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catalyst

AMERICAN UNIVERSITY SCIENCE

EDITORIAL

SCIENCE ISSUES—Campus Sustainability

According to the Environmental Protection Agency, "sustainability is the ability to achieve continuing economic prosperity while protecting the natural systems of the planet and providing a high quality of life for its people."

For those of us who are unsure about how we can effect sustainability on a global scale, making a difference on a smaller scale, such as on a college campus, seems like a reasonable start. After all, aren't universities the laboratories for implementing promising ideas and theories?

American University is currently attempting some measures to encourage campus sustainability. The university currently recycles 42 percent of the campus's waste every year, which is one of the highest campus recycling rates in the country, according to Riley Neugebauer, AU's environmental coordinator. Recycling has saved $20,000 in landfill fees, in the past year. In addition, energy-saving washers used in the residence halls save the university about $30,000 in electricity every year.

AU's Katzen Arts Center also has in place a "green cleaning" program that may be expanded to other buildings. This program involves using fewer chemicals for cleaning, using washable cloths rather than disposable paper towels or cloths, and buying environmentally friendly paper products for the restrooms, said Neugebauer.

While recycling does save energy and resources, it remains a singular, individual measure. The School of International Service's new building will attempt to consolidate environmentally sustainable measures from fuel to water efficiency. Current plans for the building will make use of extra windows to require less reliance on electricity for lighting, and a cistern, which will collect rainwater for irrigation and landscaping after being processed through a leaf filtration system, in addition to other fuel-efficient and environmentally friendly features.

Because sustainability is such a significant issue both locally and globally, we've decided to devote a portion of this issue to that theme. Our cover is a take on the *Charlie's Angels* movie with an environmental twist. We have also featured Claire Roby, who is president of a campus environmental group, Eco-Sense.

On another note, *Catalyst* has two new coeditors who will take over beginning with the spring 2007 issue: Grenye O'Malley, a sophomore premedical student, and Michael Lucibella, a junior journalism major minoring in physics. Grenye and Michael bring different, yet complementary, science backgrounds. I believe that their enthusiasm and drive will maintain, if not improve, *Catalyst's* quality as a science publication.

Mishri Someshwar

Editor

Please submit letters to the editor to Grenye O'Malley at g_omalley@hotmail.com or Michael Lucibella at ml1438a@american.edu

See letters to the editor on the inside back cover.

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Mission Statement:

A catalyst, as defined by scientists, facilitates chemical reactions by bringing together substances that might not interact in its absence. Similarly, *Catalyst* is one place where all the sciences come together to relay exciting scientific developments happening at AU in the AU community and beyond. *Catalyst* is a semi-annual magazine created to promote discourse and keep us up-to-date about how science at AU affects and inspires us all. Our mission is to: serve students and faculty in the sciences as a means to inspire, inform, and promote discourse; share news and accomplishments of students and faculty; inform students of timely and valuable opportunities; raise the profile of the sciences at AU; and expose students outside of CAS to exciting science classes.

Our success will be measured by how useful and informative you find this publication, so we want to hear from you!

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ON THE COVER

Inspired by the film *Charlie's Angels,* the cover features AU biology graduate students (l–r) Erika Trovato, Cara Crawford, and Jennifer Hsieh.
Photo by Jeff Watts.

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SCIENCE STARS:

Student projects affecting you!

FROM BATH WATER TO FUEL

By Kelly Moynihan, journalism '08

CARTER DODD (CAP '08) IS WORKING ON A fusor, a device to create nuclear fusion. During the process of fusion, atoms are smashed together in a vacuum chamber by a power source so that they fuse and release energy. However, less power is released from fusing atoms than the amount of power it takes to cause fusion.

"If you use a 600-watt power supply, the amount of power you get out of fusion will be a thousandth or a millionth of that power," Dodd said. "I just want to get fusion to happen."

Dodd contacted his physics professor, Nathan Harshman, about the project and they, along with Professor Jean Pierre Auffret, have been working together on the initial stages of the experiment.

The team first plans to test its experiment on a smaller scale to see whether it will work and then, if successful, expand it. Dodd hopes to have a power source of 30,000 volts; fusion can begin to occur at 10,000 volts.

Though fusion is an inefficient source of power in terms of the power used versus the power produced, it can occur from a variety of power sources as long as they have atoms.

"Efficiency doesn't really have anything to do with it; it's just that there is so much energy there," said Dodd. "You can have a tub of water and use it as fuel because it's the atoms themselves that contain the energy. You don't need a chemical like natural gas."

Dodd plans to use deuterium, an isotope of hydrogen whose nucleus contains a neutron that will be released during fusion, which will let Dodd detect the process occurring.

However, Dodd has been unable to start his experiment because of lack of funding. He estimates all his supplies will cost $4,000 but he has received only about $1,000 so far for his project. Dodd is considering seeking grants to fund his research. He hopes his proposal will be approved shortly and that the first steps of his experiment can begin in the next few months. He plans for his experiment to occupy the rest of his time at American University and is hopeful that the experiment will work.

"If I do it right it will work," Dodd said. "Other people have done this successfully."

Dodd has attempted other research as well at AU. In December 2004, he succeeded in executing the reverse sprinkler, a physics puzzle that explores what would happen if a sprinkler sucked water in instead of spewing water out.

Before enrolling at AU, Dodd attended the Arkansas School of Math and Science for two years of his high school education. "I've always been science oriented," he said.

LEARNING IN THE DARK: THE MADISON CAVE ISOPOD PROJECT

By Amanda Hoffman, journalism '07

IN DARK CAVES, DEEP BENEATH THE Shenandoah Valley, **Ben Hutchins (BIO '07)** is searching for a small aquatic species that survived millions of years after losing its original ocean home.

This ancient species is the Madison Cave Isopod (MCI) or *Antrolana lira.* Thought to exist only in Madison's Cave in the Shenandoah Valley of Virginia and West Virginia, this distant relative of the pill bug was later found living in underground lakes in about 12 other locations in the region.

This isopod's ancestors are marine animals, leaving scientists to theorize that when sea levels dropped millions of years ago, MCIs were stranded in these caves, in pools of saltwater that, over time, became fresh water.

But after millions of years of cave dwelling, MCIs have made cave biologists wonder if these separate Shenandoah populations could still be genetically connected in terms of gene flow via reproduction or if time has isolated them from one another.

Hutchins, 23, a graduate student at American University, is on the path to finding the answers through his work on the Madison Cave Isopod Project.

Hutchins' love for the outdoors and animals led him to get his bachelor's degree in biology at Western Kentucky University, where he was first exposed to caves.

