University of California San Francisco

Curriculum Vitae

Graham T. Johnson

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Position QB3@UCSF Faculty Fellow
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Education

1991–95	St. Mary's College of Maryland	ISDM: Scientific Illustration	B.A.
1995–97	Johns Hopkins School of Medicine	Medical & Scientific Illustration	M.A.
2002–04	University of Colorado, Boulder	Chemistry & Physics	NA
2005–11	The Scripps Research Institute, CA	Biology: Biophysics	Ph.D.

Licenses and Certifications

2004– Certified Medical Illustrator (CMI)

Principle Positions Held

1997– Freelance Medical Illustrator and Founder of grahamj.com
1999– Illustrator/Coauthor for Textbook *Cell Biology* versions 1 and 2 by Tom Pollard, Bill Earnshaw and Jennifer Lippincott-Schwartz
2005–11 NSF Predoctoral Fellow, Biophysics, Arthur Olson, The Scripps Research Institute (TSRI)
2011 Research Associate, Andrew Ward Lab, TSRI
2011 Research Associate, Arthur Olson, Molecular Graphics Lab, TSRI
2012– QB3@UCSF Faculty Fellow, University of California, San Francisco

Other Positions Held Concurrently

1995–96 Paleontological Illustrator, Johns Hopkins School of Medicine, Department of Anatomy
1996– Freelance Medical Illustration Apprentice, Levente Efe MD, Melbourne, Australia
1997–06 Freelance Medical Illustrator and Cofounder of fiVth.com
2000–02 Animator & Narration Collaborator for Molecular Biology of the Cell 4e by Bruce Alberts et al
2008–10 Teaching Assistant & Lecturer (Molecular Graphics and Protein-Ligand Docking), Structural Biology, instructed by Ian Wilson, TSRI
2010– Game Design, Scientific Consultant & Artist, Immune Attack 2 (educational game), Melanie Stegman, Federation of American Scientists
2011– Consultant, Sriram Subramaniam, NIH

Honors and Awards

1995–97 William P. Didusch Scholarship, Johns Hopkins University
1996 Certificate of Merit, *Dynamic Vasculature of the Politeal Fossa*, Association of Medical Illustrators, Cincinnati, OH
1996–97 Vesalius Trust Scholarship, Johns Hopkins University, for Masters Thesis: *3D Applications in an Archetype for Education: A Multimedia Computer Frog Dissector with Accompanying Plastic Model*
1997 Annette Burgess Award, Ophthalmological Illustration, Johns Hopkins School of Medicine
2002 Award of Excellence, Cell Biology text, Association of Medical Illustrators, Austin, TX
2005 Certificate of Merit, *The Synapse Revealed*, Association of Medical Illustrators, Los Angeles, CA
2005 1st place illustration, *The Synapse Revealed*, NSF Science Visualization Challenge, National Science Foundation and Science Magazine
2006–09 National Science Foundation Predoctoral Fellow
2007 1st place Animation, *The Synapse Revealed*, ASCB Cell Dance

2007 Runner Up Animation, *Kinesin Walking*, National Science Foundation and Science Magazine
2007 2nd place Animation, *ATP synthase*, ASCB Cell Dance
2007 Runner Up Animation, *Kinesin Walking*, National Science Foundation and Science Magazine
2009–11 Visionary Grant, Gordon Research Conference on Visualization in Science and Education. *In Search of Best Methods to Illustrate Complex Information*
2010 Award of Merit, *Promiscuous Membrane Drug Transporters Provide Novel Pharmaceutical Targets*, Association of Medical Illustrators, Portland, OR
2011 1st place video, *Rapid Visual Inventory & Comparison of Complex 3D Structures*, NSF Science & Engineering Visualization Challenge, National Science Foundation and Science Magazine
2012 NVIDIA best poster award at VIZBI 2012 with Ludovic Autin. *uPy: a ubiquitous Python API with biological modeling applications enables ePMV & autoFill*, EMBL, Germany
2012 Artist in Residence, The Art of Systems Biology and Nanoscience, Santa Fe, NM

