CURRICULUM VITAE

Name — Frederick J. Sigworth

Born — October 20, 1951 in Berkeley, California

Nationality — American Citizen

Marital Status — Married; three children.

Education

Stanford University (1969-1971), Electrical Engineering

California Institute of Technology (1971-1974), Applied Physics. Concentrated on semiconductor physics with Professor C.A. Mead as advisor. Received B.S. with honor, 1974.

Graduate study at the University of Washington (1974-1975) and at Yale University (1975-1979) under C.F. Stevens, working on conductance fluctuations in nerve membrane. Received Ph.D. from Yale in 1979.

Post-Doctoral Fellow of the Alexander von Humboldt Stiftung (1979-1981), and continued as a Research Associate (1981-1984) in the laboratory of E. Neher at the Max Planck Institute for Biophysical Chemistry, Göttingen, Germany.

Faculty positions at Yale University

Assistant Professor, Department of Physiology, 11/1984 to 6/1989.
Associate Professor with Tenure, Department of Cellular and Molecular Physiology, 7/1989-6/1991.
Professor, Department of Cellular and Molecular Physiology, 7/1991 to present.
Professor, Department of Biomedical Engineering, 7/2002 to present.
Professor, Molecular Biophysics and Biochemistry, 7/2015 to present.

Honors

Alexander von Humboldt Fellow, 1979-1981
Jacob Javits Neuroscience Investigator Award, 1992
Yale Science and Engineering Award, 1996
K. C. Cole Award, Biophysical Society, 1997
Bohmfalk Teaching Prize, Yale School of Medicine, 2002
Member-Elect, National Academy of Sciences, 2016

Other experience

Chairman, 1994 Gordon Conference on Ion Channels
Editorial Boards, *Neuron*, *Journal of General Physiology, European Biophysics Journal.*
Invited lecturer in the Shanghai Ion Channel Workshop, 1987; Ion Channels course at Cold Spring Harbor Laboratory, 1990-1994; Computational Neuroscience course 1994-7 and the Neurobiology Course, 1996-2005 at the Marine Biological Laboratory. Invited lecturer in the Membrane Biophysics course, Rockefeller University, 1999-2007. Member, BPNS Study Section, NIH, 2010-2013; chairman 2011-2013.

Research interests

My main interest has been in the areas of gating and ion permeation in the ionic channels of excitable cell membranes, and how the structure of channel proteins give rise to these properties. The original approach in my laboratory has been to develop techniques for sensitive electrical measurements of ion channel currents, and to apply these techniques along with biochemical and molecular biology tools to the study of the function of ion channel proteins. More recently, my laboratory has been working on structural studies of ion channels using high-resolution electron microscopy. We have been developing new techniques for cryo-EM imaging of ion channels and other membrane proteins as reconstituted into lipid bilayer membranes.

Current teaching

Medical Physiology. For the medical school physiology course I developed and have delivered since the 1990s the segment of the course (7-10 lectures) on excitable cells and cardiac electrophysiology.
BENG 410a/ ENAS 510a, Physical & Chem Basis of Biosensing. I am an instructor, contributing 4 lectures.
C&MP 560b/ MCDB 560b/ ENAS 570b/ PHAR 560b/ MCDB 415b, Molecular Machines in Human Disease. I teach about half of this course.
C&MP 620/ NBIO 610/ NSCI 610, Fundamentals in Neurophysiology. I am one of three organizers of this course.
C&MP 710b/ MB&B 710b: Electron cryo-microscopy. I am course director of this half-semester course.

