

# CURRICULUM VITAE

**Robert F. Murphy**

**Ray and Stephanie Lane Professor of Computational Biology Emeritus**

Carnegie Mellon University  
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## ***EDUCATION***

Columbia University, New York, B.A., 1974, Biochemistry.  
California Institute of Technology, Pasadena, CA, Ph.D., 1980, Biochemistry (Dr. James Bonner)

## ***PROFESSIONAL EXPERIENCE***

**Ray and Stephanie Lane Professor of Computational Biology Emeritus**, School of Computer Science, Carnegie Mellon U. 2021-

Ray and Stephanie Lane Professor of Computational Biology, Carnegie Mellon U., 2007-2021  
Founding Head, Computational Biology Department (originally called the Lane Center for Computational Biology, which received department status in the School of Computer Science in September 2009; name changed to Computational Biology Department in January 2015), Carnegie Mellon University, 2007-2020

Professor of Machine Learning, Carnegie Mellon U., 2006-2021

Professor of Biological Sciences and Biomedical Engineering, Carnegie Mellon U., 2003-2021

**Honorary Professor of Biology**, Albert Ludwig University of Freiburg, 2011-

Founder and Board Member, Quantitative Medicine LLC, 2012-2020 (sold to Predictive Oncology, Inc.)

Senior Fellow, Allen Institute for Cell Science, 2015-2020

External Senior Fellow, Freiburg Institute for Advanced Studies, Freiburg, Germany 2008-2017

Founding Director, Joint CMU-Pitt Ph.D. Program in Computational Biology, 2005-2009

Founding Director, Center for Bioimage Informatics, Carnegie Mellon U., 2004-2008

Associate Professor of Biological Sciences, Carnegie Mellon University, 1989-2003

Associate Professor of Biomedical Engineering (by courtesy), 2002-2003

Voting Faculty Member, Center for Automated Learning and Discovery, 2002-2006

Director, Merck Computational Biology and Chemistry Program, 1999-2004

Director, Summer Undergraduate Research Program, Dept. Biological Sciences, 1996-2004

Member, University of Pittsburgh Cancer Institute, 1994-2021.

Faculty of Biomedical Engineering, Carnegie Mellon University, 1998-2002

Faculty Member and Program Leader for Undergraduate and Graduate Education, Center for Light Microscope Imaging and Biotechnology, 1991-2002.

Undergraduate Research Advisor, Dept. of Biological Sciences, Carnegie Mellon, 1996-2000

Director, Beckman Scholars Program at Carnegie Mellon University, 1998-1999

Visiting Associate Professor of Biology, Johns Hopkins University, 1994.

Associate Member, Pittsburgh Cancer Institute, 1986-1993.

Founding Member, Center for Fluorescence Research in Biomedical Sciences, 1983-1991

Assistant Professor of Biological Sciences, Carnegie Mellon University, 1983-1989

Consultant, Becton Dickinson Immunocytometry Systems, 1982-1992.

Postdoctoral Research Associate, Columbia University, Dr. Charles Cantor, Departments of Chemistry and Human Genetics, 1979-1983.

### ***BUSINESS EXPERIENCE***

CoFounder and Member of the Board of Directors, Quantitative Medicine LLC, 2012-2020  
Company acquired by Predictive Oncology Inc (NASDAQ: POAI) on July 1, 2020  
Scientific Advisory Board, Predictive Oncology, Inc., January 2023-

### ***HONORS***

Alan J. Perlis Award for Imagination, School of Computer Science, Carnegie Mellon U., 2021  
**Fellow**, IEEE, 2020  
**Senior Member**, International Society for Computational Biology, 2018  
Distinguished Service Award, International Society for Advancement of Cytometry, 2016  
**Honorary Professor of Biology**, Albert Ludwig University of Freiburg, 2011  
Alexander von Humboldt Foundation Research Award, 2008  
Senior Member, IEEE, 2007  
**Fellow**, American Institute of Medical and Biological Engineering, 2007  
Presidential Young Investigator Award, 1984  
Damon Runyon-Walter Winchell Cancer Foundation Fellowship, 1979  
Earle C. Anthony Fellowship, Caltech, 1974

### ***PROFESSIONAL SERVICE***

#### **Editorial**

Guest Editor (with Gaudenz Danuser and Erik Meijering), Special Issue on Molecular and Cellular Bioimaging, IEEE Transactions on Image Processing, September 2005  
Guest Editor (with Jelena Kovacevic), Special Issue on Molecular and Cellular Bioimaging, IEEE Signal Processing Magazine, May 2006  
Member, Editorial Advisory Board, *Journal of Proteome Research*, January 2006-December 2008  
Member, Editorial Board, *Cytometry Part A*, May 2007-June 2019  
Software Section Editor, *PLOS Computational Biology*, March 2009-March 2015  
Associate Editor, *BMC Bioinformatics*, May 2011-May 2016  
Associate Editor, *Bioinformatics*, January 2014-December 2019  
Member, Editorial Board, *Scientific Data*, January 2014-May 2023  
Guest Editor (with Thilo Figge), Special Issue on Image-Based Systems Biology, *Cytometry Part A*, June 2015

#### **Committee and Society Positions**

Member, Data Standards Committee, International Soc. Analytical Cytology, Jan. 1990-March 2003 (Chair, Jan. 1998-March 2003)  
Member, Publications Committee, International Society for Computational Biology, January 2004-2014  
Councillor, International Society for Analytical Cytology, May 2004-May 2006  
Chair, Scientific Communications Committee, International Society for Analytical Cytology, May 2004-May 2006  
Member, International Society for Analytical Cytology Management Task Force, March 2005-September 2006  
President-elect, International Society for Advancement of Cytometry, May 2006-May 2008

President, International Society for Advancement of Cytometry, May 2008-May 2010  
Immediate Past-President, International Society for Advancement of Cytometry, May 2010-2012  
Member, Steering Committee, Bioimage Informatics Conferences, November 2011-2014