Professional Organizations and Activities

Memberships

1995– Association of Medical Illustrators
1995– Guild of Natural Science Illustrators
2005– American Society for Cell Biology
2006– Association for Computing Machinery
2006– National Informal Science Education Network
2011– Biophysical Society
2012– IEEE

Service to Professional Organizations

2001– Association of Medical Illustrators Workshop instructor, Techniques showcase Instructor
2001– Association of Medical Illustrators Portfolio reviewer, intern mentor, application mentor
2007 Invited Panelist, *Futures Forum*, Association of Medical Illustrators Annual Meeting, Bozeman, MO
2008 Association of Medical Illustrators Salon judge
2009 American Society for Cell Biology Miniworkshop organizer, and presenter at Educational Resources/Minorities Affairs Committee Booth
2010 Keystone Symp.: Struct. Genomics Conference Assistant
2011– Association of Medical Illustrators Salon setup
2012 Keystone Symp.: High Through SB Conference Assistant
2012 Association of Medical Illustrators Salon judge

Service to Professional Publications

2008– Association of Medical Illustrators Interviewer and article author

Competitively selected or Invited presentations

International Presentations

2005 Invited speaker and instructor, *Photoshop for Scientists*, Conference on The Teaching of Signal Transduction, IECB, Bordeaux, France.

2007, 2008 *Automated Visualization of Subcellular Environments*, World Molecular Engineering Network 18th and 19th annual meetings, San Jose del Cabo, Baja, Mexico

2009 Selected speaker, *Automated Visualization of Subcellular Environments: The Role of Tomography in the Proteomics Era*, Asia Pacific Congress on Electron Tomography, Brisbane, Australia

2009 Poster, *Automated Visualization of Subcellular Environments: The Role of Tomography in the Proteomics Era*, Gordon Research Conference on Visualization in Science and Medicine, Oxford, UK

2010 Invited Speaker, *Automated Modeling and Visualization of Subcellular Environments*, World Molecular Engineering Network 20th annual meeting, San Jose del Cabo, Baja, Mexico

2010 Guest Speaker, *Automated Modeling and Visualization of Subcellular Environments,* Linköping University, Sweden

2011 Invited Speaker, *Advances in Mesoscale Modeling*, World Molecular Engineering Network 21th annual meeting, San Jose del Cabo, Baja, Mexico

2012 Invited Speaker, *Visualizing the Mesoscale,* Visualization of Proteins & Complexes Session at Visualizing Biological Data (VIZBI) Conference 2012, EMBL, Heidelberg Germany.

2012 Keynote Speaker, *Modeling and Visualizing the Mesoscale,* Eurographics Workshop on Visual Computing for Biology and Medicine (VCBM), Norköpping, Sweden.

2012 Cinematic Biological Animation Festival Visualization Center Dome Theatre, Norrköping, Sweden

National Presentations

2005, 2006, 2007, 2008 Techniques Instructor, *Molecular Graphics for Illustrators*, Association of Medical Illustrators Annual Meetings, varied cities, USA

2007 Invited Speaker, *Visualizing Complexity in the Cell*, Gordon Research Conference on Visualization in Science and Medicine, Providence, RI

2007 Workshop Instructor, *Introduction to Drawing for the Scientist*, Gordon Research Conference on Visualization in Science and Medicine, Providence, RI

2007 Invited Panelist, *Futures Forum*, Association of Medical Illustrators Annual Meeting, Bozeman, MO

2007 Workshop Instructor, *Cell and Molecular Biology for the Medical Illustrator*, Association of Medical Illustrators Annual Meeting, Boseman, MO

2007 Invited Speaker, *Automated Visualization of Subcellular Environments and Complexes: Early Steps*, Center for Molecular and Cellular Dynamics, Harvard Medical School, Boston, MA

2008 Invited Plenary Lecturer, *Automated Visualization of Subcellular Environments: Step Two*, Association of Medical Illustrators Annual Meeting, Indianapolis, IN