Department committees

CMP Graduate Education Committee (2000-present)
CMP Core facility committee (past years)
BME and CMP faculty search committees (past years)

Thesis advisory committees

At any given time I am a member of several committees; in the past year I have been a member of the following students' committees: Enping Hong (BME), Yanbin Wang (CMP), Grace Kim (CMP), Muhamed Hadzipsic (INP/Genetics), Brandon Gassaway (CMP)

University committees

YSM electron microscopy core committee (2008-present)
Provost's advisory committee on students with disabilities 2009-2012
Several YSM committees investigating academic misconduct (past years)
Provost's advisory committee on cryo-EM facilities

Graduate students, and their degree-granting institutions or departments

Stefan Heinemann (Uni. Göttingen)
Jiuying Zhou (CMP)
Scott Shenkel (CMP)
Nathan Schoppa (CMP)
Jie Zheng (CMP)
Theodore Cummins (INP)
Lalitha Venkataramanan (EE)
Qiu-Xing Jiang (CMP)
Leon D. Islas (CMP)
Christoph Cantener (INP)
Puey Ounjai (Mahidol Univ.)
Fiona E. Müllner (Uni. Freiburg)
Andrew Barthel (BME)
Pujitha Weerakoon (BME)
Brian Goldstein (EE)
Yi Chen (CMP)

Postdoctoral fellows

Steven Sine
Hubert Affolter
Ken McCormack
Serge C. Crouzy
Richard Ayer
David Chester
Shumin Bian
Youshan Yang
Kathryn G. Klemic
Theresa Giraldez
Liguo Wang
Yunhui Liu
Hideki Shigematsu

PUBLICATIONS

Research Articles

1. Sigworth, F.J. Sodium channels in nerve apparently have two conductance states. Nature 270, 265-267 (1977).

2. Sigworth, F.J. Sodium current fluctuations in frog myelinated nerve. Thesis, Yale University (1979).

3. Sigworth, F.J. and Spalding, B.C. Chemical modification reduces the conductance of sodium channels in nerve. Nature 283, 293-295 (1980)

4. Sigworth, F.J. and Neher, E. Single Na-channel currents observed in cultured rat muscle cells. Nature 287, 447-449 (1980).

5. Sigworth, F.J. The variance of sodium current fluctuations at the node of Ranvier. J. Physiol. 307, 97-129 (1980).

6. Sigworth, F.J. The conductance of sodium channels under conditions of reduced current at the node of Ranvier. J. Physiol 307, 131-142 (1980).

7. Sigworth, F.J. Covariance of nonstationary sodium current fluctuations in the node of Ranvier. Biophys. J. 34, 111-133 (1981).

8. Sigworth, F.J. Interpreting power spectra from nonstationary membrane current fluctuations. Biophys. J. 35, 289-300 (1981).

9. Hamill, O.P., A. Marty, E. Neher, B. Sakmann and F.J. Sigworth. Improved patch-clamp techniques for high-resolution current recording from cells and cell-free membrane patches. Pfluegers Arch. 391, 85-100 (1981).

10. Sigworth, F.J. Electronic design of the patch clamp. In: Single Channel Recording, B. Sakmann and E. Neher, eds. Plenum (1983).

11. Colquhoun, D. and Sigworth, F.J. Fitting and Statistical analysis of single-channel records. In: Single Channel Recording, B. Sakmann and E. Neher, eds. Plenum (1983).

12. Sigworth, F.J. An example of analysis. In: Single Channel Recording, B. Sakmann and E. Neher, eds. Plenum (1983).

13. Sigworth, F.J. Open channel noise. I. Noise in acetylcholine receptor currents suggests conformational fluctuations. Biophys. J. 47, 709-720 (1985).

14. Sigworth, F.J. Open channel noise. II. A test for coupling between current fluctuations and conformational transitions in the acetylcholine receptor. Biophys. J. 49, 1041-1046 (1986).

15. Sigworth, F.J. and S.M. Sine. Data transformations for improved display and fitting of single-channel dwell time histograms. Biophys. J. 52: 1047-1054 (1987).

16. Sigworth, F.J., D.W. Urry and K. U. Prasad. Open channel noise. III. High-resolution recordings show rapid current fluctuations in Gramicidin A and four chemical analogues. Biophys. J. 52:1055-1064 (1987).

17. Claudio, T., W.N. Green, D.S. Hartman, D. Hayden, H.L. Paulsen, F.J. Sigworth, S.M. Sine and A. Swedlund. Genetic reconstitution of functional acetylcholine receptor channels in mouse fibroblasts. Science 238: 1688-1694 (1987).

