Curriculum Vitae

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Education

Indian Institute of Technology, Kanpur	B. Tech.	1974
Vanderbilt University, Nashville, TN	M.S.	1975
Vanderbilt University, Nashville, TN	Ph.D.	1978

Positions

1978-80	Postdoctoral Associate, Vanderbilt University
1980-83	Research Assistant Professor, Dept. of Neurobiology and Behavior, S.U.N.Y., Stony Brook
1983-86	Assistant Professor, Section of Neuroanatomy, Yale University School of Medicine
1986-92	Associate Professor of Neuroscience, Dept. of Brain and Cognitive Sciences, M.I.T.
1992-93	Associate Professor with tenure, Dept. of Brain and Cognitive Sciences, M.I.T.
1993-	Professor of Neuroscience, Dept. of Brain and Cognitive Sciences, M.I.T.
1994-97	Associate Head, Dept. of Brain and Cognitive Sciences, M.I.T.
1997-2012	Head, Dept. of Brain and Cognitive Sciences, M.I.T.
1998-2008	Sherman Fairchild Professor of Neuroscience, M.I.T.
2000-	Investigator, Picower Institute for Learning and Memory, M.I.T.
2008-	Paul E. and Lilah Newton Professor of Neuroscience, M.I.T.
2009-2011	Director, Simons Foundation Initiative on Autism and the Brain, MIT
2012-	Director, Simons Center for the Social Brain, M.I.T.

Research Interests

Development, plasticity and dynamics of the cerebral cortex
Experimental and computational approaches to neural networks and processing
Technologies for imaging cortical cells, synapses and circuits *in vivo*
Brain disorders and diseases

Honors and Awards

First Division with Distinction, Indian Institute of Technology, Kanpur, 1974
Meghnad Saha Award, Institute of Electronics and Telecommunication Engineers, India, 1976
Charles Judson Herrick Award, American Association of Anatomists, 1983
A.P. Sloan Foundation Fellowship, 1985
Whitaker Health Sciences Fund Faculty Award, 1986
Distinguished Neuroscientist Award, ASIOA, 1987
McKnight Neuroscience Development Award, 1988
Graduate Student Council Teaching Award, MIT, 1989
TOKTEN Award, United Nations Development Program, 1991

Hans-Lukas Teuber Scholar in the Brain Sciences, MIT, 1997
Sherman Fairchild Chair of Neuroscience, MIT, 1998
School of Science Prize for Excellence in Graduate Teaching and Advising, MIT, 2000
Sigma Xi, 2001
Elected Member, National Academy of Sciences, India, 2001
Distinguished Alumnus Award, Indian Institute of Technology, Kanpur, 2002
Elected Fellow, Neurosciences Research Program, La Jolla, 2002
Elected Member, Rodin Remediation Academy, Stockholm, 2002
Elected Fellow, American Academy of Arts and Sciences, 2003
Elected Fellow of the Royal Society, UK, 2006
Elected Fellow, The World Academy of Sciences/Academy of Sciences of the Developing World, 2007
Elected Fellow, International Neuropsychological Symposium, 2008
Elected Fellow, American Association for the Advancement of Science, 2008
Newton Chair of Neuroscience, MIT, 2008
Foundation Day Lecture and Medal, National Brain Research Center, India, 2008
Convocation Address and Scroll, Indian Statistical Institute, Calcutta, 2009
Top 50 Alumni, IIT Kanpur, 2010
DBT Distinguished Biotechnology Chair, National Brain Research Center, India, 2011
Elected Member, National Academy of Medicine (formerly Institute of Medicine), 2011
Distinguished Alumnus Award in the Psychological Sciences, Vanderbilt University, 2012
Brain and Cognitive Sciences Award for Excellence in Undergraduate Advising, MIT, 2013
BRAIN Initiative inaugural award, NIH, 2014
Narayana Murthy Distinguished Chair, IIT Madras, 2015
Elected Foreign Fellow, Indian National Science Academy, 2015
Cortical Discover Prize, Cajal Club, USA, 2016

Distinguished Lectures

Institute Lecture, Indian Institute of Technology, Delhi, 1993
NINDS Distinguished Lecture, National Institutes of Health, 1996
Distinguished Overseas Lecture, Australian Neuroscience Society, 2000
Sigma Xi Distinguished Lecturer, 2001
Grass Foundation Lecture, University of Missouri, Columbia, 2001
Institute Lecture, Indian Institute of Technology, Kanpur, 2003
The Charles E. Schmidt Lecture on Frontiers of Science, Florida Atlantic University, 2003
Schmitt Lecture, University of Rochester, 2006
Society for Neuroscience Special Lecture, 2007
Darwin Bicentennial Lecture, National Institute of Immunology, 2008
College de France Lecture, 2008
Brain-Mind Institute Distinguished Lecture, Michigan State University, 2011
Distinguished University Lecture, University of Hyderabad, 2012
Merson Distinguished Lecture, Queensland Brain Institute, 2012
Flexner Discovery Lecture, Vanderbilt University Medical Center, Nashville, 2012
American Junior Academy of Science Lecture, 2013
University Lecture, Presidency University, India, 2015
Leadership Lecture, Indian Institute of Technology, Madras, 2015
Chicago Society for Neuroscience Lecture, 2015
Bearg Lecture, Carnegie-Mellon University, 2016
Michigan Society for Neuroscience Distinguished Lecture, 2016
Institute Lecture, Indian Institute for Science, Education and Research, Mohali, 2016
Institute Lecture, ISI, 2016
Merzenich Discovery Lecture, UCSF, 2016

Presidency University 200 Year Anniversary Lecturer, 2017
Keynote and Plenary Lectures at various conferences, 1995-2017

Boards, Advisory Committees

Editorial Boards

Editorial Board, Philosophical Transactions of the Royal Society, 2016-
Editorial Board, Cerebral Cortex, 1995 –
Chief Editor, Systems Neuroscience, Frontiers in Neuroscience, 2007 - 2009
Associate Editor, Frontiers in Systems Neuroscience, 2009 –
Editorial Board, International Journal of Humanoid Robotics, 2007 -
Advisory Board, IEEE Transactions on Cognitive and Developmental Systems, 2009 - 2015
Section Editor, The Cognitive Neurosciences, MIT Press, 2007 -2011
Editorial Board, Neurosignals, 2001-2014
Editorial Board, The Visual Neurosciences, 2001
Scientific Advisory Board, Encyclopedia of Neuroscience (George Adelman, Editor), 1999
Member, Faculty of 1000, Current Science, 2002-2004
Editorial Advisory Board, The MIT Press – Cognitive Science, 1998-2003
Editorial Board, Journal of Biosciences, 1998-2001
Editorial Board, Journal of Basic and Applied Biomedicine, 1992-1994
Editorial Board, Visual Neuroscience, 1990-1994

Advisory Committees - current

Finance Committee, Society for Neuroscience, 2013-
Scientific Advisory Board, Institute for Stem Cell Biology and Regenerative Medicine, 2014-
Strategic Advisory Council, Wellcome Trust India Alliance, 2011-
Member and Chair, Fellowship Committee, Wellcome Trust India Alliance, 2010-
Scientific Advisory Board, Posit Science, 2004 –
NIH Study Sections (various, ad hoc)

Advisory Committees - completed

National Eye Institute Advisory Council, NIH, 2003 - 2008
Board of Scientific Counselors, National Eye Institute, NIH, 2010-2015
Board of Governors, Academy of Scientific and Innovative Research, CSIR, 2010-2015
Board of Directors, The Autism Consortium, 2006 - 2015
World Economic Forum, Global Agenda Council (Brain and Cognitive Sciences), 2012-2013
Infosys Prize Jury, 2010-11
National Eye Institute Advisory Council Planning Oversight Committee, 2009 -2011
National Research Council Decadal Panel on Biological and Physical Sciences in Space, 2009-2010
Co-chair, NIH Blueprint for Neuroscience Research Workshop on "Neuroplasticity", 2008-2009
The Royal Society, UK, Sectional Committee 8, 2006 - 2009
Executive Committee, The Autism Consortium, 2006 - 2008
Scientific Advisory Committee (Overseas), Department of Biotechnology, India, 2000 - 2008
Chair, IEEE Conference on Human-Computer Interaction, IIIT Allahabad, 2009
Chair, RIKEN Brain Sciences Institute Group Review Committee, Japan, 2005 - 2007
Scientific Committee, International Symposium on Brain, Vision and Artificial Intelligence, 2007
Program Committee, National Academy of Science, National Academy of Engineering and Institute of Medicine *Futures Initiative on 'Smart Prosthetics'*, 2006
Principal Research Fellowship Interview Committee, Wellcome Trust, UK, 2005
National Eye Institute Director's Neuroscience Group, 2004
IEEE – NNS Committee on Autonomous Mental Development, 2004

Advisory Committee, International Conference on Biophysics, Shanghai, 2004
Advisory Board, International Conference on Development and Learning (ICDL), 2004
Advisory Committee, International Conference on Natural Language Processing, 2004, 2005
Advisory Committee, International Conference on Intelligent Signal Processing and Robotics, 2003
Visual Sciences B Study Section, NIH, 1999-2003
Program Chair, International Conference on Development and Learning, 2002
Scientific Review Board, NINDS, 1997-99
National Research Council HHMI Fellowship Review Panel, 1998
Molecular, Cellular and Developmental Neurobiology Review Committee, NIMH/NIH, 1997-98
National Research Council HHMI Fellowship Review Panel, 1997
External Advisory Committee, Center for Neuroscience, U.C. Davis, 1996
Neurological Disorders Review Committee, NIH, 1996
Behavioral and Neural Sciences I Study Section, NIH, 1991-95
Special Emphasis Study Section, NIMH, 1994
Visual Sciences Special Emphasis Panel, NIH, 1993
Visual Sciences B Study Section, NIH, 1986-90
Chair, Visual Sciences Review Committee, NIH, 1990
Communicative Disorders Review Committee, NINCDS/NIH, 1990
NIH Committee and Report on Use of Higher Mammals in Neuroscience Research, 1989
Neurological Sciences A Special Study Section, NIH, 1985

Advisory Committees and Administrative Service, MIT (selected)

Special Committee, Space Economy Systems, 2013 -
Brain and Cognitive Sciences Council, 2012-
Committee on Outside Professional Activities, MIT, 2013-2016
MIT Science Council, 1997 - 2012
Chair, Institute Professorship Committee, 2008-2009
Planning Committee on Biomedical Research, 2007 -
Council, Program in Human Rights and Justice, 2006 -
MGH-MIT Career Development Fellowship Committee, 2006 -2010
Provost's Committee on Funding of Graduate Students, 2005
MIT Neuroscience Council, 2004 - 2006
Member, Select Agents Policy Task Force, 2002-2004
Advisory Board, McGovern Institute for Brain Research, 2000-2003
Chair, Institute Professorship Committee, 2002
Committee on Inter-Institutional Initiative in Genomics and Integrative Biology (Formation of the Broad Institute), 2002

Publications

1. Sur, M., S.S. Jamuar and S.K. Mullick. Design of a contourograph using integrated circuits. Journal of Electronics and Telecommunication Engineers 22: 786-790, 1976.

