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acumen

The magazine of Lehigh University's College of Arts and Sciences

BIG ANSWERS at a CELLULAR LEVEL

LEHIGH UNIVERSITY | COLLEGE OF ARTS & SCIENCES

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Message from the Dean

Exploration and Discovery

This issue of Acumen delves into the discoveries being made in the natural sciences

I am most excited to share with you this issue of *Acumen*. This edition revolves around the importance of research in the natural sciences. It exemplifies the importance of the work taking place, both in the field and in the laboratory, as students and faculty continue to advance their respective disciplines.

As a research university, Lehigh is committed to providing students with practical opportunities to extend their understanding of the world around them. The College of Arts and Sciences fosters and supports academic inquiry at both the graduate and undergraduate levels. Student research in CAS is mentored, self-directed work that enables emerging scholars to explore an issue that interests them, and communicate the results to others. These student experiences, supported by faculty research efforts, produce more technically competitive graduates poised to pursue successfully their career goals.

The researcher's sense of tenacious exploration and innovation shapes much of what we do in the College of Arts and Sciences. The innovative work taking place throughout the natural sciences also makes an impact on respective disciplines. The stories on the following pages illustrate those successes. Inside this issue of *Acumen* you will learn about Professor Jill McDermott's research that takes her to the Earth's deepest depths to better understand the Earth's beginning. You will also discover graduate student Sonia Weimann, who is investigating communication among damselfish, and undergraduate chemistry major Julia Nelson's investigation of strategies for fighting infections.

The research to which our students are exposed often continues on long after they leave Lehigh. Nick Bigelow '81, whose expertise is in nanotechnology, has used space-age technologies to help save historic daguerreotypes. Julia Klees '82 monitors health effects of potential chemical exposures with BASF. Jeff Williams '69G went on to a renowned career with Woods Hole Coastal and Marine Science Center and recently created a $100,000 endowment to support graduate student research in Lehigh's department of earth and environmental sciences.

This issue of *Acumen* again elucidates the breadth and commitment to research by so many of our students, faculty and alumni. We encourage students to be agents of change in ways that will benefit the communities in which they live and society as a whole. Bear in mind that our work is impossible without the support of CAS alumni. Our alumni make wonderful things happen, and I'd love to speak with anyone who would like to support the work of the next generation of scientists. If you'd like to learn more about how you can create new opportunities for students in the College of Arts and Sciences, please contact Kelly Stazi, our director of development, at kbs415@lehigh.edu. I hope you enjoy reading the following stories as much as I have. I invite you to learn more about how alumni can play a role in these types of

programs. As Lehigh alumni, you help shape the future of students in the College of Arts and Sciences.

I look forward to hearing your thoughts and comments.

Donald E. Hall
Herbert and Ann Siegel Dean

The Arts

Prague Bridges by Friedrich Feigl

ART

The Eye Sees the World

Although Friedrich Feigl was a foundational figure among modern Jewish artists of the early 20th century, history has all but erased his memory. Nicholas Sawicki recently curated a show of more than 80 works involving more than 11 museums and private collections, and focusing on the artist's life and work.

Feigl was a prominent modernist painter and printmaker from Prague, and spent a large part of his career in Berlin and London. Sawicki, associate professor of art history in the department of art, architecture, and design, has been studying Feigl's work for over a decade, in an effort to piece together his mostly forgotten history.

"We have in the art world, often, a gap between those individuals we remember today as artistically significant and the many more who attained recognition in their day, but are largely forgotten, and Feigl is one of these figures. He was the most prominent Jewish artist to emerge from Prague in the 20th century, and yet so little about him is known. If you look back at the historical record, you learn he also had a great following among German-language writers like Franz Kafka, to whom he was close"

In 2013 Sawicki was approached by the Gallery of Fine Arts, a Czech state museum located in Cheb, with the idea of curating an exhibition of Feigl's work. Staff at the gallery had read some of Sawicki's previous publications and had wanted him to produce a show about Feigl's work. For three years he collaborated with the curators and scholars in the Czech Republic, Germany, England and the United States to prepare an exhibition. It first opened last summer and traveled in January to its second venue in the city of Ceské Budějovice.

The Gallery of Fine Arts has recently started organizing exhibitions of German and Jewish artists once active in Czechoslovakia, whose memory and legacy was mostly erased by World War II, the Holocaust, and postwar communism. Feigl was Jewish and spent much of his life in the country, until the Nazis advanced on Prague in spring 1939, forcing him and his wife to flee for the west. They lost much of their family to the Holocaust, and escaped for London, where Feigl joined a large community of exiled Central European artists, writers, and cultural figures.

To curate the show, Sawicki pulled together a collection of works spanning Feigl's prolific career. He travelled extensively throughout Europe and the United States to research the artist's works. In the exhibition, Feigl's life and art unfold for viewers as they walk through the gallery space.

"The show maps the arc of his career and his life story. As we move through, we also see how his attention and style change and adapt over time," he says.

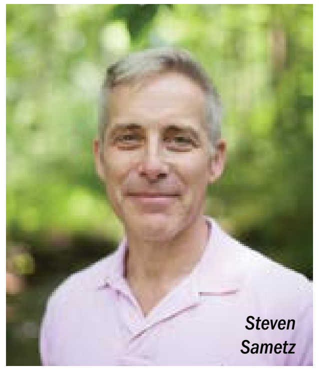
Sawicki's title for the show, *Friedrich Feigl: The Eye Sees the World*, takes its cue from what he has come to understand as a discerning feature of Feigl's art—the way this innovative modernist works always retain a connection to the visible world, and an unwavering interest in the observable subjects of his own surroundings. The exhibition coincides with the publication of the first major monograph on the artist, *Friedrich Feigl, 1884-1965*, which Sawicki prepared with colleagues in Prague and London.

MUSIC

A Musical Bridge to Shenzhen

Steven Sametz has won countless honors in nearly four decades as director of Lehigh Choral Arts. His compositions have been performed at music festivals in Austria and Germany and across the United States, and his commissions have come from the National Endowment for the Arts, the American Choral Directors Association and leading choirs like Chanticleer and the Dale Warland Singers.

In setting and orchestrating his compositions, Sametz has proven to be a tireless innovator,



Steven Sametz

choosing texts from Walt Whitman, Emily Dickinson, St. John of the Cross and a global smorgasbord of legends and folk tales and scoring his works for Burmese gongs and Indian tampuras, double orchestras and multiple choirs, hammer dulcimer and vibraphone.

None of this prepared Sametz for the reception he received recently during a whirlwind visit to Shenzhen, a fast-growing city of more than 30 million in southern China, where he and The Princeton Singers headlined the Fourth Shenzhen International Choral Festival.

Sametz has served since 1998 as artistic director of The Princeton Singers, a 17-voice professional chamber choir that has premiered more than 200 new works. His invitation to Shenzhen came about through a connection he made with a Chinese musician whom he met at a conference of the American Choral Directors Association. The ACDA is promoting exchanges between American and Chinese choirs and choral composers; Sametz has chaired ACDA's Composition Advisory Committee since 2012.

Sametz, the Ronald J. Ulrich Professor of Music at Lehigh, and The Princeton Singers spent just three days in Shenzhen. On day one, Sametz gave a lecture and demonstration for 100 Chinese choral directors on American approaches to choral tone. He opened with vocal warm-ups and overcame the language barrier.

"My Cantonese is non-existent," he said, "but musically, the choral directors responded immediately. We had a very good interpreter, but music is an instant bridge for people who cannot otherwise communicate."

Sametz then worked with the Shenzhen Lily Children's Choir, which had prepared two movements of *A Child's Requiem*, an oratorio Sametz wrote in memory of the 26 children and teachers murdered at Sandy Hook Elementary School in Connecticut in 2012. The Lily Choir later performed the oratorio sections with The Princeton Singers.

"The children were great," Sametz said. "They kept wanting to take pictures of us and give us presents. There were selfies everywhere. It was like being rock stars, which is unusual for choral singers."

The next day, the new rock stars were invited to join a flash mob in Shenzhen's biggest shopping mall.

"The Chinese put a lot of production values into that event," said Sametz. "The mall is eight stories tall. There were cameras from all eight levels focused on The Princeton Singers, who performed two Chinese

Shenzhen Concert Hall

songs and two American spirituals, while being surrounded by locals who clapped and sang along.

"We were also asked to sing the choral finale to Beethoven's *Ninth Symphony* in Chinese, accompanied by 50 ukuleles and 10 shamizen-like instruments along with little girl dancers. It was quite a conclusion. It was a bit surreal, with all of us doing a wave at the end. The Princeton Singers will remember that. I will remember that."

That night, at the Shenzhen Concert Hall, The Princeton Singers earned another rave response after performing a two-hour concert of pieces composed mostly by Sametz. The following night, the singers joined 14 choirs from Shenzhen for the festival's concluding concert, which featured selections from *A Child's Requiem* and other pieces by Sametz, along with arrangements of American spirituals and folk songs and several Chinese pieces.

The trip to Shenzhen was Sametz's second to China as a choral director. In 2007, the Lehigh University Choir toured four cities in China.

THEATRE

Producing Transformative Theatre

Since 2006, Flux Theatre Ensemble in New York City has been a vibrant change agent creating a supportive, inclusive environment for artists.

Designer Will Lowry is a creative partner with the ensemble and the newest member of Lehigh's department of theatre.

Flux Theatre Ensemble produces transformative theatre that explores and awakens the capacity for change. Flux is an ensemble-artist driven company that believes long-term collaboration and rigorous creative development can unite artists and audiences to build a creative home in New York.

The ensemble is a nonprofit organization that has staged 22 productions and countless readings and developmental projects. Flux has a non-hierarchical organization, and creative partners—comprised of artists, playwrights, designers, actors and directors—all have a collective "buy in" regarding the ensemble's direction.

"We embrace elements of theatre that can transform, in that they can be modular, can be multiple things at once, can co-exist in different realities," says Lowry, assistant professor of theatre. "It's finding those moments in a play where significant change happens, the realization of an opportunity, the volition of a character to be an agent for change in their own life or others' lives. We work as an ensemble because we believe humanity works best as an ensemble. We use this collaboration in aiming to create an equitable, creative home for our artists and audiences."

Lowry's background is in scenic, lighting and costume design, and he is currently designing scenery for *Marian, Or The True Tale of Robin Hood*. It is a collaborative process for him, and he is intimately involved throughout the production process. He typically drafts the theatre architecture in three dimensions so he can get a sense of what the space will provide, then he starts to create rough sketches based on his background research.

"Sometimes it's a rendering; sometimes it's a model. Sometimes I quickly lay in tones with a marker and talk with the director about their impression. I use the sketches to start a dialogue with a director to get a sense of what she or he envisions. In our collaboration, it progresses through several phases of sketches to find those common visions, combining and synthesizing elements together. In the case of costumes, it's about finding a common palette, the silhouette of the characters. With lighting, it's about interfacing with the ideas of the costume and set designer and supporting and heightening their work on stage."

Lowry says the experiences garnered from his work in New York have an immediate impact on students at Lehigh.

"Seeing the process makes it so much more tactile than only seeing the result. I can show students images of designs I did for a show, but it's best when I can show research or take students into a space and say, 'This is my front light system. This is my side light system. I chose to sacrifice a little bit of coverage in this area because I wanted another system later,' and they can see these choices physically in the space. Theatre is ultimately live. It exists in the moment, then it's gone. Being able to have opportunities where students can see the developmental progress and talk about that process and result puts us on a common platform for discussion. The students are actively part of the conversation."

***The scenery for* Marian, Or The True Tale of Robin Hood *(left) was designed by Will Lowry* (above).**

REGIONAL ART GALLERY–LIBEREC; ISAIAH TANENBAUM THEATRICAL PHOTOGRAPHY; JEREMY FLEMING

ENGLISH

Prison Industrial Complex

Incarceration in the United States is big business. There are now 130 private prisons in this country, with a total of 157,000 beds. The expansion of the U.S. inmate population to the political influence of private prison companies and businesses that supply goods and services to government prison agencies is the topic of the latest book by James Peterson.

