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Clive Yik-Sham Chung, a postdoctoral fellow in the Nomura lab in the Department of Nutritional Sciences and Toxicology. Read about the lab's chemical proteomics research on page 10. PHOTO: Elena Zhukova

BREAKTHROUGHS

UC BERKELEY COLLEGE OF NATURAL RESOURCES • FALL 2019

Advances for Human Health

The Secrets of Virus-Host Interactions, Reimagining "Druggability," and more

LETTER FROM THE DEAN

Here in the College of Natural Resources, the term *health* can have a lot of meanings. Depending on the class, the lab, or even the day, we might be referring to the health of a particular species, a forest, an ecosystem, the entire planet, or—of course—a person.

This issue of *Breakthroughs* spotlights work in the College that furthers human health and well-being. We feature two research labs that are advancing our understanding of human disease on a cellular level. One is a collaboration of chemists and biologists who are analyzing the human proteome with the hope of developing next-generation therapies for cancer and other diseases. The other is revealing the fascinating world of viruses and how they interact with their mammalian hosts. In addition to these labs and others engaged in fundamental science, CNR is home to social scientists and economists who are focusing on environmental health and justice, nutrition-related chronic disease, health care access, air quality, and more.

We also share the stories of two alumni who have made meaningful impacts in the world of public health, one through innovations in forensics and the other by serving Native populations and veterans as both a physician and a policy leader in the U.S. Public Health Service.

Finally, we're excited to tell you about the CNR Summer Internship Grants, a program piloted this year to support students participating in internships that are unpaid or that require additional funds for travel or living expenses. These opportunities—which range from working to reduce the carbon footprint of a hospital in India to advancing food justice in Oakland—are helping our students make a difference in the world while preparing for their careers beyond Cal.

I welcome your feedback at dackerly@berkeley.edu.

David D. Ackerly

DEAN
David D. Ackerly

EDITOR
Julie Gipple

ASSOCIATE EDITOR
Mackenzie Smith

CREATIVE DIRECTOR
Ian Price

COPY EDITOR
Lynn Rapoport

CONTRIBUTING WRITERS
Ann Brody Guy
Mark MacNamara
Kara Manke
Kirsten Mickelwait
Kristin Baird Rattini
Robert Sanders
Nate Seltenrich
Mackenzie Smith

CONTRIBUTING PHOTOGRAPHERS AND ILLUSTRATORS
Jim Block
Monte Draper
Matthew Mayes
Theresa Oborn
Deb Sklut
Elena Zhukova

DESIGN & PRODUCTION
Price Watkins Media
pricewatkins.com

ONLINE DIRECTOR
Joseph Bunik

ONLINE PRODUCTION
Anjika Pai
Lindsey Pfeiffer

Please direct correspondence to:
Breakthroughs
College of Natural Resources
University of California, Berkeley
760 University Hall #3100
Berkeley, CA 94720-3100

(510) 643-1041

breakthroughs@berkeley.edu

nature.berkeley.edu/breakthroughs

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PHOTO: Elena Zhukova

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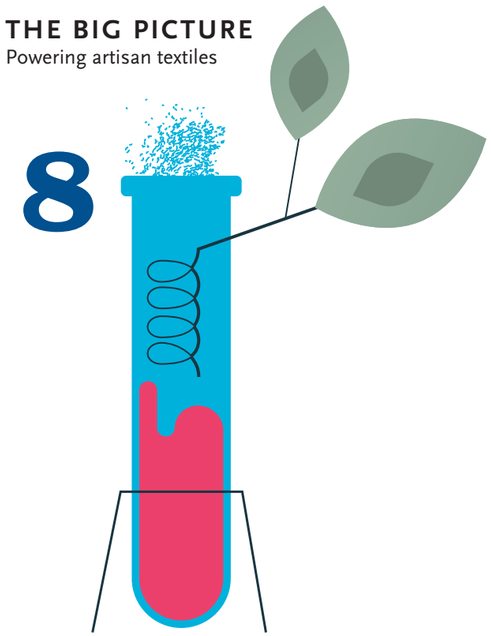
College of Natural Resources

FALL 2019

BREAKTHROUGHS



ONLINE

State of the College
Dean Ackerly delivered a College update to the CNR community in September. View the slides from his talk at **nature.berkeley.edu/soc-2019.**

COVER: Illustration of a human cell. By Science RF for Adobe Stock

Soda Wars

Sticker shock may not have been the only force driving the decline in soda consumption in Berkeley after residents voted to enact the nation's first soda tax in November 2014. The election, and the vigorous campaigning around the tax that led up to the vote, also may have played a major role in changing habits, shows a study by College of Natural Resources economists.

The study authors analyzed food and drink purchases at UC Berkeley–owned dining facilities and in drugstores in the city of Berkeley before and after residents voted in favor of levying a penny-per-ounce tax on all sugar-sweetened beverages.

Their analysis revealed that soda sales dropped by an average of 10 to 20 percent in the three months immediately following the vote—before the tax or any associated price hikes went into effect.

The results indicate that the contentious Berkeley vs. Big Soda campaign and, ultimately, the vote in favor of the tax were enough to decrease soda sales in the city.

"In this case, an election really worked to change consumption before a price change," said **Sofia Villas-Boas,** a professor in the Department of Agricultural and Resource Economics (ARE) and the senior author of the paper, which appeared in the journal *Economic Inquiry* in April.

"A key takeaway from our study is that if you replicate a soda tax or some other, similar measure in a different city, you might not witness the same consumption results if you didn't have a campaign and election leading up to the actual tax implementation," said **Scott Kaplan,** an ARE graduate student and co-author of the paper.

— KARA MANKE

UC's Newest Research Station

Students and faculty at UC Berkeley have long conducted research at Point Reyes National Seashore, and now they have a home away from home within the park to make extended field studies easier. The campus and the National Park Service signed a five-year agreement last year allowing a historic ranch house in the heart of the Olema Valley to become a campus reserve: the Point Reyes Field Station. In May, the UC Regents approved adding the field station to the UC Natural Reserve System, bringing the total number of UC reserves statewide to 41.

"Point Reyes offers so many opportunities for our students and faculty to pursue their research and contribute to the conservation of park resources," said CNR Dean **David Ackerly,** the faculty director of the station. Ackerly spearheaded the effort to create the new station, now one of 15 field stations, reserves, and experimental forests administered by UC Berkeley.

This historic ranch house in the Olema Valley is now available for student and faculty researchers. PHOTO: Allison Kidder

The field station currently hosts studies on river otters, mountain beavers, and the ticks that carry the bacteria responsible for Lyme and other diseases, and it's also home to a plot for Lawrence Berkeley National Laboratory research on how microbial communities interact with plant roots to affect soil-carbon turnover, storage, and loss.

— ROBERT SANDERS

Is Wildfire Management "for the Birds"?

Spotted owl populations are in decline along the West Coast, and as climate change increases the risk of wildfires in the region, these iconic animals face losing even more of their forest habitat.

Rather than attempting to preserve the owl's remaining habitat exactly as is, however, wildfire management practices—such as prescribed burning and restoration thinning—may be key to saving the species, argue environmental science, policy, and management professor **Scott Stephens** and his co-authors in a paper published in July in *Frontiers in Ecology and the Environment.*

The paper compares the plight of the owl with that of another threatened species, the red-cockaded woodpecker, which has made a comeback in recent years—thanks, in part, to active forest management in the southern pine forests that the woodpecker calls home. Though the habitat needs of the two birds are different, both occupy forests that harbored frequent blazes before fire suppression became the norm.

"The South has melded fire and rare-species management in a holistic way, but in the West we're doing one or the other," Stephens said. "More restoration thinning and prescribed burning could help us keep the habitat that we have now, modify it, and actually make it more sustainable in the future."

— KARA MANKE

Newsmakers

"We should be concerned on multiple levels."

Jennie Durant, *PhD '19, ESPM*
In June, the *New York Times* featured alarming results from an annual survey of U.S. beekeepers, which found that the 2018–19 winter honey bee die-off was the largest to date. Durant weighed in on the survey results, having published a separate study that same week on food-supply losses for bees, revealing that changes in the critical Midwest Prairie Pothole Region have been a major factor, as the area is losing wetlands containing clover that bees feed on.

