Frank A. Ferrone

EDUCATION

1969	BS in Physics, Manhattan College, Bronx, New York
1971	MA in Physics, Princeton University, Princeton, New Jersey
1974	PhD in Physics, Princeton University, Princeton, New Jersey

Thesis: Transient Circular Dichroism in Hemoglobin
Advisor: Professor John J. Hopfield

EMPLOYMENT

2006-2013	Senior Associate Vice Provost for Research, Drexel University
1992-2003	Associate Department Head, Department of Physics, Drexel University
1990-present	Professor, Department of Physics, Drexel University
1986-1990	Associate Professor, Department of Physics & Atmospheric Science, Drexel University
1980-1986	Assistant Professor, Department of Physics & Atmospheric Science, Drexel University
1976-1980	Staff Fellow, Laboratory of Chemical Physics, NIH, Bethesda, Maryland
1975-1976	Visiting Fellow (NIH Research Service Award), Physics Department, Princeton University
1974-1975	Instructor, Physics Department, Princeton University
1972-1974	Research Assistant, Physics Department, Princeton University
1970-1972	Assistant in Instruction, Physics Department, Princeton University
1969-1970	NASA Trainee, Physics Department, Princeton University
1969	Research Assistant, Physics Department, Princeton University
1969	Instructor in Physics, Academy of the Sacred Heart High School, New York
1966-1968	Teaching Assistant, Physics Department, Manhattan College

FUNDING HISTORY

sole Principal Investigator:

- Conformational Kinetics of Biological Molecules,
  funded by NIH (NIDDKD) 1982 -- 1993
- Photolysis Studies of Sickle Hemoglobin Polymerization,
  funded by NIH (NHLBI) 1982 — 1996
- Heterogeneous Nucleation in Sickle Cell Disease
  funded by NIH (NHLBI) 1996 — 2012

Principal Investigator, with collaborators:

- Diode Array Spectrophotometer,
  funded by NIH small instrument program
- Computation/Graphics Facility,
  NIH shared instrumentation grant
- Structure, Mechanism & Pathophysiology in Sickle Cell Disease
  part of a Program Project Grant funded by the NIH, 1997-2007
- The Implications of Multiple Axial Contacts in Sickle Hemoglobin Polymers, CURE grant from Commonwealth of PA 2016-2018
- Biophysics of Increasing Fetal Hemoglobin as Therapy for Sickle Cell Disease, funding from NIDDK 2021-2022

Non-principal investigator:

- NIH small instrument program,
  (Prof. Davis, Chemistry, PI)

PHD STUDENTS

Anthony J. Martino, *Allosteric Kinetics of Hemoglobin Probed by Modulated Excitation with Fluorescence Detection,* 1988 --staff in Engineering Physics Department, DuPont

Huan Xiang Zhou, *Numerical Simulations of the Glucagon Self-Association Dynamics,* 1988
postdoc at NIH; Asst Prof Hong Kong Univ of Science & Technology;

Michael R. Cho, *Diffusion of Monomers in Polymer Domains in Sickle Hemoglobin,* 1990
instructor at Harvard Medical School

Mingdi Zhao, *Allosteric and Protonation Kinetics in Triliganded Hemoglobin*, 1993
postdoctoral position at University of Pennsylvania

Jie Jiang, *Effect of Water on the Allosteric Equilibrium and Kinetics of Hemoglobin,* 1993
postdoctoral position at Boston Biomedical Research Institute

Zhiqi Cao, *Stochastic Studies on Nucleation in Sickle Hemoglobin* 1995
post graduation maternity leave

Dan Liao, *Kinetic Micomethod for Measuring the Solubility of Native and Mutant Sickle Hemoglobin* 1997 systems programmer

Rossen Mirchev, *Heterogeneous Nucleation of Sickle Hemoglobin* 1999, postdoc at Harvard Medical School

Weijun Weng, *Universal Metastability of Sickle Hemoglobin Polymerization* 2007
MBA at NYU

Mikhail Zakharov, *A Microrheological Study of Sickle Hemoglobin Polymerization 2009*
Postdoc at Boston University

Zenghui Liu, *Fundamental Studies in Sickle Hemoglobin Polymerization,* 2011 PhD in Economics, Drexel University

