

Biofluids, Ecology, and Evolutionary Biology, Neuroscience, and Physiology. A small sample of current research projects includes the dynamics of ant-parasitoid interactions, formation and degradation of blood clots, biofilm dynamics, pattern formation in the visual cortex, mechanisms and control of cardiac arrhythmias, the dynamics of Multiple Sclerosis, and the flow of water in plants.

The IGERT Program is housed administratively within the Mathematics Department at the University of Utah and the primary faculty are members of the Mathematics Department. Affiliated faculty include over 30 members of life science departments from around the campus.

### Financial Support

IGERT supported fellows will receive at least two years of financial support, with future support coming from teaching and research assistantships.

### Application Process

Students with a strong background in under graduate mathematics are encouraged to apply.

This includes those with a major in another topic with substantial mathematical content. A strong background in biology is not required. Upon completion of the program, students will receive a Ph.D. in Mathematics.

Application forms can be found on-line at [www.math.utah.edu/grad](http://www.math.utah.edu/grad). An application to the Mathematics Department Graduate Program should also include an additional statement indicating interest in the IGERT Graduate Program or the Mathematical Biology Graduate Program.

**Students that apply prior to January 31st, will be considered for participation in the IGERT recruitment weekend.** Held in early March, this weekend gives applicants an opportunity to learn about the program and the Salt Lake area. The schedule is comprised of interviews with faculty, meetings with students and postdocs, and visiting classes, seminars, and research group meetings. Travel, local accommodations, and meals will be covered for participants. After the recruitment weekend, formal fellowship offers will be made to some applicants.

[www.math.utah.edu/igert](http://www.math.utah.edu/igert)

## Mathematical Perspective on Cancer Immunology Workshop

May 5-7, 2008, Department of Mathematics, University of Utah

The goal of this workshop is to bring together a broad range of mathematical biology trainees, with interests ranging from immunology, physiology, biophysics and evolutionary biology, and develop a framework for synthetic research on cancer immunology. Although diverse in the balance of mathematics and biology, the speakers are united by common questions. Local and invited trainees will read and discuss recommended papers in advance, and the workshop will mix formal lectures with paper discussions and question sessions.

### Invited Speakers:

Baltazar Aguda, Boston University

Peter Lee, Stanford University

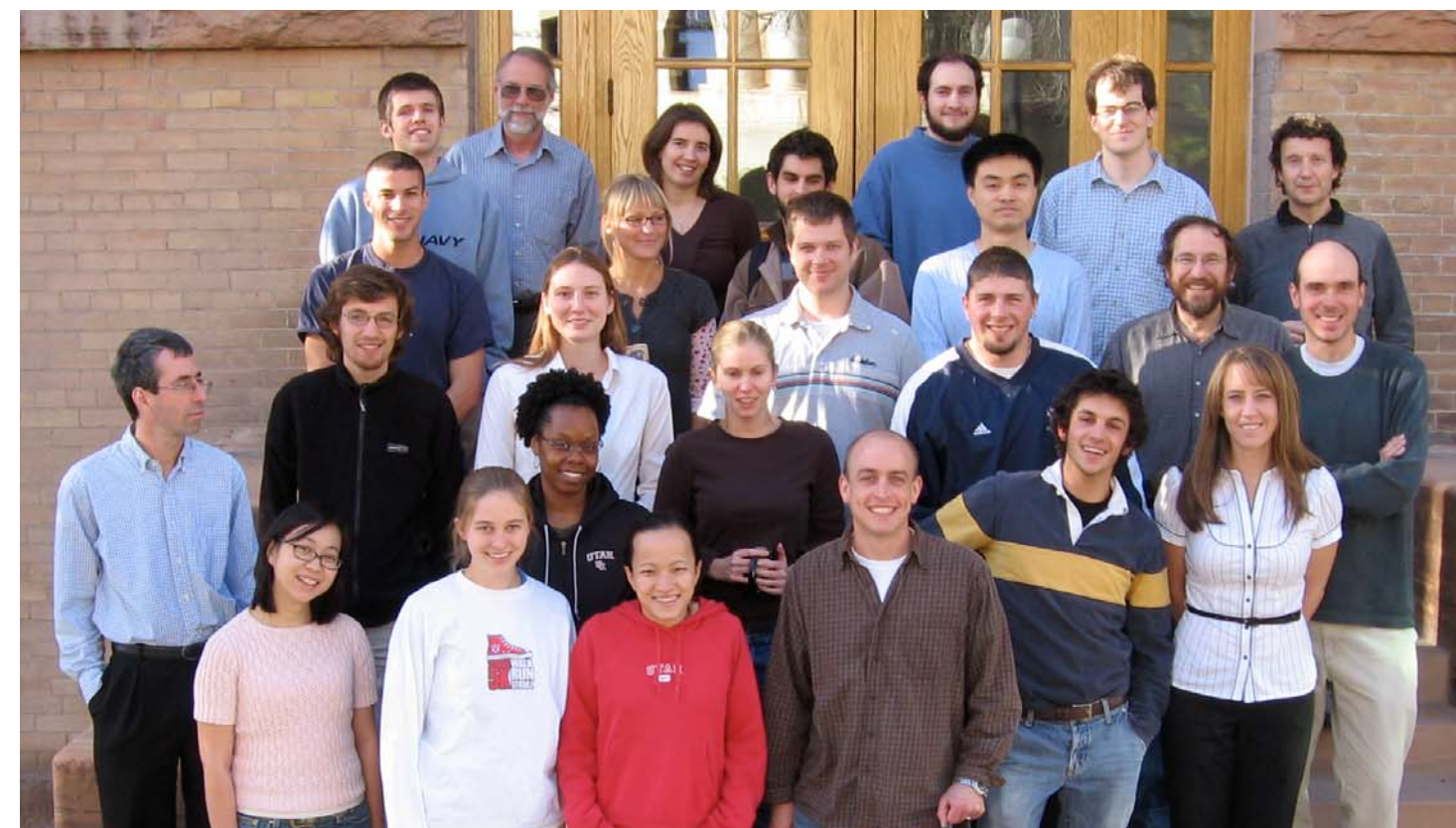
Dominik Wodarz, University of California at Irvine