In his latest work, *Prison Industrial Complex for Beginners*, Peterson has created a graphic narrative that attempts to refine and condense the fundamental components of what scholars, activists and artists have identified as the mass incarceration movement in the United States. It is a primer for how these issues emerged and how a nation's awareness of the systems at work in mass incarceration might be the very first step in reforming an institution responsible for some of society's most egregious civil rights violations.

James Peterson (above) sees race at the bottom of the problem with an abnormally high percentage of Americans in prison.

"There are a lot of scholars who have done in-depth histories that inform the current state of affairs with prisons in America, but I wanted to go back further into the history and talk about how certain elements of the Prison Industrial Complex are still present," says Peterson, associate professor of English and director of Africana studies. "Even in transatlantic slavery, even before middle passage, before slave barracoons, you see it. I wanted people to think about how early prison structures are predicates for the structures of the system. This is a historically deep-seated institution, and if we want to reform it or abolish it, we need to understand it."

Since the early 1990s, activist critics of the U.S. prison system have marked its emergence as a "complex" in a manner comparable to how President Eisenhower described the Military Industrial Complex. Peterson argues that, like its institutional "cousin," the Prison Industrial Complex features a critical combination of political ideology, far-reaching federal policy and the neo-liberal directive to privatize institutions traditionally within the purview of the government. The result is that corporations have capital incentives to capture and contain human bodies.

The Prison Industrial Complex relies on the "law and order" ideology stimulated by President Richard Nixon and developed at least partially in response to the unrest generated through the Civil Rights Movement, says Peterson. It is, and has been, enriched and bolstered by the United States' "war on drugs," a slate of policies that have failed to do anything except normalize the warehousing of nonviolent substance abusers in jails and prisons that serve more as criminal training centers than as redemptive spaces for citizens who might re-enter society successfully.

"There are many private interests vested in incarcerating people," he says. "When you ask yourself why we incarcerate more of our citizens than any other country in the world, that's one of the answers we have to reckon with—that people profit from it."

"We need a radical reordering of how we think about prison systems and how we think about people in the criminal justice system, how we think about how we deal with people with substance abuse problems versus people who are violently criminal. For me, the only way to think clearly about reform or abolishing the system is to understand the deeper history."

MODERN LANGUAGES & LITERATURES

Making the Censored Public

Initiated by Beijing college students, the 1989 Tiananmen Square protests shook all of China with their calls for democratic and social reform. They were violently repressed by the Chinese state on June 4. Since then, their memory within China has been subject to censorship. Government efforts to alter accounts of Tiananmen and the resulting works in literature and cinema are the focus of research by Thomas Chen.

Chen, assistant professor of Chinese in the department of modern languages and literatures, studies how state suppression of the dialogue on the Tiananmen protests and their alternative viewpoints create a vast space for a Chinese audience to recount and interpret a historical remembrance that is politically off limits.

"A lot has been written on cultural production outside of China that reflect on the movement," he says. "Those works do not undergo censorship. They are not banned. But within China, this is such a sensitive topic, and for the most part, since 1989, this topic is basically off limits."

As part of his book project, *Making the Censored Public: The 1989 Tiananmen Square Protests in Chinese Fiction and Film*, Chen analyzes various perspectives of the story. His book examines fiction and film that evoke Tiananmen from within mainland China and Hong Kong. He not only scrutinizes and investigates underground or banned works of literature and cinema, but he also studies government-produced literature. Immediately following the protests, the government produced tremendous amounts of propaganda and silenced nearly all mentions, and that has persisted to this day.

"The government issued large amounts of propaganda, whether pamphlets or books that sought to inculcate into the populace its version of what happened," Chen says. "These are tales of soldierly heroism, soldiers as the martyrs that keep the country safe. Students are portrayed as the hoodlums, rioters who are putting the country in danger, who are influenced by foreign operatives."

In much of the work, protagonists are writers, and films shot were without authorization. In fact, the films' editing alone indicates the hazardous circumstances of their making. Many works portray what the students had to go through,

TO COME

Students at the 1989 Tiananmen Square protests.

the aftermath, the repression, how they deal with life in China after their dreams have been crushed, he says.

Reaction was different in Hong Kong, says Chen. The post-June 4 period approaching the 1997 reversion to Chinese sovereignty drew Chen to assess the possibility of a Hong Kong interpretation in the face of collusive pressure from Chinese and British authorities.

"The reaction in Hong Kong is more visceral (compared to in Taiwan) because of its proximity to China. The event happened before Hong Kong became a territory of China. It was still a British colony, yet it knew its fate. They knew they, too, could also suffer in the same way, having their freedoms taken away. For them, the consequences were much more dire."

While many scholars have studied the protest from outside China, few have examined it from an internal perspective, which Chen says is important.

"This kind of work cannot be done by my colleagues in China. It's a subject that is very much off limits. Here, since I have academic freedom, I want to take advantage of this freedom and do things my Chinese counterparts (might want to) wish they could but cannot."

PHILOSOPHY

Good Guys with Guns

In 2008, the United States Supreme Court decided in *District of Columbia v. Heller* that the Second Amendment guarantees an individual right to bear arms. Chad Kautzer has been examining the gun debates surrounding this decision from a philosophical perspective.

Rather than focus on public health or the balance between liberty and security, his current book project investigates how practices of self-defense shape social identities. He is particularly interested in the notion of freedom informing recent debates about self-defense and the changing legal landscape in the United States.

"Quietly, at the state level, laws were being implemented that said individuals could carry guns in schools, you could carry guns on campuses and in parks, and so on. People were passionately defending these as issues of freedom," says Kautzer, associate professor of philosophy.

Kautzer is interested in how the politics of armed self-defense and its idea of individual freedom support or undermine racial and gender identities. His book project, *Good Guys with Guns*, examines recent legislative trends and the rising sense of insecurity accompanying them. What is the source of this intensifying fear, asks Kautzer, when people are objectively safer and crime rates are historically low?

"There was no longer a question of reasonable adjudication about what context might be appropriate for [carrying firearms]. It's interesting to explore why people feel increasingly insecure in places that are traditionally very secure. For example, college campuses, in terms of firearm violence, are some of the safest places. Why do some students need to come to class with guns in their backpacks?"

Kautzer argues that this increasing sense of insecurity has more to do with recent challenges to dominant racial and gender identities than with threats to physical security. This is why a philosophical analysis of identity and freedom is illuminating, he says. The idea of freedom at work in the new politics of self-defense is so individualist that it views social institutions and relations of trust as threats. Kautzer calls this notion "self-defeating." Although force may be used against attack or to liberate a people from an oppressor, it does not produce freedom. Freedom, he argues, is developed through shared norms, social cooperation and mutual recognition, all of which are undermined by force.

Trained in the interdisciplinary tradition of German critical theory, Kautzer incorporates historical studies of gun laws in the United States.

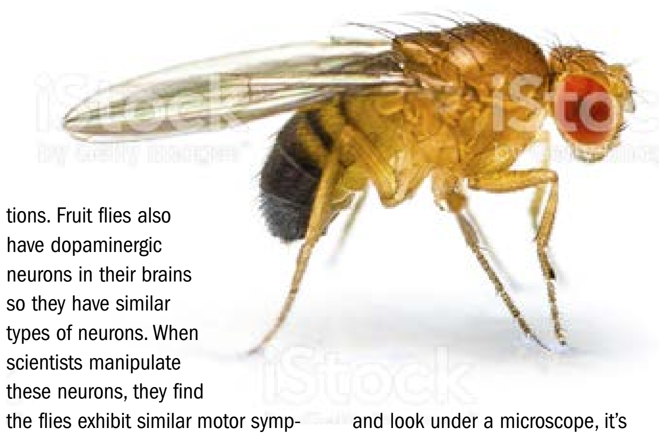
"It's fascinating to see how fast the historical understanding of the Second Amendment has changed over the past 10 to 20 years," he says.

Kautzer traces, for example, the evolution of Stand Your Ground legislation from the Castle Doctrine of British common law, which justifies deadly force in a home or business. Stand Your Ground laws, however, abstract away from the spatial conditions of the Castle Doctrine, granting new rights and immunities to the individual, says Kautzer, which is consistent with the idea of freedom he describes.

Ultimately, Kautzer says he hopes his philosophical and historical research will contribute to our understanding of these recent political and legislative trends and, thereby, the productivity of our public debates about them.

BIOLOGICAL SCIENCES

Modeling Neurodegenerative Diseases



A key feature of many neurodegenerative diseases is the accumulation and subsequent aggregation of proteins. Recent studies have highlighted the transcellular propagation of protein aggregates in several major neurodegenerative diseases, although the precise mechanisms underlying this spreading and how it relates to disease pathology remain unclear. Neuroscientist Daniel Babcock creates models of neurodegenerative diseases such as Parkinson's disease, and treatment possibilities may lie in the brain of *Drosophila melanogaster*, the fruit fly.

Babcock, assistant professor of biological sciences, studies these protein aggregates within dopaminergic neurons. Dopaminergic neurons of the midbrain are the main source of dopamine in the mammalian central nervous system, and they play an important role in the control of multiple brain functions. Fruit flies also have dopaminergic neurons in their brains so they have similar types of neurons. When scientists manipulate these neurons, they find the flies exhibit similar motor symptoms to humans, such as difficulty walking and climbing. The more in common it has with the human disease, the better the model.

Drosophila make good models because they develop from embryos to adults in 10 days and they can live a few months. Also, a single female can lay hundreds of eggs. Researchers can quickly screen through thousands of flies. Despite having a much shorter lifespan, flies exhibit many of the physical challenges encountered by humans as they age. By expressing fluorescently tagged "toxic" proteins in small subsets of neurons in the Drosophila brain, Babcock can monitor the extent of aggregate spreading and identify the key regulators required for this spreading to occur. Over a span of 30 days, Babcock's lab can express different proteins that are prone to forming protein aggregates and observe the resulting processes.

Daniel Babcock

"Using flies means we don't have to wait for years to observe things. We can observe what is happening in less than a month, which is incredible.

"In the case of Parkinson's, we can take the human form of that toxic protein and turn it on in the fly's neurons," says Babcock. "We find that it does many of the same things in the fly's neurons. If you turn these things on all over the brain and look under a microscope, it's almost impossible to see clearly because it's everywhere, but if you can target a really small subset of neurons, you can see all these fine processes. You can see these neurons degenerating, see where the proteins are going, what's actually happening to the neurons."

Scientists recently determined that long before neurons start to die, changes occur at the terminal ends of the cell. Part of Babcock's research also involves examining how synapses degenerate and how this relates to neuronal loss in Parkinson's disease.

"The hypothesis we're testing is that what's taking place at the tips of the neurons is setting off a cascade of events, ultimately causing death of the neuron. If we can understand what takes place much earlier, can we intervene at that point? Can we fix it and stop the neurons from dying?"

CHEMISTRY

Lipids and ALS

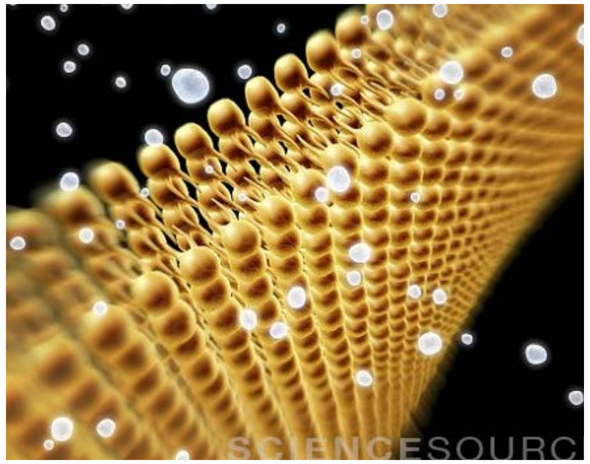
Amyotrophic lateral sclerosis (ALS), more commonly known as Lou Gehrig's disease, is a devastating, fatal neurological disease for which there currently is no cure. Developing a better model to understand these types of diseases is the focus of Nathan Wittenberg.

