College of Arts and Sciences
American University
Washington, D. C.

Fall 2009

www.american.edu/cas

catalyst

AMERICAN UNIVERSITY SCIENCE

EDITORIAL

Science Issues—The Search for Extraterrestrials

In 1992, the United States government began funding a program that fundamentally changed the way humanity perceived the night sky. Inspired by the intrepid trips of the Voyager I and Voyager II probes, which carried engraved messages from earthlings into space, the U.S. space program began MOP-the Microwave Observing Program. Not to be confused with the handy gadget in your kitchen, MOP took an opposite angle from the golden disks within the Voyager probes; instead of sending messages in a bottle, we were tuning into the cosmic radio station. Earth was now listening to the great expanse of space. Although incredibly ambitious, the fact scientists were looking at all was largely panned by critics and the U.S. Congress; searching the sky for alien radio messages was far too outlandish for the American government to pay for. In 1994, MOP was cancelled as a government program but lived on through the private, not-for-profit group the SETI League (the search for extraterrestrial intelligence).

While SETI has one of the most ambitious goals of any ongoing scientific program (that is, to make first contact with extraterrestrials), the question of what we were actually looking for has cropped up amid discussions of the possibilities of finding anything at all. Finding Klingons is generally regarded as unlikely, let alone encountering anyone like our preconceived notions of aliens. The assumption behind SETI lies in our belief that whatever life may be out there is capable of sending specific signals through space, and desires to do so. Clearly, our imaginary world of E.T. zipping through space in his flying saucer has to be thrown out the window. But trying to figure out life in the great beyond requires more than a blank slate in terms of intelligent life; we have to go all the way back to life's origin.

If you look at every single entity on Earth that science has slapped the word "organism" on, you'll notice a single recurrent theme. Beyond being mobile, eating, and reproducing (all of which widely varies between all life-forms) lies the molecule of heredity DNA. Shaped like a twisted up ladder, DNA has four different "letters" built into it, which spell out what makes a creature tick. If you change the DNA, you change the creature. It's from the starting point of DNA, the universal code for life as we know it, that we must begin to understand what beings from another world might look like.

The incorporation of DNA into all known life has its origins in the primordial soup, about 3.6 billion years ago. Earth was originally composed mainly of melted rock, slowing coalescing into the big blue marble. It took the Earth about one billion years before the conditions were right for life to emerge from the molten soup of pre-Cambrian Earth. Within this soup existed a few key ingredients, namely water, amino acids (which make up protein), and nucleic acids (which make up DNA, and its close cousin, RNA). Here is where our key to finding extraterrestrial life lies, within the key ingredients that made up our own origin.

continued on inside back cover

Please submit letters to the editor to catalyst.au@gmail.com.

Catalyst is supported in part through generous donations from alumni and friends of the College of Arts and Sciences.

If you wish to make a donation online, go to giving.american.edu. Select Make a Gift and choose the College of Arts and Sciences under Area of Benefit, then fill in the amount of your donation. At the Designation/In honor of window, key in *Catalyst* magazine. Thank you.

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 semiannual 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!

Editors:
Kathryn Thornborough, psychology '09
Andrew Frank, biology and environmental science '11
catalyst.au @gmail.com

Faculty Advisor:
Christopher Tudge
ctudge@american.edu

AMERICAN UNIVERSITY
WASHINGTON, DC

"The Hot Spot for Science Education"

Catalyst is published semiannually by the
College of Arts and Sciences
American University
4400 Massachusetts Avenue, NW
Washington, DC 20016
www.american.edu/cas/catalyst

ON THE COVER | Inspired by the film *Men in Black*, the cover features biology master's students Denisha Woods (left) and Lindsay Nugent (right). Photo by Jeff Watts

TABLE OF CONTENTS

BACTERIA, BIOREMEDIATION, AND DISCOVERING WASHINGTON'S LOST RIVER

By Jordan Maidman, history and premedical studies '11

If you don't know the health of the Anacostia River, Evan Ewers would be the first to tell you: don't swim, don't fish, don't drink. In fact, Ewers would tell you that avoiding the Anacostia waters in general would probably be a boon to your health. Simply put, pollution has led the Anacostia to inherit the ominous title of "D.C.'s forgotten river," as it flows behind the Capitol building and through some of Washington's poorest neighborhoods. But Ewers certainly has not forgotten. This American University graduate student is putting his brain power to work on saving this once naturally clean water source. Yet Ewers isn't going at this alone; he's got a little help from his friends—very tiny friends.