Yihua Wang, *Light Scattering Studies of Hemoglobin Association* 2011 Postdoc at Mayo Clinic, Rochester, MN

Donna Yosmanovich, *A Study of Partially Liganded Sickle Hemoglobin Polymerization Kinetics* 2012, Johnson & Johnson part time, + post graduation maternity leave

Christopher Brown, *The Flow of Sickle Blood Through Glass Capillaries and Its Diagnostic Implications,* 2018, Visiting Assistant Professor at Villanova University

Eli Worth, PhD expected 2022

Mark Fugate, PhD expected 2024

PROFESSIONAL SOCIETIES

American Physical Society (Fellow)
Biophysical Society

HONORS

NIH Hercules Lecture, 2007
Fellow of the American Physical Society, 1997
Drexel University Research Achievement Award, 1991
Member: Sigma Xi
Member: Sigma Pi Sigma
Woodrow Wilson Fellow 1969-1970
Radford Medal in Physics 1969 (Manhattan College)

INVITED PARTICIPANT:
(*contribution published)

Biophysical Discussions, Airlie, Virginia, 1978
Frontiers of Biological Energetics Symposium, Philadelphia, Pennsylvania, 1978*
Symposium on Biological Recognition and Assembly, Keystone, Colorado, 1979.
Symposium on the Molecular Basis of Mutant Hemoglobin Dysfunction, Chicago, Illinois, 1980*
Symposium on the Interaction between Iron and Proteins, Airlie, Virginia, 1980*.
Biophysical Discussions, Airlie, Virginia, 1980*
Conference on Rheological Aspects of Sickle Cell Disease, Airlie, Virginia, 1981.
Workshop on Development of Therapeutic Agents for Sickle Cell Disease, Bethesda, Maryland, 1983.
Biophysical Discussions, Airlie, Virginia, 1985
Annual NIH Investigators meeting on Sickle Cell Disease, Bethesda, Maryland, 1985-1993
Approaches to the Therapy of Sickle Cell Anemia, Pointe-a-Pitre, Gaudeloupe, 1985*
Pathophysiological Aspects of Sickle Cell Vasoocclusion, Tarrytown, NY, 1986*
Workshop on the Structure and Dynamics of Proteins, Paris, France, 1986.
Sickle Cell Disease in the Next Decade: Innovative Therapeutic Approaches, Washington, DC, 1987
Sickle Cell Disease: the state of the art (NY Acad. of Sciences) Bethesda, Maryland 1988*.
Symposium on Oxygen Binding Heme Proteins, Asilomar, California, 1988.
Conference on the Dynamics and Kinetics of Myoglobin and Hemoglobin, Bethesda, Maryland, 1990
European Conference on Clinical Haemorheology, Southhampton, England, 1991*
FASEB Conference on Amyloid & Other Abnormal Protein Assembly Processes, Copper Mtn, CO), 1995
Workshop on Phase Transformation Occurring in Solutions of Biological Molecules, MIT, 1997
Golden Jubilee Symposium on Trends in Cellular and Molecular Biophysics, Calcutta, India, 2000
Materials Research Society Annual Meeting, San Francisco, CA, 2001
Faraday Society, Edinburgh, Scotland, 2002
EMBO conference on Crowding, Avila, Spain 2003
Protein Aggregation Workshop, Breckenridge, CO, 2006
Conference on Protein Stability, Breckenridge, CO, 2007
35th Annual Convention of National Sickle Cell Disease Program, Washington, DC 2007
New Challenges in Protein Science, Parma, Italy, 2008
Conference on Crowding, Telluride, CO, 2009
Carolina Biophysics Symposium, Raleigh-Durham, NC, 2010
Conference on Protein Stability, Breckenridge, CO, 2011
Conference on Crowding, Telluride, CO, 2011
National Fluorescence Workshop (FCS 2012), Kolkata, India 2012
Protein Folding and Diseases, New Delhi, India 2012*
Conference on Protein Stability, Breckenridge, CO, 2015