2. Sur, M., R.J. Nelson and J.H. Kaas. The representation of the body surface in somatosensory area I of the grey squirrel. Journal of Comparative Neurology 179: 425-450, 1978.

3. Merzenich, M.M., J.H. Kaas, M. Sur and C.S. Lin. Double representation of the body surface within cytoarchitectonic areas 3b and 1 in "SI" in the owl monkey (Aotus trivirgatus). Journal of Comparative Neurology 181: 41-74, 1978.

4. Nelson, R.J., M. Sur and J.H. Kaas. The organization of the second somatosensory area (SmII) of the grey squirrel. Journal of Comparative Neurology 184: 473-489, 1979.

5. Lin, C.S., M.M. Merzenich, M. Sur and J.H. Kaas. Connections of areas 3b and 1 of the parietal somatosensory strip with the ventroposterior lateral (VPL) nucleus in the owl monkey. Journal of Comparative Neurology 185: 355-371, 1979.

6. Kaas, J.H., R.J. Nelson, M. Sur, C.S. Lin and M.M. Merzenich. Multiple representations of the body within "SI" of primates: a redefinition of "primary somatosensory cortex." Science 204: 521-523, 1979.

7. Sur, M., R.J. Nelson and J.H. Kaas. The map of the body surface in somatic koniocortex in the prosimian, Galago. Journal of Comparative Neurology 189: 381-402, 1980.

8. Sur, M., M.M. Merzenich and J.H. Kaas. Magnification, receptive field area and "hypercolumn" size in areas 3b and 1 of somatosensory cortex in owl monkeys. Journal of Neurophysiology 44: 295-311, 1980.

9. Nelson, R.J., M. Sur, D.J. Felleman, and J.H. Kaas. Representations of the body surface in postcentral parietal cortex of Macaca fascicularis. Journal of Comparative Neurology 192: 611-643, 1980.

10. Sur, M., R.E. Weller, and J.H. Kaas. The body representation in somatosensory area I of the tree shrew (Tupaia glis). Journal of Comparative Neurology 194: 71-96, 1980.

11. Sur, M., R.E. Weller, and J.H. Kaas. The organization of somatosensory area II in tree shrews. Journal of Comparative Neurology 201: 121-133, 1981.

12. Sur, M., R.E. Weller and J.H. Kaas. Physiological and anatomical evidence for a discontinuous representation of the trunk in SI of tree shrews. Journal of Comparative Neurology 201: 135-147, 1981.

13. Sur, M. Receptive fields of neurons in Areas 3b and 1 of somatosensory cortex in monkeys. Brain Research 198: 465-471, 1981.

14. Sur, M., J.T. Wall and J.H. Kaas. Modular segregation of functional cell classes within postcentral somatosensory cortex of primates. Science 212: 1059-1061, 1981.

15. Dykes, R.W., M. Sur, M.M. Merzenich, J.H. Kaas and R.J. Nelson. Regional segregation of neurons responding to quickly adapting, slowly adapting, deep and pacinian receptors within thalamic ventroposterior lateral and ventroposterior inferior nuclei in the squirrel monkey (Saimiri sciureus). Neuroscience 6: 1687-1692, 1981.

16. Kaas, J.H., M. Sur and J.T. Wall. Modular segregation of slowly and rapidly adapting neurons in somatosensory cortex of monkeys. Trends in Neuroscience 4: 13, 1981.

17. Kaas, J.H., M. Sur, R.J. Nelson and M.M. Merzenich. Multiple representations of the body in postcentral somatosensory cortex of primates. In: Cortical Sensory Organization, Vol.I, C.N. Woolsey, ed., pp. 29-45, Humana Press, 1981.

18. Merzenich, M.M., M. Sur, R.J. Nelson and J.H. Kaas. Redefinition of "SI" in primates. Some features of organization of the Area 3b and Area 1 cutaneous representations in the owl monkey. In: Cortical Sensory Organization, Vol. I, C.N. Woolsey, ed., pp. 47-55, Humana Press, 1981.

19. Kaas, J.H., R.J. Nelson, M. Sur, and M.M. Merzenich. Organization of somatosensory cortex in primates. In: The Organization of the Cerebral Cortex, F.O. Schmitt, F.G. Worden, G. Adelman, S.G. Dennis, eds., pp. 237-261, MIT Press, 1981.

20. Sur, M., R.J. Nelson and J.H. Kaas. Representation of the body surface in cortical areas 3b and 1 of squirrel monkeys: Comparison with other primates. Journal of Comparative Neurology 211: 177-192, 1982.

21. Sur, M. and S.M. Sherman. Linear and nonlinear W-cells in C laminae of the cat's lateral geniculate nucleus. Journal of Neurophysiology 47: 869-884, 1982.

22. Sur, M. and S.M. Sherman. Retinogeniculate terminations in cats: Morphological differences between X- and Y-cell axons. Science 218: 389-391, 1982.

23. Sur, M., A.L. Humphrey and S.M. Sherman. Monocular deprivation affects X- and Y-cell retinogeniculate terminations in cats. Nature 300: 183-185, 1982.

24. Merzenich, M.M., J.H. Kaas, J. Wall, R.J. Nelson, M. Sur and D.J. Felleman. Topographic reorganization of somatosensory cortical areas 3b and 1 in adult monkeys following restricted deafferentation. Neuroscience 8: 33-35, 1983.

25. Felleman, D.J., R.J. Nelson, M. Sur, and J.H. Kaas. Representations of the skin surface in areas 3b in 1 of postcentral parietal cortex of cebus monkeys. Brain Research 268: 15-26, 1983.

26. Merzenich, M.M., J.T. Wall, M. Sur, R.J. Nelson, D.J. Felleman and J.H. Kaas. Progression of change following median nerve section in the cortical representation of the hand in area 3b and 1 in adult owl and squirrel monkeys. Neuroscience 10: 639-665, 1983.

27. Sur. M., J.T. Wall and J.H. Kaas. Modular distribution of neurons with slowly adapting and rapidly adapting responses in area 3b of somatosensory cortex in monkeys. Journal of Neurophysiology 51: 724-744, 1984.

28. Kaas, J.H., R.H. Nelson, R.W. Dykes, M.M. Merzenich, and M. Sur. The representation of the body surface in the ventroposterior nucleus of the squirrel monkey, Saimiri sciureus. Journal of Comparative Neurology 226: 111-140, 1984.

29. Sur, M., R.E. Weller and S.M. Sherman. Development of retinogeniculate X-and Y-cell terminations in kittens. Nature 310: 246-249, 1984.

30. Sur, M. and S.M. Sherman. The position sensitivity of retinal X- and Y-cells in cats. Experimental Brain Research 56: 497-501, 1984.

31. Humphrey, A.L., M. Sur, D.J. Uhlrich and S.M. Sherman. Projection patterns of individual X- and Y-cell axons from the lateral geniculate nucleus to cortical area 17 in the cat. Journal of Comparative Neurology 233: 159-189, 1985.

32. Humphrey, A.L., M. Sur, D.J. Uhlrich and S.M. Sherman. Termination patterns of individual X- and Y-cell axons in the visual cortex of the cat: Projections to area 18, to the 17-18 border region, and to both areas 17 and 18. Journal of Comparative Neurology 233: 190-212, 1985.

33. Sur, M., P.E. Garraghty and C.J. Bruce. Somatosensory cortex in macaque monkeys: Laminar differences in receptive field size in areas 3b and 1. Brain Research 342: 391-395, 1985.

34. Wall, J.T., J.H. Kaas, M. Sur, R.J. Nelson, D.J. Felleman and M.M. Merzenich. Functional reorganization in somatosensory cortical areas 3b and 1 of adult monkeys after median nerve repair: possible relationships to sensory recovery in humans. Journal of Neuroscience 6: 218-233, 1986.

35. Sur, M. What does the cortex do? Behavioral Brain Science 9: 105, 1986.

36. Garraghty, P.E., M. Sur, R.E. Weller and S.M. Sherman. Morphology of retinogeniculate X and Y axon arbors in monocularly enucleated cats. Journal of Comparative Neurology 251: 198-215, 1986.

37. Garraghty, P.E., M. Sur and S.M. Sherman. The role of competitive interactions in the postnatal development of X and Y retinogeniculate axons. Journal of Comparative Neurology 251: 216-239, 1986.

38. Garraghty, P.E., D.O. Frost and M. Sur. The morphology of retinogeniculate X- and Y-cell axonal arbors in dark-reared cats. Experimental Brain Research 66: 115-127, 1987.

39. Sur, M., M. Esguerra, P.E. Garraghty, M.F. Kritzer and S.M. Sherman. Morphology of physiologically identified retinal X- and Y-cell axons in the cat lateral geniculate nucleus. Journal of Neurophysiology 58: 1-32, 1987.

40. Weller, R.E., M. Sur and J.H. Kaas. Callosal and ipsilateral cortical connections of the body surface representations in S-I and S-II of tree shrews. Somatosensory Research 5: 107-133, 1987.

41. Sur, M., D.O. Frost and S. Hockfield. Expression of a surface antigen on Y-cells in the cat lateral geniculate nucleus is regulated by visual experience. Journal of Neuroscience 8: 874-882, 1988.

42. Garraghty, P.E., C.J. Shatz and M. Sur. Prenatal disruption of binocular interactions creates novel lamination in the cat's lateral geniculate nucleus. Visual Neuroscience 1: 93-102, 1988.

43. Garraghty, P.E., C.J. Shatz, D.W. Sretavan and M. Sur. Axon arbors of X and Y retinal ganglion cells are differentially affected by prenatal disruption of binocular inputs. Proceedings of the National Academy of Sciences 85: 7361-7365, 1988.