Travel support is available for graduate students and postdocs that are US citizens, nationals, or permanent residents.

[www.math.utah.edu/ciw](http://www.math.utah.edu/ciw)

# IGERT Newsletter

## Integrative Graduate Education & Research Training in Mathematical Biology



From left to right, top to bottom: (column one) Fred Adler; (column two) Jim Keener, Ross Magi, Victor Camacho, James Moore, Nesy Tania; (column 3) Alla Borisyuk, Liz Copene, Courtney Davis, Erica Graham, Brittany Bannish; (column four) Sam Isaacson, Sean Laverty, Jay Newby, Lindsay Crowl, Giao Huynh; (column five) Elijah Bogart, Jian Du, Dane Maxfield, Berton Earnshaw; (column six) Paul Bressloff, Aaron Fogelson, Zack Kilpatrick; (column seven) Damon Toth, Amber Smith.

### 2006-2007 Update

The IGERT program is in its sixth year in the Mathematics Department at the University of Utah. This newsletter provides a summary of our recent training and research activities.

The fourth annual recruitment weekend was held the first weekend in March. Ten candidates travelled to Utah to learn about our Math Biology community. Recruits attended interviews with faculty, research group meetings, classes, a graduate student dinner, and a reception with IGERT-affiliated faculty. Current graduate students assisted recruits by sharing their experiences and showing them around our Department. On the last

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day, recruits were free to ski, snowboard, cross-country ski, or explore Salt Lake. The weekend culminated in a party at Jim Keener's cabin in Big Cottonwood Canyon.

The third annual IGERT Student Workshop was organized by Lindsay Crawl, Giao Huynh, and Karin Leiderman and held on July 18-20, 2007. The featured speaker was Charles Peskin, a math biologist at the Courant Institute. The topic of focus was modeling and simulation in the life sciences. The workshop was geared toward beginning math biology graduate students. Details of the workshop are located here: [www.math.utah.edu/research/mathbio/igert/Student\\_Workshop2007.html](http://www.math.utah.edu/research/mathbio/igert/Student_Workshop2007.html)

## PhD Recipients

**Berton Earnshaw's** thesis work under the direction of Paul Bressloff concerned the construction and analysis of biophysical models of AMPA receptor trafficking in dendrites. AMPA receptors mediate the majority of fast excitatory synaptic transmission in the central nervous system, and evidence suggests that AMPA receptor trafficking regulates synaptic strength, a phenomenon implicated in learning and memory. Berton's model reproduces a wide range of physiological data regarding receptor trafficking, and makes several important predictions regarding possible targets of second-messenger pathways activated during the induction phase of synaptic plasticity. It also leads to some interesting new mathematics regarding diffusion in domains with partially absorbing traps. During his Ph.D. work, Berton published a paper in one of the leading neuroscience journals, *J. Neurosci.*, and also published a paper in *Phys. Rev. E*. A third paper is under review in *SIAM J. Appl. Math.* Berton is currently an IGERT postdoc at Utah, where he is continuing his work on receptor trafficking in collaboration with Paul Bressloff and Villu Maricq.

**Meagan McNulty** completed her PhD in July 2007, under the supervision of Fred Adler, but in close collaboration with pulmonologist and direc-

tor of the Adult Cystic Fibrosis Center, Ted Liou. Meagan's research focused on using mathematical models to understand airway inflammation in people with cystic fibrosis. Her detailed examination of immunological mechanisms was a major force in building the current group in mathematical immunology. Her ability to distinguish among different varieties of these big hungry cells set a standard for conscientious modeling that few dare to match.

Meagan is currently a visiting assistant professor at the College of William & Mary where she is charged with mentoring interdisciplinary research in mathematics and biology. Once again broadening her horizons, Meagan is helping students with models of wren habitats and zebra finch mating.

**Elijah Newren's** work with Aaron Fogelson did not center on modeling biological processes, but on developing powerful computational tools for tackling complex biofluid dynamics problems involving interactions among a fluid and many cells (e.g., blood platelets) suspended in the fluid. His work involves the immersed boundary (IB) computational method that is used widely for biological fluid dynamics problems. He did a great deal of algorithm design and implementation concerned with extending the IB method to modern distributed-memory computer systems. In these efforts, he collaborated with other computational scientists at the University of Utah, Lawrence Livermore National Lab, and New York University. His thesis explored the formulation and analysis of unconditionally stable implicit versions of the immersed boundary method and developed efficient means of solving the resulting equations. He showed the power of his new methods by applying them to test problems motivated by our former IGERT postdoc Laura Miller's work on the dynamics of insect wings. Newren is now in a postdoctoral position at Sandia National Laboratories.