The Anacostia River's pollution problem stems from both centuries of pollution and its relatively flat nature. Years of unrelenting dumping of sewage and waste into the river have built up innumerable compounds in the waterway, fueled further by the Anacostia's extremely slow drainage and tidal flow. Despite being flanked by the United States National Arboretum and other undeveloped areas, the river is a veritable ecological disaster zone; it is saturated with chemicals, biological compounds, and even pathogens.

Ewers knows the state of the river all too well. "Because of power plants, runoff, incomplete combustion of fossil fuels, destruction of the marshes, and the presence of the Navy Yard, this river has become a polluted system that needs saving." With such a bleak outlook, saving this system may be a gargantuan task. But Ewers's research may hold the answer to avoiding a long, drawn-out restoration effort. Under the guidance of AU environmental science professor Karen Bushaw-Newton, Ewers investigated the efficacy of bioremediation of the Anacostia using bacteria.

Bioremediation is the use of organisms to return an altered environment to an improved ecological state. The focus of Ewers's bioremediation work has been on two specific types of ringed compounds, polycyclic aromatic hydrocarbons (PAHs) and monocyclic aromatic hydrocarbons (MAHs), both well-known carcinogens. A number of these compounds, namely pyrene, thiananthrene, and fluoranthene, are all found in the river. The same carcinogen found in cigarette smoke, benzo[a]pyrene, is also found in the Anacostia. In 2004, research showed that 60 percent of the river's adult bullhead catfish population had tumorous growths located on the fishes' liver, due to exposure to PAH compounds. Further studies have concluded that reproduction rates of native clams sharply decreased in the highly contaminated areas. These results indicate not only the likelihood of the river water and sediment as a detriment to human health, but also underline the need to preserve a now-faltering ecosystem.

Working from these unsettling findings, Ewers began experimenting with a novel bioremediation approach using the river's own bacterial colonies, buried within the sediment. By examining the wide range of bacterial species within the river, Ewers was able to find bacteria capable of naturally breaking down the ringed structures of the PAH and MAH compounds and using the smaller compounds formed for food. To find which types of bacteria were most effective at essentially "digesting" the pollution, Ewers carefully grew bacterial colonies isolated from sediments taken from three locations of the river: the Bladensburg Boat House, Kenilworth Park, and the Navy Yard. Ewers chose these locations carefully to avoid shipping lanes as these areas would not be "indicative of the pollution throughout the rest of the river, merely in those areas where it would logically be high," and to capture what he felt was a large source of the PAH and MAH compounds: the Navy Yard. "The navy likes to park their ships there and they run on diesel fuel. Because they're constantly running, diesel gets into the water, leading to contamination caused by MAHs and

PAHs." After four weeks of allotted growth time, 15 different colonies grew best on plates of pyrene, thinanthrene, fluorene, firanthrene, and fluoranthene, hitting a good portion of the offending PAH carcinogens found in the river. Furthermore, Ewers found that his bacteria favored growing in specific MAH compounds, benzene, toluene, and xylene, which are also well-known pollutants. Essentially, these native bacteria were capable of doing the same job as large construction vehicles dredging up the river bed and trucking it away as waste, a process which costs millions and can also harm the river system.

Ewers also investigated the genetics of the sediment samples to determine if any known PAH degradation genes were present. In 2006, researchers discovered the tmoA gene in bacteria, a gene capable of degrading MAH compounds. For Ewers, the logical assumption was that a similar gene could exist for the degradation of the PAH compounds. By using a process called polymerase chain reaction, isolation and amplification of specific DNA sequences, he amplified specific sequences in bacterial DNA isolated from the different areas and found three major families of PAH-degrading genes represented in the Anacostia bacterial populations. Results from the specific river sites point toward a great potential for these natural-born microbial communities to assist in removing at least some of the pollutants from the river bottom.

Ewers, who completed his master's thesis in the spring semester, firmly believes the Anacostia River can still be saved. Although the river had been largely ignored in the past, Ewers reports a recent groundswell of private and public support for cleanup efforts in and around the Anacostia. "This helps us because we can test areas of the river's sediment, make partnerships with other research institutions, and work to revitalize a river that should really be seen as a national treasure," he says. While estimates have been made that Anacostia River cleanup efforts could be concluded by 2020, Ewers finds this date a "very optimistic goal." Even compared to the Potomac, which President Lyndon Johnson referred to as a "national disgrace," the Anacostia is still years behind in remediation. While Ewers moves on to study infectious disease at the Uniformed Services University of the Health Sciences, his contributions have served to open new windows into accelerating the recovery of one of our nation's lost natural treasures.


Evan Ewers

Photo by Karen Bushaw-Newton

LEAPING INTO QUANTUM MECHANICS

By Brittany Horowitz, public communication, '12

It's unusual when a student still in college can say he's made potentially important findings in his field of study. However, for William Flynn, his research in quantum information theory has been anything but ordinary, and due to his dedication to his work he already boasts an impressive résumé.