18. Heinemann, S.H. and F.J. Sigworth. Open Channel Noise IV. Estimation of rapid kinetics of formamide block in Gramicidin A channels. Biophys. J. 54: 757-764. (1988)

19. Sigworth, F.J. and Shenkel, S. Rapid gating events and current fluctuations in Gramicidin A channels. Curr. Topics in Membranes and Transport 33: 113-130. (1988).

20. Shenkel, S., E.C. Cooper, W.S. Agnew and F.J. Sigworth. Purified, modified Na channels are active in planar bilayers in the absence of Batrachotoxin. Proc. Natl. Acad. Sci. U.S. 21, 1989.

21. Trimmer, J., S. Cooperman, S. Tomiko, J. Zhou, S. Crean, M. Boyle, R. Kallen, Z. Sheng, R. Barchi, F. Sigworth, R. Goodman, W. Agnew and G. Mandel. Primary structure and functional expression of a mammalian skeletal muscle sodium channel. Neuron 3:33-49, 1989.

22. Stankovic, C.J., S. H. Heinemann, J.M. Delfino, F.J. Sigworth and S.M. Schreiber. Transmembrane channels based on tartaric acid-gramicidin A hybrids. Science 244: 813-817, 1989

23. Heinemann, S.H. and F.J. Sigworth. Estimation of Na^+ dwell time in the gramicidin A channel. Na^+ ions as blockers of H^+ currents. Biochim. Biophys. Acta 987: 8-14, 1989.

24. Heinemann, S.H. and F.J. Sigworth. Open Channel Noise V. Fluctuating barriers to ion entry in gramicidin A channels. Biophys. J. 57: 499-514, 1990.

25. Sine, S.M., T. Claudio and F. J. Sigworth. Activation of Torpedo acetylcholine receptors expressed in mouse fibroblasts: single channel current kinetics reveal distinct agonist binding affinities. J. Gen. Physiol. 96: 395-437, 1990.

26. Crouzy, S. and F. J. Sigworth. Yet another approach to the dwell time omission problem of single channel analysis. Biophys. J. 58: 731-743, 1990.

27. Bouzat, C., F. J. Barrantes and F. J. Sigworth. Changes in channel properties of acetylcholine receptors during the time course of thiol chemical modifications. Pflügers Archiv 418: 51-61, 1991.

28. Shenkel, S. and F. J. Sigworth. Patch recordings from the electrocytes of Electrophorus Electricus. Na currents and P_{Na}/P_K variability. J. Gen. Physiol. 97:1013-1041, 1991.

29. Heinemann, S. H. and F. J. Sigworth. Open channel noise. VI. Analysis of amplitude distributions to determine rapid kinetic parameters. Biophys. J. 60: 577-587, 1991.

30. Zhou, J., J. F. Potts, J. S. Trimmer, W. S. Agnew and F. J. Sigworth. Multiple gating modes and the effect of modulating factors on the μ1 sodium channel. Neuron 7: 775-785, 1991.

31. Ukomadu, C., J. Zhou, F. J. Sigworth and W. S. Agnew. μI Na^+ channels expressed transiently in human embryonic kidney cells: biochemical and biophysical properties. Neuron 8: 663-676, 1992.

32. Schoppa, N. E., K. McCormack, M. A. Tanouye and F. J. Sigworth. The size of gating charge in wild-type and mutant *Shaker* potassium channels. Science 255: 1712-1715, 1992.

33. McCormack, K., L. Lin, L. E. Iverson, M. A. Tanouye and F. J. Sigworth. Tandem linkage of Shaker K^+ channel subunits does not ensure the stoichiometry of expressed channels. Biophys. J. 63: 1406-1411, 1992.

34. Crouzy, S. and F. J. Sigworth. Fluctuations in ion channel gating currents. Analysis of nonstationary shot noise. Biophys. J. 64: 68-76. 1993.