"I started caving as a pastime because caves are everywhere around Western Kentucky, which is only about 30 minutes from Mammoth Cave, the largest cave in the world," Hutchins said.

After graduation, he headed to American University, where two of the few cave biologists in the country are professors, namely Daniel Fong and Dave Culver.

Hutchins' research began in the spring, with Fong and David Carlini collecting MCI from different Shenandoah locations. Back in the lab, they look at the sequences of the gene cytochrome oxidase I (COI), often used to detect the genetic similarities or differences within a species.

Collected MCIs are preserved in the lab in 95 percent ethanol and then a small piece is removed for DNA sequencing. According to Hutchins, the more differences in the COI gene sequence of two MCIs, the more likely the two have been reproductively isolated and are separate populations.

"It's kind of tricky because no one has sequenced DNA for the MCI," Hutchins said. "We have to tweak the protocol to make it work."

Collecting MCIs can be tricky for the unprepared or inexperienced.

To reach them, the team lowers bait, such as raw shrimp, down into drilled wells and hopes to catch something. The drilled wells are too small for people to enter, although they can run very deep. Despite the bait, the MCIs don't always turn up.

"That means that we have to take lots of trips to these caves and wells and spend lots of time on our hands and knees searching through the water, turning over rocks, and getting real wet," Hutchins said.

Helmets, lights, ropes, and climbing gear are essential for maneuvering into the caves, which, according to Hutchins, are prone to floods, uneven terrain, and vertical drops.

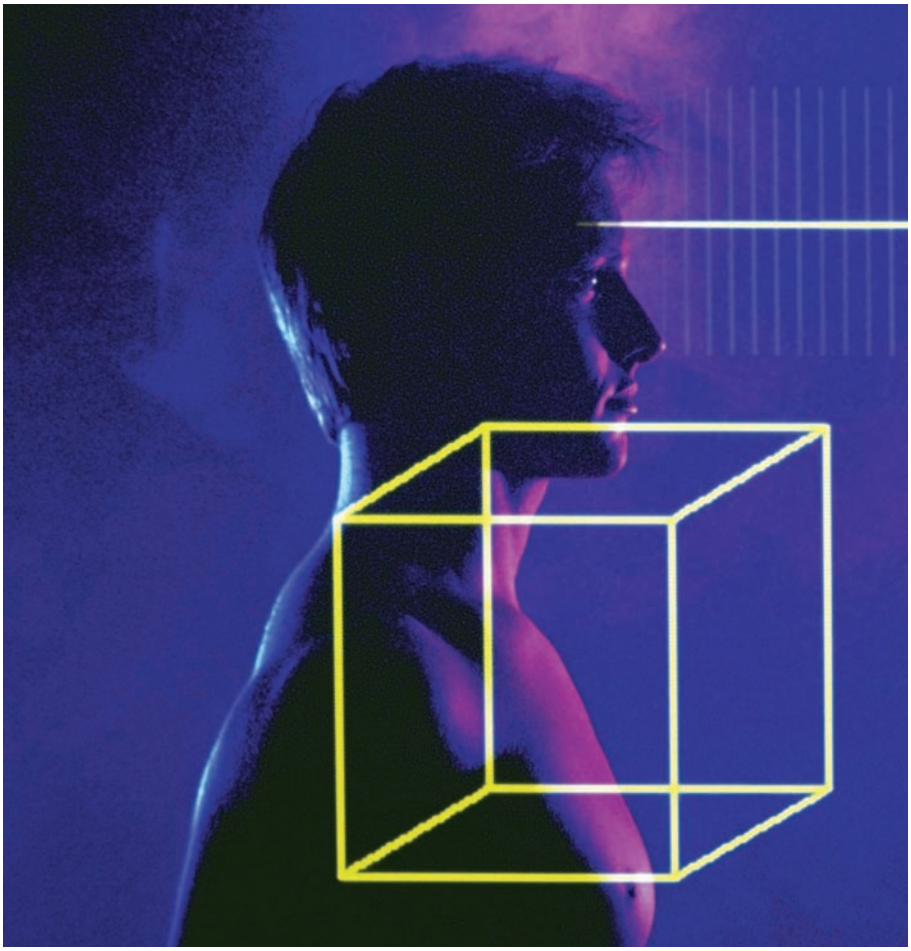
Hutchins hopes the project will provide valuable information about population structure, subterranean gene flow, and habitat discontinuity barriers the MCI face.

However, MCI research is only the beginning for Hutchins.

"There are lots of cave animals out there that we know nothing about and haven't even discovered yet," he said. "There is also a big need for education about and conservation of caves and cave animals."

COMING SOON TO A BOOKSTORE NEAR YOU

By Michael Scher, journalism ’08



SHE HAS TAKEN INTO ACCOUNT SOME OLD GESTALT THEORIES ON PERCEPTION—THEORIES ON HOW PEOPLE INTEGRATE PERCEPTUAL INFORMATION INTO MEANINGFUL WHOLES—AND MODIFIED THEM USING MODERN RESEARCH . . .

LYDIA MANIATIS (PSYC ’07) STARTED OFF HER SCIENTIFIC CAREER with an interest in biology, considering psychology a flaky science. While she still has a deep interest in evolutionary biology, her passion has become researching perception, a large area of research in the science she once called flaky.

While her thesis for graduation combines her interests in sexually linked evolutionary traits and the psychological perception of these traits (her hypothesis is that there are certain features common to facial attraction), her true passion in psychology is something she calls her manifesto.

Her manifesto is a theory on how the human brain processes and perceives three-dimensional images. She has taken into account some old Gestalt theories on perception—theories on how people integrate perceptual information into meaningful wholes—and modified them using modern research and her own thoughts to explain how we can make a computer process three-dimensional images, just like the human brain.

She believes this theory may one day allow her to write a textbook on perception and the senses, something she has dreamed of doing. She tried to write a textbook when she taught a psychology class on the senses for two semesters at American University. “I didn’t like how the book was put together, so I wrote my own,” Maniatis said.

It’s this type of attitude that has won Maniatis praise in American University’s psychology department.

“She really enjoys teaching and getting other people to be excited about things that excite her,” said her graduate advisor, Scott Parker. “She will be a good researcher and publisher because she has good ideas, gets very interested in how they’ll come out, and has a lot of energy to follow them through,” he said.

While she was teaching, Maniatis said she stayed true to her own principles by trying to teach students to understand the larger concepts and not just facts.

It was this drive that led her to write her own handouts, which she later compiled into a book of sorts. A friend recommended that she send the manuscript to McGraw-Hill, which she said rejected it because she wasn’t a well-qualified or distinguished scientist. Maniatis took the rejection in stride and pointed out that she isn’t distinguished—yet.