### **Advisory Panels**

Member, American Heart Association Western Pa. Peer Review Committee, March 1987-1991  
Member, National Science Foundation Cell Biology Review Panel B, October 1989-March 1992  
NIH, Special Study Section A (Biomedical Instrumentation), September 1990, June 1991  
NIH, Biological Sciences 2 Study Section (Special Reviewer), July 1991, November 1991  
NIH, Reviewers Reserve, December 1991-June 1993  
Member, NIH Biological Sciences 2 Study Section, July 1993-June 1997  
Chair, Carnegie Mellon University Faculty Development Fund, July 1996-June 1997  
Member, NSF Research Experience for Undergraduates Review Panel, November 1996-1998  
Member, NIH, ZRG2 CBY-1, March 1997, June 1997  
Member, NIH, ZRG2 CBY-2, July, Dec. 1998 (Chair), March, July, Nov. 1999, March, June 2000  
Member, NSF Research Experience for Undergraduates Review Panel, November 2000  
Member, NSF Graduate Research Fellowship Panel, February 2001, February 2002  
Member, Visiting Review Committee, Biological and Medical Informatics Program, University of California, San Francisco, March 28-29, 2002  
Member, Scientific Advisory Board, Sequel Genetics, 2002-2003  
Member, NIH SSS-U (Instrumentation), August 2002  
Member, NIH SSS-H (Computational Biology), June 2002, November 2002, February 2003, June 2003, November 2003  
Member, Visiting Review Committee, Image Analysis Laboratory, National Cancer Institute, Frederick, MD, January 2004  
Member, NIH BDMA Study Section, March 2004  
Chair, NIH BDMA Study Section, June 2004-June 2006  
Member, NIH ZGM1 BRT-9 (KR) Study Section, August 2006  
Member, NIH ZRG1 CB-B (40) Study Section, November 2006  
Member, NIH ZRG1 BST-R (30) Study Section, October 2007  
Member, NIH NIGMS Advisory Council, January 2009-December 2012  
Member, Advisory Board, Caribbean Computing Center for Excellence, September 2010-2014  
Member, NIH Council of Councils, November 2011-October 2014  
Member, Review Panel, NSF-NIH BIGDATA initiative, October-November, 2012  
Member, X02 Review Working Group, NIGMS, February 2013  
Member, External Advisor Board, Bioinformatics Core Facility, University of Texas Southwestern Medical Center, January 15-  
Member, Fellowship Selection Committee, Freiburg Institute for Advanced Studies, February 2015  
Chair, External Advisory Board, MEP-LINCS program, Oregon Health & Science University, April 11-12, 2016 & November 28-29, 2016  
Member, CTSA Collaborative Innovation Award Application (U01) Special Emphasis Panel ZTR1 CI-9 (01), National Center For Advancing Translational Sciences, May 11-12, 2016  
Member, Special Emphasis Panel, ZCA1 RTRB-R J2 R on Research Centers for Cancer Systems Biology, November 9-10, 2016  
Ad Hoc Member, National Institute of Allergy and Infectious Diseases Division of Intramural Research Board of Scientific Counselors, December 9-10, 2016

Chair, External Advisory Board, National Resource for Imaging Mass Spectrometry, Vanderbilt University, January 13, 2017

**Member**, Scientific Advisory Board, Morgridge Institute for Research, June 2017-

Chair, CTSA Program Data to Health Coordinating Center (U24) Special Emphasis Panel, ZTR1 CI-9 (01), National Center For Advancing Translational Sciences, May 17, 2017

Member, National Science Foundation Signal Transduction panel, February 21-23, 2018

Member, CTSA review Special Emphasis Panel ZTR1 CI-9 (01), June 14, 2018

Member, Special Emphasis Panel, ZRG1 BST-J (50) R, Tissue Mapping Centers for the Human BioMolecular Atlas Program (U54), June 28, 2018

Member, External Advisory Board, National Resource for Imaging Mass Spectrometry, Vanderbilt University, August 9, 2018

Member, Data Science Working Group, National Institutes of Health HubMAP Program, December 2018-present

Member, Schmidt Science Fellows Review Panel, December 2018-January 2019

Member, NIH Director's Transformative Research Award Editorial Board, November 2018-April 3, 2019

Member, CTSA review Special Emphasis Panel ZTR1 CI-9 (01), September 11-12, 2019

Member, Schmidt Science Fellows Review Panel, December 2019-January 2020

Final Selection Panel, Schmidt Science Fellows Program, March 2020

Member, NIH Director's Transformative Research Award Editorial Board, December 2019-April 7, 2020

Member, NIH INCLUDE Transformative R01 Study section, July 19, 2020

Member, AIMBE Review Committee on Biomedical Imaging and Instrumentation, August-September 2020

Member, NCI Subcommittee F study section, February 24, 2021

Final Selection Panel, Schmidt Science Fellows Program, March 2021

Member, NIH Director's Transformative Research Award Editorial Board, November 2020-April 3, 2021

Member, NIH Director's Pioneer Award Stage 2 Panel, April 12-14, 2021

Chair, NIH Cellular Senescence Network: Tissue Mapping Centers Panel, June 21-22, 2021

Member, AIMBE Review Committee of Computational Bioengineering, Systems Biology, and Bioinformatics, August-September 2021

Final Selection Panel, Schmidt Science Fellows Program, February 2022

Member, AIMBE Systems Biology Review Committee, August 2022

Chair, Final Selection Panel, Schmidt Science Fellows Program, February 2023

### **Conference Organization and Program Committees**

Chair, Cytometry Development Workshop, November 1998-October 2006

Scientific and Medical Advisory Board, Pittsburgh Bone Symposium, August 2003

Member, Program Committee, IEEE International Workshop on Neural Networks in Signal Processing, September 2003

Finance Chair, IEEE International Symposium on Biomedical Imaging, April 2006

Member, Organizing Committee, International Society for Analytical Cytology XXIII Congress, May 2006

