Stanford

Carla Shatz

Sapp Family Provostial Professor and Professor of Biology and of Neurobiology

Bio

BIO

Dr. Shatz's research aims to understand how early developing brain circuits are transformed into adult connections during critical periods of development. Her work, which focuses on the development of the mammalian visual system, has relevance not only for treating disorders such as autism and schizophrenia, but also for understanding how the nervous and immune systems interact. Dr. Shatz graduated from Radcliffe College in 1969 with a B.A. in Chemistry. She was honored with a Marshall Scholarship to study at University College London, where she received an M.Phil. in Physiology in 1971. In 1976, she received a Ph.D. in Neurobiology from Harvard Medical School, where she studied with Nobel Laureates David Hubel and Torsten Wiesel. During this period, she was appointed as a Harvard Junior Fellow. From 1976 to 1978 she obtained postdoctoral training with Dr. Pasko Rakic in the Department of Neuroscience, Harvard Medical School. In 1978, Dr. Shatz moved to Stanford University, where she attained the rank of Professor of Neurobiology in 1989. In 1992, she moved her laboratory to the University of California, Berkeley, where she was Professor of Neurobiology and an Investigator of the Howard Hughes Medical Institute. From 2000-2007 she was Chair of the Department of Neurobiology at Harvard Medical School and the Nathan Marsh Pusey Professor of Neurobiology. Dr. Shatz has received many awards including the Gill Prize in Neuroscience in 2006. In 1992, she was elected to the American Academy of Arts and Sciences, in 1995 to the National Academy of Sciences, in 1997 to the American Philosophical Society, in 1999 to the Institute of Medicine, and in 2011 she was elected as a Foreign Member of the Royal Society of London. Dr. Shatz was awarded the Gerard Prize in Neuroscience from the 40,000 member Society for Neuroscience, and in 2015, the Gruber Prize in Neuroscience. In 2016, she was the recipient of the Champalimaud Vision Prize, and the Kavli Prize in Neuroscience for the discovery of mechanisms that allow experience and neural activity to remodel brain circuits. In 2018 she received the Harvey Prize in Science and Technology.

ACADEMIC APPOINTMENTS

- Professor, Biology
- Professor, Neurobiology
- Member, Bio-X
- Member, Wu Tsai Human Performance Alliance
- Faculty Fellow, Sarafan ChEM-H
- Member, Wu Tsai Neurosciences Institute

ADMINISTRATIVE APPOINTMENTS

- Director, Bio-X, (2007-2025)
- Catherine Holman Johnson Emerita Director, Stanford, Bio-X, (2007-2024)
- Sapp Family Provostial Professorship, Stanford University, Inaugural Chair Holder, (2010- present)

HONORS AND AWARDS

- Harvey Prize in Science and Technology, Technion Institute, Haifa Israel (2018)
- Kavli Prize in Neuroscience, Kavli Foundation and Norwegian Academy of Arts and Sciences (2016)
- Gruber Prize in Neuroscience, Gruber Foundation (2015)
- Pasarow Foundation Award in Neuropsychiatry Research, Pasarow Foundation (2013)
- Sackler Prize for Distinguished Achievement in Developmental Psychobiology, Columbia University and Weil Cornell Medical School (2013)
- Elected Foreign Member, Royal Society, London, England (2011)
- Physiological Society Prize Lecture, Physiological Society Prize Lecture Oxford England (2011)
- Ralph Gerard Prize in Neuroscience, Society for Neuroscience (2011)
- Honorary Degree, James Watson School of Biological Sciences, Cold Spring Harbor Laboratory (2010)
- Sapp Family Provostial Professorship, Stanford University Inaugural Chair Holder (2010)
- Salpeter Lifetime Achievement Award, Society for Neuroscience (2009)
- Gill Prize in Neuroscience, Indiana University (2006)
- Honorary Degree, Federal Institute of Technology, Lausanne, Switzerland (2002)
- 2000 Weizmann Women and Science Award, Weizmann Institute (2000)
- Elected Member, Institute of Medicine, National Academy of Sciences (1999)
- Alcon Award for Outstanding Contributions to Vision Research, Alcon Research Institutre (1997)
- Elected Member, American Philosophical Society (1997)
- Charles A. Dana Award for Pioneering Achievement in Health and Education, Charles A. Dana Foundation (1995)
- Elected Member, National Academy of Sciences (1995)
- President, Society for Neuroscience (1994)
- Elected Fellow, American Academy of Arts and Sciences (1992)
- Elected Member, European Academy of Sciences and Arts (1992)

