Elements 2019

# IMPACT FACTORS

COLLEGE OF NATURAL SCIENCES
COLORADO STATE UNIVERSITY

DISCOVERY BEGINS HERE


## Women Leading the Way in Computer Science

Above: from top left (standing), undergraduate Cassidy Skorczewski, Professor Indrakshi Ray (read more on Page 9), Ph.D. candidate Hajar Homayouni, and from front left (seated), Ph.D. candidate Swetha Varadarajan, Cochran Family Professor and Associate Professor Sangmi Pallickara, Assistant Professor Laura Moreno Cubillos, and undergraduate Susanna Kyler are just some of the many women in CSU's computer science department who are leading the field forward. This year, the department was recognized for its strides in improving computer science education for all by being selected as one of just 15 departments nationwide to join the prestigious BRAID Initiative (read more on Page 19).

# Welcome to Elements

We bring you the latest issue of *Elements,* the magazine that highlights the people, research, and discoveries of the College of Natural Sciences at Colorado State University. This year, we explore the wide-ranging impacts the college and its faculty, staff, students, and alumni are having here on campus – and across the globe. We would love to hear about the impact the college has had on your life: send us an email or give us a call: **cnsdean@colostate.edu** or **(970) 491-1300.**


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COLLEGE OF NATURAL SCIENCES

# From the Dean

**HERE IN THE COLLEGE OF NATURAL SCIENCES**, we live and breathe science. We are often so in the thick of it though that we forget to pause and marvel at its elegance, its power, and the truly incredible things that it – and the people who practice it – make possible.

This year, I am excited to share with you a small handful of the very big impacts work from the college is having (read more starting on Page 8). From contributing cybersecurity research for the U.S. Air Force to developing new materials to fight antibiotic resistance to collaborating with teachers in Uganda to deploying paper-based chemical sensors across the globe, the college is turning discovery into real-world impacts every day.

As dean, I have the incredible pleasure of witnessing so many of these achievements firsthand and learning about so many more as I talk with students, faculty, and you, our alumni and friends. I am always amazed by the stories I hear about your time with the College of Natural Sciences – and the impressive influences each of you are having on the world. Denise Rutherford (Ph.D., chemistry, ’89) has spent years serving 3M and women and minorities in STEM across continents (read more on Page 4). Dr. Bruce Given (B.S., physical science, ’76) has applied his degree to further important developments in pharmaceutical treatments (read more on Page 6). And Bonnie Ross (B.A., technical communication) is supporting women in STEM in our college with her new undergraduate scholarship (read more on Page 7).

At the college, we work hard to provide an environment that empowers all of our students and faculty to succeed. More than 12 years ago, we started the group Women In Natural Sciences, which supports female faculty members across our college (read more on Page 13). As reflected in this issue's cover, our computer

Bruce Given (B.S., physical science, '76), Dean Nerger, and Karla Given

WINS members from the Department of Computer Science: Cochran Family Professor and Associate Professor Sangmi Pallickara, Professor Indrakshi Ray, and Assistant Professor Laura Moreno Cubillos

science department has prioritized inclusion of more women and other underrepresented groups. We are excited to announce that thanks to those efforts, the college has joined 14 other universities in the BRAID (Building, Recruiting, And Inclusion for Diversity) initiative (read more on Page 19). This program means even more great strides lie ahead.

We are also especially proud of the accomplishments of our many first-generation students, those who will be the first in their families to obtain a four-year degree. Nearly one in four students in our college is first-gen, and you will meet a few of them in the pages of our magazine (including Jose Rivera, on Page 18, and Andrew Cordova, on Page 25). I hope you find as much inspiration in their stories as I do.

In these students' stories are also reminders of how much we can accomplish when we come together as a community. In fact, the biggest lesson I draw from our college's many achievements is that each one is born from collaboration. We have the biggest impact when we partner together.

Thank you for being a part of the College of Natural Sciences. I look forward to working together as we aspire to have even greater influences on the future of science and education.

**JAN NERGER, Ph.D.**
Dean of the College

# Faculty Updates – 2019

## NEW HIRES

**BIOCHEMISTRY AND MOLECULAR BIOLOGY**
Soham Chanda
Grant Schauer

**CHEMISTRY**
Jean Chung

**COMPUTER SCIENCE**
Nathaniel Blanchard

**MATHEMATICS**
Maria Gillespie
Emily King

**PHYSICS**
Samuel Brewer

**PSYCHOLOGY**
Emily Merz
Joshua Prasad

**STATISTICS**
Andee Kaplan
Ben Shaby

## TENURES AND PROMOTIONS

**BIOLOGY**
Lisa Angeloni
Taiowa Montgomery
Rachel Mueller
Daniel Sloan

**CHEMISTRY**
Garret Miyake
James Neilson
Melissa Reynolds

**COMPUTER SCIENCE**
Louis-Noël Pouchet

**MATHEMATICS**
Renzo Cavalieri

## IN MEMORIAM

**BIOCHEMISTRY AND MOLECULAR BIOLOGY**
Adeline Kano

**CHEMISTRY**
Ned Daugherty

**STATISTICS**
Paul Mielke

President McConnell and Dean Nerger

## NEW PRESIDENT FOR CSU

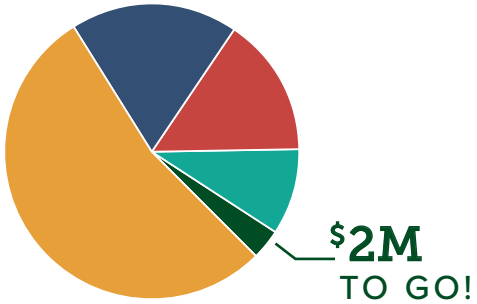
This year, Colorado State University welcomed its 15th president, Joyce McConnell. McConnell joined the University from West Virginia University, another flagship land-grant institution, where she most recently served as provost of the university. Prior to that position, she was dean of the College of Law, where she was also a faculty member. “Through higher education, we can transform lives and tackle the toughest world challenges through a can-do, innovative spirit,” she says.

