

## CURRICULUM VITAE

### PERSONAL:

Name: Elizabeth J. Goldsmith  
Address: Dept. of Biochemistry  
UT Southwestern Medical Center  
5323 Harry Hines Blvd.  
Dallas, Texas 75390-8816  
Telephone: (214) 645-6376  
FAX: (214) 645-6387  
E-mail: Elizabeth.goldsmith@utsouthwestern.edu

### EDUCATION:

1967 B. S., Chemistry  
University of California, Los Angeles  
1971 Ph.D., Physical Chemistry  
University of California, Los Angeles

### ACADEMIC POSITIONS:

1998 - Professor, Biochemistry, The University of Texas Southwestern Medical Center at Dallas, Texas  
1993 - 1998 Associate Professor, Biochemistry, The University of Texas Southwestern Medical Center at Dallas, Texas  
1986 - 1993 Assistant Professor, Biochemistry, The University of Texas Southwestern Medical Center at Dallas, Texas  
1980 - 1986 Assistant Research Professor, University of California, San Francisco, CA  
Mechanism of activation of phosphorylase by saccharides  
Structure of Oligosaccharides  
Carboxypeptidase mutants  
1976-1980 Assistant Research Professor, University of California, Los Angeles  
Crystallographic studies of glutamine synthetase  
1974-1975 Acting Assistant Professor, Postdoctoral Fellow  
University of California, Los Angeles  
Crystallographic studies of aldolase and RNA polymerase  
Crystallization and preparation of heavy atom derivatives  
Laboratory of David Eisenberg

1972-1973            Postdoctoral fellow, MRC Laboratory for Molecular Biology  
Cambridge, England  
Structure of carbonmonoxyhemoglobin at 2 Å  
Laboratory of Max Perutz

#### **AWARDS AND FELLOWSHIPS:**

1963                 Dean's List, UCLA  
1967                 Honors in Chemistry, UCLA  
1971                 Graduate Woman of the Year, UCLA  
1972                 American Assoc. of University Women Fellowship  
1973                 NIH Postdoctoral Fellowship  
1974                 Celeste Durand Rogers Fellowship  
1975                 NIH Career Development Award

#### **PROFESSIONAL SOCIETIES:**

American Crystallographic Association  
Protein Society  
Biophysical Society  
American Society of Biological Chemists

#### **RESEARCH INTERESTS:**

Conformational regulation of protein molecules. In particular, allosterics, phosphoregulation, and spontaneous conversions (serpins). Enzyme specificity. Protein design including second generation therapeutics, substrate specificity changes, and alterations in regulatory properties.

#### **PATENTS:**

Title: Serine protease mutants of the chymotrypsin superfamily resistant to inhibition by their cognate inhibitors and genes encoding the same and serine protease inhibitor mutants and genes encoding the same.

Authors: Edwin L. Madison, Elizabeth J. Goldsmith, Robert D. Gerard, Mary-Jane Gething and Joseph F. Sambrook.

Patent #5,550,042

Title: Genes encoding serine protease mutants of the chymotrypsin superfamily resistant to inhibition by their cognate protease. (Actually, these are zymogenic tissue plasminogen activators ).

Authors: Edwin L. Madison, Elizabeth J. Goldsmith, Mary-Jane Gething and Joseph F. Sambrook.  
Patent #5,486,602 (Jan. 23, 1996)

## **ACADEMIC TEACHING, UT SOUTHWESTERN MEDICAL CENTER**

Member: Department of Biochemistry  
Graduate program in Biochemistry  
& Molecular Biology  
Graduate Program in Biophysics

Lecturer in: Structural Biology  
Previously in Graduate Biochemistry  
Advanced Protein Chemistry, Advanced Cell  
& Molecular Biology, and Medical Biochemistry

Organizer: Graphics Sessions for First Year Course in  
Division of Cell and Molecular Biology

### **FACULTY COMMITTEES:**

Recruitment	Biophysics Program (created brochure)
Retreat Committee	Department of Biochemistry

### **UNIVERSITY COMMITTEES:**

Recruitment

### **GRADUATE STUDENTS TRAINED:**

Jiandong Zhang, student in the Biophysics Program  
Chen Sheng-Cheng, former student in Biochemistry  
Barbara Mark, former student in Biochemistry  
Bertram Canagarajah, Student in the Biophysics Program  
Anita Strong, Student in the Biophysics Program  
Kim Ngo, Student in the Biophysics Program  
Jinping Li, Student in the Biophysics Program

### **Ph.D. COMMITTEES, ORAL COMMITTEES:**

Carol Wise, Ph.D. committee  
Edwin Madison, Ph.D. committee  
Leon Carayannopoulos, oral exam committee  
Zhi Ping Liu, Ph.D. committee  
Terry Triplet, Ph.D. committee  
Conrad Seghers, Ph.D. committee  
Bostjan Kobe, Ph.D. committee  
Patrick Weix, Ph.D. committee  
HeeWon Park, oral exam committee  
Doug Ebert, committee  
Mark Mixon, oral committee