PUBLICATIONS

1. F. A. Ferrone, Transient Circular Dichroism Studies of Hemoglobin (1974), thesis
2. F. A. Ferrone , J.J. Hopfield, & S. E. Schnatterly, "The Measurement of Transient Circular Dichroism: A New Kinetic Technique", Rev. Sci. Instrum., 45, 1392-1396 (1974)
3. F. A. Ferrone & W. C. Topp, "Circular Dichroism and Raman Studies of the Allosteric Transition in Methemoglobin," Biochem. Biophys. Res. Comm., 66, 444- 450 (1975)
4. F. A. Ferrone & J. J. Hopfield, "Rate of Quaternary Structure Change in Hemoglobin," Proc. Nat. Acad. Sci. (USA), 73, 4497-4502 (1976)
5. F. A. Ferrone, J. Hofrichter & W.A.Eaton, "Hemoglobin S Polymerization in the Photostationary State," in Frontiers of Biological Energetics, Vol. II (P.L. Dutton, J. Leigh & A. Scarpa, eds.) Academic Press, New York, pp. 1085-1092 (1978)
6. H.R.Sunshine, F. A. Ferrone, J. Hofrichter & W. A. Eaton, "Gelation Assays and the Evaluation of Therapeutic Inhibitors," in Development of Therapeutic Agents for Sickle Cell Disease, INSERM Symposium No. 9 (J. Rosa, Y., Beuzard & J. Hercules, eds.), Elsevier/North Holland, pp. 31-46 (1979)
7. F. A. Ferrone, J. Hofrichter, H. R. Sunshine, & W. A. Eaton, "Kinetic Studies on Photolysis Induced Gelation of Sickle Hemoglobin Suggest a New Mechanism," Biophys. J., 32, 361-380 (1980)
8. J. Hofrichter, H. R. Sunshine, F. A. Ferrone & W. A. Eaton, "Oxygen Binding and the Gelation of

Sickle Cell Hemoglobin," in Proceedings of the Symposium on the Molecular Basis of Mutant Hemoglobin Dysfunction (P. B. Sigler, ed.), Elsevier, North Holland, pp. 225-237 (1981).