"Putting something in the blue bin is not the same as recycling it."

Kate O'Neill, *Professor, ESPM*
O'Neill joined NPR's *The Takeaway* in May to discuss the future of U.S. recycling. Commenting on the Malaysian government's decision to send more than 3,000 tons of nonrecyclable plastic waste back to countries including the U.S., the U.K., and Canada, O'Neill noted that the United States has been "let off the hook for 20 years" when it comes to responsibly recycling and disposing of plastic. She suggested eliminating some plastics from the recycling stream, educating consumers, and investing in recovery facilities to battle our mounting trash problem.

"There's [an] idea that there's this magical place called the back of the refrigerator where everything gets lost."

Laura Moreno, *Graduate Student, Energy and Resources Group*
An April *National Geographic* article explored the psychology of food waste and featured Moreno's tips for rethinking our consumption choices. Her recommendations included increasing food literacy and stocking water supplies in the back of the refrigerator, to prepare for emergencies and push food forward to keep it from getting lost.

PHOTOS: Anjika Pai, Julie Gipple, Jim Block

Falling Levels of Air Pollution Drove Decline in California's Tule Fog

The Central Valley's heavy wintertime tule fog—known for snarling traffic and closing schools—has been on the decline over the past 30 years, and falling levels of air pollution are the cause, according to a study by scientists in the College of Natural Resources. Tule fog, named for a sedge that populates California's wetlands, is a thick ground fog that periodically blankets the valley during the winter months.

To find out why the fog is fading, researchers analyzed meteorological and air pollution data from the Central Valley reaching back to 1930. They found that while yearly fluctuations in fog frequency could be explained by changes in annual weather patterns, the long-term trends matched those of pollutants in the air.

The results help explain the puzzling decades-long rise and fall in the number of "fog days" affecting the region, which increased by 85 percent between 1930 and 1970, then decreased by 76 percent between 1980 and 2016. Air pollution in the valley increased during the first half of the 20th century, as the region was farmed and industrialized at a quickening pace, then dropped off after the enactment of air pollution regulations in the 1970s.

"That increase and then decrease in fog frequency can't be explained by the rising temperatures due to climate change that we've seen in recent decades," said **Ellyn Gray,** a graduate student in the Department of Environmental Science, Policy, and Management (ESPM) and first author on the paper, which appeared in the *Journal of Geophysical Research: Atmospheres* in March. "When we looked at the long-term trends, we found a strong correlation between the trend in fog frequency and the trend in air pollutant emissions." Co-authors on the paper include ESPM professors **Dennis Baldocchi** and **Allen Goldstein.**

— KARA MANKE

Supporting China's National Park System

Chinese president Xi Jinping has called for a national park system in the country by 2030, and the **UC Berkeley Institute for Parks, People, and Biodiversity** is playing an integral role in the country's progress toward that goal. Led by executive director **Jon Jarvis** and funded by the Paulson Institute, the group is evaluating one of China's pilot parks, Sanjiangyuan National Park—an area of nearly 30 million acres on the Tibetan Plateau. Within the park lie the headwaters of three major rivers—the Yellow, the Yangtze, and the Mekong—that supply water to 900 million people in China and five other nations. The institute is also assisting in the development of a sustainable financial model for the national park system and training senior Chinese leaders in national parks management, with a focus on conservation and stewardship. "We have the opportunity to build a program of conservation of national parks that will foster national pride in China and will have a huge impact for the biodiversity of the nation and hopefully the planet," said Jarvis.

Jon Jarvis meeting Tibetan community rangers in Sanjiangyuan National Park. PHOTO: Rudy D'Alessandro, U.S.National Park Service

PHOTO: Courtesy of Mackenzie Feldman

Mackenzie Feldman, Bridget Gustafson, and Helen Haugenes working on a pesticide-free garden bed on campus.

Herbicide-Free UC

In May, two CNR students' multiyear efforts were rewarded when the University of California issued a temporary ban on the use of glyphosate-based herbicides at all UC locations.

Back in 2017, undergraduates and beach volleyball teammates **Mackenzie Feldman,** BS '18 Society and Environment, and **Bridget Gustafson** worked to get glyphosate, a probable carcinogen, banned from the area around the Cal beach volleyball courts and then from other parts of Berkeley's campus. Feldman next launched a UC-wide campaign to eliminate the use of toxic herbicides on UC campus grounds. The effort, called Herbicide-Free UC, expanded across the UC system as teams of student activists joined the campaign at the Davis, UCLA, Santa Barbara, and Riverside campuses.

UC president **Janet Napolitano** noted that the ban—which has some exceptions, including agricultural operations and certain research or restoration efforts—was instated "due to concerns about possible human health and ecological hazards." Gustafson, now a senior majoring in molecular and environmental biology, is serving on a UC task force that is evaluating the use of toxic herbicides in the UC system and will deliver recommendations to President Napolitano this fall.

Since graduation, Feldman has been working full-time on Herbicide-Free Campus, the nationwide organization she created, whose focus now includes not only other universities but also primary schools. One recent campaign in Feldman's native Hawaii scored a victory in June when the state's superintendent announced an herbicide ban at all public schools.

— MACKENZIE SMITH

SUBJECT:

Why I Do Science

ENTRY BY: **Rachel Morello-Frosch**

ENTRY #: **018**

I'm the daughter of immigrants: My father was a Jewish refugee who fled Germany. My mother was an activist who emigrated from Argentina in the 1950s and later became one of the first Latinas to be promoted to full professor at UC Santa Cruz. My parents' story motivates the research I do as an environmental health scientist and animates my desire to translate my work into policies that improve community health.

As an undergraduate at UC Berkeley, I majored in development studies, and my first job after college was at a civil rights organization in San Francisco. While working that job, I met people whose environmental and occupational health was jeopardized by discriminatory policies, and I wanted to build a career that could help change that. I returned to Berkeley to study epidemiology and biostatistics, with a plan to attend medical school. But I quickly realized that I was more interested in research and teaching than in clinical work, so I remained at Cal and earned my doctorate in environmental health sciences.

As a professor, I relish the community of researchers and students in my lab, where we give one another rigorous and supportive feedback on our work that pushes the methodological boundaries of our thinking and helps us consider the policy impacts of our science. I am proud of my collaborations with communities and colleagues, in which we translate our research into assessment tools that measure the impacts of social and environmental stressors. One of these tools is the Environmental Justice Screening Method, which was a foundation for the California Environmental Protection Agency's CalEnviroScreen. This spatial screening method is used to identify vulnerable communities that are burdened by multiple sources of pollution and require enhanced regulatory attention.

Rachel Morello-Frosch is a professor in the Department of Environmental Science, Policy, and Management and the School of Public Health. She was the 2018 recipient of the Chancellor's Award for Advancing Institutional Excellence and Equity.

100 Percent Empowerment, Zero Percent Guilt Trip

During workshops, Cat Adams and Linet Mera of the Unconscious Bias Project use cartoons they commissioned as catalysts for discussion.

CARTOONS: Theresa Oborn

The Unconscious Bias Project (UBP) wants to help scientists tackle the biases lurking in our labs, lives, and classrooms. "We work to help scientists acknowledge the problem of unconscious bias, understand that they shouldn't feel bad about it, and—most importantly—know that there's something they can do about it," said **Cat Adams,** a PhD candidate in the Department of Plant and Microbial Biology, who launched UBP at UC Berkeley in 2017. "This is why our slogan is 'one-hundred percent empowerment, zero-percent guilt trip.'"

Unconscious bias often stems from stereotypes that can lead to prejudiced or unsupported judgments regarding a person or group. Through participatory workshops and media campaigns, UBP guides researchers, students, and faculty on the path to understanding and correcting their own biases, with the goal of reducing unconscious bias in STEM through "fact, tact, art, and activism." When Adams and co-founder Linet Mera conduct a training, they promote a sense of shared ownership of this goal by inviting a member of the group to learn the material in advance and act as a co-leader of the session.