Wittenberg, assistant professor of chemistry, studies the biological surfaces, specifically the lipid membrane that construct the boundaries of cells. Cell boundaries are made up of complex environments that include proteins, sugars and lipids. Wittenberg simplifies these environments by creating models of the cell membrane, then builds in complexity one step at a time. His work focuses on integrating membranes into biosensors. With many medications, the drug interacts with a specific receptor on the surface of a cell. Using two separate membrane systems—one flat, the other a sphere, or a vesicle—Wittenberg's lab examines these interactions using fluorescent microscopy. He then examines the molecular interaction with these surfaces, providing measurable data to answer questions surrounding issues such as how long the interactions persist, how strong the interactions are and how quickly they form or fall apart.

"By doing this, we're able to interrogate how these membranes interact, almost to the level of single molecule interactions," says Wittenberg. "When you look at individual events like this, you can get a lot more information than more traditional analyses. When you start looking at individual events, then you can start to tease apart unique properties of the individuals. Not every binding event is the same. By examining groups of individual events, we can get more information about different types of interactions on biological surfaces."

TO COME

Computer rendering of the lipid bilayer that forms the membrane around all living cells.



His work is helping to provide a more assessable picture of how the antibodies interact with models of cell membrane surfaces. Wittenberg collaborates with researchers in the neurology department at the Mayo Clinic to explore therapeutic strategies for ALS. The team discovered a group of antibody molecules that, Wittenberg says, have some interesting properties in promoting nervous system repair. Some of the antibodies stick to specific types of cells in the nervous system, and Wittenberg and his team are helping the Mayo Clinic better understand how these surface interactions lead to the function of the molecule. Mayo scientists applied Wittenberg's work when studying two sets of mice that have genetic mutations causing ALS. The researchers found that if mice were given a single dose of this antibody, the animals lived longer. The animals also possessed more living motor neurons in the spine than prior to the antibody treatment. He is also shedding light on how these interactions disrupt certain normal interactions found on cell surfaces.

"In the diseased nervous system, especially for diseases like multiple sclerosis or ALS—where there's a lot of cell death and we want to promote some repair—it's very difficult because there's a lot of these inhibitory interactions."

Wittenberg will test whether these antibodies disrupt inhibitory interactions in the nervous system. By doing so, they envision possible strategies to stimulate cell repair. The team's work might prove significant to discovering future treatment strategies.

PHYSICS

Going with the Flow

Atherosclerotic plaques don't form just anywhere; they are more likely to occur at stagnation points in large blood vessels, where the flow of blood is disturbed. Investigating the mechanical principles underlying the response of living cells to fluid flow and its relation to atherosclerosis are the focus of experimental biophysicist Aurelia Honerkamp-Smith.

Honerkamp-Smith, assistant professor of physics, combines fluorescence microscopy, lipid physical chemistry and fluid mechanics to study the biophysics of cell membranes. Her lab examines the membrane as a system in its own right to consider flow-mediated membrane protein sorting at the intersection of fluid mechanics and membrane physical chemistry.

"A lot of people think proteins do everything interesting and the membrane is just a substrate for proteins to sit in," she says. "I want to show that lipids are also important and have interesting properties, and we need to understand how they work, how they are put together, what the energies are of the various interactions."

Her work crosses scientific disciplines, but physics is the best place for her work because she focuses on the mechanical properties of membrane proteins and lipids, she says. Her work explores the interactions between molecules of different types, the flow of lipids and the forces and energies involved in these interactions. Understanding these interactions is important since proteins and lipids affect how cells function and, thus, our health.

In the lab, she forms vesicles, consisting of fluid enclosed by a lipid bilayer, which she applies to a glass surface. This glass surface is put inside a microscopic channel. She applies a flow and watches then to see how the bilayer responds. By manipulating these interactions, Honerkamp-Smith hopes to determine how much force is needed to force a protein to move. It is also a way to study protein/protein interactions. If proteins are stacked on the downstream edge, eventually they should repel each other. She can then adjust the repulsion properties and, by observing their movement under a fluorescence microscope, measure how much they push each other away.

Aurelia Honerkamp-Smith examines fatty plaque that develops in the bodies large blood vessels.

"When proteins stick out of the membrane, they can act like a sail and move relative to the lipids, as long as there is enough friction keeping the lipids from moving as well," she says. "This has been observed on the surfaces themselves, but nobody has studied it quantitatively. It hasn't been studied as a possible mechanism for cell signaling. It's an interesting physical process that could give us information about what is happening outside the cell. We don't know if the cells take advantage of this or not."

Critical forces in lipid membranes are governed not only by membrane properties, but also by how the membrane couples to the surrounding bulk fluid. These basic cellular properties are of interest to biophysicists. The work underway by Honerkamp-Smith and her colleagues will increase our understanding of how cells sense their environment and may lead to improved clinical therapies in the treatment of heart disease.

HISTORY

Youth Squad

At the end of the 19th century, politicians across North America enacted a series of measures to address juvenile delinquency. Youth caught in public after curfew were brought to the new juvenile

Tamara Myers examines the evolution of policing juveniles in Canada.

courts and disciplined; those deemed incorrigible could be sent to reform school. The evolution of policing juveniles and how state laws dealt with misbehaving adolescents are the focus of research by Tamara Myers.

As part of her current book project, titled *Youth Squad: Cultural History of Policing Children in Mid-20th Century North America*, Myers examines how the police—once at the edge of the juvenile justice system—became central to it and ultimately embedded into schools in the late 20th century.

"The historical change here," she says, "is that urban police forces become 'youth conscious' in the 20th century, attempting to shed their reputation as the repressive arm of the law," she says.

Myers, associate professor of history, says one of the ways police did this was to establish youth squads. These units were charged with clearing the parks and streets of delinquents, all the while "befriending" young people. Youth squads went after kids who were seemingly growing up in misspent youths. This resulted in heavy policing of children, particularly in the middle decades of the 20th century. Her research focuses on curfew laws, police athletic leagues and police involvement in traffic safety campaigns.

"There's a change as police move into the schools to educate kids about their legal rights and to educate them about what is a delinquent act, what the law is and what happens when you abrogate the law," Myers says. "Kids had previously been taught to be afraid of police, but youth squads saw themselves as bestowers of liberal citizenship. They told kids, 'All you need to do is obey authority.' Yet, not all youth had access to this form of belonging, as it was racially and ethnically prescribed and predicated on conformity to masculine norms.

"The rhetoric of youth conscious policing suggested they were on the side of kids. But what this process produced was a surveillance network that normalized the police presence in modern childhood."

INTERNATIONAL RELATIONS

Modeling Nuclear Counterforce

Nuclear counterforce—attacks aimed at destroying a country's strategic nuclear weapons—has been of interest to researchers and policy makers since the Soviet Union developed the atomic bomb in 1949. Deterrence depends on the major nuclear powers—today, including China—being able to retaliate even after a first strike by another.

Researchers have modeled nuclear scenarios with various levels of success, but a simulation program developed by Chaim Kaufmann, with support from the Stanton Foundation, promises to provide a better teaching and research tool.

Kaufmann, associate professor and chair of international relations, has created a program that allows students and researchers to create nuclear strike scenarios and use data to ask, "What if?" He says it is an improvement on Excel spreadsheets previously used for the purpose.

"I wanted something I could distribute easily at no cost to researchers and teachers at other universities," says Kaufmann. "The tool allows students to create scenarios and test assumptions in a manner that is not currently available. Students can ask, 'What if China deploys more mobile ICBMs (intercontinental ballistic missiles)? What if Russia's ability to patrol with their submarines gets better or worse? What happens if the U.S. develops conventional weapons that are so accurate we don't need nuclear weapons?'"

The package will come with a set of default data that are widely accepted in the arms control field. Users can then edit data to create customized scenarios. Researchers can change the data to align with their research, while instructors can change the data or allow students to do so. While default data is provided for three countries—United States, Russia and China—the tool can accommodate up to eight countries.

Kaufmann's program allows students and researchers to create nuclear strike scenarios.

"It will especially be an effective tool for teaching. Should we be worried that technical improvements will make nuclear deterrence more fragile than we thought it was? What we're trying to provide is more than a set group of numbers you should believe. Students can change the weapons systems, change the terms of arms control treaties."

Understanding real-world situations is important to experiential learning opportunities in the classroom. As of 2016, it has been 71 years since two major powers were at war with one another, and one of the leading explanations is nuclear deterrence.

"We've come to a situation among major powers where war just means everyone dies. Nuclear deterrents rely on major nuclear powers having strong second-strike capability. Even the winner will consider that they've lost."

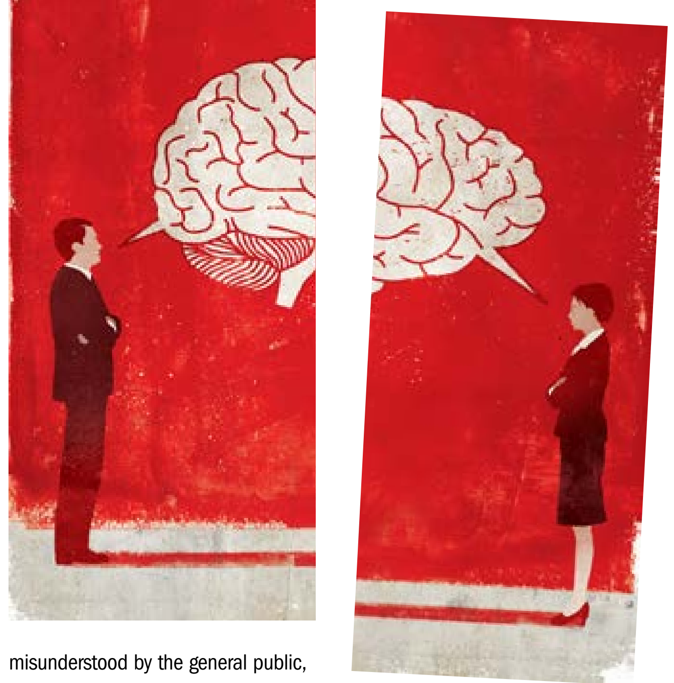
PSYCHOLOGY

Misunderstanding Mental Disorders

Do you know where depression comes from? Do you understand what an antidepressant does to make a person feel better? Cognitive psychologist Jessecae Marsh and Andrew Zeveney '14G have new research showing that members of the general public believe they know the answers to these questions much better than they actually do.

Previous research has shown that people think they understand how everyday objects, like air conditioners and faucets, work. However, when asked to explain how something as ordinary as a faucet actually works, people quickly realize that they actually understand much less than they think. Marsh and Zeveney examined whether this illusion of understanding existed for mental health disorders and their treatments. Mental disorders are notoriously

TO COME



misunderstood by the general public, and scientists are open about how much more there is to learn about mental health. Does the lay public still overestimate their understanding?

Marsh, assistant professor of psychology, and Zeveney asked participants to estimate how well they knew how the symptoms of different mental disorders develop and how different disorder treatments alleviated symptoms. They then asked participants to provide a detailed explanation of how those symptoms developed or how those treatments worked. While people were initially confident that they understood how disorders and treatments worked, after attempting to explain the phenomena, people's confidence in their ratings dropped dramatically.

"Ask someone how an antidepressant works and they say they know how it works, but ask them to explain it to you, and they will eventually admit they have no idea what its actual mechanism is," says Marsh.

Though the research is ongoing, Marsh notes that the results are informative as to the extent of people's overconfidence in the area of health care. Overconfidence may give people a false sense of understanding what treatment will best address a disorder's symptoms since they feel like they understand how the disorder works, at least in some part.

"We know from other work in our lab that how people think about the causes of mental health symptoms dictates their treatment choices. If people think they understand how symptoms develop, when they really do not, they could be making some ill-guided treatment decisions."

SOCIOLOGY

More Empowered Women = Fewer Disaster Victims

Among the bad news related to the ill effects of climate change is that women are impacted disproportionately by the resulting disasters. Women are more likely to experience poverty, poorer health outcomes and increased vulnerability to sexual violence due to climate-related disaster events, such as floods, storms and drought.