**John Zobitz** completed his Ph.D. thesis under the joint supervision of Fred Adler and biologist

stretch-activated channels in the heart and is under the supervision of Dr. Keener. At the Cardiovascular Research and Training Institute (CVRTI), he collaborates with Dr. Frank Sachse and Dr. John Bridge as part of his thesis work. Geoffrey will begin some wet lab work in January in Dr. Bridge's lab where he will carry out some immunolabeling of the canonical transient receptor potential type 1 (TRPC1) in myocardium. This September Geoffrey presented his thesis work at the University of British Columbia. He is currently optimizing a Markov model of TRPC1 channels that he hopes to have in publishable form early next year.

Geoffrey's publication:  
Sachse FB, Hunter GAM, Weiss DL, Seemann G. "A framework for modeling of mechano-electrical feedback mechanisms of cardiac myocytes and tissues." *Conf Proc IEEE Eng Med Biol Soc.* 2007;1:160-3

**Samuel Isaacson** is in the third year of his RTG postdoctoral fellowship. His research has focused on exploring the relationship between two stochastic reaction-diffusion models appropriate for studying biochemical systems at the scale of a single cell. In particular, he has shown that the reaction-diffusion master equation model may be interpreted as an asymptotic approximation to the diffusion limited reaction model of Smoluchowski. This resolved an open problem as to what, if any, spatially-continuous physical model is approximated by the spatially-discrete reaction-diffusion master equation. Two papers have been submitted based on this work, and a third is to be submitted.

He has given invited talks in the past year at Michigan State University, McGill University, the 2007 Canadian Applied and Industrial Mathematics Society annual meeting in Banff, the Applications of Mathematics in Biology, Physiology, and Medicine: Conference at the Courant Institute, and the Biosystems Modeling Workshop at the Statistical and Applied Mathematical Sciences

Institute. For the 2007 SIAM Dynamical Systems conference at Snowbird, he served as an organizer of a session on stochastic modeling and methods in biological systems. Other meetings he attended in the past year included the 2006 Biophysical Society Annual Meeting, and workshops on Cardiac Electrophysiology and Arrhythmia, and Cardiac Mechanics and Remodeling at the Mathematical Biosciences Institute. He recently had his first grant funded by the NIH, for the project "Explicit 3D models of the spatiotemporal effects of the regulatory loops in cAMP dependent heart failure". This project is one of four primary projects being investigated by the newly established Systems Biology Center New York.

During Fall 2006 and Summer 2007, he served as a REU mentor for a project developing ODE based models of VEGF receptor trafficking in heart development, and PDE based models of VEGF gradients between myocardial and endocardial cells.

## Information for Prospective Students

The NSF-IGERT Program for Cross-Disciplinary Research Training in Mathematical Biology aims to train graduate students to use the tools of Applied Mathematics to study the challenging problems of modern biology.

IGERT fellows have experiences that are normally missing from traditional graduate programs. Students start engaging in research earlier in their graduate study. First-year journal clubs get students reading and understanding current research from the start. Lab rotations and internships further diversify their skills. Attending conferences is expected and supported. Students organize seminars and workshops. IGERT fellows leave the program having taken on roles as lab assistant, researcher, teacher, presenter, collaborator, and administrator.

The broad research emphases of the program are

Aaron wrote a chapter "Cell-based Models of Blood Clotting", for the book *Single Cell Based Models in Biology and Medicine*, A. Anderson, M. Chaplain, and K. Rejniak (eds), Birkhauser, 2007.

Aaron and Bob Guy wrote two papers "Immersed-Boundary-Motivated Models of Intra-vascular Platelet Aggregation" and "A Wave-Propagation Algorithm for Viscoelastic Fluids with Spatially and Temporally Varying Properties" which will appear in the journal *Computer Methods in Applied Mechanics and Engineering*. They are continuing work with biologist John Weisel at the University of Pennsylvania on a number of aspects of fibrin polymerization.

Aaron is co-editor of a special issue of the journal *Computer Methods in Applied Mechanics and Engineering* that will be devoted to extensions and applications of the Immersed Boundary Method.

In the past year, **James Keener** gave seminars at University of Colorado, University of Wyoming, University of California Merced, the Claremont Colleges, University of Hawaii, University of British Columbia, Utah State University, and University of Iowa, gave lectures at conferences at Duke University, and the Mathematical Biosciences Institute, gave a short course on cell physiology at the MBI, and helped lead an Undergraduate Summer School at University of Edmonton.

Jim recently received NSF research funding for his proposal: "Mathematical Investigations of the Dynamics of Cellular Physiological Processes." Examples of the projects supported by this grant are the dynamics of quorum sensing in *V. fischeri* (with Geoffrey Hunter), length regulation of hooks and filaments in salmonella and chlamydomonas, the dynamics of stochastic calcium release in cardiac cells (with Nesy Tania), non-gap junction coupling of cardiac cells (with Liz Copene), and regulation of microtubule length during cell division (with Blerta Shtylla).

