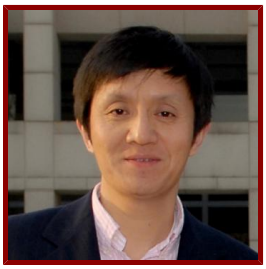
Stanford



Liqun Luo

Ann and Bill Swindells Professor in the School of Humanities and Sciences and Professor, by courtesy, of Neurobiology

Biology

CONTACT INFORMATION

- **Alternate Contact**

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Bio

BIO

Dr. Luo grew up in Shanghai, China, and earned his bachelor's degree in molecular biology from the University of Science and Technology of China. After obtaining his PhD in Brandeis University, and postdoctoral training at the University of California, San Francisco, Dr. Luo started his own lab in the Department of Biology, Stanford University in December 1996. Together with his postdoctoral fellows and graduate students, Dr. Luo studies the logic of brain wiring using genetic tools. They have developed mosaic marking systems in flies and mice and used them to study how signals are transduced from cell surface receptors to the cytoskeleton, how neuronal processes are pruned, and how neural circuits are organized and built. Dr. Luo is currently a Professor of Biology and an investigator of the Howard Hughes Medical Institute. He teaches neurobiology to Stanford undergraduate and graduate students. He recently published a single-author textbook entitled “Principles of Neurobiology.”

Dr. Luo has served on the editorial boards of several scientific journals, including Neuron, eLife, and Annual Review of Neuroscience. He has also served on the Pew Scholar National Committee and Scientific Advisory Committee of Damon Runyon Cancer Research Foundation. He is recipient of the McKnight Technological Innovation in Neuroscience Award, the Society for Neuroscience Young Investigator Award, the Jacob Javits Award from National Institute of Neurological Disorders and Stroke, HW Mossman Award from American Association of Anatomists, and the Lawrence Katz Prize. Dr. Luo is a Member of the National Academy of Sciences and a Fellow of the American Academy of Arts and Sciences.

ACADEMIC APPOINTMENTS

- Professor, Biology
- Professor (By courtesy), Neurobiology
- Member, Bio-X
- Member, Stanford Cancer Institute
- Member, Wu Tsai Neurosciences Institute

HONORS AND AWARDS

- Technology Innovation Award in Neuroscience, McKnight Foundation (2002)
- Young Investigator Award, Society for Neuroscience (2002)

- Investigator, Howard Hughes Medical Institute (2005)
- Jacob Javits Award, National Institute of Neurological Disorders and Stroke (2005)
- H.W.Mossman Award, American Association of Anatomists (2007)

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PROFESSIONAL EDUCATION

- B.S., Univ. of Sci. & Tech. of China , Molecular Biology (1986)
- Ph.D., Brandeis University , Biology (1992)

PATENTS

- He Z, Zhai Q, Wang J, Watts R, Hoopfer E, Luo L. "United States Patent 7,012,063 Reducing axon degeneration with proteasome inhibitors", Harvard & Stanford
- Luo L, Zong H. "United States Patent 7,282,621 Somatic recombination", Stanford
- Luo L, Tsai RY, Tasic B, Hippenmeyer S, Zong H. "United States Patent 9,125,385 Site-directed integration of transgenes in mammals", Stanford

LINKS

- LuoLab: http://web.stanford.edu/group/luolab/

Research & Scholarship

CURRENT RESEARCH AND SCHOLARLY INTERESTS

1. Organization of the olfactory system

The olfactory systems from flies to mammals use a similar organizational principle. Olfactory receptor neurons (ORNs) expressing the same odorant receptor project their axons to the same glomerulus. Projection neurons (PNs) send dendrites to individual glomeruli, and relay olfactory information via their axons to high olfactory centers. Using MARCM (see below) to label individual fly PNs, we found that PN axon terminals exhibit striking stereotypy at the lateral horn according to the glomeruli they send dendrites to. Axon terminals of PNs representing food odors are spatially segregated from those that represent mating pheromones. By contrast, PN axon terminal arborizations in the mushroom body, the olfactory learning and memory center, exhibit much less stereotypy. We are currently using two-photon calcium imaging, optogenetics, and quantitative behavioral assays to identify principles of information processing at the antennal lobe and in higher olfactory centers suggested by previous anatomical studies. We are also investigating how the glomerular map in the mouse olfactory bulb is represented in olfactory cortex using virus-mediated trans-synaptic tracing.

