David Don Busath

January 8, 2019

Position: Professor

Date of Birth: August 5, 1952

Place of Birth: Salt Lake City, Utah

Address: Department of Physiology and
and Developmental Biology
and Center for Neuroscience
Brigham Young University
Provo, UT 84602
Office: (801) 422-8753
Fax: (801) 422-0700
e-mail: david_busath@byu.edu

Home Address: 706 W. Sunny Lane
Orem, Utah 84058

Academic Record:

University of Utah, Salt Lake City, UT	B.A. Physics & Honors (Cum laude)	1974
University of Utah, Salt Lake City, UT	M.D.	1978

Academic Positions:

2011-2013	Adjunct Professor Research, Touro University Nevada
2004 - present	Professor, Department of Physiology and Developmental Biology, Brigham Young University, Provo, Utah
1999 - present	Professor, Center for Neuroscience, Brigham Young University, Provo, UT
1996 - 2004	Professor, Zoology Department, Brigham Young University, Provo, UT
1995 - 1996	Associate Professor, Zoology Department, Brigham Young University, Provo, UT
1989 - 1995	Associate Professor with Tenure, Department of Physiology, Brown University, Providence, RI
1983-1989	Assistant Professor, Section of Physiology and Biophysics Brown University, Providence, RI
1980-1983	Research Associate, Department of Physiology and Biophysics University of Texas Medical Branch, Galveston, TX
1978-1980	Postdoctoral Fellow, Department of Physiology University of Rochester Medical School, Rochester, NY

Honors and Awards:

Markey Fellow, Mount Dessert Island Biological Laboratory, 1985
NIH Research Career Development Award, 1986-1991
Alcuin Fellowship for General Education Teaching (BYU), 2001-2003
Excellence in Research Award, College of Biology and Agriculture (BYU), 2002
Thomas B. Martin Professorship, College of Biology and Agric. (BYU), 2003-2006
Distinguished Faculty Award, Dept. of PDBio (BYU), 2010
Outstanding Research Award, College of Life Sciences (BYU), 2014

Editorial Positions:

Editor in Chief, Molecular Modeling and Computational Chemistry Review. 1997 – 2007
Associate Editor, Biochimica et Biophysica Acta, 1999-2004
Editorial Board, The Open Journal of Structural Biology, Bentham Press, 10/2007-2012
Editorial Board Member, Journal of Membrane Biology 2008-2015

Articles in journals (yellow: undergrads; cyan: graduate students):

1. Busath, D.D. and R.O. Stenerson. 1971. 2-particle, 3-particle and 4-particle spatial correlations among tertiary cosmic ray muons. Nuclear Physics B. 35:141-159.
2. Eichwald, E.J., G. Pay, D. Busath, and C. Smith. 1976. Ischemic versus cytotoxic damage in white graft rejection - its relationship to hyperacute kidney rejection. Transplantation 22:86-93.
3. Begenisich, T. and D. Busath. 1981. Sodium flux ratio in voltage-clamped squid giant axons. Journal of General Physiology 77:489-502.
4. Busath, D. and G. Szabo. 1981. Gramicidin forms multi-state rectifying channels. Nature 294:371-373.
5. Prasad, K.U., T.L. Trapane, D. Busath, G. Szabo and D.W. Urry. 1982. Synthesis and characterization of 1-13 C-D-Leu 12, 14 Gramicidin A. International Journal of Peptide and Protein Research 19:162-171.
6. Busath, D. and T. Begenisich. 1982. Unidirectional sodium and potassium fluxes through the sodium channel of squid giant axons. Biophysical Journal 40:41-50.
7. Prasad, K.U., T.L. Trapane, D. Busath, G. Szabo and D.W. Urry. 1982. Solid phase (Fmoc) synthesis and characterization of [1-13C Phe11]-Gramicidin B. J. Protein Chem. 1:191-202.
8. Prasad, K.U., T.L. Trapane, D. Busath, G. Szabo and D.W. Urry. 1983. Synthesis and characterization of (1-13C) Phe9 Gramicidin A:effects of side chain variations. International Journal of Peptide and Protein Research 22:341-347.
9. Busath, D.D. and R.C. Waldbillig. 1983. Photolysis of gramicidin A channels in lipid bilayers. Biochimica et Biophysica Act. 736:28-38.

10. Busath, D. and G. Szabo. 1984. Atypical gramicidin A channels have increased field strength at one binding site. Biophysical Journal 45:75-76.

11. Chabala, L.D., R.S. Morello, D. Busath, M. Danko, C.J. Smith, and T. Begenisich. 1986. Capture, transport, and maintenance of live squid (Loligo pealei) for electrophysiological studies. Pfluger Arch. 407:105-108.

12. Jones, D., Hayon, E. and D. Busath. 1986. Tryptophan photolysis is responsible for gramicidin-channel inactivation by ultraviolet light. Biochimica et Biophysica Act. 861:62-66.

13. Busath, D.D., O.S. Andersen, and R.E. Koeppe II. 1987. On the conductance heterogeneity in membrane channels formed by gramicidin A. A cooperative study. Biophysical Journal 51:79-88.

14. Busath, D. and G. Szabo. 1988. Low conductance gramicidin A channels are head-to-head dimers of β6.3-Helices. Biophysical Journal 53:689-695.

15. Busath, D. and G. Szabo. 1988. Permeation characteristics of gramicidin conformers. Biophysical Journal 53:697-707.

16. Busath, D.D. and E. Hayon. 1988. Ultraviolet flash photolysis of gramicidin-doped lipid bilayers. Biochim. Biophy. Acta 944:73-78.

17. Roeske, R.W., Hrinyo-Pavlin, T.P. Pottorf, R.S., Bridal, T., Jin, X., and D. Busath. 1989. Synthesis and channel properties of Tau-16 gramicidin A. Biochimica et Biophysica Acta 982:223-227.

18. Hemsley, G. and D. Busath. 1991. Small iminium ions block gramicidin channels in lipid bilayers. Biophysical Journal 59:901-908.