Anthony Riley, chair of AU’s psychology department, said that Maniatis is a student who is intensely driven by her own ideas and innate curiosity about everything around her.

“She is quirky, which is a grand quality in an academician,” Riley said. “She likes to test the water on lots of issues and she simply loves to think.”

CREATING A CULTURE OF SUSTAINABILITY

By Alicia Pimental, public communication '06

IN A LITTLE MORE THAN ONE SEMESTER, **Claire Roby (ENVS '09)** has established herself as a leader in the movement for campus sustainability at American University.

Roby is president of Eco-Sense, AU's environmental club, which raises campus awareness of environmental issues. After assuming the role of president in the spring semester, Roby reorganized the club into groups, each of which works on a specific project or campaign. "My role is to help the members implement their ideas, whether it be developing a strategy or reserving rooms," Roby says. "I also let the club know about other environmental events happening on and off campus."

Increasing awareness of campus sustainability is one of Eco-Sense's major focuses. For one campaign, members are gathering signatures on a petition to get a referendum about clean energy on Student Government ballots. The referendum would determine whether students want the university to buy clean energy, i.e., energy that is renewable and not polluting. Eco-Sense wants AU to set a goal of 50 percent clean energy by 2012.

The club is also asking Interim President Neil Kerwin to sign the Talloires Declaration, an agreement among university presidents to increase the profile of sustainability on their campuses. Roby said: "We are doing quite well on many of the points listed in the Talloires Declaration, and in order to fulfill the remaining steps, we need the commitment from the leadership of the university. AU is a really values-driven university; it would be good to codify their commitment to sustainability."

Eco-Sense is also working on long-term campaigns to make the campus more sustainable. "We want to create a culture of bringing your own mugs to the Davenport Lounge to reduce the use of Styrofoam cups," Roby said. Currently, the popular coffee shop takes 10 cents off the purchase of a cup of coffee when customers bring their own mugs. Eco-Sense wants this changed to a punch-card system, in which customers would receive a free cup of coffee after using their own mugs for 12 purchases. Eco-Sense also wants the new SIS building to include a coffee shop capable of providing regular mugs that can be washed and reused.

Claire Roby at Little Paint Branch Park in Maryland, where she and other Eco-Sense members cleaned out invasive plants. Photo courtesy of Claire Roby.

In addition to her involvement with Eco-Sense, Roby works with Riley Neugebauer, AU's environmental coordinator, on various projects to raise awareness of sustainability on campus. During the spring semester, Roby planned a fair for AU's annual Campus Beautification Day. The fair, which was held on April 18 on the quad, focused on sustainable businesses and student groups. Roby also helped plan a summit on campus sustainability during Green D.C. Week, which was held April 17–21. The plan was to get a group of students from each area university to share projects and learn from each other, she said.

Roby hopes to get much more from her experience with Eco-Sense than an appreciation for the environment. "I want to be able to mobilize people, to organize student movements," she said. "That is a skill that is applicable to real life."

ZEBRAFISH AND HUMANS AREN'T THAT DIFFERENT AFTER ALL

By Jihane Abou Chabke, journalism '09

AMERICAN UNIVERSITY PHD STUDENT **RANIA TARBOUSH (PSYC '07)** IS STUDYING HOW THE retina of the eye works and the effects of light on the development of the retina.

Light starts its journey entering through the pupil of the eye. It then is focused and converted by the cornea and lens, to be finally projected to the back of the eye, where the retina lies. This is where Tarboush's research lies.

Tarboush's interest in visual neuroscience began in a neurobiology class she took as an undergraduate student. As a result, she decided to apply for the four-year PhD neuroscience program at American University.

Under her mentor, Victoria Connaughton, Tarboush is writing her thesis in visual neuroscience by researching zebrafish, which are wonderful models for studying vertebrate development and genetics, she said. "A lot of zebrafish genes are similar to human genes," she said. "Using them for research will hopefully help us understand what is going on in our own body."

Tarboush is studying the effects of light on the model's retina by raising juvenile zebrafish (up to the age of 15 days) in constant light and constant darkness, and then comparing the results.

Other requirements in Tarboush's program are three laboratory rotations for which she gets to pick a research subject. Currently, she is doing her lab rotation with biology professor Christopher Tudge on the morphology of the eye in adult zebrafish on a very microscopic level. For this, she uses an electron microscope, similar in purpose to a light microscope, but which achieves much greater resolution by using a parallel beam of electrons instead of a beam of light to illuminate the object. "It's a powerful tool," Tarboush said. "It lets you see the anatomy of the different neurons and how they are connected to each other."

To her, the value of science, and the value of using animals in science, is to find something that applies to humans and to increase our understanding of human conditions.

Rania Tarboush at the biology lab in Hurst Hall. Photo courtesy of Rania Tarboush.

Tarboush currently spends most of her time on the AU campus, attending classes, researching, and being a teaching assistant for an undergraduate biology class. "I love the program," she said. "My classes are very interesting, and the faculty approachable. That's the benefit of having a small number of students in our school: you have the chance of one-on-one interactions with the teachers, and thus get a lot of attention."

MEASURING EARTHQUAKE MAGNITUDE IN A MATTER OF MINUTES

By Adam Ross, journalism '06

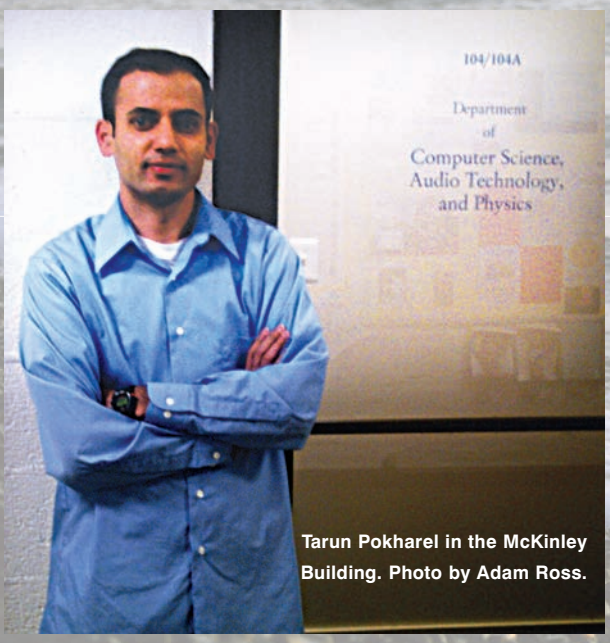
TARUN POKHAREL (CAP '05) DESIGNED HIS master's thesis to better interpret the magnitude of an immense earthquake, minutes after its eruption.