Flynn, graduating in 2010 with a double major in physics and mathematics, spent the summer of 2008 at American University researching quantum information theory with AU professor Nathan Harshman. "Bill is great at solving math problems," Harshman says. "He knows how to take a long calculation, break it into steps, find patterns to shorten the process, and cross-check results. Problem solving like that is hard to teach, but he has an easy intuition that is remarkable in an undergrad."

Photo by Brittany Horowitz

William Flynn

While conducting his research, Flynn focused on entanglement, which he describes as "a correlation that exists between two quantum systems or subsystems." Flynn worked on developing an equation that could calculate how much entanglement exists within a molecule given certain characteristics of a system.

To conduct his research, Flynn used computer software and quantum mechanics. "Quantum mechanics dictates a certain indeterminacy about everything," says Flynn. "You know almost nothing about anything until you measure it. So if you flip a coin, catch it in your hand and keep your hand closed, is the coin heads or tails? According to QM, it's both heads and tails until you open your hand and look."

Flynn's work to measure entanglement might seem highly technical and inapplicable to daily life. However, the ability to measure entanglement has far-reaching implications not just in the work of academia, but for everyday uses as well. Being able to calculate entanglement could ultimately be used to make credit card transactions through the Internet more secure, or it could aid in quantum teleportation research (the teleportation of quantum states, not matter).

Flynn's work over the summer also provided Flynn with the opportunity to learn about a new area of research. Harshman had a grant from the Research Corporation that helped fund Flynn's studies. About his experience working with Flynn, Harshman says, "One of the hardest things about doing research in theoretical physics is framing a research question that can be turned into a solvable problem. Bill, despite his limited background in quantum theory, was able to make that leap quicker and more successfully than any other student I have worked with."

After completing his research, Flynn wrote a paper with Harshman that explains their findings. The final product will be submitted to physics and mathematics journals. Their topic is very timely, as Harshman explains: "Entanglement is a property of quantum systems that is getting a lot of attention lately because of possible applications in quantum computing, quantum cryptography, and other types of quantum information processing."

Flynn's research has the potential to benefit science, and he has already benefited from it personally. His experience helped him win the prestigious Barry M. Goldwater scholarship, established to support outstanding students in mathematics, the natural sciences, and engineering.

Photo by Andrew Frank

Suma Satish-Chandra

SEEING THROUGH THE DARK: SATISH-CHANDRA TRACES EVOLUTION OF OPSIN GENE

By Chelsea Babcock, biology '12

Biology graduate student Suma Satish-Chandra is taking a deep look into evolution through a very different set of eyes. Under the guidance of Professor David Carlini, American University's resident geneticist, Satish-Chandra is investigating the nature of eyesight in tiny freshwater-dwelling crustaceans, *Gammarus minus*. Obtained through the intrepid fieldwork of AU biology professor Daniel Fong, these small shrimp-like creatures, known as amphipods, use the protein opsin for photo-detection, seeing light. This relatively common protein, found within the photoreceptor cells in the retinae of a large portion of the animal kingdom, aids in the process of converting a photon of light into an electrical signal, which can then be interpreted as an image within the creature's brain. But the unusual habitat of some members of *G. minus* radically affects the nature of their eyesight, and their use of opsin. They live in caves.

A native of India, Satish-Chandra became interested in pursing biology as a career as biotechnology became increasingly present in the second-largest country in the world. Since the turn of the millennium, India's two major economic sectors, agriculture and

(continued on page 12)

FIGHTING RESISTANCE

By Caitlin Hillyard, broadcast journalism '11

When it comes to changing the world, Tim Beck has a bold philosophy. “Sometimes it comes, sometimes it doesn't. But you can't stop dreaming big,” Beck says.

Beck is a postbaccalaureate student completing the requirements to apply to medical school. He is also beginning research in antimicrobial compounds, chemical components that can fight drug-resistant bacteria. “Drug resistance is growing,” Beck says. Thus, he believes that we need to build a new line of defense against the threat of drug-resistant bacteria.

Drug resistance is explained by natural selection. Some bacteria have random mutations in their genetic code that make them more resistant to antibiotics. Over time, bacteria with more resistance survive, while less resistant bacteria are eliminated by antibiotics. The bacteria that survive reproduce, creating a larger population of bacteria that are resistant to drugs.

Working with a professor and five other students, Beck hopes to use chemistry to fight this growing problem. He is specifically focusing on multidrug resistant tuberculosis. Once Beck closes the theoretical portion of his research, he will begin to synthesize compounds in the lab.