19. Turano, B., Pear, M., and D. Busath. 1992. Gramicidin channel selectivity: molecular mechanics calculations for formamidinium, guanidinium, and acetamidinium. Biophysical Journal 63:152-161.

20. Bridal, T. and D. Busath. 1992. Inhibition of gramicidin channel activity by local anesthetics. Biochimica et Biophysica Acta. Biochim. Biophys. Acta 1107:31-38.

21. Bogusz, S., Boxer, A., and D.D. Busath. 1992. An SS1-SS2 β-barrel structure for the voltage-activated potassium channel. Protein Engineering 5:285-293.

22. Bogusz, S. and D.D. Busath. 1992. Is a β-barrel comprised of SS1 and SS2 from the voltage-gated potassium channel energetically feasible? Biophysical Journal 62:19-21.

23. Seoh, S. -A. and D. Busath. 1993. The permeation properties of small organic cations in gramicidin A channels. Biophysical Journal 64:1017-1028.

24. Seoh, S.-A. and D.D. Busath. 1993. Formamidinium-induced dimer stablization and flicker block behavior in homo- and heterodimer channels formed by gramicidin A and N-acetyl gramicidin A. Biophysical Journal 65:1817-1827.

25. Seoh, S. and D. D. Busath. 1995. Gramicidin tryptophans mediate formamidinium-induced channel stabilization. Biophysical Journal 68:2271-2279.

26. Hao, Y., Pear, M.R. and D.D. Busath. 1997. Molecular dynamics study of free energy profiles for organic cations in gramicidin A channels. Biophysical Journal 73: 1699-1716.

27. Busath, D.D., Thulin, C.D., Hendershot, R.W., Phillips, L.R., Maughan, P., Cole, C.D., Bingham, N.C., Morrison, S., Baird, L.C., Hendershot, R.J., Cotten, M., and Cross, T.A. 1998. Noncontact dipole effects on channel permeation. I. Experiments with (5F-Indole)Trp13 gramicidin A channels. Biophysical Journal 75:2830-2844.

28. Dorigo, A.E., Anderson, D.G., and Busath, D.D. 1999. Noncontact dipole effects on channel permeation. II. Trp conformations and dipole potentials in gramicidin A. Biophysical Journal 76: 1897-1908.

29. Andersen, O.S., H.J. Appell, E.Bamberg, D.D. Busath, R.E. Koeppe II, F.J. Sigworth, G. Szabo, D.W. Urry, and A. Woolley. 1999. Gramicidin channel controversy -- The structure in a lipid environment. Nature Structural Biology 6:609-611.

30. Cotten, M., C. Tian, D.D. Busath, R.B. Shirts, and T.A. Cross. 1999. Modulating Dipoles for Structure-Function Correlations in the Gramicidin A Channel. Biochemistry 38:9185-9197.

31. Fairbanks, T.G., C.L. Andrus, and D.D. Busath. 1999. Lorentzian noise in single gramicidin A channel formarmidinium currents. In. Gramicidin and Related Ion Channel-Forming Peptides. Novartis Foundation Symposium 225. John Wiley & Sons, Ltd. Chichester, UK. pp 74-92.

32. Phillips, L.R., C.D. Cole, R.J. Hendershot, M. Cotton, T.A. Cross, and D.D. Busath. 1999. Noncontact dipole effects on channel permeation. III. Anomalous proton conductance effects in gramicidin. Biophysical Journal 77:2492-2501.

33. Hollerbach, U., D.P. Chen, D.D. Busath, and B. Eisenberg. 2000. Predicting function from structure using the Poisson-Nernst-Planck equations: sodium current in the gramicidin A channel. Langmuir 16:5509-5514.

34. Boda, D., D.D. Busath, D. Henderson, and S. Sokolowski.2000. Monte Carlo simulations of the mechanism for channel selectivity: The competition between volume exclusion and charge neutrality. J. Phys. Chem. B. 104:8903-8910.

35. Thompson, N., G. Thompson, C.D. Cole, M. Cotton, T.A. Cross, and D.D. Busath. 2001. Non-contact dipole effects on channel permeation. IV. Kinetic model of 5F-Trp13 gramicidin A currents. Biophys. J. 81: 1245-1254.

36. Anderson, D.G., R.B. Shirts, T.A. Cross, and D.D. Busath. 2001. Non-contact dipole effects on channel permeation. V. Computed potentials for fluorinated gramicidin. Biophys. J. 81: 1255-1264.

37. Crozier, P.S., R.L. Rowley, N.B. Holladay, D. Henderson, and D.D. Busath. 2001. Molecular dynamics simulation of continuous current flow through a model biological membrane channel. Physics Review Letters 86:2467-2470.

38. Crozier, P.S., D. Henderson, R.L. Rowley, and D.D. Busath. 2001. Model channel ion currents in NaCl-Extended Simple Point Charge Water solution with applied-field molecular dynamics. Biophysical Journal 81:3077-3089.

39. Boda, D., D. Henderson, and D.D. Busath. 2001. Monte Carlo study of the effect of ion and channel size on the selectivity of a model calcium channel. J. Physical Chemistry B 105:11574-11577.

40. Henderson, D., D.D. Busath, and R. Rowley. 2001. Fluids near surfaces and in pores and membrane channels. Progress in Surface Science 68:279-295.

41. Markham, J.C., J.A. Gowen, T.A. Cross, and D.D. Busath. 2001. Comparison of gramicidin A and gramicidin M channel conductance dispersion properties. Biochimica et Biophysical Acta 1513:185-192.

42. Boda, D., D. Henderson, and D.D. Busath. 2001. Monte Carlo study of the effect of ion and channel size on the selectivity of a model calcium channel. J. Physical Chemistry B 105:11574-11577.

43. Cole, C. D., A. S. Frost, N. Thompson, M. Cotten, T. A. Cross, and D. D. Busath. 2002. Non-contact dipole effects on channel permeation. VI. 5F- and 6F-Trp gramicidin channel currents. Biophys J. 83:1974-1986.