## **PUBLICATIONS:**

1. P. Haake, J. P. McNeal, E. Heidner (Goldsmith) (1968). "Proton Magnetic Resonance Studies of Ethylene Phosphites and Ethylene Sulfoxide." *J. Amer. Chem. Soc.* **90**, 7-19.
2. K. Seff, E. Heidner (Goldsmith), M. Meyers, K. N. Trueblood (1969). "The Crystal and Molecular Structure of Methanesulfinic Acid." *Acta Crystallogr.* **B25**, 350.
3. E. G. Heidner (Goldsmith), B. Weber, D. S. Eisenberg (1971). "Subunit Structure of Aldolase." *Science* **171**, 667.
4. D. Eisenberg, E. G. Heidner (Goldsmith), P. Goodkin, M. N. Dastoor, B. H. Weber, F. Wedler, J. D. Bell (1971). "Molecular Symmetry and Crystal Packing of E. coli Glutamine Synthetase." *Cold Spring Harbor Symp. Quant. Biol.* **36**, 291. (Invited article)
5. M. F. Perutz, E. G. Heidner (Goldsmith), J. E. Ladner, J. G. Beetlestone, C. Ho, E. F. Slade (1974). "Influence of Globin Structure on the State of the Haem. III. Changes in Haem Spectra Accompanying Allosteric Transitions in Met-Haemoglobin and their Implications for Haem-Haem Interaction." *Biochemistry* **13**, 2187.
6. E. Heidner (Goldsmith), R. Ladner, and M. F. Perutz (1976). "Structural Differences Between CO and Met-Haemoglobin at .28nm Resolution." *J. Mol. Biol.* **104**, 707-722.
7. R. Ladner, E. Heidner (Goldsmith), and M. F. Perutz (1977). "Structure of Horse Carbonmonoxyhaemoglobin." *J. Mol. Biol.* **114**, 385-314.
8. E. Heidner (Goldsmith) (1977). "Protein Crystallization: The Functional Dependence of Nucleation Rate on the Protein Concentration and the Solubility." *Journal of Crystal Growth* **44**, 139-144.
9. E. G. Heidner, T. G. Frey, L. S. Weissman, R. Fenna, M. Lei, M. Harel, R. M. Sweet, and D. Eisenberg (1978). "New Crystal Forms of Glutamine Synthetase and Implications for the Molecular Structure." *J. Mol. Biol.* **122**, 163
10. M. Lei, U. Aebi, E. G. Heidner, D. Eisenberg (1979). "Limited Proteolysis of Glutamine Synthetase is Inhibited by Glutamate and by Feedback Inhibitors." *J. Biol. Chem.* **254**, 3129.
11. E. Goldsmith, S. Sprang, and R. J. Fletterick (1982). "The Structure of Maltoheptaose by Difference Fourier Methods and a Model for Glycogen." *J. Mol. Biol.* **156**, 411-427.
12. S. Sprang, E. J. Goldsmith, R. J. Fletterick, S. Withers, and N. B. Madsen (1982). "The Catalytic Site of Glycogen Phosphorylase: Structure of the T-State and Specificity for Glucose." *Biochemistry* **21**, 5364-5371.
13. E. J. Goldsmith and R. J. Fletterick (1983). "Oligosaccharide Conformation and Protein Saccharide Interactions in Solution." *J. Pure and Applied Chem.* **55**, 577-588.
14. C. Thaller, B. Alberts, E. Goldsmith, S. Sprang, and R. J. Fletterick (1984). "Crystallization of the Gene 45, Protein from the DNA Replication Fork of Bacteriophage T4." *J. Biol. Chem.*

- 259**, 2568-2569.
15. S. R. Sprang, E. Goldsmith, and R. J. Fletterick (1987). "Structure of the Nucleotide Activation Switch in Glycogen Phosphorylase *a*." *Science* **237**, 1012-1019.
  16. E. Goldsmith, R. J. Fletterick, and S. Withers (1987). "The Three-dimensional Structure of Acarbose, Bound to Glycogen Phosphorylase *a*." *J. Biol. Chem.* **262**, 1449-1455.
  17. V. Rath, C. B. Newgard, S. R. Sprang, E. J. Goldsmith, and R. J. Fletterick (1987). "Modeling the Biochemical Differences between Rabbit Muscle and Human Liver Phosphorylase." *Proteins* **2**, 225-235.
  18. R. J. Fletterick, C. S. Craik, E. Goldsmith, C.B. Newgard, V.L. Rath, W.J. Rutter, S.R. Sprang, and T. S. Standing (1987). "Enzyme Mechanisms: Allostery and Catalysis. In *PROTEINS: Structure, Folding, and Design* **2**, New York: Alan R. Liss, Inc., pp. 247-256. (Chapter)
  19. S. R. Sprang, K. R. Acharya, E. J. Goldsmith, D. I. Stuart, K. Varvill, R. J. Fletterick, N. B. Madsen and L. N. Johnson (1988). "Structural changes in glycogen phosphorylase induced by phosphorylation." *Nature* **336**, 215-221.
  20. S. J. Gardell, C. S. Craik, E. Clauser, E. J. Goldsmith, C.-B. Stewart, M. Graf and W. J. Rutter (1988). "A Novel Rat Carboxypeptidase CPA2: Characterization, Molecular Cloning, and Evolutionary Implications on Substrate Specificity in the carboxypeptidase Gene Family." *J. Biol. Chem.* **263**, 17828-17836.
  21. E. Goldsmith, S. Sprang, R. Hamlin, N.-G. Xuong, and R. J. Fletterick (1989). "Domain Separation in the Activation of Glycogen Phosphorylase *a*." *Science* **245**, 528-532.
  22. E. L. Madison, E. J. Goldsmith, R. D. Gerard, M.-J. H. Gething, and J. F. Sambrook (1989). "Serpine-resistant mutants of human tissue-type plasminogen activator." *Nature* **339**, 721-723.
  23. Melanie H. Cobb, Bi-Ching Sang, Roberto Gonzalez, Elizabeth Goldsmith and Leland Ellis (1989). "Autophosphorylation Activates the soluble Cytoplasmic Domain of the Insulin Receptor in an Intermolecular Reaction." *J. Biol. Chem.* **264**, 18701-18706.
  24. Goldsmith, E., Sprang, S. R, and Fletterick, R. J. (1989). "Alternative Binding Modes for Maltopentaose in the Activation Site of Glycogen Phosphorylase *a*." In *Transactions of the American Crystallographic Association* **25**, 87-104. (Invited article)
  25. E. L. Madison, E. J. Goldsmith, R. D. Gerard, M.-J. Gething, J. F. Sambrook and R. S. Bassel-Duby (1990). "Amino acid residues that affect interaction of tissue plasminogen activator with the serpin, plasminogen activator inhibitor type-1." *Proc. Natl. Acad. Sci.* **87**, 3530-3533.
  26. E. L. Madison, E. J. Goldsmith, M.-J. H. Gething, J. F. Sambrook and R. D. Gerard (1990). "Restoration of serine protease-inhibitor interaction by protein engineering." *J. Biol. Chem.* **265**, 21423-21426.