The idea for UBP began to percolate before Adams came to Berkeley, but it wasn't until she arrived on campus that she felt she had found a home for the organization. "As a public institution, Berkeley fosters a sense of transparency," she said. "I knew this was the ideal place to help scientists identify and correct unconscious bias." UBP was recently invited to lead workshops at the University of Arizona and the University of Puerto Rico, and this spring it was awarded a $10,000 Chancellor's Advisory Committee on Student Services and Fees grant.

— MACKENZIE SMITH

Half-Earth Day 2019

Conceived by renowned biologist and naturalist Edward O. Wilson, the "half-earth" concept is a call to conserve half the earth's land and sea in order to provide sufficient habitat to safeguard the bulk of the planet's biodiversity, including humanity. On October 7, the College of Natural Resources and the E.O. Wilson Biodiversity Foundation cohosted the third annual Half-Earth Day celebration, bringing together people from around the world and across disciplines to share perspectives on how to reach this goal. After a full-day conference, Wilson joined former U.S. secretary of the interior Sally Jewell for a panel discussion on the topic as part of the Albright Lecture in Conservation. Watch a video of the discussion or the conference proceedings at nature.berkeley.edu/half-earth.

PHOTO: Anastasiia Sapon

New Cannabis Research Center Explores Impacts of Legalization

Because of its unusual history as a U.S. crop—once illegal to grow, now legal in many states but heavily regulated—cannabis has left a unique footprint on the environment and the communities of farmers who cultivate it.

Launched in early 2019, UC Berkeley's Cannabis Research Center explores how cannabis production affects the environment and society and how these impacts will evolve under new regulations set in place by legalization. The center is co-directed by **Van Butsic** and **Ted Grantham,** both assistant Cooperative Extension specialists in the Department of Environmental Science, Policy, and Management. While other research groups in the University of California are focusing on the individual and public health effects of cannabis, the center will be the first in the UC system to explore these oft-overlooked dimensions of cannabis growth. "This is a rapidly changing industry, and no one really knows where it is headed," said Grantham. "We believe researchers have an important role in bringing independent scientific information to conversations around cannabis policy."

— KARA MANKE

Government officials, climate change advocates—including Al Gore—and leaders from UC Berkeley and Tsinghua University gathered at a launch event for the California-China Climate Institute.

PHOTO: Beowulf Sheehan

California-China Climate Institute

On September 23rd, UC Berkeley launched a groundbreaking partnership with former California governor Edmund G. Brown Jr. and China's top climate change official Xie Zhenhua: the **California-China Climate Institute**—which will spur further climate action through joint research, training, and dialogue.

Housed at CNR and Berkeley Law, the institute will be chaired by Brown and will collaborate with the Institute of Climate Change and Sustainable Development at Tsinghua University, which Xie Zhenhua leads. The institute will deploy the University's resources and expertise to advance research on low-carbon transportation and zero-emission vehicles, carbon pricing, climate adaptation and resilience, sustainable land use and climate-smart agriculture, carbon capture and storage, and long-term climate goal setting and policy enforcement.

"The climate threat doesn't respect borders, and it doesn't pause for politics. Now is the time for action from leaders everywhere—for humanity and our common future," said Brown, who will have a visiting professorship at Berkeley in his role as co-chair. "With this institute, California and China are pushing forward together."

ON THE GROUND

Human Health across Disciplines

BY MACKENZIE SMITH

CLEARING THE AIR

Rachel Morello-Frosch, a professor in the Department of Environmental Science, Policy, and Management (ESPM), studies environmental health and justice, focusing on U.S. populations that are vulnerable to the toxic effects of pollution because of poverty, malnutrition, discrimination, and underlying health conditions. One of her recent research projects found that closing coal- and oil-fired power plants in California lowered the rate of preterm births and improved fertility in neighboring communities.

EXAMINING MIGRANTS' ACCESS TO HEALTH CARE

A cultural and medical anthropologist and a physician, ESPM associate professor **Seth Holmes** investigates health care inequalities faced by migrant and undocumented communities. For his book, *Fresh Fruit, Broken Bodies: Migrant Farmworkers in the United States,* Holmes spent more than a year conducting participant-observation research in collaboration with indigenous families in Mexico and immigrant communities in the U.S., a partnership that included accompanying migrant laborers on clinic visits and trekking across the border desert into Arizona. One of his current projects seeks to understand how medical trainees perceive and respond to social difference in their patients.

FOCUS ON MATERNAL AND PEDIATRIC HEALTH

Susana Matias joined the Department of Nutritional Sciences and Toxicology (NST) as an assistant Cooperative Extension specialist in July. Matias is an epidemiologist whose research promotes health through nutrition and the prevention of nutrition-related chronic diseases. She focuses on infant feeding, diet, food security, and obesity, with a particular concentration on the mother-child dyad and vulnerable populations.

GUT CHECK

ESPM professor **Jill Banfield** and her team use phylogenetic and metagenomic approaches to examine normal and diseased infant guts. By studying the microbial colonies that bloom in the gut during the critical first 100 days of a baby's life, Banfield's lab hopes to better understand the abnormal microbial colony growth associated with the higher rates of illness and death among premature infants.

CRISPR VS. CHOLERA

Collaborating with scientists and medical professionals in Bangladesh to collect and analyze patient samples, plant and microbial biology assistant professor **Kim Seed** works to understand how epidemic strains of cholera continue to evolve to infect human hosts. She and her lab use comparative genomics and molecular approaches such as CRISPR to untangle the impacts of bacteriophages—viruses that infect and replicate within bacteria—on the evolution and epidemiology of cholera's causal agent, *Vibrio cholerae*.

DISEASE AT THE CELLULAR LEVEL

NST associate professor **James Olzmann**'s research illuminates the cellular processes governing how the body stores and uses fat. By revealing the cellular mechanisms that control lipid homeostasis, Olzmann hopes to be a leader in the development of therapeutics for cancer, diabetes, nonalcoholic fatty liver disease, and other medical conditions.

MORE THAN A DROP TO DRINK

Isha Ray, an associate professor in the Energy and Resources Group, examines access to safe, affordable water and sanitation for the rural and urban poor in developing economies. In a recent study co-authored with School of Public Health colleagues, Ray reported the presence of *E. coli* in drinking water in Alibag, India, demonstrating that even in communities that have gained drinking water access, contamination can still pose a significant risk.

Reimagining "Druggability"

Dan Nomura's lab explores the human proteome for the development of next-generation therapeutics

By Mark MacNamara | Photography by Elena Zhukova

In the modern age of pharmacology, some of the newest heroes in the war against human disease are biologists and chemists working in chemical proteomics. The term *proteome* is a portmanteau of *protein* and *genome;* roughly speaking, if genomics is focused on the genetic mapping of disease, proteomics identifies the proteins that can be targeted with drugs to actually fight disease. Chemical proteomics—also known as chemoproteomics—is the field in which chemical tools are combined with proteomics to help develop those drugs.

Among the leaders in this research is the Novartis-Berkeley Center for Proteomics and Chemistry Technologies (NB-CPACT), a joint venture linking Novartis, a large pharmaceutical company, and the world's leading public research university.

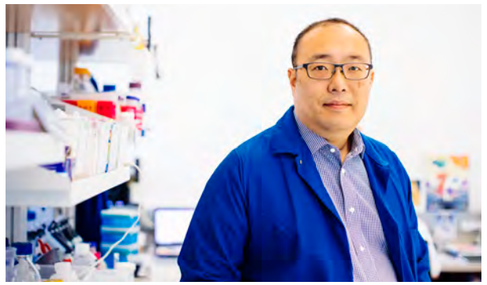
Launched in October 2017, the center is developing new technologies to further the discovery of next-generation therapeutics for cancer and other diseases.

"This collaboration has been a catalyst for our work on drug-discovery technologies," says **Dan Nomura**, director of the center and a professor in the Departments of Nutritional Sciences and Toxicology (NST), Chemistry, and Molecular and Cell Biology. "It's an opportunity to combine the brainpower, innovation, and infrastructure of a large pharmaceutical company with the creativity of academia to tackle blue-sky ideas."

THE UNDRUGGABLES

The proteome includes more than 20,000 human proteins. Roughly 90 percent appear to be molecularly inscrutable—or, in pharma terms, "undruggable." Why?