When the second-largest earthquake ever recorded erupted under the Indian Ocean near Sumatra in December 2004, the Pacific Tsunami Warning Center (PTWC) reported a magnitude of 8.0 within 15 minutes of the quake and the U.S. Geological Survey's National Earthquake Information Center (NEIC) reported a magnitude of 8.5 after an hour. But hours later, further analysis showed the quake measured as a 9.0—30 times stronger than originally predicted.

Unlike methods used by the NEIC and PTWC, the technique Pokharel has proposed may interpret earthquake magnitude measurements fairly accurately minutes after an earthquake erupts by using mathematics and historical data from the region.

"Based on Bayesian Monte Carlo methods, this technique requires a comprehensive list of data," Pokharel said. "Using that data, if something happens today, by looking at the history, the technique can interpret the accuracy of reported magnitude. The more historical information that is available, the better the interpretation."

The Bayesian approach, according to the *Economist* magazine, provides a mathematical rule that allows scientists to combine new data with their existing knowledge or expertise.



Tarun Pokharel in the McKinley Building. Photo by Adam Ross.

In 2004, there was a gap of few hours between the underwater earthquake and the final tsunami that hit the coast. Faster and more accurate analysis could have warned people to flee to higher ground.

However, in developing countries little historical data exist on file. Thus Pokharel studied the United States, where data date back to the 1800s. In the past, analyzing all of that data was far too time consuming, but today, with faster computers, that's not a problem, Pokharel said.

"The goal of this thesis is not to go for predictions but to point to researchers this could be an option to implement if such things happen, so that 283,000 died in 2004, maybe we can reduce that down to 100,000," Pokharel said.

According to Pokharel, determining the right magnitude is essential for a warning system that could save lives and reduce economic impact. "The study isn't proposing a technique to stop the loss [of lives] but to minimize the loss," Pokharel added.

After deciding on his thesis topic, Pokharel presented the idea to Angela Wu, a computer science professor at AU. Wu informed him that no one at AU was a specialist in the field, and so she found someone who was. That someone was former AU professor Charles Linville.

"It's a clear example of how supporting our professors are here," Pokharel said. "She [Wu] went above and beyond her obligations and duties and she found a person who was interested in that topic."

Pokharel and Linville have discussed the idea of converting the thesis into a scholarly journal article.

GETTING OUT OF DODGE

FULBRIGHT WINNER RESEARCHES ANTIBIOTICS IN IRELAND

By Alexia Terzopoulos, journalism '06

CAREY MYERS (CHEM '05) HAD ALWAYS wanted to spend time studying in Europe, but her demanding undergraduate schedule at American University prevented her from doing so.

But by the time she graduated, Myers, 23, had found the perfect solution—a government-funded Fulbright grant to spend 10 months researching penicillin derivatives in Ireland.

In September 2005, she began researching under Timothy Smyth, a renowned penicillin researcher, of the University of Limerick.

"I had used several of Dr. Smyth's papers in my research at AU," Myers said. "His research is similar to what I was doing at AU, but taking a different approach to solving the same problem."

The problem Smyth, Myers, and two PhD candidates are combating is antibiotic resistance. Many strains of bacteria can no longer be suppressed by typical antibiotic therapy, Myers said. "Resistance is a very natural phenomenon," she said. Bacteria have the ability to mutate quickly. But, Myers added, it is also exacerbated by human activity, such as incomplete, improper, and over utilization of antibiotics.

Myers and Smyth have focused on developing penicillin derivatives for use against these antibiotic-resistant bacteria strains.

Penicillin, which is used to treat certain types of bacterial infections, binds to the enzyme transpeptidase, which links the sugar polymers forming the bacterial cell wall. It irreversibly blocks the enzyme's activity, thus weakening the bacterium's cell wall during replication—by preventing cross-linking between the polymers—and causing the cell to rupture.

However, some bacterial strains have developed defense mechanisms, such as beta-lactam enzymes, that destroy penicillin and render it harmless.

Penicillin derivatives are molecules of penicillin that have been chemically altered, Myers said. For her research, the penicillin derivatives have had a new chemical component added. When they are metabolized by the beta-lactam enzymes, "the component that was added, i.e., the modification, serves as an antibiotic," she said. Using synthetic organic chemistry and typical laboratory equipment and techniques, she and Smyth are researching how these derivatives can be developed as alternatives to penicillin.

Myers finished her research in Ireland in June. She begins a master's program at AU this fall.

Her research is still in progress and results are not yet available, but her findings will certainly be a step forward for the medical industry. "Hopefully, my research will contribute to the development of new drugs that are effective against these antibiotic-resistant bacteria," she said.

Carey Myers at Blarney Castle in Ireland. Photo courtesy of Carey Myers.

PROFESSOR PROFILES

PSYCHOLOGY PROFESSOR STUDIES FACTORS THAT INCREASE VULNERABILITY TO DRUG ADDICTION

By Allison Young, journalism '09

WHEN TONY RILEY FIRST BEGAN TEACHING AT American University, he was unsure of his plans for the future but decided to stay for a few years to see whether AU was a good fit. That was in 1976. Some 30 years later, it is clear that American was a perfect match for Riley. An active professor and researcher since his arrival, Riley has been chair of AU's psychology department for six years.

Riley says American University has allowed him the freedom to follow his passions. Further, it is a strong university that attracts solid students, many of whom migrate to his lab, where he studies pharmacology by working with animal models to understand drug use and addiction.

"By using animal models, we can learn something about causes and treatment of human diseases," said Riley. "And drug abuse is a disease. In fact, it is a disease of the brain."

Riley's research focuses on finding factors that predispose rats to drug dependence. Some factors Riley assesses are sex, strain, and maternal interactions.

"We find out how the rats are different genetically, and how that makes them more or less disposed to the drugs."

Another aspect of study in Riley's research is the effect of drugs used in combination. Riley studies alcohol and cocaine as an example. When each drug is administered alone and in a low dose, he said, the effect is minimal. When used together, however, they produce a drastic change in the animal, which suggests the drugs work synergistically.

"This is a real concern given that these two drugs are often used in combination by people. By studying them in animals, we get some insight into how they act and where they work," Riley said.

Riley began college at the University of North Carolina at Chapel Hill planning to major in antebellum American history. This all changed when an Introduction to Psychology course lit his passion for the subject. "I had this wonderful group of professors who were passionate about it. I never ever thought about psychology till I took that course," he said.

