

* * * PROFESSOR RUSSELL FERLAND: SEARCHING FOR THE ORIGINS OF AUTISM



The cover of the July 11 edition of *Science* magazine highlights research on autism. Assistant Professor of Biology Russell Ferland is coauthor of the study that offers some exciting new clues about the elusive origins of this complex and increasingly prevalent disease.

“If you examine the brain of a person with autism and compare it to the brain of a person without autism, they look virtually identical,” Ferland said. “This suggests there is a molecular process or mechanism in the neurons of the brain that is abnormal that then alters the larger brain network.”

In their paper, the researchers provide evidence for this cellular hypothesis. The research team uncovered small deletions in the genomes of children with autism that are strongly correlated to brain function. According to the researchers, these missing pieces of DNA may contribute to abnormal brain function in people with autism. Isolating these missing sections of DNA could help researchers narrow down the search for the genetic causes of the disorder.

To discover the patients' missing genes, the researchers started with a population mapping method known as homozygosity mapping. Homozygosity occurs when both parents pass on a specific gene sequence to their child, which results in the child having two identical copies of the sequence. In some cases, the sequence being passed on by each parent is a deletion.

In their study of children with autism and their unaffected siblings and parents, the researchers discovered that on a specific region of both of the parents' DNA only one half of the normal genetic information was encoded. Because half of the genetic material is present in each of the parents, the parents still have normally functioning cells. If only one copy of the two genomic regions is passed on to a child, this child will also be unaffected. But when this identical deleted portion of their parent's DNA is passed down to a child in a homozygous fashion, the child will have neither half and is missing the entire region of this part of his or her genetic code. Such homozygous deletions were found in the autistic children of these parents. Based on these results, the researchers hypothesize that the inherited missing pieces in their study's subjects may be a part of the underlying cause of their autism.

Once the deletions were found, the researchers worked to link them to specific genes. Genes are encoded by various segments of our DNA. When an entire segment of the DNA is missing, as is the case with many of the children with autism studied, the molecular instructions to encode certain genes are missing and those genes are not expressed in the individual. The researchers hypothesized that the missing genes in the children with autism could be related to the outward symptoms of their disease and indeed their findings support this idea.

The researchers discovered that some of the genes likely missing in the children with autism are related to neural or brain activity — a lack of these genes could possibly lead to abnormal brain functions, a hallmark of autism. Ferland is hopeful that researchers are getting closer to pinpointing the causes of the disorder. “The findings are beginning to suggest that the genes critical for controlling neural activity and plasticity, at the molecular level in the cell, could be important in autism,” he said.

The research team has been working on this study for nearly a decade. The first author of the paper was Eric Morrow and the corresponding author was Christopher Walsh, both of Harvard Medical School. —*Gabrielle DeMarco*



NEW RESEARCH COULD HELP ISOLATE GENETIC BASIS FOR DISEASE & POPULATION VARIATION

An international team of researchers has identified just 200 positions within the curves of the DNA helix that they believe capture much of the genetic diversity in European Americans, a population with one of the most diverse and complex historic origins on Earth. Their findings narrow the search for the elusive ancestral clues known as single nucleotide polymorphisms, or SNPs, that cause disease and account for the minute variations in the European American population.

“With this study, we looked at a very large population to determine how each individual could be stratified based on his or her DNA,” said Petros Drineas, assistant professor of computer science at Rensselaer Polytechnic Institute and one of the two lead authors of the study. The researchers can now begin to analyze each SNP to understand the possible biological significance of those genetic, ancestral differences.

The research, which was published in the July 2008 edition of *PLoS Genetics*, is the first to isolate genetic ancestral clues based on a method that is purely computational, requiring no previous personal history. The other lead author of the study is Peristera Paschou of the Democritus University of Thrace in Greece.