The beta-lactams, a component of penicillin, Beck is working with seem to prevent bacteria from proliferating. “We're not quite sure why this is effective,” Beck admits.

The current theory is that part of the lactam molecule separates, then a portion targets proteins. Once he and the other students have synthesized the compound, they will send the mixture to an outside lab to test for impurities.

Beck is still in the early stages of his research, and he is currently working on a proposal for the Rolex Foundation's Young Laureates program to fund his work. This grant promotes science among young people. If Beck's proposal is successful, he will be awarded $50,000 for his research over the next two years.

Although he currently spends most days in the lab, Beck started his time at AU in the library. “I really had no concept what organic chemistry was,” Beck says. He spent hours teaching himself organic chemistry with help from a professor. “Once I was in the lab, I was mesmerized by chemistry,” Beck says.

Now he has finished an upper-level course in the subject.

Beck was originally attracted to medicine while working in a hospital as an undergraduate. He was struck by the patient-doctor relationship he saw on a day-to-day basis. Beck now wants to attend medical school so he can build this relationship with his own patients. He hopes his research on antimicrobial compounds can help him realize this goal. He believes that finding a “big impact solution” for drug-resistant bacteria is another aspect of helping patients.

Beck is currently applying to medical schools. But if Rolex offers to fund his research, he will have to choose between staying at AU for two more years and going to medical school immediately. “Certainly if this grant works out, that would be an incentive to stay,” Beck says.

Beck originally came to AU because the school has an excellent track record for preparing postbaccalaureate students to study medicine. More than 80 percent of AU's postbaccalaureate students are admitted to medical school after completing the program.

AU also provided him with opportunities he might not have in a larger chemistry department. “At other universities, students are not allowed to use the equipment,” Beck says. At AU, even undergraduate students may be allowed to use expensive equipment. Beck is using a $25,000 nuclear magnetic resonance machine for his research.

Also important to him is the school's team mentality.

“I think AU is very unique in that it is not incredibly competitive. If you are someone who wants to succeed, you can do that,” Beck says. “Students in the laboratory, we help each other.”

Beck says that even if he chooses to leave for medical school, he wants to continue his interest in antimicrobial compounds.

“You have to believe you can change the world,” Beck says. “Once you stop believing it, you really can't change the world.”

ANOTHER LOOK AT THE 'GATEWAY DRUG' THEORY

By Shelby Krick, literature '12

Because the "gateway drug" theory, the idea that use of one drug will lead to use of another in the future, is so widely believed in our society, you might assume that the research on the effect is conclusive. In reality, it is a very complicated topic, but psychology PhD students Mary Anne Hutchison and Jennifer Rinker are working hard to clarify this complex area of psychopharmacology.

Photo by Daniel Albaugh

Mary Anne Hutchison and Jennifer Rinker

Both are currently working toward a PhD in behavioral neuroscience, and they conduct their research in Professor Anthony Riley's psychopharmacology laboratory. In Riley's laboratory, experiments are formed around the tenet that every drug has both rewarding effects that will fuel drug abuse as well as aversive effects that will serve to limit the use of a drug. The balance between these rewarding and aversive effects contributes to the likelihood that someone will abuse the drug.

Their experiments focus on the aversive effects of drugs because determining what factors impact such effects might give insight into risk factors for drug use. They examine these effects using a method called the conditioned taste aversion design. In this procedure, rats are given a novel, sweet (usually saccharin) flavored solution. After allowing the rat to consume the sweet solution, they inject a drug. The idea is that rats will come to associate the negative effects of the drug with the flavored water, and thus if the drug is perceived to be aversive, the rats will stop drinking the sweet solution. This conditioned effect has been shown with many drugs that humans abuse, like nicotine, alcohol, and cocaine.

Hutchison and Rinker hypothesize that if the rat is exposed to a drug earlier in life, such as during adolescence, the early exposure will create a drug history that might diminish the aversive effects of that drug, or other drugs, later in life. If this is the case, one might expect it to be more difficult or take longer to condition an aversion to the flavored water with rats that had previous drug exposure, and that is precisely what they found. Both Rinker and Hutchison are interested in examining the effects of drugs that are commonly consumed during adolescence in humans, like nicotine or alcohol. Rinker's research focuses mostly on how exposure to nicotine during adolescence affects the response to alcohol later in life, and Hutchison is interested in the reaction to cocaine after an adolescent exposure to nicotine or alcohol.

"There are many other factors besides age that can affect the aversive properties of these drugs, such as gender and drug combinations. We are just hoping that through our research we will be able to clarify how drug exposure at an early age may factor into drug taking later in life more specifically. We are also both very interested in examining what neurological changes are happening as a consequence of early drug exposure that might be mediating the changes in the behavioral responses we see," says Rinker.