At this time, Riley volunteered in a laboratory that studied learning in pigeons. "My first interest in psychology was in conditioning and learning," he said. In his junior year at UNC, Riley took a course in ethology, which introduced him to the concept of evolution. "I grew up in the fundamentalist Baptist town of Durham, North Carolina, and had never heard of evolution," he said. "It was the most fascinating phenomenon I'd ever heard of, and now evolution is my hobby."

Riley pursued this interest in graduate school at the University of Washington in Seattle, where he worked with a professor who was studying psychology with a concentration in evolution. After two years of postdoctoral work at Dalhousie University in Nova Scotia, Riley moved back to the United States to begin his career at American University.

Today, Riley shares his zeal for psychology, evolution, and pharmacology by teaching a wide range of classes, including Psychology as a Natural Science, Drugs and Behavior, Neuropharmacology, and the Evolution of Evolution.

MATH PROFESSOR USES BIOSTATISTICS TO UNDERSTAND DISEASE OUTBREAKS

By Margaret Tolly, journalism '08

MATHEMATICS IS NOT ONLY ABOUT THEOREMS and proofs. Just ask AU math professor Monica Jackson. In addition to teaching introductory and graduate-level courses, Jackson also conducts medical research by developing statistical models of disease outbreak.

Although she has a master's degree in mathematics from Clark Atlanta University and a PhD in applied mathematics from the University of Maryland, she began to focus on applied math after interning at a hospital and dealing with biostatistics and medical research.

"I've never done just straight math; it's always been applied math," she said. That may be why Jackson takes a special interest in helping math and non-math majors alike appreciate the importance and practical applications of mathematics.

Her post at AU is the most recent addition in a long list of research work, internships, and teaching positions. She received teaching experience at Clark Atlanta University for two years and at the University of Maryland for seven years. Though she was on a career trajectory to become an engineer, it was not until she interned at a hospital that she became deeply involved in biostatistics and medical research.

Her area of expertise is spatial statistics, correlating factors, specifically diseases in this case, with locale. The objective is to determine which diseases, if any, people are more likely to develop because of where they live. Once the numbers and data from a study are collected, partnering epidemiologists and medical doctors determine what it actually means. Presently, her work has advanced to include disease surveillance, which creates models to simulate how the early stages of a disease outbreak would look.

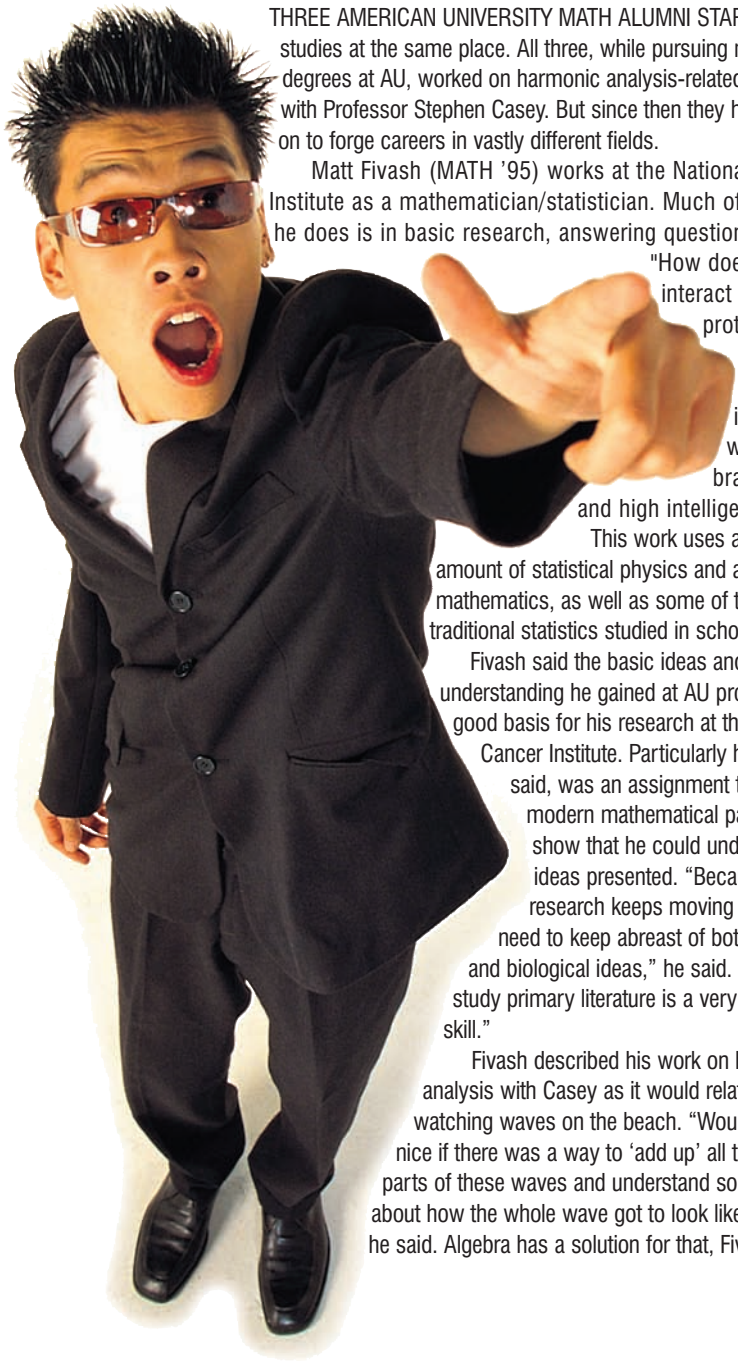
"I've always loved math. I had no clue what I would do with it. Research programs got me excited about math even more," Jackson said.

Now, Jackson can easily rattle off a list of programs she would like to put into action and additional work she would like to do, using the resources at AU. One of her major goals is to add to AU's undergraduate research program because such a program jump-started her own interest. "I hope to get funding in the next couple years to build upon the math department's current program, 15 to 20 students, not just to work on my research with me, but with all faculty." Jackson also seeks to introduce a new course in disease surveillance. It would involve epidemiology and biostatistics geared toward students who aren't necessarily in math but have a general interest in science, and would show them how math and statistics are used to help scientists. Longer-term goals include having her papers published and conducting new research.

HARMONIOUS YET DIFFERENT

Matt Fivash
Terrence Moore
Chris Organ

By April Astor, journalism '06



THREE AMERICAN UNIVERSITY MATH ALUMNI STARTED THEIR studies at the same place. All three, while pursuing master's degrees at AU, worked on harmonic analysis-related theses with Professor Stephen Casey. But since then they have gone on to forge careers in vastly different fields.