Member, Program Committee, MICCAI Workshop on Microscopic Image Analysis with Applications in Biology, October 1, 2006

Member, Program Committee, International Conference on Bioinformatics Research and Development (BIRD), March 2007

Special Sessions Chair, IEEE International Symposium on Biomedical Imaging, April 2007

Member, Program Committee, Second International Workshop on Microscopic Image Analysis with Applications in Biology, September 21, 2007

Topic Chair, Bioengineering and Imaging Research Opportunities Workshop, January 2008

General Chair, International Society for Analytical Cytology XXIII Congress, May 2008

General Chair, International Conference on Bioinformatics Research and Development (BIRD), July 2008

Workshop Co-Organizer, “Automated Interpretation and Modeling of Cell Images,” International Conference on Machine Learning (ICML), June 2009

Area Chair for Bioimaging (with Eugene Myers), Intelligent Systems for Molecular Biology, July 11-13, 2010

Member, Organizing Committee, Bioimage Informatics 2010, Carnegie Mellon University, September 17-19, 2010

Organizer (with Anne Carpenter), Special Session, International Symposium on Biomedical Imaging, Chicago, Illinois, April 1, 2011

Member, Steering Committee, Great Lakes Bioinformatics Conference 2011, May 2-4, 2011

Member, Organizing Committee, CYTO 2011, Baltimore, Maryland, May 21-25, 2011

Area Chair for Bioimaging and Visualization (with Eugene Myers and Sean O’Donoghue), Intelligent Systems for Molecular Biology, Vienna, Austria, July 15-19, 2011

Chair, “Image-based Models of Cell Organization and Function,” International Conference on Systems Biology, Heidelberg, Germany, August 28-September 1, 2011

Member, Program Committee, Microscopic Image Analysis with Applications in Biology, Mannheim, Germany, September 2, 2011

Member, Program Committee, International Symposium on Biomedical Imaging, Barcelona, Spain, May 2-5, 2012

Honorary Conference Chair and member of Organizing Committee, GLBIO 2012, Ann Arbor, Michigan, May 15-17, 2012

Member, Organizing Committee, CYTO 2012, Leipzig, Germany, June 22-27, 2012

Area Chair for Bioimaging and Visualization (with Sean O’Donoghue), Intelligent Systems for Molecular Biology, Long Beach, California, July 15-17, 2012

Track Chair for Bioimage Analysis, ACM Conference on Bioinformatics, Computational Biology and Biomedicine, Orlando, Florida, October 7-10, 2012

Special Sessions Chair, IEEE International Symposium on Biomedical Imaging, San Francisco, California, April 7-11, 2013

Steering Committee, GLBIO 2013, Pittsburgh, Pennsylvania, May 13-15, 2013

Member, Organizing Committee, CYTO 2013, San Diego, California, May 19-22, 2013

Track Chair for Bioimage Analysis, ACM Conference on Bioinformatics, Computational Biology and Biomedicine, Washington, DC, 2013

Member, Program Committee, 2nd International Workshop on Pattern Recognition in Proteomics, Structural Biology and Bioinformatics, Naples, Italy, September 10-11, 2013

Member, Organizing Committee, CYTO 2014, Ft. Lauderdale, Florida, May 17-21, 2014

Area Chair for Bioimaging and Visualization, Intelligent Systems for Molecular Biology, Boston, Massachusetts, July 11-15, 2014

Member, Organizing Committee, CYTO 2015, Glasgow, Scotland, June 26-30, 2015

Session Organizer and Chair, Machine-Learning Advances in the Life Sciences, Society for Laboratory Automation and Screening Annual Meeting, Washington, DC, February 9, 2015

Area Chair for Bioimaging and Visualization, Intelligent Systems for Molecular Biology, Dublin Ireland, July 11-15, 2015

Organizer (with James Faeder), National Institute for Mathematical and Biological Synthesis  
Working Group on “Spatial Cell Simulations, Knoxville, Tennessee, December 1-3, 2015

Associate Editor, IEEE International Symposium on Biomedical Imaging, Prague, Czech  
Republic, April 13-16, 2016

Member, Organizing Committee, CYTO 2016, Seattle, Washington, June 11-15, 2016

Area Chair for Bioimaging and Visualization, Intelligent Systems for Molecular Biology,  
Orlando, Florida, July 8-12, 2016

Organizing Committee member, Symposium on Clinical and Pharmaceutical Solutions through  
Analysis, 2016-2017

Member, Scientific Program Committee, 2018 Annual Meeting, American Association for  
Cancer Research, Chicago, Illinois, April 14-18, 2018

Member, Program Committee, Intelligent Systems for Molecular Biology, Chicago, Illinois, July  
6-10, 2018

Associate Editor, IEEE International Symposium on Biomedical Imaging, Prague, Czech  
Republic, April 8-11, 2019

Member, Program Committee, Intelligent Systems for Molecular Biology, Basel, Switzerland,  
July 21-25, 2019

Member, Program Committee, Intelligent Systems for Molecular Biology, Montreal, Canada,  
July 12-16, 2020

Member, Program Committee, Intelligent Systems for Molecular Biology, Madison, Wisconsin,  
July 10-14, 2022

Co-Chair, Organizing Committee, 3<sup>rd</sup> Nobel Turing Challenge Initiative Workshop, Pittsburgh,  
Pennsylvania, July 11-12, 2023

### **Courses and Tutorials**

Invited Tutorial “Signal and Image Processing Issues in Molecular and Cellular Imaging,”  
ICASSP 2005, Philadelphia, Pennsylvania, March 19, 2005

Invited Tutorial “Signal and Image Processing Issues in Molecular and Cellular Imaging” (with  
Christos Faloutsos), SIGMOD 2005, Baltimore, Maryland, June 14, 2005

Faculty Member, Tenth Annual Course on 3D Microscopy of Living Cells, University of British  
Columbia, Vancouver, BC, June 16-24, 2005