Initially, their main question was whether exposure to drugs such as nicotine or alcohol

(continued on page 11)

Photo by Ari Comart


Bill Edgar

FROM AU TO IBM

By Ari Comart, journalism ’11

When Bill Edgar came to American University in 1997, his path seemed fairly straightforward: he would earn his master’s degree at the university’s renowned School of International Service and begin a career in international relations. Now, as Edgar prepares to complete a grid computing project for his master’s thesis in AU’s graduate computer science program, he often wonders how he got from Point A to Point B.

The answer, it seems, lies in his willingness to follow his passion. When he landed a co-op position at the U.S. Department of State through AU’s CareerWeb during his second semester, he was placed in the computer systems division. He began to recall his time as an undergraduate at the University of Akron in Ohio, where he worked part time in the computer center.

“I always kind of did it for fun, as a side job, because I knew how to do it,” he explained. “I never thought of it as a career. But then I got down here to AU and got a job at the help desk in the Computer Center [through AU’s Office of Information Technology] and the co-op at the State Department, and that made me realize what I really enjoyed.”

Edgar acknowledged the importance of nurturing one’s passions, but for him, one stood out among the rest. “I love international relations and history and that sort of thing, but it gave me perspective on how much I enjoyed working with technology, and not only that, but that I could make money out of it and make a career out of it,” he said.

Edgar eventually earned a full-time position in information technology and consulting at the State Department. He worked and went to school part time in the evenings until the spring of 2000, when he and several colleagues founded a company called Novus Consulting Group, which provided computer software development and IT consulting services. Novus grew rapidly to about 130 employees when Edgar and his partners sold the company to IBM in 2007.

Edgar currently runs a team of 25 software developers at IBM in Manassas, Virginia, where his daily work would befuddle the average businessman. “The biggest product that we’re working on is a Web-based data warehouse for analyzing storage infrastructure data. I tell my wife about it and it bores her to tears,” he said with a grin. But his sector caters to a wide array of corporate powerhouses. “It’s an interesting place to be in terms of the IT market,” he says.

While he is comfortable at IBM, Edgar relishes the opportunity to recapture the hands-on side of computer programming at AU. “It’s nice to be able to come here and work on a master’s thesis, where I’m getting really technical. I don’t get many chances to do that at my job,” he says. “But it depends on what type of person you are. I'm the type of person who enjoys doing some hands-on technical work, and so it's refreshing to be able to do that on a regular basis here."

Edgar has savored his time working with AU's computer science faculty, notably Michael Black, Michael Gray, and department chair Angela Wu. "The faculty is small, but as a result you get to know them very well and they get really interested and involved in what you're doing," Edgar said.

He has also used the connections AU gave him to create opportunities for younger students. He helped Priyanka Komala, who recently earned her master's degree in computer science, get a job at an agency in D.C., and he mentored Pavneet Singh, a 2008 graduate and member of AU's 2007 computer programming team. He has helped several students earn paid internships with IBM in Manassas, as well.

"I think in D.C., whether in the IT field or whatever field you're in, there's a tremendous amount of resources around here, and it's critical to have both business exposure or federal government exposure, or whatever career you're headed for, as well as the academic education," Edgar said.

Photo by Han Lee

Traci Yokoyama performs in New York City with her traditional Japanese drumming group.

TAKING MATH TO THE LIMIT

Shirin Karimi, literature and premedical studies '11

Mathematics. For some, the word itself inspires fear. Often considered one of the most difficult subjects for students, especially those with greater interests in liberal arts and humanities, mathematics can be a very tangible hurdle in a student's academic career. Of course, others appreciate the finer points of the quadratic formula and the linear equation. These students, with a combination of hard work and something of a natural knack, eventually move on to even higher levels. But seldom do you find someone capable of bridging the gap between the world of natural mathematical understanding and struggling students. Such a teacher is Traci Yokoyama. For this American University alumna, her journey from AU and beyond has brought her not only a greater sense of self-identification but to a place where she can truly help others jump-start their own futures.

Yokoyama began her journey into mathematics in the unlikeliest of places. As a freshman just arriving from Orange County, California, she began her first semester intending to join her fellow students in the School of International Service. However, something unexpected happened; she soon began to miss math. The following year, she enrolled in Calculus I and began her semester-long trek through derivatives, limits, and their applications. By then she was on a roll; Yokoyama enjoyed her calculus class immensely and decided to continue taking math courses. Certainly, this

(continued on page10)

Photo by Matt Tom-Wolverton

Traci Yokoyama

TAKING MATH TO THE LIMIT

(continued from page 9)

wasn't the route of a typical SIS major. This realization came when she sat down with Stephen Casey, one of American University's mathematics professors, and student advisors. Casey made his case clear; she belonged in American's mathematics and statistics department. Considering the level of intellectual stimulation Yokoyama was now enjoying from her math classes, Casey told her that she was guaranteed individual attention and "opportunities you wouldn't have in a larger department." Yokoyama agreed; she was to join the mathematics and statistics department and switch from the School of International Service.

