

BISC 461- Imaging of Neuronal Structure and Function: From molecules to Memories

Fall 2016

This course covers 12-14 papers that trace the exciting advances in molecular biology, microscopy and physiology that have revolutionized neuroscience in the last two decades. Starting with the cloning of GFP, which enabled cells and proteins to be visualized in vivo, through development of optogenetics and super-resolution microscopy, we will trace how this new technology has impacted the study of neuroscience. Each week a different student will present one of the papers listed below and will be responsible for explaining the technology used in the paper and the experiments that were performed. In addition, the student will lead a discussion on the relative merits of the paper.

The following papers will be presented:

Papers:

1. Fischer, M., S. Kaech, et al. (1998). "Rapid actin-based plasticity in dendritic spines." *Neuron* **20**(5): 847-854.
2. Emptage, N., T. V. P. Bliss, A. Fine (1999) "Single Synaptic Events Evoke NMDA Receptor-Mediated Release of Calcium from Internal Stores in Hippocampal Dendritic Spines. *Neuron* **22**: 115-124.
3. Maletic-Savatic, M., R. Malinow, et al. (1999). "Rapid dendritic morphogenesis in CA1 hippocampal dendrites induced by synaptic activity [see comments]." *Science* **283**(5409): 1923-1927.
4. Miesenbock, G., D. A. De Angelis, et al. (1998). "Visualizing secretion and synaptic transmission with pH-sensitive green fluorescent proteins." *Nature* **394**(6689): 192-195.
5. Patterson, G. H. and J. Lippincott-Schwartz (2002). "A photoactivatable GFP for selective photolabeling of proteins and cells." *Science* **297**(5588): 1873-1877.
6. Betzig, E., G. H. Patterson, et al. (2006). "Imaging intracellular fluorescent proteins at nanometer resolution." *Science* **313**(5793): 1642-1645.
7. Miyawaki, A., J. Llopis, et al. (1997). "Fluorescent indicators for Ca²⁺ based on green fluorescent proteins and calmodulin." *Nature* **388**(6645): 882-887.
8. Nakai, J., Ohkura, M., and Imoto, K. "A high signal-to-noise Ca²⁺ probe composed of a single green fluorescent protein" *Nature Biotechnology* **19**:137-141 (2001).
9. Chen, T.W., Wardill, T.J., Sun, Y., Pulver, S.R., Renninger, S.L., Baohan, A., Schreiter, E.R., Kerr, R.A., Orger, M.B., Jayaraman, V., Looger, L.L., Svoboda, K., Kim, D.S. (2013) Ultrasensitive fluorescent proteins for imaging neuronal activity. *Nature* **499**(7458):295-300.

10. Zhang, F., L. P. Wang, et al. (2007). "Multimodal fast optical interrogation of neural circuitry." *Nature* **446**(7136): 633-639.
11. Wu, Yi, Frey, D., Lungu et al. (2009). A genetically encoded photoactivatable Rac controls the motility of living cells *Nature* **461**(7260):104-8.
12. Nizak, C, Monier, S, del Nery, E, Moutel, S, Goud, B, Perez, F. (2003) Recombinant Antibodies to the small GTPase Rab6 as conformation sensors. *Science* 300:984-987.
13. Livet J, Weissman TA, et al. (2007) Transgenic strategies for combinatorial expression of fluorescent proteins in the nervous system. *Nature* 450(7166):56-62.
14. Gross, G.G., Junge, J.A., Mora, R., Kwon, H-B., Olson, C.A., Takahashi, T.T., Liman, ER, Ellis-Davies, G.E.C, McGee, A.W, Sabatini, B.L., Roberts, R.W. and Arnold, D.B. (2013) Recombinant probes for visualizing endogenous synaptic proteins in living neurons. *Neuron* **78**(6):971-85.
15. Huisken, J., Swoger, J., Del Bene, F., Wittbrodt, J., Stelzer, E.H. (2004) Optical sectioning deep inside live embryos by selective plane illumination microscopy. *Science* 305(5686):1007-9.
16. Truong, TV, W. Supatto, D. S. Koos, J. M. Choi, S. E. Fraser (2011). Deep and fast live imaging with two-photon scanned light-sheet microscopy. *Nature Methods* **8**(9):757-60.
17. K. I. Willig, Rizzoli, O., Westphal, V., Jahn, R., Hell, S. W. (2006) STED microscopy reveals that synaptotagmin remains clustered after synaptic vesicle exocytosis *Nature* 440:935-939.

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Pre-requisites: BISC 320 or BISC 421

Textbook: None

Time and Place: 4:00-5:50 PM, RRI 221.

Grading: The grades for the course will be determined by the presentation (50%), class participation (10%) and questions (40%). Every student must bring a question about the paper to be discussed to each class. After the class, the questions will be collected and graded.

Disabilities. Students requesting academic accommodations based on a disability are required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP when adequate documentation is filed. Please be sure the letter is delivered to Dr. Arnold as early in the semester as possible. DSP is open Monday-Friday, 8:30-5:00. The office is in Student Union 301 and their phone number is (213) 740-0776.

Disclaimer: It may be necessary to make some changes in the syllabus during the semester.