"We believe that we can move the needle in the treatment of human disease." — Dan Nomura



"The Berkeley-Novartis collaboration has opened up doors for my research."
— Jessica Spradlin

Because they seem to lack a "pocket" in which to insert a drug. In proteins that do have such a pocket, it could be a deep groove or a mere indentation—a physiological nuance. Imagine a tiny baseball glove waiting to catch a small-molecule drug that can disrupt the function of the protein. However, as Nomura notes, "many proteins are not enzymes or receptors that have nicely crafted pockets that are meant to bind to chemicals or metabolites." In other words, their natural function doesn't require them to have a pocket. Or maybe their protein "body type" bonds with another kind of interface altogether, one with a completely flat surface.

Using a chemoproteomic technology called activity-based protein profiling (ABPP), Nomura's lab has started tackling the problem of undruggable proteins by locating new protein pockets, or "hotspots" that can be targets for disease therapy. One of these discoveries involved the use of an anticancer natural product called withaferin-A, which comes from the winter cherry tree (*Withania somnifera*) and has long been known to help in the treatment of arthritis and gout. In 2017, Nomura's lab was able to use withaferin-A to target and activate a heretofore undruggable protein: a tumor-suppressing enzyme called protein phosphatase 2A, which impairs breast cancer.

And the team is confident it can do more. "It's a big challenge," says Nomura. "But we believe that we can help move the needle in the treatment of human disease by finding new ways to drug the 'undruggable.'"

THE COLTRANE OF CHEMISTRY

Nomura grew up in a small town at the foot of the San Gabriel Mountains, in Southern California. He set out to become a jazz musician, awed by the complexity of the music of John Coltrane, and thought he could pursue science "on the side." He was offered a scholarship to study saxophone at the Eastman School of Music but at the last moment veered away and came to Berkeley to begin a career as a chemical biologist. As an undergraduate, Nomura majored in molecular and cell biology and worked in the lab of the preeminent toxicologist and NST professor **John Casida** (1929–2018). He stayed on in the Casida lab as a graduate student, earning a PhD in molecular toxicology in 2008.

Next, Nomura began three years of postdoctoral work at Scripps Research in a lab run by Ben Cravatt, who invented ABPP. It was there that Nomura began to study chemical biology, cancer, and neurodegenerative diseases and to search for drugs that would slow or halt those potentially life-threatening conditions. One of his breakthroughs during this period, widely recognized in the neuroscience world, was finding a way to use inhibitors to block the activity of a particular enzyme in order to decrease brain inflammation and prevent neurodegeneration.

BUILDING AN ANTICANCER ARSENAL

More recent iterations of ABPP have enabled Nomura to extend his research beyond enzymes and pathways to all proteins in a cell—work that is flourishing through the collaboration with Novartis. In June, one of the first papers to come out of NB-CPACT was published in *Nature Chemical Biology*. In the study, the team used ABPP to pinpoint how another natural compound, called nimbolide, which is derived from the neem tree (*Azadirachta indica*), could be used in cancer drug therapies.

The neem tree grows on the Indian subcontinent, as well as in China, Brazil, and West Africa. An evergreen in the mahogany family, it can grow to 65 feet tall and has a 200-year life span. Nowadays, neem oil is popularly known as an insect repellent. However, neem bark has been used to treat malaria and ulcers; the fruit has been used as a remedy for diabetes and leprosy; and the leaf has been used to help prevent cardiovascular disease and pancreatic cancer.

"People have been isolating natural products for centuries," says Nomura. "It has become an obsession of mine to learn how these chemicals work and how to harness the enormous power of chemoproteomics to help cure human diseases."

For Nomura's purposes, nimbolide is a tenacious chemical that can bind to a cellular protein called RNF114. RNF114 is an E3 ligase—a protein whose function is to tag other proteins for elimination by the "cellular trash can," naturally degrading proteins for which the cell no longer has a use. Nimbolide attaches to RNF114 and impairs its ability to degrade certain tumor suppressors, leading to an increase in the availability of anticancer proteins and the death of cancer cells.

For **Jessica Spradlin**, a fourth-year graduate student in Nomura's lab—and first author on the nimbolide study—the project began as a perfunctory effort to understand more about how nimbolide functions to kill cancer cells. But when Spradlin discovered that nimbolide targets an E3 ligase, the project took a unique turn.

She and Nomura—in collaboration with **Tom Maimone**'s lab in the Department of Chemistry and scientists from Novartis—hypothesized that they might be able to exploit nimbolide to recruit RNF114 to cancer-causing proteins to tag them for destruction. Known as targeted protein degradation, this approach of tagging specific proteins for destruction has taken off in pharmaceutical drug discovery over the past few years. According to Nomura, a major challenge is that there are very few recruiting molecules for E3 ligases that can be used to tag the proteins that cause cancer and other diseases. The team's discovery adds nimbolide to the arsenal.

"In our training as chemical biologists, we are taught to approach problems with an interdisciplinary mind-set, so it can be frustrating to have an idea that we can't follow up on due to the lack of necessary tools or experimental expertise," says Spradlin, reflecting on the opportunities that NB-CPACT has created for her and the other scientists involved. "This collaboration has opened up doors for my research." More than 35 researchers from across campus are currently involved in NB-CPACT, including faculty, postdocs, graduate students, and undergraduate assistants, notes Nomura.

Nomura is optimistic about future advances in the science, given the resources and knowledge-sharing avenues the collaboration has created for his team, and he's confident that scientists will eventually be able to access 100 percent of the proteins within a cell. "We have the capability of finding molecules that bind to pockets for nearly any protein of interest," he says. "The question is, how long will it take to find the individual molecules that would fit into individual pockets *across every single protein?* Right now, we're prioritizing those targets or pathways that we know are major drivers of human disease. This will be game-changing."

Molecular MIMICRY

Britt Glaunsinger uncovers how viruses interact with—and steal from—their hosts

By Nate Seltenrich
Photography by Elena Zhukova
Illustrations by Deb Sklut

A geodesic dome, a soccer ball, a herpes virus. What do they share? The shape of an icosahedron. Certain crystals and microscopic organisms do too. “It’s a structure repeated again and again throughout the natural world and the human-designed world,” says **Britt Glaunsinger**, a virologist in the Department of Plant and Microbial Biology. “There’s a beauty to it, and there’s a logic to it.”

It’s a structure also encountered on Glaunsinger’s office walls, on T-shirts worn at her lab’s retreats, and on a former student’s arm in the form of a simple black tattoo. “We know it’s a useful shape because it appears so often,” Glaunsinger says. “For viruses, it’s one of the most popular solutions that they’ve come up with to house their genome.”

Among the many viruses that use an icosahedral protein shell to enclose their genetic material are household names like rotavirus, human papillomavirus, and polio. But the primary object of Glaunsinger’s attention is a subset of herpes viruses known as gammaherpesviruses, and in particular one called Kaposi’s sarcoma–associated herpesvirus, a major cause of AIDS-associated cancers worldwide and especially in sub-Saharan Africa. What she and others in her lab learn about the virus could help reduce its reach—as well as that of viruses with similar approaches, like influenza and SARS.

Glaunsinger and her team study the creative tactics these viruses use to manipulate gene expression in host cells during infection. They seek to understand more about how viruses and their mammalian hosts interact, as well as about human-specific pathways to disease—in the hope of discovering something that can be used in the development of drug treatments or that would otherwise be beneficial to human health.

That mission will become more critical as climate change, deforestation, and urban development continue to force animals and the viruses they carry into greater contact with humans. Viruses that evolve within one animal species and then jump to a new animal or a human—as occurred with HIV and Ebola—can be especially dangerous, Glaunsinger says.

We can also study viruses to learn more about ourselves, she adds. In a nutshell, viruses steal what host cells have and make it work for them. So if you want to find the most important components of a particular cellular pathway, Glaunsinger says, you look for the components that viruses target. "Viruses find the crux of how a cell works. Follow those molecules, and you can learn a lot about how the host works, be it a plant or a bacteria or a human or some other animal."

DRAMA AT THE MICROSCOPIC SCALE

Viruses are not living organisms but minuscule bundles of genetic code often coated by a space-efficient icosahedral shell. They're so small that we can see them only through powerful electron microscopes, but they can wreak havoc on our bodies. When coming into contact with a host cell, which is orders of magnitude larger, a virus can use its genetic code to take over the cell and force it to produce more viruses.