44. Sur, M., P.E. Garraghty and A.W. Roe. Experimentally induced visual projections into auditory thalamus and cortex. Science 242: 1437-1441, 1988.

45. Sur, M. Development and plasticity of retinal X and Y axon terminations in the cat's lateral geniculate nucleus. Brain Behavior and Evolution 31: 243-251, 1988.

46. Garraghty, P.E. and M. Sur. Interactions between retinal axons during development of their terminal arbors in the cat's lateral geniculate nucleus. In: Cellular Thalamic Mechanisms, M. Bentivoglio and R. Spreafico, eds., pp. 465-477, Elsevier, 1988.

47. Sur, M. Visual projections induced into auditory thalamus and cortex: implications for thalamic and cortical information processing. Progress in Brain Research vol. 75: Vision within extrageniculostriate systems, T.P. Hicks and G. Benedek, eds., pp. 129-136, 1988.

48. Sur, M. Visual plasticity in the auditory pathway: visual inputs induced into auditory thalamus and cortex illustrate principles of adaptive organization in sensory systems. In: Dynamic Interactions in Neural Networks: Models and Experiments, M.A. Arbib and S. Amari, eds., Springer-Verlag Research Notes in Neurocomputing, vol. 1: 35-51, 1988.

49. Garraghty, P.E., T.P. Pons, M. Sur and J.H. Kaas. The arbors of axons terminating in middle cortical layers of somatosensory area 3b in owl monkeys. Somatosensory and Motor Research 6: 401-411, 1989.

50. Roe, A.W., P.E. Garraghty and M. Sur. The terminal arbors of single On-center and Off-center X and Y retinal ganglion cell axons within the ferret's lateral geniculate nucleus. Journal of Comparative Neurology 288: 208-242, 1989.

51. Garraghty, P.E., A.W. Roe, Y.M. Chino and M. Sur. The effects of convergent strabismus on the development of physiologically identified retinogeniculate axons in cats. Journal of Comparative Neurology 289: 202-212, 1989.

52. Garraghty, P.E. and M. Sur. The morphology of single intracellularly stained axons terminating in area 3b of macaque monkeys. Journal of Comparative Neurology 294: 583-593, 1990.

53. Pallas, S.L., A.W. Roe and M. Sur. Visual projections induced into the auditory pathway of ferrets. I. Novel inputs to primary auditory cortex (AI) from the LP/pulvinar complex and the topography of the MGN-AI projection. Journal of Comparative Neurology 298: 50-68, 1990.

54. Roe, A.W., S.L. Pallas, J.O. Hahm and M. Sur. A map of visual space induced in primary auditory cortex. Science 250: 818-820, 1990.

55. Langdon, R.B. and M. Sur. Components of field potentials evoked by white matter stimulation in isolated slices of primary visual cortex: spatial distributions and synaptic order. Journal of Neurophysiology 64: 1484-1501, 1990.

56. Sur, M., S.L. Pallas and A.W. Roe. Cross-modal plasticity in cortical development: differentiation and specification of sensory neocortex. Trends in Neuroscience 13: 227-233, 1990.

57. Hockfield, S. and M. Sur. Monoclonal antibody Cat-301 identifies Y-cells in the dorsal lateral geniculate nucleus of the cat. Journal of Comparative Neurology 300: 320-330, 1991.

58. Hahm, J.-O., R.B. Langdon and M. Sur. Disruption of retinogeniculate afferent segregation by antagonists to NMDA receptors. Nature 351: 568-570, 1991.

59. Kwon, Y.H., M. Esguerra and M. Sur. NMDA and Non-NMDA receptors mediate visual responses of neurons in the cat's lateral geniculate nucleus. Journal of Neurophysiology 66: 414-428, 1991.

60. Sur, M. Sensory inputs and the specification of neocortex during development. In: The Development of the Visual System, D.M.K. Lam and C.J. Shatz, eds., pp. 217-228, MIT Press, 1991.

61. Esguerra, M., Y.H. Kwon and M. Sur. Retinogeniculate EPSPs recorded intracellularly in the ferret lateral geniculate nucleus in vitro: role of NMDA receptors. Visual Neuroscience 8: 545-555, 1992.

62. Kwon, Y.H., S.B. Nelson, L.J. Toth and M. Sur. Effect of stimulus contrast and size on NMDA receptor activity in the cat lateral geniculate nucleus. Journal of Neurophysiology 68: 182-196, 1992.

63. Roe, A.W., S.L. Pallas, Y.H. Kwon and M. Sur. Visual projections routed to the auditory pathway in ferrets: receptive fields of visual neurons in primary auditory cortex. Journal of Neuroscience 12: 3651-3664, 1992.

64. Nelson, S.B. and M. Sur. NMDA receptors in sensory information processing. Current Opinion in Neurobiology 2: 484-488, 1992.

65. White, C.A. and M. Sur. Membrane and synaptic properties of developing lateral geniculate nucleus neurons during retinogeniculate axon segregation. Proceedings of the National Academy of Sciences 89: 9850-9854, 1992.

66. Langdon, R.B. and M. Sur. The effects of selective glutamate receptor antagonists on synchronized firing bursts in layer III of rat visual cortex in vitro. Brain Research 599: 283-296, 1992.

67. Sur, M., J.O. Hahm and M. Esguerra. Role of postsynaptic activity in retinogeniculate pattern formation. In: The Visual System from Genesis to Maturity, R. Lent, ed., pp. 104-110, Birkhauser Boston, 1992.

68. Sur, M. Input activity and cortical development. Neuroscience Facts 3: 58, 1992.

69. Garraghty, P.E. and M. Sur. Factors influencing the development of retinal axon arbors in the cat's lateral geniculate nucleus. Physiological Reviews 73: 529-545, 1993.

70. Roe, A.W., P.E. Garraghty, M. Esguerra and M. Sur. Experimentally induced visual projections to the auditory thalamus in ferrets: Evidence for a W cell pathway. Journal of Comparative Neurology 334: 263-280, 1993.

71. Pallas, S.L. and M. Sur. Visual projections induced into the auditory pathway of ferrets. II. Corticocortical connections of primary auditory cortex. Journal of Comparative Neurology 336: 317-333, 1993.

72. Esguerra, M. and M. Sur. Spike trains and signaling modes of neurons in the ferret lateral geniculate nucleus. Experimental Brain Research 273-286, 1993.

73. Pallas, S.L., L.S. Carman and M. Sur. Visual inputs and information processing in sensory cortex: An in vivo developmental study. In: Analysis and Modeling of Neural Systems, F. Eeckman, ed., pp. 167-178, Kluwer Academic Publishers, 1993.

74. Sur, M. Cortical specification: Microcircuits, perceptual identity, and an overall perspective. Perspectives on Developmental Neurobiology 1: 109-113, 1993.

75. Garraghty, P.E., A.W. Roe, Y.M. Chino and M. Sur. Abnormal development of retinogeniculate X axons in strabismic cats: a possible substrate for visual dysfunction. Neuroscience Letters 165: 223-226, 1994.

76. Chino, Y.M., H. Cheng, E.L. Smith, P.E. Garraghty, A.W. Roe and M. Sur. Early discordant binocular vision disrupts signal transfer in the lateral geniculate nucleus. Proceedings of the National Academy of Sciences 91: 6938-6942, 1994.

77. Nelson, S., L. Toth, B. Sheth, and M. Sur. Orientation selectivity of cortical neurons persists during intracellular blockade of inhibition. Science 265: 774-777, 1994.

78. Pallas, S.L., J. Hahm, and M. Sur. Morphology of axons induced to arborize in a novel target, the medial geniculate nucleus. I. Comparison with arbors in normal targets. Journal of Comparative Neurology 347: 1-20, 1994.

79. Pallas, S.L. and M. Sur. Morphology of axons induced to arborize in a novel target, the medial geniculate nucleus. II. Comparison with arbors from the inferior colliculus. Journal of Comparative Neurology 347: 21-35, 1994.

80. Smetters, D.K., J. Hahm and M. Sur. An N-methyl-D-aspartate receptor antagonist does not prevent eye-specific segregation in the ferret retinogeniculate pathway. Developmental Brain Research 658:168-178, 1994.

81. Cramer, K.S., C.I. Moore and M. Sur. Transient expression of NADPH-diaphorase in the lateral geniculate nucleus of the ferret during early postnatal development. Journal of Comparative Neurology 353:306-316, 1995.

82. Somers, D.C., S.B. Nelson and M. Sur. An emergent model of visual cortical orientation selectivity. In: The Neurobiology of Computation, J. Bower, Ed., Kluwer Academic Publishers, pp. 311-316, 1995.

83. Cramer, K.S. and M. Sur. Activity-dependent remodeling of connections in the mammalian visual system. Current Opinion in Neurobiology 5:106-111, 1995.

84. Rocha, M. and M. Sur. Rapid acquisition of dendritic spines by visual thalamic neurons after blockade of NMDA receptors. Proceedings of the National Academy of Sciences 92: 8026-8030, 1995.

85. Somers, D.C., S.B. Nelson and M. Sur. An emergent model of orientation selectivity in cat visual cortical simple cells. Journal of Neuroscience 15: 5448-5465, 1995.

86. Clasca, F., A. Angelucci and M. Sur. Cell-specific programs of development in neocortical projection neurons. Proceedings of the National Academy of Sciences 92: 11145-11149, 1995.

87. Sur, M. Maps of time and space. Nature 378: 13-14, 1995.

88. Sur, M. and Cowey, A. Cerebral cortex: function and development. Neuron 15: 497-505, 1995.

89. Angelucci, A., F. Clasca and M. Sur. Anterograde axonal transport of Cholera Toxin Subunit B: a highly sensitive immunohistochemical protocol for revealing fine axonal morphology in adult and neonatal brains. Journal of Neuroscience Methods 65: 101-112, 1996.

90. Ramoa, A.S. and M. Sur. Short-term synaptic plasticity in the visual cortex during development. Cerebral Cortex 6: 640-646, 1996.

91. Toth, L.J., S.C. Rao, D.-S. Kim, D. Somers and M. Sur. Subthreshold facilitation and suppression in primary visual cortex revealed by intrinsic signal imaging. Proceedings of the National Academy of Sciences 93: 9869-9874, 1996.

92. Cramer, K.S. and M. Sur. The role of NMDA receptors and nitric oxide in retinogeniculate development. Progress in Brain Research 108: 235-244, 1996.