27. E. J. Goldsmith, C. Sheng-Cheng, D.E. Danley, R. D. Gerard, K.F. Geoghegan, J. Mottonen, and A. Strand (1991). "Preliminary X-ray Analysis of Crystals of Plasminogen Activator Inhibitor-1." *PROTEINS: Structure, Function, and Genetics* **9**, 225-227.
28. S. R. Sprang, S. G. Withers, E. J. Goldsmith, R. J. Fletterick, and N. B.Madsen (1991). "Structural basis for the activation of glycogen phosphorylase b by adenosine monophosphate." *Science* **254**, 1367-1371.
29. F. Zhang, B. Kobe, C.-B. Stewart, W. J. Rutter, and E. J. Goldsmith (1991). "Structural evolution of an enzyme specificity: Rat carboxypeptidase A2 at 1.9 Å resolution." *J. Biol. Chem.* **266**, 24606-24612.
30. J. Mottonen, A. Strand, R. D. Gerard, R., J. Symersky, K. F. Geoghegan, K.F., and E. J. Goldsmith (1992). "Structural basis of latency in plasminogen activator inhibitor-1." *Nature* **355**, 270-273.
31. S. S. Boddupalli, C. A. Hasemann, K. G. Ravichandran, J.-Y. Lu, E. J. Goldsmith, J. Deisenhofer, and J. A. Peterson (1992). "Crystallization and preliminary x-ray diffraction analysis of P450<sub>terp</sub> and the hemoprotein domain of P450<sub>BM-3</sub>, enzymes belonging to two distinct classes of the cytochrome P450 superfamily." *Proc. Natl. Acad. Sci. USA* **89**, 5567-5571.
32. Z. Faming, D. J. Robbins, M. H. Cobb, and E. J. Goldsmith (1993). "Crystallization and preliminary X-ray studies of extracellular signal-regulated kinase-2/MAP: Kinase with an incorporated His-tag." *J. Mol. Biol.* **233**, 550-552.
33. E. L. Madison, A. Kobe, M.-J. Gething, J. F. Sambrook and E.J. Goldsmith (1993). "Converting tissue plasminogen activator to a zymogen: A regulatory triad of Asp-His-Ser." *Science* **262**, 419-421.
34. G. S. J. Rao, J. Mottonen, E. J. Goldsmith and P. F. Cook (1993). "Crystallization and preliminary x-ray data for the A-isozyme of *O*-acetylserine sulfhydrylase from *Salmonella typhimurium*." *J. Mol. Biol.* **231**, 1130-1132.
35. F. Zhang, A. Strand, D. Robbins, M. Cobb and E.J. Goldsmith (1994). "Atomic structure of the MAP kinase ERK2 at 2.3Å resolution." *Nature* **367**, 704-711.
36. E. J. Goldsmith and J. Mottonen (1994). "Serpins: the uncut version." *Structure* **2**, 241-244.
37. E. Goldsmith and M. Cobb (1994). "Protein kinases." *Current Opinion in Structural Biology* **4**, 833-840.
38. J. Zhang, F. Zhang, D. Ebert, M. H. Cobb and E. J. Goldsmith (1995). "Activity of the MAP kinase ERK2 is controlled by a flexible surface loop." *Structure* **3**:299-307.
39. H. M. Tucker, J. Mottonen, E. J. Goldsmith and R. D. Gerard (1995). "Engineering of plasminogen activator inhibitor-1 to reduce the rate of latency transition." *nature structural*

- biology **2**, 442-445.
40. M. H. Cobb and E. J. Goldsmith (1995). "How MAP kinases are regulated." *J. Biol. Chem.* **270**, 14843-14846.
  41. N. V. Grishin, M. A. Phillips and E. J. Goldsmith (1995). "Modeling of the spatial structure of eukaryotic ornithine decarboxylases." *Protein Science* **4**, 1291-1304.
  42. N.V. Grishin, A. L. Osterman, E. J. Goldsmith, M. A. Phillips (1996). "Crystallization and preliminary X-ray studies of ornithine decarboxylase from *Trypanosoma brucei*." *PROTEINS* **24**, 272-273.
  43. M. Cheng, E. Zhen, M. J. Robinson, D. Ebert, E. Goldsmith and M. H. Cobb (1996). "Characterization of a protein kinase that phosphorylates serine 189 of the mitogen-activated protein kinase homolog ERK3." *J. Biol. Chem.* **271**, 12057-12062.
  44. E. J. Goldsmith (1996). "Allosteric enzymes as models for chemomechanical energy transducing assemblies." *The FASEB Journal* **10**, 702-703
  45. M. J. Robinson, P. C. Harkins, J. Zhang, R. Baer, J. W. Haycock, M. H. Cobb and E. J. Goldsmith (1996). "Mutation of position 52 in ERK2 creates a nonproductive binding mode for adenosine 5'-triphosphate." *Biochemistry* **35**, 5641-5646.
  46. M. J. Robinson, M. Cheng, A. Khokhlatchev, D. Ebert, N. Ahn, K. L. Guan, B. Stein, E. Goldsmith and M. H. Cobb (1996). "Contributions of the mitogen-activated protein (MAP) kinase backbone and phosphorylation loop to MEK specificity." *J. Biol. Chem.* **271**, 29734-29739.
  47. Z. Wang, J. Mottonen and E. J. Goldsmith (1996). "Kinetically controlled folding of the serpin plasminogen activator inhibitor-1." *Biochemistry* **35**, 16443-16448.
  48. M.H. Cobb, S. Xu, M. Cheng, D. Ebert, D. Robbins, E. Goldsmith, and M. Robinson (1996). "Structural analysis of the MAP kinase ERK2 and studies of MAP kinase regulatory pathways." *Adv. Pharmacol.* **36**, 49-65.
  49. Z. Wang, P. C. Harkins, R. J. Ulevitch, J. Han, M. H. Cobb and E. J. Goldsmith (1997). "The structure of the MAP kinase p38 and 2.1 Å resolution." *Proc. Natl. Acad. Sci. USA* **94**, 2327-2332.
  50. B. Canagarajah, A. Khokhlatchev, M. H. Cobb and E. J. Goldsmith (1997). "The structure of phosphorylated MAP kinase ERK2 at 2.5 Å resolution." *Cell* **90**, 859-869.
  51. B.J Canagarajah, A. Khokhlatchev, M.H. Cobb, and E.J. Goldsmith (1997). "Activation mechanism of the MAP kinase ERK2 by dual phosphorylation." *Cell* **5**, 859-869.
  52. A. V. Khokhlatchev, B. Canagarajah, J. Wilsbacher, M. Robinson, M. Atkinson, E. J. Goldsmith and M. H. Cobb (1998). "Phosphorylation of the map kinase ERK2 promotes its homodimerization and nuclear translocation." *Cell* **93**, 605-615.