35. Cummins, T. R., J. Zhou, F. J. Sigworth, C. Ukomadu, M. Stephan, L. J. Ptacek and W. S. Agnew. Functional consequences of a Na^+ channel mutation causing hyperkalemic periodic paralysis. Neuron 10: 667-678, 1993.

36. McCormack, K., L. Lin and F. J. Sigworth. Substitution of a hydrophobic residue alters the conformational stability of Shaker K^+ channels during gating and assembly. Biophys. J. 65:1740-1748, 1993.

37. Cascio M., Schoppa NE., Grodzicki RL., Sigworth FJ. and Fox RO. Functional expression and purification of a homomeric human alpha 1 glycine receptor in baculovirus-infected insect cells. J. Biol. Chem. 268(29):22135-42, 1993.

38. Jiang, C., F. J. Sigworth and G. G. Haddad. Oxygen deprivation activates an ATP-inhibitable K+ channel in substantia nigra neurons. J. Neurosci. 14:5590-5602, 1994

39. Sigworth, F. J. Design of the EPC-9, a computer-controlled patch clamp amplifier. 1. Hardware. *J. Neurosci. Methods* 56:195-202, 1995.

40. Sigworth, F. J., H. Affolter and E. Neher. Design of the EPC-9, a computer-controlled patch clamp amplifier. 2. Software. *J. Neurosci. Methods* 56:203-215, 1995.

41. Cummins, T. R. and F. J. Sigworth. Impaired slow inactivation in mutant sodium channels. Biophys. J. 71: 227-236, 1996

42. Andreose, J. S., G. Fumagalli, F. J. Sigworth and M. J. Caplan. Real-time detection of the surface delivery of newly synthesized membrane proteins. Proc. Natl. Acad. Sci. U.S. 93: 7661-7666, 1996.

43. Mathur, R., J. Zheng, Y. Yan and F. J. Sigworth. Role of the S3-S4 linker in Shaker potassium channel activation. J. Gen. Physiol 109: 191-200, 1997.

44. Ayer, R. K. and F. J. Sigworth. Enhanced closed-state inactivation in a mutant Shaker K^+ channel. J. Membrane Biol. 157:215-230, 1997.

45. Yang, Y., Y. Yan and F. J. Sigworth. How does the W434F mutation block current in *Shaker* potassium channels? J. Gen. Physiol. 109: 779-789, 1997.

46. Zheng, J. and F. J. Sigworth. Selectivity changes during activation of mutant *Shaker* potassium channels. J. Gen. Physiol. 110: 101-117, 1997.

47. Schoppa, N.E. and F. J. Sigworth. Activation of Shaker potassium channels. I. Characterization of voltage-dependent transitions. J. Gen. Physiol. 111:271-294, 1998.

48. Schoppa, N.E. and F. J. Sigworth. Activation of *Shaker* potassium channels. II. Kinetics of the V2 mutant channel. J. Gen. Physiol. 111: 295-312, 1998.

49. Schoppa, N.E. and F. J. Sigworth. Activation of *Shaker* potassium channels. III. An activation gating model for wild-type and V2 mutant channels. J. Gen. Physiol. 111: 313-342, 1998.

50. Venkataramanan, L., J. L. Walsh, R. Kuc and F. J. Sigworth. Identification of hidden Markov models for ion channel currents containing colored background noise. IEEE Transactions on Signal Processing 46: 1901-1915, 1998.

51. Venkataramanan, L., R. Kuc and F. J. Sigworth. Identification of hidden Markov models for ion channel currents containing state-dependent noise. IEEE Transactions on Signal Processing 46:1916-1929, 1998.

52. Zheng, J. and F. J. Sigworth. Intermediate conductances during deactivation of heteromultimeric *Shaker* potassium channels. J. Gen. Physiol. 112:457-474, 1998

53. Sigworth, F. J. A maximum-likelihood approach to single-particle image refinement. J. Struct. Biol. 122: 328-339, 1998.

54. Yang, Y. and F. J. Sigworth. Single-Channel Properties of I_{Ks} Potassium Channels. J. Gen. Physiol. 112: 665-678, 1998.