9. H. R. Sunshine, J. Hofrichter, F. A. Ferrone & W. A. Eaton, "Sickle Cell Hemoglobin Polymers Bind Oxygen Non-cooperatively," in Proceedings of the Symposium on the Interaction between Iron and Proteins in Oxygen and Electron Transport, (C. Ho, ed.), Academic Press, pp. 291-295 (1982)
10. H. R. Sunshine, J. Hofrichter, F. A. Ferrone & W. A. Eaton,"Oxygen Binding by Sickle Hemoglobin Polymers", J. Mol. Biol., 158, 251-273 (1982)
11. M. Coletta, J. Hofrichter, F. A. Ferrone & W. A. Eaton, "Kinetics of Sickle Haemoglobin Polymerization in Single Red Cells," Nature, 300, 194-197 (1982)
12. M. F. Bishop & F. A. Ferrone, "Kinetics of Nucleation Controlled Polymerization: A Perturbation Treatment for Use with a Secondary Pathway", Biophys. J., 46, 631-644, (1984)
13. F. A. Ferrone, J. Hofrichter & W. A. Eaton, "Kinetics of Sickle Hemoglobin Polymerization I. Studies Using Temperature Jump and Laser Photolysis Techniques", J. Mol. Biol. 183, 591-610 (1985)
14. F. A. Ferrone, J. Hofrichter & W. A. Eaton, "Kinetics of Sickle Hemoglobin Polymerization II. A Double Nucleation Mechanism," J. Mol. Biol.183, 611-631 (1985)
15. F. A. Ferrone, A.J. Martino, & S. Basak "Conformational Kinetics of Triligated Hemoglobin," Biophys. J.48 269-282 (1985)
16. F. A. Ferrone, M. Cho, & M. F. Bishop, "Can a Successful Mechanism for HbS Gelation Predict Sickle Cell Crises?" in Beuzard, Y., Charache, S. & Galacteros, F. (ed) Approaches to the Therapy of Sickle Cell Disease, INSERM, 1986, pp 53-66.
17. F. A. Ferrone, "Allosteric Interpretation of the Measurement of Cooperative Free Energy in Cyanomethemoglobin", Proc. Nat. Acad. Sci. USA, 83 6412-6414 (1986)
18. F. A. Ferrone, S. Basak, A. J. Martino & H. X. Zhou, "Polymer Domains, Gelation Models and Sickle Cell Crises", in Nagel, R. (ed.) Pathophysiological Aspects of Sickle Cell Vasoocclusion, Alan R. Liss (1987) 47-58.
19. A. Weber, J. Northrup, M. F. Bishop, F. A. Ferrone & M. M. Mooseker, "Nucleation of Actin Polymerization by Villin & Elongation at Subcritical Monomer Concentration," Biochemistry, 26 2528-2536 (1987)
20. A. Weber, J. Northrup, M. F. Bishop, F. A. Ferrone & M. M. Mooseker, "Kinetics of Actin Elongation and Depolymerization at the Pointed End," Biochemistry, 26 2537-2544. (1987)
21. S. Basak, & F. A. Ferrone, "A Simple, Externally-Triggered Filter Changer" Rev. Sci. Instrum. 59 505-506 (1988)
22. S. Basak, F.A. Ferrone, & J. T. Wang, "Kinetics of Domain Formation by Sickle Hemoglobin Polymers", Biophys. J. 54 829-843. (1988)
23. S. Basak & F. A. Ferrone, "Numerical Linearization of a SIT vidicon Response", Rev. Sci. Instrum. 59 1423-1425 (1988)
24. F. A. Ferrone, "Kinetic Models and the Pathophysiology of Sickle Cell Disease," Ann. N. Y. Acad. Sci. 565 63-74. (1989)
25. A. J. Martino & F. A. Ferrone "The Rate of Allosteric Change in Hemoglobin Measured by Modulated Excitation Using Fluorescence Detection" Biophys. J. 56 781-794 (1989)
26. N. Zhang, F. A. Ferrone, & A. J. Martino "Allosteric Kinetics and Equilibria Differ for Carbon Monoxide and Oxygen Binding to Hemoglobin". Biophys. J. 58 333-340 (1990)
27. H. X. Zhou & F. A. Ferrone, "Theory of the Spatial Dependence of the Polymerization of Sickle Hemoglobin," Biophys. J. 58 695-703 (1990)
28. M. R. Cho & F. A. Ferrone, "Monomer Diffusion into Polymer Domains in Sickle Hemoglobin", Biophys. J. 58 1067-1073 (1990)
29. F. A. Ferrone, "Modulated excitation and conformational change in hemoglobin", *Comments in Biophysics* (1991) 7 309-332.
30. F. A. Ferrone, "Sickle hemoglobin polymerization: the relationship between kinetics and pathophysiology:" *Clin. Hemorheology* 12 163-175 (1992)
31. M. R. Cho & F. A. Ferrone, "Monomer Diffusion and Polymer Alignment in Domains of Sickle Hemoglobin" *Biophys. J.* 62 205-214 (1992)
32. M. Zhao, J. Jiang, M. Greene, F. A. Ferrone, M. Andracki, S. Fowler & J. A. Walder," Allosteric Kinetics and Equilibrium of Cross-Linked Hemoglobin." *Biophys. J.* 64 1520-1532 (1993)
33. F. A. Ferrone, "Polymerization of Sickle Hemoglobin in Solutions and in Cells", *Experientia*, 49 99-

