



## Carla Shatz

Sapp Family Provostial Professor and Professor of Biology and of Neurobiology

### Bio

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#### 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 Institute (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

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### 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 Schizophrenia, but also for understanding how the nervous and immune systems interact.

## Teaching

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### COURSES

#### 2025-26

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

### STANFORD ADVISEES

#### Doctoral Dissertation Reader (AC)

Clara Bacmeister, Xiaochen Xiong

#### Postdoctoral Faculty Sponsor

Monique Mendes

#### Doctoral Dissertation Advisor (AC)

Jolie Huang

### GRADUATE AND FELLOWSHIP PROGRAM AFFILIATIONS

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

## Publications

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### PUBLICATIONS

- **C4d, a high-affinity LirilB2 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., Djuricic, 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*  
Djuricic, 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., Djuriscic, 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.  
2017; 6
- **Cell-Autonomous Regulation of Dendritic Spine Density by PirB.** *eNeuro*  
Vidal, G. S., Djuriscic, 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., Djuriscic, 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., Djuriscic, 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., Djuriscic, 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.  
2014; 509 (7499): 195-?
- **PirB regulates a structural substrate for cortical plasticity** *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA*  
Djuriscic, M., Vidal, G. S., Mann, M., Aharon, A., Kim, T., Santos, A. F., Zuo, Y., Huebener, M., Shatz, C. J.  
2013; 110 (51): 20771-20776
- **David Hunter Hubel (1926-2013).** *Nature*  
Shatz, C. J.  
2013; 502 (7473): 625
- **Human LILRB2 is a  $\beta$ -amyloid receptor and its murine homolog PirB regulates synaptic plasticity in an Alzheimer's model.** *Science*  
Kim, T., Vidal, G. S., Djuriscic, M., William, C. M., Birnbaum, M. E., Garcia, K. C., Hyman, B. T., Shatz, C. J.  
2013; 341 (6152): 1399-1404
- **Human LILRB2 Is a beta-Amyloid Receptor and Its Murine Homolog PirB Regulates Synaptic Plasticity in an Alzheimer's Model** *SCIENCE*  
Kim, T., Vidal, G. S., Djuriscic, M., William, C. M., Birnbaum, M. E., Garcia, K., Hyman, B. T., Shatz, C. J.  
2013; 341 (6152): 1399-1404
- **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.  
2012; 32 (23): 8004-8011
- **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., Djuriscic, M., Xiong, X., Shatz, C. J., Giffard, R. G.  
2012; 73 (6): 1100-1107
- **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.  
2009; 64 (4): 463-470

- **MHC Class I: An Unexpected Role in Neuronal Plasticity** *NEURON*  
Shatz, C. J.  
2009; 64 (1): 40-45
- **Synaptogenesis in Purified Cortical Subplate Neurons** *CEREBRAL CORTEX*  
McKellar, C. E., Shatz, C. J.  
2009; 19 (8): 1723-1737
- **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.  
2009; 587 (12): 2857-2867
- **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*  
McConnell, M. J., Huang, Y. H., Datwani, A., Shatz, C. J.  
2009; 106 (16): 6784-6789
- **PirB is a Functional Receptor for Myelin Inhibitors of Axonal Regeneration** *SCIENCE*  
Atwal, J. K., Pinkston-Gosse, J., Syken, J., Stawicki, S., Wu, Y., Shatz, C., Tessier-Lavigne, M.  
2008; 322 (5903): 967-970
- **Regulation of CNS synapses by neuronal MHC class I** *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA*  
Goddard, C. A., Butts, D. A., Shatz, C. J.  
2007; 104 (16): 6828-6833
- **A burst-based "Hebbian" learning rule at retinogeniculate late synapses links retinal waves to activity-dependent refinement** *PLOS BIOLOGY*  
Butts, D. A., Kanold, P. O., Shatz, C. J.  
2007; 5 (3): 651-661
- **PirB restricts ocular-dominance plasticity in visual cortex** *SCIENCE*  
Syken, J., GrandPre, T., Kanold, P. O., Shatz, C. J.  
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- **Subplate neurons regulate maturation of cortical inhibition and outcome of ocular dominance plasticity** *NEURON*  
Kanold, P. O., Shatz, C. J.  
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- **Effects of visual experience on activity-dependent gene regulation in cortex** *NATURE NEUROSCIENCE*  
Majdan, M., Shatz, C. J.  
2006; 9 (5): 650-659
- **Lawrence C. Katz (1956-2005) - Obituary** *NATURE*  
Shatz, C. J.  
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- **Multiple periods of functional ocular dominance plasticity in mouse visual cortex** *NATURE NEUROSCIENCE*  
Tagawa, Y., Kanold, P. O., Majdan, M., Shatz, C. J.  
2005; 8 (3): 380-388
- **Changing scientific publishing** *SCIENCE*  
RAFF, M. C., Stevens, C. F., Roberts, K., Shatz, C. J., Newsome, W. T.  
2004; 305 (5686): 945-946
- **Immune signalling in neural development, synaptic plasticity and disease** *NATURE REVIEWS NEUROSCIENCE*  
Boulanger, L. M., Shatz, C. J.  
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- **Expression of T cell receptor beta locus in central nervous system neurons** *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA*