Jim's recent publications include R. D. Guy, A. Fogelson, and J. P. Keener, Fibrin growth in a shear flow, *Mathematical Medicine and Biology*, 24, 111-130 (2006), and N.P. D. Nguyen, H. Kuwahara, C. J. Myers, and J. P. Keener, The Design of a Genetic Muller C-Element, In *The 13th IEEE International Symposium on Asynchronous Circuits and Systems*, 2007. This paper received the Best Paper Award at the conference.

### IGERT Affiliates

Graduate student **Liz Copene** has been doing research and participating in the physiology and neuroscience group meetings. She attended the Fall 2007 Workshop for Young Researchers in *Mathematical Biology* at MBI, where she presented a poster on the electrical coupling of cardiac cells through junctional potassium. She also spoke about her recent work in the local graduate colloquium. Last Spring, Liz participated in an REU where she helped a senior undergraduate student work on a research project concerning the fractal structure of the lungs. Liz is expecting her first publication with James Keener, titled "Ephaptic Coupling of Cardiac Cells Through the Junctional Electric Potential", to appear in the *Journal of Mathematical Biology*.

**David Goulet** has just completed his second year as an RTG postdoc. He mentored an undergraduate REU project on the effects of stress hormones on the human digestive system, lead and redesigned the graduate mathematical biology journal club, worked with Peter Trapa in Math Circle, an after school mathematics enrichment program for talented high school students, and co-organized a summer workshop on delay differential equations. In addition, he has continued his research in developmental biology, and to this end has helped form a collaboration between math biology graduate students and evolutionary developmental biologist Michael Shapiro at the University of Utah.

**Geoffrey Hunter** is interested in the role of

Dave Bowling: "Mathematical approaches to partition net ecosystem exchange of carbon dioxide in a high-elevation subalpine forest." His first summer internship focused on modeling carbon dioxide flux measurements in a desert grassland. His research moved to steadily higher levels along with his developing interest in the inverse methods needed to partition measured carbon dioxide flux into photosynthesis and respiration.

After his support from IGERT expired, John secured a three-year Department of Energy Graduate Research Environmental Fellowship, and used that to initiate an international collaboration with Jerome Ogee at the Institut National de la Recherche Agronomique in Bordeaux, France.

John has taken a position as Assistant Professor in the Department of Mathematics at Augsburg State College in Minneapolis. He will develop their new program in mathematical biology.

### New Comers

**Jian Du** received his Ph.D. from SUNY Stony Brook under the direction of James Glimm. His thesis was entitled "Simulation of Magnetohydrodynamic Multiphase Flow".

He is currently working on the "Gels" grant. Specifically, he is interested in numerical simulations of the growth of fibrin gel networks during blood clotting, vesicular exocytosis of mucin gel, and the growth and regulation of the mucin layer in the stomach.

His recent publications:

A simple package for front tracking, J. Du, B. Fix, J. Glimm, X. Jia, X. Li, Y. Li and L. Wu. *J.Comp. Phys.* 213 (2006), pp. 613-628.

A Numerical Algorithm for MHD in Ablated Material, T. Lu, J. Du, R. Samulyak. In Press, *J.Nanosci. Nanotechnol.*, 2007.

A Numerical Algorithm for MHD of Free Surface Flows at Low Magnetic Reynolds Numbers, R.Samulyak, J. Du, J. Glimm, Z. Xu. *J. Comp.*

*Phys.* 226 (2007), pp. 1532-1549.

Recent progress in the stochastic analysis of turbulent mixing, W. Bo, B. Cheng, J. Du, B. Fix, E. George, J. Glimm, etc. *Stochastic Analysis and Partial Differential Equations*, ISBN-13: 978-0-8218-4059-7.

**Damon Toth** is a new postdoctoral fellow under the NSF-RTG grant. He arrived at Utah after earning his Ph.D. in Applied Mathematics at the University of Washington, advised by Dr. Mark Kot.

Damon's interests lie in the fields of mathematical ecology and populations dynamics. His graduate work involved the use of differential equations and dynamical systems theory to study chemostat population models. At Utah, he is establishing collaborations with various scientists and laboratories around campus to work on mathematical modeling projects, including bird lice competition (with members of Dale Clayton's lab in Biology) and the dynamics of yearly outbreaks of respiratory syncytial virus (with Fred Adler and faculty at the School of Medicine).

Damon's recent publications:

D.J.A. Toth, Strong resonance and chaos in a single-species chemostat with periodic pulsing of resource. *Chaos, Solitons & Fractals*. Article in Press (2007).

D. Toth and M. Kot, Limit cycles in a chemostat model for a single species with age structure. *Mathematical Biosciences* 202:194-217 (2006).

New IGERT students are Victor Camacho, Ross Magi, James Moore, and Nathan Rickett.

**Victor Camacho** majored in mathematics at Harvey Mudd College in Claremont, CA. As an undergraduate he did research on viscoelastic fluid flow in one dimension. His current interests include computational modeling of fluids and various biological systems. Being a native of California he is certainly enjoying the beautiful snow here in Salt Lake City!

**Ross Magi** studied mathematics at Walla Walla College. As an undergraduate, he did his senior project on SIR epidemic models. His possible research interests involve physiology, ecology, or immunology. When not doing math, Ross enjoys playing sports and outdoor activities.