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Cross-modal plasticity and cortical specificity. Symposium on "Development of the Visual System", Retina Research Foundation, Houston, May 1990.

NMDA receptors in visual development and plasticity. International School on "Morphological and Functional Development of the Visual System", Erice, July 1990.

Self-organization in brain development. Symposium on "Prenatal Development of Function", American Psychological Association, Boston, August 1990.

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Plasticity and Dynamics of Neuronal and Astrocyte Networks in Visual Cortex. Symposium, International Institute for Neuroscience in Natal, Brazil, February 2007.

Plasticity and Dynamics of Neuronal and Astrocyte Networks in Visual Cortex. Neurosciences Research Program, La Jolla, CA, March 2007.

Plasticity and Dynamics of Neuron and Astrocyte Networks in V1. Workshop on Information Processing in the Visual System, Ohio State University, April 2007.

Plasticity and Specificity of Cortical Pathways and Networks. International Symposium on Applied Neuroscience, University of Hong Kong, May 2007.

Plasticity in the Visual Cortex. Cold Spring Harbor Course on the Biology of Learning and Memory, NY, July 2007.

New Approaches for Revealing Cortical Function: Plasticity and Dynamics of Visual Cortex Networks. Society for Neuroscience Special Lecture, San Diego, November 2007.

Role of IGF1 Signaling in Brain Development and Autism. NLM Family Foundation, Boston, December 2007.

Brain Wiring and Brain Function. Sigma Xi Lecture, Defence and Engineering Research Center, Natick, December 2007.
Brains, Computers and Intelligence. Platinum Jubilee Lecture, Indian Statistical Institute, Kolkata, January 2008.
Plasticity and Dynamics of Cerebral Cortex Networks. Platinum Jubilee Lecture, Indian Statistical Institute, Kolkata, January 2008.
Plasticity. Boston Colloquium for Philosophy of Science, Boston University, February 2008.
Plasticity and Dynamics of Visual Cortex Networks. US-Germany Computational Neuroscience Symposium, Munich, June 2008.
Cortical Plasticity and its Mechanisms. Symposium on Critical Periods and Plasticity, McGill University, Montreal, June 2008.
Patterning and Plasticity of the Cerebral Cortex. Symposium on Cognitive Neuroscience, Tahoe, June 2008.
Brain Wiring, Evolution, and Brain Disorders. Darwin Bicentennial Lecture, National Institute of Immunology, India, July 2008.
Cortical Plasticity. FENS/IBRO School on Imaging, Lausanne, Sseptember 2008.
Plasticity and Dynamics of Visual Cortex Networks. Symposium in honor of Brenda Milner, Montreal Neurological Institute, Montreal, September 2008.
Deficits in Synapse Maturation and their Therapeutic Reversal in a mouse model of Rett Syndrome. World Rett Syndrome Congress, Paris, October 2008.
Brain Wiring and Brain Disorders. College de France Lecture, Paris, October 2008.
Rules of Plasticity in the Developing and Adult Cortex. Symposium in honor of Lamberto Maffei, Pisa, Italy, October 2008.
Therapeutic Strategies for Rett Syndrome and Autism Spectrum Disorders. Autism Consortium Symposium, Boston, November 2008.
Brain Wiring and Brain Disorders. Centennial Symposium of the Indian Institute of Science, Bangalore, India, December 2008.
Brains, Computers and Intelligence. Foundation Day Lecture, National Brain Research Center, India, December 2008.
Role of Astrocytes in Visual Cortex. Symposium, American Society for Neurochemistry, Charleston, March 2009.
Role of Astrocytes in Visual Cortex: Tuned Responses, Hemodynamic Regulation and Gain Control. Gordon Conference on Astrocytes, Ventura, CA, March 2009.
The Brain and Mind. Convocation Address, Indian Statistical Institute, Kolkata, March 2009.
Brain Disorders. MIT Symposium 'Brains on Brains, May 2009.
Rules of Cortical Plasticity. Workshop on 'Research Frontiers in Neuroscience: Brainstorming Tinnitus'. Cernobbio, Italy, May 2009.
Brains, Machines and Intelligence. Keynote Lecture, International Conference on Development and Learning, Shanghai, June 2009.
Brain Wiring and Brain Disorders. Annual Lecture, Institute of Neuroscience, University of Newcastle, June 2009.
Deficits in Synapse Maturation and their Therapeutic Reversal in Rett Syndrome. Symposium, International Rett Syndrome Foundation, Chicago, June 2009.
Plasticity of Neuron and Astrocyte Networks in Visual Cortex. Physiological Society Symposium, Dublin, Ireland, July 2009.
Brain Plasticity and Brain Disorders. 'Salad Symposium', L.V.Prasad Eye Institute, Hyderabad, India, July 2009.
Neural Plasticity. National Academies Kavli Chinese-American Frontiers of Science Symposium, China, September 2009.
Rules of Cortical Plasticity. Keynote Lecture, Bernstein Conference on Computational Neuroscience, Germany, October 2009.
How the Brain Creates Intelligence. Science Conclave, IIIT Allahabad, India, December 2009.

Brains, Computers & Intelligence. Indian Inst of Science, Education and Research, Pune, India, December 2009.

Cell-specific Circuits and Plasticity in Visual Cortex. National Institute for Basic Biology Symposium on Cortical Organization, Okazaki, Japan, March 2010.

Convergence in Neuroscience: Its Past and Future History. Pathways to Convergence Symposium, MIT, April 2010.

Rules of Visual Cortex Plasticity. International Symposium of the GRSNC, "Enhancing Performance for Perception and Action", University of Montreal, May 2010.

Two-photon Calcium Imaging of Cell-specific Circuits and Responses in Visual Cortex. Fifth Statistical Analysis of Neuronal Data (SAND5) Meeting, Pittsburgh, May 2010.

Brains and Computers. IISER Mohali, India, August 2010.

Role of Astrocytes in Cortical Information Processing and Hemodynamic Signaling. 29th Naito Conference, Japan, October 2010.

From Genes to Synapses in Developmental Disorders: Therapeutics for Rett Syndrome. Williams Syndrome meeting, The Allen Institute for Brain Science, Seattle, October 2010.

Effects of Serotonin on Cortical Development and Autism. Vanderbilt Conte Center 3rd Annual Symposium, Vanderbilt University, November 2010.

Mechanisms of patterning and plasticity that generate precise thalamocortical and intracortical circuits in the visual pathway, Development of Thalamocortical Systems, Arolla, Switzerland, February 2011.

Introduction to Brain Disorders. MIT Symposium 'Brains on Brains', April 2011.

Genes and plasticity. MIT 150 Symposium on Nature and Nurture, Brains, Minds and Machines, Cambridge, May 2011.

Mechanisms and Therapeutics for Rett Syndrome. International Rett Syndrome Foundation Family Conference, Boston, May 2011.

Mechanisms and Therapeutics for Rett Syndrome. MIT-Children's Hospital Boston Symposium, June 2011.

The Functional Basis of Hemodynamic Brain Imaging: Role of Astrocytes. Keynote Lecture, Organization for Human Brain Mapping, Quebec City, Canada, June 2011.

Brains, Computers and Intelligent Machines. Distinguished University Lecture, Panjab University, Chandigarh, August 2011.

Mechanisms and Emerging Therapeutics for Neurodevelopmental Disorders. AIIMS Special Lecture, Department of Pediatrics, August 2011.

Brains, Computers and Intelligent Machines. Public Lecture, Society for the Promotion of Science and Technology in India, Chandigarh, August 2011.

Brain Wiring and Brain Disorders. School of Science talks series, MIT, September 2011.

Mechanisms and Emerging Therapeutics for Rett Syndrome. Simons Foundation Autism Research Initiative Symposium, Washington DC, September 2011.

IGF1: Mechanisms and Emerging Therapeutics for Rett Syndrome. NIH Workshop on Setting Priorities for Therapy Development in Rett Syndrome, Washington, DC, September 2011.

Brain Wiring and Brain Function. Distinguished Speakers Series lecture, Brain-Mind Institute, Michigan State University, October 2011.

Mechanisms and emerging therapeutics for Rett Syndrome and autism spectrum disorders. Cell Symposium on Autism Spectrum Disorders, Washington DC, November 2011.

Brain Wiring and Brain Disorders. Symposium Honoring Obaid Siddiqi at 80, National Center for Biological Sciences, Bangalore, January 2012.

Brains, Minds and Machines. Distinguished University Lecture, University of Hyderabad, India, January 2012.

Cortical Plasticity: Cell-specific Circuits and Disorders of Brain Development. Symposium, International Society for Developmental Neuroscience, Mumbai, January 2012.

Mechanisms and Emerging Therapeutics for Autism Spectrum Disorders. Neurology Grand Rounds, Medical University of South Carolina, Charleston, February 2012.