## DISTINGUISHED ALUMNA 2019

Denise Rutherford (Ph.D., chemistry, ’89) was the first one in her family to obtain a four-year degree, which she quickly followed with two graduate degrees. At CSU, she cemented her passion for lifelong learning. She has applied this – and her doctorate in chemistry – throughout her career, rising through the ranks at 3M from senior research chemist to senior vice president for corporate affairs. She has held international leadership roles in Asia, Latin America, and Europe and has advocated for youth, minorities, and women in STEM. She and her husband, Maurice Kuypers recently established a CSU scholarship for first-generation chemistry students. This spring, they also celebrated the graduation of their son Ethan, who earned his CSU degree in business. Rutherford has been named this year’s College of Natural Sciences distinguished alumna.

# BEYOND A BILLION

To help Colorado State University reach Beyond a Billion, the College of Natural Sciences is raising $60 million by Summer 2020.



## COLLEGE PROFESSOR LAUREATES 2019

The college recognized the outstanding research, teaching, and service of professors Jennifer DeLuca and Mingzhong Wu by naming them the 2019 College of Natural Sciences Professor Laureates. DeLuca is a professor in the Department of Biochemistry and Molecular Biology, where she studies mitotic cell division (read more on Page 9). Wu is a professor in the Department of Physics and researches electron spin (read more on Page 21). Wu delivered his laureate lecture this spring, and DeLuca presented hers this fall.

## NEW DEVELOPMENT DIRECTOR

This summer, the college welcomed Jill Higham as the new director of development. Most recently, Higham was director of philanthropy for the American Civil Liberties Union of Colorado. She previously served as director of development for the CSU College of Agricultural Sciences and as associate director of development for the College of Engineering, so she is poised to step in and lead the college fundraising efforts. Higham, who holds a Juris Doctorate, is excited to join the team and looks forward to meeting more of you in person over the coming year. She succeeds Simone Clasen, who, after 18 years leading the college's development efforts, has joined CSU's central University Advancement team as associate vice president of philanthropic operations. As part of her new role, Clasen will continue to help guide the college fundraising efforts.

## CURRENT STATUS $58 MILLION – AND COUNTING!

**$32.2M** RESEARCH | **$11.1M** SCHOLARSHIPS

**$9.1M** COLLEGE PROGRAMS | **$ 5.6M** PROFESSORSHIPS

ALUMNUS SPOTLIGHT **BRUCE GIVEN**

# Tackling the Intractable

**DR. BRUCE GIVEN** (B.S., physical science, '76) has never shied away from formidable tasks. He is currently chief operating officer of Arrowhead Pharmaceuticals, which is developing targeted small RNA treatments for some of the toughest medical conditions, including cancer, infectious diseases, and cardiovascular disease. Before helping to take on these challenges, he served as an international president for Johnson and Johnson and as chairperson of the board for a multi-national medical services company.

But he didn't start out planning to go into the medical field. In fact, "I was pretty sure that I wasn't going to go to med school," he says with his characteristic good humor. "My parents really wanted me to go in that direction, so the deal was that I would take the necessary course work – but I was also going to educate myself more broadly. I viewed it as an education rather than trade preparation," he says of his time at CSU. So he augmented his physical science degree with a diverse range of classes – from philosophy to political science. "And it worked!" he says.

After graduating from CSU with Phi Beta Kappa honors, Given indeed went on to medical school, landing at the University of Chicago Pritzker School of Medicine. There, he says, "most of the other kids were Ivy League- and private school-educated. But I had no trouble standing toe-to-toe with them. CSU was a first-rate education." He graduated with honors and with publications in *Nature,* the *New England Journal of Medicine,* and the *Proceedings of the National Academy of Sciences* under his belt before completing his medical training at Brigham and Women's Hospital as a Harvard Medical School Clinical Fellow.

Today, he brings his impressive medical pedigree and solid natural sciences foundation to the many challenges in his current work. Arrowhead is addressing issues surrounding small RNA treatments. These therapies work by leveraging RNAs that do not make proteins (non-coding RNAs) to regulate the translation of other genetic material. These small RNAs were discovered only in the late 1990s, and work in the field was the subject of a 2006 Nobel Prize. But translating these minute molecules into targeted therapies that are useful in patients has been difficult – especially delivering them to the location in the body where they can be most effective. This often comes down to a question of chemistry. Organic chemistry, to be specific.

Forty-five years ago, though, when Given was sitting in his first organic chemistry class, he would not have guessed he would be so deeply immersed in the field. "I was surprised by how hard it was," he says of the course. But beyond the complex reactions and challenging recitations, the notorious College of Natural Sciences class "taught me I really did enjoy the science – and that maybe medicine was the way to go. It opened up new frontiers for me."

Given and his wife, Karla, who is trained as an industrial engineer and has two master's degrees and an adopted love for CSU, are now opening up new frontiers for the next generation of science students. They recently created the Dr. Bruce D. and Karla S. Given Scholarship, which supports outstanding undergraduate students in the College of Natural Sciences. They also support the Janice L. Nerger Scholarship as well as CSU programs Rams Against Hunger and Fostering Success, which provides resources to students coming from foster care or an unaccompanied background. For Given, a relationship with CSU was not predestined. In fact, Given grew up more than a thousand miles away in Michigan City, Indiana. A family trip to Colorado when he was in high school inspired him to attend college in the state. "It's been fun to reengage with the school and with the college," says Given, "and to take part and to try to be helpful." ●

DONOR SPOTLIGHT **BONNIE ROSS**

# A Seat at the Table – And the Console

**WHEN BONNIE ROSS** (B.A., technical communication) enrolled at CSU, her plan was to follow in her father's footsteps and become an engineer. After three years in that line of study, as one of few women in her classes, however, she had trouble seeing exactly where she would go after graduation.

"It's a common problem, especially with women in STEM fields: not being able to see what you can do with that education," Ross has said.

So Ross eventually switched out of her engineering major and created a course of study that was way ahead of its time, pairing the new technical communication major in the College of Liberal Arts with concentrations in computer science and physics in the College of Natural Sciences. And that combination served her well. After graduation, she parlayed a summer internship at IBM into a two-year position. And from there, she knew she would make her career in tech.

Ross is now a corporate vice president at Microsoft, the founder and head of 343 Industries, the studio that leads the blockbuster *Halo* sci-fi entertainment franchise that has generated nearly $6 billion in worldwide sales to date. Ross is a 20-year veteran of the video game industry, having worked on such titles as *NBA: Inside Drive, Zoo Tycoon, Counter-Strike,* and many others. In 2014, *Fortune Magazine* named her one of the 10 most powerful women in video games, and she was featured on the cover of a 2015 issue of *Bloomberg Businessweek*.