The researchers plan to use the data to determine if any of the approximately 200 ancestry informative SNPs that they have identified change the way the body develops. “We want to see if the SNPs tied to a specific ancestry hold any biological significance to populations of different origins. We want to see if the SNPs that we isolated are related to natural selection and adaptation, for example to the weather conditions of different regions,” Drineas said. To help do so, the research team will move from the computer lab to the biology lab for further study. In addition, the researchers hope that their findings will help narrow down the search for those SNPs that cause disease, according to Drineas. To read more about this study, visit <http://news.rpi.edu/update.do?artcenterkey=2479>

Fuel Cells

Green Energy for the 21st Century

In the face of mounting energy-related concerns, fuel cells are a major research focus at Rensselaer's School of Science. Fuel cells convert the energy in hydrogen into electricity and heat by electrochemical means instead of combustion, and hold promise to become a widespread alternate source of energy for the 21st century. Without a doubt, many challenges remain before fuel cells can fully meet America's energy demands. Continued research will create fuel cells which are more practical, reliable, and cost-effective.



JORDAN MADER, ACCELERATED B.S./PH.D. STUDENT

Jordan Mader's interest in fuel cells and the need for alternative energy sources began with a high school chemistry class research project. "We didn't have much success building fuel cells in that class, but the idea stuck in my head," she said.

Mader now conducts research on new polymer membranes for use in fuel cells with her thesis advisor, Brian Benicewicz, professor of chemistry. She is enrolled in Rensselaer's Accelerated B.S./Ph.D. Program, which enables students to complete a bachelor's degree and a doctoral degree in seven years. Since earning

her undergraduate degree in 2005, she has been working towards her doctorate, which she expects to receive in May 2009 at the age of 24. The Accelerated B.S./Ph.D. program has been an excellent opportunity for Mader because she was able to start her research at the end of her sophomore year at Rensselaer, whereas students at most other universities must wait until graduate school to begin serious research.

"Fuel cells are a green energy source that hold promise to solve some of the world's major energy problems," Mader said. "Right now, companies such as BASF and Plug Power are making fuel cells to provide alternate back-up power in the case of an outage due to a storm or earthquake. And in the next five to ten years, we could have fuel cells on the market here in the U.S. to power individual people's homes, off-grid."

WHAT IS A FUEL CELL?

A fuel cell is an electrochemical device that converts a supplied fuel into electricity and heat. The most common type is the Proton Exchange Membrane (PEM) Fuel Cell, which works by passing protons from hydrogen through the membrane to combine with oxygen and form water and heat, while electrons pass through an external circuit, providing electricity. Essential in a fully functional fuel cell membrane are good conductivity, thermal stability, tolerance to impurities, long life (more than 40,000 hours (~5 years) for stationary applications), and low cost.

One of the largest barriers to more widespread use of fuel cells is that they cannot withstand extreme hot or cold temperatures. Another problem is that, like humans, fuel cells can suffer from carbon monoxide poisoning. "Fuel cell catalysts can't tolerate carbon monoxide at low temperatures," Mader said. "The carbon monoxide in exhaust from a gasoline powered car or lawn mower, for example, can cause a fuel cell not to function, which is a major problem because cars are one of the main places where we want to use fuel cells."

Another challenge is finding cheaper materials and production methods to make fuel cells more affordable and efficient for the average consumer. Many fuel cells run on and require pure hydrogen, which is extremely expensive. Mader is working on fuel cells that run on reformed natural gas, which is widely available and currently much more affordable.

FUEL CELL RESEARCH AT RENSSELAER

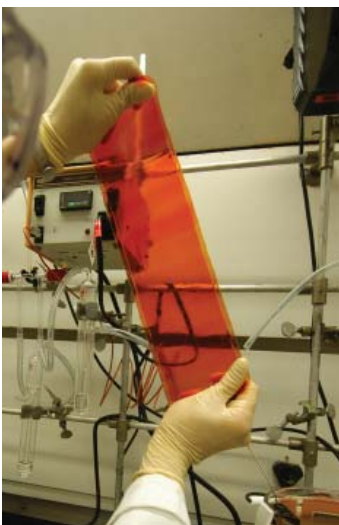
In 1999, scientists at Rensselaer's New York State Center for Polymer Synthesis, led by Professor Brian Benicewicz, began research focused on developing alternative fuel cell membranes, specifically with the polymer polybenzimidazole (PBI).

For years, PEM fuel cell technology had been based on Nafion and other perfluorinated sulfonic acid-based membranes which work by ionic clustering into hydrophobic backbone regions and hydrophilic sulfonic acid/proton transport regions. These membranes have good conductivity and performance, but poor carbon monoxide tolerance and only work at less than 80 °C.