53. Z. Wang, B.J. Canagarajah, J. C. Boehm, S. Kassis, M. H. Cobb, P. R. Young, S. Abdel-Meguid, J. L. Adams, and E. J. Goldsmith (1998). "Structural Basis of MAP Kinase Selectivity." *Structure* **6**, 1117-1128.
54. R. J. Gum, M.M. McLaughlin, S. Kumar, Z. Wang, M.J. Bower, J.C. Lee, J.L. Adams, G.P. Livi, E.J. Goldsmith, and P.R. Young (1998). "Acquisition of Sensitivity of Stress-activated Protein Kinases to the p38 Inhibitor, SB203580, by Alteration of One or More Amino Acids within the ATP Binding Pocket." *J. Biol. Chem.* **273**, 15605-15610.
55. M.J. Robinson, S.A. Stippec, E.J. Goldsmith, M.A. White, and M.H. Cobb (1998). "A constitutively active and nuclear form of the MAP kinase ERK2 is sufficient for neurite outgrowth and cell transformation." *Curr. Biol.* **21**, 1141-1150.
56. J. Li, Z. Wang, B. Canagarajah, H. Jiang, M. Kanost, and E. J. Goldsmith (1999). "The Structure of Active Serpin K from *Manduca sexta* and A Model for Serpin-Protease Complex Formation." *Structure* **7**, 103-109.
57. F.W. Farley, B. Satterberg, E.J. Goldsmith, and E.A. Elion (1999). "Relative Dependence of Different Outputs of the *Saccharomyces cerevisiae* Pheromone Response Pathway on the MAP Kinase Fus3p." *Genet.* **151**, 1425-1444.
58. N.V. Grishin, A.L. Osterman, H.B. Brooks, M.A. Phillips, and E.J. Goldsmith (1999). "X-ray Structure of Ornithine Decarboxylase from *Trypanosoma brucei*: The Native Structure and the Structure in Complex with  $\alpha$ -Difluoromethylornithine." *Biochem.* **38**, 15174-15184.
59. J.L. Wilsbacher, E.J. Goldsmith, and M.H. Cobb (1999). "Phosphorylation of MAP kinase by MAP/ERK involves multiple regions of MAP kinases." *J. Biol. Chem.* **24**, 16988-16994.
60. M.H. Cobb and E.J. Goldsmith (2000). "Dimerization in MAP Kinase Signaling." *Trends in Biochem. Sci.* **25**:7-9.
61. G.S. Jagannatha Rao, D.E. Coleman, G. Kulkarni, E.J. Goldsmith, P.F. Cook, and B.G. Harris (2000). "NAD-Malic Enzyme from *Ascaris suum*: Sequence and Structural Studies." *Protein and Peptide Letters*, **7**:297-304.
62. L.K. Jackson, H.B. Brooks, A.L. Osterman, E.J. Goldsmith, and M.A. Phillips (2000). "Altering the reaction specificity of eukaryotic ornithine decarboxylase." *Biochemistry* **39**, 11247-57.
63. B. Xu, J.M. English, J.L. Wilsbacher, S. Stippec, E.J. Goldsmith, and M.H. Cobb, (2000). "WNK1, a novel mammalian serine/threonine protein kinase lacking the catalytic lysine in subdomain II." *J. Biol. Chem.* **22**: 16795-801.
64. A.H. Hoofnagle, K.A. Resing, E.J. Goldsmith, and N.G. Ahn (2001). "Changes in Protein Conformational Mobility Upon Activation of Extracellular Regulated Protein Kinase-2 as