Brain Wiring and Brain Disorders. MIT Club of Boston, April 2012.
Brains, Minds and Machines. Distinguished Alumnus Award and Psychology Day Lecture, Vanderbilt University, Nashville, April 2012.
Cell-specific circuits in the cerebral cortex. Gordon Research Conference, Hong Kong, June 2012.
Insights from Rett Syndrome and autism can inform the neurobiology of Williams Syndrome. Keynote Lecture, International Williams Syndrome Scientific/Professional Conference, Boston, July 2012.
Brain Wiring and Brain Disorders. Merson Lecture, Queensland Brain Institute, Australia, August 2012.
Brain Circuits and Brain Disorders. National Institute of Immunology, India, August 2012.
Signals that affect synapses in autism: Insights from Rett Syndrome. Symposium on Systems Biology of Autism, Cold Spring Harbor Labs, September 2012.
Meeting the challenge of Autism Spectrum Disorders. Autism Consortium Annual Symposium, Boston, October 2012.
Mechanism-based treatments in Neurodevelopmental Disorders: Rett Syndrome. Presidential Symposium, Child Neurology Society, Huntington Beach, CA, November 2012.
Mechanisms and Emerging Therapeutics for Autism Spectrum Disorders. Flexner Discovery Lecture, Vanderbilt University Medical Center, Nashville, November 2012.
Cortical Plasticity and Neurodevelopmental Disorders. Symposium, Melbourne Brain Institute, University of Melbourne, February 2013.
Circuits that create tuned responses in Visual Cortex. Australian Neuroscience Society Symposium on "Neural basis of visual cortical orientation selectivity: 50 years after Hubel & Wiesel's hypothesis", Melbourne, February 2013.
Brains, Minds and Machines. Keynote lecture, American Junior Academy of Science, February 2013.
Brain Wiring and Brain Disorders. Life Sciences Colloquium, Colorado State University, March 2013.
Understanding Autism Spectrum Disorders. MIT Symposium “Brains on Brains 2”, April 2013.
The Functional Logic of Information Processing Circuits in the Cerebral Cortex. Symposium, Indian Institute of Science, Bangalore, June 2013.
Rules of Plasticity in the Developing and Adult Visual Cortex. Federation of European Neuroscience Societies (FENS) Symposium, Prague, September 2013.
Brain Plasticity. Symposium on Neuroethics, Federation of European Neuroscience Societies (FENS) Symposium, Prague, September 2013.
The Functional Logic of Cortical Circuits. Cajal Institute, Madrid, November 2013.
Mechanisms and Emerging Therapeutics for Autistic Disorders. West Syndrome Symposium, Madrid, November 2013.
How the Brain Works. Science Conclave, IIIT Allahabad, India, December 2013.
Rules of Cortical Plasticity: Circuits, Neurons and Synapses. Workshop: A Dynamic Architecture of Life, Academia Nazionale dei Lincei, Rome, May 2014.
Role of Major Vault Protein (MVP) in synaptic and circuit plasticity in cortex. Simons Foundation Workshop, New York, June 2014.
The Functional Logic of Cortical Circuits. Bernstein Conference on Computational Neuroscience, Gottingen, September 2014.
Signaling and Circuit Mechanisms of Rett Syndrome. EMBO Conference on Brain Disorders, La Ciotat, France, September 2014.
MicroRNA Mechanisms of Rett Syndrome. Simons Foundation Autism Research Initiative Symposium, New York, September 2014.
Cortical circuits and their dysfunction in developmental brain disorders. 6th Annual Tufts Neuroscience Symposium, October 2014.
Brains, Minds and Machines. Institute Lecture, Saha Institute for Nuclear Physics, India, January 2015.
Brain Wiring and Brain Disorders. University Lecture, Presidency University, India, January 2015.
Brains, Minds and Machines. Leadership Lecture, Indian Institute of Technology, Madras, February 2015.
Role of Astrocyte Calcium Signaling and Glutamate Transporters in Visual Cortex. Gordon Research Conference on Glial Biology, Ventura, CA, March 2015.

Signaling and Circuit Mechanisms of Rett Syndrome. Keystone Symposium, "Pathways of Neurodevelopmental Disorders", Tahoe City, March 2015.
Brain Wiring and Brain Disorders. Chicago Society for Neuroscience Keynote Lecture, March 2015.
The Functional Logic of Cortical Circuits. Symposium on Physics, Mathematics and Neuroscience of Cortical Function, Boston University, May 2015.
Animal Models of Cortical Plasticity: Implications for Understanding and Treating Amblyopia. Lasker Foundation/IRRF Initiative on Amblyopia Workshop, Woods Hole, July 2015.
Mechanisms of Plasticity in the Cerebral Cortex. Conference on 'Exciting Biologies – Biology of Plasticity', IPSEN/Cell Press, La Jolla, October 2015.
Plasticity in Cortical Circuits. Symposium on Molecular and Cellular Mechanisms of Neural Homeostasis, Max Planck Institute for Brain Research, Frankfurt, October 2015.
Neural Architectures for Cognition. Workshop, Center for Computational Brain Research, Indian Institute of Technology, Madras, January 2016.
The Functional Logic of Cortical Circuits. Victor Bearg Lecture, Carnegie-Mellon University, February 2016.
Mechanisms and Potential Therapeutics for Neurodevelopmental Disorders. Special Lecture, National Center for Biological Sciences, Bangalore, India, March 2016.
The Functional Logic of Cortical Circuits. Michigan Society for Neuroscience Keynote Distinguished Lecture, Michigan State University, East Lansing, May 2016.
Mechanisms and Emerging Therapeutics for Neurodevelopmental Disorders. Symposium on Biology of Brain Disorders, Trinity College, Dublin, June 2016.
The Neural Architecture of Cognition. Institute Lecture, Indian Institute of Science, Education and Research, Mohali, August 2016.
The Neural Architecture of Cognition. Institute Lecture, Indian Statistical Institute, Kolkata, August 2016.
The Functional Logic of Cortical Circuits. Merzenich Discovery Lecture, Univ of California, San Francisco, October 2016.
Brain Circuits and Neural Dynamics underlying Cognition. Workshop, Center for Computational Brain Research, Indian Institute of Technology, Madras, January 2017.
Brain Circuits and Dynamics of Cognition. Symposium on Brain, Computation and Learning, Indian Institute of Science, Bangalore, January 2017.
Brains, Minds and Society. Presidency University 200 Year Anniversary Symposium, January 2017.

Expositions

Radio and Television

Universities Grants Commission, India: Television film on The Visual System, 1991
BBC World Service Radio, April 2000
Canadian Broadcasting Corporation – Radio show "Quirks and Quarks", April 2000
Public Broadcasting Service Television Series, "The Secret Life of the Brain. Episode 1: The baby's brain: Wider than the sky", David Grubin Productions, January 2002
The University of the Air, Japan, "Learning under Transformation: Brain and Epistemology", September 2003

Lectures on the Web

The Brain and Mind. MIT Lectures on Fundamentals of the Brain and Mind, June 2003
http://mitworld.mit.edu/video/194/

Our Brains, Ourselves, Our Common Future. Science, Technology and Human Rights Series, MIT, November 2004. http://mitworld.mit.edu/video/247/

Brains, Minds and Machines. American Junior Academy of Science, February 2013. http://techtv.mit.edu/tags/166-education/videos/22794-professor-mriganka-sur-speaks-to-the-american-junior-academy-of-science

Teaching

Yale University School of Medicine (1983-86)

Co-instructor, Neuroscience 502: Structure and function of neocortex, Fall 1983
Lectures in Neuroscience 500: Structural and functional organization of the human nervous system, Spring 1984-86
Instructor, Tutorial on Sensory-motor integration, Spring 1984
Instructor, Tutorial on Organization of the nervous system: general principles, Spring 1985-86
Co-director, Neuroscience 501: Principles of Neuroscience, Fall 1985

Massachusetts Institute of Technology (1986-present)

Director, 9.011: Principles of Neuroscience, Fall 1989-97; 1999-2002
Co-instructor, 9.024: Development and plasticity of the visual system, Spring 1987, 1989, 1991
Co-instructor, 9.373: Somatosensory and motor systems, Spring 1988, 1990, 1992, 1994, 1996, 1998, 2000, 2002, 2004
Co-instructor, 9.05: Neural basis of movement, Spring 1995, 1997, 1999, 2001, 2003, 2005, 2007
Instructor, 9.24: Disorders and diseases of the nervous system, Spring 2015, 2016, 2017.
Lectures in Independent Activities Period (IAP), 1990-2015.

Other

Short courses on brain organization, function and development, International Center for Theoretical Physics, Trieste, 1986, 1988, 1990, 1993, 1995, 1998
Review and Update of Neuroscience for Neurosurgeons (RUNN), Woods Hole, 1996
Workshop on Computational Neuroscience, Institute for Theoretical Physics, University of California, Santa Barbara, 2001
Workshop on Neural Spectroscopy, Woods Hole, 2003
GIAN Workshop on Modelling and Plasticity of the Cerebral Cortex, IIIT Allahabad, India, 2016.
GIAN Workshop on Cognition: An Interdisciplinary Perspective, IISER Mohali, 2016.

Graduate Students

Current Doctoral Students:

Gerald Pho, Marvin Nayan, Karen Guadalupe Cruz

Doctoral Theses Supervised:

Anna W. Roe, Ph.D. 1991. Functional transformations of visual input by auditory thalamus and cortex: An experimentally induced visual pathway in ferrets. Current position: Director, Zhejiang University Institute of Neuroscience and Technology, China; Professor, Oregon Health and Sciences University.

Young H. Kwon, Ph.D 1991. Functional role of neurotransmitters in the visual thalamus. Current position: Clifford M. and Ruth M. Altermatt Professor of Glaucoma; Professor of Opthalmology and Visual Sciences, University of Iowa School of Medicine.

Jong-On Hahm, Ph.D. 1991. Influence of the target on development of the ferret retinogeniculate projection. Current position: Distinguished Senior Fellow, Schar School of Policy and Government, George Mason University.

Manuel Esguerra, Ph.D. 1991. Synaptic transmission in the ferret lateral geniculate nucleus in vitro: Modulation by membrane voltage and neurotransmitters. Current position: Research Assistant Professor, Dept. of Physiology, University of Minnesota School of Medicine.

Diana K. Smetters, Ph.D. 1995. Electrotonic structure and synaptic integration in cortical neurons. Current position: Google Inc.

Louis J. Toth, Ph.D. 1995. Layout and connectivity of orientation domains in mammalian visual cortex: A physiological description. Current position: Associate Professor, Department of Anatomy and Neurobiology, Boston University School of Medicine.

Bhavin Sheth, Ph.D. 1996. Representation of a class of subjective contours in visual cortex. Current position: Associate Professor, Department of Computer Science, University of Houston.

Alessandra Angelucci, Ph.D. 1996. Experimental retinal projections to the auditory thalamus: morphology, development and effects on auditory cortical organization. Current position: Professor, Program in Neuroscience and Department of Ophthalmology, University of Utah School of Medicine, Salt Lake City.

Christopher Moore, Ph.D. 1998. Some principles of somatosensory cortical organization in rats and humans. Current position: Professor, Department of Neuroscience, Brown University.

Carsten Hohnke, Ph.D. 1999. The development of functional inputs to a neural circuit: Synaptic strength before and after the activity-dependent maturation of the retinogeniculate system. Current position: Senior Vice-President, Michigan Economic Development Corporation.

James Schummers, Ph.D. 2003. Examination of inhomogeneities in the representation of orientation in the primary visual cortex (area 17) of the cat. Current position: Group Leader, Max Planck Institute, Florida.

Serkan Oray, Ph.D. 2004. Structural dynamics and synaptic development in the visual system. Current position: Senior Director, Device and Technology, UCB Pharma, Brussels.

Charlene Ellsworth, Ph.D. 2004. Intrinsic constraints on cross-modal plasticity. Current position: Internist/ General Internal Medicine, Barnes-Jewish Hospital, Providence.