These facts are confirmed by new research that aims to quantitatively assess the causes of suffering from disasters in less-developed nations with a specific emphasis on gender relations. The research also reveals some good news: Women who are economically empowered have a disproportionately positive impact on disaster outcomes—reducing the overall number of people affected.

Kelly F. Austin, assistant professor of sociology at Lehigh, and Laura A. McKinney, of Tulane University, looked at data from 85 less-developed nations for their study, the results of which have been published in an article in *Social Forces*.

Austin and McKinney found that advancing the economic status of women reduces the number of people directly affected by disasters, as economically empowered women can better prepare for and respond to disasters. This improved status also has the indirect benefit of enhancing health resources in the community, thus helping to reduce harm and prevent deaths.

The authors point out that the same report also acknowledges that women are underrepresented in all levels of the decision-making process on efforts to combat climate change and that this is limiting.

"Public policies and initiatives to address climate change effects," the researchers wrote, "would similarly benefit by recognizing women as agents of harm reduction and advocates of community development."

The results of their research suggest a need to shift from post-disaster response to preparedness before a disaster strikes, they note.

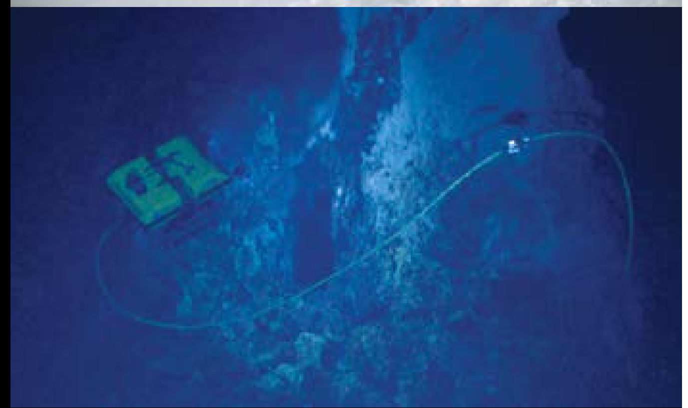
Preparedness makes good economic sense, the authors say. Reports indicate that for every

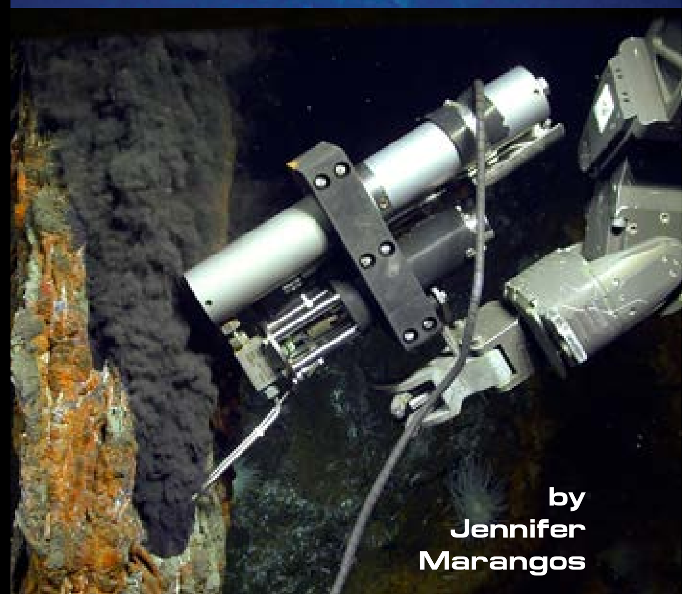
Kelly Austin argues that women are impacted disproportionately by disasters caused by climate change.

dollar spent on basic preparation, including provisions for health infrastructure like hospitals and clean water facilities, $7 in disaster aid and recovery is prevented.

INNER SPACE

EES faculty member embarks on a voyage of discovery at Earth's deepest depths





by Jennifer Marangos

Jill McDermott makes a habit of boldly going where few have gone before.

An assistant professor in Lehigh University's department of earth and environmental sciences, McDermott is a geochemist whose research focuses on two environments that only a handful of humans have ever experienced—deep-sea hydrothermal vents and ancient terrestrial fracture waters that are tapped by mines. It is believed that a better understanding of these places could ultimately result in a better understanding of the origin of life on Earth.

"I examine natural waters that are rich in reduced chemical species, including dissolved hydrogen," explains McDermott. "In both the vent and mine systems, a deep biosphere would exist in total darkness, so they are chemosynthetic rather than photosynthetic. This means that microbes in these environments make biomass and energy using chemical energy, rather than directly relying on sunlight-driven photosynthesis."

In many ways, McDermott's work entails studying both strange new worlds: those created along the global mid-ocean ridge system, around 60,000 kilometers in total length, where tectonic plates diverge, and strange old worlds, the fluids and gases found in the exploratory boreholes drilled into the ore deposits in the mines, which have average residence times of millions to billions of years underground.

"I've traveled up to three kilometers vertically underground into base metal mines in the Canadian Precambrian Shield, where the bedrock is some of Earth's oldest, ranging from 2 to 3 billion years old. The ore deposits in some of these systems formed on the ancient seafloor," McDermott says. "Along the modern mid-ocean ridge network, magma upwells and erupts to form new seafloor crust, and tectonic-driven faulting creates deep fissures in the rock. Hydrothermal vents form when seawater percolates down through fractures in the seafloor and is heated, either by a magma body or hot, fresh rock."

(LEFT COLUMN) MARCEL NICOLAUS, AWI/KEVIN HAND, CALTECH-JPL/NOAA OKEANOS EXPLORER, (RIGHT COLUMN) KEVIN HAND, CALTECH-JPL/NOAA OKEANOS EXPLORER/WOODS HOLE OCEANOGRAPHIC INSTITUTION, (RIGHT PAGE) DOUGLAS BENEDICT

McDermott, who joined the Lehigh faculty in the fall semester of 2016, will draw on her professional experiences as she envisions teaching a first-year seminar on current understanding about the origin of life, its connection with the evolution of Earth and efforts to search for life within our solar system and beyond.

McDermott recently joined a six-week expedition to the high-central Arctic aboard the German icebreaker and research vessel Polarstern. Due to challenging practical logistics and complex politics, she says it is rare for researchers to gain access to such a remote place. In fact, U.S. scientists have been there only twice before to look for seafloor vents.

"We sailed to the top of the world, at 87°N latitude, to investigate the origin and nature of hydrothermal activity along the Gakkel Ridge, Earth's slowest spreading center," McDermott explains. "On the first expedition in 2001, scientists predicted that there would be limited or no hydrothermal activity, due to low rates of volcanic activity. Instead, they were shocked to discover abundant evidence for hydrothermal venting, based on chemical signatures detected in the ocean overlying the ridge. On this expedition, we were equipped with water column sampling devices as well as the Nereid Under Ice, a submersible that was built and is operated by Woods Hole Oceanographic Institute (largest independent oceanographic research institution in the United States) and is designed to navigate an ice-covered ocean."

Working with a team of planetary scientists and geomicrobiologists, McDermott made the first measurements of dissolved methane emanating from vents along the Gakkel Ridge and conducted experiments to examine the rates of methane consumption by microbes.

McDermott says that even after six weeks at sea in almost constant darkness and with winter closing in, she found it difficult to set sail for home. She hopes one day soon to return to the mysterious Arctic seafloor to continue her research.

Three Lehigh undergraduate students will be assisting McDermott with making measurements on the Arctic samples and testing methods in her geochemistry lab during the spring 2017 semester. Although some time-sensitive measurements are performed on board the ship, according to McDermott, many chemical analyses are also performed on samples brought home to Lehigh.

"There will be opportunities for both undergraduate and graduate students to travel to new places and help with the research process, in my Lehigh lab, in the field and in presenting results at national and international conferences," she says, adding that she is actively proposing and planning new field expeditions.

Jill McDermott

"Hydrothermal vent and deep terrestrial fracture water ecosystems exist in permanent darkness. This 'life in the dark' is among the most poorly understood on the planet."

In summer 2017, McDermott says she plans to join an expedition to the Pescadero Basin in the Gulf of California, the location of the deepest (3800 m) high-temperature hydrothermal vents in the Pacific Ocean.

"At these vents, deep-sea biological communities thrive among carbonate chimney structures. I will collect gas-tight fluid samples and link these with novel *in situ* instrumentation to provide an integrated view of the environmental conditions controlling the transport of organics in modern systems."

The higlyh dissolved hydrogen gas contents of the Pescadero Basin vent fluids provide an opportunity to examine "abiotic and biotic" influences on the production of hydrocarbons and organic compounds, according to McDermott. Biotic factors are the living things in an ecosystem, such as animals, microbes and fungi, while abiotic factors are the nonliving parts, including volcanic and atmospheric gases, water and minerals.

In the future, in order to understand the limits of habitability, McDermott would like to continue to link fluid and gas chemistry with microbiology in the deep terrestrial subsurface.

"Hydrothermal vent and deep terrestrial fracture water ecosystems exist in permanent darkness. This 'life in the dark' is among the most poorly understood on the planet," McDermott explains. "In joint collaborations with microbiologists, I seek to understand the key questions of how big are these ecosystems, what are they doing, and how quickly are they growing and reproducing? As a chemist, I am interested in how the deep biosphere impacts biogeochemical processes on different spatial scales and over varying timescales. Do reactions happen right in front of my eyes, or am I looking at the cumulative effects of geologic time? I look for the transition point at which the environment becomes habitable or uninhabitable.

"The 'limits of habitability' are set by physical, chemical and energetic characteristics of the environment. In the vent and mine systems, the waters can be hot, acidic, chemically reducing and/or very saline. In order to survive, life must adapt to these extreme characteristics or perish," she says.

It seems space may not have been the final frontier after all.

(Far left, top to bottom): *Woods Hole Oceanographic Institution's Hybrid remotely operated vehicle (ROV) Nereid Under Ice. Sampling sea ice cores at 87°N latitude overlying the Gakkel Mid Ocean ridge. Chemosynthetic shrimp swarm in the Von Damm Hydrothermal Field, 2300m deep, Mid-Cayman Rise.*

(Near right, top to bottom): *German research icebreaker Polarstern, surrounded by meter thick ice. Remotely operated vehicle Little Hercules explores the Van Damm Hydrothermal Field. Isotonic gas tight hydrothrermal flued sampler on the ROV Jason II, collecting from the 398°C Piccard hydrothermal system in the Caribbean Sea.*

Researchers dig deep to find answers about how cells function and therapies when things go wrong

FOR BETTER OR WORSE

by Manasee Wagh

Breakthroughs in medicine often lead to innovative approaches to treatments and therapies. Across Lehigh's College of Arts and Sciences, research may shed light on treatments for cancer and bacterial infections.

Many basic cell functions that involve changes of cell shape and cell motion, such as during organism development or cancer cell metastasis, rely significantly on the properties of the actin cytoskeleton. The actin protein forms filaments that provide cells with mechanical support and driving forces for movement. The processes that drive cellular locomotion are not fully understood but are the focus of biophysicist Dimitrios Vavylonis.

Vavylonis uses the methods of physics to study, analyze and model the physical properties of these biological materials. He wants to decipher their mechanical properties, how they move and multiply, in the hope of finding a weakness that will help other scientists develop better therapeutic options.

"My background is in theoretical physics, working on polymer properties. But I was always interested in biology. At some point, I went to a conference on biophysics and was just fascinated," said Vavylonis, professor of physics.

He began studying biopolymers and discovered a seemingly endless supply of questions to investigate.

Vavylonis has been collaborating with researchers both at Lehigh and internationally to understand the physics involved as cells move in the body. In collaboration with researchers at Kyoto University, he is investigating the mechanism of cell movement by modeling the kinetics of the cell. The project combines mathematical modeling, image analysis and experimental biology to study actin filaments, abundant cellular protein that regulates cellular shape and motion.

All eukaryotic cells have actin, which forms long fibers that span the distance of the cell and crosslink to make a gel-like network. This network provides the cell's mechanical properties and can drive changes in cell shape, a constant process of assembly and disassembly.