55. Baumgartner, W. and F. J. Sigworth. Two-Microelectrode Voltage Clamp of Xenopus Oocytes: Voltage Errors and Compensation for Local Current Flow. *Biophys J* 77:1980-1991, 1999.

56. Islas, L. D. and F. J. Sigworth. Voltage sensitivity and gating charge in *Shaker* and *Shab* family potassium channels. *J Gen Physiol* 114:723-742, 1999.

57. Venkataramanan, L., R. Kuc and F. J. Sigworth. Identification of hidden Markov models for ion channel currents, part III. Band-limited, sampled data. *IEEE Transactions on Signal Processing* 48:376-385, 2000.

58. Islas, L. D. and F. J. Sigworth. Electrostatics and the gating pore of Shaker potassium channels. J. Gen. Physiol. 117:69-89, 2001.

59. Cascio M, Shenkel S, Grodzicki RL, Sigworth FJ, Fox RO. Functional reconstitution and characterization of recombinant human alpha 1-glycine receptors. J Biol Chem. 276:20981-8, 2001.

60. Jiang, Q-X., D. W. Chester and F. J. Sigworth. Spherical reconstruction. A method for structure determination of membrane proteins from cryo-EM images. J. Struct. Biol. 133:119-131. 2001.

61. Zheng, J., L. Venkataramanan and F. J. Sigworth. Hidden Markov Model Analysis of Intermediate Gating Steps Associated with the Pore Gate of *Shaker* Potassium Channels. J. Gen Physiol. 118:547-562, 2001.

62. Klemic, K.G., Klemic, J.F., Reed, M.A. and Sigworth, F.J. Micromolded PDMS planar electrode allows patch clamp electrical recordings from cells. *Biosensors and Bioelectronics* 17:597-604, 2002.

63. Venkataramanan, L. and F. J. Sigworth. Applying hidden Markov models to the analysis of single ion channel activity. Biophys. J. 82: 1930-1942, 2002.

64. Jiang, Q.-X., E. C. Thrower, D. W. Chester, B. E. Ehrlich and F. J. Sigworth.Three-dimensional structure of the type 1 inositol 1,4,5-trisphosphate receptor at 24 A resolution. EMBO J. 21:3575-3581, 2002.

65. Bhattacharjee A, Joiner WJ, Wu M, Yang Y, Sigworth FJ, L. K. Kaczmarek Slick (Slo2.1), a rapidly-gating sodium-activated potassium channel inhibited by ATP. J Neurosci. 17:11681-91, 2003.

66. Sigworth, F. J. Classical detection theory and the cryo-EM particle selection problem. J. Struct. Biol. 145:111-122, 2004.

67. Yang, Y., Yan, Y. and Sigworth, F. J. Can Shaker potassium channels be locked in the deactivated state? J. Gen. Physiol. 124:163-171, 2004.

68. Klemic, K. G., Klemic, J. F. and Sigworth, F. J. An air-molding technique for fabricating PDMS planar patch-clamp electrodes. Pflugers Arch. 449:564-572, 2005.

69. Sigworth, F. J. and Klemic, K. G. Microchip technology in ion-channel research. IEEE Trans Nanobioscience.4:121-127, 2005.

70. Giraldez, T., Hughes, T.E. and Sigworth, F. J. Generation of functional fluorescent BK channels by random insertion of GFP variants. J. Gen. Physiol. 126:429-438, 2005.

71. Zhang, P., Sigworth F. J. and Canessa, C.M. Gating of acid-sensitive ion channel-1: release of Ca2+ block vs. allosteric mechanism. J Gen Physiol. 127:109-117, 2006.

72. Li, X., Klemic, K. G., Reed, M. A. and Sigworth, F. J. Microfluidic system for planar patch clamp electrode arrays. Nano Lett. 6:815-819, 2006.

73. Yang B, Gribkoff VK, Pan J, Damagnez V, Dworetzky SI, Boissard CG, Bhattacharjee A, Yan Y, Sigworth FJ, Kaczmarek LK. Pharmacological activation and inhibition of Slack (Slo2.2) channels. Neuropharmacology. 51:896-906, 2006.