Under the guidance of Casey and the now retired I-Lok Chang (another American University professor who provided great help and encouragement throughout Yokoyama's undergraduate career), she excelled in her higher-level courses. She began her mathematical research career with Chang and rose to be president of the American University Math Club in her senior year. Yokoyama recalled her time in the Math Club with nostalgia, "watching the movie *Pi*, having pizza night with the club, all while doing math problems." As a busy intellectual and active member of the American University community, she committed herself to be a tutor in AU's math lab (now located in Gray Hall). Yokoyama taught a wide scope of American University students, working directly with AU's soccer, tennis, and basketball teams during her time at the math lab. She seized her job with vigor, even teaching an entire Calculus III course to one athlete who was unable to attend his classes due to his rigorous schedule. Little did Yokoyama know at the time that her work at the math lab would foreshadow her future. When she graduated, the department lost not only a great student and researcher but also a guide for future students. However, the education provided to her at American University's mathematics and statistics department served as a launching pad for the next stage of Yokoyama's life and successful future.

After graduation, she faced the biggest issue for all seniors donning caps and gowns:

the job market. She soon realized that many jobs in industries and at institutions where she could apply her skills, like the National Institutes of Health, required a graduate degree. Faced with a tough playing field, Yokoyama turned back to her trusted professor and advisor, Casey, who would set her onto a new and unexpected career path. “Dr. Casey suggested I teach. I hadn’t considered it until he recommended it!” With a new prospect for her career, Yokoyama began her search for a teaching position in math. Fortunately, Casey was able to help her in this respect, too; he suggested that she apply for a position in the nearby Montgomery County public school system. Soon enough, Casey’s advice paid off, and she began a full-time position in 2001 at Montgomery Blair High School, in Silver Spring, Maryland. After one year, Yokoyama knew that it was time to take the next step. Realizing that she truly loved teaching, and wanting to learn more about education itself, she began applying for graduate programs for a master’s in math education. Yokoyama was accepted into Columbia University, a great success for her and an indication of her dedication and love of both her subject and career path. In 2004, she graduated with her master’s in math education from the Teachers College of Columbia University.

With her degree in hand, Yokoyama accepted a teaching position at the prestigious all-girl independent Nightingale-Bamford School on the Upper East Side of Manhattan (for those not in the know, the Nightingale-Bamford School is the basis for the popular book and television series *Gossip Girl*). She soon began teaching a wide variety of subjects to her students, ranging from geometry and trigonometry to calculus and algebra. While her initial position was teaching sixth- to eighth-grade students, she later began teaching at the high school level and found her own unique niche among these students.

She keeps herself busy; she begins every day with math lab in the mornings (harkening back to her days at AU), serves as homeroom teacher for the 10th grade, and teaches for the entire school day. Her duties go beyond the classroom, though; she has the chance to accompany students on school trips (including a recent trip to Prague) and meet one-on-one as a faculty advisor, when she has the chance to sit down with students at lunch for six days a week. “I have seven advisees, and I am responsible for seeing how the students’ school life and home life are going. We develop a really close relationship.”

Yokoyama has been teaching in New York City for six years now, mostly at the high school level. When asked about her future plans, she says, “I hope to stay at Nightingale. It’s the best job in the world and the colleagues are so nice.” Certainly, throughout her teaching career so far, she has maintained a passion for what she does. “I love my students, even the freshman who tried to pick a fight with me once! . . . How can I help them learn better? How do I keep them interested in derivatives after they get accepted to college? How do I help them remember $(a+b)^2$ does not equal $a^2 + b^2$? Mostly, I enjoy watching them grow as problem solvers and gain confidence in their mathematical abilities.”

ANOTHER LOOK AT THE ‘GATEWAY DRUG’ THEORY

(continued from page 7)

during adolescence, a sensitive developmental period, would change the aversive effects of other drugs later in life. However, their research has mostly shown that exposing the animals to the drugs in adolescence yields the same results as when the animal is introduced to the drug in adulthood. Basically, giving an animal a drug history is enough to alter the effects of other drugs later in life; it doesn’t really matter when that drug history occurs, although more work needs to be done to see if this holds true for all drugs. The overall goal of this research is to advance knowledge in the field and raise more interest about the impact of drug history on later drug use, or the “gateway drug” theory.