Nafion is a dry film, and thus requires constant hydration. Maintaining a constant amount of water in these membranes is critical for performance and can lead to reliability issues.

To avoid complications of current fuel cells, Benicewicz turned his research toward PBI, taking advantage of Rensselaer's expertise in polymer synthesis. Used for high-performance protective apparel for firefighters and astronauts, PBI has fiber characteristics important to building a successful and inexpensive fuel cell, such as having no melting point, and being resistant to age, mildew, and abrasion.

And most importantly, PBI (as developed at RPI) is a gel, which soaks up and retains so much phosphoric acid that it requires no water for conductivity.



Benefits of the complete PBI system over conventional processes include high temperature operation (120 - 180 °C), exceptional thermal and chemical stability, high conductivity, and low cost. In addition, the fuel cell can operate at very low or zero humidity levels, eliminating the need for the external humidification procedures used with Nafion membranes.

Mader's primary focus is creating these PBI polymer membranes and testing them in actual fuel cells. According to Mader, the transparent gel polymer film looks deceptively like an orange fruit roll-up. (Although, an orange fruit roll-up would not likely be as effective in a fuel cell.)

"Using our polybenzimidazole gel film, we can build fuel cells faster, and with a much cheaper and easier process than current industry methods for PBI fabrication," Mader said. And industry is paying attention. Currently much of their research funding comes from the multi-national chemical manufacturing corporation, BASF. They also receive funding from the U.S. Department of Energy and Basic Energy Sciences. —*Rebekah Mullaney*

RPI SCHOOL OF SCIENCE

honors - awards - travel - new faculty

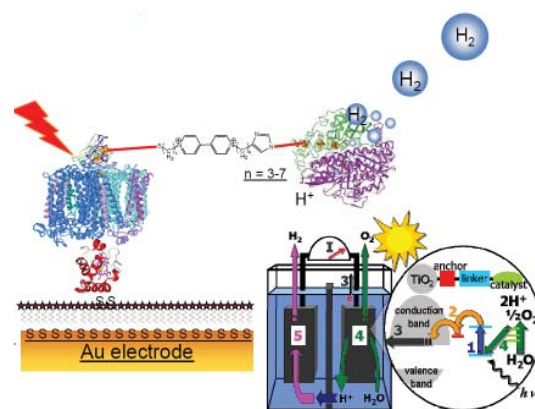
News

Dr. Steve Roecker, Professor of Geophysics, Earth and Environmental Sciences, gave an invited talk on the Tien Shan mountain range in Bishkek, Kyrgyzstan, June 14-21, then traveled to Tajikistan. For the past 10 years, he has been conducting research on the Tien Shan, studying active intracontinental mountain building. Professor Roecker uses seismological techniques to produce pictures of the structure of the crust and upper mantle beneath these mountains in order to understand their dynamics and how they evolved. Last year, he began a similar project in western Tibet, but the Chinese government is not currently allowing foreigners into the region since the riots in Lhasa last March. "My interest in Tajikistan is as an analogue to Tibet – geologically it's like Tibet in miniature," Roecker said. "I traveled to Tajikistan to see how useful it would be to write a joint proposal to work there, regarding the geology, politics and road conditions."



Darrin Fresh Water Institute/Biology Department scientists have been awarded a \$250,000 one-year research grant from the Helen V. Froehlich Foundation for studying non-native invasive species and the impact of development on water quality in Lake George. **Dr. Sandra Nierzwicki-Bauer** will lead efforts to develop an experimental mesocosm simulation facility in Lake George in collaboration with scientists from Skidaway Institute of Oceanography (Savannah, GA) and University of Bergen (Norway), and to improve monitoring and management strategies for zebra mussel populations. **Dr. Charles Boylen** will lead efforts to study the influence of Eurasian watermilfoil on water quality in Lake George and develop hydroacoustic methods to accurately track the spread of this invasive aquatic plant. Additionally, these scientists will carry out studies on the impact of human activities on watersheds in the Lake George basin in partnership with the Lake George Land Conservancy.