185 (1993)
34. Q. Dou & F. A. Ferrone, "Simulated Formation of Polymer Domains in Sickle Hemoglobin (1993) *Biophys. J.* 65 2068-2077 (1993)
35. D. Liao, J. Jiang, M. Zhao & F. A. Ferrone, "Modulated Excitation of Singly Ligated Carboxyhemoglobin," *Biophys. J.* 65 2059-2067 (1993)
36. F. A. Ferrone, "Modulated Excitation Spectroscopy in Hemoglobin," *Methods Enzymol* 232 292-321 (1994)
37. F. A. Ferrone, "Oxygen Transits and Transports," in *Sickle Cell Disease: Basic Principles and Clinical Practice* , Hebbel, Mohandas and Steinberg, Raven Press, New York, 89-98 (1994)
38. Z. Cao & F. A. Ferrone, "A 50th order reaction predicted and observed for sickle hemoglobin nucleation" *J. Mol. Biol.* (1996) 256 219-222.
39. D. Liao, J. J. Martin de Llano, J-P Himanen, J. M. Manning & F. A. Ferrone "Solubility of Sickle Hemoglobin Measured by a Kinetic Micromethod" *Biophys. J.* (1996) 70 2442-2447
40. Z. Cao & F. A. Ferrone, "Homogeneous nucleation in sickle hemoglobin: stochastic measurements with a parallel method," *Biophysical Journal* (1997) 72 343-353
41. Z. Cao, D. Liao, R. Mirchev, J. J. Martin de Llano, J-P Himanen, J. M. Manning & F. A. Ferrone, "Nucleation and Polymerization of Sickle Hemoglobin with Leu β 88 substituted by Ala" *J. Mol. Biol* (1997) 265 580-589
42. R. Mirchev & F. A. Ferrone "The Structural Link Between Polymerization and Sickle Cell Disease" *J. Mol. Biol.* (1997) 265 475-479
43. F. A. Ferrone, "Analysis of Protein Aggregation Kinetics", *Methods of Enzymology*, v 309 256-274 (1999)
44. F. A. Ferrone & R. L. Nagel, "Structure and Polymerization of Deoxyhemoglobin S" *Disorders of Hemoglobin* (M. Steinberg, B. G. Forget, D. R. Higgs & R. L Nagel, eds.) Cambridge University Press 577-610 (2000)
45. M. Ivanova, R. Jasuja, S. Kwong, R. W. Briehl, and F. A. Ferrone: (2000) Nonideality and homogeneous nucleation of sickle hemoglobi*n Biophysical Journal,* 79: 1016-1022
46. A. Roufberg and F. A. Ferrone (2000) A Model for the Sickle Hemoglobin Fiber Using Both Mutation Sites *Protein Science 9:1031-1034*
47. K. Adachi, T. Yamaguchi, Y. Yang, P. T. Konitzer, J. Pang, K. S. Reddy, M. Ivanova, F. Ferrone, S. Surrey (2000) "Expression of Functional Soluble Human α Globin Chains of Hemoglobin in Bacteria" Protein Expr. and Purif. 20, 37-44.
48. M Ivanova, R Jasuja, L Krasnosselskaia, R Josephs, Z Wang, M Ding, K Horiuchi, K Adachi, and F A. Ferrone, (2001) Flexibility and Nucleation in Sickle Hemoglobin *J. Mol. Biol*. 314:851-61
49. R. Jasuja, M. Ivanova and F. A. Ferrone, Heterogeneous nucleation and crowding in sickle hemoglobin An analytic approach. .(2002) *Biophys J*. 82 399-406
50. X. Li, R. W. Briehl, R. M. Bookchin, R. Josephs, B. Wei, J. M. Manning, and F. A. Ferrone (2002) Sickle Hemoglobin Stability Probed by Triple and Quadruple Mutant Hybrids, *J. Biol. Chem.* 277: 13479-13487.
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52. Turner, M.S, Wang, J.C., Jones, C.,, Ferrone, F.A. Josephs R, and Briehl, R.W. (2002) Fluctuations in self-assembled sickle hemoglobin fibers, *Langmuir*, *18*(19); 7182-7187
53. G. Agarwal, Wang, J.C., Kwong, S., Cohen, S. M., Ferrone, F. A., Josephs, R., and Briehl, R.W. (2002) Sickle Hemoglobin Fibers: Mechanisms of Depolymerization *J. Mol. Biol* 322:395-412.
54. S. Chen, F. A. Ferrone, and R. Wetzel (2002) Monomeric nucleation of polyglutamine aggregation related to Huntington's Disease age-of-onset, *Proc Natl Acad Sci* Sep 3; 99(18):11884-9.
55. MS Turner, Briehl RW, Ferrone FA, Josephs R. (2003) Twisted protein aggregates and disease: the stability of sickle hemoglobin fibers. *Phys Rev Lett.* 90(12):128103.
56. CW Jones, Wang JC, Ferrone FA, Briehl RW, Turner MS. (2003) Interactions between sickle hemoglobin fibers. *Faraday Discuss.*123:221-36; discussion 303-22, 419-21
57. F.A. Ferrone, (2004) Polymerization and Sickle Cell Disease: A Molecular View, *Microcirculation* 11: 115-128.
58. G. Rivas, F. Ferrone , amd J. Herzfeld . (2004) Life in a crowded world. *EMBO Rep*. 5:23-7