44. Ramakrishnan, V. and D. D. Busath. 2002. An inverting basket model for Band 3 obligate exchange. Journal of Theoretical Biology 215:215-226.

45. Gowen, J.A. J.C. Markham, S.E. Morrison, D.D. Busath, T.A. Cross, E.J. Mapes, and M.F. Schumaker. 2002. The role of Trp side chains in tuning single proton conduction through gramicidin channels. Biophysical Journal 83:880-898.

46. Yang, Y., D. Henderson, P. Crozier, R.L. Rowley, and D.D. Busath. 2002. Permeation of ions through a model biological channel: Effect of periodic boundary conditions and cell size. Molecular Physics. 100:3011-3019.

47. Boda, D., D. Henderson, and D.D. Busath. 2002. Monte Carlo study of the selectivity of calcium channels: Improved geometrical model. Molecular Physics. 100:2361-2368.

48. Boda, D., D.D. Busath, B. Eisenberg, D. Henderson, and W. Nonner. 2002. Monte Carlo simulations of selectivity in neuronal Na channels: Charge space competition. Phys. Chem. Chem. Phys. 4, 5154-5160.

49. Fu, F.-N. D.D. Busath, and B.R. Singh. 2002. Spectroscopic analysis of low pH and lipid induced structural changes in type A botulinum neurotoxin relevant to membrane channel formation and translocation. Biophys Chem. 99:17.

50. Duffin, R.L., Garrett, M.P., Flake, K.B., Durrant, J.D., and D. D. Busath. 2003. Modulation of lipid bilayer interfacial dipole potential by phloretin, RH421, and 6-ketocholestanol as probed by gramicidin channel conductance. Langmuir 19:1439-1442.

51. Yang, Y., D. Henderson, and D.D. Busath. 2003. Applied-field molecular dynamics study of a model calcium channel selectivity filter. J. Chem. Phys. 118: 4213-4220.

52. Bingham, N.C., N.E.C. Smith, T.A. Cross, and D.D. Busath. 2003. Molecular dynamics simulations of Trp side-chain conformational flexibility in the gramicidin A channel. Biopolymers 71: 593-600.

53. Yang, Y., D. Henderson, and D.D. Busath. 2004. Calcium block of sodium current in a model calcium channel: Cylindrical atomistic pore with glutamate side chains. Molecular Simulation 30:77-80.

54. Yang, Y., M. Berrondo, D. Henderson, and D. Busath. 2004. The importance of water molecules in ion channel simulations. J. Phys.: Condens. Matter 16: S2145-S2148.

55. Hughes T., B. Strongin, F.P. Gao, V. Vijayvergiya, D.D. Busath, and R.C. Davis. 2004. AFM visualization of mobile influenza A M2 molecules in planar bilayers. Biophysical Journal 87: 311-22.

56. Ramakrishnan, V., D. Henderson, and Busath, D.D. 2004. Applied field nonequilibrium molecular dynamics simulations of ion exit from a beta-barrel model of the L-type calcium channel. Biochim Biophys Acta 1664: 1-8.

57. Vijayvergiya V., R. Wilson, A. Chorak, P.F. Gao, T.A. Cross, and D.D. Busath. 2004. Proton conductance of influenza virus M2 protein in planar lipid bilayers. Biophysical Journal 87: 1697-1704.

58. Hu, J., R. Fu, K. Nishimura, L. Zhang, H.-X. Zhou, D. D. Busath, V. Vijayvergiya and T.A. Cross. 2006. Histidines: Heart of the H+ channel from influenza A virus. Proceedings of the National Academy of Sciences 103:6865-6870.

59. Durrant, J.D., D. Caywood, D.D. Busath. 2006. Tryptophan contributions to the empirical free-energy profile in gramicidin A/M heterodimer channels. Biophysical Journal 91: 3230-3241.

60. Moffatt, C., V. Vijayvergiya, P.F. Gao, T.A. Cross, D.J. Woodbury, and D.D. Busath. 2008. Proton transport through influenza A virus M2 protein reconstituted in vesicles. Biophysical Journal 94:434-445.

61. Miller, C.E., D.D. Busath, B. Strongin, and J. Majewski. 2008. Integration of Ganglioside GT_{1b} Receptor into DPPE and DPPC Phospholipid Monolayers: An X-ray Reflectivity and Grazing Incidence Diffraction Study. Biophysical Journal 95:3278-3286.

62. Mustafa, M. and D.D. Busath. 2009. The gramicidin channel ion permeation free-energy profile: direct and indirect effects of CHARMM force field improvements. Interdisciplinary Science: Computational Life Sciences 1:113-127.

63. Mustafa M., D.J. Henderson, and D.D. Busath. 2009. Free-energy profiles for ions in the influenza M_2-TMD channel. Proteins 76:794-807.

64. Mustafa M., D.J. Henderson, and D.D. Busath. 2009. Computational studies of gramicidin permeation: An entryway sulfonate enhances cation occupancy at entry sites. Biochim. Biophys. Acta. 1788:1404-1412.

65. Spohr, E., E. Sovyak, A. Trokhymchuk, and D.D. Busath. 2009. Electrostatic control of occupancy and valence selectivity in a charged nanometer-sized cylindrical pore. Materialwissenschaft und Werkstofftechnik 40: 247-254.

66. Jones, T.L., R. Fu, F. Nielson, T.A. Cross, and D.D. Busath. 2010. Gramicidin channels are internally gated. Biophys. J. 98:1486-1493.

67. Sharma, M., M. Yi, D. Hao, H. Qin, E. Peterson, D. D. Busath, H.-X. Zhou, and T. A. Cross. 2010. Insights into the mechanism of the influenza A proton channel from a structure in a lipid bilayer. Science 330:509-512.

68. Peterson, E., T. Ryser, S. Funk, D. Inouye, M. Sharma, H. Qin, T. A. Cross, and D. D. Busath, Functional reconstitution of influenza A M2(22-62). 2011. Biochim. et Biophys. Acta, Biomembranes 1808:516-521 (Published electronically 2010).