Invited Faculty Member, Short Course on High-Content Analysis, Society for Biomolecular  
Sciences Conference 2005, Geneva, Switzerland, September 11, 2005

Invited Tutorial “Image Analysis of Subcellular Patterns for High Throughput Screening and  
Systems Biology,” International Society for Analytical Cytology XXIII Congress, Quebec  
City, Quebec, Canada, May 20, 2006

Invited Tutorial “Basics of Machine Learning for Image or Flow (Cytometry),” International  
Society for Analytical Cytology XXIII Congress, Quebec City, Quebec, Canada, May 20,  
2006

Invited Faculty Member, Short Course on High-Content Analysis, Society for Biomolecular  
Sciences Conference 2006, Seattle, Washington, September 17, 2006

Faculty Member, Machine Learning Department Autumn Course on Data Mining from Text and  
Image, Pittsburgh, PA, September 27, 2006

Invited Tutorial “Machine Learning Approaches to Information Extraction from Text and Images  
in Biomedical Journal Articles,” International Association of Science and Technology for  
Development Biomed 2007 and Signal Processing, Pattern Recognition, and Applications  
2007, Innsbruck, Austria, February 15, 2007

Invited Faculty Member, IV Interactive Course in Cytometry, Modena, Italy, March 6-9, 2007

Faculty Member, Twelfth Annual Course on 3D Microscopy of Living Cells, University of British Columbia, Vancouver, BC, June 29-July 2, 2007

Invited Faculty Member, Short Course on High-Content Analysis, Society for Biomolecular Sciences Conference 2008, St. Louis, Missouri, April 6, 2008

Faculty Member, Thirteenth Annual Course on 3D Microscopy of Living Cells, University of British Columbia, Vancouver, BC, June 28-30, 2008

Short Course, “Machine Learning Approaches to Biological Research: Bioimage Informatics and Beyond”, Freiburg Institute for Advanced Studies, Freiburg, Germany, September 29-October 1, 2008

Selected Tutorial “Automated Proteome-wide Determination and Modeling of Subcellular Location”, Sixth Conference on Computational Methods in Systems Biology, Rostock, Germany, October 12, 2008

Invited Faculty Member, V Advanced Course in Cytometry, Modena, Italy, March 3-8, 2009

Invited Speaker, EMBO Practical Course on Light Microscopy of Living Cells, Oeiras, Portugal, May 29-June 5, 2009

Lecture on Advanced Image Analysis, Life Cell Imaging Workshop, Zentrum für Biosystems Analyse, Freiburg, Germany, July 14, 2009

Short Course, “Bioimage Informatics: Automated Image Analysis and Modeling”, Biogem, Ariano Irpino, Italy, July 7-9, 2010

Invited Faculty Member, International Symposium in Applied Bioimaging, Porto, Portugal, September 20-21, 2012

Invited Faculty Member, EMBO Practical Course on “Intravital Microscopy, Flow Cytometry and Cell Sorting”, Berlin, Germany, July 7-12, 2013

Instructor and Co-Organizer, MMBioS Workshop on “Computational Methods for Spatially Realistic Microphysiological Simulations”, Pittsburgh, April 28-30, 2014

Instructor and Co-Organizer, MMBioS Workshop on “Computational Methods for Spatially Realistic Microphysiological Simulations”, Pittsburgh, April 27-29, 2015

Instructor, Bioinformatics Course, University of Freiburg, July 20-24, 2015

Instructor and Co-Organizer, MMBioS Workshop on “Computational Methods for Spatially Realistic Microphysiological Simulations”, Pittsburgh, June 1-3, 2016

Instructor, Bioinformatics Course, University of Freiburg, July 24-27, 2016

Instructor and Co-Organizer, MMBioS Workshop on “Computational Methods for Spatially Realistic Microphysiological Simulations”, Pittsburgh, June 26-28, 2017

Instructor and Co-Organizer, MMBioS Workshop on “Computational Methods for Spatially Realistic Microphysiological Simulations”, Seattle, Washington, March 7-9, 2018

Instructor and Co-Organizer, MMBioS Workshop on “Cell Modeling”, Pittsburgh, May 8-10, 2019

Instructor and Co-Organizer, MMBioS Virtual Workshop on “Cell Modeling”, Pittsburgh, June 22-26, 2020

Session Chair, Convergence in Oncology Summit, Lausanne, September 23-25, 2020

### ***PROFESSIONAL SOCIETIES***

American Association for Advancement of Science, American Institute for Medical and Biological Engineering (Fellow), American Society for Cell Biology, Institute of Electrical and Electronic Engineers (IEEE, Fellow), International Society for Advancement of Cytometry, International Society for Computational Biology (Senior Member)

### ***BOOKS***

1. Applications of Fluorescence in the Biomedical Sciences (1986) D. L. Taylor, A. S. Waggoner, R. F. Murphy, F. Lanni, R. Birge (eds.), Alan R. Liss, Inc., New York.
2. Endosomes and Lysosomes: A Dynamic Relationship (1993) B. Storrie and R. F. Murphy (eds.), JAI Press.
3. Bioinformatics Research and Development: Second International Conference, BIRD 2008, Vienna, Austria, July 7-9, 2008 Proceedings (Communications in Computer and Information Science) (2008) M. Elloumi, J. Küng, R. Murphy, K. Schneider, C. Toma (eds.), Springer, Berlin.
4. New Trends in Image Analysis and Processing, ICIAP 2013 Workshops: Naples, Italy, September 2013, Proceedings (Lecture Notes in Computer Science) (2013) A. Petrosino, L. Maddalena, P. Pala, V. Cantoni, M. Ceccarelli, R. F. Murphy, A. Del Bimbo, M. Pantic, C. Grana, J. Oomen, G. Serra, M. Leo, D. P. Mandic, G. Pirlo, M. Fairhurst, D. Impedovo (eds.), Springer, Heidelberg.