"After my talks, I have a ton of women and girls come up to me and say, 'I didn't know you could do this,'" Ross has noted. And she is now out there, showing them that they can.

But although her games might be, Ross can't be everywhere. And to improve the gaming industry – and, really, all STEM fields – they need a more diverse workforce.

"We have an issue that starts in high school and college," she has said. "You can't recruit them if they're not there. How do we make technology and engineering the fields that both men and women want to pursue?"

Ross recently made a big move to help fill that pipeline with more talented women, creating the Bonnie Ross Women in STEM Scholarship. The scholarship will benefit "students demonstrating interest in the promotion and participation of women and underrepresented students within the computer science or physics departments in the College of Natural Sciences or in any department in the Walter Scott, Jr. College of Engineering" at CSU. "I believe, in the next five to 10 years, it's not going to matter who you are," Ross has said. "If you don't have a technical background, you won't go far."

Ross is not only supporting women through educational scholarships and by being a powerful role model, but also by fighting against bullying on video game platforms and by ensuring there are more complex female characters in the games themselves.

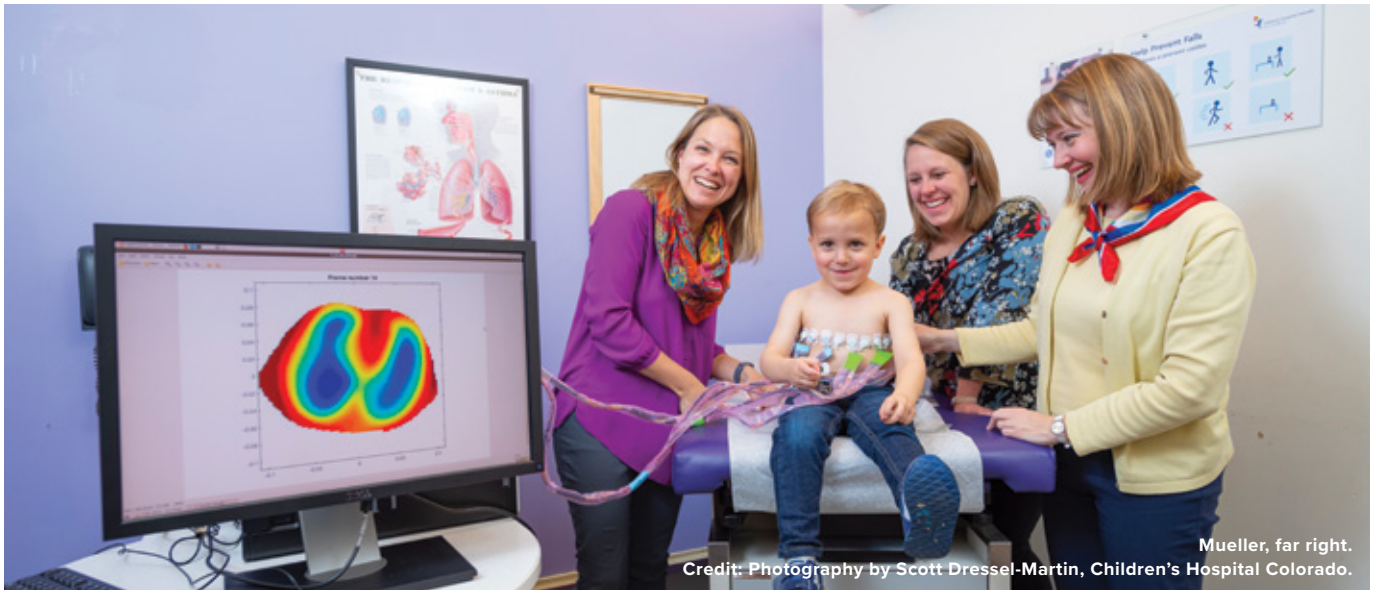
Earlier this year, Ross was inducted into the Academy of Interactive Arts and Sciences' Hall of Fame – only the second woman to receive the honor. "To blend art and science, that's my sweet spot," she has said. "I love how technology is bringing the arts to life. With gaming, I found my place." And with Ross's new scholarship, more people will be able to find theirs, too. •

FEATURE

# IMPACT FACTORS

**THE IMPACTS OF FOUNDATIONAL SCIENCE AND SCIENCE EDUCATION** are not always easy to spot. But they are everywhere. From creating medical technologies with mathematics to using psychology to help people make healthier choices to using new microscopes to view the very foundations of life, the natural sciences are a major force in our daily lives and in our future. At CSU, the College of Natural Sciences takes that work to the next level, conducting groundbreaking research while also advancing the education of our students and engagement with the community – and communities around the globe. Read on to learn how the college has turned discovery into impact.

## FIELDS OF IMPACT



Mueller, far right.
Credit: Photography by Scott Dressel-Martin, Children's Hospital Colorado.

### MEDICAL IMAGING WITH MATHEMATICS

A picture might be worth a thousand words. But when it comes to imaging technologies, thousands of numbers are what make up the picture. "All medical imaging techniques rely on solving a mathematical problem," says Jennifer Mueller, a professor in and associate chair of the Department of Mathematics, who also is a core faculty member in the School of Biomedical Engineering and has a joint appointment in the Department of Electrical and Computer Engineering.

Mueller is using mathematics to develop and refine medical imaging technologies for cystic fibrosis as well as for acute respiratory distress syndrome and other conditions of the lungs. Specifically, she is working to improve electrical impedance imaging, which uses electrodes placed on the skin to create images of blood and airflow inside the body. The large amounts of data pouring back is analyzed through partial differential equations, optimization, and other mathematical processes to create usable diagnostic images.

She and her team are partnering with GE Research to improve electrical impedance imaging technologies. They are currently in clinical tests at Children's Hospital Colorado, where CSU mathematics is helping doctors better see what respiratory challenges their young patients are facing. "Improvements in medical image quality and resolution are rarely accomplished without sophisticated mathematics," Mueller says.

Professors Indrakshi and Indrajit Ray

## SECURING A COMPUTER-DRIVEN WORLD

At the interface of technology and the physical world, there can be friction – and sometimes fatal impacts. Self-driving cars are one of the more visible ways in which we now see artificial intelligence interacting with us in a nondigital space. The "convergence of cybersecurity with the physical world – through smart sensors, richer interactions with humans, and increased reliance on artificial intelligence – poses some of the biggest challenges in data security," says Indrajit Ray, a professor of computer science. He and his wife, computer science and electrical engineering Professor Indrakshi Ray, work separately and together studying this brave new world of security in the cyber-physical interface.