Brandon Farley, Ph.D. 2006. Principles underlying the organization and development of feature maps in the visual cortex. Current position: Scientist, Biogen-Idec Inc.

Beau Cronin, Ph.D. 2008. Quantifying uncertainty in computational neuroscience with Bayesian statistical inference. Current position: Chief Scientist, Beseeq.

Cortina McCurry, Ph.D. 2009. Deficient plasticity in the visual cortex of Arc null mice. Current position: Principal, Boston Consulting Group.

Sam H. Horng, Ph.D. 2009. Identification and functional characterization of two patterning genes, Zic4 and Ten_m3, in topographic map formation of the visual pathway. Current position: Fellow in Neurology, Mount Sinai School of Medicine.

Caroline Runyan, Ph.D. 2012. Structure, function and circuits of inhibitory neuron subtypes in the visual cortex. Current position: Postdoctoral fellow in Neurobiology, Harvard Medical School.

Naiyan Chen, Ph.D. 2013. Cell-type specific cholinergic modulation of the cortex. Current position: Postdoctoral fellow, NSTAR, Singapore and MIT.

Rodrigo Garcia, Ph.D. 2016. Cell-type specific contributions to Rett Syndrome: neuronal and astrocytic signaling and sensory processing. Current position: Postdoctoral fellow, MIT.

Rajeev Rikhye, Ph.D. 2016. The mechanisms of reliable coding in mouse visual cortex. Current position: Research Specialist, Janelia Research Campus, HHMI.

Danielle Feldman, Ph.D. 2016. Human induced pluripotent stem cell models of Rett Syndrome reveal deficits in early cortical development. Current position: Seven Bridges Genomics, Cambridge.

Gerald Pho, Ph.D. 2017. Sensorimotor transformation and information coding across cortex during perceptual decisions. Current position: MIT.

Master's Theses Supervised:

Ben Y. Reis, M.S. 1996. Implementation of a line attractor-based model of the gaze holding integrator using nonlinear spiking neuron models.

Sherri L. Hitz, M.S. 1998. Postnatal development of brainstem cholinergic inputs to the dorsal lateral geniculate nucleus of the domesticated ferret, *Mustela putorius fero*.

Postdoctoral Fellows

Current Postdoctoral Fellows and Research Scientists:

Jitendra Sharma, Hiroki Sugihara, Jeremy Petravicz, Jacques Ip, Rafiq Huda, Vincent Breton-Provencher, Ming Hu, Murat Yildirim, Keji Li, Jamie Benoit, Chloe Delepine, Grayson Sipe, Elie Adam

Previous Fellows:

Preston Garraghty, 1984-87; Professor, Dept. of Psychology, Indiana University
Ronald Langdon, 1987-90; Expert Scientific Writer, Novartis Ireland
Sarah Pallas, 1988-92; Professor, Dept. of Biology, Georgia State University
Darren Gitelman, 1990-91; Associate Professor, Dept. of Neurology, Northwestern University School of Medicine
Ary Ramoa, 1990-91; Professor, Dept. of Anatomy, Medical College of Virginia (deceased)
Laurie Carman, 1990-92; Staff Scientist, Merck AG, Frankfurt
Cheryl White, 1990-93; Plastic Surgeon, Texas
Monica Santos-Rocha, 1990-1993; Professor, Inst. of Biophysics, Federal Univ. of Rio de Janeiro

Sacha Nelson, 1991-1994; Professor and Chair, Dept. of Biology, Brandeis University
Francisco Clasca, 1992-1995; Professor, Dept. of Anatomy, University of Madrid
S. Chenchal Rao, 1992-1995; Research Scientist, Vanderbilt University School of Medicine
Dae-Shik Kim, 1994-1996; Professor, Korea Advanced Institute of Science and Technology
David Somers, 1992-1996; Professor and Chair, Dept. of Psychology, Boston University
Karina Cramer, 1992-1997; Professor, Dept. of Neurobiology and Behavior, University of California, Irvine
Jitendra Sharma, 1994-97; Research Scientist, MIT
Cathy Leamey, 1996-1998; 2000-2003; Senior Lecturer, Dept. of Physiology, University of Sydney, Australia
Chrystal Ho Pao, 1997-1998; Associate Professor of Biology, Trinity International University
George Kalarickal, 1998-1999; Research Staff, Digital Technology Inc
Casto Rivadulla, 1998-1999; Associate Professor, University of Coruña, Spain
Valentin Dragoi, 1998-2003; Professor, Dept. of Neurobiology and Anatomy, University of Texas – Houston Medical School
Jorge Marino, 2002-2003; Research Scientist, University of Coruña, Spain
Alvin Lyckman, 1998-2004; Assistant Professor, Tufts University School of Medicine and St. Elizabeth's Hospital, Boston
David Lyon, 2002-2004; Associate Professor, Dept. of Neurobiology and Anatomy, University of California, Irvine
Serkan Oray, 2004; Senior Director, UBS Pharma, Brussels
Jessica Newton, 2001-2004; Helix Medical Communications LLC, San Francisco
Ania Majewska, 2000-2005; Associate Professor, Dept. of Neurobiology and Anatomy, University of Rochester Medical Center
Paul George, 2005-2006; Assistant Professor of Neurology, Stanford University School of Medicine
Hiroki Sugihara, 2005-2008; Research Scientist, MIT
Anna Bolteus, 2005-2007; MRC consultant, Sweden
Leigh Carmody, 2006-2008; Scientist, Broad Institute
Audra Van Wart, 2006-2009; Director of Education and Training, Virginia Tech Carilion Research Institute
Amanda Mower, 2004-2009; Medical Director, Impact Communication Partners, New York
Daniela Tropea, 2003-2009; Assistant Professor, Trinity College Dublin
Hongbo Yu, 2002-2009: Associate Professor, School of Life Sciences, Fudan University, Shanghai
Rong Mao, 2005-2010; Research Scientist, Stanford University School of Medicine
Beata Jarosiewicz, 2006-2010; Senior Research Scientist, Stanford University
Damon Page, 2004-2010; Associate Professor, Scripps Institute, Florida
James Schummers, 2003-2010; Group Leader, Max Planck Institute, Florida
Nathan Wilson, 2005-2012; Chief Technical Officer, Nara Systems, Boston
Show-ming Kwok, 2009-2013; Scientist, Verily Life Sciences
Jorge Castro, 2008-2013; IP and Tech Licensing Consultant
Gertrudis Perea, 2010-2013; Permanent Scientist, Spanish Research Council, Cajal Institute, Madrid
Ikue Nagakura, 2010-2014; Research Scientist, Beth-Israel Deaconess Medical Center, Boston
Jeremy Petravicz, 2010-2014; Research Scientist, MIT
Vardhan Dani, 2012-2014; Research Scientist, MIT
Sami El-Boustani, 2011-15; Research Scientist and Marie Curie Fellow, EPFL Lausanne
Nikolaos Mellios, 2009-15; Assistant Professor, University of New Mexico, Albuquerque
Michael Goard, 2010-15; Assistant Professor, Depts of Molecular, Cellular and Developmental Biology, and Psychology, University of California, Santa Barbara
Abhishek Banerjee, 2010-15; Marie Curie Fellow, Brain Research Institute, University of Zurich

Research Support

Active:

Research Grants:

NIH BRAIN Initiative, U01 NS090473 (PI, M. Sur; co-PIs, E.Brown, I.Wickersham, K.Chung): Cortical circuits and information flow during memory-guided perceptual decisions, 2014-2017.

NSF BRAIN EAGER EF145125 (PI, M. Sur): Massive-scale multi-area single neuron recordings to reveal circuits underlying short-term memory, 2014-2017.

NIH, R01 EY007023 (PI, M. Sur): Cell-specific circuits and contextual modulation in visual cortex, 2015-19.

NIH, R01 MH085802 (PI, M. Sur): MicroRNA mechanisms of Rett Syndrome, 2015-2020.

Picower Institute Innovation Fund (PI, M. Sur): Astrocyte-neuron interactions during cortical plasticity *in vivo*, 2015-2018.

NIH, R24 MH109081 (PI, A. Jasanoff, co-PI, M. Sur): Toward functional molecular neuroimaging using vasoactive probes in human subjects, 2015-2018

NIH, R01 EB022726 (PI, E. Brown, co-PI, M. Sur): Filtered point process inference framework for modeling neural data, 2016-2021

Center Grants:

Simons Foundation Autism Research Initiative: Simons Center for the Social Brain at MIT (Director, M. Sur), 2012-2019.

Training and Core grants:

NIH Training Grant T32 GM07484 (co-PI): Integrative Neuronal Systems, 2012-2017 (PI: 1997-2013).

NIH Core Grant EY02621 (co-PI): Central Visual Processes, 2008-2018.

NIH Training Grant T32 MH074249 (co-PI): Training in the Neurobiology of Learning and Memory, 2007-2017.

Completed Grants:

NIH, R01 MH085802 (PI, M. Sur): Mechanisms and therapeutics for Rett Syndrome, 2009-2015.

NIH, R01 EY007023 (PI, M. Sur): Cell-specific circuits in visual cortex, 2009-2014.

Simons Foundation Autism Research Initiative (PI, R. Jaenisch, co-PI, M. Sur): iPSC derived isogenic neurons for characterizing fragile X and Rett Syndrome, 2011-2014.

NSF, US-German Collaboration (PIs, M. Sur and K. Obermayer): Role of astrocytes in cortical information processing, 2010-2014.

NIH, R01 EY 018648 (PI, M. Sur): Cortical Representations and Plasticity: Neurons and Astrocytes, 2007-2012.

NIH, R01 EY019152 (PI, M. Sur): Molecular and Functional Mechanisms underlying Binocular Vision, 2010-2012.

Simons Foundation Autism Research Initiative: Simons Initiative at MIT on Autism and the Brain (Program Director: M.Sur), 2009-2012.

Simons Foundation: Neural and Cognitive Mechanisms of Autism (Program Director, M. Sur), 2005-2012.

NIH, R01 EY 17098 (PI, M. Sur): Structural Correlates of Rapid Cortical Plasticity, 2006-2011.

Marcus Family Foundation (Program Director, M. Sur): Research on Autism and Developmental Disorders, 2006-2009.

Picower Institute Innovation Fund (PI, M. Sur): Role of astrocytes in cortical circuits, 2007-2009.