Some viruses, like smallpox and certain strains of Ebola and influenza, can be so potent that they effectively put themselves out of business by killing their hosts. Others, like certain herpes viruses, are typically much less harmful but can still cause chronic pain or severe illness in individuals with weakened immune systems.

While her work is ultimately geared toward protecting us from them, Glaunsinger also expresses a certain admiration for viruses. "From the moment I started learning about them, I found viruses to be the most fascinating biological entities out there," she says.

This moment she speaks of was not an abstraction, any more than the viruses themselves are, no matter how tiny and mysterious. It came in 1994, via the best-selling nonfiction thriller *The Hot Zone*. The book tells the story of viral hemorrhagic fevers like Ebola, including their origins and past outbreaks.

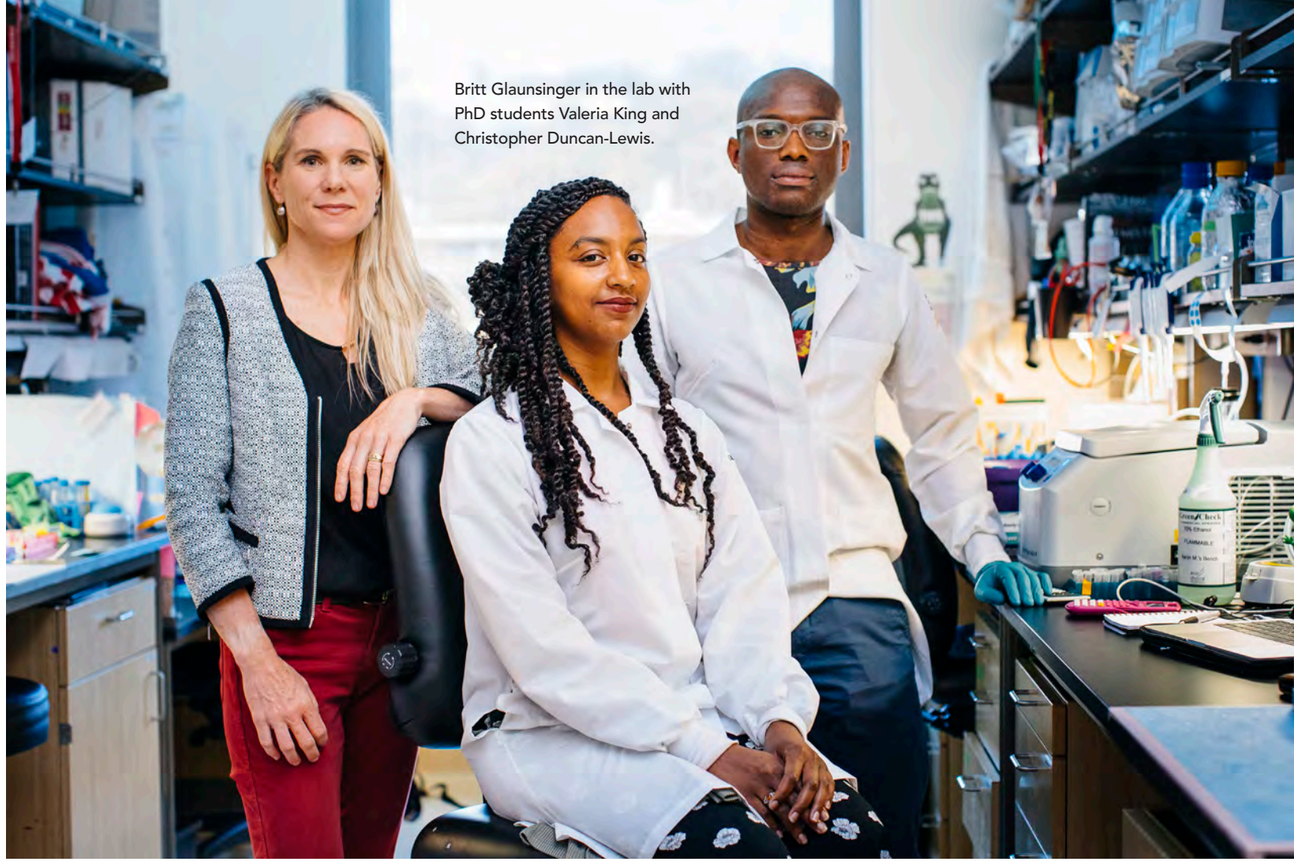
An undergraduate at the University of Arizona at the time, Glaunsinger was intrigued by the book's tales of scientists risking their lives to study viruses in the hope of reducing their human toll. But that wasn't all that captured her, Glaunsinger says. "What I found more interesting is what viruses can do with an incredibly small amount of genetic information." After reading the book, she went on to enroll in a virology class and later majored in molecular and cell biology.

Over the course of her studies, she also learned that, as captivating as they are, viruses are just half the story. The other partner in the intimate dance of exposure and infection is the host cell. Today, research in Glaunsinger's lab is aimed squarely at this interaction, investigating how cells detect and then attempt to stop an infection, as well as how viruses respond in kind. Other work is targeted at understanding how the Kaposi's sarcoma herpesvirus uses what Glaunsinger calls "molecular mimicry" to slip past host cells' built-in defense systems.

It's complex stuff, but Glaunsinger has a gift for making virus-host interactions sound less like an encyclopedia entry and more like a stage play. When discussing her work and the habits of viruses, she jumps back and forth between our world and theirs, or slips in and out of the perspective of a cell, explaining with passion and enthusiasm all the drama at the microscopic scale.

Granted, at first glance there may not be much there. While humans have more than 20,000 genes, some viruses have fewer than 10. But by pilfering from our DNA, they can be powerful and persistent.

While humans have more than 20,000 genes, some viruses have fewer than 10. But by pilfering from our DNA, they can be powerful and persistent.



Britt Glaunsinger in the lab with PhD students Valeria King and Christopher Duncan-Lewis.

Herpes viruses, for example, which have been around for 200 million years, are endemic in the human population worldwide: everybody is infected with at least one herpes strain, even if, to the virus's advantage, most of us don't get too sick.

"What makes the virus so successful, and how has it been able to strike that balance where it can invade an entire population and yet not burn itself out?" Glaunsinger says. "That's something we want to know more about."

BOLD SCIENCE

When Glaunsinger speaks of viruses as "thieves" and "masters of genetic economy" and boasts of their "ingenuity," it's easy to be pulled into the world of her research. Much of her lab's exploration could be called basic or fundamental science, geared toward gaining greater insight into exactly how viruses behave and cells respond. But it's all done with an eye to the possibility of informing a breakthrough in medical science: a molecule that could be targeted by an antiviral drug, or an insight that could help someone design a vaccine or a diagnostic test.

"That's always the possibility and the hope, but it could be something that's far removed from the virus you are studying," she says. "It's extremely difficult to predict which of your findings are going to lead to therapies, even if you go looking in a very directed way."

The key, she says, is being able to persevere in the face of what can feel like constant failure. "The answers are not always obvious. You're searching, and you're failing, and then you're searching and you're failing again."

Don Ganem, Glaunsinger's postdoctoral adviser at UC San Francisco, remembers her as not only talented but also bold. "Together we dreamed up what we thought was a pretty risky project to try to identify genes in the Kaposi's sarcoma–associated herpesvirus that might be responsible for shutting off host gene expression," he says. As is often the case, they didn't know how the project would pan out, Ganem notes. "Not all postdocs want to take on a high level of risk in their research, but that instantly resonated with Britt. She was all for it, because she's a person who likes to ask big questions."

And as it turned out, the research was fruitful. She found what she was looking for, both in the study and in her career trajectory. "I still remember seeing the early results of that study," she says. "It's led us down a lot of really interesting paths and resulted in years of discoveries in many areas of science related to this virus and to RNA biology in general."

TEACHING THE HOT ZONE

If Glaunsinger were solely a scientist, she'd be a successful one. In 2015, she was one of just 26 biomedical researchers nationwide to be named a Howard Hughes Medical Institute Investigator. The appointment is designed to encourage creativity in research, in particular ideas whose risky nature makes them difficult to support through traditional means—in other words, the sort of work that has become Glaunsinger's hallmark.