**James Moore** majored in Mathematical Biology at Harvey Mudd College. He did three summers of undergraduate research at HMC, modeling plant circumnutation and cancer treatment. He wrote his senior thesis on modeling immunotherapy treatment of cancer. In 2007, his research team presented their project "Curing Cancer with Mathematics" at the 13th annual CNSF in Washington D.C. His current research interest is mathematical immunology, but he is also interested in physiology and evolution.

**Nathan Rickett** majored in mathematics at the University of Utah. He is interested in neuroscience and immunology. As an undergraduate, he worked in a research group mentored by Paul Bressloff and Berton Earnshaw on AMPA receptor trafficking. This group presented model results at the MAA Intermountain Section Meeting in March 2007.

## IGERT Alumni

**Noelle Conforti** completed her second year as an IGERT student by finishing her Masters coursework and focusing on potential research questions. Currently, her research interests include immunology, virology, and cancer. An area of promising research that has come to include all three of these interests is Human Papillomavirus (HPV). While HPV is gaining recognition, as a result of the new HPV vaccine, there is much to learn about the effect of vaccination, how HPV causes cancer, and how the human immune system interacts with HPV.

Additionally, Noelle attended the MAA's annual conference, MathFest, where one of the primary topics was mathematical biology education at the

undergraduate level. She also passed the Differential Equations qualifying examination.

**Lindsay Crowl** spent six weeks of her summer performing whole blood experiments with Dr. Connie Hall at the Illinois Institute of Technology. She studied the effect of shear stress on platelet adhesion and aggregation.

Lindsay developed a lattice Boltzmann-immersed boundary method and presented a poster on her work at the SIAM Conference on Applications of Dynamical Systems (May 30th, 2007) at Snowbird, UT. She also gave a poster presentation at the Conference on Frontiers in Applied and Computational Mathematics (May 14-16, 2007) held at the New Jersey Institute of Technology.

**Courtney Davis** passed her oral qualifying exam in August on research involving mathematical models of immune memory regulation. Before that, she spent the summer at Emory University working with Rustom Antia's group on questions related to immune memory attrition during infections. In addition, an article entitled "Diversity Graphs", which presents work that she conducted as an undergraduate, will soon be published in *Challenges in Biological Networks*.

**Giao Huynh** devoted her time to teaching and working on her research. For the Summer 2007, Giao spent seven weeks visiting Dr. Thorley-Lawson's lab at Tufts University to learn more about the biology of Epstein-Barr Virus infection. Giao also attended the Nobel Laureates Meeting in Lindau, Germany from July 1-7, 2007.

**Zachary Kilpatrick's** joint work with Paul Bressloff and Stefan Folias on traveling waves in primary visual cortex has afforded him the opportunity to present work locally, at other institutions, and in press. He attended, but did not present at February's COSYNE conference at the Canyons; a vision workshop in April at MBI; and June's SIAM Dynamical Systems conference at Snowbird. Over the summer, Carnegie Mellon hosted

B. A. Earnshaw and P. C. Bressloff. A biophysical model of AMPA receptor trafficking and its regulation during LTP/LTD. *J. Neurosci.* 26 12362-12373 (2006).

P. C. Bressloff and S. Coombes (editors). Special issue on neural development. *IMA J. Math. Med. Biol.* 23 77-78 (2006).

P. C. Bressloff. Stimulus-induced activity bumps in two-dimensional neural field theory. *Fluids and Waves - Recent Trends in Applied Analysis.* AMS Contemporary Mathematics 440, 91--114. (2007)

P. C. Bressloff and B. A. Earnshaw. Diffusion-trapping model of receptor trafficking in dendrites. *Phys. Rev. E.* 75 041916 (2007).

W. H. Nesse, G. A. Clark and P. C. Bressloff. Spike patterning of a stochastic phase model neuron given periodic inhibition. *Phys. Rev. E* 75 031912 (2007).

J. Icheda, L. Schwabe, P. C. Bressloff and A. Angelucci. Response facilitation from the "suppressive" surround of V1 neurons. *J. Neurophysiol.* 98, 2168-2181 (2007).

**Aaron Fogelson** and Eric Cytrynbaum are chairs of the 2008 Gordon Research Conference on Theoretical and Mathematical Biology to be held in Tuscany in June 2008. They have put together nine sessions of speakers on a variety of topics in physiology, cell biology, and the collective motion of organisms.

Aaron spoke at a conference at NYU in honor of the 60th birthdays of Charlie Peskin and David McQueen. Aaron also lectured at the conference "Frontiers of Applied and Computational Mathematics" at NJIT.

Along with Fred Adler, Alla Borisjuk, Paul Bressloff, Kathleen Moore and others, Aaron organized a conference JPK60 held at the University of Utah in May 2007 in honor of Jim Keener's 60th birthday.

Aaron's student, Elijah Newren, completed his thesis on stable versions of the Immersed Boundary Method. With Elijah, Bob Guy, and Mike Kirby

from the School of Computing, Aaron wrote two papers on this work, "Unconditionally stable discretizations of the Immersed Boundary Method" that appeared in the *Journal of Computational Physics*, and "A Comparison of Implicit Solvers for the Immersed Boundary Equations" that will appear in a special issue of *Computer Methods in Applied Mechanics and Engineering*.