Dr. K. V. Lakshmi, Assistant Professor in the Department of Chemistry and Chemical Biology, was co-chair of the 25th Eastern Regional Photosynthesis Conference (ERPC) recently held at the Marine Biological Laboratory in Woods Hole, MA. Numerous researchers presented their findings, highlighting the need for carbon neutral energy and the potential of solar energy conversion, as well as chemical and biochemical avenues for solar fuel production. Colleagues and student researchers in the lab groups of Professors Lakshmi, Dinolfo, and Kempf attended the conference. Dr. Lakshmi has also been invited to chair the 26th ERPC in April 2009. For more info on the 2008 conference, visit: <http://tiny.cc/Do01n>





Dr. Jim Hendler, Tetherless World Constellation Chair, gave a series of talks on the Semantic Web and Artificial Intelligence at Microsoft Labs in late July. In addition, a paper entitled, Web Science, written by Professor Hendler and colleagues from MIT, was the featured article in the July issue of *Communications of the ACM* – the computer science journal with the largest circulation in the world.

Dr. Chjan C. Lim, Professor of Mathematical Sciences, conducted a seminar titled: Quasi 2D Vortex filaments - applications to Electron MagnetoHydrodynamics, on August 1, 2008, at the University of Malaya (Kuala Lumpur, Malaysia). Negative specific heat is a dramatic phenomenon where processes decrease in temperature when adding energy. It has been observed in gravo-thermal collapse of globular clusters. Professor Lim reports finding this phenomenon in bundles of nearly parallel, periodic, single-sign vortex filaments and electron columns in the unbounded plane under strong magnetic confinement. He derives the specific heat using a steepest descent method and a rigorous mean field property. The derivations show that as temperature increases, the overall size of the system increases exponentially and the energy drops. The implication of negative specific heat is a runaway reaction, resulting in a collapsing inner core surrounded by an expanding halo of columns.



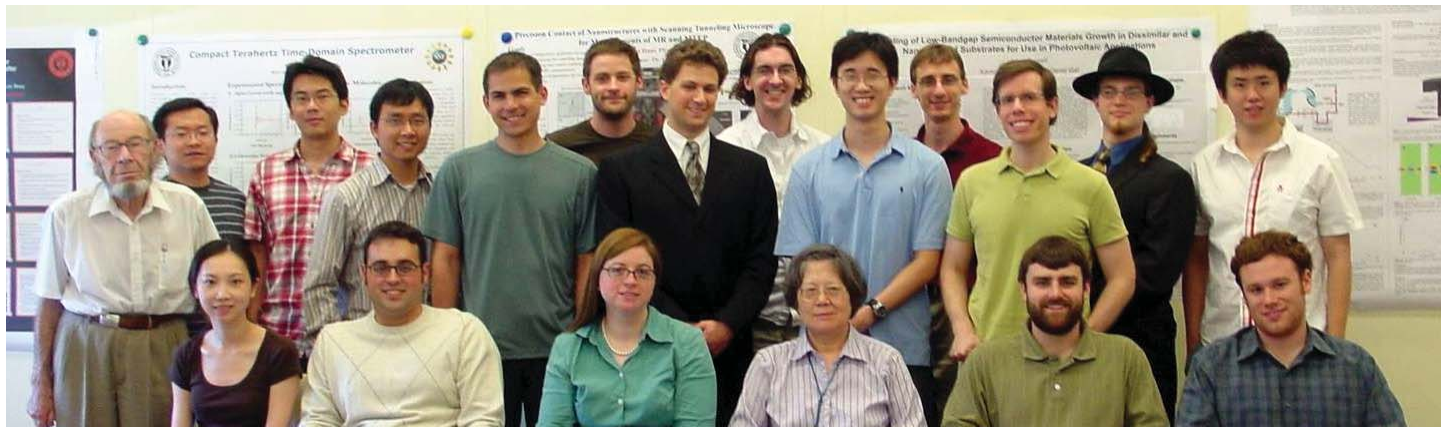
IGERT/GAANN Student Retreat: On July 16, 2008, students from the Integrated Graduate Education and Research Traineeship (IGERT) and the Graduate Assistance in Areas of National Need Program (GAANN) gathered for the annual student retreat and poster session, to discuss their research projects and listen to a talk by Dr. Cynthia Langburg Davis '95 of GE Global Research. Poster topics ranged from a quantum mechanical perspective on the generation of terahertz waves by two-color pulses in gases, to 3D architecture for terascale data transfer, to surface diffusion in magnesium.