59. F. A. Ferrone & M. A. Rotter (2004) Crowding and the polymerization of sickle hemoglobin *J Molec. Recog* 17: 497-504
60. M A. Rotter, A Aprelev, D Dragos, S Kwong, RW. Briehl, & FA. Ferrone (2004) Aspartame has no effect on the polymerization of sickle hemoglobin *Clin Pharmacol Ther* 75:248-249.
61. A Aprelev, M A. Rotter, Z Etzion, R M. Bookchin, R W. Briehl, and F A. Ferrone (2005) The effects of erythrocyte membranes on the nucleation of sickle hemoglobin *Biophys. J.* 88: 2815-2822
63. M A Rotter, A. Aprelev, K. Adachi & F. A. Ferrone, (2005) Molecular Crowding Limits the Role of Fetal Hemoglobin in Therapy for Sickle Cell Disease *J. Mol. Biol.* 347: 1015-1023
64. S. M. Vaiana, A. Emanuelle, M. A. Rotter, F. A. Ferrone, B. Vittorelli-Palma, (2005) Effect of T-R Conformational Change on Sickle Cell Hemoglobin Interactions and Aggregation *Proteins* 58:426-438
65. M. Rotter, S. Kwong, R. W. Briehl, & F. A. Ferrone (2005): Heterogeneous Nucleation in Sickle Hemoglobin: Experimental Validation of a Structural Mechanism *Biophys. J.* 89, 2677-84.
66. F. A. Ferrone (2006) Nucleation: the connections between equilibrium and kinetic behavior *Methods in Enzymol.* 412:285-99
67. M. S. Turner, R. W. Briehl, J. C. Wang,F.A. Ferrone and R. Josephs (2006) Anisotropy in sickle hemoglobin fibers from variations in bending and twist *J Mol Biol* 357(5):1422-7
68. Turner, M. S., Agarwal, G., Jones, C. W., Wang, J. C., Kwong, S., Ferrone, F. A., Josephs, R. & Briehl, R. W. (2006). Fiber depolymerization. *Biophys J* 91, 1008-13.
69. Adachi K, Ding M, Surrey S, Rotter M, Aprelev A, Zakharov M, Weng W, Ferrone FA (2006). The Hb A Variant (beta73 Asp-->Leu) Disrupts Hb S Polymerization by a Novel Mechanism. *J Mol Biol* 362, 528-538.
70. F. A. Ferrone (2007) Sickle Hemoglobin Polymerization: Just the Beginning, in *Renaissance of Sickle Cell Disease Research in the Genome Era* (Pace, ed.)
71. Aprelev A, Weng W, Zakharov M, Rotter M, Yosmanovich D, Kwong S, Briehl RW, Ferrone FA. (2007) Metastable polymerization of sickle hemoglobin in droplets. *J Mol Biol.* 369:1170-4
72. Liu, Z., Weng, W., Bookchin, R. M., Lew, V. L., and Ferrone, F. A. (2007) Free Energy of Sickle Hemoglobin Polymerization: A scaled-particle treatment for use with dextran as a crowding agent, *Biophys. J.* 94 :3629-34.
73. Weng W, Aprelev A, Briehl RW, Ferrone FA. (2008) Universal metastability of sickle hemoglobin polymerization. *J Mol Biol.* 377:1228-35.
74. Medkour T, Ferrone F, Galactéros F, Hannaert P. (2008) The double nucleation model for sickle cell haemoglobin polymerization: full integration and comparison with experimental data. Acta Biotheor. Jun;56(1-2):103-22.
75. Jiang Cheng Wang, Suzanna Kwong, Frank A. Ferrone, Matthew S. Turner, and Robin W. Briehl (2009). Fiber Depolymerization: Fracture, Fragments, Vanishing Times and Stochastics in Sickle Hemoglobin *Biophys J.* Jan;96(2):655-70
76. Rotter, M., Chu, H., Low, P., Ferrone FA (2010) Band 3 Catalyzes Sickle Hemoglobin Polymerization *Biophys. Chem.* 146(2-3):55-9.
77. Zakharov MN, Aprelev A, Turner MS, Ferrone FA (2010) The microrheology of sickle hemoglobin gels. *Biophys J.* 99(4):1149-56.
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79. Aprelev, A., Liu, Z, and Ferrone, FA (2011) The growth of sickle hemoglobin polymers *Biophys J.* 101: 885-91.
80. Rotter M, Yosmanovich D, Briehl RW, Kwong S, Ferrone FA. (2011) Nucleation of sickle hemoglobin mixed with hemoglobin A: experimental and theoretical studies of hybrid-forming mixtures. *Biophys J.*101(11):2790-7.
81. Aprelev A, Stephenson W, Noh HM, Meier M, Ferrone FA. (2012) The physical foundation of vasoocclusion in sickle cell disease. *Biophys J.* 103(8):L38-40.
82. F. A. Ferrone (2012) Nucleation and entropy compensation in biological assembly. *J. Proteins and Proteomics,* 3 (2) 157-168
83. Ferrone, F. A. and Aprelev, A. (2013) Ratchets, red cells, and metastability *Biophysical Reviews* **5 (**2)**:**217-224
84. Wang, Y. and Ferrone, F. A. (2013) Dissecting the energies that stabilize sickle hemoglobin polymers. *Biophys J.* Nov 5;105(9):2149-56.