- Detected by Hydrogen Exchange.” Proc. Natl. Acad. Sci. **98**, 956-961.
65. S. Ye, A. Cech, R. Belmares, R. Bergstrom, D. Corey, M. Kanost, and E. J. Goldsmith (2001). “The structure of a Michaelis Serpin-Protease Complex.” *Nat. Str. Biology* **8**, 979-983.
  66. S. Ye and E.J. Goldsmith (2001). “Serpins and other covalent protease inhibitors.” *Curr. Opin. Struc. Biol.* **11**, 740-745.
  67. D.E. Coleman, G.S. Jannatha Rao, E.J. Goldsmith, P.F. Cook, and B.G. Harris (2001). “Crystal structure of the malic enzyme from *Ascaris suum* complexed with NDA<sup>+</sup> at 2.3 Å resolution.” *Biochemistry* **22**, 6928-6938.
  68. E.J. Goldsmith, M.H. Cobb, and C.-I. Chang (2001). “Structural Studies of MAP Kinases.” MAP Kinase Protocols Humana Press.
  69. C. Chang, B. Xu, R. Akella, M.H. Cobb, and E.J. Goldsmith (2002). “Crystal Structures of MAP Kinase p38 Complexed to the Docking Sites on Its Nuclear Substrate MEF2A and Activator MKK3b.” *Mol. Cell*, **9**, 1241-1249.
  70. E.J. Goldsmith and C-I. Chang (2002), “Another Twist in Helix C and a Missing Pocket.” *Structure* **10**, 888-889.
  71. R.C. Bergstrom, Coombs, GS, Ye, S, Madison, EL, Goldsmith, EJ, Corey, DR (2003). “Binding of nonphysiological protein and peptide substrates to proteases: differences between urokinase-type plasminogen activator and trypsin and contributions to the evolution of regulated proteolysis.” *Biochemistry* **42**, 5395-402.
  72. L.K. Jackson, Elizabeth J. Goldsmith, and Margaret A. Phillips (2003). “X-ray Structure Determination of *Trypanosoma brucei* Ornithine Decarboxylase Bound to D-Ornithine and to G418.” *J. Biol. Chem.*, **278**, 22037-22043.
  73. T. Zhou, Malavika Raman, Yan Gao, Zhu Chen, Mischa Machius, Melanie H. Cobb and Elizabeth J. Goldsmith (2004). “Active Structure of the TAO2 Kinase Domain: Activation and Specificity of a Ste20p MAP3K”, *Structure* **12**, 1891-900.
  74. X. Min, Byung-Hoon Lee, Melanie H. Cobb, Elizabeth J. Goldsmith (2004). “Crystal Structure of the Kinase Domain of WNK1, a Kinase that Causes a Hereditary Form of Hypertension.” *Structure*, **12**, 1303-1311.
  75. E.J. Goldsmith, Cobb, MH, Chang, CI (2004). “Structure of MAPKs”, *Methods Mol. Biol.* **250**, 127-43.
  76. Jackson LK, Baldwin J, Akella R, Goldsmith EJ, Phillips MA. (2004 ). " Multiple active site conformations revealed by distant site mutation in ornithine decarboxylase". *Biochemistry*, **43**, 12990-9.

77. T. Lee, Andrew N. Hoofnagle, Yukihito Kabuyama, James Stroud, Xiaoshan Min, Elizabeth J. Goldsmith, Lin Chen, Katheryn A. Resinhg, and Natalie G. Ahn (2004), "Docking Motif Interactions in MAP Kinases Revealed by Hydrogen Exchange Mass Spectrometry", *Mol. Cell* **14**, 43-55.
78. B.H. Lee, Xiaoshan Min, Charles J. Heise, Bing-e Xu, She Chen, Hongjun Shu, Kate Luby-Phelps, Elizabeth J. Goldsmith, and Melanie H. Cobb (2004). "WNK1 Phosphorylates Synaptotagmin 2 and Modulates Its Membrane Binding", *Mol. Cell* **15**, 741-751.
79. Xu BE, Lee BH, Min X, Lenertz L, Heise CJ, Stippec S, Goldsmith EJ, Cobb MH. (2005) "WNK1: analysis of protein kinase structure, downstream targets, and potential roles in hypertension". *Cell Res.* **15**, 6-10.
80. Lenertz NY, Lee BH, Min X, Xu BE, Wedin K, Earnest S, Goldsmith EJ, Cobb MH. (2005). "Properties of WNK1 and implications for other family members". *J. Biol. Chem.* **280**, 26653-8.
81. Zhou T, Sun L, Humphreys J, Goldsmith EJ. (2006 ). "Docking Interactions Induce Exposure of Activation Loop in the MAP Kinase ERK2". *Structure* **6**, 1011-9.
82. Zhou TJ, Sun LG, Gao Y, Goldsmith EJ. (2006) "Crystal Structure of the MAP3K TAO2 Kinase Domain Bound by an Inhibitor Staurosporine". *Acta Biochim Biophys Sin (Shanghai)*. **6**, 385-92.
83. Mukherjee S, Keitany G, Li Y, Wang Y, Ball HL, Goldsmith EJ, Orth K. (2006 ). "Yersinia YopJ acetylates and inhibits kinase activation by blocking phosphorylation". *Science* **5777**, 1211-4.
84. Zhou H, Zheng M, Chen J, Xie C, Kolatkar AR, Zarubin T, Ye Z, Akella R, Lin S, Goldsmith EJ, Han J. (2006). "Determinants that control the specific interactions between TAB1 and p38alpha". *Mol Cell Biol.* **10**, 3824-34.
85. Wilsbacher JL, Juang YC, Khokhlatchev AV, Gallagher E, Binns D, Goldsmith, EJ, Cobb MH. (2006). "Characterization of mitogen-activated protein kinase (MAPK) dimers". *Biochemistry* **45**, 13175-82.
86. Lee SJ, Zhou T, Goldsmith EJ. (2006). "Crystallization of MAP kinases". *Methods* (2006). **3**, 224-33. Review.
87. Shah R, Akella R, Goldsmith EJ, Phillips MA.(2007). "X-ray structure of Paramecium bursaria Chlorella virus arginine decarboxylase: insight into the structural basis for substrate specificity". *Biochemistry* **46**, 2831-41.
88. Goldsmith EJ, Akella R, Min X, Zhou T, Humphreys JM.(2007). "Substrate and Docking Interactions in Serine/Threonine Protein Kinases". *Chem Rev.* **107**:5065-5081.
89. Yazicioglu MN, Goad DL, Ranganathan A, Whitehurst AW, Goldsmith EJ, Cobb MH.