But along the path she took from reading *The Hot Zone* to leading a lab, she also honed her skills as a teacher and mentor. One of her most popular courses is an annual graduate seminar called Making Yourself Clear: How to Give an Engaging Science Talk, which helps students practice relaying their science to a wider audience. In 2018, she was one of five faculty members across campus to be recognized for outstanding mentorship of graduate students. A student nomination letter noted that "she encourages curiosity and exploration while ensuring that we don't lose sight of the ultimate goal."

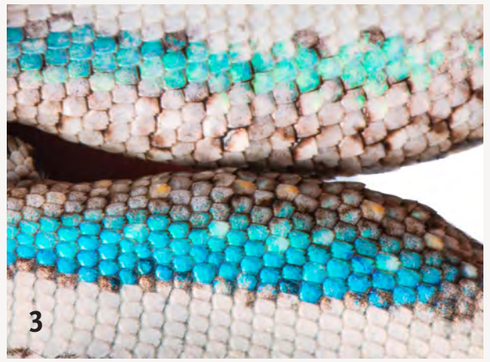
Marta Gaglia, who worked in Glaunsinger's lab as a postdoctoral fellow from 2009 to 2013, now runs her own lab as an assistant professor in the Department of Molecular Biology and Microbiology at Tufts University. "She really thought about each of us as a whole person. She met with us to discuss not just where our research project was but where we wanted to go in general," Gaglia says. "I now follow that mentorship model in my lab."

Another former student, **Renuka Kumar,** PhD '12 Microbiology, says it's no accident that her time as a graduate student researcher in Glaunsinger's lab led to two postdoctoral fellowships and ultimately her current position as a virologist at Chan Zuckerberg Biohub in San Francisco. "What struck me about Britt was her pure excitement for molecular interaction. It was contagious," says Kumar. "I knew I wanted to focus on virus-host interactions after falling in love with them in her lab."

Love may not be too strong a word. Glaunsinger's work teaches us that viruses are something to fear, certainly, but also something to behold with wonder, to learn from, and even to thank. They are, in the end, a part of us.

The graphic behind Britt Glaunsinger on page 14 is derived from a screen print by **Deb Sklut,** BA '10 Art Practice, whose husband, **Sergio Covarrubias,** earned his PhD in infectious diseases and immunity in 2012 after studying in the Glaunsinger lab. Sklut was inspired to create this artwork—which depicts herpes virions and cells overlayed with entries from Covarrubias's research notebook—to represent the beauty of the microscopic biological world.

Highlights from the 2019 CNR PHOTO CONTEST



1 *Using Drones to Estimate Vegetation Health* by Chippie Kislik
2 *Learning about Flowers for Earth Day* by Tuesday Simmons
3 *Sceloporus cowlesi* by Erin Westeen
4 *Logging Sports* by Stanley Shaw
5 *Field Research in the Sierra Nevada* by Joan Dudney
6 *Studying Elk Migration Impacts in Yellowstone National Park* by Avery Shawler

View more photo contest submissions at **nature.berkeley.edu/2019-contest.**
For more photos of CNR in action, follow us on Instagram: **@natureatcal.**

PHOTO: Courtesy of Steven B. Lee

PHD '90 MOLECULAR AND PHYSIOLOGICAL PLANT BIOLOGY

STEVEN LEE

After nearly three decades at the forefront of forensics, **Steven B. Lee** can speak with authority about what real CSI looks like. Hint: it's nothing like the depictions on television. "The shows make it look like evidence is always there and always found," he says, "and as if their methods are so sensitive that they are always able to provide meaningful results in 30 minutes or less!"

By Kristin Baird Rattini

Lee's work on forensic techniques and technologies has helped bring clarity and efficiency to a complex field that has made quantum leaps over the course of his career. He both advanced the automation of DNA extraction, amplification, and next-generation sequencing and championed those emerging technologies, which have since become industry standard worldwide.

Throughout his forays in industry, Lee has always kept one foot firmly and enthusiastically planted in academia. He credits his formative years studying molecular mycology as a graduate student in Professor **John Taylor**'s lab as the foundation for how he now mentors his own students at San José State University and Florida International University (FIU).

The purpose behind the science

Soon after coming to Berkeley, Lee made a significant mistake: he accidentally threw away mitochondrial DNA that it had taken him weeks to isolate. Taylor's reassuring response surprised him. "He made it a learning moment," Lee says. "He told me, 'Don't be hard on yourself; it's likely you'll never make that mistake again.'" And he was right. Lee notes that the experience influenced his approach with his own students: he runs his lab as an open place where they are free to make mistakes and learn from them. "And, of course, some mistakes can lead to great, unexpected discoveries," he adds.

Lee joined Taylor's team right as it was beginning to use the newly invented polymerase chain reaction (PCR) to enable the identification and phylogeny of fungi and advance the study of the molecular evolution of fungi. (The team's 1990 paper on its work is one of the most frequently cited scientific publications to come out of UC Berkeley.) Previously, isolating and sequencing genes had taken weeks or months and required growing gallons of the organism being studied. PCR took less than half a day and required just a speck of material. "To this day, it's a significant method used in molecular biology laboratories," Lee says. "In the world of forensic DNA, you can use it to process tiny stains that have been exposed to extreme heat or chemical abuse, or stored for decades underneath floorboards or in car trunks—even after attempts to clean up—and still get a meaningful result."

Lee pivoted from molecular mycology to forensics when he joined the California Department of Justice Laboratory as the assistant laboratory director for research and development in 1994. A key moment came in 1996, when his expert testimony about DNA analysis enabled prosecutors to use DNA evidence in a double-murder case to obtain a guilty verdict. "Meeting the parents of the victims and witnessing how our work helped bring about a resolution connected me to this field and illuminated the purpose behind the science," he says.

Developing the next generation

At the Justice Department lab and in his subsequent roles as director of research and development at MiraiBio Inc. and senior technical manager at Illumina Inc., Lee developed robotic processes, new technology, and software programs that automated and accelerated the extraction, analysis, and next-generation sequencing of forensic DNA markers.

"Automation allows DNA scientists to skip the tedious steps and spend more time on analysis."

He likens the effect of these advances to that of automated espresso machines: "You could get your coffee beans out, roast them, grind them, put them into your coffee maker, and then add the water and make your milk separately and do everything manually, or you can push a button and end up with a beautiful latte. Automation allows DNA scientists to skip the tedious steps and spend more time on analysis."

Lee's advocacy of next-gen sequencing at international symposia helped move the industry toward a new standard. And his openness to new opportunities—be it quality assurance for the Armed Forces DNA Identification Laboratory or fecal-source tracking in water systems—helps keep him at the cutting edge of his field. "I tell my students that you always have to be on your toes learning new things," he says.

His most recent appointment, as a professor at FIU's International Forensic Research Institute, is as much about developing the next generation of forensic scientists as it is about developing rapid, efficient DNA technologies. In addition to working with the institute's professors, graduate students, and postdocs, he's creating educational programs in forensic science through international conferences, seminars, and CSI camps for kids.

"These programs can really spark an interest in young students," Lee says. "Some of them may end up at universities and in careers in forensic science. But even if we only dispel the myths, so that the next time they watch *CSI* they say, 'You can't do that,' then we've done a service, because they're able to educate the people around them."

Steven Lee has advanced new methods for DNA extraction, amplification, and sequencing that are used in crime scene investigation.

Q&A

An Economic Lens on World Health

By Kirsten Mickelwait

Three faculty from the Department of Agricultural and Resource Economics discuss their research on global health issues.

Public Transit and Air Quality

Associate Professor ***Marco Gonzalez-Navarro*** *studies economic growth in developing countries with an emphasis on urban issues, including transportation, land use, and retail globalization. His study "Subways and Urban Air Pollution" is under revision for publication in the* American Economic Journal: Applied Economics.

What's the problem you wanted to identify or solve with this study?

We sought to answer this question: Do subways lead to improved air quality in urban areas? Many feel it's obvious that rail transportation will lead to improved air quality because public transit will result in fewer cars on the road. However, previous research has not found conclusive evidence to support this. If public transportation gets some people to stop using their cars, traffic on the road may lessen, but that could also encourage non–transit users to drive more, potentially undoing the effect of those who left their cars at home.