Aaron worked with Karin Leiderman and Laura Miller on the effects of endothelial glycocalyx heterogeneities on flow near the endothelium and they submitted a paper "The Effects of Spatial Inhomogeneities on Flow Through the Endothelial Surface Layer" to the *Journal of Theoretical Biology*. Aaron also worked with Karin and Bob Guy on methods for computing the permeability of materials made up of fibers and cells, like blood clots. He is working with Karin on spatial models of coagulation.

Aaron is working with Lindsay Crowl on methods merging the Lattice Boltzmann method with the Immersed Boundary Method. They are currently applying this method to study the motion of red blood cells and the effects of this motion on the distribution of platelets in blood vessels.

He has been working with Bob Guy and Grady Wright on developing multiphase flow models of gels (in which different materials have different velocities) and in developing numerical methods to solve the equations that arise in these models. They have developed a robust numerical method for the viscous dominated version of the model that is described in the paper "An Efficient and Robust Method for Simulating Two-Phase Gel Dynamics" which they submitted to the *SIAM Journal of Scientific Computing*. They are working (with Jian Du) on parallelizing that code and developing methods for gel problems in which elasticity and inertia are important. This work is supported by a 5-year \$2,000,000 grant from the NSF/NIGMS program, the "Gels" grant, awarded to Aaron, Jim Keener, Bob Guy, and Grady Wright.

during the development of epilepsy and that occurs following severe head trauma.

### Faculty

**Fred Adler** was featured on the local NBC-affiliate's news broadcast talking about the latest paper in the cystic fibrosis saga, as picked up by such other media outlets as the Tehran Times and the Deseret News. This project began 10 years ago when Dr. Ted Liou took the math modeling class from Fred and did a very rudimentary version of this for his project (T. G. Liou, F. R. Adler, B. Cahill and D. R. Cox. The Effects of Lung Transplantation on Survivorship in Children with Cystic Fibrosis. *New England Journal of Medicine*, 357:2143-2152, 2007.).

Fred also secured funding from the James S. McDonnell Foundation to really start work on the rhinoviruses, the charismatic and diverse beasts that cause the majority of common colds. With the help of Adi Gundlapalli in Clinical Epidemiology, samples will be collected and sequenced from chairs, toys, and tissues to see the links between population dynamics and evolution. With the help of our expert team of mathematical immunologists (Amber Smith, Courtney Davis, Giao Huynh, Noelle Conforti and Erica Graham), this project will attempt to uncover how the immune system mediates these dynamics.

Other publications during the last year include: B. O'Fallon, Adler F. R., and S. R. Proulx. Quasispecies evolution in subdivided populations favors maximally deleterious mutations. *Proc. Roy. Soc. of London B* (in press). F. R. Adler, J. M. C. Pearce-Duvet and M. D. Dearing. How host dynamics translate into time-lagged prevalence: an investigation of Sin Nombre Virus in deer mice *Bulletin of Mathematical Biology*, (in press). K. R. Groch, J. T. Palazzo Jr., P. A. C. Flores, F. R. Adler, and M. E. Fabian. Recent rapid increases in the right whale *Eubalaena australis* population off southern Brazil. *LAJAM*, 4:41-47, 2007.

F. R. Adler and E. G. LeBrun and D. H. Feener Jr. Maintaining diversity in an ant community: Modeling, extending, and testing the dominance-discovery tradeoff. *The American Naturalist* 169:323-333, 2007.

F. R. Adler. Commentary on Calcagno et al (2006): Coexistence in a metacommunity: the competition-colonization tradeoff is not dead. *Ecology Letters*, 9:907-909, 2006.

**Alla Borisyyuk** gave invited talks at the Society for Neuroscience Annual meeting in October 2006, Dynamical systems workshop at MSRI in January 2007, Frontiers in Applied and Computational Mathematics at NJIT in May 2007, and SIAM Dynamical Systems at Snowbird UT in May 2007. She also gave a talk at the Non-linear Dynamics Seminar at the University of Houston in February 2007.

Alla has submitted the following papers: W.H. Nesse, A. Borisyyuk, P.C. Bressloff. Fluctuation-Driven Rhythmicity in an excitatory network with slow adaptation. D. Terman, A. Borisyyuk, B.H. Smith. Transient temporal dynamics and the processing of sensory information.

**Paul Bressloff** served as chair of the Gordon Research Conference on Theoretical Biology and Biomathematics (2006) and as a co-organizer of Vision Workshop at the Mathematical Biosciences Institute (2007). He was an invited speaker at the School on Neuromathematics of Vision, Scuola Normale Superiore, Pisa (Sep 2006), Distinguished colloquium speaker, University of British Columbia (Mar 2007), the Society for Math Biology, San Jose (July 2007) and the Mathematical Neuroscience Conference, Montreal (Sep 2007).

Paul's student, Berton Earnshaw, completed his Ph.D. thesis. Their work on protein receptor trafficking was covered by an article in *Scientific American* and local newspapers.