Matt Fivash (MATH '95) works at the National Cancer Institute as a mathematician/statistician. Much of the work he does is in basic research, answering questions like "How does a protein interact with other proteins?" or "Is there a gene that interacts with both brain cancer and high intelligence?" This work uses a significant amount of statistical physics and applied mathematics, as well as some of the more traditional statistics studied in school.

Fivash said the basic ideas and understanding he gained at AU provided a good basis for his research at the National Cancer Institute. Particularly helpful, he said, was an assignment to read a modern mathematical paper and show that he could understand the ideas presented. "Because research keeps moving forward, I need to keep abreast of both statistical and biological ideas," he said. "Learning to study primary literature is a very helpful skill."

Fivash described his work on harmonic analysis with Casey as it would relate to watching waves on the beach. "Wouldn't it be nice if there was a way to 'add up' all the different parts of these waves and understand something about how the whole wave got to look like it does?" he said. Algebra has a solution for that, Fivash said.

There is a way to add and subtract those waves, similar to the algebra taught in high school, said Fivash. By picking a set of "simple" waves that do not "interfere" with each other and using them like numbers, it is possible to add, subtract, and perform other functions with these "simple" waves, using harmonic analysis as a tool to figure out how the waves will behave.

Fivash explains harmonics by using the example of the sound of a voice. "Most people can easily tell who is calling them on the phone just by listening. This is possible, in part, because each person's tone differs. Those 'partials' or 'harmonics' that make up a 'tone' are another way in which waves (here sound waves) may be taken apart and studied. When you decide to analyze what's going on with those harmonics, you end up with harmonic analysis."

Terrence Moore (MATH '00) describes harmonic analysis as the study of representing functions as a summation of a set of other basis functions (e.g., sines and cosines). He also worked on harmonic analysis with Casey for his MA in mathematics. "Higher level mathematics is also considered an art. Actually, Dr. Casey often used to say that when first learning a new idea in math it was like creating art and thereafter it was a tool," Moore said.

Moore's thesis was on sampling theory. "Think of a film," he said. "A movie is actually a periodic sampling of movie stills, but the eye interpolates those stills to give the appearance of continuous motion on the screen. People's eyes and brain connect the dots or reconstruct the motion that must have happened from what is actually seen in the stills."

His current job involves research. He writes technical papers, published primarily in engineering journals, for the Army Research Lab on signal processing for communications.

Moore says this work relates very little to his thesis. Both deal with signal processing but use different theories: sampling theory versus statistics. He has briefly looked at some problems that were more closely related to his thesis and to harmonic analysis. On those occasions, he was working on one project dealing with the power spectrum of a digital signal and on another with wavelet theory. But, he said, from time to time he uses the tools that built up the sampling theory.

Chris Organ (MATH '97), another of Casey's students, also sees the link between math and art. "My enthusiasm for mathematics comes from the artistic inspiration it provides," he said.

Beginning this fall, Organ will teach math to artists in the only undergraduate math class at the Maryland Institute College of Art in Baltimore.

Organ said he doesn't actually use harmonic analysis, or even math, very often at his job. He does modeling, simulation, and analysis for a defense contractor. "The work is more at the operational level than at the engineering level, so the math

involved is pretty basic. On the other hand, the simulations can be extremely large and complex," he said.

"Many people at my workplace do have a background in mathematics because it helps to have a mathematical mind for this type of work."

Organ's thesis was an investigation of a multidimensional version of Shannon's sampling theorem, a theorem used especially in the telecommunications field. "I prefer thinking of harmonic analysis as the study of objects defined on spaces," Organ said.

"In a way it relates to the artistic process, where on the one side there is response to and evaluation of experience (analysis), and on the other side, re-interpretation and re-creation of experience through the art-making process (synthesis)."

AU DEGREES:
MATT FIVASH, MA, MATHEMATICS 1995
TERRENCE MOORE, MA, MATHEMATICS 2000
CHRIS ORGAN, MA, MATHEMATICS 1997

WHOSE WATER IS IT ANYWAY?

Uday V. Joshi

By Michael Lucibella, journalism '08

HERE ON THE EAST COAST, WHERE RAINFALL IS ABUNDANT and the summers are humid, water ownership rights are rarely a hot topic. For states in the Southwest, however, water rights are often the difference between an area's economic success and failure.

Uday V. Joshi decided to put his dual degrees to work in New Mexico to formulate water rights policies and help resolve allocation disputes. Joshi went on to do his master's in water resources from the University of New Mexico as well as earn a law degree there. He now works as counsel for the Office of the State Engineer in New Mexico. The office supervises all measurement, appropriation, and distribution of water in the state. This is a big task, and the office has broad powers to implement its policies. These policies are so far-reaching they affect even neighboring Texas, Colorado, and Arizona.

Joshi's experiences at American University have helped him prepare for public service. His degree in environmental studies helps him think critically about technical analyses while his international studies degree helps him apply those technical issues to make sound policy. Joshi said he has also found his degree in international relations useful when dealing with interstate water disputes because the allocation problems he encounters are akin to water disputes between countries around the globe. During his senior year in college, he also interned at the National Oceanic and Atmospheric Administration and continued his work in the Office of Oceanic and Atmospheric Research's International Activities Office.

While he credits his classes and internship with preparing him for his job, Joshi also credits the people he met at AU with preparing him for New Mexico. "The diverse population at AU lends itself to an exploration of different cultures, ethnicities, disciplines, and diverging thoughts and opinions from around the world. I became friends with people from all over the country and world who challenged the status quo and provided new global and national perspectives. The diversity in cultures at AU parallels, in some respects, the diversity in New Mexico, which has its own unique diversity represented by descendants from Spain and Mexico, and Native Americans," he said.

Joshi plans to continue his work in the field of natural resource law and hopes to develop and broaden his work.

Though Joshi's experience at AU helped him in his professional career, he cautions that academic work is not the be-all and end-all. "School and work are quite different, so however you did at AU is separate from how you will perform professionally."

AU DEGREE:
ENVIRONMENTAL STUDIES AND INTERNATIONAL STUDIES 1998

PIPING HOT: Scholarships, Internships, and Jobs

For more information on internships and jobs, visit the Career Center's Web site at www.american.edu/careercenter. You can set up an appointment with a career advisor or an internship advisor and search the Career Center's job database.

For more information on scholarship opportunities, visit the Office of Merit Awards Web page at www.american.edu/careercenter/oma/awardlisting.html. Staff at the office can also help you prepare your application for any of the following scholarships.