NIH, R01 EY 15068 (PI, M. Sur): Cortical Plasticity: Inputs, networks and behavior, 2003-2009.

NIH, R01 EY 07023 (PI, M. Sur): Orientation Specificity in Visual Cortex, 2002-2008.
NIH, R03 EY 14134 (PI, M. Sur): Novel genes underlying connectivity in visual cortex, 2003-2007.
NIH, R01 NS 39022: Dynamic integration in somatosensory cortex, 2000-2005.
Marcus Family Foundation (PI, M. Sur), Research on Autism and Developmental Disorders, 2003-2006.
NIH, R01 EY 11512: Activity-dependent mechanisms of visual development, 1996-2004.
DuPont-MIT Alliance (PI, M. Sur; co-PI, R. Langer): Biopolymer based neuronal networks, 2001-2004.
March of Dimes Birth Defects Foundation: Mechanisms of thalamic compartmentalization and plasticity, 2000-2003.
Markey Foundation grant in Developmental Neuroscience (co-PI, M. Sur), 1990-1998.
NSF, IBN-9602143: Role of retrograde messengers in visual development, 1996-1998.
Sloan Fund: Cortical dynamics of learning, 1997-1998
March of Dimes Birth Defects Foundation: Plasticity and specificity in visual development, 1995-1997.
Science Partnerships Fund: Orientation modules in visual cortex: theory and experiments, 1995-1997.
NIH, R01 EY 07719: Development and plasticity of visual projections, 1988-1996 (1988-91, 1991-96).
March of Dimes Birth Defects Foundation: Visual inputs and cortical development, 1992-1994.
NIH, Biomedical Research Support Grant: Optical recording of electrical activity in rewired cortex, 1992-1993.
McKnight Fund for Neuroscience: Target specificity in visual development, 1988-1992.
Whitaker Health Sciences Fund: Cellular mechanisms underlying spared functions after damage to visual cortex, 1990-1991.
Sloan Foundation: Research Fellowship in Neuroscience, 1985-1989.
March of Dimes Birth Defects Foundation: Functional visual projections induced into auditory thalamus and cortex, 1987-1989.
Center for Environmental Health Sciences/National Institute of Environmental Health Sciences: Formamidine pesticides and adrenergic modulation of function in visual cortex, 1989-1991.
Educational Foundation of America: Retinal axon outgrowth and arborization, 1989-1990.
National Science Foundation, BNS 8411973: Functional organization of primate somatosensory cortex, 1985-1988.
Whitaker Health Sciences Fund: Functional development of central visual structures, 1986-1988.
Educational Foundation of America: Role of fibroblast growth factors in development, 1988-1989.
Educational Foundation of America: Role of testosterone in neuronal development, 1988-1989.
NIH, Biomedical Research Support Grant: Target specificity in development, 1987-1988.
NIH Shared Instrumentation grant: Transmission electron microscope to study cell structure, 1990.

Postdoctoral fellowships sponsored:

Preston Garraghty, NIH, 1984
Sarah Pallas, NIH, 1989
Leah Krubitzer, NIH, 1990 (declined)
Cheryl White, NIH, 1990; Bunting Fellowship, 1992
Sacha Nelson, NIH, 1991
Karina Cramer, NIH, 1992
Francisco Clasca, M.E.C. Spain, 1992; Fogarty Fellowship, 1993
David Somers, McDonnell-Pew Fellowship, 1992; NIMH, 1993
Jitendra Sharma, Fogarty Fellowship, 1994
Ding-you Li, MRC Canada, 1995 (declined)
Chrystal Ho, NIH, 1996
Casto Rivadulla, Fulbright Fellowship, 1998
Valentin Dragoi, Merck Fellowship, 2000; McDonnell-Pew Foundation Fellowship, 2000
Jorge Marino, M.E.C. Spain, 2000
Ania Majewska, MIT Science Fellowship, 2001; Burroughs Wellcome Award, 2003
Jessica Newton, NIH, 2001

David Lyon, NIH, 2002
Amanda Mower, NIH, 2004
Damon Page, Nancy Lurie Marks Foundation, 2004, 2007
Daniela Tropea, NIH, 2005
Nathan Wilson, NIH, 2006; Simons Fellowship, 2009
Beata Jarosiewicz, NIH, 2006
Rong Mao, NIH, 2006
Audra Van Wart, NIH, 2007
Jorge Castro, M.E.C. Spain, 2007
Showming Kwok, Simons Fellowship, 2009
Nikolaos Mellios, NIH, 2009
Gertrude Perea Parilla, Marie-Curie Fellowship, 2010
Abhishek Banerjee, Simons Fellowship, 2010
Sami El-Boustani, Marie-Curie Fellowship, 2011
Ikue Nagakura, Simons Fellowship, 2011
Jeremy Petravicz, NIH, 2012
Michael Goard, NIH, 2013; K99 award 2014
Rafiq Huda, NIH, 2014
Jacques Pak Kan Ip, IBRO 2013; HFSP, 2014
Vincent Breton-Provencher, FRSQ, Canada, 2015
Jamie Benoit, JFDP Fellowship, 2016
Keji Li, International Rett Syndrome Foundation, 2016
Grayson Sipe, NIH, 2017

Major Contributions to Science

My laboratory studies the organization, plasticity and dynamics of the cerebral cortex. We aim to understand how specific cell classes of the cortex contribute to circuits that process visual information, how synapses and cell-specific connections develop, and how visual experience influences their development. Over the past few years, we have used two-photon imaging of single cells and synapses in the intact visual cortex *in vivo*, combined with targeted electrophysiological recording and optogenetic activation and inactivation, to discover specific functions of neuronal subtypes and astrocytes in cortical processing and plasticity. By utilizing massive scale imaging of neuronal activity in awake, behaving mice performing visual discrimination and short-term memory tasks, we have revealed principles of information flow and representation across multiple cortical areas. A defining feature of our work is that we integrate multiple levels of analysis utilizing systems, computational and cellular/molecular approaches. Alongside, we aim to understand how fundamental mechanisms of brain development and plasticity can provide insights into developmental disorders of the brain. Some recent reviews are:

Sur, M. and C. Leamey. Development and plasticity of cortical areas and networks. Nature Reviews Neuroscience 2: 251-262, 2001. PMID: 11283748

Sur, M. and J. Rubenstein. Patterning and plasticity of the cerebral cortex. Science 310: 805-810, 2005. PMID: 16272112

Majewska, A. and Sur, M. Plasticity and specificity of cortical processing networks. Trends in Neurosciences 29: 323-329, 2006. PMID: 16697057

Tropea, D., A. Van Wart and M. Sur. Molecular mechanisms of experience-dependent plasticity in visual cortex. Philosophical Transactions of the Royal Society B 364: 341-355, 2009. PMID: 18977729

Mellios, N. and M. Sur. The emerging role of microRNAs in schizophrenia and autism spectrum disorders. Frontiers in Psychiatry 3: 39 [doi: 10.3389/fpsyt.2012.00039], 2012. PMID: 22539927

Sur, M., I. Nagakura, N. Chen and H. Sugihara. Mechanisms of plasticity in the developing and adult visual cortex. Progress in Brain Research 207: 243-254, 2013. PMID: 24309257

Sahin, M. and M. Sur. Genes, circuits and precision therapies for autism and neurodevelopmental disorders. Science 350: 926, 2015. [doi: 10.1126/science.aab3897]. PMID: 26472761

Cortical plasticity and rewiring

Our work on the phenomena and mechanisms of cortical plasticity has overturned an innate 'labeled line' hypothesis of cortical development. By routing visual inputs to the auditory thalamus in neonatal ferrets, we showed that the auditory cortex, which normally processes hearing, can 'rewire' its circuits and process vision. Auditory cortex in rewired ferrets and mice is re-specified by vision: it develops neuronal response properties and circuits typical of visual cortex, and mediates visual behavior. In rewired mice, the visual pathway through the auditory thalamus to the amygdala mediates visual learning. The auditory thalamus in rewired mice expresses genes that enable it to attract retinal inputs, demonstrating inducible molecular mechanisms underlying plasticity of axon targeting. These studies have laid the groundwork for understanding how genes and activity together influence patterning, plasticity and function of the cerebral cortex.

Sur, M., P.E. Garraghty and A.W. Roe. Experimentally induced visual projections into auditory thalamus and cortex. Science 242: 1437-1441, 1988. PMID: 2462279

Roe, A.W., S.L. Pallas, J.O. Hahm and M. Sur. A map of visual space induced in primary auditory cortex. Science 250: 818-820, 1990. PMID: 2237432

Sharma, J., A. Angelucci and M. Sur. Induction of visual orientation modules in auditory cortex. Nature 404:841-847, 2000. PMID: 10786784

Von Melchner, L., S.L. Pallas and M. Sur. Visual behavior mediated by retinal projections directed to the auditory pathway. Nature 404:871-876, 2000. PMID: 10786793

Newton, J.R., C. Ellsworth, T. Miyakawa, S. Tonegawa and M. Sur. Acceleration of visually cued conditioned fear through the auditory pathway. Nature Neuroscience 7: 968-973, 2004. PMID: 15322551

Horng, S.H., G.Kreiman, C.Ellsworth, D.Page, M.Blank, K.Millen and M.Sur. Differential gene expression in the developing lateral geniculate nucleus and medial geniculate nucleus reveals novel roles for Zic4 and Foxp2 in visual and auditory pathway development. Journal of Neuroscience 29: 13672-13683, 2009. PMID: 19864579

Mechanisms of cortical plasticity

Our laboratory has discovered specific mechanisms by which electrical activity induces changes in visual cortex circuits during development and in adulthood, including activity-dependent changes in gene expression and microRNA regulation. Using high resolution imaging *in vivo* coupled with novel probes, we have demonstrated structural, functional and molecular changes at synapses that underlie experience-dependent plasticity. These discoveries have contributed to a detailed understanding of feedforward and feedback mechanisms that implement developmental plasticity in cortical circuits.