Beyond consumer cars, artificial intelligence is also being deployed in heavy vehicles such as semi-trucks and tanks. Indrakshi Ray is working on cybersecurity for these systems – as well as for access control models for information technology and health care systems. She has been appointed as the director of the new Cyber Security Center at CSU. Indrajit Ray, who is also a program director with the National Science Foundation, is researching new methods for analyzing risk for the cybersecurity of nuclear power plants, oil and gas production facilities, and smart grids as well as security of synthesized DNA and cryptographic techniques for the health care field.

> "We view cybersecurity as a scientific discipline," says Indrajit Ray.

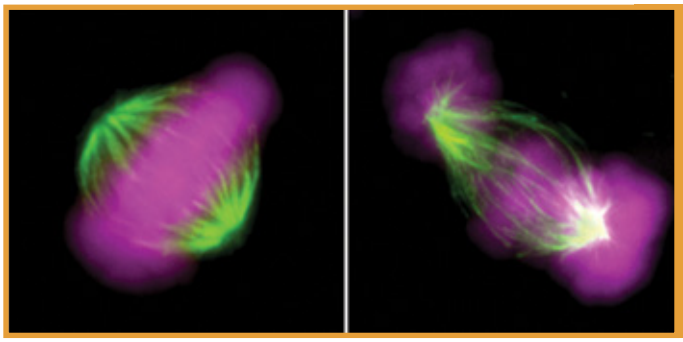
"Thus our research focuses on building models, metrics, and methodologies." And these academic advances are making a difference in the real world. Their combined work on trust modeling, for example, has been used by the U.S. Air Force. "The interaction of cyber, physical, human, and artificial intelligence elements are not always known a priori and can be good, bad, or ugly – with implications not only on technology but also on the socio-political world," he says.

## TAKING OUT CANCER CELLS

Cancer cells seem tough – ironclad interlopers that are too-often impervious to our medical assaults, assaults that can lay waste to the body's own healthy cells. But behind their malevolent mutations may lie cancer cells' hidden vulnerabilities. It is these molecular Achilles' heels that biochemistry and molecular biology Professor Jennifer DeLuca is looking to find. And attack.

"In our lab, we have discovered that many cancer cells exhibit certain defects during the process of cell division," she says. "This results in vulnerabilities in cancer cells such that they become dependent on certain cellular factors for survival."

By better understanding these processes – and those dependencies – they can try to create better treatments. "An ideal cancer therapy would specifically target cancer cells for destruction while leaving healthy cells in the body unharmed," she notes. So DeLuca is collaborating with researchers at the Fred Hutchinson Cancer Research Center in Seattle to study the defects in a form of brain cancer called glioblastoma multiforme. They found that the glioblastoma cells need specific proteins to divide – but healthy body cells do not. The researchers are currently testing whether using small molecules to stop these proteins will kill off the cancer cells while leaving healthy cells intact. This line of research, she says, "will provide a platform on which to build new cancer therapeutic strategies."



**Two human cancer cells: The one on the left is untreated, but the one on the right has been depleted of a key protein it needs for cell division.**

FEATURE

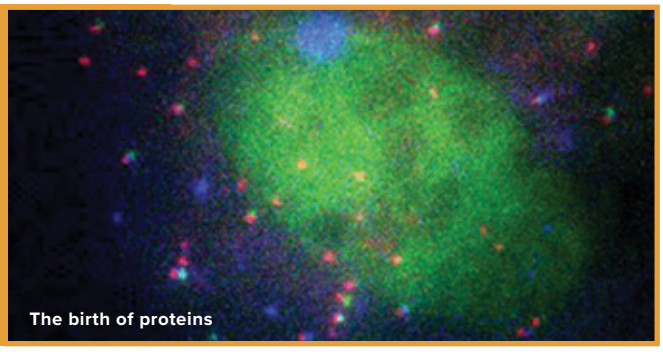
## BRINGING THE LABORATORY TO THE FIELD – ON A PIECE OF PAPER

When you say something looks good on paper to chemistry Professor Chuck Henry – if it's one of his pieces of paper – he knows it means something more. Henry and collaborators have developed numerous paper-based chemical sensors to deploy in the field – whether that's a food processing plant, a hospital, or an actual field.

Technological advances have made astoundingly precise measurements possible in the lab, "but the associated instruments remain large and expensive," Henry says. "We saw an opportunity to make use of the natural wicking of paper to get rid of much of the instrumentation. This makes devices easier to use, less expensive, and easier to make." Many of their tests are created with less than a nickel's worth of materials. And they are quick and easy for nonexperts to read.

Henry and his lab are currently working on environmental tests, including ones for pollution and for agricultural pathogens, which they are now testing in West Africa. And, taking the work a step further, pairing their physical tests with machine learning, "would enable us to map pollutants with the help of citizens around the globe to understand changes as they occur – and address the areas of most critical need," Henry says.

## A NEW VIEW ON LIFE



The birth of proteins

At the very basis of life, DNA is used to create RNA, which is used to create proteins. "But few people have seen the process play out in real time – right in front of their eyes," says Tim Stasevich, an assistant professor in the Department of Biochemistry and Molecular Biology. Stasevich is one of those few. He and his lab built a powerful single-molecule microscope – along with novel imaging reagents – that enable us to peer into cells as they take these basic steps. "Members of my lab now regularly image this fundamental process," he says. "This is revealing all sorts of crazy and unexpected things, so each day I feel a little like a kid in a candy store."

Perhaps one of the most powerful things about their microscope, beyond its resolution, is its accessibility. It uses open-source code and is built on a modular system "so it is easy to adapt for different experiments," Stasevich says. Now, for example, "we've begun to look at viral proteins and see how these tiny bugs hijack host machinery to replicate more of themselves," he says.

These new views into the basic building processes of life have the potential for massive impacts in science – as well as in medicine. "We are studying the fundamentals of how proteins are made in cells," he says, pointing to the importance of basic research. "This process goes awry in a wide range of diseases, from Alzheimer's to cancers. I am confident our imaging technology will help reveal new aspects of these diseases – and this may lead to more effective and targeted therapeutics."