- (2007). “Mutations in ERK2 binding sites affect nuclear entry”. *J Biol Chem.* **282**:28759-67.
90. Lee J, Michael AJ, Martynowski D, Goldsmith EJ, Phillips MA. (2007). “Phylogenetic diversity and the structural basis of substrate specificity in the beta/alpha-barrel fold basic amino acid decarboxylases”. *J. Biol. Chem.* **282**:27115-25.
91. Akella R, Moon TM, Goldsmith EJ (2008). “Unique MAP Kinase binding sites”. *Biochim Biophys Acta.* **1784**:48-55.
92. Min X, Akella R, He H, Humphreys JM, Tsutakawa SE, Lee SJ, Tainer JA, Cobb MH, Goldsmith EJ. (2009). “The structure of the MAP2K MEK6 reveals an autoinhibitory dimmer”. *Structure* **17**:96-104.
93. Lee SJ, Cobb MH, Goldsmith EJ (2009). “Crystal structure of domain-swapped STE20 OSR1 kinase domain”. *Protein Sci.* **18**:304-13.
94. Deng X, Gujjar R, El Mazouni F, Kaminsky W, Malmquist NA, Goldsmith EJ, Rathod PK, Phillips MA (2009). “Structural plasticity of malaria dihydroorotate dehydrogenase allows selective binding of diverse chemical scaffolds”. *J Biol Chem.* **284**(39):26999-7009. PMID: 19640844.
95. Deng X, Lee J, Michael AJ, Tomchick DR, Goldsmith EJ, Phillips MA. (2010) “Evolution of substrate specificity within a diverse family of beta/alpha barrel-fold basic amino acid decarboxylases: X-ray structure determination of enzymes with specificity for L-arginine and carboxynorspermidine.” *J Biol Chem.*; **285**:25708-19. PMID: 20534592.
96. Goldsmith EJ, Min X, He H, Zhou T. (2010) “Structural studies of MAP Kinase cascade components.” *Methods Mol Biol.* **661**: 223-37. PMID: 20811986.
97. Booker ML, Bastos CM, Kramer ML, Barker RH Jr., Skerlj R, Sidhu AB, Deng X, Celatka C, Cortese JF, Guerrero Bravo JE, Crespo Llado KN, Serrano AE, Angulo-Barturen I, Jiménez-Díaz MB, Viera S, Garuti H, Wittlin S, Papastogiannidis P, Lin JW, Janse CJ, Khan SM, Duraisingh M, Coleman B, Goldsmith EJ, Phillips MA, Munoz B, Wirth DF, Klinger JD, Wiegand R, Sybertz E (2010). “Novel inhibitors of Plasmodium falciparum dihydroorotate dehydrogenase with anti-malarial activity in the mouse model.” *J Biol Chem.* **285**:33054-64. PMID:20702404; PMCID: PMC2963363.
98. Akella R, Min X, Wu Q, Gardner KH, Goldsmith EJ. (2010). “The third conformation of p38a MAP kinase observed in phosphorylated p38a and in solution.” *Structure* **18**:1571-8. PMID: 21134636.

99. Coterón JM, Marco M, Esquivias J, Deng X, White KL, White J, Koltun M, El Mazouni F, Kokkonda S, Katneni K, Bhamidpati R, Shackelford D, Barturen I, Ferrer S, Jiménez-Díaz MB, Gamo FJ, Goldsmith EJ, Charman B, Bathurst I, Floyd D, Matthews D, Burrows JN, Rathod PK, Charman SA, Phillips MA. (2011). "Structure-guided lead optimization of triazolopyrimidine-ring substituents identifies potent *Plasmodium falciparum* dihydroorotate dehydrogenase inhibitors with clinical candidate potential." *J Med Chem.* 54:5540-61. PMID 21696174; PMCID: PMC3156099.
  
100. Ahn YH, Yang Y, Gibbons DL, Creighton CJ, Yang F, Wistuba II, Lin W, Thilaganathan N, Alvarez CA, Roybal J, Goldsmith EJ, Tournier C, Kurie JM (2011). "Map 2k4 functions as a tumor suppressor in lung adenocarcinoma and inhibits tumor cell invasion by decreasing peroxisome proliferator-activated receptor  $\gamma$ 2 expression." *Mol Cell Biol*, **31**:4270-85. PMID: 21896780; PMCID: PMC3209326.
  
101. Ahn YH, Yang Y, Gibbons DL, Creighton CJ, Yang F, Wistuba II, Lin W, Thilaganathan N, Alvarez CA, Roybal J, Goldsmith EJ, Tournier C, Kurie JM. *Mol Cell Biol*. (2011). "Map2k4 functions as a tumor suppressor in lung adenocarcinoma and inhibits tumor cell invasion by decreasing peroxisome proliferator-activated receptor  $\gamma$ 2 expression" *Nov*;31(21):4270-85. doi: 10.1128/MCB.05562-11. Epub 2011 Sep 6.
  
102. Goldsmith EJ. (2011). "Three-dimensional docking in the MAPK p38 $\alpha$ ." *Sci. Signal.* **4**(204):pe47. PMID:22375047.
  
103. Kato M, Han TW, Xie S, Shi K, Du X, Wu LC, Mirzaei H, Goldsmith EJ, Longgood J, Pei J, Grishin NV, Frantz DE, Schneider JW, Chen S, Li L, Sawaya MR, Eisenberg D, Tycko R, McKnight SL. (2012). "Cell-free formation of RNA granules: low complexity sequence domains form dynamic fibers within hydrogels." *Mol Cell Biol*, **149**(4):753-67. PMID:22579281.
  
104. Moon TM, Correa F, Kinch LN, Píala AT, Gardner KH, Goldsmith EJ. (2013) "Solution Structure of the WNK1 Autoinhibitory Domain, a WNK-Specific PF2 Domain" *J Mol Biol*. 2013 Apr 26;425(8):1245-52. doi: 10.1016/j.jmb.2013.01.031. Epub 2013 Jan 30. PMID: 23376100
  
105. Humphreys JM, Píala AT, Akella R, He H, Goldsmith EJ. (2013) "Precisely Ordered Phosphorylation Reactions in the p38 MAP Kinase Cascade." *Epub J Biol Chem*. 2013 Jun 6.

### Ongoing Research Support

I-1128 The Welch Foundation Goldsmith (PI) 6/1/12-5/31/14

"Docking interactions between the MAP3Ks, ASK1/TAO2 and B-Raf with their cognate MAP2Ks MEK6 and MEK1"

The project concerns docking interactions between members of the MAPK module TAO2, MEK6 and p38, as well as B-raf, MEK2 and ERK2.

RP38482 Goldsmith (PI) 06/10/-09/13

Cancer Prevention and Research Institute of Texas

Inhibitors of the MAP3K TAO2

The goal of this study is to identify and characterize specific inhibitors of the MAP3K TAO2 using thermal shift assays. Inhibitors will be used to modulate cell checkpoint regulation, increasing the efficacy of chemotherapeutic treatments.

