

Integrative Graduate Education and Research Traineeship Program



IGERT graduate students: back row, left to right: Will Nesse, Bill Koppelman, John Zobitz, Courtney Davis, Aaron McDonald; front row, left to right: Ben Sukow, Amber Smith, Katherine Fitzgerald, and Nessy Tania.

Welcome to our first ever IGERT/Math Biology Newsletter. One of the requirements of the IGERT grant is that we keep track of our training and research activities. Rather than put these into some long-winded document that no one ever reads, we thought we would summarize them in a short newsletter that people might at least scan quickly.

Here is that summary.

The purpose of our IGERT program is to give students broad interdisciplinary training in Mathematical Biology on the way to earning a Ph.D. in Mathematics. The IGERT program helps support two journal clubs, an active Math Biology Seminar, as well as four weekly lab meetings.

Although this is only our first IGERT year, we are fortunate to have nine IGERT-supported students. The five first year students are Courtney Davis (Trinity University), Katherine Fitzgerald (Carleton College), Amber Smith (Colorado School of Mines), Ben Sukow (University of Colorado) and Nessy Tania (UC Davis and Cornell University). The four IGERT-supported students beginning their second year of study are Aaron McDonald (University of Kansas), William Koppelman (University of Wyoming), William Nesse (Boise State University), and John Zobitz (St. John's College).

To report another first, at the start of the 2003-2004 academic year we held an IGERT/Math Biology retreat at the Commander's House in Fort Douglas. The event provided an opportunity for faculty and graduate students to meet and discuss their

work.

Seven different life scientists gave talks: David Goldenberg from Biology, "Protein folding, dynamics, and energetics"; Thure Cerling from Geology and Biology, "Stable isotopes in biological tissues and what they (can) tell us about diet"; Greg Clark from Bioengineering, "Physiological and computational analyses of neural function"; Jean Marc Lalouel from Human Genetics, "Functional genomics of homeostatic control"; Wayne Potts from Biology, "Experimental pathogen evolution"; Richard Normann from Bioengineering, "Parallel processing of information by the nervous system"; and Bob Palais from Pathology and Mathematics, "Genotyping for real-time organ transplant compatibility testing." Four students discussed their lab rotation experiences: Shawn Harrison, William Koppelman, Aaron McDonald, and John Zobitz. Other students presented posters: Robert Guy, Brynja Kohler, Frank Lynch, Young-Seon Lee, Elijah Newren, Andrew Oster, and Thomas Robbins. To close out the retreat, the Math Biology faculty (Fred Adler, Paul Bressloff, Aaron Fogelson, and Jim Keener) gave brief overviews of their research.

Departing Graduates

Brad Peercy:

Brad is one of two students who completed his Ph.D. thesis this year. His thesis was entitled

border zone arrhythmias in acute cardiac ischemia.” He is now at Rice University as a VIGRE postdoc. Brad is also the proud father of a daughter named Paige who was born in May.

Last year, Brad attended the SMB Annual Conference in Knoxville, TN. He has also given several talks:

- Mathematics Department Seminar, Rice University
- SMB Annual Conference, Knoxville, TN
- U of U, Undergraduate Colloquium, *Experimentation with Acid*
- U of U, Graduate Colloquium, *Dropping Acid: Quantification of Hydrogen Movement in Cardiac Cells*

Brad published two papers this year:

- R. D. Vaughn-Jones, B. E. Peercy, J. P. Keener, and K. W. Spitzer. Intrinsic H^+ ion mobility in the rabbit ventricular myocyte. *Journal of Physiology* 541.1, pp.139-158 (2002).
- K. W. Spitzer, R. L. Skolnick, B. E. Peercy, J. P. Keener, and R. D. Vaughn-Jones. Facilitation of intracellular H^+ ion mobility by CO_2HCO^{-3} in rabbit ventricular myocytes is regulated by carbonic anhydrase. *Journal of Physiology* 541.1, pp. 159-167 (2002).

Nick Cogan:

Nick is the second student who completed a Ph.D. thesis this past year. His thesis was entitled “A model of biofilm growth and structural development.” He is currently in a postdoctoral position at Tulane University. He gave seminar talks at Boston University and Tulane University.

Thomas Robbins:

Tom recently defended his thesis, entitled “Seed dispersal and biological invasions: A mathematical analysis.” Tom is also the proud father of a new daughter named Finley who was born in June. He will become our first IGERT postdoc, with primary responsibilities in overseeing two journal clubs. Tom attended the SIAM Applications of Dynamical Systems and BIRS Conference on Seed Dispersal. He has given talks at a VIGRE mini-course titled *Biological Invasions in Heterogeneous Environments*, and at the BIRS Focused Research Group on Mathematical Models for Plant Dispersal titled *A mathematical analysis of seed dispersal models*.