### **PATENTS**

R.F. Murphy, A. Rao, E. Glory-Afshar, J.Y. Newberg, S. Bhavani, A. Kumar. Identifying Location Biomarkers. U.S. patent number 9,092,850 (WO 2012100190).

### **PUBLICATIONS**

These papers have received over 14,000 citations and a Hirsch index (h-index) of 60.

1. R. F. Murphy and J. Bonner (1975). Alkaline Extraction of Non-Histone Proteins from Rat Liver Chromatin. *Biochim. Biophys. Acta* 405:62-66.
2. J. M. Gottesfeld, R. F. Murphy and J. Bonner (1975). Structure of Transcriptionally Active Chromatin. *Proc. Natl. Acad. Sci. USA* 72:4404-4408.
3. R. B. Wallace, T. D. Sargent, R. F. Murphy and J. Bonner (1977). Physical Properties of Chemically Acetylated Rat Liver Chromatin. *Proc. Natl. Acad. Sci. USA* 74:3244-3248.
4. J. Bonner, R. B. Wallace, T. D. Sargent, R. F. Murphy and S. K. Dube (1977). The Expressed Portion of Eukaryotic Chromatin. *Cold Spring Harbor Symp. Quant. Biol.* 42:851-857.
5. R. F. Murphy, R. B. Wallace and J. Bonner (1978). Altered Nucleosome Spacing in Newly Replicated Chromatin from Friend Leukemia Cells. *Proc. Natl. Acad. Sci. USA* 75:5903-5907.
6. R. B. Wallace, J. Schaeffer, R. F. Murphy, T. Hirota, K. Itakura and J. Bonner (1979). Hybridization of Synthetic Oligodeoxyribonucleotides to  $\phi$ X174 DNA: The Effect of Single Base Pair Mismatch. *Nucleic Acids Res.* 6:3543-3557.
7. R. F. Murphy, W. R. Pearson and J. Bonner (1979). Computer Programs for Analysis of Nucleic Acid Hybridization, Thermal Denaturation and Gel Electrophoresis Data. *Nucleic Acids Res.* 6:3911-3921.
8. R. F. Murphy, R. B. Wallace and J. Bonner (1980). Isolation of Newly-Replicated Chromatin by Using Shallow Metrizamide Gradients. *Proc. Natl. Acad. Sci. USA* 77:3336-3340.
9. R. F. Murphy (1980). Chromosomal Protein-DNA Interactions. Doctoral Thesis. California Institute of Technology.
10. R. F. Murphy, J. R. Daban and C. R. Cantor (1981). Flow Cytofluorometric Analysis of the Nuclear Division Cycle of *Physarum Polycephalum* Plasmodia. *Cytometry* 2:26-30.



11. R. F. Murphy, E. D. Jorgensen and C. R. Cantor (1982). Kinetics of Histone Endocytosis in Chinese Hamster Ovary Cells: A Flow Cytofluorometric Analysis. *J. Biol. Chem.* 257:1695-1701.
12. R. F. Murphy, S. Powers, M. Verderame, C. R. Cantor and R. Pollack (1982). Flow Cytofluorometric Analysis of Insulin Binding and Internalization by Swiss 3T3 Cells. *Cytometry* 2:402-406.
13. R. Haas, R. F. Murphy and C. R. Cantor (1982). Testing Models of the Arrangement of DNA Inside Bacteriophage Lambda by Crosslinking the Packaged DNA. *J. Mol. Biol.* 159:71-92.
14. P. L. McNeil, R. F. Murphy, F. Lanni and D. L. Taylor (1984). A Method for Incorporating Macromolecules into Adherent Cells. *J. Cell Biol.* 98:1556-1564.
15. R. F. Murphy, S. Powers and C. R. Cantor (1984). Endosome pH Measured in Single Cells by Dual Fluorescence Flow Cytometry: Rapid Acidification of Insulin to pH 6. *J. Cell Biol.* 98:1757-1762.
16. R. F. Murphy, S. Powers, C. R. Cantor and R. Pollack (1984). Reduced Insulin Endocytosis in Serum Transformed Fibroblasts Demonstrated by Flow Cytometry. *Cytometry* 5:275-280.
17. W. Hiddemann, J. Schumann, M. Andreeff, B. Barlogie, C. J. Herman, R. C. Leif, B. H. Mayall, R. F. Murphy, A. A. Sandberg (1984). Convention on Nomenclature for DNA Cytometry. *Cytometry* 5:445-446.
18. R. F. Murphy and T. M. Chused (1984). A Proposal for a Flow Cytometric Data File Standard. *Cytometry* 5:553-555.
19. R. F. Murphy, D. B. Tse, C. R. Cantor and B. Pernis (1984). Acidification of Internalized Class I MHC Antigen by T Lymphoblasts. *Cell. Immunol.* 88:336-342.
20. R. F. Murphy, E. Bisaccia, C. R. Cantor, C. Berger and R. L. Edelson (1984). Internalization and Acidification of Insulin by Activated Human Lymphocytes. *J. Cell. Physiol.* 121:351-356.
21. P. L. Wollenzien, C. F. Hui, C. Kang, R. F. Murphy and C. R. Cantor (1984) RNA structure, Free and on the Ribosome, as Revealed by Chemical and Enzymatic Studies. In: **Mechanisms of Protein Synthesis**, Bernek, (ed.), Springer-Verlag, Berlin.
22. P. L. McNeil, A. L. Kennedy, A. S. Waggoner, D. L. Taylor and R. F. Murphy (1985). Light Scattering Changes During Chemotactic Stimulation of Human Neutrophils: Kinetics Followed by Flow Cytometry. *Cytometry* 6:7-12.
23. R. F. Murphy (1985). Automatic Identification of Subpopulations in Flow Cytometric List Mode Data Using Cluster Analysis. *Cytometry* 6:302-309.
24. P. L. Wollenzien, R. F. Murphy, C. R. Cantor, A. Expert-Bezancon and D. H. Hayes (1985). Structure of the E. coli 16S rRNA. Psoralen Crosslinks and N-Acetyl-N'-(p-Glyoxylylbenzoyl) Cystamine Crosslinks Detected by Electron Microscopy. *J. Mol. Biol.* 184:67-80.
25. C. R. Cantor, D. B. Tse, J. McDowell, R. Murphy, and B. Pernis (1985). Internalization of Histocompatibility Antigens Studied by Flow Cytometry. In: **Cell Biology of the Major Histocompatibility Complex**, B. Pernis & H. J. Vogel (eds.), Academic Press, New York, pp. 165-172.
26. R. F. Murphy (1985). Analysis and Isolation of Endocytic Vesicles by Flow Cytometry and Sorting: Demonstration of Three Kinetically Distinct Compartments Involved in Fluid-Phase Endocytosis. *Proc. Natl. Acad. Sci. USA* 82:8523-8526.
27. M. Fechheimer, C. Denny, R. F. Murphy, and D. L. Taylor (1986). Measurement of cytoplasmic pH in Dictyostelium discoideum by using a new method for introducing macromolecules into living cells. *Eur. J. Cell Biol.* 40:242-247.