- Syken, J., Shatz, C. J.  
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- **Role of subplate neurons in functional maturation of visual cortical columns** *SCIENCE*  
Kanold, P. O., Kara, P., Reid, R. C., Shatz, C. J.  
2003; 301 (5632): 521-525
  - **Selective vulnerability of subplate neurons after early neonatal hypoxia-ischemia** *JOURNAL OF NEUROSCIENCE*  
McQuillen, P. S., Sheldon, R. A., Shatz, C. J., Ferriero, D. M.  
2003; 23 (8): 3308-3315
  - **A novel role for p75NTR in subplate growth cone complexity and visual thalamocortical innervation** *JOURNAL OF NEUROSCIENCE*  
McQuillen, P. S., DeFreitas, M. F., Zada, G., Shatz, C. J.  
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  - **An instructive role for retinal waves in the development of retinogeniculate connectivity** *NEURON*  
Stellwagen, D., Shatz, C. J.  
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  - **Neuronal plasticity and cellular immunity: shared molecular mechanisms** *CURRENT OPINION IN NEUROBIOLOGY*  
Boulanger, L. M., Huh, G. S., Shatz, C. J.  
2001; 11 (5): 568-578
  - **A novel p75NTR signaling pathway promotes survival, not death, of immunopurified neocortical subplate neurons** *JOURNAL OF NEUROSCIENCE*  
DeFreitas, M. F., McQuillen, P. S., Shatz, C. J.  
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  - **Functional requirement for class I MHC in CNS development and plasticity** *SCIENCE*  
Huh, G. S., Boulanger, L. M., Du, H. P., Riquelme, P. A., Brotz, T. M., Shatz, C. J.  
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  - **Netrin-1 promotes thalamic axon growth and is required for proper development of the thalamocortical projection** *JOURNAL OF NEUROSCIENCE*  
Braisted, J. E., Catalano, S. M., Stimac, R., Kennedy, T. E., Tessier-Lavigne, M., Shatz, C. J., O'Leary, D. D.  
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  - **Dynamic regulation of BDNF and NT-3 expression during visual system development** *JOURNAL OF COMPARATIVE NEUROLOGY*  
Lein, E. S., Hohn, A., Shatz, C. J.  
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  - **Rapid regulation of brain-derived neurotrophic factor mRNA within eye-specific circuits during ocular dominance column formation** *JOURNAL OF NEUROSCIENCE*  
Lein, E. S., Shatz, C. J.  
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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*  
Lein, E. S., Finney, E. M., McQuillen, P. S., Shatz, C. J.  
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  - **Dynamics of retinal waves are controlled by cyclic AMP** *NEURON*  
Stellwagen, D., Shatz, C. J., Feller, M. B.  
1999; 24 (3): 673-685
  - **Dynamic regulation of cpgr15 during activity-dependent synaptic development in the mammalian visual system** *JOURNAL OF NEUROSCIENCE*  
Corriveau, R. A., Shatz, C. J., Nedivi, E.  
1999; 19 (18): 7999-8008
  - **Retinal waves are governed by collective network properties** *JOURNAL OF NEUROSCIENCE*

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1999; 19 (9): 3580-3593
- **Brain waves and brain wiring: The role of endogenous and sensory-driven neural activity in development** *PEDIATRIC RESEARCH*  
Penn, A. A., Shatz, C. J.  
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  - **Establishment of patterned thalamocortical connections does not require nitric oxide synthase** *JOURNAL OF NEUROSCIENCE*  
Finney, E. M., Shatz, C. J.  
1998; 18 (21): 8826-8838
  - **Regulation of class I MHC gene expression in the developing and mature CNS by neural activity** *NEURON*  
Corriveau, R. A., Huh, G. S., Shatz, C. J.  
1998; 21 (3): 505-520
  - **Major glutamatergic projection from subplate into visual cortex during development** *JOURNAL OF COMPARATIVE NEUROLOGY*  
Finney, E. M., Stone, J. R., Shatz, C. J.  
1998; 398 (1): 105-118
  - **Activity-dependent cortical target selection by thalamic axons** *SCIENCE*  
Catalano, S. M., Shatz, C. J.  
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  - **Many major CNS axon projections develop normally in the absence of semaphorin III** *MOLECULAR AND CELLULAR NEUROSCIENCE*  
Catalano, S. M., Messersmith, E. K., Goodman, C. S., Shatz, C. J., Chedotal, A.  
1998; 11 (4): 173-182
  - **Competition in retinogeniculate patterning driven by spontaneous activity** *SCIENCE*  
Penn, A. A., Riquelme, P. A., Feller, M. B., Shatz, C. J.  
1998; 279 (5359): 2108-2112
  - **A two-layer model describes the spatiotemporal properties of spontaneous retinal waves** *6th Annual Computational Neuroscience Conference*  
Butts, D. A., Feller, M. B., Aaron, H. L., Shatz, C. J., Rokhsar, D. S.  
PLENUM PRESS DIV PLENUM PUBLISHING CORP.1998: 337-342
  - **Activity-dependent regulation of NMDAR1 immunoreactivity in the developing visual cortex** *JOURNAL OF NEUROSCIENCE*  
Catalano, S. M., Chang, C. K., Shatz, C. J.  
1997; 17 (21): 8376-8390
  - **Dynamic processes shape spatiotemporal properties of retinal waves** *NEURON*  
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  - **Blockade of endogenous ligands of trkB inhibits formation of ocular dominance columns** *NEURON*  
CABELLI, R. J., Shelton, D. L., Segal, R. A., Shatz, C. J.  
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  - **Dendritic development of retinal ganglion cells after prenatal intracranial infusion of tetrodotoxin** *VISUAL NEUROSCIENCE*  
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1997; 14 (4): 779-788
  - **Migration of neocortical neurons in the absence of functional NMDA receptors** *MOLECULAR AND CELLULAR NEUROSCIENCE*  
Messersmith, E. K., Feller, M. B., Zhang, H., Shatz, C. J.  
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  - **Form from function in visual system development.** *Harvey lectures*  
Shatz, C. J.  
1997; 93: 17-34
  - **Changing patterns of expression and subcellular localization of trkB in the developing visual system** *JOURNAL OF NEUROSCIENCE*  
CABELLI, R. J., Allendoerfer, K. L., Radeke, M. J., Welcher, A. A., Feinstein, S. C., Shatz, C. J.