74. Wang, L., P. Bose and F. J. Sigworth. Using cryo-EM to measure the dipole potential of a lipid membrane. PNAS 103:18528-18533, 2006.

75. Chester DW, Klemic JF, Stern E, Sigworth FJ, Klemic KG. Holey carbon micro-arrays for transmission electron microscopy: A microcontact printing approach. Ultramicroscopy.107(8):685-91, 2007.

76. Stern E, Wagner R, Sigworth FJ, Breaker R, Fahmy TM, Reed MA. Importance of the Debye screening length on nanowire field effect transistor sensors. Nano Lett. 7:3405-3409, 2007.

77. Ounjai P, Unger VM, Sigworth FJ, Angsuthanasombat C. Two conformational states of the membrane-associated Bacillus thuringiensis Cry4Ba delta-endotoxin complex revealed by electron crystallography: implications for toxin-pore formation. Biochem Biophys Res Commun. 361:890-895, 2007.

78. Wang, L., Ounjai, P. and Sigworth, F.J. Streptavidin crystals as nanostructured supports and image-calibration references for cryo-EM data collection. *J. Struct. Biol.* 164:190-198, 2008.

79. Coifman RR, Shkolnisky Y, Sigworth FJ, Singer A. Graph Laplacian tomography from unknown random projections. IEEE Trans Image Process. 17:1891-1899, 2008

80. Weerakoon, P.; Sigworth, F.; Culurciello, E.. Integrated patch-clamp biosensor for high-density screening of cell conductance. Electronics Letters, 44:81-82, 2008.

81. Wang, L and Sigworth FJ. Structure of the BK potassium channel in a lipid membrane from electron cryomicroscopy. Nature 461:292-295, 2009. PMC2797367

82. Singer A, Coifman RR, Sigworth FJ, Chester DW, Shkolnisky Y. Detecting consistent common lines in cryo-EM by voting. J Struct Biol. 169:312-322, 2009. PMID: 19925867 PMC2826584

83. Chen H, Kronengold J, Yan Y, Gazula VR, Brown MR, Ma L, Ferreira G, Yang Y, Bhattacharjee A, Sigworth FJ, Salkoff L, Kaczmarek LK. The N-terminal domain of Slack determines the formation and trafficking of Slick/Slack heteromeric sodium-activated potassium channels. J Neurosci. 29:5654-65, 2009. PubMed PMID: 19403831. PMC3688047

84. Coifman RR, Shkolnisky Y, Sigworth FJ, Singer A. Reference Free Structure Determination through Eigenvectors of Center of Mass Operators. Appl Comput Harmon Anal. 28:296-312, 2010. PubMed PMID: 20436952; PubMed Central PMCID: PMC2860334.

85: Barmeyer C, Rahner C, Yang Y, Sigworth FJ, Binder HJ, Rajendran VM. Cloning and identification of tissue specific expression of KCNN4 splice variants in rat colon. Am J Physiol Cell Physiol. 2010 May 5. [Epub ahead of print] PMID: 20445171 PMC2928625

86. Xu J, Sigworth FJ, LaVan DA. Synthetic protocells to mimic and test cell function. Adv Mater. 2010 22:120-127. PubMed PMID: 20217710; PubMed Central PMCID: PMC2845179.

87. Brown MR, Kronengold J, Gazula VR, Chen Y, Strumbos JG, Sigworth FJ, Navaratnam D, Kaczmarek LK. Fragile X mental retardation protein controls gating of the sodium-activated potassium channel Slack. Nat Neurosci. 13:819-21, 2010. PubMed PMID: 20512134; PMC2893252.