Hahm, J.-O., R.B. Langdon and M. Sur. Disruption of retinogeniculate afferent segregation by antagonists to NMDA receptors. Nature 351: 568-570, 1991. PMID: 1675433

Majewska, A. and M. Sur. Motility of dendritic spines in visual cortex in vivo: Changes during the critical period and effects of visual deprivation. Proceedings of the National Academy of Sciences 26: 16024-16029, 2003. PMID: 14663137

Oray S, A. Majewska and M. Sur. Dendritic spine dynamics are regulated by monocular deprivation and extracellular matrix degradation. Neuron 44: 1021-1030, 2004. PMID: 15603744

Tropea, D., G. Kreiman, A. Lyckman, S. Mukherjee, H. Yu, S. Horng and M. Sur. Gene expression changes and molecular pathways mediating activity-dependent plasticity in visual cortex. Nature Neuroscience 9: 660-668, 2006. PMID: 16633343

McCurry, C.L., J.D.Shepherd, D.Tropea, K.H.Wang, M.F.Bear and M.Sur. Loss of Arc renders the visual cortex impervious to the effects of sensory deprivation or experience. Nature Neuroscience 13: 450-457, 2010. PMID: 20228806

Mellios, N., H. Sugihara, J. Castro, A. Banerjee, C. Le, A. Kumar, B. Crawford, J. Strathmann, D. Tropea, S. S. Levine, D. Edbauer and M. Sur. miR-132, an experience-dependent microRNA, is essential for visual cortex plasticity. Nature Neuroscience 14: 1240-1242, 2011. PMID: 21892155

Cell-specific circuits in visual cortex

Our analyses of cortical circuits and dynamics combine experimental and computational approaches. Visual cortex circuits utilize feedforward connections, recurrent excitatory connections and local inhibitory connections between specific types of neurons to generate feature-selective responses and temporal codes. By combining sophisticated measurements of neuronal activity and dynamics in the intact brain with manipulations of activity, we have discovered specific and unique functions for inhibitory neuron classes in response tuning and gain control. Recently, we have demonstrated a crucial role for cholinergic inputs to inhibitory-disinhibitory circuits in shaping the temporal structure of cortical activity. These discoveries shape the understanding that specific cortical circuits mediate unique functions, and even ‘diffuse’ neurotransmitter systems act via cell-specific circuits to modulate cortical functions and brain states.

Nelson, S., L. Toth, B. Sheth, and M. Sur. Orientation selectivity of cortical neurons persists during intracellular blockade of inhibition. Science 265: 774-777, 1994. PMID: 8047882

Somers, D.C., S.B. Nelson and M. Sur. An emergent model of orientation selectivity in cat visual cortical simple cells. Journal of Neuroscience 15: 5448-5465, 1995. PMID: 7643194

Mariño J., J. Schummers, D.C. Lyon, L. Schwabe, O. Beck, P. Wiesing, K. Obermayer and M. Sur. Invariant computations in local cortical networks with balanced excitation and inhibition. Nature Neuroscience 8: 194-201, 2005. PMID: 15665876

Runyan, C.A., J. Schummers, A. Van Wart, S. Kuhlmann, N. Wilson, Z.J. Huang and M. Sur. Response features of parvalbumin-expressing interneurons suggest precise roles for subtypes of inhibition in visual cortex. Neuron 9: 847-857, 2010. PMID: 20826315

Wilson, N.R., C.A. Runyan, F.L. Wang, and M. Sur. Division and subtraction by distinct cortical inhibitory networks in vivo. Nature 488: 343-348, 2012. PMID: 22878717

El-Boustani, S. and M. Sur. Response-dependent dynamics of cell-specific inhibition in cortical networks in vivo. Nature Communications [doi: 10.1038/ncomm6689], 2014. PMID: 25504329

Chen N, H. Sugihara and M. Sur. An acetylcholine-activated microcircuit drives temporal dynamics of cortical activity. Nature Neuroscience 18: 892-902, 2015. PMID: 25915477

Bottom-up and top-down dynamics in cortical processing

A key feature of V1 networks - local and long-range connections between excitatory neurons critically balanced by inhibition - is essential for explaining their spatiotemporal response dynamics. Following orientation adaptation, specific locations in cortex ("pinwheel centers") are sites of maximal orientation plasticity while other regions ("iso-orientation domains") remain stable, due to inhibition and excitation being exquisitely co-tuned and hence easily offset at pinwheel centers. V1 responses are also shaped by top-down influences, such as attention and expectation of where a stimulus would appear next. Our laboratory has developed 2- and 3-photon technologies for large-scale imaging of the calcium activity of neurons, across multiple cortical areas and depths. Combined with region- and individual neuron-specific optogenetic manipulation, these technologies have revealed principles of information flow from sensory through parietal to frontal and anterior cingulate cortex in mice during goal-directed behavior.

Sheth, B.R., J. Sharma, S.C. Rao and M. Sur. Orientation maps of subjective contours in visual cortex. Science 274: 2110-2115, 1996. PMID: 8953048

Dragoi, V., J. Sharma and M. Sur. Adaptation-induced plasticity of orientation tuning in primary visual cortex. Neuron 28:287-298, 2000. PMID: 11087001

Dragoi, V., C. Rivadulla and M. Sur. Foci of orientation plasticity in visual cortex. Nature 411: 80-86, 2001. PMID: 11333981

Sharma, J., V. Dragoi, J. Tenenbaum, E. Miller and M. Sur. V1 neurons signal acquisition of an internal representation of stimulus location. Science 300: 1758-1763, 2003. PMID: 12805552

Yu, H., B. Farley, D. Z. Jin and M. Sur. The coordinated mapping of visual space and stimulus features in visual cortex. Neuron 47: 267-280, 2005.

Sharma, J., H. Sugihara, Y. Katz, J. Schummers, J. Tenenbaum and M. Sur. Spatial attention and temporal expectation under timed uncertainty predictably modulate neuronal responses in monkey V1. Cerebral Cortex 25: 2894-2906 (doi:10.1093/cercor/bhu086), 2015. PMID: 24836689

Goard, M.J., G.N. Pho, J. Woodson and M. Sur. Distinct roles of visual, parietal, and frontal motor cortices in memory-guided sensorimotor decisions. e-Life 5: e13764. [doi: 10.7554/eLife.13764], 2016. PMID: 27490481

Mechanisms of Rett Syndrome

We have applied our cellular and circuit-level understanding of plasticity to animal models of autism and neurodevelopmental disorders. In mouse models of Rett Syndrome, we have discovered synapse- and circuit-specific deficits in maturation and plasticity that underlie core features of the disorder. The dysfunction arises from a deficit in neuronal signaling molecules that are regulated by MECP2, the gene underlying Rett Syndrome. Many deficits are evident during the earliest stages of brain development, as

revealed in human cerebral organoids. Stemming from this work, we have suggested novel mechanism-based pharmacological treatments for Rett Syndrome.

Tropea, D., E. Giacometti, N. R. Wilson, C. Beard, C. McCurry, D. Fu, R. Flannery, R. Jaenisch, and M. Sur. Partial reversal of Rett-Syndrome like symptoms in MeCP2 mutant mice. Proceedings of the National Academy of Sciences 106: 2029-2034, 2009. PMID: 19208815

Li Y., H. Wang, J. Muffat, A.W. Cheng, D.A. Orlando, J. Lovén, S. Kwok, D.A. Feldman, H.S. Bateup, Q. Gao, D. Hockemeyer, M. Mitalipova, C.A. Lewis, M.G. Vander Heiden, M. Sur, R.A. Young, and R. Jaenisch. Global transcriptional and translational repression in human-embryonic-stem-cell-derived Rett Syndrome neurons. Cell Stem Cell 13: 446–458, 2013. PMID: 24094325

Mellios, N., J. Woodson, R. Garcia, B. Crawford, J. Sharma, S.D. Sheridan, S.J. Haggarty and M. Sur. β-2 adrenergic receptor agonist ameliorates phenotype and corrects microRNA-mediated IGF1 deficits in an animal model of Rett Syndrome. Proceedings of the National Academy of Sciences 111: 9947-9952, 2014. PMID: 24958851

Swiech, L., M. Heidenreich, A. Banerjee, N. Habib, Y. Li, J. Trombetta, M. Sur and F. Zhang. In vivo interrogation of gene function in the mammalian brain using CRISPR-Cas9. Nature Biotechnology 33: 102-106 [doi:10.1038/nbt.3055], 2015. PMID: 25326897

Banerjee, A., R.V. Rikhye, V. Breton-Provencher, X. Tang, C. Li, C.A. Runyan, Z. Fu, R. Jaenisch and M. Sur. Jointly reduced inhibition and excitation underlies circuit-wide changes in cortical processing in Rett Syndrome. Proceedings of the National Academy of Sciences 113: E7287-E7296, 2016. PMID: 27803317

Mellios, N., D.A. Feldman, S.D. Sheridan, J.P.K. Ip, S. Kwok, S.K. Amoah, B. Rosen, B.A. Rodriguez, B. Crawford, R. Swaminathan, S. Chou, Y. Li, M. Ziats, C. Ernst, R. Jaenisch, S.J. Haggarty, and M. Sur. MeCP2-regulated miRNAs control early human neurogenesis through differential effects on ERK and AKT signaling. Molecular Psychiatry [doi: 10.1038/mp.2017.86], 2017. PMID: 28439102

Astrocyte-neuron interactions in cortical processing and hemodynamic regulation

We have discovered new and critical roles for astrocytes in brain function. By high resolution imaging in the intact cortex, we have shown that astrocyte calcium responses sensitively reflect neuronal activity. Astrocyte signals are importantly mediated via glutamate transporters on processes that surround synapses, and they influence local blood flow and hence hemodynamic signals that underlie brain imaging methods such as fMRI. Astrocytes are also crucial targets of neuromodulatory inputs such as acetylcholine, and cholinergic inputs in the adult brain act via astrocytes to alter the strength of excitatory synapses. These studies have contributed importantly to the view that astrocytes are partners with neurons in mediating information processing and plasticity, as well as phenotypes of brain disorders.

Schummers, J., H. Yu and M. Sur. Tuned responses of astrocytes and their influence on hemodynamic signals in the visual cortex. Science 320: 1638-1643, 2008. PMID: 18566287

Chen, N., H. Sugihara, J. Sharma, G. Perea, J. Petravicz, C. Le, and M. Sur. Nucleus basalis enabled stimulus specific plasticity in the visual cortex is mediated by astrocytes. Proceedings of the National Academy of Sciences 109: E2832–E2841, 2012. PMID: 23012414

Perea, G., A. Yang, E. Boyden and M. Sur. Optogenetic astrocyte activation modulates response selectivity of visual cortex neurons *in vivo*. Nature Communications [doi: 10.1038/ncomms4262], 2014. PMID: 24500276