Graduate Student Activities

Robert Guy:

Bob attended and gave talks at the Seventh U.S. Congress on Computational Mechanics, Albuquerque, NM in July, 2003 and at the SIAM Dynamical Systems Meeting, Snowbird, UT in May, 2003.

Bob has a paper accepted for publication in the *Journal of Theoretical Biology* titled “Probabilistic modeling of platelet aggregation: Effects of activation time and receptor occupancy,” co-authored with Aaron Fogelson.

Shawn Harrison:

Shawn worked this past summer in Dr. Gary Rose's Neurobiology lab. He helped out in various projects dealing with mechanisms, structure, and modeling of neural networks representing memory and recognition. They successfully tested a network hypothesis explaining song selectivity in songbirds, where they were able to shed light on the neural basis of a template memory. They also worked on temporal selectivity in auditory midbrain neurons of Anurans. Currently, they are working on isolating excitation and inhibition while intercellularly recording from interpulse-interval tuned neurons that appear to be responsible for call recognition.

Stefanos Falias:

This year, Stefanos attended and presented a poster at the Society for Neuroscience (2003) in San Diego. He also spent five weeks in France attending the Les Houches Summer School in Neurophysics. His study focused on mathematical and physical techniques used to study many levels of the brain.

Stefanos gave a talk about traveling waves in many types of equations at the SIAM Dynamical Systems Conference titled *Oscillatory Waves in Inhomogeneous Neural Media*.

He has papers submitted to the *SIAM Journal of Dynamical Systems* and *Physical Review Letters*.

Brynja Kohler:

Brynja presented a poster titled *Regulatory T Lymphocyte Dynamics* at the annual SMB Meeting in Dundee, Scotland. She attended a meeting of the AWS: Program for Women in Mathematics on Mathematical Biology at the Institute for Advanced Study in Princeton where she gave a talk on her work. During the Conference on Partial Differential Equations and Applications at Purdue University, she gave a talk titled *Modeling the Molecular Basis of*

Muscle Contraction. Brynja also acted as a "lab group leader" at the IMA "New Directions" Short Course in June 2003.

William Koppelman:

This summer, Bill completed a four week internship at the Rocky Mountain Biological Laboratory in Gothic, Colorado. The emphasis was on how biological field research is done and included a class on mammalogy and a class on plant-animal interactions.

Frank Lynch:

Frank attended the SIAM Applied Dynamical Systems at Snowbird and SMB Annual Meeting in Dundee, Scotland where he gave a poster presentation.

Frank was also a "lab group leader" at the IMA "New Directions" short course in June 2003.

Aaron McDonald:

Aaron did a lab rotation this summer with Dr. Alan Rogers from anthropology. During this time, they developed and analyzed a game theoretical model of resource utilization, intended as a model of prey exploitation by the Bari people of Venezuela.

William Nesse:

Will did a lab rotation this summer in the bio-engineering department working with Dr. Greg Smith. There he studied and created some mathematical models of sensory encoding in the vestibular system. As part of this rotation, he spent three weeks at the Marine Biological Labs in Woods Hole, Massachusetts working with Dr. Steve Highstein.

Elijah Newren:

At the 2003 Krell/DOE CSGF conference held in Washington, D.C., Elijah presented a poster. Last fall, he did an internship at the Lawrence Livermore National Laboratory where he learned more about the SAMRAI package and techniques for writing simulation codes on high performance machines.

Andrew Oster:

Andy attended the SIAM Snowbird Applications of Dynamical Systems Conference in 2003.

John Zobitz:

John has been working for Dr. Dave Bowling in the Biology Department. Dr. Bowling's research area is stable isotope ecology to determine carbon cycling and ecosystem photosynthesis and plant respiration. John has been developing a model for carbon dioxide cycling in desert soils applied to a field study site outside of Canyonlands National Park. In

addition to exploring and parameterizing the model, he has participated in laboratory and field work.

Postdoctoral Activities

Nancy Sundell-Turner:

Nancy finished the first year of her VIGRE postdoc after completing her Ph.D. at Cornell under the direction of Rick Durrett.

Part of Nancy's VIGRE activities is to help mentor the journal clubs.

Faculty Activities

Fred Adler:

Over the past year, Fred gave talks at the University of Idaho's Departments of Mathematics and Biology, the University of Georgia's Institute of Ecology, the Mountain West Cystic Fibrosis Consortium, the University of Illinois at Chicago, and at the Mathematical Association of America's Rocky Mountain Section. His publications this year included:

-F. R. Adler and D. M. Gordon. Optimization, conflict, and non-overlapping foraging ranges in ants. *American Naturalist*, (accepted), 2004.

-S. L. Elliot, F. R. Adler, and M. W. Sabelis. How virulent should a parasite be to its vector? *Ecology*, (accepted), 2003.