2009 Invited Speaker, *Automated Modeling and Visualization of Subcellular Environments*, Mini-Symposium Exploring Cell Biology at the Frontier of 3D Visualization, at the American Society for Cell Biology Annual Meeting, San Diego, CA

2009 Informal Presentations at the Educational Resources/Minorities Affairs Committee Booth, *Scientific Animation for Research and Education*, at the American Society for Cell Biology Annual Meeting, San Diego, CA

2009 Poster, *Iterative Probabilistic Deposition Algorithm Fills Subcellular Volumes with Molecular Detail*, at the American Society for Cell Biology Annual Meeting, San Diego, CA with authors Graham Johnson, Mostafa Al-Alusi, David Goodsell, and Arthur Olson

2009 Poster, *Novel Techniques for the Rapid Visual Inventory & Comparison of 3D Organelle Maps Generated from Cellular Tomograms*, at the American Society for Cell Biology Annual Meeting, San Diego, CA with authors Graham Johnson, Andrew Noske, Garry Morgan, and Brad Marsh

2009 Poster, *Structure-Function Complexity of the Insulin Secretory Pathway Revealed from Comparative Whole Cell Maps of Insulin-Secreting Beta Cells Reconstructed in 3D at 10-15nm Resolution Using Cellular Electron Tomography* BJ Marsh, AB Noske, GP Morgan, O Cairncross, MA Ragan, G Johnson, at the American Society for Cell Biology Annual Meeting, San Diego, CA

2010 Selected speaker, *Automated Visualization of Subcellular Environments*, Keystone Symposia joint session for Structural Biology and Structural Genomics, Breckenridge, CO

2010 Invited speaker, *Automated Modeling and Visualization of Subcellular Environments*, National Biomedical Computation Resource (NBCR) Summer Institute, UCSD, La Jolla, CA

2010 Workshop Instructor, *embedded Python Molecular Viewer*, National Biomedical Computation Resource (NBCR) Summer Institute, UCSD, La Jolla, CA

2010 Invited speaker, *Automated Modeling and Visualization of Subcellular Environments,* UCSF, San Francisco, CA

2010 Short Workshop Instructor, *embedded Python Molecular Viewer*, UCSF, San Francisco, CA

2010 Selected Speaker and poster, Advances in Subcellular Modeling and Visualization. Recent Advances and Future Prospects for Visualizing Macromolecular Complexes and Cellular Structures Workshop Oct 12-13 Lister Hill, NIH

2010 Invited Speaker, *Modeling and Animating Molecular and Cellular Biology*, Nanoscale Informal Science Education Outreach, National Informal Science Education Network, Exploratorium, San Francisco, CA

2010 Invited speaker, Advances in Subcellular Modeling and Visualization, UCSF, San Francisco, CA

2011 Workshop Instructor, *ePMV*, Association of Medical Illustrators Annual Meeting, Baltimore, MD

2011 Techniques Showcase Instructor, *ePMV*, Association of Medical Illustrators Annual Meeting, Baltimore, MD

2011 Invited Speaker, *Advances in Mesoscale Modeling,* Art As Applied to Medicine Centennial Celebration, Johns Hopkins School of Medicine, CME certified, Baltimore, MD

2011 Workshop Instructor, *ePMV*, Gordon Research Conference on Visualization in Science and Medicine, Providence, RI

2011 Invited Speaker, *Advances in Mesocsale Modeling*, Gordon Research Conference on Visualization in Science and Medicine, Providence, RI

2011 Workshop Instructor, *embedded Python Molecular Viewer*, National Biomedical Computation Resource (NBCR) Summer Institute, UCSD, La Jolla, CA

2011 Invited Speaker, *Advances in Mesocsale Modeling*, National Biomedical Computation Resource (NBCR) Summer Institute, UCSD, La Jolla, CA

2011 Invited Speaker, *Applications of Mesocsale Modeling*, Subramaniam Lab Retreat, NIH, Bethesda, MD

2012 Selected speaker, *Applications of Mesoscale Modeling and Visualization Software*, joint session Pushing the Limits of Structural Biology, Keystone Symposia for High Throughput Structural Biology (J5) & Structural Biology of Cellular Processes: From Atoms to Cells (J6), Keystone, CO