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- **Synaptic activity and the construction of cortical circuits** *SCIENCE*  
Katz, L. C., Shatz, C. J.  
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- **Thalamic relay of spontaneous retinal activity prior to vision** *NEURON*  
Mooney, R., Penn, A. A., Gallego, R., Shatz, C. J.  
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- **Developmental changes revealed by immunohistochemical markers in human cerebral cortex** *CEREBRAL CORTEX*  
Honig, L. S., Herrmann, K., Shatz, C. J.  
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- **Requirement for cholinergic synaptic transmission in the propagation of spontaneous retinal waves** *SCIENCE*  
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- **Emergence of order in visual system development** *Colloquium on Vision - From Photon to Perception*  
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- **Emergence of order in visual system development (Reprinted from Proc Natl Acad Sci USA, vol 93, pg 602-608, 1996)** *JOURNAL OF PHYSIOLOGY-PARIS*  
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- **BLOCKADE OF ACTION-POTENTIAL ACTIVITY ALTERS INITIAL ARBORIZATION OF THALAMIC AXONS WITHIN CORTICAL LAYER-4** *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA*  
Herrmann, K., Shatz, C. J.  
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- **SEMAPHORIN-III CAN FUNCTION AS A SELECTIVE CHEMOREPELLENT TO PATTERN SENSORY PROJECTIONS IN THE SPINAL-CORD** *NEURON*  
Messersmith, E. K., Leonardo, E. D., Shatz, C. J., TESSIERLAVIGNE, M., Goodman, C. S., Kolodkin, A. L.  
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- **EARLY FUNCTIONAL NEURAL NETWORKS IN THE DEVELOPING RETINA** *NATURE*  
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- **Viktor Hamburger Award review. Role for spontaneous neural activity in the patterning of connections between retina and LGN during visual system development.** *International journal of developmental neuroscience*  
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- **SEGREGATION OF GENICULOCORTICAL AFFERENTS DURING THE CRITICAL PERIOD - A ROLE FOR SUBPLATE NEURONS** *JOURNAL OF NEUROSCIENCE*  
Ghosh, A., Shatz, C. J.  
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- **NEURONAL COUPLING IN THE DEVELOPING MAMMALIAN RETINA** *JOURNAL OF NEUROSCIENCE*

- Penn, A. A., Wong, R. O., Shatz, C. J.  
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- **INDEPENDENT CONTROL OF DENDRITIC AND AXONAL FORM IN THE DEVELOPING LATERAL GENICULATE-NUCLEUS** *JOURNAL OF NEUROSCIENCE*  
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  - **SUBPLATE PIONEERS AND THE FORMATION OF DESCENDING CONNECTIONS FROM CEREBRAL-CORTEX** *JOURNAL OF NEUROSCIENCE*  
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  - **THE SUBPLATE, A TRANSIENT NEOCORTICAL STRUCTURE - ITS ROLE IN THE DEVELOPMENT OF CONNECTIONS BETWEEN THALAMUS AND CORTEX** *ANNUAL REVIEW OF NEUROSCIENCE*  
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  - **TRANSIENT PERIOD OF CORRELATED BURSTING ACTIVITY DURING DEVELOPMENT OF THE MAMMALIAN RETINA** *NEURON*  
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  - **ENHANCEMENT OF TRANSMISSION AT THE DEVELOPING RETINOGENICULATE SYNAPSE** *NEURON*  
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