-K. McCulloh, F. R. Adler, and J. Sperry. Water transport in plants obeys murray's law. *Nature*, 421:939-942, 2003.

-F. R. Adler and J. Mosquera. Super- and coinfection: Filling the range. In U. Dieckmann, H. Metz, M. Sabelis, and K. Sigmund (Eds.). *Virulence Management: The Adaptive Dynamics of Pathogens-Host Interactions*, pages 138-149. Cambridge University Press, 2002.

Paul Bressloff:

Paul gave talks at the Workshop on Complex Neural Dynamics (University of Chicago), the Summer School in Computational Neuroscience (Obidos), the Mathematical Biosciences Institute (Ohio State University), Smith-Kettlewell (San Francisco), the University of Montana, UC San Diego, the Salk Institute, the SIAM Applied Nonlinear Dynamics Meeting (Snowbird), the BIRS Conference on Symmetry and Bifurcations in Biology, the Les

Houches Summer School in Neurophysics, and the Institute of Theoretical Physics (UC Santa Barbara).

His recent publications include:

- P. C. Bressloff, J. D. Cowan, M. Golubitsky, P. J. Thomas, and M. Wiener. What geometric visual hallucinations tell us about the visual cortex. *Neural Comput.* 14, 473-491 (2002).
- P. C. Bressloff and J. D. Cowan. An amplitude approach to contextual effects in primary visual cortex. *Neural Comput.* 14, 493-525 (2002).
- P. C. Bressloff and J. D. Cowan. SO(3) symmetry breaking mechanism for orientation and spatial frequency tuning in visual cortex. *Phys. Rev. Lett.* 88, 078102 (2002).
- P. C. Bressloff. Bloch waves, periodic feature maps and cortical pattern formation. *Phys. Rev. Lett.* 89, 088101 (2002).
- P. C. Bressloff and J. D. Cowan. The visual cortex as a crystal. *Physica D* 173, 226-258 (2002).
- P. C. Bressloff and J. D. Cowan. Spontaneous pattern formation in primary visual cortex. In: *Nonlinear dynamics: where do we go from here?*, S. J. Hogan, A. Champneys, and B. Krauskopf (Eds.). Chapter 11. (Institute of Physics: Bristol, 2002).
- P. C. Bressloff and S. Coombes. Synchronization of synaptically coupled neural oscillators. In: *Epilepsy as a Dynamical Disease*, P. Jung and J. Milton (Eds.). (Springer 2003).
- P. C. Bressloff and J. D. Cowan. Pattern formation, neural. In: *Handbook of brain theory and neural networks*, M. Arbib (Ed.). (MIT Press 2003).
- P. C. Bressloff and J. D. Cowan. Spherical model of orientation and spatial frequency tuning in a cortical hypercolumn. *Phil. Trans. Roy. Soc. Lond. B* (2003).
- J. S. Lund, A. Angelucci, and P. C. Bressloff. Anatomical substrates for functional columns in macaque monkey primary visual cortex. *Cerebral Cortex* 12, 15-24 (2003).
- M. James, S. Coombes, and P. C. Bressloff. The effects of quasi-active membrane on multiply-periodic traveling waves in integrate-and-fire systems. *Phys. Rev. E* 67, 051905 (2003).

Aaron Fogelson:

Aaron gave a plenary lecture at the SMB annual meeting in Dundee, Scotland.

Aaron has published the following:

- C. S. Yi, A. Fogelson, J. P. Keener, and C. Peskin. A mathematical study of volume shifts and ionic concentration changes during ischemia and hypoxia. *J. Theor. Biol.* 220:83-106 (2003).
- A. Fogelson, H. Yu, and A. Kuharsky. Computational modeling of blood clotting: Coagulation and three-dimensional platelet aggregation. To appear in *Polymer and Cell Dynamics: Multiscale Modeling and Numerical Simulations*, Alt et. al. (Eds.), Birkhaeuser-Verlag, Basel, 2002.

James Keener:

Jim gave talks at:

- SIAM 50
- Santa Fe Institute
- University of Nottingham
- Georgia Tech
- University of British Columbia
- Hope College
- University of Waterloo
- Kansas University
- Harvey Mudd College

He taught a two week "New Directions" short course this summer at the IMA at the University of Minnesota on cell physiology.

His recent publications include:

- E. Cytrynbaum and J. P. Keener. Stability conditions for the traveling pulse - modifying the restitution hypothesis. *Chaos*, 12, 788-799 (2002).
- C. S. Yi, A. Fogelson, J. P. Keener, and C. Peskin. A mathematical study of volume shifts and ionic concentration changes during ischemia and hypoxia. *J. Theor. Biol.* 220:83-106 (2003).
- J. P. Keener and E. Cytrynbaum. The effect of spatial scale of resistive inhomogeneity on defibrillation of cardiac tissue. *J. Theoretical Biology* 223, 233 - 248 (2003).