Role: PI

Patent Fees Goldsmith (PI) 01/01/- ongoing

Chymotrypsin family proteases resistant to inhibition by serpins

### **Completed Research Support**

I1128 Goldsmith (PI) 06/10/-05/12

Welch Foundation

Structure of Vop A, a virulence factor of *Vibrio Parahaemo*

The goal of this study is to elucidate structure/function relationships of VopA as a selective inhibitor of MAPK signaling pathways.

Role: PI

3 R01 DK046993-16S1 Goldsmith (PI) 05/06-04/10

National Institutes of Health

Interactions and dual phosphorylation in MAP kinase cascades

The major goal of this project is to understand substrate interactions in MAP kinases.

Role: PI

5 RO1 DK46993-16S1 1/10/10-3/31/10 Goldsmith (PI) 05/06-04/10

National Institutes of Health

Interactions and Dual Phosphorylation in MAP Kinase Cascades

This grant is a Recovery Act Funds for Administrative Supplements (ARRA) award.

Role: PI

### **Invited Lectures and Seminars**

University of California, San Francisco, January 1991. Bill Rutter, host, seminar to the Hormone Research Institute. "Evolution of Specificity in an Enzyme Family".

Wesleyan University, Middleton Connecticut, March 1991. Paul Haake, host, seminar to Biochemistry department "Evolution of Specificity in an Enzyme Family".

Pfizer Chemical, Groton, Connecticut, March 1991. Kieran Goeghegan, host, seminar to research unit, "Progress on the Structure of PAI-1 and tPA Mutagenesis."

Purdue University, West Lafayette, Indiana, September 1991. Cynthia Stauffacher, host, seminar to Crystallography Department, "Structure of Plasminogen Activator Inhibitor-1".

University of Arizona, Tucson, Arizona, January 1992. Bill Montfort, host, seminar to Biophysics, "Latent Tendencies of PAI-1".

University of California, Los Angeles, March 1992. David Eisenberg, host, Molecular Biology Institute seminar "Structure and Regulation of Plasminogen Activator Inhibitor-1".

Virginia Commonwealth University, Richmond VA, April 1992. Tonie Wright, host, seminar to Biochemistry Department, "Structure of Plasminogen Activator Inhibitor-1".

Texas A&M, College Station Texas, May 1992. Jeff Kelly, host, seminar to Chemistry, "Structure and Regulation of Plasminogen Activator Inhibitor-1".

Arrhus University, Arhus, Denmark, June 1992. Peter Andreasen, host, "Structure and Regulation of Plasminogen Activator-1".

University of Umeå, Umeå, Sweden, June 1992. Tor Ny, host, Applied Cell- and Molecular Biology, "Structure and Regulation of Plasminogen Activator Inhibitor-1".

University of Leuven, Leuven, Belgium, June 1992. Paul Declerck, host, seminar "Structure and Regulation of Plasminogen Activator Inhibitor-1".

Kerckhoff-Clinic, Max Planck-Gesellschaft, Bad Nauheim, Germany, June 1992. Klaus T. Preissner, host, seminar "Structure and Regulation of Plasminogen Activator Inhibitor-1".

Max Planck Institut, Martinsried, Germany, June 1992. Wolfram Bode and Robert Huber, hosts, seminar "Structure and Regulation Plasminogen Activator Inhibitor-1".

Gordon Conference on Serine Proteases, June 1992. Robin Carrell, host, "Structure and Regulation of Plasminogen Activator Inhibitor-1".

University of Cambridge, Cambridge, England, June 1992. Robin W. Carrell, host, "Structure and Regulation of Plasminogen Activator Inhibitor-1".

International Union of Fibrinolysis, Copenhagen, Denmark, July 1992. Tor Pederson, host, symposium presentation "Structure and Regulation of Plasminogen Activator Inhibitor-1".

DuPont, Wilmington, Delaware September 1992. Thomas Reilly, host, "Structure and Regulation of Plasminogen Activator Inhibitor-1".

Scripps Research Institute, La Jolla, California, September 1992. Elizabeth Getzoff, host, "Structure and Regulation of Plasminogen Activator Inhibitor-1".

Biophysical Society National Symposium, Washington D.C, Feb 1993. "Structure of the MAP kinase ERK2".

University of Pennsylvania, Philadelphia, Penn, March 1993. "Structure and Regulation of PAI-1"

Proteins Gordon Conference, Tilton School NH June 1993. "Structure and Regulation of PAI-1"

Kansas State Univ., Manhattan, KS, October 1993. "Structure and Regulation of PAI-1."

ASBMB Symposium on Signal Transduction, Washington D.C. May 1994. "Structure of the MAP kinase ERK2.

FASEB Summer Course on Protein Kinases, August 1994. "MAP kinases."

Scripps Research Institute, La Jolla, California, January 1995. Edwin L. Madison, host, "MAP kinases."

Smith Kline Beecham, King of Prussia, PA, March 1995. "MAP kinases."

Parke-Davis, Ann Arbor, Michigan, January 1995. Alan Saltiel, host, "MAP kinases"

Scripps Research Institute, La Jolla, California, January 1995. Edwin L. Madison, host.

Dupont-Merck, February 1995. "MAP kinases."

The Structural basis for Phosphate Signaling Workshop, Tatry Mountains Poland, May 10-26, 1995. "MAP kinases."

International Union of Crystallography, Seattle Washington, August 1995. "MAP kinases."

University of Texas, Austin, TX September 1995. John Robertus, host, "MAP kinases."

Vertex, Boston Mass, March 1996. "MAP kinases."

Serpin International Symposium on the Biology of Serpins, March 1996. "Serpin structure and folding"

Glaxo-Wellcome, March 1996. "MAP kinases."

SmithKline Beecham, King of Prussia, PA, May 1996. "MAP Kinases."

Ciba Geigy, N.J., June 1996. "Activation and Inhibition of MAP Kinases."

Roche Biosciences, Palo Alto, CA, June 1997. "The structure of p38."