69. Sharma M, C. Li, D. D. Busath, H.-X. Zhou, and T. A. Cross. 2011. Drug sensitivity, drug-resistant mutations, and structures of three conductance domains of viral porins. Biochim. et Biophys. Acta., Biomembranes 1808:538-546.

70. Mellor, B., E. Cruz Cortés, D. D. Busath, and B. Mazzeo. 2011. Method for estimating the internal permittivity of proteins using dielectric spectroscopy. J. Phys. Chem. B. 115:2205-2213.

71. Mellor, B. L., S. Khadka, D. D. Busath, and B. Mazzeo. 2011. Influence of pKa shifts on the calculated dipole moments of proteins. Protein Journal 30:490-498.

72. Nelson, S. C., S. K. Neeley, E. D. Melonakos, J. D. Bell, and D. D. Busath. 2012 Fluorescence anisotropy of diphenylhexatriene and its cationic trimethylamino derivative in liquid dipalmitoylphosphatidylcholine liposomes: Opposing responses to isoflurane. BMC Biophysics 5:5.

73. Cross, T. A., H. Dong, M. Sharma, D. D. Busath, H.-X. Zhou. 2012. M2 Protein from Influenza A: From multiple structures to biophysical and functional insights. Current Opinions Virology 2:128-133.

74. Mazzeo, B. A. and D. D. Busath. 2013. From molecular dynamics to fluorescence anisotropy of fluorophores bound to oriented structures. J. Comp. Phys. 232:482-497.

75. Shin, S. I., Andersen, D. J., Hansen, D. M., Yorgason, J. T., Schilaty, N. D., Busath, D. D., and S. C. Steffensen. 2013. Connexin-36 knock-out mice have increased threshold for kindled seizures: Role of GABA inhibition. Biochem & Pharmacol S1: 006. doi:10.4172/2167-0501.S1-006.

76. Kolocouris, A., Tzitzoglaki, C., Johnson, B., Zell, R., Wright, A., Cross, T.A., Tietjen, I., Fedida, D. & D. Busath. 2014. Adamantanes with persistent in vitro efficacy against H1N1 (2009) Influenza A. J. Med. Chem. 57:4629-4639.

77. Gleed, M. and D. D. Busath. 2015. Why bound amantadine fails to inhibit proton conductance according to simulations of the drug-resistant influenza A M2 (S31N). J. Phys. Chem. B 119 (3):1225-31.

78. Durrant, M.G., Eggett, D.L., and D.D. Busath. 2015. Investigation of a recent rise of dual amantadine-resistance mutations in the Influenza A M2 Sequence. BMC Genetics 16 (Suppl. 2): S3.

79. Gleed, M. L., Ioannidis, H., Kolocouris, A., and D.D. Busath. 2015. Resistance-mutation (N31) effects on drug orientation and channel hydration in amantadine-bound influenza A M2. J. Phys. Chem. B 119: 11548-11559.

80. Gordon, N.A., McGuire, K.L., Wallentine, S.K., Mohl, G.A., Lynch, J.D., Harrison, R.G., Busath, D.D. 2017. Divalent copper complexes as influenza A M2 inhibitors, Antiviral Research 147: 100-106, doi: 10.1016/j.antiviral.2017.10.009.

81. Drakopoulos A, Tzitzoglaki C, McGuire K, Hoffmann A, Konstantinidi A, Kolokouris D, Ma C, Freudenberger K, Hutterer J, Gauglitz G, Wang J, Schmidtke M, Busath DD, Kolocouris A. 2018. Unraveling the Binding, Proton Blockage, and Inhibition of Influenza M2 WT and S31N by Rimantadine Variants. ACS Med Chem Lett. 9: 198-203.

82. Mohl, G., Liddle, N., Nygaard, J., Dorius, A., Lyons, N., Hodek, J., Weber. J., Michaelis, D., Busath, D.D. Novel Influenza Inhibitors Designed to Target PB1 Interactions with Host Importin RanBP5. Antiviral Research, In Press.

Opinions/Editorials

1. Andersen O. S., H. J. Apell, E. Bamberg, D. D. Busath, R. E. Koeppe 2nd, F. J. Sigworth, G. Szabo, D. W. Urry, and A. Woolley. 1999. Gramicidin channel controversy--the structure in a lipid environment. Nat Struct Biol. 6:609; discussion 611-2.
2. Separovic, F., J. A. Killian, M. Cotten, D. D. Busath, and T. A. Cross. 2011. Modeling the membrane environment for membrane proteins. Biophysical Journal 100:2073-2074.
3. Busath D. D., D. J. Woodbury, and A. Frost. 2012. Endosis and exosis: new names for fusion and budding. J Membr Biol. 245:759-760.

Chapters in Books, Invited Reviews, Proceedings, Etc.:

Szabo, G. and D.D. Busath. 1983. Ion movement through membrane channels. In: "Membrane Biophysics: Physical Methods in the Study of Biophysical Systems." M.A. Dinno, A.B. Callahan, T.C. Rosell, Eds. Alan R. Liss, Inc., New York.

Busath, D., Hemsley, G., Bridal, T., Pear, M., Gaffney, K. and M. Karplus. 1988. Guanidinium as a probe of the gramicidin channel interior. In: "Transport through Membranes: Carriers, Channels and Pumps." A. Pullman, J.J. Jortner, B. Pullman Eds. Kluwer Academic Publishers, Boston (Norwell, MA 02061).

Chen, I. and D. Busath. 1990. Animating a cellular transport mechanism. Pixel 1:16-23.

Busath, D.D. 1993. The use of physical methods in determining gramicidin channel structure and function. Annual Reviews of Physiology 55:473-501.

Henderson, D., D. D. Busath, R. L. Rowley, P. S. Crozier, and D. Boda. 2001. Simulation study of channels in biological membranes. Proceedings of the International Conference on Computational Nanoscience. Pp. 45-48.

Yang, Y., Boda, D., Henderson, D. and D. Busath. 2002. Computer simulation studies of the selectivity and conductance of a model calcium channel. Journal of Computational Electronics. 1: 353-357.