SCHOLARSHIPS

HORIZONS Scholarship

Women In Defense, A National Security Organization, established this scholarship to encourage women to pursue careers related to national security and to provide development opportunities to women already working in national security and defense fields. Those in the following fields are eligible: computer science, math, chemistry, and physics. The scholarship provides funding for undergraduate or graduate studies. Award amounts vary from $500 to $1,500.

Eligible applicants must be female U.S. citizens and currently enrolled at an accredited university or college full time or part time. Undergraduates must be at least juniors. Applicants must demonstrate financial need and have a minimum GPA of 3.25. Deadline for completed applications, essays, recommendations, and transcripts is November 1. Send application packages to: WID HORIZONS, 2111 Wilson Blvd., Suite 400, Arlington, VA 22201-3061. For questions, contact Jane Patrick Casey at jcasey@ndia.org.

The application form can be accessed at the organization's Web site: www.wid.ndia.org/horizon.

Dr. Wesley Eckenfelder Jr. Scholarship

In recognition of Dr. Wesley Eckenfelder's contributions to the environmental profession, environmental engineering firm Brown and Caldwell offers a $3,000 award for undergraduate or graduate students pursuing education and careers within the environmental industry. The scholarship is usually awarded to only one student per year, and is not renewable.

Applicants must be U.S. citizens or permanent residents enrolled full time in an undergraduate or graduate program at an accredited college or university, have declared a major in one of the environmental sciences, and have a cumulative GPA of 3.0 or higher.

The deadline for application is January 31. An application form for the scholarship can be accessed at www.brownandcaldwell.com/EckenApp.pdf. To apply, send application form, a résumé, two recommendation letters, an essay, and an official transcript to: Attn: HR/Scholarship Program, Brown and Caldwell, 201 North Civic Drive, Suite 115, Walnut Creek, CA 94598.

Refer to www.brownandcaldwell.com for more details.

National Network for Environmental Management Studies Fellowship

This program allows undergraduate and graduate students to perform research projects designed by the EPA. Projects are in the general areas of environmental policy, regulation, and law; environmental management and administration; environmental science and computer programming and development. Fellows are given a stipend paid in monthly installments throughout the duration of the research project. The average award for 2005 winners was $16,000.

Applicants must be U.S. citizens or permanent residents. Undergraduates should be at least juniors and must have already completed four courses relating to the environmental field. Seniors graduating before the fellowship ends must be accepted into a relevant graduate program to apply. Minimum GPA is 3.0.

For more information visit: www.epa.gov/enviroed/students.html.

National Science Foundation's Graduate Research Fellowship

Three-year graduate fellowships are awarded for graduate study leading to research-based master's or doctoral degrees in fields supported by the NSF: science, mathematics, and engineering. Awards include a $20,500 stipend for 12-month tenure; a cost-of-education allowance of $10,500 per tenure year; and a one-time $1,000 international research travel allowance. The funding can be used for graduate students, internships, or post-graduate fellowships.

Applicants must be in the early stages of their graduate study in science, mathematics, or engineering and must be U.S. citizens or permanent residents.

For more information, see www.nsf.gov/funding/pgm_summ.jsp?pims_id=6201.

INTERNSHIPS:

Research Internships in Germany

RISE, or Research Internships in Science and Engineering, gives students in the fields of biology, chemistry, engineering, geology, and physics the chance to spend a summer working with German doctoral students on serious research projects. The doctoral students help integrate undergraduates directly into lab work and serve as personal and professional mentors. All participants receive stipends to help cover living expenses, and the partner universities and research institutions provide housing assistance.

Students will be provided a monthly scholarship of 615 euros for six weeks to three months (prorated depending on length of stay) between June and August 2007; the organization will also provide health insurance and accident and personal liability insurance. The host institution will help the intern find reasonably priced housing for the duration of the internship. The scholarship will not cover international travel costs.

To apply for a RISE placement you must be currently enrolled at a U.S. university or college as a full-time student in the field of biology, chemistry, physics, earth sciences, or engineering (or a closely related field). You must also be an undergraduate who will have completed at least two years of a degree program by the time of the placement, prove that you will be registered at your university or college for the academic year 2007–2008 (i.e., that you will still have student status upon your return to North America). German

language skills are not required for most positions but would be helpful to manage everyday life outside of the laboratory. The working language will generally be English.

For more information, visit: www.daad.de/rise/en.

If you are interested in participating in the RISE program in summer 2007, please register online. This will enable you to access the internship offers which have been submitted by German PhD students. Apply after December 5. You may apply for up to three internships. One set of the original documents should be sent to the German Academic Exchange Service at the address below. Copies of your application should be sent directly to the PhD students (electronically or via postal mail). The application deadline is February 1, 2007 (receipt date). You will be notified by the beginning of March 2007 whether your application has been successful.

Applicants must submit the following documents in ONE package: an application form (available only online), a cover letter addressed to each German host institution to which you will forward your application, full curriculum vitae/résumé, a list of subjects studied by the time the internship begins, a letter of reference from a senior academic in your field of study, and an official university or college transcript.

For more information contact: German Academic Exchange Service, Michaela Gottschling, Kennedyallee 50, 53175 Bonn. Phone: +49-0-228-882-567, from 8 a.m. to 1 p.m. E-mail: rise@daad.de

Spaceflight and Life Sciences Training Program

This intensive six-week program at the Kennedy Space Flight Center in Florida is for undergraduate college students interested in learning how to successfully design and conduct biological research and operations in space and how to assess the environmental impacts of a launch site.

Applicants must be U.S. citizens or resident aliens, 18 or older, and an undergraduate or non-graduating senior at a two- or four-year college or university. Minimum requirement is completion of the freshman year with a major in a hard science or engineering with a minimum GPA of 3.0. Check the organization's Web site for the latest information on eligibility.

Deadline to apply is January 31. For questions contact: Laurel Lichtenberger, evaluation coordinator, by phone at 321-867-4036 or via e-mail at laurel.lichtenberger-1@ksc.nasa.gov.

Summer Undergraduate Research Experience (SURE) at the Oak Ridge Institute for Science and Education

The 10-week SURE program sponsors an orientation workshop, research with mentors at Department of Energy facilities, and an end-of-summer workshop. Participants receive a weekly stipend, and their travel expenses are paid.

Applicants must be U.S. citizens. The program targets sophomores and juniors, but outstanding freshman applicants will also be considered. Be sure to check the organization's Web site for the latest information on eligibility. Deadline for applications is late January. For more information see www.atmos.anl.gov/GCEP.