Regeneron Corp, Tarrytown, NY, Feb. 4, 1998. "Activation and Inhibition of MAP Kinases."

Wyeth-Ayrherst, Princeton, N.J., March 1998. "Structure and Folding of Serpins."

Wyeth Ayrherst, Yorktown Heights, March 1998. "Activation and Inhibition of MAP kinases."

Northwestern Drug Discovery Program, Linda Van Eldik, host, March 1998. "Activation and Inhibition of MAP kinases."

NMHCC Conference: Cell Signaling Signal Transduction and Gene Transcription, San Diego, July 14-15 1998. "Activation and Inhibition of MAP kinases."

FASEB Conference of Receptors and Signal Transduction, July 19-24, 1998. "Activation and Inhibition of MAP kinases."

The Salk Institute, San Diego, California, August 1999. Oncogene Symposium.

Crystallography Congress, Glasgow, Scotland, August 1999. International Union of Crystallography, host, James Naismith.

Selectide, Tucson, Arizona, September 1999. Ken Wertman, host, "Activation and Inhibition of MAP Kinases".

UT Southwestern Department of Physiology October 2000. "Serpine Mechanism"

American Crystallographic Association, August 2000 "Serpine/Protease Complex"

West Coast Protein Crystallography Workshop, Asilomar, March 2001, "Serpine/Protease Complex" (Sheng Ye).

Galveston Symposium on Structural Biology, May 2001 "Serpine Inhibitory Mechanism"

Biogen, Boston, MA August 2001, "Activation and Inhibition of MAP kinases"

Arqule, Boston, MA August 2001, "Activation and Inhibition of MAP kinases"

Cell Signalling (FASEB meeting), Taos, March 2002, "Interactions of MAP kinases"

Montsanto/Pharmacia, St. Louis Mo., March 2002, "Activation and Inhibition of MAP kinases"

Serpine Symposium Chicago, June 2-4, 2002, Knickerbocker Hotel, "Serpine-Protease Complex"

West Coast Protein Crystallography Workshop, San Jose, CA, March 23-26, 2003, "The Crystal Structure of the Kinase Domain of Wnk Protein Kinase, a Kinase Involved in Hypertension Disease" (Xiaoshan Min); "How a MAP Kinase Kinase talks to a MAP Kinase: a Kinetic Investigation" (Prashanti Madhavapeddi)

University of Toledo, March 30-31, 2003, "Substrate Interactions in Protein Kinases."

Shering Plough, June 12, 2003, "Substrate Interactions in Protein Kinases."

GlaxoSmithKline, August 6-8, 2003, "Substrate Interactions in Protein Kinases."

Roche Palo Alto, Palo Alto, CA, August 21-22, 2003, "Substrate Interactions in Protein Kinases."

Southwest Macromolecular Symposium Crystallography Meeting, Woodlands, TX, October 27-28, 2003, "Substrate Interactions in Protein Kinases."



Case Western Reserve University, November 17-18, 2003, "Substrate Interactions in MAP Kinase Pathway Enzymes."

Weill Medical College of Cornell University, New York, NY, March 3-7, 2004, "Substrate Interactions in MAP Kinase Pathway Enzymes."

University of California at Los Angeles, March 22-24, 2004, "Substrate Interactions in Protein Kinases."

Pfizer Global Research & Development, 6<sup>th</sup> Winter Conference on Medicinal & Bioorganic Chemistry, Steamboat Springs, CO, January 24-28, 2005.

Biophysical Society Annual Meeting, Salt Lake City, Utah, February 18-22, 2006.

American Chemical Society Meeting, Atlanta, GA, March 25-30, 2006.

American Society for Biochemistry and Molecular Biology Annual Meeting, San Francisco, CA, April 1-4, 2006.

American Society for Biochemistry and Molecular Biology Annual Meeting, Galveston, TX, May 18-21, 2006.

American Crystallography Association, Honolulu, Hawaii, July 22-27, 2006.

The 20<sup>th</sup> Symposium of the Protein Society, San Diego, CA, August 5-9, 2006.

American Chemical Society, 62<sup>nd</sup> Southwest Regional Meeting, Houston, TX, October 19-22, 2006, "Processing Conformation of MAP Kinases."

The 18<sup>th</sup> West Coast Protein Crystallography Workshop, San Francisco, CA, March 11-14, 2007.

The 5<sup>th</sup> International Conference on Inhibitors of Protein Kinase, Warsaw, Poland, June 23- 27, 2007, "Conformational Changes in MAP Kinase Signaling."

The University of Montana, Missoula, MT (Invited Speaker), October 11-12, 2007.

The 51<sup>st</sup> Conference on Chemical Research, Houston, TX, October 21-23, 2007.

First International Conference of Drug Design and Discovery, Dubai, United Arab Emirates, (Invited Speaker) February 2-7, 2008.

Gordon Research Conference: Phorylation and G-Protein Mediated Signaling Networks, University of New England in Biddeford ME, June 15-20, 2008.

The 22<sup>nd</sup> Symposium of the Protein Society, San Diego, CA, July 19-23, 2008

Duke University Medical Center, Invited speaker, Raleigh Durham, NC, September 16-18, 2008.

Welch Conference, Houston, TX, October 26 – 28, 2008

American Medical Informatics Association Summit on Translational Bioinformatics, San Francisco, CA, March 15-17, 2009.

University of Utah, Graduate Reviews for Fall 2009, Salt Lake City, UT, November 1-3, 2009.

Keystone Symposium on Structural Biology (Session Chair), Denver, CO, January 8-12, 2010.

Texas Protein Folders (Invited Lecture) College Station, TX, April 5, 2012

Experimental Biology (Attending WNK symposium) San Diego, CA, May 5, 2012

MAP Kinases in Health and Disease (Invited Lecture) Jerusalem, Israel, Sept 4, 2012

Advisory Panel for U. Montana COBRE (panelist) Missoula, MT, Sept 12, 2012

Advisory Panel for U. Oklahoma COBRE (panelist) Norman, OK, May 20, 2013