Caywood, D. and D.D. Busath. 2002. Oriented Gramicidin M - Gramicidin A heterodimers: Rectification decreases with increased ion concentration. In: "Membrane Interacting Peptides and Proteins 2002." F. Heitz, ed., Research Signpost , Kerala, India. Pp 147-153.

Boda, D., Busath, D.D., and Henderson. 2002. Simulation of the selectivity of a calcium channel.

Applied Surface Science 196:154-156.

Yang, Y., D. Henderson, and D.D. Busath. 2004. Calcium block of sodium current in a model calcium channel: Cylindrical atomistic pore with glutamate side chains. Molecular Simulations 30:75-80.

Boda D., T. Varga, D. Henderson, D.D. Busath, W. Nonner, D. Gillespie, and B. Eisenberg. 2004. Monte Carlo simulation study of a system with a dielectric boundary: Application to ion channel selectivity. Molecular Simulations 30:89-96.

Busath, D., D. Henderson, and S. Sokolowski. 2004. Density functional theory for an electrolyte in a cylinder: The selectivity of a calcium channel. J. Phys.: Condens. Matter 16: S2193-S2201.

Busath, D. D. 2009. Influenza A M2: Channel or Transporter? In "Advances in Planar Lipid Bilayers and Liposomes," A. Leitmannova Liu and Aleš Iglič, editors, Burlington: Academic Press,10:161-201.

Grants Awarded:

9/1/78 - 8/31/80	NIH NRSA 5F32 NS-06084-02 Postdoctoral Fellowship The sodium flux ratio in squid axon sodium channels. Sponsor: Ted Begenisich. $26,300.
7/1/83 - 6/30/85	American Heart Association, Texas Affiliate The pore structure in transmembrane channels. P.I. David Busath. $53,906, direct costs.
8/1/83 - 7/31/86	NIH 1 RO1 GM33361 Molecular interactions inside a transmembrane pore. P.I. David Busath. $166,088, direct costs.
6/1/85 - 7/31/85	Mount Desert Island Biol. Lab. Markey Fellowship. The photolysis of transmembrane channels in nerve and oocyte. P.I. David Busath. $5,000, direct costs.
7/1/86 - 6/30/91	NIH 1 K04 NS01085 Research Career Development Award Gramicidin channel blockade induced by guanidinium. P.I. David Busath. $261,198, direct costs.
8/1/86 - 7/31/91	NIH R01 GM33361 Molecular interactions inside a transmembrane pore. P.I. David Busath. $421,517, direct costs.
4/1/87 - 3/31/88	NIH BRS Shared Instrumentation Grant Peptide Synthesizer and Peptide Sequencer. P.I. Wayne Bowen. $101,000, direct costs.
12/1/88 - 11/30/89	NIH DRR BRS Shared Instrumentation Grant. Molecular Modeling Network. P.I. John W. Suggs. $81,080, direct costs.
3/1/95 - 2/28/00	NIH RO1 AI 23007 Correlations: Structures-Dynamics-Functions in Gramicidin P.I. Timothy A. Cross; Sub-contract P.I. David Busath. $1,067,657 total costs. $213,215, total costs in the Brown/BYU subcontract.
10/1/96-9/30/99	NSF Academic Research Infrastructure. Acquisition of a Computational

	Chemistry Server. P.I. Randall B. Shirts; Co-P.I. David Busath and others. $100,000 direct costs. (Matched by BYU matching funds)
3/1/00-2/29/05	NIH RO1 AI 23007 Correlations: Structure-Dynamics-Functions in Channels. P.I. Timothy A. Cross; Sub-contract P.I. David Busath. $1,771,739 total costs. $462,353 total costs in the BYU subcontract.
4/1/00-3/31/03	NSF Research Experience for Undergraduates (REU Site) "Neuroscience Research Experiences for Undergraduates Site at BYU" P.I. Edwin Lephart, $237,829 total costs.
3/1/01-12/31/01	BYU "Neuroscience Environment for Mentoring" P.I. Edwin Lephart, $34,650.00 total costs.
3/1/05-2/29/10	NIH RO1 AI 23007 Correlations: Structure-Dynamics-Functions in Channels. P.I. Timothy A. Cross; Sub-contract P.I. David Busath. $1,805,550 total costs. $353,827 total costs in the BYU subcontract.
1/1/08-9/1/08	Botulinum Toxin Research Associates Subcutaneous Botox Effects on Electrically Induced Seizures. P.I. David Busath; co-P.I. Scott Steffensen $16,000 total costs.
8/1/11-7/31/15	NIH RO1 AI 23007 Correlations: Structure-Dynamics-Functions in Channels. P.I. Timothy A. Cross; Sub-contract P.I. David Busath. ~$500,000 total costs in the BYU subcontract.

Internal funding:

Mentoring Environment Grants from ORCA, BYU of $20,000 in 2004, 2006, 2008, 2011, 2012, and 2014

Robert Gardner Fund from the College of Life Sciences, BYU of $30,000 in 2009 to search for mechanisms of food intolerance

Seed award of $10,000 from the Fulton College of Engineering, BYU to Brian Mazzeo and me for "Dielectric Spectroscopy Assessment of Influenza A M2 Drug Binding" in 2010

Capital equipment award from Depts. of PDBio and Chem/Biochem, BYU of $90,000 to Dixon Woodbury and me for a circular dichroism spectrometer in 2010

Tech Transfer Bridging Award of $25,000 for development of influenza drugs in 2012

Capital equipment award from Dept. of PDBio, BYU of $18,500 to John Bell and me for a fluorescence lifetime spectrophotometer in 2013.

Student Entrepreneur Mentoring Award from the BYU Rollins Center of $5,000 in 2014.

CHIRP Award from Dept. of Chemistry and Biochemistry, BYU of $20,000 to spark translational research to Roger Harrison and me in 2014.

Research award from the Magnetic Resonance Imaging Facility, BYU of $1,000 to help initiate an fMRI study of chronic pain in 2014; additional $9,000 in 2015.