## STATISTICS UNCOVERS HIDDEN CONNECTIONS

When it comes to making a positive difference in people's lives, statistics might not be the first field that comes to many minds. But Ander Wilson, an assistant professor in the Department of Statistics, saw an opportunity for a big positive impact through data. Wilson now develops statistical models for large and complex environmental health issues.

"Environmental health is a critical issue that affects everyone," Wilson says. "We are continuously exposed to a multitude of environmental chemicals, and we know very little about how the majority of these chemicals influence health," especially in combination. The field has relied heavily on observational data, which can get mired in confounding variables. And

Wilson has found that many of the statistical models used to interpret the data from these studies are over-simplified or can be biased.

> "Improved statistical methods allow us to answer questions about the health effects of exposure to environmental chemicals more precisely," he says.

Wilson, who completed a fellowship with the U.S. Environmental Protection Agency and was a postdoctoral research fellow at the Harvard T.H. Chan School of Public Health, is studying how multiple simultaneous exposures to environmental chemicals impact health. Analyzing such a large array of factors has required new, advanced statistical methodologies. He is also investigating the impact of pregnant women's exposure to air pollution on child health, in particular, identifying sensitive windows of fetal development. "Understanding and quantifying how environmental chemicals affect health is critical for protecting the public's health and will allow us to improve regulatory policy and public health messaging and develop interventions," Wilson says.

## BATTLING BUGS WITH SMARTER MATERIALS

A crisis is looming in the world of medicine. Bacteria have been evolving to survive our antibiotic attacks, leaving people vulnerable to untreatable infections. But what if we could develop materials that were resistant to bacteria in the first place?

That is the work Melissa Reynolds, chemistry professor and associate dean for research, has been undertaking. In the new Chemistry Research Building, her lab is developing "antibacterial materials that kill bacteria on contact," she explains. "These have a clearly defined path to use and would meet an immediate need."

But this is not the problem she set out to solve. In fact, she and her graduate students were working on anti-clotting materials for implantable devices, such as catheters. In the course of their experiments, however, they found that the copper nanocrystals they were using also prevented bacterial growth. This pioneering work was recently featured in *Newsweek* magazine.

Reynolds, who has a joint appointment with the CSU School of Biomedical Engineering, is a keen mentor to her student collaborators. "I see my work as an opportunity to enable and train students to make the discoveries that impact our world," she says.

## UNDERSTANDING THE PSYCHOLOGY OF CHOICES

What goes into your decision to purchase a particular food? What about whether to get up and take a walk? Thousands of tiny decisions throughout our days can cumulatively have a big impact on our lives. And psychology Associate Professor Daniel Graham is looking to better understand these through quantifiable research so that better decisions are easier to make.

In a basement lab in CSU's Clark Building, shelves of food line the walls, mimicking a grocery store aisle. To observe how people make purchasing decisions, study participants – such as Fort Collins residents and their families – don eye-tracking cameras and go "shopping." The data from the cameras is analyzed to see what aspects of food packaging people examine as they make their decisions.

Graham is also using psychology to find new ways to integrate physical activity into our lives – so we don't have to make the "decision" to exercise so frequently. "Specifically," he says, they are working to identify ways to get "more widespread adoption of movement during currently sedentary activities, such as office jobs and classrooms. Our preliminary data suggest that children learn at least as well and enjoy learning more when they are more active." For adults, "we are investigating several different types of workstations, such as treadmill desks, cycling desks, exercise ball seats, and more, to see what types of alternative work environments can reduce sedentary time – while also potentially improving work performance," he says. "The goal is to find ways to simultaneously improve health and productivity."

FEATURE

# HUMAN IMPACT

## DATA SCIENCE PREPARES NEW GENERATION

As the 20th century was built on manufacturing, the 21st century is being constructed on data. But the country has a major shortage of people trained to work in this new medium. To help address this pressing issue, the College of Natural Sciences became the first in the region to create an undergraduate program dedicated to data science.

The first students will graduate with a B.S. in data science from CSU in Spring 2021. These students will have solid foundations in computer science, mathematics, and statistics, as well as the theory, skills, and creativity to take on complex challenges. In fact, before graduating, they will complete a team capstone project that addresses a real-world data problem. “This innovative multidisciplinary degree program will prepare students to be successful in one of the most in-demand careers in the 21st century,” says Jan Nerger, dean of the college.

Beyond the undergraduate program, the college is creating a data science institute, hiring additional faculty members in the field, and starting graduate programs to take the study and application of data science to the next level.

## HELPING STUDENTS FEEL AT HOME IN SCIENCE

The College of Natural Sciences Learning Community welcomes 400 undergraduate students each year into the residential program, where they can study, socialize, and seek support where they live.

The program thrives on the diversity of students who join it. “They come in with a lot of different strengths and assets,” says Alexandra Keller, director of the program. Within that environment, the program can provide integrated support for students who might be the first ones in their families to navigate an institution of higher education.

> “Although many of those students might not be familiar with the class registration process, for example, they bring skills and perspectives that are ultimately very powerful,” Keller notes.

“Many of our students have a highly developed ability to solve problems and are incredibly curious, which are things that we really need in the field of science,” she says. “There is a need for diverse perspectives to come together to engage with complex problems in the world,” Keller says.

Some of the Learning Community's organized programs include Diversity through Technology and Science Outreach Scholars. These experiences support "the development of key scientific approaches, such as inquiry, exploration, and curiosity – and show students that science isn't just about memorization," Keller says. "This helps them feel like they're doing something and engaging in something – rather than just sitting in a class. Because science is not about memorizing information or getting good grades – science is about inquiry. And that requires doing, not just being a passive learner."

## WHEN WOMEN SUCCEED, EVERYONE WINS

From the Department of Computer Science: Cochran Family Professor and Associate Professor Sangmi Pallickara, Professor Indrakshi Ray, and Assistant Professor Laura Moreno Cubillos

In the U.S., women still make up a minority of science faculty. And because scientific progress depends on bringing a diversity of perspectives and ideas to the bench, it is crucial to ensure support for those who are underrepresented in the field. That is why, in 2007, Dean Jan Nerger and Ellen Fisher, now assistant vice president for strategic initiatives for the vice president for research, started Women In Natural Sciences. The organization provides networking and mentoring to female faculty members – as well as to other women in the sciences.

The group, also known as WINS, "brings a richness of experience and opportunity for female faculty, which, in turn, enriches the entire college and campus," Nerger says.

> "When faculty members are supported, their students benefit, their research benefits – we all benefit."