2. Development of wiring specificity in the fly olfactory system

The assembly of the fly olfactory system requires precise glomerular targeting of axons from each of the 50 ORN classes, as well as dendrites of each of the 50 PN classes. We are using this neural circuit as a model to investigate the general principles by which precise wiring specificity arises during development. Our previous studies have shown that PN dendrite patterning precedes ORN axon targeting. PN dendrite targeting relies on global cues in the form of gradients, as well as local cues distributed in a “salt-and-pepper” fashion on dendrites projecting to different glomeruli. Targeting of ORN axons may use the same molecules as PN dendrite targeting, but via distinct mechanisms including axon-axon interactions and axon-target interactions. We are currently performing systematic genetic studies to identify the cell-surface code ORNs and PNs use to form specific connections at stereotypically organized glomeruli.

3. Developmental neurobiology

In addition to our focus on the olfactory system, we are investigating several other developmental neurobiological problems. These include mechanisms of axon pruning, the roles of neuronal activity in neuronal maturation and incorporation into functional circuits, and cell autonomous functions of genes that are implicated in human neurological disorders. We are using both fly and mouse systems to study these problems.

4. Creating genetic tools

In the process of dissecting the adult organization and developmental assembly of complex neural circuits, we have created several useful genetic tools. The MARCM method (Mosaic Analysis with a Repressible Cell Marker) enables the visualization and genetic manipulation of small populations of cells or single neurons in a mosaic fly. We have developed a new repressible binary expression system, the Q system, which has many applications and is helping us to study several problems described above.

We have also developed a mosaic method in the mouse called MADM (Mosaic Analysis with Double Markers) that allows sparse labeling and genetic manipulation of individual cells or cells that share the same lineage with distinct colors in mosaic animals. We have used MADM as trace lineages and study cell autonomous gene functions in neural developmental processes. We are currently expanding the MADM technique to other mouse chromosomes, and will use MADM to study several developmental neurobiological problems (see above). We have also developed other useful mice, such as a double fluorescent Cre reporter and synapse labeling tools in vivo.

Teaching

COURSES

2018-19

- Exploring Neural Circuits: BIO 222 (Spr)
- Molecular and Cellular Neurobiology: BIO 154 (Win)
- Molecular and Cellular Neurobiology: BIO 254, NBIO 254 (Win)

2017-18

- Exploring Neural Circuits: BIO 222 (Spr)

2016-17

- Exploring Neural Circuits: BIO 222 (Spr)
- Molecular and Cellular Neurobiology: BIO 154 (Win)

2015-16

- Exploring Neural Circuits: BIO 222 (Win)

STANFORD ADVISEES

Doctoral Dissertation Reader (AC)

Eddy Albarran, Jose Andrade Lopez, Daniel Friedman, Michelle Pang

Postdoctoral Faculty Sponsor

Drew Friedmann, Wei-Hsiang Huang, Justus Kebschull, Hongjie Li, Tongchao Li, Colleen McLaughlin, Daniel Pederick, Mark Wagner

Doctoral Dissertation Advisor (AC)

Jiefu Li

Doctoral Dissertation Co-Advisor (AC)

Will Allen

Doctoral (Program)

Jiefu Li

GRADUATE AND FELLOWSHIP PROGRAM AFFILIATIONS

- Biology (School of Humanities and Sciences) (Phd Program)
- Neurosciences (Phd Program)

Publications

PUBLICATIONS

- **Temporal evolution of cortical ensembles promoting remote memory retrieval.** *Nature neuroscience*
  DeNardo, L. A., Liu, C. D., Allen, W. E., Adams, E. L., Friedmann, D., Fu, L., Guenthner, C. J., Tessier-Lavigne, M., Luo, L.
  2019
- **Genetic Dissection of Neural Circuits: A Decade of Progress** *NEURON*
  Luo, L., Callaway, E. M., Svoboda, K.
  2018; 98 (2): 256–81
- **Teneurin-3 controls topographic circuit assembly in the hippocampus.** *Nature*
  Berns, D. S., DeNardo, L. A., Pederick, D. T., Luo, L.
  2018; 554 (7692): 328–33
- **Anatomically Defined and Functionally Distinct Dorsal Raphe Serotonin Sub-systems.** *Cell*
  Ren, J., Friedmann, D., Xiong, J., Liu, C. D., Ferguson, B. R., Weerakkody, T., DeLoach, K. E., Ran, C., Pun, A., Sun, Y., Weissbourd, B., Neve, R. L., Huguenard, et al
  2018
- **Cerebellar granule cells encode the expectation of reward** *NATURE*
  Wagner, M. J., Kim, T. H., Savall, J., Schnitzer, M. J., Luo, L.
  2017; 544 (7648): 96-?

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