Vavylonis and his team are interested in understanding how cells use these mechanisms to establish monopolar and bipolar growth patterns and how these patterns contribute to cell shape. He and his collaborators anticipate that acquiring biophysical knowledge about how cells move, change shape and divide can be the basis for explaining fundamental disease mechanisms such as cell metastasis or malignant tumor growth. While his study with Kyoto University uses frog cell lines, Vavylonis separately studies yeast cell remodeling, which uses its actin filaments in a very different way. Yeast cells don't move, but they grow by remodeling their outer walls with the help of actin filaments. And when a yeast cell divides during mitosis, its actin filaments first assemble a narrow ring shape in the middle of the cell in a perfectly coordinated dance of expansion and compaction.

"Normal cells do this successfully each time. But certain mutant cells have a specific problem with assembly of the ring. We showed that our models can predict how ring failure occurs in these mutant cells. We generated actin filament patterns that were verified by our experimental collaborators studying those yeast cells that cannot divide," Vavylonis says.

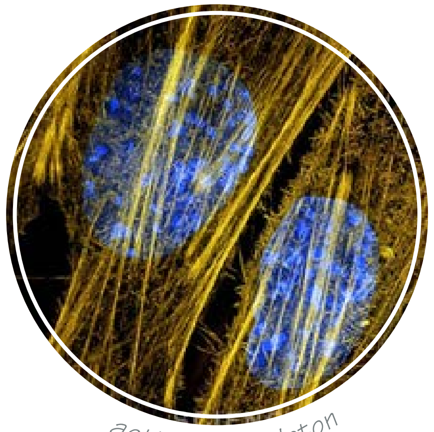
The team was also able to model how another type of mutant yeast cell could survive the ring failure by using a backup pathway to redistribute their actin filaments through an aggregate structure. They recently created a complex model of this behavior to analyze the physical interactions of cellular proteins. He speculates that this information may be useful to researchers hoping to stop cancer cells from multiplying.

"Many forms of chemotherapy are based on preventing cells from dividing," he says. "This may give insight for the making of a drug that prevents the division of certain cell types."

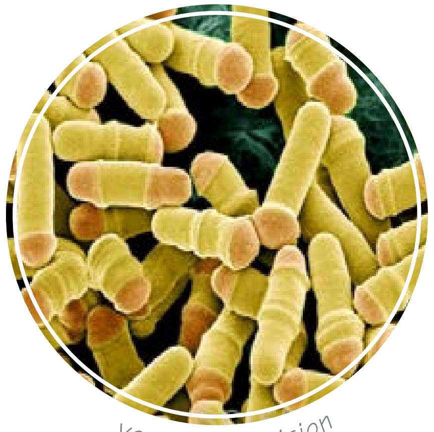
Vavylonis published two papers in 2016 in *Current Biology* about his yeast cell research. More recently, his partnership with Kyoto University received a new NIH grant to continue studying actin dynamics in cell motility and cell mechanics. Among his developing projects is a collaboration with Lehigh chemical engineering professor Jeetain Mittal to model actin polymerization using Mittal's expertise in methods of molecular simulation.

Together with Mittal and Damien Thévenin, assistant professor of chemistry, they organized the Pennsylvania branch of the Biophysical Society meeting that brought together more than 100 scientists with a quantitative perspective on biological phenomena at Lehigh.

"Biology is moving toward a more quantitative look at life's processes," says Vavylonis. "There is a big need to quantify and model all this information, because a model helps to organize it all. Several people at Lehigh are working on modeling, using mathematical, biophysical and quantitative approaches."



actin cytoskeleton



yeast cell division

Dimitrios Vavylonis

"Many forms of chemotherapy are based on preventing cells from dividing. This may give insight for the making of a drug that prevents the division of certain cell types."

Modeling the perfect cell to test antibiotics

Cellular function can also be dramatically impacted by infections, and harmful bacteria have been living the good life for the past 30 years. All bacteria adapt new survival techniques against existing drugs, but research on new antibiotics isn't keeping up. Some strains, such as MRSA and Streptococcus pneumonia, have taken on superbug status, multiplying into new, truly deadly strains.

"Of greater concern is the fact that nearly all antibiotics brought to market over the past 30 years have been variations on existing drugs," according to The PEW Charitable Trusts, which plans to establish a consortium of academics and industry experts to fight superbugs more aggressively.

Research in the academic setting is gaining momentum. Lehigh University's strength in biomolecular studies is fueling a movement that is drawing together the best minds in academia, industry and policy, in a race against the evolution of superbugs. In November 2016, leading experts in research and policy to accelerate antibiotic drug development converged at Lehigh for the "Workshop to Take Aim at Bacteria" This event that was organized by Wonpil Im, professor of biological sciences and bioengineering and Presidential Endowed Chair in Health Science and Engineering at Lehigh, included talks by several Lehigh researchers about new avenues of research that could benefit the fight against superbugs.

Without radical new approaches to eradicating these harmful bacteria, says Im, it's going to get increasingly harder to stay ahead of their natural evolutionary curve.

"Otherwise, it's like going back to the pre-penicillin era," says Im.

While some companies are doing antibacterial work, technological challenges and fewer research dollars mean the work remains largely stunted. Worldwide, superbugs cause about 700,000 deaths each year. The UK-based Review on Antimicrobial Resistance estimates that by 2050, more people could die of drug-resistant infections than from cancer.

"Our goal is to get not just one LPS structure, but to also load it into CHARMM-GUI Membrane Builder this year to allow researchers to build various bacterial outer membranes."

Im is one of select group of researchers seeking fresh solutions to antibiotic resistance. His decade of work to model bacterial cells has come to fruition with a publicly available biomolecular tool that simulates the complex membrane of lethal pathogens. It's the first crucial step toward understanding how to penetrate bacterial cells and target and destroy the machinery inside. Antibiotics work because they penetrate the outer membrane of bacterial cells, but when cells mutate to develop tougher exteriors, existing antibiotics are useless.

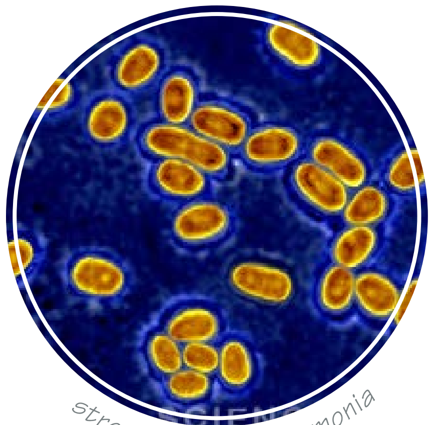
While gram-positive bacteria have a single membrane barrier that is relatively easy to penetrate, gram-negative bacteria, such as E. coli, have a tough double membrane, as well as other mechanisms that help push unwanted compounds like drugs out of their cells. The problem still remains that researchers don't really know the mechanics of how molecules penetrate the outer bacterial membrane, Im says. By understanding this process thoroughly, researchers could more easily predict what kinds of molecular structures could target specific bacterial proteins and kill the cell.

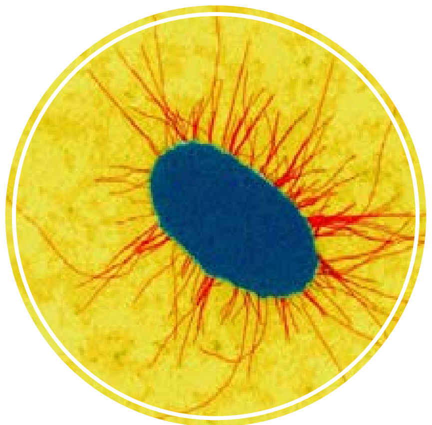
After six months of work, Im's group figured out how to use lipopolysaccharide, a simple phospholipid, to mimic the outer membrane of E. coli, which causes serious food poisoning. It was the first major step for his lab to simulate a gram-negative pathogen for drug discovery.

Im's CHARMM GUI can model lipopolysaccharide structures' various bacteria in less than 10 minutes. He hopes the free graphical user interface will allow researchers worldwide to model any number of bacterial cells efficiently.

"Our goal is to get not just one LPS structure, but to also load it into CHARMM-GUI Membrane Builder this year to allow researchers to build various bacterial outer membranes," Im says.

His ultimate goal is to model complex biomolecular systems that will further scientific understanding of the structure and functions of 10 different superbugs. Im is also working with other Lehigh researchers to create a center for membrane study at the university.


streptococcus pneumonia


e. coli bacteria


Wonpil Im

Investigating bacterial immunotherapy

Lehigh's Marcos Pires is looking for an altogether different approach to beat gram-negative superbugs. He believes in harnessing the body's natural defenses to do the job without traditional drugs. Despite tremendous efforts and investment toward the discovery of new antibiotics, no new class has been unveiled during the past 30 years. He believes that a nontraditional avenue may be just what the field needs.

The solution sounds like a simple fix: Design a molecular marker for the bad bacteria that mimics a compound the immune system naturally eliminates. Once the marker is attached to the bacteria, immune cells should seek out and destroy the cell, like a torpedo homing in on a target.

"This is immunotherapy, and it's already a reality for beating some cancers and for fighting HIV. Even in the case of more complex types of cells, such as HIV and certain cancer cells, immunotherapy has proven to be a powerful new mode of combating diseases. So why not design a similar strategy with the idea of having the immune system inactivate disease-causing bacteria? This was still not happening for bacteria until we came into this area," says Pires, assistant professor of chemistry.

Bacteria have evolved many tricks to avoid the immune system, so Pires wants to provide a hint that would trigger a boost in the immune response.

His research team took advantage of a unique cell wall bacterial building block, amino acids called D-amino acids. He and his students designed synthetic D-amino acids that bacteria incorporated onto their surfaces when growing and dividing. Pires tagged the synthetic D-amino acids with antibody recruiting markers that stuck to the exterior walls of the bacteria. When immune cells floating encountered the markers, they zoomed in and eliminated the cells. After initial success with single-walled gram-positive pathogens, Pires' team designed an antibody tag that could perform similarly with gram-negative bacteria. The team could watch the activity inside the flask because they designed the antibody markers with fluorescent tags, allowing them to verify that the antibodies were coating the bacterial cells.

"Even in the case of more complex types of cells, such as HIV and certain cancer cells, immunotherapy has proven to be a powerful new mode of combating diseases."

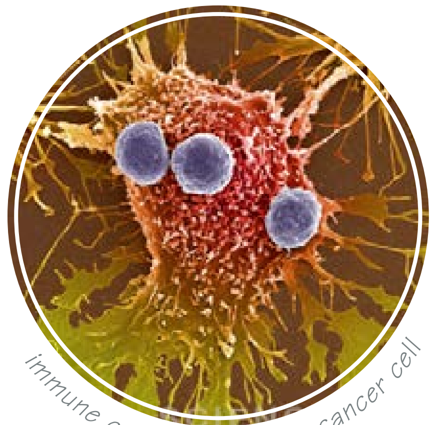
His team is also trying to bypass the use of antibodies by looking for a new type of antigen tag that would engage immune cells directly, therefore removing a layer of steps required for the immune system to activate. Theoretically, the immune cells will be triggered to act against the bacterial infection in their vicinity if they notice the tags floating around.

When it comes to antibacterial immunotherapy, there are other, larger hurdles to cross. Success in a flask is but the first step toward proving the technique in an infected human body.