PROFESSIONAL EDUCATION

- Postdoctoral, Harvard Medical School , Neurobiology (1978)
- Ph.D., Harvard University , Neurobiology (1976)
- M.Phil, University College London , Physiology (1971)
- B.A., Radcliffe College, Cambridge, MA , Chemistry (1969)

LINKS

- Shatz Lab Site: https://web.stanford.edu/group/shatzlab/

Research & Scholarship

CURRENT RESEARCH AND SCHOLARLY INTERESTS

By studying the visual system of mammals, the Shatz Lab discovered that adult wiring emerges from dynamic interactions between neurons involving neural function and synaptic plasticity. Even before birth and long before vision, the eye spontaneously generates and sends coordinated patterns of neural activity to the brain. Blocking this activity in utero, or preventing vision after birth, disrupts normal tuning up of circuits and brain wiring. In turn, neural activity regulates the expression of genes involved in the process of circuit tuning. To discover cell and molecular underpinnings of circuit tuning, her lab has conducted functional screens for genes regulated by neural activity. Among these genes is the MHC (major histocompatibility)

Class I family. This finding was very surprising because these genes- HLA genes in humans- are involved in cellular immunity and were previously not thought to be expressed by neurons at all! The Shatz Lab showed that other components of a signaling system for Class I MHC are also present in neurons, including a novel receptor, PirB. By studying and/or generating knockout mice, the lab is exploring a role for these molecules in synaptic plasticity, learning, memory and neurological disorders. The lab employs a variety of approaches in these studies, ranging from molecular biology to slice electrophysiology to in vivo imaging to behavior. Research has relevance not only for understanding brain wiring and developmental disorders such as Autism and Schizphrenia, but also for understanding how the nervous and immune systems interact.

Teaching

COURSES

2025-26

- Eye, Brain, Vision: BIO 26N (Spr)

STANFORD ADVISEES

Doctoral Dissertation Reader (AC)

Xiaochen Xiong

Postdoctoral Faculty Sponsor

Jolie Huang

GRADUATE AND FELLOWSHIP PROGRAM AFFILIATIONS

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

Publications

PUBLICATIONS

- **C4d, a high-affinity LilrB2 ligand, is elevated in Alzheimer's disease and mediates synapse pruning.** *Proceedings of the National Academy of Sciences of the United States of America*
  Brott, B. K., Raissi, A. J., Micheva, K. D., Vielmetter, J., Mendes, M. S., Baccus, C. J., Huang, J., Shatz, C. J.
  2025; 122 (38): e2519253122
- **The nonclassical MHC class I Qa-1 expressed in layer 6 neurons regulates activity-dependent plasticity via microglial CD94/NKG2 in the cortex.** *Proceedings of the National Academy of Sciences of the United States of America*
  Marin, I. A., Gutman-Wei, A. Y., Chew, K. S., Raissi, A. J., Djurisic, M., Shatz, C. J.
  2022; 119 (23): e2203965119
- **Enhancing motor learning by increasing the stability of newly formed dendritic spines in the motor cortex.** *Neuron*
  Albarran, E., Raissi, A., Jaidar, O., Shatz, C. J., Ding, J. B.
  2021
- **Where I work** *NATURE*
  Powell, K., Shatz, C.
  2020; 577 (7790): 442
- **Activity-dependent modulation of hippocampal synaptic plasticity via PirB and endocannabinoids** *MOLECULAR PSYCHIATRY*
  Djurisic, M., Brott, B. K., Saw, N. L., Shamloo, M., Shatz, C. J.
  2019; 24 (8): 1206–19
- **Automated dendritic spine detection using convolutional neural networks on maximum intensity projected microscopic volumes.** *Journal of neuroscience methods*
  Xiao, X., Djurisic, M., Hoogi, A., Sapp, R. W., Shatz, C. J., Rubin, D. L.