So far, they have been successful in achieving this second goal. Because many people are affected by the specific drugs that Hutchison and Rinker chose to study, more awareness has been raised and colleagues who are not typically interested in animal studies have taken more notice of their work. They have both received grants from the Andrew W. Mellon Foundation, and both recently presented their work at the Robyn Rafferty Mathias CAS Student Research Conference at AU. Both Hutchison and Rinker have presented their studies at many conferences, and their next event is the meeting of the College on Problems of Drug Dependence in Reno, Nevada. Both students plan to continue conducting research in their field after receiving their degrees.

SEEING THROUGH THE DARK: SATISH-CHANDRA TRACES EVOLUTION OF OPSIN GENE

(continued from page 5)

industry, moved radically forward to combat the country's stagnant productivity, leading to a revolution in agricultural biotechnology. While the change in India's direction wasn't always met with a positive review, it soon saturated the culture. "Everywhere people were talking about genetically modified foods, edible vaccines . . . I was curious to learn more," Satish-Chandra says of her choice to go into biology. In 2007, she began her research career at American University, pursuing genetic research with her advisor, Carlini.

The species of amphipod Satish-Chandra is examining presents a unique and fascinating case of distinct populations of the same organism. *G. minus* resides on both the surface, in streams and springs, and underground, in caves throughout the eastern United States, including those populations in West Virginia and Virginia which Satish-Chandra studies. The stark distinction between these two environments creates many tangible, and sometimes intangible, differences between the surface and cave-dwelling amphipods, especially when it comes to the entirely light-dependent opsin protein. By studying the opsin gene sequences and expression, Satish-Chandra can observe directly the genetic differences between the populations displaying mutation over time, and generate a better understanding of the evolutionary processes that may lead to the creation of another distinct species within the genus *Gammarus*.

To observe the genetic differences within the opsin between the cave and surface populations, Satish-Chandra first isolated the opsin DNA sequence from the entirety of the amphipod's genome. To do this, she designed DNA primers, small sequences of RNA, which complement a region upstream and downstream of the opsin gene. Once these were created, Satish-Chandra used a technique called polymerase chain reaction, or simply PCR. This process, which takes the building blocks of DNA, nucleotide bases, and builds them onto the primers, isolates the specific sequence between the set of primers and amplifies the sequence (sometimes to the extent that the DNA strands can be seen by the naked eye), leaving Satish-Chandra with strands of DNA that contain only the opsin gene.

With the isolated opsin gene in hand from samples of both surface and cave populations, Satish-Chandra needed to find out just what each sequence said about opsin between these distinct habitats. Using American University's DNA sequencer, she was able to read out the sequences for members of each population and search for distinct differences between the two populations, specifically for mutations within the opsin gene of the cave-dwelling amphipods. Because the *G. minus* population within these cave systems no longer needs its opsin protein, according to Satish-Chandra, individuals from this population that accumulate detrimental mutations in their opsin gene will more likely pass on these mutations than their surface cousins, which are far more likely to perish from any detrimental opsin mutation because of the importance of sight for survival above ground. Therefore, Satish-Chandra explains, it would make more sense for the surface population's opsin sequence to be more constrained over evolutionary time, and therefore far more functional, due to the population's life in the daylight. In addition to analyzing opsin DNA sequences from surface and cave populations, she is also comparing levels of opsin gene expression, the degree to which the genes are "turned on" to produce opsin protein, in these populations. This work is being carried out using a new instrument funded by the AU Major Equipment in the Sciences grant, and it would not have been possible without the instrument, which is capable of accurately and precisely quantifying levels of gene expression over a large dynamic range. As expected, Satish-Chandra is finding that levels of opsin gene expression are significantly reduced in the cave populations.

Satish-Chandra has worked on the genetics of amphipod opsin for two years now, and she plans to defend her final thesis in the fall 2009 semester. Throughout her study, she has constantly maintained a positive attitude for her work, despite unexpected results. "How we expect to see something, but it turns out to be completely opposite, can be my favorite part of the research I'm working on. That unexpected turn is what is interesting and motivating," she says. Now that Satish-Chandra's time at AU is finished, she plans to return to the fast-paced world of Indian biotechnology, hoping to work in her home country as a research associate at one of India's biotech or research institutes.

Science Issues

(continued from inside front cover)

Life on another world would probably arise in the same way as ours. As on primitive Earth, scientists predict, another planet's first life would probably be simple bacteria-like cells. While modern science has developed many theories on how this jump from organic molecule to organisms took place, life on Earth has been based solely upon these primary building blocks; we don't know any other definition of "life." On one hand, if life is based only upon the building blocks we recognize here on Earth, life on other planets would likely be moderately recognizable. But what if life doesn't fit into our organic molecule definition? Non-DNA based life forms could go beyond the reaches of human imagination.