On the other hand, subways can efficiently move many people in and out of downtown areas at peak hours, which are when vehicular congestion is at its worst. So it is plausible that subways could have a meaningful impact on air quality.

In our study, we found that by moving a small share of overall trips off the roads at those times and places, subways can make a meaningful dent in pollution.

What area did you focus on, and what methods did you use?

We took a global perspective, studying subway system openings all over the world wherever they occurred between 2000 and 2014; over this time period, the majority of subway openings were in China and Europe. We also used satellite data that measured a proxy for PM2.5—an EPA-regulated pollutant that's responsible for millions of premature deaths worldwide.

Using these data, we found that air quality in these areas improved by about 4 percent in terms of reduced pollutants. The effect was larger near the city centers, and that persisted over the longest time horizon that we could measure with our data, which was about eight years. We estimated that a new subway system provides an external benefit of about $594 million per year by reducing deaths. Overall, our results suggest that the value of subway-induced improvements to air quality represents a substantial fraction of construction costs.

What's the potential application of these findings?

Rail transportation systems are expensive to build and operate, typically requiring significant governmental subsidies to be viable. Fare revenue is usually insufficient to cover operating costs. Because this mode of transport requires subsidies, our study asks whether subways provide any benefits for citizens who don't utilize them, which could justify such subsidies. One of these benefits is improved air quality, which has been shown to have important human-health

A recent study by Marco Gonzalez-Navarro examines the potential health benefits—like improved air quality—related to the implementation of new subway systems.

PHOTOS: Portraits by Jim Block

impacts, including reduced mortality. If a subway system leads to improved air quality for everyone living in a city, it could provide a rationale for that system to be financed by general taxation.

Insurance and Emergency Room Visits

Associate Professor ***Michael L. Anderson*** *focuses on topics such as transportation, education, population health, and health insurance. His research on the relationship between health insurance coverage and emergency room visits as well as other uses of medical services has been published in the* American Economic Journal: Economic Policy *and the* Review of Economics and Statistics.

What were you investigating with these studies?
Our goal with these studies was to measure the effect of health insurance on emergency room visits and hospitalizations. Under federal law, an ER must stabilize any patient who arrives there, regardless of their ability to pay. ERs are thus viewed as health care providers of last resort, and proponents of universal health insurance coverage have often argued that the costs of insurance coverage can be partially offset through a reduction in ER visits by the uninsured.

What did you find?
To estimate the effects of insurance coverage on the utilization of emergency room and hospital inpatient services, we looked at a sharp change in insurance coverage rates that resulted from young adults "aging out" of their parents' insurance plans. Prior to the Affordable Care Act (ACA), young adults who were not in college aged out of their parents' insurance at 19.

Using ER and hospital discharge records on millions of episodes of care across seven states—Arizona, California, Iowa, New Jersey, New York, Texas, and Wisconsin—we found that aging out resulted in an abrupt 5 to 8 percentage point reduction in the probability of having health insurance. We found accompanying drops in ER and hospital visits that implied that not having insurance led to a 40 percent reduction in ER visits and a 61 percent reduction in inpatient hospital admissions. That is, contrary to conventional assumptions, the loss of insurance caused ER visits to decrease. The drops in ER visits and inpatient admissions were concentrated in privately owned hospitals, with particularly large reductions at for-profit hospitals. ER visits to public hospitals, which typically have mandates to treat all patients regardless of insurance status or ability to pay, did not decrease.

What has been the broader impact of this research?
Under the ACA, employers and insurers are now required to cover enrollees' children through age 26—at least for now. Nevertheless, our study results remain topical: the idea that insurance can cut costs by reducing ER visits persists as a common talking point. We should be honest about the costs and benefits of expanded health insurance coverage. The notion that people respond to health insurance coverage by reducing ER utilization simply isn't supported by our results.

Michael Anderson's research includes studies on the relationship between health insurance coverage and emergency room visits.

Aprajit Mahajan is working to lower rates of anemia in India through a study on behavior modification.

Reducing Anemia in India

Associate Professor ***Aprajit Mahajan****'s studies have covered a broad swath of subjects, including credit markets, health, and productivity in India and Mexico.*

In this study, what's the question you're asking or the problem you want to solve?
Micronutrient deficiency and anemia are long-standing problems in India. Past attempts to address them have been made with tablets and food supplements, but the results have been mixed. We collaborated with the state government of Tamil Nadu to provide fortified rice to populations that have had high rates of anemia.

One prominent hypothesis for the failure of previous interventions, particularly at scale, is that they required substantial behavior modification: people had to remember to take a pill or to sprinkle a supplement over their food. There may also be financial or other barriers if they have to buy the pills and supplements.

How are you addressing that problem?
We wondered if we could design a solution that involved minimal behavioral change. Tamil Nadu has a well-functioning public food distribution program (PDS): 20 kilos of free rice are provided to all families monthly, or 35 kilos for poor households. Uptake rates are very high as well, so this seemed like a good place for our study. We're asking, can we fortify rice with iron, B_{12}, and other micronutrients and provide it through the existing PDS? Using this method of provision, households don't have to change their behaviors—they'll obtain and cook rice from the PDS just as they did in the past.

What are your next steps?
Our research team—from UC Berkeley, Stanford, Emory University, Universitat Pompeu Fabra in Spain, and J-PAL South Asia in India—has been designing the study since 2014, and the intervention will occur from November 2019 to November 2020. We'll implement a randomized controlled trial, providing fortified rice to 110 shops distributing PDS food. We'll follow the intervention for a year and evaluate the effects it has on the most vulnerable populations (women and children from six months to five years old).

If successful, this should provide a model for how to reduce anemia and micronutrient deficiencies through the PDS not just in Tamil Nadu but more generally in other rice-consuming states in India. We think it should work, but there are conditions under which it might not. For example, it may be that even though people consume the fortified rice, they can't absorb the nutrients owing to conditions like chronic gut inflammation. Our thinking is that if we can't move the needle on anemia in this way, we really need to rethink how it could be done.

PHOTO: Courtesy of Dawn Wyllie

ADVOCATING & EDUCATING FOR PUBLIC HEALTH

BS '78 CONSERVATION OF NATURAL RESOURCES

DAWN WYLLIE

A life-threatening bout with pneumonia couldn't quell **Dawn Wyllie**'s childhood curiosity. The six-year-old peppered her pediatrician with questions about the bug in her lungs. He patiently answered and even let her view the infection under a microscope. She was captivated. Hospitalized again for an injury a year later, she hailed someone she thought was a nurse to ease a discomfort. "Just so you know, I'm a doctor, not a nurse," the woman gently corrected her. "It was an 'aha' moment," Wyllie recalls. "For the first time, I realized women could be doctors."

By Ann Brody Guy

Wyllie went on to earn her MD and MPH and served for 27 years in the U.S. Public Health Service—what she calls "a small but mighty force" charged with protecting and improving America's health. Working first as a family physician and then as a policy leader, she rose to the rank of rear admiral and served as an assistant U.S. surgeon general until her retirement in 2016.

Wyllie attributes her curious nature in part to an upbringing rich in diversity, starting with her early childhood in San Francisco's Mission and Bernal Heights neighborhoods. When she was a teen, her family moved to the still orchard-covered South Bay. She was immersed in rural life during summers with her grandparents in and around Crescent City, where cycles of logging, farming, canning, and animal care ruled daily life.

That's where she formed close family connections with Native people—Wyllie is a descendant of the Sisseton Wahpeton Oyate of the Lake Traverse Reservation, in South Dakota. That heritage and those cultural ties became a central component of her work; she served in the Indian Health Service, a division within the U.S. Department of Health and Human Services that provides health care and advocacy assistance to Native people, for most of her career.

The threads of Wyllie's life experiences first coalesced at the College of Natural Resources. Her academic adviser, **Angela Little** (MS '55 Nutrition Science; PhD '69 Agricultural Chemistry), then a nutrition science professor, pointed her toward conservation of natural resources, a flexible major—now called conservation and resource studies—that allowed her to choose areas of emphasis. "I could focus on public health and environmental health," she says, "and also add classes in resource conservation and forestry that I found interesting"—all while completing her pre-med courses.