2018

- **A saturation hypothesis to explain both enhanced and impaired learning with enhanced plasticity.** *eLife*
  Nguyen-Vu, T. B., Zhao, G. Q., Lahiri, S., Kimpo, R. R., Lee, H., Ganguli, S., Shatz, C. J., Raymond, J. L.
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- **Cell-Autonomous Regulation of Dendritic Spine Density by PirB.** *eNeuro*
  Vidal, G. S., Djurisic, M., Brown, K., Sapp, R. W., Shatz, C. J.
  2016; 3 (5)

- **Developmental Sculpting of Intracortical Circuits by MHC Class I H2-Db and H2-Kb.** *Cerebral cortex*
  Adelson, J. D., Sapp, R. W., Brott, B. K., Lee, H., Miyamichi, K., Luo, L., Cheng, S., Djurisic, M., Shatz, C. J.
  2016; 26 (4): 1453-1463

- **Blocking PirB up-regulates spines and functional synapses to unlock visual cortical plasticity and facilitate recovery from amblyopia** *SCIENCE TRANSLATIONAL MEDICINE*
  Bochner, D. N., Sapp, R. W., Adelson, J. D., Zhang, S., Lee, H., Djurisic, M., Syken, J., Dan, Y., Shatz, C. J.
  2014; 6 (258)

- **Blocking PirB up-regulates spines and functional synapses to unlock visual cortical plasticity and facilitate recovery from amblyopia.** *Science translational medicine*
  Bochner, D. N., Sapp, R. W., Adelson, J. D., Zhang, S., Lee, H., Djurisic, M., Syken, J., Dan, Y., Shatz, C. J.
  2014; 6 (258): 258ra140-?

- **Synapse elimination and learning rules co-regulated by MHC class I H2-D-b** *NATURE*
  Lee, H., Brott, B. K., Kirkby, L. A., Adelson, J. D., Cheng, S., Feller, M. B., Datwani, A., Shatz, C. J.
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- **PirB regulates a structural substrate for cortical plasticity** *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA*
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- **David Hunter Hubel (1926-2013).** *Nature*
  Shatz, C. J.
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- **Human LilrB2 is a ß-amyloid receptor and its murine homolog PirB regulates synaptic plasticity in an Alzheimer's model.** *Science*
  Kim, T., Vidal, G. S., Djurisic, M., William, C. M., Birnbaum, M. E., Garcia, K. C., Hyman, B. T., Shatz, C. J.
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- **Synaptic Plasticity Defect Following Visual Deprivation in Alzheimer's Disease Model Transgenic Mice** *JOURNAL OF NEUROSCIENCE*
  William, C. M., Andermann, M. L., Goldey, G. J., Roumis, D. K., Reid, R. C., Shatz, C. J., Albers, M. W., Frosch, M. P., Hyman, B. T.
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- **Neuroprotection from Stroke in the Absence of MHCI or PirB** *NEURON*
  Adelson, J. D., Barreto, G. E., Xu, L., Kim, T., Brott, B. K., Ouyang, Y., Naserke, T., Djurisic, M., Xiong, X., Shatz, C. J., Giffard, R. G.
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- **Classical MHCI Molecules Regulate Retinogeniculate Refinement and Limit Ocular Dominance Plasticity** *NEURON*
  Datwani, A., McConnell, M. J., Kanold, P. O., Micheva, K. D., Busse, B., Shamloo, M., Smith, S. J., Shatz, C. J.
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- **MHC Class I: An Unexpected Role in Neuronal Plasticity** *NEURON*
  Shatz, C. J.
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- **Synaptogenesis in Purified Cortical Subplate Neurons** *CEREBRAL CORTEX*
  McKellar, C. E., Shatz, C. J.
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- **Co-regulation of ocular dominance plasticity and NMDA receptor subunit expression in glutamic acid decarboxylase-65 knock-out mice** *JOURNAL OF PHYSIOLOGY-LONDON*
  Kanold, P. O., Kim, Y. A., GrandPre, T., Shatz, C. J.
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- **H2-K-b and H2-D-b regulate cerebellar long-term depression and limit motor learning** *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA*
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- **Subplate neuron ablation alters neurotrophin expression and ocular dominance column formation** *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA*
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  Catalano, S. M., Chang, C. K., Shatz, C. J.
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- **Changing patterns of expression and subcellular localization of trkB in the developing visual system** *JOURNAL OF NEUROSCIENCE*
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  Wong, R. O., CHERNJAVSKY, A., Smith, S. J., Shatz, C. J.
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