88: Tagare HD, Barthel A, Sigworth FJ. An adaptive Expectation-Maximization algorithm with GPU implementation for electron cryomicroscopy. J Struct Biol. 171:256-265, 2010. PubMed PMID: 20538058. PMC2967204

89: Weerakoon P, Culurciello E, Yang Y, Santos-Sacchi J, Kindlmann PJ, Sigworth FJ. Patch-clamp amplifiers on a chip. J Neurosci Methods 293:187-192, 2010. PubMed PMID: 20637803 PMC2978236

90. Müllner FE, Syed S, Selvin PR, Sigworth FJ. Improved hidden Markov models for molecular motors, part 1: basic theory. Biophys J. 99:3684-3695, 2010. PMC2998602

91. Syed S, Müllner FE, Selvin PR, Sigworth FJ. Improved hidden Markov models for molecular motors, part 2: extensions and application to experimental data. Biophys J. 99:3696-3703, 2010. PMC2998599

92. Ye M, Hong J, Zhou M, Huang L, Shao X, Yang Y, Sigworth FJ, Chi C, Lin D, Wang C. A novel conotoxin, qc16a, with a unique cysteine framework and folding. Peptides 32:1159-1165, 2011. PMC3547678

93. Bian S, Bai JP, Chapin H, Le Moellic C, Dong H, Caplan M, Sigworth FJ, Navaratnam DS. Interactions between β-catenin and the HSlo potassium channel regulates HSlo surface expression. PLoS One 6:e28264, 2011. PMID: 22194818; PMC3237428

94. Barthel AC Tagare H Sigworth FJ. Surface-constrained 3D reconstruction in cryo-EM. Proceedings of the 2011 IEEE Asilomar Conference on Image Processing, 1026-1030, 2011.

95. Kucukelbir A, Sigworth FJ, Tagare HD. A Bayesian adaptive basis algorithm for single particle reconstruction. J Struct Biol. 179:56-67, 2012. PMID: 22564910 PMC3377842

96. Shang Z, Sigworth FJ. Hydration-layer models for cryo-EM image simulation. J. Struct. Biol. 180:10-16, 2012. PMC3577369

97. Yan Y, Yang Y, Bian S, Sigworth FJ. Expression, Purification and Functional Reconstitution of Slack Sodium-Activated Potassium Channels. J Membr Biol. 245:667-674, 2012. PMC3577369

98. Miranda P, Contreras JE, Plested AJR, Sigworth FJ, Holmgren, M, and Giraldez T. State-dependent FRET reports calcium- and voltage-dependent gating-ring motions in BK channels. PNAS 110:5217-5222, 2013. PMC3612663

99. Kim D, Goldstein B, Wei Tang, Sigworth FJ, Culurciello E. Noise analysis and performance comparison of low current measurement systems for biomedical applications. IEEE Trans Biomed Circuits Syst. 7:52-62, 2013.

100. Shigematsu H and Sigworth FJ. Noise models and cryo-EM drift correction with a direct-electron camera. Ultramicroscopy 131C:61-69, 2013.

101. Kucukelbir, A, Sigworth FJ, Tagare HD. Quantifying the local resolution of cryo-EM density maps. Nature Methods 11:63-65, 2014.

102. Liu Y, Sigworth FJ. Automatic cryo-EM particle selection for membrane proteins in spherical liposomes. J. Struct. Biol. 185:295-302, 2014.

103. Dvornek NC, Sigworth FJ, Tagare HD. SubspaceEM: A fast maximum-a-posteriori algorithm for cryo-EM single particle reconstruction. J Struct Biol. 190:200-214, 2015.

104. Tagare HD, Kucukelbir A, Sigworth FJ, Wang H, Rao M. Directly reconstructing principal components of heterogeneous particles from cryo-EM images. J Struct Biol. pii: S1047-8477(15)30004-6. doi: 10.1016/j.jsb.2015.05.007. [Epub ahead of print] 2015.

105. Jensen KH, Brandt SS, Shigematsu H, Sigworth FJ. Statistical modeling and removal of lipid membrane projections for cryo-EM structure determination of reconstituted membrane proteins. J. Struct. Biol. 194:49-60, 2016.

Review Articles

R1. Sigworth, F.J. Sodium current fluctuations in myelinated axons. Chapter 4 in: Abnormal Nerves and Muscles as Impulse Generators, J. Ochoa and W. Culp, eds. Oxford University Press (1981).