Paul's recent publications:

an IGERT Student Symposium on Neuroscience where he presented a poster entitled "Traveling Pulses and Wave Propagation Failure in Inhomogeneous Neural Media." In September, he spoke about this in the department's graduate colloquium. Then in October, *SIAM Journal on Applied Dynamical Systems* informed him and his coauthors Paul Bressloff and Stefan Folias that their paper of the same name would be published. Zack passed his final prelim in August in *Numerical Analysis*. He plans to take his oral examination in November.

**Sean Laverty** passed the third of his required preliminary exams - Applied Math. He began a lab rotation with the Dearing Lab in the Department of Biology, working on a survey project aimed at understanding factors contributing to prevalence of Hantavirus in small mammals. Continuing this research, Sean is involved in monthly sampling and monitoring of a small mammal community in Juab County, Utah.

In January of 2007, **Karin Leiderman** gave a talk at the annual biology meeting for the Society for Integrative and Comparative Biology. She described her work on how blood flow interacts with the endothelial surface layer attached to the vessel walls. She won an award for best student oral presentation. She also gave a poster presentation in January at the Mathematical Biosciences Institute at Ohio State University while attending the workshop on blood flow in the microcirculation. In May, she presented two more posters at the 2007 IGERT project meeting in Arlington, Virginia and at the 2007 SIAM dynamical systems meeting in Snowbird, Utah. In September, she passed her oral exam and just recently submitted her first paper to the *Journal of Theoretical Biology*.

During this last year **Dane Maxfield** passed all three of his three prelims: Differential Equations, Numerical Analysis, and Applied Mathematics. He also did a lab rotation this summer in the Maricq Lab at the University of Utah studying AMPA

receptor trafficking in *C. elegans* using a technique known as FRAP, or fluorescent recovery after photobleaching. As part of his lab rotation, Dane attended the 16th International *C. elegans* Meeting at UCLA from June 27-July 1 to get a first hand look at what *C. elegans* research was all about. He has joined the lab and is currently pursuing a joint project with Villu Maricq and Paul Bressloff.

During July 2007, **Aaron McDonald** traveled to the University of Rochester in New York to work with Dr. John Jaenike and his laboratory members. The visit culminated in the creation of a collaborative theoretical study whose aim is to gain an understanding of epidemiological and ecological factors that are responsible for thwarting the invasion of male-killer resistance genes within insect populations infected with male-killing bacteria.

Aaron passed his oral examination in November 2007. His committee is chaired by Fred Adler and, in addition, includes Jon Seger, John Jaenike, James Keener, and David Dobson. In this thesis, Aaron will study factors leading to observed spatial and temporal variation in male-killer prevalence in naturally infected insect populations.

**Will Nesse** has been studying two topics: Statistical phase locking of stochastic neural oscillators, and coherent oscillations of excitatory neural networks undergoing stochastic forcing. Will had his first paper published in March (Nesse, Clark, and Bressloff, 2007, Spike patterning of a stochastic phase model neuron given periodic inhibition. *Phys. Rev. E* 75, 031912). He submitted another paper in June, and is preparing a third to be submitted shortly. Will looks forward to starting to write his dissertation soon, with the working title "Patterning and coherent action of neural systems with random forcing." Will traveled to John Rinzel's laboratory at NYU's Center for Neural Science in March and Christopher Del Negro's laboratory at the College of William & Mary in May

to collaborate on upcoming research and give a talk titled "Fluctuation Induced Rhythmogenesis in Excitatory Neural Networks With Slow Adaptation." Will has also attended the Society for Neuroscience Annual Meeting in Atlanta in October 2006 to give a poster (Nesse, Bressloff, and Clark, Sensory encoding, phase-locking, and noise: Lessons from the hermissenda eye. 351.22/X17). Currently, Will is in the lab with Dr. Gregory Clark performing electrophysiology experiments on the Hermissenda eye as well as applying for Postdoctoral positions.

**Amber Smith** spent January 2007 in Dr. Jonathan McCullers' laboratory at the St. Jude Children's Research Hospital in Memphis, Tennessee. There, she worked with Dr. Julie McAuley to complete an experiment on the in vivo characterization of BALB/c mouse lung viral titers, bacterial titers, and secondary pneumonia for an infection with Influenza A virus strain PR8-PB1-F2(1918) and Streptococcus pneumoniae. This work was recently published: McAuley, J.L., F. Hornung, K.L. Boyd, A.M. Smith, R. McKeon, J. Bennink, J.W. Yewdell, and J.A. McCullers. "Expression of the 1918 Influenza A Virus PB1-F2 Enhances the Pathogenesis of Viral and Secondary Bacterial Pneumonia." *Cell Host & Microbe*, 2:240-249, 2007.

Amber returned for her second summer working at the Los Alamos National Laboratory as part of the Theoretical Biology and Biophysics (T-10) group and the Center for Nonlinear Studies. There she continued her work on modeling the lethal synergism between Influenza and Streptococcus pneumoniae with Dr. Alan Perelson and Dr. Ruy Ribeiro. While at LANL, she gave a talk at the Mathematical Modeling and Analysis/Center for Nonlinear Studies student seminar series: A.M. Smith, R.M. Ribeiro, J.A. McCullers, and A.S. Perelson. "Within-Host Dynamics of Secondary Infections: Influenza and Streptococcus pneumoniae." June 2007, and presented a poster at the LANL Student Research Symposium: A.M. Smith, R.M. Ribeiro, J.A. McCullers, and A.S.