The group also provides donor-funded research grants and travel awards. And it sponsors lectures that serve the entire community. Earlier this year, for example, WINS helped to bring Julia Gillard, former prime minister of Australia, to campus to speak about her work in education and leadership.

Speaking of the group's 110-plus members, Nerger says, "these women are amazing scholars and teachers, and the work they do is world-class. I have already seen the difference WINS has made in creating an even better workplace for all faculty – and in educating the next generation of scientists."

## TEACHING INNOVATIONS THROUGH SCIENCE

College faculty are using the latest science and new research to help students learn better. This science-based learning has long been evident in the Department of Psychology, but it also appears throughout the college's other seven departments.

For example, in a popular cell biology course, students are participating in research not just in the lab but in the classroom too. Faculty in the biosciences are developing improved methods for helping students understand challenging content beyond memorization. The finely tuned approach, which they call "writing-to-learn" was described in a paper published in *BioScience*.

It might sound like a humanities-based tactic, but, especially in the sciences, the researchers have found, this type of exercise helps students "organize ideas, identify evidence, and develop reasoning," explains Meena Balgopal, an associate professor of biology and a leader of the program (which was implemented in collaboration with biochemistry and molecular biology Professor Paul Laybourn – and which is also being tested in classrooms in other colleges across campus).

The technique benefits all students' comprehension and is especially helpful for first-generation students and those who identify as minorities. And Balgopal is now working with local school and community college teachers to help integrate this successful model of learning beyond the CSU campus.

FEATURE

# GLOBAL IMPACT

## FINDING CLIMATE CLUES HIDDEN UNDER DISTANT LANDS

At the bottom of the world, in wind-swept valleys, the dry land appears entirely barren – with no animals or plants in sight. But below the surface, a microscopic world of life ekes by. Here, in the salty, inhospitable soils, a nematode reigns supreme. *Scottnema lindsayae* is the tiny creature that draws biology Professor Diana Wall to these far reaches of the globe year after year.

Wall, a member of the National Academy of Sciences and University Distinguished Professor, has devoted decades – and nearly 30 Antarctic summers – to extracting lessons about ecosystem response to climate change from this hardy, humble worm. She and her colleagues have found that as the dry valleys of Antarctica warm and become damper, the populations of this survivor are declining, upsetting the ecological balance of species – and geochemical dynamics – beyond what we might expect.

Although the fate of a small species living continents away might not appear to have a global impact, the findings about it do. As temperature and moisture patterns shift rapidly across the globe, soil animals change as well. And this has big implications for carbon turnover as well as soil productivity on every continent.

Wall, who is also director of CSU's School of Global Environmental Sustainability and science chair of the Global Soil Biodiversity Initiative, has said, "soil biodiversity – whether in Antarctica or right here in soils around Colorado State University – works 24/7 to maintain the crucial ecosystem services our life depends on. The food we eat, the air we breathe, and the water we drink all depend on the interactions within our living soil." And with the climate changing so rapidly, it behooves us to better understand the impacts that is having underfoot.

## GLOBAL INSPIRATION FOR BETTER SCIENCE EDUCATION

This summer, college outreach group Little Shop of Physics traveled to Uganda with more than 700 pounds of science equipment. But it wasn't the group's usual stock of student-made activities that they trek to dozens of schools each year in Colorado. It was raw materials – "all matched to topics teachers there told us they were working to teach more effectively," says Little Shop Director Brian Jones.

"We worked with the students and the teachers to develop a curriculum suited to the locale."

This was far from Little Shop's first passport stamp. In the past year alone, the group has also worked with educators and students on the ground in Slovenia and

Norway – as well as on numerous Native American reservations.

> "The clearest indication that the work we do is having an impact is that we are repeatedly invited back!" Jones says.


"At every visit, we make it clear that our goal is to interact – to engage – with the people we meet. We don't just say, 'Here is some cool stuff we brought, enjoy!' We want to get other people's ideas; we want to hear their take on the world and the wonders they see in it. We don't have all the answers – we just have ideas and a willingness to share and, together, to develop something that neither party could have dreamed up alone."

Little Shop's approach has been informally "franchised," with locally run spinoff programs in Asia, Africa, and Europe, as well as in other regions of the U.S. and on multiple reservations. Jones has his eye on "more work in South America and Australia – so we can have a Little Shop-style program on every [inhabited] continent!" All of this globetrotting also creates "an impact closer to home," Jones notes. "We've been able to take hundreds of CSU students to these areas, to work with students and teachers in these communities as partners. The CSU students on these visits are changed by the experiences they have – and that's one of the most lasting impacts of this work that we do."

## STUDYING THE UNIVERSE – ONE PARTICLE AT A TIME

In the era of instantaneous communication and universe-probing physics, it can be easy to forget that much of science still happens in physical places. One of those places is Kamioka, Japan. There, CSU physicists, led since 2006 by Professor Walter Toki, are among those looking for clues in a neutrino beam that travels 180 miles from Tokai, Japan, through the earth's crust, to the Super Kamiokande Detector. This was where researchers first saw that neutrinos can transform themselves in unexpected ways.

Neutrinos are nature's most elementary particles, but we still have much to learn about them. Furthering their mystery is that they have been observed oscillating into different forms, which, as researchers have put it, is kind of like seeing a beagle starting on a 180-mile run – but, along the way, being detected as a poodle.

Were other types of transformations also possible (to extend the canine metaphor, from beagle to, say, chihuahua)? To help find out, CSU physics Professor Robert Wilson joined the "T2K" collaboration, along with Associate Professor Norm Buchanan. Using neutrino detectors designed and built at CSU and installed at Tokai, the T2K collaboration found this new type of oscillation. The discovery earned the CSU members, along with their T2K colleagues, the 2016 Breakthrough Prize in Fundamental Physics.

**CSU personnel at the neutrino detectors in Tokai in 2009: from left to right: Walter Toki, Shamil Assylbekov, Vladimir Kravstov, Norm Buchanan, Robert Wilson, and Dave Warner.**

And the detection hasn't ended there. The endeavor has now found indications that this oscillation might happen at a higher rate in neutrinos than in antineutrinos, which challenges the long-held principle of particle charge parity symmetry. This particle symmetry and other fundamental questions about neutrinos and the universe are also being studied by CSU physicists and others, including Assistant Professor Michael Mooney, slightly closer to home through the DUNE, NoVA, MicroBooNe, and ICARUS experiments at Fermilab in Illinois. •

# Building a New Source for Histones

In the expanding world of genetic research, a key component can be hard to come by: histones. These proteins help wind the long strands of DNA in chromosomes. For years, the department's Protein Expression/Purification Facility has churned out research-ready histones for labs on campus and off. Recently, they created the Histone Source to focus on broader distribution of these specialized materials. We spoke with the director of both groups, Hataichanok Scherman.