2012 The Art of Systems Biology and Nanoscience, split talk with Ron Vale as the Artist in Residence.

2012 Workshop Instructor, *ePMV*, Association of Medical Illustrators Annual Meeting, Toronto, Canada

2012 Techniques Showcase Instructor, *ePMV*, Association of Medical Illustrators Annual Meeting, Toronto, Ca

2012 Invited Speaker, *Modeling and Visualization of the Cellular Mesoscale,* Association of Medical Illustrators Annual Meeting, Toronto, Ca

Regional and Other Presentations

1997 Vesalius Trust Award Presentation, 3D Applications in an Archetype for Education: A Multimedia Computer Frog Dissector With Accompanying Plastic Model. Association of Medical illustrators Annual Meeting, Baltimore, MD

1999 *Alternative Careers in Science*, Aaron Price Fellows program speaker, Salk Institute, La Jolla, CA

2007 Invited lecture, Wake Forest University, *Painting with Numbers*, Department of Art, Winston-Salem, NC

2007 Invited speaker, Wake Forest University, *Automated Visualization of Subcellular Environments: Step One*, Department of Physics, Winston-Salem, NC

2007 Workshop and Poster, *Seeing What Can't yet Be Seen: Life on the Mesoscale*, Nanoscale Informal Science Education Outreach, National Informal Science Education Network, San Francisco, CA

2008 Workshop Instructor, *Photoshop for Scientists*, The Scripps Research Institute, La Jolla, CA

2009-2011 Workshop Instructor, *Introduction to Protein Structure via PyMOL and FOLDIT*, The Scripps Research Institute Summer Internship Program*,* La Jolla, CA

CME courses instructed

2011 Invited Speaker, *Advances in Mesoscale Modeling,* Art As Applied to Medicine Centennial Celebration, Johns Hopkins School of Medicine, CME certified, Baltimore, MD

University and Public Service

2012	Cinematic Biological Animation Festival Santa Fe, NM	Currents New Media Festival & Cappriccio Foundation,
2012	Cinematic Biological Animation Festival	Visualization Center Dome Theatre, Norrköping Sweden

Public Service

I work with others in our group to provide lab tours, design science activities, and lead discussions for waves of secondary school students from all over the county and country who visit several times each year. I volunteer to teach anatomy and demonstrate art techniques at secondary schools.

Summary of Service

I have participated in numerous outreach efforts, both in person and by providing illustrations, animations, or 3D models to instructors of all levels. At TSRI, I have volunteered my service on numerous occasions to provide illustrations for articles and journal covers. Within my Association of Medical Illustrators, I continually counsel students who are interested in applying to the medical illustration masters degree programs and regularly review and critique portfolios for the same purpose. Online, I frequently answers technical questions (hundreds of them over the years) that medical illustrators have about the 3D software packages they use and I regularly provide examples of proper techniques to help improve the accuracy of scientific communication in all venues.

Teaching and Mentoring

Graduate Courses

2008–2009 Structural Biology, The Scripps Research Institute, gave lecture on molecular graphics

2008–2009 Structural Biology, The Scripps Research Institute, organized tutorials, handouts and online material, and assisted with instruction of homology modeling tutorials, and rewrote/graded the associated exam questions

2008–2009 Structural Biology, The Scripps Research Institute, organized and participated in lectures on protein-ligand docking and wrote/graded the associated exam questions

Teaching and Mentoring

2007–09 Mostafa Al-Alusi, High School, Internship Advisor, now a Junior at Yale University

2001– Association of Medical Illustrators Workshop instructor, Techniques showcase Instructor

Informal Teaching

Instructed workshops at Scripps and at various conferences to teach scientists how to use graphics tools like Adobe Photoshop and 3D software and to teach illustrators how to use scientific tools like molecular viewer software

Taught various labmates and people around the institute aspects of scientific or graphics software in one-on-one visits and frequently troubleshot their visualization problems

Continually teach medical illustrators and non-medical illustrators about scientific software and graphics solutions via my websites and email list-serves

Teaching Aids

Co-authored textbook on Cell Biology as the sole Illustrator as Illustrator: T Pollard, W Earnshaw. Cell Biology 1e. Elsevier, NY, 2002.