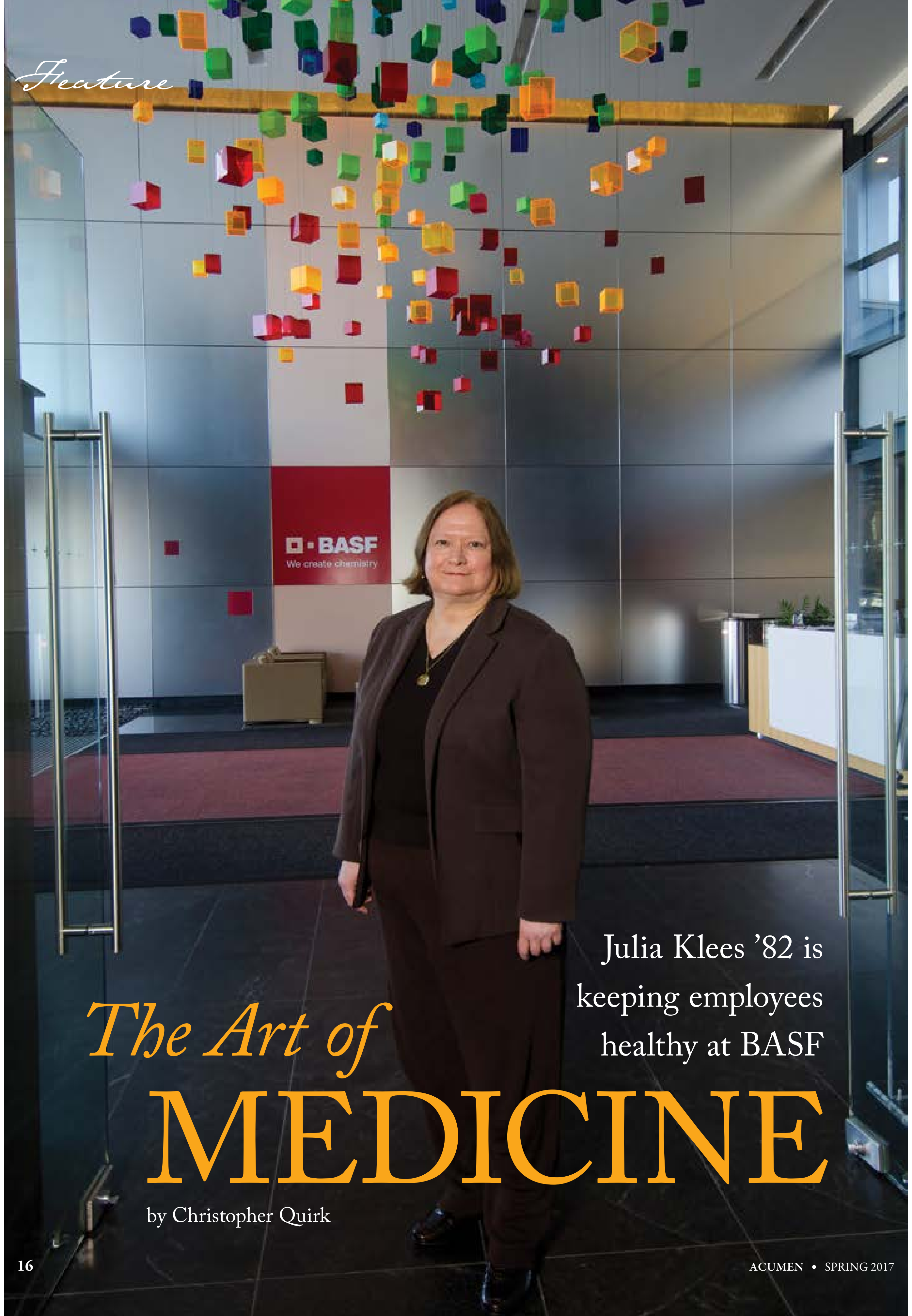
"There's a lot we still don't understand about the immune system. If we had an artificial immune system to test, it would be a great advantage," Pires says. "It feels for us like swimming upstream, but unless we see data showing this will not work, we'll stick with it. In fact, all evidence shows this should be easy for the immune system, considering how different bacteria are to our own cells."

Pires feels that this type of work is a race against the clock. Bacterial strains will always keep finding ways to get around standard drugs and become superbugs, he says.

"We were very spoiled in the past. We treated bacteria as a second thought because we had so many drugs to fight them," he says. "But now, a standard medical operation comes with the added caveat that you have to think about the tradeoff between the operation's success and the possibility of lethal infection. It's on our doorstep."


immune cells attacking a cancer cell


Marcos Pires



The Art of MEDICINE

Julia Klees '82 is keeping employees healthy at BASF

by Christopher Quirk

DARIA AMATO PHOTOGRAPHY

Julia Klees '82 thought she might be headed for a career in medicine early on. What was less foreseeable was the shape that career would take and the breadth of expertise it would require.

"There were a lot of things I was interested in growing up, but my father was a physician and I had gone to the hospital a lot with him," she says. "I liked the biological sciences and chemistry particularly, so I did the prerequisites and enrolled in the Lehigh-Hahnemann program, a seven-year B.A./M.D. degree program, which was a good option for somebody like me, and if I decided I didn't want to do it, I could leave the program."

She didn't leave, and Klees is now the associate medical director for BASF Corporation. Her post falls under the broad rubric of occupational medicine, but those unfamiliar with the field may not recognize its scope and complexity. Klees oversees the health of a village-sized population of 16,000 employees spread across the country while they are on the job at BASF. Her day-to-day responsibilities include everything from designing systems for monitoring health effects of potential chemical exposures at plants to implementing the company-wide flu vaccine program—and everything in between.

"Medicine is a real art. That is why it appealed to me. For instance, there is an art to taking a history and conversing with patients and talking to people of all sorts—and not just patients, but your colleagues and coworkers. There's a bit of the Socratic Method in there, too, in terms of obtaining an answer and then following up on that answer with the appropriate question that digs a little deeper. That's the key to taking a good medical history."

"I am looking for health effects and trying to find them early, before we have real disease; that is medical surveillance."

Part of Klees' interest in public health was inspired by the career of Alice Hamilton, whom she learned of in a public health course with the late John Ellis, who taught in the department of history at Lehigh. Hamilton was a groundbreaking physician who did seminal work in the fields of toxicology and occupational health. She became the first woman ever appointed to the Harvard University faculty, in 1919.

"In her study of workers suffering from diseases like lead poisoning, she sifted tirelessly through hospital records, climbed treacherous catwalks and slipped covertly into factories around the country," according to the T.H. Chan School of Public Health at Harvard.

"Hamilton was one of the people instrumental in passing the first workers compensation laws in the United States," Klees said. "In the day when physicians were trained in an apprenticeship system, she actually traveled to Germany to study pathology."

While Klees' preparation for her career was broad and rigorous, none of it turned out to be surplus to requirements.

"At Lehigh, having taken the harder road in terms of engineering, physics and chemistry, and so forth, it gave me a wonderful toolkit for working at a chemical company," she said.

After receiving her medical degree from Drexel (Hahnemann) in 1984, Klees continued her professional training, doing a residency in internal medicine at the Mayo Graduate School of Medicine in Minnesota, followed by a residency in occupational medicine at the University of California, San Francisco. Klees then earned a master's degree in public health with a focus in environmental health sciences at the University of California, Berkeley. All the clinical, policy and organizational training has proved valuable.

"I ended up in medicine, but for folks who are interested in health, medicine is not the only possibility. There are other disciplines in public health—like toxicology, epidemiology and health education—which are really important tools that I use every day."

After completing her studies and residencies, Klees went to work as an attending physician and medical director of the Occupational Health Service at the Albert Einstein Medical Center in Philadelphia. After two years, she returned to academic medicine as an assistant professor in the Division of the Environmental Medicine and Toxicology in the department of medicine at Jefferson Medical College, while maintaining a private practice in occupational medicine. Klees has continued her teaching to this day and currently holds an appointment at the Mount Sinai School of Medicine.

When Klees was offered the position at BASF, she seized the chance to put her full training to work on a larger scale.

"If you're a private clinician, you are working with smaller populations and just seeing lots of exams," she said. "In the land of academics, you are limited unless you can develop some of the other pieces to the practice, which is hard to do because you have to have access to a population to practice population health, which is what preventive medicine and public health are. It's tough to do that in academic medicine; it really is. So that's the big difference, and what I am doing now, in essence, is implementing a public health system for a sizable population, but within a corporation."

A principal duty of an occupational health professional is touring work facilities. At a manufacturing plant, Klees looks for potential points of exposure to a dangerous chemical that may put employees at risk.

"The dose makes the poison," Klees said.

Other information Klees seeks is less tangible.

"Exposure to heat, to noise and, frankly, to other people, because in the workplace, you're very dependent on other people. They can do something suddenly that results in an injury."

Secondary prevention—finding changes in health that accrue more subtly over time—is just as critical as preventing direct exposures.

"I am looking for health effects and trying to find them early, before we have real disease; that is medical surveillance," Klees said.

Then comes the logistical challenge.

"How do you manage that and put the systems in place to organize the information to track employees over time? Add to that (that) BASF has120 sites nationwide. How do you organize the whole thing so that you can review the information and also meet all the regulatory and ethical requirements? That's where it gets fun. And just when you think you'd seen it all, something new crops up."

Feature

GETTING VOCAL

A biological sciences graduate student leads an exploration of damselfish vocalizations

by Geoff Gehman '89 M.A.

Sonia Weimann's life is coral-reef busy. She's a doctoral candidate in Lehigh's department of biological sciences who also balances family life, being a co-owner of a decorative painting/wall-papering business, and is a member of a rock 'n' roll band. She specializes in studying sound from several perspectives starting at basic science in the mammalian auditory brainstem up to animal communication through vocalizations. Her study subject is currently the damselfish, one of the coral reef's busiest residents.

A star of aquariums, damselfish are the focus of a novel study supervised by neuroscientist R. Michael Burger and lead by Weimann and four Lehigh colleagues. Accepted in January for publication by *Bioacoustics*, a leading journal of research about animal communication, it is the first analysis of vocalizations that demonstrates that damselfish adjust their vocalizations based on the identity of intruder species. Based on an experiment conducted in the Caribbean, it provides vital information about a valuable creature in an invaluable ecosystem threatened by storms, tourists and other predators. It also confirms Weimann as a collaborator combining neuroscience and vocalization behavior.

Marine life has long been linked to Weimann's life. Growing up in Rhode Island, she spent countless hours in and along the ocean, a "magical" place for observing all sorts of organisms. Her inland hangout was a store called the Fish Bowl, where she spent much of her newspaper-delivery money on guppies, angel fish and other staples for her 100-gallon aquarium. She insists that had she been able to afford a salt-water tank, she would have stocked it with damselfish, which are prized as pets for their neon colors, bright patterns and salty personalities.

TO COME, LUCHEN WANG

Raised in a religious family, Weimann initially intended to be a minister. She changed her career course after receiving a bachelor's degree in theology from Valley Forge University.

"I've always been inherently curious about everything," she says. "I love logical thinking; I love critical thinking. Religion has a way of understanding the world without asking too many questions, and I'm not good with that. In science you must question everything and get answers that are measurable; it's the basic way of understanding our world. To know nothing about that world would be a travesty."

In 2005 Weimann began her new path as a biology major at Cedar Crest College. Her research subjects included a hormone that controls aggression in fish named after Jack Dempsey, the heavyweight champion boxer. Dissecting frog vocalizations prepared her for dissecting the froggy croaks of damselfish.

Weimann graduated magna cum laude from Cedar Crest in 2009, the same year she entered Lehigh's integrative-biology program. Her first research project at Lehigh was guided by Murray Itzkowitz, professor and department chair of biological sciences, who has studied damselfish for five decades. Itzkowitz's research concentrates on how the quality of breeding sites affects courting and defending nests. An avid snorkeler, Weimann knew that damselfish formed a busy, beautiful blanket on the bottom of reefs. Itzkowitz and Burger had planned an acoustic study in the Caribbean examining damselfish vocalizations. Damselfish are an ideal study subject because they protect their turf aggressively and loudly, making sounds that are easily heard and recorded.

Guided by Itzkowitz and Burger, Weimann joined the project and set up a damselfish experiment in a shallow coral reef near an oceanographic institute in Holetown, Barbados. She established 10 tagging stations for dusky damselfish and longfin damselfish, which have different traits and overlapping habitats. She placed three intruders—duskies, longfins and slippery dick wrasses, nicknamed for their habit of stealing eggs—in clear plastic bottles. She then recorded vocal responses to the invaders over two-minute intervals.

> In science you must question everything and get answers that are measurable; it's the basic way of understanding our world.