***ELEMENTS***: *What was the impetus behind creating the Histone Source?*

**SCHERMAN**: The new entity better communicates to those outside the University that we specialize in making these proteins. In addition to histones, we offer other custom proteins as well as consulting and training.

***ELEMENTS***: *Where are your histones being used?*

**SCHERMAN**: CSU, and in particular the department, has a substantial number of researchers who employ histones in their research projects. A fair portion of our sales and services are to researchers at other institutions and industry partners. We have repeat customers from the Max Planck Society, the Francis Crick Institute, the National Institutes of Health and the National Cancer Institute, the Howard Hughes Medical Institute, and Stanford University, among many others. It is our hope that as the name garners more worldwide recognition, it will increase exposure not only for the facility but also for the department and University.

***ELEMENTS***: *Where do the proceeds from the sales go?*

**SCHERMAN**: The Histone Source is not-for-profit and is self-funded, so sales go to operating the facility and to expanding our offerings and services.

## TWO NEW MASTER'S PROGRAMS TACKLE GROWING FIELDS

**DATA**: The future of biosciences is being fueled, in part, by big data. That is why the Department of Biochemistry and Molecular Biology and the Department of Biology have partnered to create a new Professional Science Master of Biological Data Analytics. The two-year program is open to those with backgrounds in the biological or computer sciences and will prepare students for careers leading the dynamic future of science.

**MICROSCOPY**: Paving the way in the U.S., the department has created a novel Professional Science Master of Microscope Imaging Technology. This one-year degree uses an interdisciplinary approach to prepare scientists to lead imaging facilities and create the next generation of imaging techniques. Students will work extensively with leaders in the field and with the campus's renowned Microscope Imaging Network.

## UNDERGRADS RECEIVE NEW HOMEBASE

If you're familiar with the Molecular Radiological Biosciences Building on Lake Street, some terms that come to mind for the 1989 structure might be "functional" or "research-oriented." But "welcoming" perhaps would not be one of them. And if you're a first-year undergraduate, it might be especially difficult to feel at home there. "The utilitarian design and look of MRB often 'scares' students," says the department's undergraduate program coordinator Aaron Sholders. The students spoke, and the department listened, taking big steps to creating a warm and welcoming community among its now 300-plus majors.

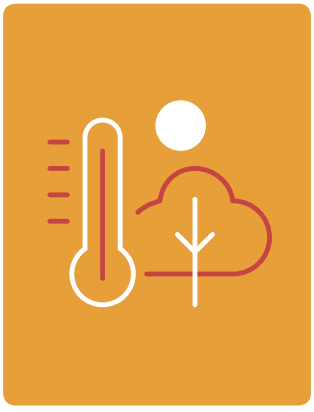
A newly renovated wing of the Anatomy-Zoology Building opened last fall "to be the common meeting place for all of our undergraduate students for advising, computing, and academics," Sholders says. "We hope that this new space acts as a catalyst for the development of rich relationships among our students – relationships they will need to support one another in studying, research, and career development."

# How "of a Feather" Are Birds That Flock Together?

The study of subtle bird variations – in the beaks of Galapagos finches – launched the theory of evolution more than 160 years ago. But now, genomics is helping to gain a clearer resolution of different species – and how to save them.

The lab of Kristen Ruegg, an assistant professor who joined the department last year, is using a combination of genomic tools and field research to better understand diversity within bird species as well as their migratory movements. A single feather can now provide information to better understand how bird populations may or may not be able to adapt to changing climate conditions, Ruegg explains. "Integrating multiple approaches allows us to get a more general understanding of the processes that generate avian diversity," she notes. "Climate change is having an undeniable impact on ecosystems and the species that depend upon them. By understanding factors important to generating species diversity, we can better manage species in a changing world."

Ruegg is also a cofounder of the Bird Genoscape Project, which uses genetics to empower migratory bird conservation work. Their goal is to create maps of where genetically distinct populations of 100 species of migratory birds across North America migrate, overwinter, and breed. "Migratory birds are particularly challenging because we have to study their biology across time and space, which is challenging," she says, "but also super fun."



## WHAT DOES CLIMATE CHANGE MEAN FOR PLANTS?

As the average global temperature rises, it changes precipitation patterns, altering floods and droughts around the globe. But we still have little understanding of what that means for plants – even those on which we depend.

Recent Ecology Program graduate Robert Griffin-Nolan (M.S., ecology, '19) dived into this challenge during his time at CSU. He and others have found that many of the models scientists use to study the impact of a changing climate on plants are based on tree physiology – which is very different from that of other plants, such as native grasses, which cover about a third of the land on Earth, and major crops that are also grasses such as wheat, corn, and rice. Their work aims to recalibrate models to better reflect the impacts on all plants so that scientists can be more accurate in painting a picture of what our future under a changing climate will really look like.

## FINDING A HOME WHERE THE WILDEBEEST ROAM

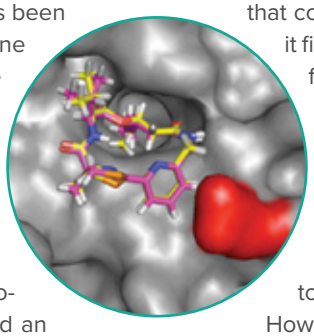
When Zoe Arndt (B.S., zoology, '19) first arrived at CSU from Colorado Springs, she could not have imagined that her course of study would land her a U.S. State Department Scholarship to study in Tanzania.

Arndt, who is the first one in her family to graduate from college, studied abroad in the eastern African country during her junior year. And, after graduating this past spring, she received one of just 550 of the State Department Critical Language Scholarships awarded across the country. With it, she spent two months studying Swahili this summer in the town of Usa River.

Her next stop will be a graduate degree in zoology before pursuing her dream of becoming a wildlife conservation researcher in eastern Africa.

# Fighting Cancer with Nature's Weapons

Many scientists stumble into their career's work in the lab of a Ph.D. adviser or by way of a happenstance result. But University Distinguished Professor Robert Williams has been laser-focused through his chemistry career on one goal: treating cancer. "I was inspired to try to make a contribution to cancer therapeutics, as my father died of esophageal cancer at age 56," he says.