JOBS:

QC Analyst with Kelly Scientific Resources

Kelly Scientific Resources is seeking a quality control (QC) analyst for its client located in a Boston suburb. The QC analyst will perform microbiological assays in a GMP laboratory to determine the quality and stability of biological products. In addition, the analyst will conduct environmental monitoring of the production facility to prevent potential microbiological outbreaks.

Preferred candidates will possess a BS in biological sciences, 0 to 2 years of professional lab experience, attention to detail, and good documentation skills.

Kelly Scientific Resources is the largest company in the world dedicated to scientific staffing, currently employing 5,000 scientists through 110 locations in 16 countries. KSR provides scientific staffing services on a temporary, project, and full-time basis to a broad spectrum of industries, including biotechnology, pharmaceutical, chemical, consumer products, cosmetics, environmental, and food sciences. Visit www.kellyscientific.com.

Clinical Trial Support Specialist at Antean

Each trial support specialist (TSS) is assigned to studies as needed. The trial support specialist supports the clinical trial manager in study start-up and site management responsibilities. While assigned to a study, the TSS is managed by the clinical trial manager responsible for the study. A TSS will work on a variety of studies and during many study phases. This role is a training ground for future clinical trial managers. Trial specialists may also be candidates for clinical scientist positions in the medical research organization.

The TSS will be the point of contact for incoming site communications; will support the clinical trial manager in outgoing site communications; support the clinical trial manager in managing communications among the trial execution team members and field operations; assist the clinical trial manager in documenting trial execution team meetings, decisions, and other required documentation; coordinate and send study documentation to sites (letters, faxes, e-mails); maintain the clinical trial portal for each study; and maintain the trial team roster in IMPACT.

In addition, the TSS will assist in site prescreening, track IRB approvals, and assist the clinical trial manager with site prescreening activities, site selection, and qualification visits. The TSS will also assist with ordering test articles, central lab supplies, and other study supplies and collaborate to ensure study documents are collected before site initiation (e.g., FDA 1572, CVs, ICF, financial disclosure forms, lab normal ranges and certification, and IRB approvals).

A bachelor's degree in science is required. Experience in the pharmaceutical industry is preferred. See www.antean.com.

Assistant Scientist with MRI

The Midwest Research Institute is currently seeking assistant scientists to provide sample analysis and lab support for several biological-based testing programs, assist with data collection and analysis, contribute to research and analysis as needed for proposals and reports, and possibly provide guidance and training analysis in laboratory techniques and procedures.

Candidates need a BS in biology, molecular biology, microbiology or biochemistry; experience in a research environment; basic analytical skills; the ability to learn new software and systems; and the capability to effectively communicate and interact with technical staff at all levels in a team-based environment.

Applicants selected will be subject to a government security investigation and must meet eligibility requirements for access to classified information. U.S. citizenship is required. See www.mriresearch.org to apply.

I just received the spring 2006 issue of *Catalyst.* Unfortunately, I did not receive the issue where you summarized intelligent design. Clearly, you missed certain important facts.

I am the individual who first investigated mathematically the intelligent design of natural-system behavior. This was begun in 1979. The General Grand Unification model (GGU-model) formulated in 1979 is the first mathematical "Theory of Everything" that is testable and even falsifiable. It meets all of the criteria for a physical theory. However, all of the universe-producing operators also have intelligent agent signatures. The General Intelligent Design model (GID) interprets these signatures. Of course, these signatures can be ignored as is done in such areas as quantum logic. Using the GID interpretation, the GGU-model can be interpreted theologically.

The ID theory that has been publicized by the media is the restricted ID theory (RID) championed by the Discovery Institute and this theory can be shown to be of no significance. RID is not a physical theory, has no definition of "intelligence," it is cosmology dependent, and any physical evidence that matches the RID patterns can be considered as indirect evidence for a cosmology where the RID assumption that the patterns are intelligent designed is false. This cannot happen with the GID interpretation.

Numerous accepted physical theories discussed in the classroom have both positive and negative theological interpretations. The fact that the GGU-model, as a physical theory, has a theological interpretation should not preclude the GGU-model from being discussed within any classroom setting.

Robert A. Herrmann
Math '73 (PhD)

Editor: There was no "summary" of intelligent design in the fall 2005 issue of Catalyst; *it was simply the subject of the Science Issues—You Decide editorial inside the front cover. We are happy to see that the editorial is performing its role in inspiring thought and comment. See past issues of* Catalyst *online at www.american.edu/cas/catalyst.*

I'm actually a grad student in SIS, but have a recreational interest in science. I spend a lot of time in Hurst at the computer lab, and picked up a copy of *Catalyst* while I was taking a break on the lobby couches. I thought the publication was very slickly done, had some interesting research updates, and on the whole was a great way to spend a break from doing my own work. Thanks, and keep up the good work!

Laura K. Meissner
International Development '06 (MA)

COOL WEB SITES

Check out these Web sites for science-related employment information.

www.american.edu/cas

Go to the CAS Web site for details on all AU science programs.

www.biologyjobs.com

BiologyJobs.com was created as a targeted resource for job seekers and employers who are specifically interested in the life sciences. Job searchers can search for free and post their resumes online.

www.cdc.gov/hrmo/intshps4.htm

Programs sponsored or coordinated by the U.S. Centers for Disease Control and Prevention and the Agency for Toxic Substances and Disease Registry

www.cyber-sierra.com/nrjobs/natres.html

Cyber-Sierra's Jobs in Natural Resources page focuses on employment geared toward fieldwork and resource professions.

www.earthworks-jobs.com

Earthworks has a large number of jobs for those interested in earth sciences and related fields.

www.ecojobs.com

Search engine for several opportunities in environmental and natural sciences fields

www.fbi.gov/employment/academy.htm

This site lists unpaid internships with the FBI.

www.hr.lanl.gov

View job listings for professionals and technical positions at the Los Alamos National Laboratory.

www.nps.gov

The National Park Service posts employment opportunities available in all U.S. national parks.

www.rileyguide.com/science.html

View opportunities in every possible natural sciences area.

www.scied.science.doe.gov

U.S. Department of Energy, Office of Science Education

www.scijobs.org

This Web site contains job listings in biology, chemistry, biochemistry, biotechnology, and a range of other jobs in science.

www.sciencejobs.com

Search for jobs mainly in the fields of chemistry and bioscience. Also sign up for a "jobs e-mail" alert.

www.tncrimlaw.com/forensic

Forensic science resources

www.training.nih.gov/careers/careercenter/index.html

The Science Professional Network provides links to job listings, with complete position descriptions.

www.training.nih.gov/student/index.asp

This site lists research and training opportunities at the National Institutes of Health. New announcements are frequently added.

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