The ocean was a reluctant partner, obscuring damselfish vocals with crashing waves, popping shrimp and other disruptive noises. "You would think that spending so much time in the Caribbean would be relaxing," says Weimann. "Spend a few 12-hour days staring at fish and you'll think otherwise."

The results were well worth the sacrifice. Weimann discovered that duskies were the most vocal subjects, confirming their status as the chattier damselfish. The most common sound was a chirp. The most chirped-at intruder was the wrasse, the most foreign fish.

Weimann's and her colleagues' study is important for at least three reasons. One, it establishes that damselfish speak differently to different species. Two, it confirms that fish have a language, although it's not as understandable as the languages of dolphins and whales. And, three, it provides new information about the behavior of essential creatures that eat algae that corrode coral reefs, thereby protecting havens for food, medicine and erosion control.

"Every animal has its place in the circle of life," says Weimann. "When an animal is missing, something's missing."

Itzkowitz praises Weimann for expanding the collaboration between the two lab groups. As he points out, she worked from sun up to sun down in the sea and took a half-hour cab ride to find a replacement for a faulty microphone. "Sonia made the study her own," he says. "She is really smart and really, really hard working."

Sonia is completing her thesis work in the lab of Burger, associate professor of biological sciences. The Burger lab studies how animals translate acoustic cues to localize a sound source. Having already co-authored two published papers on amino acids that inhibit the auditory systems of birds, Burger is also advising Weimann's dissertation on neurotransmitter receptors activated by nicotine, a strong modulator of neural activity.

Weimann's role as an auditory neuroscientist dovetails with her role as the mother of a child born with profound hearing loss. Her work in the lab and the field has been strengthened by her work with her daughter's surgeons, speech therapists and special-needs teachers. Scarlet, 5, hears with the aid of cochlear implants. She shares her mother's love for fish, tending her own aquarium.

Weimann portrays the brain as a sort of neural coral reef. "It has to make amazing computations to make sense of all this sensory information that bombards us," she says. "Essentially, we're a brain in the jar."

Weimann's jar is overflowing. She supports herself by wallpapering and painting with her husband, Matthew, a third-grade teacher. She unwinds as the singing keyboardist in Ask Alice, a '60s-'70s rock cover band named after a Jefferson Airplane hit. Every now and then she runs a half-marathon for charity in a Wonder Woman costume, an entertaining sign of female empowerment for her daughter. She wears the outfit in a photo on the Web site of Burger's lab, which, thanks to her crammed life, she routinely enters at 4:00 a.m. The caption identifies her as "Graduate Student/Superhero."

Burger says he first acknowledged Weimann's unique powers during an after-work drink with their spouses. "At one point I asked Sonia: 'What do you exactly want to do with your career?' She said: 'I want to take over the world.' That's when I thought to myself: This is someone I want in my lab."

Weimann remembers a more powerful answer to Burger's question. "I believe I told Mike: 'World domination: I want to be the best at what I'm doing, or die trying.' I believe we have one life and it's limited and we have to do something important—now. It's important for us to contribute in any way, even in a minor way, if it can save us as a species. You can always shoot for the stars, right?"

SCIENCE SOURCE

Feature

a climate of giving

EES alumnus creates endowment to fund graduate student research

by Leslie Feldman

S. Jeffress "Jeff" Williams '69G is a strong proponent of understanding Earth systems for environmental protection. A national and international expert in coastal and marine geology, focusing on understanding the geologic history and processes of coastal, estuarine and wetlands, Williams created a $100,000 endowment in November 2015 to support graduate students in Lehigh University's department of earth and environmental sciences (EES).

"I favor donating to worthy causes and organizations that have a record of helping protect the environment, educate students needing support and, in general, provide benefits to society, particularly to disadvantaged students of modest means," explained Williams. "I find that Lehigh meets my criteria, and in addition, the university was very generous to me and I wanted to provide some payback for students now and in the future."

In recognition of the education he received at Lehigh, Williams established the S. Jeffress Williams '69G and Rebecca Upton Endowment Fund in Earth and Environmental Sciences to support students and faculty in the department of earth and environmental sciences at Lehigh to advance their research and teaching. The funds may be used for graduate or undergraduate student research stipends and/or travel to professional conferences.

"The S. Jeffress Williams '69G and Rebecca Upton Endowment Fund helps EES fulfill its mission to educate the next generation of earth and environmental scientists and to advance our knowledge of the solid earth, oceans, atmosphere and life through research," said David Anastasio, professor and chair of earth and environmental sciences. "This provides student stipend support so that a few additional deserving students can continue their research projects full time over the summer. We are extremely grateful for the continued support from our alumni and friends.Endowment earnings and gifts provide the majority of the EES budget and the means to support student professional travel and research expenses."

A commitment to the environment

Williams spent 43 years as a coastal marine geologist with the U.S. Geological Survey (USGS) at Woods Hole Coastal and Marine Science Center in Woods Hole, Mass. His research focused on understanding the geologic history and processes of coastal, estuarine, wetland and inner continental shelf regions. He led and participated in more than 80 field studies along the Atlantic, Gulf of Mexico, Pacific and Great Lakes coasts and the Irish Sea and, in 2009, was awarded the Coastal Zone Foundation Award for career achievement in coastal science and the USGS 40-year career service award. In 2010, he was awarded career achievement awards for natural resources research from both the eastern regional director of the National Park Service (NPS) and the director of the NPS, one of only five such national awards presented. Williams has authored more than 350 scientific publications and journal papers and has been a member of more than a dozen high-level national and state science advisory committees.

In 2010, Williams officially retired from the U.S. Geological Survey but stays active writing, performing coastal research as senior scientist emeritus with the USGS in Woods Hole and consulting. Most recently, he completed six years assessing the environmental impacts of the 2010 BP oil spill on the beaches and wetlands for a major land trust in Louisiana. He decided to retire in order to travel, spend time with his son's family in Hawaii and do some writing about the effects of climate change on coasts.

From an early age, Williams was interested in science, natural history and the outdoors. His parents instilled in him the prime importance of education and working toward a fulfilling career.

CARRIE VONDERHAAR/OCEAN FUTURES SOCIETY/GETTY, KRISTEN HOOK

"In my spare time growing up, I was always outside exploring the woods and fields and visiting national parks across the country and natural history museums with my family."

As an undergraduate, Williams attended Allegheny College in Meadville, Pa., earning a Bachelor of Science degree in geology in 1967. He continued his education at Lehigh because he wanted to pursue a Ph.D. in geology, and Lehigh had an excellent reputation for its geology program and staff.

"Lehigh was just about the right size school I was looking for, and they also offered me a much-needed, generous teaching assistanceship that included tuition and a teaching stipend."

A different path

Williams graduated from Lehigh in 1969 with a Master of Science degree in geology and a minor in geophysics and oceanography. Thoughhe was accepted into the Ph.D. program, his career path changed when he was drafted into the U.S. Army. Following induction and basic training, hewas accepted into the Officer Candidate School program and graduated as a 2nd Lieutenant in the Corps of Engineers.

"I spent three years in the Army serving as a research marine geologist at facilities in Washington, D.C., and Fort Belvoir, Va. Being drafted and getting that assignment was not my choice, but it started me into a career specialty of coastal and marine geology."

Williams thanks Lehigh for an excellent education and preparing him for his future.

"I feel I got a good foundational education at Lehigh...good classes, individual support from professors, experience in conducting research, critical thinking, public speaking and technical writing. I visited there two years ago, and with the new building and staff, the program is solid and likely even better than when I attended. I highly recommend Lehigh when I consult undergraduates looking for a graduate school."

Williams is happily married to Rebecca Upton, has a son, Derek, and two grandchildren, Solen, age 9, and Aleya, age 6, who live in Kailua, Hawaii. For hobbies, he enjoys reading non-fiction, traveling to interesting and historical places, and owning and showing his two classic cars. He and his wife spend most of the year in North Falmouth on Cape Cod and spend winters in Hawaii.

"I've been fortunate to have had supportive parents growing up and be the first in my family to graduate college," Williams added. "I had a rewarding career as a scientist, serving the public good and benefitting from living in a country that values merit, diversity, equal opportunity and expertise and experience. America is a great democracy, and I'd like for everyone having the drive and character to have the same advantages that I've benefitted from."

> *"I feel I got a good foundational education at Lehigh. . .good classes, individual support from professors, experience in conducting research, critical thinking, public speaking and technical writing."*

Feature

The Unlikely Case of the Physicist and the Disappearing Photographs

Nick Bigelow '81 uses his expertise in nanotechnology to save daguerreotypes

by Weld Royal '88

University of Rochester's Integrated Nanosystems Center Director Nicholas Bigelow '81 stops work on research he's leading at the International Space Station later this year to talk about the most unlikely project in his quantum physics career.

It all started in 2005, when conservators mounted an exhibit at the International Center for Photography in New York and became alarmed that parts of unique artifacts on display were disappearing. The show of historic photos of leaders and events included 37-year-old Illinois Congressman-elect Abraham Lincoln, the first photograph of the moon and an image of Harriet Beecher Stowe, before the publication of *Uncle Tom's Cabin*. The show had received rave reviews.

"Precious in the very best sense: literally beyond price, and almost, but not quite, beyond praise," gushed *The New York Times*.

As museum-goers arrived to see the exhibit of 150 mid-19th-century photographs titled "Young America: The Daguerreotypes of Southworth and Hawes," conservators noticed that the photographs were deteriorating. Some had blistered, and others had formed halos. Parts of certain photos had disappeared beneath white spots. When the two-and-a-half-month exhibit drew to a close, conservators assessed the damage. About two dozen unique daguerreotypes were severely damaged.

"There was a cry of urgency because you only have one daguerreotype. There's no negative, and people were worried about losing these incredibly important recordings forever," said Bigelow, who learned about the problem not long after the show closed.

Daguerreotypes are the world's earliest photographs. They came about nearly 180 years ago in Paris, when Louis-Jacques-Mandé Daguerre unveiled a process that changed the way wars, astronomy, presidents and plain folk would be remembered. In 1839, the French painter and printmaker presented an invention that would create a one-of-a-kind photographic image on a silver-plated sheet of metal, treated with iodine vapors, developed with mercury fumes and fixed with salt water. He called it a daguerreotype. The image's precision made it a clear choice for capturing political moments and figures through the Civil War era, after which other photographic techniques began to take its place.

Today, a strong collector's market exists for daguerreotypes. A few years ago, Sotheby's sold one of 19th-century New York City for $62,000. A small group of aficionados has even started new artsy work using the antique photographic process. But historic daguerreotypes are at risk. Bigelow discovered the photo-preservation crisis when he attended a lecture at the Eastman House, which has one of the world's largest collections of daguerreotypes and is just down the street from his physics labs.

Bigelow thought his work in nanoscience could help reveal causes for the decaying artifacts and agreed to help conservationists at the Eastman House look for clues. He also believed that the work of daguerreotypists nearly two centuries ago would help scientists today think about new ways to explore problems.

"The daguerreotype is one of humankind's most disruptive technological advances," said Bigelow. "Not only was it the first successful imaging medium, it was also the first truly engineered nanotechnology."

Most people think of nanotechnology as tiny electronic circuits, the processor in their phone or computer. But it's much more expansive. Nanoscience is the study and control of biological or chemical materials that are between one and 100 nanometers in size. A nanometer is a billionth of a meter, according to Bigelow.

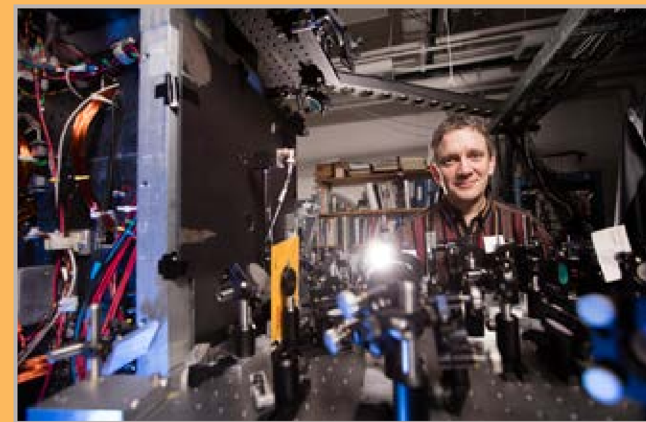
Nanotechnology is all part of Bigelow's "day job" centering on ultra-cold quantum physics. He studies atoms in the coldest matter that humans know how to make, about a billionth of a degree above absolute zero, known as a Bose-Einstein condensate. With a grant from NASA, he's working with a team on research at the space station to yield ideas on how atoms behave in near-zero-gravity conditions. There's a practical purpose to his work. Its results are used to refine sensors, such as gyroscopes, and his experiments could lead to next-gen gyroscopes to help navigate deep space.