Gift from the Sorenson Legacy Foundation, 2016, $25,000 for "Identify new methods to block neuropathic pain."

College of Life Sciences Technology Transfer Award, 2016, $15,000 for "Leveraging Three Anti-

Influenza Drug Patent Applications By Development of a Zebrafish Larvae Virus-Injection Assay." Arminda Suli, Co-PI.

College of Life Sciences Technology Transfer Award, 2017, $15,000 for "Continued Development of a Zebrafish Larvae Virus-Injection Assay." Arminda Suli, Co-PI.

Provisional Patent Applications Submitted:

9/1/2017 App No. 62/553,732 "Novel Influenza Chemotherapeutics: Nuclear Import Inhibitors of the Influenza Polymerase," Inventors: David D. Busath, David Michaelis, and Greg Mohl.

4/5/2017 App No. 62/481,909 "Novel Influenza Chemotherapeutics: Nuclear Import Inhibitors of the Influenza Polymerase," Inventors: David D. Busath, Greg Mohl, David Michaelis

1/30/2017 App No. 62/451,988 "Novel Influenza Chemotherapeutics: Nuclear Import Inhibitors of the Influenza Polymerase," Inventors: Greg Mohl and David D. Busath.

9/23/2014 App No. Not filed. "Antiviral-Metal Complexes for Treatment of Influenza Virus Infections," Inventors: David D. Busath, Timothy Cross, David Fedida, Nathan Gordon, Roger G. Harrison, Antonios Kolocouris, Michaela Schmidtke, Roland Zell.

6/12/2014 App No. 61/997,888 "Divalent Copper Compounds as Inhibitory Agents of Influenza A," Inventors: Nathan Gordon, Roger Harrison, David D. Busath.

12/23/2013 App No. 61/920,359 "A Novel Set of Antiviral Drugs for M2/S31N-bearing Influenza A. Inventors: David D. Busath, F. Brent Johnson, Antonios Kolocouris.

2/2/2013 App No. 61/760,060 "A Novel Set of Antiviral Drugs for M2/S31N-bearing Influenza A," Inventors: David D. Busath, F. Brent Johnson, Antonios Kolocouris.

9/29/2011 App No. 61/626,618 "A Novel Set of Antiviral Drugs for M2/S31N-bearing Influenza A. Inventors: David D. Busath, F. Brent Johnson, Antonios Kolocouris.

Patent Cooperation Treaty (PCT) Patent Applications Submitted:

6/12/2015 App No. PCT/US15/35604 "ORGANO-TRANSITION METAL COMPLEXES FOR THE TREATMENT OF VIRAL INFECTIONS," Inventors: Nathan Gordon, Kelly McGuire, Spencer Wallentine, James Clark, Roger Harrison, David D. Busath

2/2/2014 App No. PCT/US14/14359 "A Novel Set of Antiviral Drugs for M2/S31N-bearing Influenza A." Inventors: David D. Busath, F. Brent Johnson, Antonios Kolocouris.

Full Patent Applications Submitted:

12/12/2016 App No. 15/318,198 "ORGANO-TRANSITION METAL COMPLEXES FOR

THE TREATMENT OF VIRAL INFECTIONS," Inventors: Nathan Gordon, Kelly McGuire, Spencer Wallentine, James Clark, Roger Harrison, David D. Busath (according to Faculty Profile/TTO).

8/2/2015+ App No. 14/765,539 "Antiviral Compounds." Inventors: David D. Busath, F. Brent Johnson, Antonios Kolocouris. (USPO). Also submitted within one month to patent offices in Korea, EP, AU, and Japan.

Patents Awarded:

12/12/2017 USPO #9,840,465 "Antiviral Compounds." Inventors: David D. Busath, F. Brent Johnson, Antonios Kolocouris.

Invited Lectures:

9/1985 "Guanidinium Blocks in Gramicidin Channels". Department of Physiology, Emory University, Atlanta, GA.

11/1985 "Iminium Ion Blocks in Gramicidin Channels". Department of Physiology, Yale University, New Haven, CT.

3/1986 "Small iminium ions block gramicidin channels in lipid bilayers". Department of Pharmacology and Toxicology. Dartmouth Medical School. Hanover, NH.

5/1988 "Guanidinium as a probe of the gramicidin channel interior". Jerusalem Symposium on Quantum Chemistry and Biochemistry, Jerusalem, Israel.

5/1988 "Guanidinium as a probe of gramicidin channels". Laboratoire de Physicochimie des Systemes Polyphases. C.N.R.S. Montpellier, France.

9/1990 "Guanidinium as a probe of gramicidin channel structure". Department of Physiology, University of Illinois, Champaign, IL.

2/1992 "The voltage-gated K+ channel: a beta-barrel structure". Section of Physiology, Brown University, Providence, RI.

2/28/1992 "Modeling the pore of voltage-gated K+ channels". Department of Biophysical Sciences, SUNY, Buffalo, NY.

2/27/1992 "Molecular modeling of the voltage-gated K+ channel". Department of Physiology and Biophysics, University of Rochester, Rochester, NY.

3/26/1992 "The structure of voltage gated potassium channels". Physics Dept., Boston University, Boston, MA.

5/16/1992 "An SS1-SS2 beta barrel model for the voltage-gated K+ channel". Department of Physiology, Albert Einstein Medical School, Bronx, NY.

11/5/1992 "Molecular modeling of large biomolecules". Department of Chemistry, University of Massachusetts at Dartmouth, Dartmouth, MA.

3/19/1993 "Molecular modeling of voltage-gated potassium channels". Department of Chemistry, State University of New York at Binghamton, Binghamton, NY.

4/1993 "Molecular modeling of gramicidin and potassium channels". Department of Chemistry, University of Montreal at Montreal, Quebec, Canada.

5/1993 "Molecular modeling of the voltage-gated K+ channel". Pfizer Pharmaceutical Corporation, Groton, CT.