85. F. A. Ferrone (2013) Dangerous Braids that Tangle in Brains and Veins *Sci. Am.* (guest blog) http://blogs.scientificamerican.com/guest-blog/2013/05/30/dangerous-braids-that-tangle-in-brains-and-veins/
86. F. A. Ferrone (2015) Assembly of Aβ Proceeds via Monomeric Nuclei. *J Mol Biol.* 427(2):287-90
87. F. A. Ferrone (2015) The delay time in sickle cell disease after 40 years: A paradigm assessed. *Am J Hematol.* 90(5):438-45
88. F. A. Ferrone (2015) Secondary Nucleation Wears the BRICHOS in this family *Nature Struct Mol Biol* 22(3):180-1
89. F. A. Ferrone, (2015) 2013 Benjamin Franklin Medal in Life Science presented to Rudolf Jaenisch, *Journal of the Franklin Institute*
90. Yosmanovich D, Rotter M, Aprelev A, Ferrone FA. (2016) Calibrating Sickle Cell Disease. *J Mol Biol.* 428(8):1506-14
91. Cellmer T, Ferrone FA, Eaton WA. (2016) Universality of supersaturation in protein-fiber formation. *Nat Struct Mol Biol.* 23(5):459-61
92. F. A. Ferrone (2016) GBT440 increases haemoglobin oxygen affinity, reduces, sickling and prolongs RBC half-life in a murine model of sickle cell disease (editorial comment) *Brit J Haematology*. 174(4):499-500
93. F. A. Ferrone (2016) Sickle Cell Disease: Its molecular mechanism and the one drug that treats it *Int. J. Biol. Macromolecules.* 93 part A, 1168-1173.
94. A. Mohammad, M. Davis, A. Aprelev, F. A. Ferrone (2016) Note: Professional Grade Microfluidics Fabricated Inexpensively. *Rev. Sci. Instrum.* 87(10):106105.
95. Ferrone FA (2018) Solid nuclei and liquid droplets: A parallel treatment for 3 phase systems. *Protein Sci.* 27(7):1286-1294
96. Ferrone, FA (2018) Targeting HbS Polymerization in *Seminars in Hematology* , 55 (2), 53-59
97. Rotter MA, Jiang J, Ferrone SM, Ferrone FA. (2018) Water, Ions, and Hemoglobin: Effects on Allostery and Polymerization. *Phys Chem B.* 122(49):11591-11597
98. Brown , CD, Aprelev, AM, Aliprando,M, Harkness,EA, and Ferrone FA (2021) The flow of sickle blood in glass capillaries: Fundamentals and potential applications *Biophys J* 120(11):2138-2147

TEACHING:

Courses developed:

Physics for Business Students: (3 credit lecture course, ~100 students) This was a 2 quarter course taken by students in the School of Business. Conventional conceptual physics courses, colloquially known as "Physics for Poets" maintain a more liberal-arts flavor, while algebra based courses focus on Pre-meds, and calculus based courses focus on Engineers and Physicists. The Business students had their own unique interests, mainly differing from the "poets" course in being highly numerate. I developed an approach to this cohort, and with Prof. Lane subsequently composed a text which we used for several years.