IGERT at Rensselaer focuses on terahertz science and technology, and fuel cell development, funded by a grant from the National Science Foundation. GAANN at Rensselaer focuses on terascale electronic and photonic materials and devices, funded by a grant from the U.S. Department of Education. Each renewable fellowship covers full tuition and provides a stipend of up to \$30,000. To be considered, candidates must pursue a Ph.D. For more info, visit: http://admissions.rpi.edu/graduate/financial_aid/fellowships.html

Row 1: Yuting Chen, Nicholas LiCausi, Dr. Cynthia Langburg Davis '95, Dr. Gwo-Ching Wang, Scott LeFevre, Christopher Johansen.

Row 2: Dr. Joseph Levinger, Jianhui Tian, David Hunt, Adam Gennett, Ming He, Nicholas Karpowicz.

Row 3: Kai Liu, Xiaoyu Guo, Thomas Parker, Eric Hoffman, David Brigada, Adam Beece, Jingle Liu.





Dr. Michael Shur, Patricia W. and C. Sheldon Roberts Professor (ECSE and Physics), had a paper published in *Applied Physics Letters*. The University of Vilnius/RPI team (A. Žukauskas, R. Vaicekauskas, F. Ivanauskas, H. Vaitkevicius, and M. S. Shur) proposed a new approach to the optimization of sources of white light based on colored light-emitting diodes (LEDs) and demonstrated that multichip LEDs can produce the quality of light far superior to that produced by conventional fluorescent tubes (see *Appl. Phys. Lett.* 93, 021109, 2008).



Dr. Joel Giedt, Assistant Professor, Department of Physics, Applied Physics & Astronomy, gave a talk, "Domain Wall Fermion Lattice Super-Yang-Mills," at the conference Lattice 2008, in Williamsburg, VA, July 14-19. He chaired one of the parallel sessions and participated in this week-long conference, held each year. He also gave a talk, "Glueballs condensing at the CCNI: 4096 CPUs weigh in," at the Workshop on Continuous Advances in QCD 2008, in Minneapolis, MN, May 15-18 (print version of the talk: <http://arxiv.org/abs/0807.2032>). In addition, Professor Giedt authored three journal articles that describe research results obtained with collaborators: "Phase diagram of SU(2) with 2 flavors of dynamical adjoint quarks," which was submitted to *Journal of High Energy Physics* (text available at: <http://arxiv.org/abs/0807.0792>); "Against Tachyphobia," submitted to *Physical Review D* (<http://arxiv.org/abs/0806.3648>); and "Lattice four-dimensional N=4 SYM is practical," submitted to *Physical Review Letters* (<http://arxiv.org/abs/0806.0013>).



Dr. Miriam (Mimi) Katz has accepted the position of Assistant Professor, Department of Earth and Environmental Sciences. Dr. Katz was previously a Visiting Assistant Professor at RPI. She holds a Ph.D. in Geology from Rutgers University.



Dr. Linda B. McGown, William Weightman Walker Professor and Head of the Department of Chemistry and Chemical Biology, was appointed to the editorial board of the *International Journal of Spectroscopy*, a new peer-reviewed, open access journal. For more information, visit <http://www.hindawi.com/journals/ij/s/>.



Dr. James A. Moore, Professor, Department of Chemistry and Chemical Biology, has been named Acting Director for the New York State Center for Polymer Synthesis at Rensselaer. Moore served as a National Institute of Health Postdoctoral Fellow at the University of Mainz in West Germany from 1967 to 1968, and joined RPI in 1969. In 1999, he won the Presidential Green Chemistry Award. His research areas include vapor deposition polymerization, dendrimer polyelectrolytes, and novel polymers and polymerizations.

* This newsletter is prepared monthly and distributed to faculty, staff and students in the School of Science to keep everyone informed of accomplishments and events within the school. Please submit news items, including photos, for the next newsletter to **Rebekah Mullaney, Communications Specialist for the School of Science** at mullar2@rpi.edu.