4/1994	"Gramicidin transport and dynamics with iminium ions." Friends of the Membrane. Department of Physiology. Cornell University Medical School, New York, NY.
2/1995	"Binding selectivity in Voltage-gated channels". Dept. Of Physiology, University of Utah Medical School, Salt Lake City, Utah.
2/1995	"Binding selectivity in Voltage-gated channels". Zoology Dept, Brigham Young University, Provo, Utah.
3/1996	"Organic Cation Permeability of the Gramicidin Channel". Theoretical Physics Group, BYU, Provo, Utah.
9/1996	"Organic Cation Permeability of the Gramicidin Channel". Zoology Dept., BYU, Provo, Utah.
10/1996	"Organic Cation Permeability of the Gramicidin Channel". Microbiology Dept., BYU, Provo, Utah.
11/18/98	"Lorentzian noise in single gramicidin A channel formamidinium currents." Novartis Symposium. London, UK.
6/98	"Formamidinium noise in gramicidin channels." Dept. of Physiology and Biophysics. Rush Medical School. Chicago, IL
9/15/99	"Proton permeation in gramicidin analogs: An assay of water reorientation rates." Satellite Symposium of XIII Int. Biophysics Congress. Center for Cellular & Molecular Biology. Hyderabad, India.
9/24/99	"The influence of polar side chains on channel conductance: Proton conductance in gramicidin." MBBG Seminar. University of Delhi, South Campus. New Delhi, India
1/13/00	"The biophysics of neuron behavior." Non-linear Networks Seminar. Mathematics Dept., BYU, Provo UT.
2/2/00	"Gramicidin, a model ion channel." NSF Program Directors Seminar. Arlington, VA.
2/8/00	"Using fluorination to explore the electric field in gramicidin channels." Dept. of Anatomy and Neurobiology. University of Utah, Salt Lake City, UT.
2/10/00	"Using fluorination to explore the electric field in gramicidin channels." Center for Neuroscience. Brigham Young University, Provo, UT.
4/23/01	"Determinants of channel permeability." Dept. of Physiology and Biophysics. Rush University Medical School. Chicago, IL
4/25/01	"Proton Exit, Not Water-Reorientation, is Rate Limiting for Proton Currents in Gramicidin Channels." Dept. of Physiology. Loyola University Medical Center. Chicago, IL.
5/4/01	"Issues in ion transport by protein channels." BYU Workshop on Electrolytes and Interfaces. Dept. of Chemistry. Brigham Young University. Provo, UT.
12/5/01	"Excitability begins here: Voltage-gated channels in nerve and muscle." Physics Dept. Colloquium. Brigham Young University, Provo, UT.
3/02	"Excitable channels in nerve and muscle." Dept. of Chemistry and Biochemistry, Brigham Young University, Provo, UT.
6/02	"The structure and function of voltage gated channels." Neuroscience REU Summer Seminar, Brigham Young University, Provo, UT.
7/02	"Channel behaviors of the M2 protein from Influenza A virus." Dept. of Chemistry, Florida State University, Tallahassee, FL.

11/03 "M2 Protein Function and Images in Planar Bilayers." M2 Workshop, Northwestern University, Evanston, Illinois.

1/04 "M2 Protein Function and Images in Planar Bilayers." PDBio Departmental Seminar, Brigham Young University, Provo, UT.

10/5/2004 "Selectivity of Ion Channels." Beckmann Institute Lab Meeting. University of Illinois at Champaign-Urbana. Urbana, IL.

12/17/05 "Tryptophan Fluorination Effects on Gramicidin Channel Conductance." Fluorine NMR Applications Symposium. Pacifichem 2005. Honolulu, HI.

3/15/06 "An Achilles Tendon in the Influenza Virus: M2." Department of Biology, Utah Valley State College, Orem, UT.

11/06 "Progress report on Influenza M2 channel behavior." Cross Lab Group. Dept. of Chemistry and Biochemistry. NHMFL. Florida State Univ. Tallahassee, FL.

10/16/07 "Molecular Modeling of Lipid Bilayers and Channel Forming Peptides." Richard Rowley Lab Group. Dept. of Chemical Engineering. Brigham Young University. Provo, UT.

10/25/07 "A Proposal for Radical Change in NIH Funding." NIH Peer Review Consultation Meeting. San Francisco, CA.

8/24/07 "Biophysical Measurements with Botulinum/A Toxin", Dartmouth Botulinum Toxin Symposium, Dartmouth, MA

3/10/08 "Single Channel Studies With Influenza A M2 (C19,50S) From E. Coli Inclusion Bodies." Influenza Research Group, Northwestern University, Evanston, IL.

4/22/11 "Influenza A M2 is a Drug Target." Toto Olivera Lab Meeting Seminar, Dept. of Biology, University of Utah, Salt Lake City, UT.

10/13/11 "Can we Stop Pandemic Flu with an Anti-viral Drug?" BYU Dept. of Physiology and Developmental Biology Seminar, Provo, UT

11/17/11 "Can we Stop Pandemic Flu with an Anti-viral Drug?" BYU Current Topics in Molecular Life Sciences Seminar Series, Provo, UT

9/18/2012 "Can we Stop Pandemic Flu with an Anti-viral Drug?" Dept. of Physics, Solid State Group Seminar Series, Provo, UT

5/15/2013 "Persistent in vitro inhibition of influenza A by amantadine analogs." William DeGrado Research Group Meeting, San Francisco, CA

9/12/2013 "Persistent Blockers for Modern Influenza A." Seminar, BYU Dept. of Physiology and Developmental Biology, Provo, UT

2/17/2014 "Influenza A Blockers with Reduced Resistance Formation." Conference Platform Presentation, 58th Annual Meeting, Biophysical Society, San Francisco, CA

2/08/2015 "Molecular dynamics of amantadine block in M2 of influenza A: WT vs S31N." Conference Platform Presentation, 59th Annual Meeting, Biophysical Society, Baltimore, MD. Lecture presented by student, Mitchell Gleed.