Bigelow, who holds a Ph.D. in physics from Cornell University, credits his experience solving problems in Lehigh's research labs for helping to push him into a career in science.

"I came to Lehigh not really knowing what engineers did but always enjoyed rebuilding things. I ended up volunteering in different labs, including one in the physics department, and I liked working there, making things in a shop, and seeing what people who were physicists did with their time," he said.

Bigelow also says his Lehigh experience ultimately pushed him to take a job at the University of Rochester.

"Rochester's undergraduate program is similar in size and scale to Lehigh, and when I was looking at different opportunities, I realized that at Rochester I'd have a chance to get to know students and faculty members, and that was really attractive."



Nicholas Bigelow, in his laboratory at the University of Rochester, where he led a team to save daguerreotypes.

Exposure to some of the world's leading physicists and mathematicians before college also played a role in Bigelow's career. He grew up in Princeton, N.J., where his father worked for John von Neumann on a predecessor to the computer at the Institute for Advanced Study, a place where "there's still so much we don't know about the world" kind of wonder prevailed. Although the institute's legendary physicist, Albert Einstein, had died a few years before the Bigelows arrived, the Nobel Prize winner's thoughts and philosophy still had a huge presence. So did the work of institute scholar Freeman Dyson, a pioneer in modern theory in elementary particle physics.

"When you're lucky enough to grow up in an environment where curiosity is a valued attribute, it rubs off," Bigelow said.

Curiosity led Bigelow to connect with the daguerreotype experts at the Eastman House. He had something special to offer them: high-powered microscopes that might be able to see what was happening on the surface of the artifacts. Bigelow worked quickly with Eastman House conservators to put together a National Science Foundation grant application to study the decaying photographs. The foundation gave the team $450,000 through the SCIART award program that funds projects bringing together science and art.

With resources to back the research, Bigelow and his team at the Integrated Nanosystems Center began putting nonmuseum-quality daguerreotypes beneath high-powered electron microscopes to identify culprits behind the damage. They used a scanning electron microscope that scatters electrons off the surface of the daguerreotypes, providing magnification of 150,000 times and analyzing the makeup of any suspicious spot on the image. A transmission electron microscope delivers magnification of up to 300,000 times. They also used equipment for X-ray photo-emission spectroscopy. The high-powered devices revealed stuff growing all over the images.

"Highlights such as the whites of the man's eyes revealed a hidden nanostructure that resembled tiny clusters of white eggs—uniform silver mercury crystals whose images determined the image's whites and grays," according to *Scientific America*, which profiled the groundbreaking research.

The team also saw a kind of mold, which had metabolized residual sulfur and other things that form the structure of the surface that made the image. In other words, mold was eating away the foundation of the image—and that wasn't all. The physicists saw how a "network of holes" below the thin foil on which the image sits was allowing in substances from the atmosphere and causing the image to exfoliate.

Bigelow's work has contributed to conservators trying out prototype frames that can seal the daguerreotypes in argon, a gas that can protect the plates from contaminants that cause reactions on the silver surface. Bigelow said his team is also looking at broader applications for the research. "Self-assembling nanotechnology" is an area of intense interest, particularly in medicine, and self-assembly of nanoparticles is what Bigelow and other researchers discovered on the surface of the daguerreotype. It's terrible for the photographs but promising for drug delivery and other purposes.

"It's remarkable that something discovered in the 1800s has given us insight into future nanofabrication techniques," he said.

SCIENCE & SOCIETY PICTURE LIBRARY/GETTY IMAGES; MATT WITTMEYER PHOTOGRAPHY

Fighting Superbugs

Chemistry major helps develop new possible strategies for fighting infections

by Violet Baron

The coolest thing about bacteria, according to Julia Nelson '18, is their multitude of little quirks. Certain bacteria have even evolved to switch on an enzyme that modifies their cell walls in order to fight their traditional nemesis, penicillin. These so-called superbugs can resist drugs like penicillin and render antibiotics useless in fighting infections.

Nelson works to fight bugs like these each week in the lab of Marcos Pires, assistant professor of chemistry. For eight hours every week, she steps out of the closed worlds of her undergraduate labs and joins three other undergraduate researchers and two graduate students in his lab, where she has been helping to chip away at the puzzle since the spring of her freshman year. The lab is unique in its style of attack: The team is looking for a way to use immunotherapies to prompt patients' own defense systems and sidestep drugs altogether. *(Editor's note: You can read more about Pires' research on p. XX.)*

Nelson joined the project in the spring of her freshman year, when David Vicic, chemistry professor and department chair, alerted her to an opening in the lab.

"This was a topic I found really interesting, so I couldn't help but jump at the opportunity. I didn't want to pass it by."

In her own time, Nelson has taken on three distinct majors. Now a junior, she will graduate next year with degrees in molecular biology, pharmaceutical chemistry and mathematics.

While she currently receives academic credit for her work in the lab, she won a grant to carry out the research last summer.

"The summer work is generally more productive because it's not as interrupted as during the school year," she said. "You can accomplish things a lot more quickly."

Pires' project takes on more urgency as new superbugs arise.

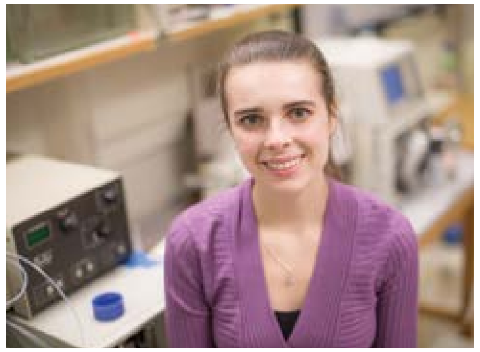
"Once that (drug-resistant) strain appears, it will spread rapidly because there is nothing that can kill it," said Nelson.

What started as an isolated threat can become an epidemic unless scientists can come up with another means of fighting it. By 2050, according to a report on antimicrobial resistance, the issue could eclipse cancer as a leading cause of death worldwide.

If no drug can touch it, Nelson's lab is betting that our bodies can be taught to fight the battle for themselves, a sort of martial arts on the molecular level. The lab is trying to guide the immune system into a coordinated attack by manipulating the bacteria's own makeup and implanting an antigen, or marker, to allow the system to detect the bacteria more easily.

"Our method would just target the cell wall, which has been relatively constant in bacteria for a very long time," Nelson said.

The other advantage to this method is speed: "The immune system will recognize the bacteria more quickly (than a drug would) and get to the site of infection more quickly—and kill them in that way."



Nelson now builds peptides, proteins that bacteria use to construct their cell walls. The idea will be to imbed a special molecule into the peptides, a signal that human immune systems would pick up on and hopefully stimulate an attack. For now, Nelson imbeds a marker into the peptides to see if the plan will work.

"I do a lot of synthesis to build these molecules," Nelson said.

Because the immune system and its components are so complex, a working therapy for drug-resistant bacteria may be a long way off. In the meantime, Pires' lab focuses on incremental progress, like successfully imbedding marker probes into proteins.

"We are more focused on celebrating the little victories," Nelson said.

After two years in the lab, actual patient interaction sounds appealing to Nelson—she is considering medical school after graduation.

"Right now," she said, "I think I would prefer to be a practicing physician and am also considering pursuing work in clinical trials."

Until then, she appreciates her time in the lab.

"It's fun because I have learned about some of this in my classes, and now I am actually doing research about it and really understanding it."

Nelson, along with three other undergraduate researchers, gains invaluable bench experience in the Pires lab.

LUCHEN WANG

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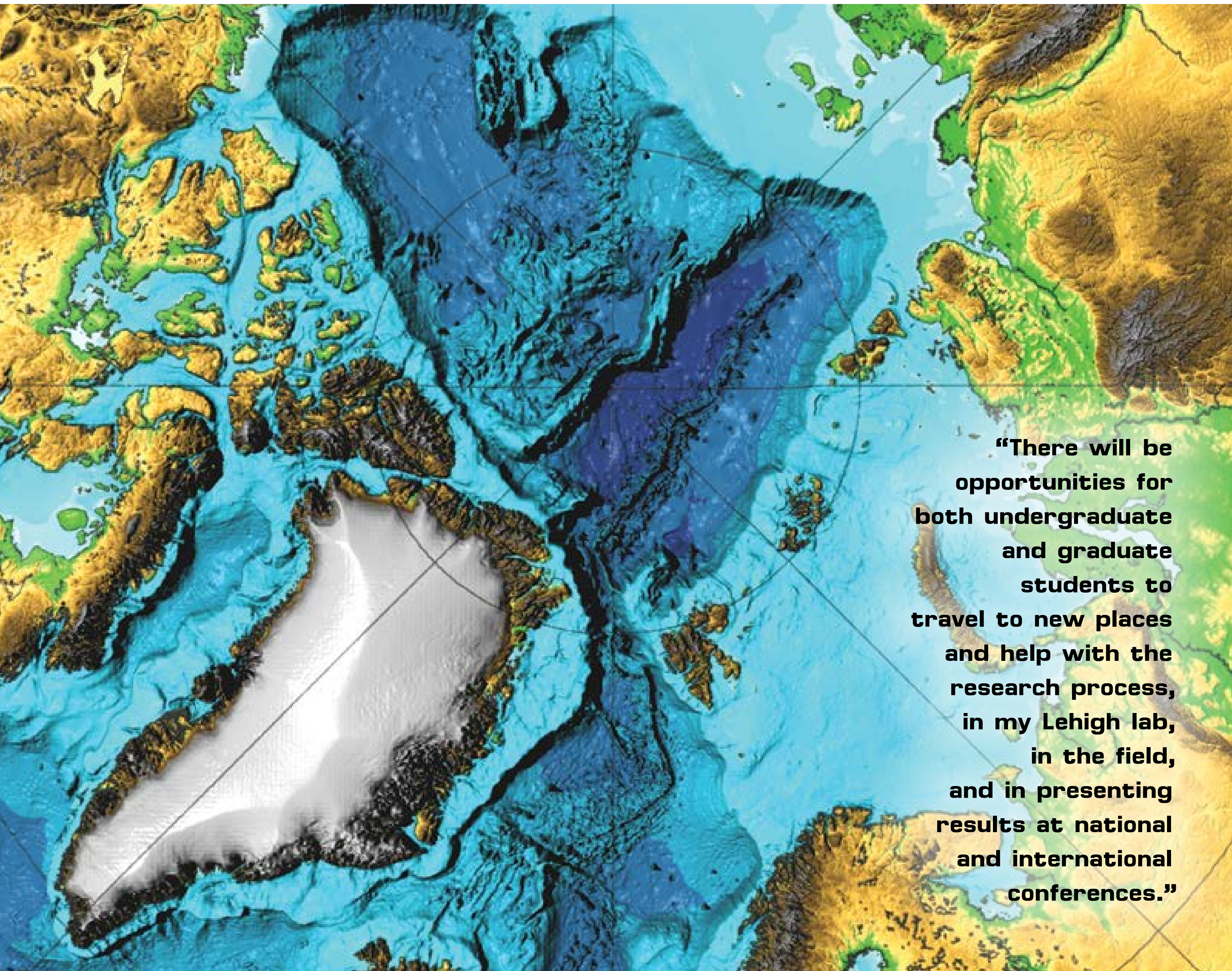

"There will be opportunities for both undergraduate and graduate students to travel to new places and help with the research process, in my Lehigh lab, in the field, and in presenting results at national and international conferences."