Co-authored textbook on Cell Biology as the sole Illustrator: T Pollard, W Earnshaw, J Lippincott-Schwartz. Cell Biology 2e. Elsevier, NY, 2007.

Authored numerous tutorials on our software package ePMV available at http://ePMV.scripps.edu

Authored numerous tutorials available on my site http://grahamj.com and at conferences that teach principles of molecular, structural and cellular biology from within the context of molecular graphics programs to learners of all levels

Co-author and direct the development of various learning games and computational/electronic device learning tools related to biology

Rewrote a Homology Modeling Tutorial for TSRI Structural Biology Coarse based closely on the original by Adam Godzik and Mallika Veeramalai at http://bioinformatics.burnham.org/SSBC/modeling.html

Wrote a general Introduction to Protein Structure via PyMOL and FOLDIT tutorial that I modify to teach both high school and graduate level audiences:
http://www.grahamj.com/teaching/HighSchoolInterns_IntroToProteinStructure_Graham_2011.pdf

Teaching Narrative

As described in my Positions and Presentations section, I have taught learners from all backgrounds in a variety of settings. Formally, I lectured and guided Structural Biology graduate students through tutorials I authored about molecular graphics and tutorials I coauthored or rewrote about protein-ligand docking and homology modeling. I have illustrated and animated thousands of figures to teach molecular and cellular biology, and I have designed and instructed numerous hands-on conference workshops that teach scientists how to sensibly generate figures and that teach artists how to illustrate science more accurately. I mentored a high-school intern for 2 years, and have visited middle and elementary schools to illustrate my own informal lecture on gross human anatomy for over 15 years.

Research and Creative Activities

Research Awards and Grants

NSF Predoctoral Fellowship
NCRR Graduate Student under Arthur Olson and Michel Sanner
NSF Visionary Grant Investigator (seed money for collaborative travel)

Peer Reviewed Publications

Goodsell, D.S., and Johnson, G.T. (2007). Filling in the gaps: artistic license in education and outreach. PLoS Biol 5, e308.
Al-Amoudi, A., Castaño-Diez, D., Devos, D. P., Russell, R. B., Johnson, G.T., Frangakis, A.S. (2011). The three-dimensional molecular structure of the desmosomal plaque. PLoS Biol 5, e308.
Johnson, G.T., Autin, L., Goodsell, D.S., Sanner, M.F., Olson, A.J. (2011). ePMV Embeds Molecular Modeling into Professional Animation Software Environments. Structure *19*, 293-303.
Autin, L., Johnson, G.T., Hake, J., Olson, A. Sanner, M. (2012). uPy: a ubiquitous Python API with biological modeling applications enables ePMV & autoFill. IEEE, in review March 2012.
Johnson, G.T., Autin, L., Al-Alusi, M., Goodsell, D.S., Olson, A.J., Sanner, M.F. (2012). Applications: Automated Modeling and Visualization of the Cellular Mesoscale. Submitting April. 2012.
Johnson, G.T., Autin, L., Al-Alusi, M., Goodsell, D.S., Olson, A.J., Sanner, M.F. (2012). Methods: Automated Modeling and Visualization of the Cellular Mesoscale. Submitting April. 2012.

Non Peer Reviewed Publications

Co-authored as Illustrator: Pollard, T., Earnshaw, W., Lippincott-Schwartz, J.. Cell Biology 1e. Elsevier, NY, 2002.
Co-authored as Illustrator: T Pollard, W Earnshaw, J Lippincott-Schwartz. Cell Biology 2e. Elsevier, NY, 2007.
Johnson, G. T., Goodsell, D. S.. Molecule of the Month: Clathrin. Protein Data Bank, www.rcsb.org, (2007).
Written Interview Response: Goodsell, D. S. (2009). RCSB Protein Data Bank Newsletter 41, PDB Community Focus: Gael McGill, Ph.D., and Graham Johnson, Molecular Animators. (Piscataway: RCSB).
Johnson, G. (2011) AMI Newsletter: Interview with Drew Berry, 2010 MacArthur Fellow. (Lexington: AMI).
Johnson, G., de Kok-Mercado, F., Autin, L. (2012) AMI Newsletter: ePMV embedded Python Molecular Viewer. (Lexington: AMI).