Culturally appropriate care

During her clinical years, Wyllie cared for patients from many different tribes. "Each tribe has a unique history and set of traditions and approaches to wellness," she says. In her work, she drew upon her background in environmental health and her experiences with rural and tribal cultures—while also taking contextual factors like socioeconomic status, education, and living conditions into account.

In Wyllie's many years of policy work, she engaged with issues as diverse as health disparities, vaping, and emergency response. The opioid epidemic represented one of her greatest challenges but also a proud accomplishment: she was a key author and adviser on the 2014 Indian Health Service manual's chapter on chronic non-cancer pain management, which presented a "culturally appropriate, integrative approach," according to Wyllie, and was one of the first such clinical guidelines from any federal agency.

In Minnesota, where she spent 17 years as the chief medical officer for the five-state Great Lakes region, Wyllie served on the governor's medical cannabis task force, helping to define when scientific evidence supported cannabis use while identifying unwanted consequences such as increased accident rates. As with most public health issues, she says, "there are lots of layers, lots of complexity." Board certifications in family medicine and addiction medicine helped her navigate these and other complicated topics in her work related to suicide prevention, addiction, and adolescent health. And her uniform helped her connect with veterans while assessing the service-related environmental exposures that can affect health.

As a doctor, Wyllie drew upon her background in environmental health and her experiences with rural and tribal cultures.

Everything is integrated

"CNR helped teach me that everything is connected," Wyllie says. That jelled with what she knew from a cultural perspective. "In Native communities, the concept of the Medicine Wheel teaches that everything's related—nature, people, experience—so you have to look at the broader picture." Integration means avoiding patient labels like "noncompliant." "That word takes a pejorative view," she says. "I ask, 'Why is a patient struggling with guidelines for care?' That's a different question that gets to the underlying challenges anyone faces in being compliant with anything—whether it's transportation to the clinic visit, taking medications, cooking a meal that helps control their diabetes. It's all connected."

Wyllie remembers talking about these bigger issues at CNR. "Discussions with Angela nurtured my ability to think outside the box," she says, a skill she's used throughout her career, especially working in under-resourced agencies and communities. "Obstacles are just challenges to creativity."

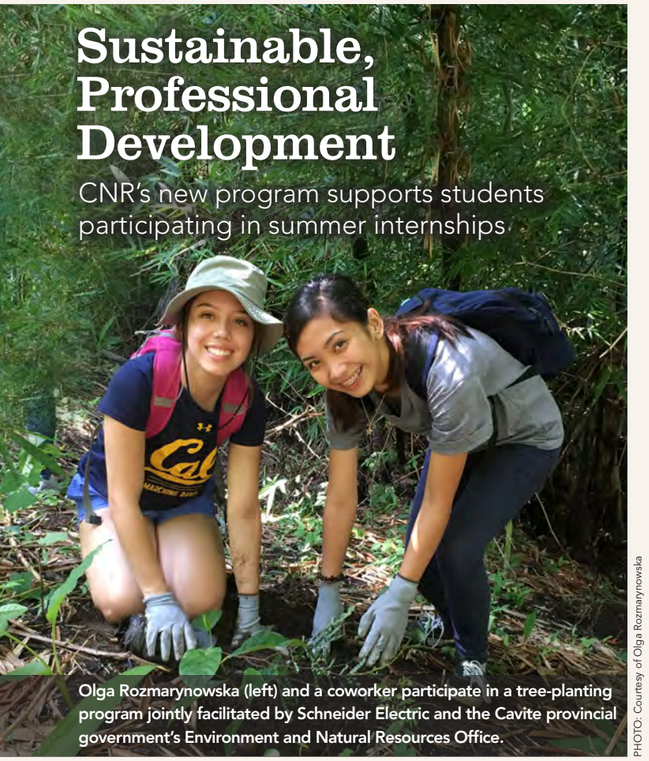
As a retiree, Wyllie continues to serve, volunteering with organizations such as the American Medical Women's Association, where she was recently named a fellow. She gives lectures and leads workshops, mentors students and junior officers, and continues to educate and advocate for Native people and veterans. Looking back, she can't imagine a better career path. "Ultimately, it was a way to do the work my spirit was calling me to do," she says.

Dawn Wyllie served families from many different tribes as a physician in the U.S. Public Health Service.

PHOTO: Monte Draper

Sustainable, Professional Development

CNR's new program supports students participating in summer internships



Olga Rozmarynowska (left) and a coworker participate in a tree-planting program jointly facilitated by Schneider Electric and the Cavite provincial government's Environment and Natural Resources Office.

PHOTO: Courtesy of Olga Rozmarynowska

For **Olga Rozmarynowska,** Cal's blue and gold makes for the perfect shade of green. The fourth-year transfer student is majoring in both society and environment and classical civilizations, alongside a minor in sustainability. She's the editor in chief of *Leaflet,* Berkeley's undergraduate environmental publication. She's working to create a partnership between the Green Life, an environmental education program for inmates at San Quentin State Prison, and Berkeley's Student Environmental Resource Center. And she's even helping to reduce the carbon footprint of the Cal Marching Band, in which she plays the mellophone.

Although she's surrounded by other environmentalists on campus, when Rozmarynowska goes to Sacramento to visit her parents—who are immigrants in a lower income bracket—she's reminded that sustainability isn't easily achievable for everyone. So she set her sights on finding a summer internship that would help her "gain more exposure to the ways those living outside the bubble of California can live sustainably."

She was excited to be offered an internship in the Environment and Natural Resources Office of the Cavite provincial government in the Philippines, where her mother was raised.

But pursuing an unpaid internship was out of reach for Rozmarynowska, given her family's finances. Such cases are the inspiration for the College of Natural Resources' Summer Internship Grants, a program that was piloted this year and is supported by CNR's Annual Fund. Thirteen students received awards ranging from $350 to $3,000, with the amount depending on the student's need, proposed budget, and statement of how their work would promote social equity and inclusion.

From June through mid-August, Rozmarynowska worked with the Cavite office's Integrated Coastal Management division to begin locally enacting the UN's Sustainable Development Goal 6, which focuses on ensuring access to sanitation services and integrated water resource management for all. She examined assessment reports to explore the links between climate change and water supply, public health, marine ecosystems, agricultural productivity, and food security within the province. And she helped create educational materials for a joint summit on water and solid waste held in Cavite this fall.

Introducing CNR students to such meaningful work is the motivation behind the Summer Internship Grants, which enable them to apply their Berkeley educations to real-world settings. "This is a big first step toward pursuing my career goals in climate change mitigation and adaptation in developing communities," Rozmarynowska says. "I'm gaining skills and experience that will play a vital role when I embark on my graduate studies and will build on my passion to aid the less fortunate."

— KIRSTEN MICKELWAIT

Making a Difference Through CNR's Internship Grants

Michael Spencer helped Aravind Eye Care Systems reduce waste and shrink the carbon footprint of its hospital in Pondicherry, India.

Savannah Autran worked with Planting Justice in East Oakland to research food and environmental justice and equity.

Martin Banuelos learned about aquaponics systems and the packaging, marketing, and distribution of locally sourced produce at Waiea Aquaponics in Hawaii.

Jessica Aguilar assisted a neurosurgeon at the Forensic Medical Center in Mexico City.

Make a gift to support this program at give.berkeley.edu/CNR.

Powering Artisan Textiles | Photo by Matthew Mayes

Indonesian batik—an ancient resist-dyeing technique in which wax is applied to textiles before they're dyed to create patterns—is an important source of income for the archipelago's artisan communities. **Matthew Mayes,** '19 Master of Development Practice, spent the summer of 2018 as a USAID Global Development Fellow in Bali and Java. Partnering with an artisanal batik-production community, Mayes analyzed the feasibility of a proposed project to integrate biogas and bio-slurry into the community's manufacturing processes. The assessment found that by using biogas instead of propane to heat the wax needed to create their fabrics, artists could transition to an environmentally friendly heat source. The bio-slurry by-product could be recycled and used by Javanese farmers to fertilize the indigo crops that provide the vivid blue tint used in batik.

See more photos from the CNR photo contest on page 19.