Perelson. "Modeling the Lethal Synergism Between Influenza and Streptococcus pneumoniae." July 2007. Additionally, Amber attended two conferences during the summer (2007), both held in Santa Fe, NM: Complexity of Biological & Soft Materials, May 2007, and the First Bio Conference on Cellular Information Processing, August 2007.

During the previous academic year, **Nessy Tania** continued her work with Jim Keener on stochastic modeling of calcium regulation in cardiac cell. She passed her oral qualifying exam in the Spring semester. The result from this research was then put together as a poster presentation during the SIAM Conference on Applications of Dynamical Systems in Snowbird, UT, May 2007: N. Tania and J.P. Keener. Stochastic Calcium Release in Ventricular Cardiac Myocytes. In addition, a paper based on her work with James Sneyd from the previous summer was submitted to the *Biophysical Journal* and is currently in review: Y. Wang, N. Tania, Y. Bai, M.J. Sanderson, and J. Sneyd. A mathematical model of airway smooth muscle contraction and relaxation in the lung.

## IGERT Students

**Brittany Bannish** successfully completed a year's worth of classes and attended the AMS/MAA Joint Mathematics Conference in New Orleans in January. She spent the summer studying for her 2 preliminary exams (Applied Math and Numerical Analysis) which she passed in August, and doing a lab rotation with Dr. Mike Shapiro in the biology department. During the lab rotation she learned about the genetics of stickleback fish, took care of the hundreds of fish that are part of the lab, and went to the Northwest Territories, Canada for a week to collect fish to bring back to the lab.

**Elijah Bogart** spent summer 2007 in the lab of Carl Franck at Cornell, studying contact signaling, adhesion and growth regulation in the amoeba *Dictyostelium discoideum*. He contrib-

uted to a paper, tentatively titled "Contact Mediated Cell-Assisted Cell Growth in a Model Eukaryotic Single-Celled Organism: An Explanation for the Lag Phase in Shaken Cell Culture", to be submitted to *Phys. Rev. E*.

The majority of **Erica Graham's** lab rotation experience was spent in the Yost Lab in the Department of Pharmacology and Toxicology. The focus was on the induction of the Cytochrome P450 enzyme family by various glucocorticoids used in the treatment of asthma patients. Other lab rotation-related activities included exploring the different aspects of a study based on the interaction between St. John's Wort and emergency contraceptives with Dr. Patricia Murphy (College of Nursing) and pharmacokinetic modeling with Dr. Steven Kern (Department of Pharmaceutical Chemistry). Erica also passed preliminary exams in Applied Math and Numerical Analysis.

**Jay Newby** worked this summer in Eric Jorgensen's neuroscience lab studying calcium signaling in *C. elegans*. He passed the Numerical Analysis and Applied Math preliminary exams.

**Christopher Remien** had an exciting and busy first year in Utah. He spent the summer learning about stable isotopes with Thure Cerling's lab in the Biology department. His project included sampling a hippo canine tooth along its growth axis to gain insight into the hippo's diet as a function of time by analyzing the tooth enamel's isotopic composition. Inverse models were then used to try to better recover the original diet signal. Chris also passed the Applied Math and Numerical Analysis preliminary exams.

**Darci Taylor** attended the "Hippocampal and entorhinal plasticity, coding and computation" workshop, held at the 2007 COSYNE Conference. Darci's summer lab rotation took place in Dr. Ed Dudek's labs, where she conducted experiments involving whole cell and patch clamp recording in pyramidal neurons located in the hippocampus for the purpose of epilepsy

research. Future research includes developing a neural network model to explain the role of synaptic plasticity in epileptogenesis.

## IGERT Postdocs

**Berton Earnshaw** is a new IGERT Postdoctoral Fellow. Berton recently finished his PhD at the University of Utah where he and his advisor, Paul Bressloff, modeled the trafficking of AMPA receptors and their role in determining synaptic strength. Berton continues to work with Paul Bressloff on related projects, and has also begun work modeling hiccups at the systems level with James Keener. Berton's research interests lie primarily in neuroscience, both theoretical and philosophical. He is also interested in combinatorial theory, particularly as it applies to biological problems.

Berton's recent publications:

P.C. Bressloff and B.A. Earnshaw. Diffusion-trapping model of receptor trafficking in dendrites. *Phys. Rev. E*. 75 041915 (2007).

B.A. Earnshaw and P.C. Bressloff. Biophysical model of AMPA receptor trafficking and its regulation during long-term potentiation/long-term depression. *J. Neurosci.* 26 12362-12373 (2006).  
R.O.W. Franz and B.A. Earnshaw. A constructive enumeration of meanders. *Ann. Comb.* 6 7-17 (2002).

**Peter Roper** has just completed the first year of his IGERT fellowship. He has continued with researching models of the preBotzinger complex and the control of the breathing rhythm with Christopher Del Negro's group at the College of William and Mary, Virginia. This research was presented at the Society for Neuroscience meeting in San Diego in 2007. He has also started a new collaboration with Ed Dudek in the physiology department at the University of Utah, and has recently been awarded a University of Utah Interdisciplinary Research Seed Grant to support the initial stages of this project. The aim of this project is to understand the "rewiring" that occurs in the brain