28. R. F. Murphy (1986). Flow Cytometry in Cell Biology. In: **Applications of Fluorescence in the Biomedical Sciences**, D. L. Taylor, A. S. Waggoner, R. F. Murphy, F. Lanni, R. Birge (eds.), Alan R. Liss, Inc., New York, pp. 525-530.
29. R. F. Murphy and M. Roederer (1986). Flow Cytometric Analysis of Endocytic Pathways. In: **Applications of Fluorescence in the Biomedical Sciences**, D. L. Taylor, A. S. Waggoner, R. F. Murphy, F. Lanni, R. Birge (eds.), Alan R. Liss, Inc., New York, pp. 545-566.
30. C. C. Cain and R. F. Murphy (1986). Growth Inhibition of 3T3 Fibroblasts by Lysosomotropic Amines: Correlation with Effects on Intravesicular pH but Not Vacuolation. *J. Cell. Physiol.* 129:65-70.
31. M. Roederer and R. F. Murphy (1986). Cell-By-Cell Autofluorescence Correction for Low Signal-to-Noise Systems: Application to EGF Endocytosis by 3T3 Fibroblasts. *Cytometry* 7:558-565.
32. M. Roederer, R. Bowser, and R. F. Murphy (1987). Kinetics and Temperature Dependence of Exposure of Endocytosed Material to Proteolytic Enzymes and Low pH: Evidence for a Maturation Model for the Formation of Lysosomes. *J. Cell. Physiol.* 131:200-209.
33. S. Taylor, M. Roederer, and R. F. Murphy (1987). Flow Cytometric DNA Analysis of Adrenocortical Tumors in Children. *Cancer* 59:2059-2063.
34. D. M. Sipe and R. F. Murphy (1987). High resolution kinetics of transferrin acidification in Balb/c 3T3 cells: Exposure to pH 6 followed by temperature-sensitive alkalinization during recycling. *Proc. Natl. Acad. Sci. USA* 84:7119-7123.
35. R. A. Preston, R. F. Murphy, and E. W. Jones (1987). Apparent Endocytosis of FITC-Dextran by *Saccharomyces cerevisiae* Reflects Uptake of Low Molecular Weight Impurities, not Dextran. *J. Cell Biol.* 105:1981-1987.
36. C. C. Cain and R. F. Murphy (1988). A Chloroquine-resistant Swiss 3T3 Cell Line with a Defect in Late Endocytic Acidification. *J. Cell Biol.* 106:269-277.
37. S. Taylor, J. Blatt, J. Costantino, M. Roederer, and R. F. Murphy (1988). Flow Cytometric DNA Analysis of Neuroblastoma and Ganglioneuroma: a 10-year Retrospective Study. *Cancer* 62:749-754.
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## **TRAINEES**

### Past Ph.D. students

1. Dr. Mario Roederer, Biological Sciences Ph.D. 1988, postdoctoral fellow, senior postdoctoral fellow, and Research Scientist with Dr. Leonard Herzenberg, Stanford University (1988-2000); currently Director, Flow Cytometry Core, Vaccine Research Center, NIAID, NIH
2. Dr. David M. Sipe, Biological Sciences (Biochemistry/Biophysics Program) Ph.D. 1990, postdoctoral fellow with Dr. Jerry Kaplan, University of Utah (1990-1991); Senior Scientist, Gull Labs, Inc. (1997-1998), Senior Scientist, Lumenal Technologies, L.P. (1999-2000), currently Senior Researcher with Dr. Alan Waggoner, Carnegie Mellon University.
3. Dr. Cynthia Corley Cain Mastick, Biological Sciences Ph.D. 1990, postdoctoral fellow with Dr. Gustav Lienhard, Dartmouth Medical School (1991-1992) and Dr. Alan Saltiel, Parke-Davis Pharmaceutical (1993-1995); Senior Scientist, Parke-Davis Pharmaceutical Research Division (1995-1998); Assistant Professor, Department of Biochemistry, University of Nevada, Reno (1998-2003); currently Associate Professor, Department of Biochemistry, University of Nevada, Reno
4. Dr. Sandra A. Brockman, Biological Sciences Ph.D. 1994, postdoctoral fellow with Dr. Harvey Lodish, Whitehead Institute, Massachusetts Institute of Technology (1994-1997); Technical Specialist, Hamilton, Brook, Smith and Reynolds, PC, Boston, MA (1997-2002); currently Associate, Hamilton, Brook, Smith and Reynolds, PC, Boston, MA
5. Dr. Sheree L. Rybak, Biological Sciences Ph.D. 1997, postdoctoral fellow with Dr. Gary Thomas, Vollum Institute, Oregon Health & Science University (1997-1998); Technical Consultant, Klarquist Sparkman Campbell Leigh & Whinston, LLP, Portland, OR (1998-2003); currently Attorney, Klarquist Sparkman Campbell Leigh & Whinston, LLP, Portland, OR