Research Program

1. **Modeling and Visualizing the Cellular Mesoscale:** Two computational toolkits developed under my NSF predoctoral Fellowship, *autoFill* and the *embedded Python Molecular Viewer (ePMV),* provide modeling ease and audience accessibility to cellular mesoscale (10^{-7}–10^{-8}m) content. The toolkits arrive at the dawn of an era where the continuing efforts of decades of reductionist biological research can begin to be assembled into comprehensive mesoscale and whole-cell models. Such models not only generate structural representations of the poorly visualized mesoscale, but quickly supply data-driven starting models for mesoscale simulation techniques like Brownian Dynamics. Together, autoFill and ePMV provide visualization and modeling standards that can harness, manipulate, and assess the data produced across multiple scientific disciplines– to frame the details of molecular biology on a broader cellular map and to extrapolate predictions to levels appropriate for specific audiences.

2. **Modernizing Biology Education:** As the sole illustrator, I've coauthored two editions of a textbook, Cell Biology by Tom Pollard, Bill Earnshaw, and Jennifer Lippincott-Schwartz. Additionally, I work with two

educational evaluation collaborators, Lena Tibell and IJsbrand Kramer to improve biological education though a Gordon Research Conference Visionary Grant– In Search of Best Methods to Illustrate Complex Information. I combine information learned from these studies with my formal training in instructional design to develop tools and modify protocols for my own work. Every year I give lectures and teach workshops on molecular illustration/animation techniques to researchers and scientific illustrators in an effort to spread knowledge of current tools and protocols that my colleagues and I have garnered through practice and from attending diverse conferences.

3. **Outreach:** I work with director Melanie Stegman as an artist and game-play design consultant on the educational video game ImmuneAttack2. In her words, "Immune Attack2.0 will take advantage of new technology, new molecular science and new video game innovations to create an engaging means of explaining molecular science to students and the public." Many of the 3D maps and characters that comprise this version of the game are being generated with autoFill and ePMV (synergistic activity #1), directly from data to provide a relatively accurate portrayal of the molecular realm. I've recently started working with Jennifer Frazier at the Exploratorium to discuss molecular exhibit designs for public science museums and plan to serve as a liaison between UCSF and such outreach institutions.
4. **Community Mesoscale Modeling:** We have begun to apply autoFill to generate *community models* that in turn generate a public forum for debating theories of the tough-to-visualize mesoscale. For example, an HIV model is being presented for community criticism and debate. We will iteratively update variations of the model based on community suggestions/consensus by modifying the autoFill input parameters. While evolving, such 3D models will be made publically accessible, allowing any audience to interactively explore the mesoscale structure or to generate representations for education and outreach through online viewers.
5. **Integration of Art and Science:** I present at diverse conferences and forums to improve scientific interest and accuracy within the art/illustration communities, and to expose researchers to modeling and visualization options. For example, I worked with Drew Berry, and Gael McGill on an effort spearheaded by Janet Iwasa to entrench visualization approaches like molecular animation into biological research communities. We presented a Mini-Symposium, Exploring Cell Biology at the Frontier of 3D Visualization, and ran a 4-day desk on Animation for Research and Education at the Educational Resources/Minorities Affairs Committee Booth, at the American Society for Cell Biology Annual Meeting 2009– we plan to expand in 2012. I present regularly at the Gordon conference on Visualization in Science and Education, at the National Informal Science Education Network, at Keystone and other science conferences, and at various professional illustration/ animation conferences including the Association of Medical Illustrators and SIGGRAPH to help merge many of the overlapping and otherwise redundant visualization efforts of these communities.