So, is there a worthwhile place for SETI? Certainly the answer is complex. The chance of communicating with an extraterrestrial life-form is remote. Even in our own solar system, Earth is seemingly the only planet which harbors life, existing in the "solar sweet spot" where our planetary temperature is just right for the conditions of life to arise. But new research tells us that many more stars have planets in orbit than previously thought. Even if the chance of life arising is one in a million, there are still up to 400 billion stars in our Milky Way galaxy, each with the possibility of its own solar system. Clearly, with numbers this large, the chance exists, even if it is incalculably low. And, after all, if you don't take the time to listen, you'll never hear the message.

If you want to participate in SETI's search for extraterrestrials, you can help analyze satellite data from home by downloading SETI@home, run by the University of California–Berkeley, at setiathome.berkeley.edu.

Andrew Frank, coeditor

COOL SCIENCE CLASSES

A non-science major studies biology

Student: Chelsea Lynn, CLEG '11
Class: BIO-100, Great Experiments in Biology, with Professor Chris Tudge (spring 2009)

Andrew Frank: What prompted you to pick biology as a general education requirement?

Chelsea Lynn: My choice was between Psychology as a Natural Science or Great Experiments in Biology. Psychology as a Natural Science helps explain the science behind how people act, but Great Experiments delved into how the world works and explores the connection between all aspects of life.

AF: What was your impression of the class before you started attending?

CL: I was actually a little intimidated by the thought of taking my first college biology course. I hadn't taken a science class in two years, and the stuff I learned in high school was a distant memory. Once I got into the class, though, I found that the lectures and the labs weren't as threatening as I originally assumed. The professor made the information very accessible by utilizing real-world examples and links between concepts, and the labs helped cement the topics that we discussed in the lectures.

AF: Talk about some of the subjects you covered in class.

CL: We covered a wide range of topics, starting with the basics of life and working out to the grander aspects of biology. The class was designed to build on itself, so we started with the smallest pieces—molecules, energy production in cells, and DNA. The lectures on DNA led to a section on genetics, which led to evolution and discussions on how creatures affect their environment. The last topics included ecology and environmentalism. The first half of the class really dealt with the mechanics of biology and how life exists, but the lectures on conservation and the biosphere were more theoretical and engaging. There is no way to change the process of photosynthesis, but it is possible to protect the earth's natural resources and try to reverse the damage humans have left on the planet.

AF: Did you find the class to be more difficult than humanities classes?

CL: Not really. After two years of politics and law courses, I really enjoyed studying a subject that was so different from the rest of my major requirements. The greatest challenge I had was adjusting my writing style to the requirements of the course. I'm used to narrative-based papers, so it was interesting to use the plain, concrete style used for science.

AF: What was your favorite part of the class?

CL: I really enjoyed the lectures that dove into the nitty-gritty of molecular biology. Some of my favorite classes covered the process of photosynthesis and how cells produce energy. I also enjoyed lectures and labs that used medical examples to explain concepts. It was fascinating to learn about what happens when genetics go wrong, or the differences between viruses and other forms of life.

AF: What are some benefits in your other schoolwork of having taken general biology?

CL: I had to study biology in a different way than some of my other courses. Some topics in law and politics are open to multiple viewpoints and interpretations, but this bio course largely dealt with undisputable facts. I found that most of my effort was spent in learning the details of biology after I absorbed the general themes through lectures and labs. The course really emphasized the scientific method, which I hadn't studied or used in years. This method for learning is more logical than some of the other methods used in humanities classes. Taking biology didn't change how I learn or study in major ways, but it reintroduced a way of thinking that I can use in my other courses.

AF: Would you recommend this class to anyone else seeking a science-related general education class?

CL: Yes. BIO-100 was accessible, even entertaining, for nonscience majors. The class started with the basics, but it moved well and covered a lot of material. The labs are structured to use real-life situations and examples, like mock crime scenes and genetic testing, rather than dry experiments with test tubes or pea plants. I really enjoyed taking Great Experiments in Biology, and I would definitely recommend the course to others.

SIGN UP FOR MONTHLY E-MAILS TO FIND OUT ABOUT CAS EVENTS AT AU.
To sign up, send an e-mail to cas-mail@american.edu with the subject line: CAS EVENTS-Subscribe.

2007 APEX® AWARDS FOR PUBLICATION EXCELLENCE

Non-Profit Org.
U.S. Postage
PAID
Permit No. 966
Washington, D.C.

AMERICAN UNIVERSITY
WASHINGTON, DC

College of Arts and Sciences
American University
4400 Massachusetts Avenue, NW
Washington, DC 20016
www.american.edu/cas