6. Dr. Michael V. Boland, Biomedical Engineering Ph.D. 1999, completed M.D./Ph.D. program, University of Pittsburgh Medical School (1999-2001), Intern, University of Pittsburgh Medical School (2001-2002); Resident, Department of Ophthalmology and Visual Sciences, University of Iowa (2003-2005); Assistant Professor, Department of Ophthalmology, Johns Hopkins University; currently Associate Professor
7. Dr. E. John Meharr (deceased), Biological Sciences Ph.D. 2001, postdoctoral fellow with Dr. Humphrey Gardner (1998-1999) and Dr. Martin Lotz (1999-2000), Scripps Research Institute
8. Dr. Meel Velliste, Biomedical Engineering Ph.D. 2002 (Thesis: Image Interpretation Methods for a Systematics of Protein Subcellular Location), currently postdoctoral fellow with Dr. Andrew Schwartz, Department of Neurobiology, University of Pittsburgh, 2002-2006; Research Assistant Professor, University of Pittsburgh, 2006-2013; currently Vice President of Engineering, Fivetran, 2013-
9. Dr. Kai Huang, Computational and Statistical Learning M.S., 2003, Biological Sciences Ph.D. 2004 (Thesis: Data Mining Approaches for Interpreting Protein Subcellular Location Patterns in Fluorescence Microscope Images), currently Associate, Fixed Income and Derivatives Department, Credit Suisse First Boston, New York
10. Dr. Xiang Chen, Computational and Statistical Learning M.S., 2004, Biological Sciences Ph.D., 2005 (Automated interpretation of protein subcellular location patterns in 3D images), postdoctoral fellow, Yale University, New Haven, Connecticut, 2005-2010; currently Bioinformatics Research Scientist at St. Jude Children's Research Hospital
11. Dr. Juchang Hua, Computational and Statistical Learning M.S., 2006, Biological Sciences Ph.D., 2007 (Image databases for automated determination of protein subcellular locations), currently Goldman Sachs, New York
12. Dr. Yanhua Hu, Biological Sciences Ph.D., 2007 (Automated Analysis of Protein Subcellular Locations in Time Series Images)
13. Dr. Ting Zhao, Biomedical Engineering Ph.D., 2007 (Generative Models of Protein Subcellular Location Patterns), postdoctoral fellow with Dr. Eugene Myers, Janelia Farm Research Campus, Howard Hughes Medical Institute 2007-2009; Assistant Professor, Qiushi Academy for Advanced Studies, Zhejiang University 2009-2012; Currently Senior Software Engineer, Howard Hughes Medical Institute, Janelia Farm Research Campus
14. Dr. Shann-Ching Chen, Biomedical Engineering Ph.D., 2007 (Graphical Model Approaches to Segmentation and Classification for Analysis of Protein Subcellular Location Patterns), postdoctoral fellow with Dr. Gaudenz Danuser, Scripps Research Institute, La Jolla, California 2007-2009; Bioinformatics Research Scientist, St. Jude's Children's Research Hospital, 2009-2013; Currently Staff Scientist, Bioinformatics, Life Technologies.
15. Dr. Elvira (Garcia) Osuna Highley, Biomedical Engineering Ph.D., 2007 (Automated Analysis of the Subcellular Location of Proteins in NIH3T3 and CaCo2 Cells Using

Fluorescence Microscope Images), currently postdoctoral fellow with Dr. Phillip Campbell, Carnegie Mellon University

16. Dr. Justin Y. Newberg, Biomedical Engineering Ph.D., 2009 (Frameworks for Classifying Proteins Across Human Cells Lines and Tissues), currently postdoctoral fellow with Dr. Michael Mancini, Baylor College of Medicine
17. Dr. Tienho Lin, Language Technology Ph.D., 2011 (Learning Cellular Sorting Pathways Using Protein Interactions and Sequence Motifs), currently postdoctoral fellow with David Heckerman at Microsoft Research (joint with Ziv Bar-Joseph)
18. Dr. Tao Peng, Biomedical Engineering Ph.D., 2011 (Image-derived Generative Models for Three-dimensional Cellular Organization); 2011-2013; Software Engineer, Bing Indexing and Knowledge team, Microsoft; currently Staff Scientist at Opera Solutions
19. Dr. Luis Pedro Coelho, Computational Biology Ph.D., 2011 (Modeling the space of subcellular location patterns using images and other sources of information), currently postdoctoral fellow with Musa Mhlanga at University of Lisbon
20. Dr. Aabid Shariff, Computational Biology Ph.D. 2012 (Learning Generative Models of Microtubule Distributions), currently Senior Scientist, Image Analysis and Computational Biology, GrassRoots Biotechnology, Durham, NC (joint with Gustavo Rohde)
21. Dr. Jieyue Li, Biomedical Engineering Ph.D. 2012 (Automated Learning of Subcellular Location Patterns in Confocal Fluorescence Images from Human Protein Atlas), currently Machine Learning Expert, ZestFinance, Los Angeles, CA
22. Dr. Joshua D. Kangas, Computational Biology Ph.D., 2013 (Active Learning for Drug Discovery), Chief Science Officer, Quantitative Medicine, LLC; currently Assistant Teaching Professor, Carnegie Mellon University
23. Dr. Armaghan Naik, Computational Biology Ph.D., 2013 (Efficient Modeling and Active Learning of Biological Responses: Learning without Prior Knowledge), Lane Fellow in Computational Biology, Carnegie Mellon University, 2013-2016; currently Director and Head of Design Sciences, FluNXT, Sanofi Pasteur
24. Dr. Taraz Buck, Computational Biology Ph.D., 2013 (Automated Construction of Dynamic Models of Subcellular Structure), postdoctoral fellow in Computational Biology, Carnegie Mellon University
25. Dr. Devin P. Sullivan, Computational Biology Ph.D., 2015 (Image-derived generative modeling of complex cellular organization in both space and time), postdoctoral fellow with Dr. Emma Lundberg, Stockholm, Sweden
26. Dr. Gregory R. Johnson, Computational Biology Ph.D., 2016 (Image-derived Models of the Organization of Cellular Components), Machine Learning Scientist, Allen Institute for Cell Science, Seattle, WA
27. Dr. Xiongtao Ruan, Computational Biology Ph.D., 2019 (Computational Methods for Image-



derived Modeling of Cell Shape and Organization Dynamics), currently postdoctoral fellow with Gokul Upadhyayula and Eric Betzig, University of California, Berkeley