R2. Sigworth, F.J. Nonstationary noise analysis of membrane currents. In: Membranes, Channels and Noise, R.S. Eisenberg, M. Frank and C.F. Stevens, eds. Plenum Press, 1984.

R3. Sigworth, F.J. The patch clamp is more useful than anyone had expected. Federation Proc. 45:2673-2677 (1986).

R4. Sigworth, F.J. Rapid fluctuations in ionic current through membrane channels. Proceedings of the 9th International Symposium on Noise in Physical Systems. C. M. Van Vliet, Ed. (1987).

R5. Claudio, T., H. L. Paulson, D. Hartman, S. Sine and F. J. Sigworth. Establishing a stable expression system for studies of acetylcholine receptors. Current Topics in Membranes and Transport 33: 219-247 (1988).

R6. Sigworth, F.J. and Zhou, J. Analysis of nonstationary single-channel currents. Methods in Enzymology 207: 746-762 (1992).

R7. Heinemann, S. H. and F.J. Sigworth. Fluctuations of ionic currents and ion channel proteins. In: Thermodynamics of Cell Surface Receptors, M. B. Jackson, ed., CRC Press (1993).

R8. Sigworth, F. J. Voltage gating of ion channels. Q. Rev. Biophys. 27:1-40, 1994.

R9. Sigworth, F. J. Charge movement in the sodium channel. J. Gen. Physiol. 106:1047-1051, 1995.

R10. Schoppa, N. E., Y. Yang and F. J. Sigworth. How is voltage coupled to channel opening in Shaker K^+ channels? Progress in Cell Research 6: 99-109, 1997.

R11. Sigworth, F. J. Potassium Channel Mechanics. Neuron 32: 555-556, 2001.

R12. Sigworth F. J. and Klemic, K. G. Patch clamp on a chip. Biophys. J. 82:2831-2832,2002.

R13. Sigworth, F. J. Life's transistors. Nature 423:21-22, 2003.

R14. Wang, L. and Sigworth, F. J. Cryo-EM and single particles. Physiology (Bethesda) 21:13-18, 2006.

R15. Sigworth, F. J. From cryo-EM, multiple protein structures in one shot. Nature Methods 4:20-21, 2007.

R16. Sigworth FJ. The last few frames of the voltage-gating movie. Biophys J. 93:2981-2983, 2007.

R17. Carragher B, Potter CS, Sigworth FJ. Software tools for macromolecular microscopy. J Struct Biol. 2007 Jan;157:1-2.

R18. Wang L, Sigworth FJ. Liposomes on a streptavidin crystal: a system to study membrane proteins by cryo-EM. Methods Enzymol. 481:147-164, 2010.

R19. Sigworth FJ, Doerschuk PC, Carazo JM, Scheres SH. An introduction to maximum-likelihood methods in cryo-EM. Methods Enzymol. 482:263-294, 2010. PMC3051286

R20. Singh SJ, Sigworth FJ. Cryo-EM: spinning the micelles away. Structure 23:1561, 2015. PMC4901521

R21. Sigworth FJ. Principles of cryo-EM single-particle image processing. Microscopy 65:57-67, 2016.

Books

Sokabe, M., A. Auerbach and F. J. Sigworth, eds. *Towards Molecular Biophysics of Ion Channels. Progress in Cell Research* **6.** Elsevier. 1997.

Patents

Sigworth, F.J. Impedance Plethysmograph. U.S. Patent no. 3,882,851 (1975).

Morris, H.D. and Sigworth, F.J. Angular position sensing and control system, apparatus and method. U.S. Patent no. 3,889,028 (1975).

Sigworth, F.J. Low noise electronic circuit, transducer using the same, and method. U.S. Patent no. 3,967,064 (1976).

Klemic, K.G., J. F. Klemic, M. A. Reed and F. J. Sigworth. Planar patch clamp electrodes. U. S. Patent no. 6,699,697 (2004).