International Symposium Lectures:

5/1988 "Guanidinium as a probe of the gramicidin channel interior". Jerusalem Symposium on Quantum Chemistry and Biochemistry, Jerusalem, Israel.

11/18/98 "Lorentzian noise in single gramicidin A channel formamidinium currents." Novartis Symposium. London, UK.

9/1999	"Proton permeation in gramicidin analogs: An assay of water reorientation rates." Satellite Symposium of XIII International Biophysics Congress on Membranes, Sensors, and Cell Surfaces. Hyderabad, India.
12/13/05	"Flourinated gramicidin channels: effects on the single channel conductance." Symposium, Pacifichem 2005. Honolulu, Hawaii.
6/23/11	"Influenza A M2 is a Drug Target." Ion Channel Workshop, Vancouver, BC, Canada.
6/26/2013	"Persistent *in vitro* inhibition of influenza A by amantadine analogs." Ion Channel Retreat, Vancouver, BC

Teaching Experience:

1984-1991	Bio 110, Cell Physiology and Biophysics. Course director (1985).
1985-1989	Bio 117, Mammalian Physiology.
1992-1994	Bio 117, Mammalian Physiology. Course director (1993-1995).
1986-1994	Chem/Bio 121, Molecular Modeling. Course director (1986, 1988, 1990-1995).
1993-1995	Bio 80, Introduction to Physiology.
1995-present	Zool 260, Physiol. & Dev. Biol. 220, Introduction to Human Anatomy
1997-1999	Zool 562, Neurophysiology
2000-2003	Neuro 105, Introduction to Neuroscience
2000-2003	Chem 489, Structural Biochemistry
2000-2002	Neuro 480, Advanced Neuroscience
2000-2001	Neuro 480, Neuroscience Lab
2003-present	Zoo 460, Physiol. & Dev. Biol. 362, Human Physiology
2004-present	Physiol. & Dev. Biol. 568, Electrophysiology and Cellular Biophysics
2005-present	Physiol. & Dev. Biol. 550R, Molecular Dynamics Simulations Lab
2011-present	Physiol. & Dev. Biol. 450R, Biophysics Research Training

Trainees:

Postdoctoral Fellows:

9/1986-12/1988	Dr. Irina Vayl. Molecular definition of bilayer surface tension.
1/1991-1/1992	Dr. Andrea Dorigo. Electrostatic impact of Trp side chain in gramicidin channels, free energy profile of guanidinium transport in gramicidin channels.
9/1996-10/1997	Dr. Craig Thulin. Mechanism of Conductance increase by fluorination of Trp^{13} in gramicidin A.
1/2002-1/2006	Dr. Viksita Vijayvergiya. Influenza M2 reconstitution and channel activity.

Ph.D. Recipients:

1992 Xian-Zheng Jin. Tau-16 gramicidin channel properties.
1993 Sang Ah Seoh. Organic cation selectivity in gramicidin channels.
1994 Steve Bogusz. Molecular modeling of voltage-gated channels.

1995 Yili Hao. Free energy profile for transport of small amines in gramicidin channels.
2002 Vivek Ramakrishnan. Cation flow selection in model calcium channels.
2008 Morad Alawneh. (with Doug Henderson) Molecular dynamics of M2 and gramicidin.
Current doctoral student: Kelly McGuire

Master's Degree Recipients:

1989 Terry Bridal. The inactivation of gramicidin channels by local anesthetics.
1999 Chad Cole. Fluorination effects on gramicidin channel permeation.
2004 Travis Hughes. Atomic force imaging of influenza M2 proteins.
2005 Jacob Durrant. Estimation of the tryptophan potential in gramicidin channels.
2005 Mario Pinoli. Stability and permeability of the polyglutamine μ-helix in simulations.
2007 Brad Strongin. Thermodynamic evidence that ganglioside-mediated insertion of Botulinum A into the cholinergic nerve ending may precede endocytosis and acidification: a Langmuir film study.
2011 Emily Peterson. Proteoliposome Proton Flux Assays Establish Net Conductance, pH-Sensitivity, and Functional Integrity of a Novel Truncate of the M2 Ion "Channel" of Influenza A.
2013 Nathan A. Gordon. Divalent Copper Compounds as Inhibitory Agents of Influenza A.

Intramural Service:

Member BYU Internal Review Board 1999-2003
Member College Faculty Rank and Status Committee 2005-2010
Member Board of Directors, Magnetic Resonance Imaging Facility 2012-2014
Member, Departmental Faculty Rank and Status Committee 2009-2013
Chair, Departmental Faculty Rank and Status Committee 2013 - present

Extramural Service:

NIH Small Business Grant Reviewer 11/86, 6/87
NIH Physiology Study Section (ad hoc members) 2/88
National President, Masscomp User's Society 4/88-10/89
Organizer of the Gramicidin Club and its Banquet (-30 members), which met annually since 1987.
NSF Computers in Education Grant Reviewer 8/90
Reviewer: Biophysical Journal, Biophysica Biochimica Acta, Biochemistry, European Biophysics Journal, Journal of Biological Chemistry.
NRC Howard Hughes Predoctoral Fellowship Panelist 2/95, 2/98, 2/00
NRC Associateship Program Panelist 2/96-2/99.
Spearheaded Invitation of Biophysical Society to meet in Salt Lake City in 2006.
Spearheaded Formation of Permeation/Transport Biophysics Subgroup in the Biophysical Society, Feb. 2002; president of the group 2003-2006.
NIH Ad Hoc Reviewer 11/03
NSF Ad Hoc Reviewer 8/03
NIH Biophysics of Neural Systems Study Section (ad hoc member) 10/07

Professional Society Memberships:

Biophysical Society (1978 - present)
New York Academy of Sciences (1984-1992)
The American Association for the Advancement of Science (1985-1999)
American Chemical Society (1985-1993; 2005 – 2013)
The Society of General Physiologists (1986-1995)
Boston Channel Group (1986-1995)
The American Physiological Society (1987-1995)
The Protein Society (1987-1993)
Antiviral Society (2011 – present)
International Society for Antiviral Research (2012 – present)