28. Dr. Aparna Kumar, Computational Biology Ph.D., 2021 (Automated analysis of protein subcellular location in immunohistochemistry images for cancer diagnosis).

#### Past M.S. students

Edward Roques, M.S. in Computational Biology, Dec. 2001; currently at Atto Bioscience, Rockville, MD (June 2003-)

Swapnil Prakash Uganlawar (M.S. in Computational Biology)

Amol Shanbhag, M.S. in Biomedical Engineering, Sep. 2006; currently at Microsoft, Pullman, WA (September 2006-)

Ivan Cao-Berg, M.S. in Computational Biology, May 2009; currently Senior Research Programmer, Carnegie Mellon University

Gregory Johnson, M.S. in Biomedical Engineering, May 2012; received Ph.D. in Computational Biology under my supervision; currently Machine Learning Scientist, Allen Institute for Cell Science (February 2016-)

Jingyi Wang, M.S. in Biomedical Engineering, May 2017

Sun Uk Kim, M.S. in Biomedical Engineering, May 2018

Kelvin Liu, M.S. in Computational Biology, December 2018

Huangqingbo Sun, M.S. in Automated Science, May 2021

#### Past Postdoctoral fellows

Dr. Russell B. Wilson, October 1987-May 1991, Assistant Professor of Pathology, Tulane University Medical School (1991-1995); currently President, Autoimmune Technologies, Inc., New Orleans, LA

Dr. Peter C. Kulakosky, November 1989-May 1991, postdoctoral fellow, Insect Science Center, University of Arizona (1991-1997); currently at Boyce Thompson Institute for Plant Research

Dr. Bruce Taillon, March 1993-September 1993, postdoctoral fellow, Washington University (1993-1997); currently Senior Scientist, Vyrex Corp.

Dr. Estelle Glory, October 2006-July 2010, currently on maternity leave.

Dr. Arvind Rao (Lane Fellow), July 2008-June 2011, Assistant Professor of Bioinformatics, University of Texas Southwestern Medical Center (2011-)

Dr. Baek-Hwan Cho, December 2008-February 2012, Research Staff, Samsung Advanced Institute of Technology (2012-)

Dr. Seung-II Huh, March 2013-December 2013, Google Laboratories (2013-)

Dr. Felix Reisen (co-mentor), January 2013-August 2014

Dr. Maja Temerinac-Ott, May 2013-April 2016, Postdoctoral Fellow, University of Strasbourg (2016-)

Dr. Armaghan Naik (Lane Fellow in Computational Biology), 2013-2016; currently Director and Head of Design Sciences, FluNXT, Sanofi Pasteur

Dr. Jose Lugo-Martinez (Lane Fellow in Computational Biology), 2017-2021; currently Assistant Professor of Computer Science, University of Puerto Rico-Rio Pedras

#### Past Visiting Graduate Students

Dr. Johannes Schmid, February 1993-March 1993, Dept. of General and Experimental Pathology, University Vienna, Vienna, Austria, Ph.D. 1994; currently Ao. Univ. Prof. DI., Dept. of Vascular Biology and Thrombosis Research and Competence Center Bio-Molecular Therapeutics

Dr. Daniela Schober, January 1994-March 1994, Dept. of General and Experimental Pathology, University Vienna, Vienna, Austria

Ying Li, September 2014-March 2015, State Key Laboratory of Information Engineering in Surveying, Mapping and Remote Sensing, Wuhan University, Wuhan, China

Yingying Xu, September 2015-October 2016, Institute of Image Processing & Pattern Recognition, School of Electronics, Information and Electrical Engineering, Shanghai Jiaotong University, Shanghai, China

#### Past Visiting Scientists

Dr. Moshe Yaacobi, July 1986-September 1986, Chemistry Lecturer, Practical Engineering College of Beer Sheva, Beer Sheva, Israel

Dr. Andrea Fattorossi, November 1993-December 1993, Head, Department of Hygiene and Immunology, Aerospace Medical Center, Divisione Aerea Studi Ricerche e Sperimentazioni, Rome, Italy

Dr. Yuntao Qian, January 2006-December 2006, Professor, College of Computer Science, Zhejiang University, Hangzhou, China

Dr. Tim Nattkemper, April 2008, University of Bielefeld, Germany

Dr. Hagit Shatkay, School of Computing, Queen's University, Kingston, Ontario, Canada

Dr. Dechang Xu, Food Science & Engineering School, Harbin Institute of Technology, China

Dr. Jianwei Zhang, College of Computer Science and Engineering, <sup>[1]</sup><sub>SEP</sub>South China Univ. of Technology, Guangzhou, China

Dr. Zhaowen Qiu, Institute of Information and Computer Engineering, Northeast Forestry University of China, Harbin, China

Dr. Liqiang Pan, Harbin Institute of Technology, China

Dr. Long Liu, Xi'an University of Technology

Dr. Jörn Dengjel, University of Fribourg, Switzerland

#### Current Ph.D. students

Gary Wilkins, Biological Sciences Ph.D. Program

Haoran Chen, Computational Biology Ph.D. Program

Huangqinbo Sun, Computational Biology Ph.D. Program