493, 537–541.
8	Zhu, P., Narita, Y., Bundschuh, S.T. <i>et al</i> 2009 Optogenetic Dissection of Neuronal Circuits in Zebrafish using Viral Gene Transfer and the Tet System. <i>Front Neural Circuits</i> 3 (21): 1-12.
9	Bitzenhofer, S.H., Ahlbeck, J., Hanganu-Opatz, I.L. 2017 Methodological Approach for Optogenetic Manipulation of Neonatal Neuronal Networks. <i>Front Cell Neurosci.</i> 11 (239):1-13.
10	Scitech Imaging Specialists (n.d.) Optogenetics.Mightex (n.d.) Polygon <a href="https://www.mightexbio.com/products/patterned-illumination/polygon/">https://www.mightexbio.com/products/patterned-illumination/polygon/</a>



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