Physics for Life Sciences: (4.5 credit lecture course, today ~200 students) When I first became involved with this course, it had been deemed unnecessary for Biology majors to take more than 2 quarters of physics, and thus a 3 quarter sequence taken by the other sciences was abruptly truncated after 2 quarters with no regard to what might have been cut. I reorganized the course to cover a full survey of introductory physics. While I was engaged in administration the course was revised to be a full 3 quarter course, and I was asked to rebuild the curriculum to appropriate division among the quarters. When I returned from administrative duties, the course had grown in numbers and now had a laboratory component. My philosophy was to use the labs as exemplary of the week's material, so that I needed one lab per week. The suite of labs available as part of the Engineering course was designed to use 4 labs per quarter, whereas I needed 10, and thus I had to construct a large number of labs from scratch.

Introduction to Experimental Physics: (3 credit lecture course, ~20 students) This course is taken by first year Physics majors in their first quarter. When I took over this course, it had just been moved from a second-year course. The labs done were taken from existing labs in the Engineering sequence. There was a significant challenge because the students' knowledge of Physics was dependent on their high school preparation in the main (which had not been a problem when it was a sophomore course). I developed two new labs from scratch, revised several others, and rewrote all the writeups to be appropriate to a group of Physics students taking the sequence. In place of conventional lab reports, I made the students report their work in the style of a scientific publication. To facilitate learning how to present posters, we used a projector to generate "virtual posters" for one week.

Misc. Biophysics special topics courses: these were given for several years until the hiring of junior faculty in this field led me to hand the course over so they would have better access to graduate students.

Curricular Innovations:

1. Use of spreadsheets in the Business Physics course. This corresponded to the introduction of the Macintosh to Drexel. The spreadsheets permitted calculations that would normally need calculus.
2. Development of Peer Instruction: This corresponded to my work with the Biology course. The Bio majors asked why they did no group work in Physics, but did group work in all their other courses, so I began to have them work in groups in class. This concept, later developed by Eric Mazur at Harvard, is known as Peer Instruction.
3. Course Website: While this is *de rigueur* today, at the time it was sufficiently novel that I had one student excitedly remark that she'd never had a course with a website before. This stood in contrast to my colleagues who were posting solutions to exams on bulletin boards at the time versus uploading them as I was.
4. MCAT form exams: Since most of the Bio majors are pre-med, I realized that using a paragraph with questions model would provide career-appropriate training for them while still providing the ability to assess students' performance. In addition, by providing the past exams on our course website, the questions become a vehicle for providing content that might not be covered (e.g. how lightning works).
5. Partial-credit multiple choice: In response to students' concerns that multiple choice questions had no partial credit option, I introduced a system whereby students can enter two choices if they feel uncertain about an answer. The second choice is worth less, and even the first choice is slightly lowered in value because of their "admitted" uncertainty.
6. Integration of on-line and face-to-face content for Bio-major Intro Course. Following our accommodations to the pandemic I realized that we had remarkable success with our on-line lecture that required students to watch in groups and create a blog that maintained our peer-instruction model. As a result, we have retained the on-line lecture format since it actually provided *more* student participation than the in-person lecture format had done. We also used our recorded solutions to tailor recitation sections to student needs, which received spontaneous favorable comments in student evaluations.

ADMINISTRATIVE DUTIES:

Serving in a half-time position as Associate Vice-Provost for Research I oversaw (and overhauled) University-wide research day, which engaged over 600 posters judged by two impartial but appropriate judges. I also oversaw all internal competitions, and was the Research

Integrity Officer, in which capacity I was involved in several allegations of research misconduct. Activities also included interfacing with Good Shepherd Rehab, and oversight of the Neuroengineering Initiative that had been funded by the University, liaison with the College of Medicine, overseeing the construction of the University Research Computing Center.

I also served as Graduate Advisor (now called Associate Department Head for Graduate Studies), in which capacity I oversaw recruitment and selection of graduate students, as well as the construction and administration of the annual Departmental Qualifying Exam. I reorganized the position to use a second faculty member as Advisor to the pre-qualifying students to allow closer liaison with them as they began their careers.

COMMITTEES at various times:

Franklin Institute Committee on Science and the Arts (ongoing)
COAS Tenure and Promotion Committee
Departmental Space Committee
Departmental Undergraduate Curriculum Committee
Departmental Hiring Committee
Departmental T&P Committee
University Committee on Institutional Effectiveness