To do this, Williams has not started from scratch, but instead he has looked to the natural world for possible leads. And he has found one in largazole, an intriguing compound found in a cyanobacterium that lives off the coast of Florida. "It had an attractive and interesting chemical structure," he says. And he found that it had a powerful capability: it was a strong histone deacetylase inhibitor that works as an epigenetic regulator of gene transcription – a new mechanism of action. Williams designed a potent, synthetic version that is more chemically stable that could also easily be scaled up for manufacturing. So it fits all the requirements of a "new and exciting target for cancer intervention," he explains.

He has collaborated with researchers from Harvard Medical School, the Broad Institute, and many other groups. Through a spinoff company called Cetya Therapeutics, "we are currently in the process of selecting our first clinical candidate to treat pancreatic and lung cancer," Williams says. How did he happen upon such a powerful compound – from the great, wide world of nature? As Louis Pasteur said, "Chance favors the prepared mind."

## MAKING DREAMS A REALITY

When Jose Rivera was 2 years old, his parents moved their family from the small town of Huejuquilla El Alto in central Mexico to the U.S. Growing up as an undocumented minor in a family with eight children gave Rivera the strength and persistence to create a successful future. He just didn't know what it would be. Two things changed that: a high school chemistry teacher and a full scholarship to CSU.

"The moment I learned to look at the simplest reactions on a molecular level, it felt like glimpsing a whole new world," he says. "My chemistry teacher in high school introduced me to that world, and ever since then I have absolutely loved it." Despite this passion and drive, however, his future in the sciences was not guaranteed. That is, until he was selected as one of 10 Michael Smith Scholars in Chemistry, a cohort funded by successful energy entrepreneur and former CSU student Michael Smith and his wife, Iris. "Being a Smith Scholar means that I am able to focus on my career goals and my dream to become a successful chemist," says Rivera, who will graduate in spring 2021 and now plans to pursue a Ph.D. "It is my dream to make an impact on chemistry and the world as a whole.

## A LASTING LEGACY FOR DEPARTMENT'S LEADING COUPLE

Forty years ago, powerhouse chemistry couple Branka Ladanyi and Marshall Fixman joined CSU's faculty. Ladanyi brought her expertise in supercritical fluids, molecular clusters, and the modeling of liquids. During her career, she served as editor-in-chief of the *Journal of Chemical Physics* and on executive committees of the American Chemical Society and American Physical Society. Fixman pioneered new approaches in polymer physical chemistry and received numerous honors, including being named a University Distinguished Professor, winning multiple American Chemical Society awards, and being elected to the U.S. National Academy of Sciences. The husband and wife passed away within a month of each other in 2016. A new faculty fund has been created to keep their memories alive: The Marshall Fixman and Branka Ladanyi College Professorship in Chemistry.

# Joining the Leaders of CS Inclusion

Undergraduate Susanna Kyler, Ph.D. candidate Swetha Varadarajan, undergraduate Cassidy Skorczewski, and Ph.D. candidate Hajar Homayouni

Nearly one in five students in this year's Department of Computer Science entering class is a woman. This is a sizable jump for the department where, in past years, closer to one in 10 undergraduates were women. And more progress is on the horizon.

This year, the department joined the ranks as one of just 15 universities nationwide to participate in the Building, Recruiting, and Inclusion for Diversity initiative (also known as BRAID), which is led by the AnitaB.org nonprofit and Harvey Mudd College.

"Evolving our computer science program to be more welcoming to women and minorities is clearly important, both for equity of access to high-tech jobs and to improve the diversity of the high-tech workforce," says Department Chair Craig Partridge. And the new partnership will help improve that future for the students on campus today – and the industry as a whole for tomorrow.

## UNDERGRAD TEAM WINS HACKATHON WITH NEW VOTING TECH

Only about 60 percent of eligible U.S. voters turn out to cast a vote in presidential elections, a figure that drops to about 40 percent for midterm elections. How can you use technology to increase that figure – especially among young minority voters? This was the 10-hour hackathon challenge put forth to teams of undergraduates from across the West at the National Society of Black Engineers regional conference last fall. The CSU team of Daniel Cooke, Augusta Irechukwu, Simon Nardos, and Abel Ykalo – all computer science majors – took home first place with their new online platform design that leveraged Google Maps API to help voters connect with polling locations.

Daniel Cooke, Simon Nardos, Augusta Irechukwu, and Abel Ykalo

## HOME IS WHERE THE HEART MONITOR IS

With a handful of Raspberry Pis and everyday tech accessories, Professor Shrideep Pallickara is hoping to create a way for millions more people to age at home more safely. Pallickara, who was recently awarded $3.1 million from the National Science Foundation for a separate project, is leveraging the proliferation of data-gathering sensors and his own research for a project he calls VitalHome. The idea is simple: functioning like a smart home, an in-home network would gather noninvasive, continuous health data and look out for potential health issues.

In fact, walk into a small lab in the Computer Science Building, and you can already be wirelessly monitored for your heart rate, blood-oxygen levels, blood pressure, movement, and more. This information can be collected from existing wireless monitors, such as FitBits, or from medical sensors, and fed into models to generate predictive health alerts. With about 20 percent of the U.S. population reaching 65 or older by 2050, this approach could help many more people make the most of their golden years.

# Bringing the Laboratory to Mathematics

For generations, the most hands-on activity in mathematics courses involved chalk and a blackboard. But for the past decade, mathematics Associate Professor Patrick Shipman has been changing that.

As a researcher who develops models for patterns in diverse nonequilibrium phenomena, Shipman knows that "participating in experiments is essential" for applied mathematics, he says. Together with chemistry Professor Emeritus Stephen Thompson, Shipman began creating experiments in pattern formation for undergraduate and graduate students – as well as for public outreach. And the Laboratory for Mathematics in the Sciences was born.

Now located just down the hallway from the Education and Outreach Center (read more on Page 24), the lab is currently partnering with that group to create more hands-on mathematics kits for school classrooms. "There is potential for major impact in integrated teaching of science and mathematics," Shipman says of the Laboratory for Mathematics in the Sciences. "Few institutions have such a facility and ability to make progress in integrating STEM teaching and research that we do. I hope to continue to expand it to bring it to its full potential!"

## STUDENTS LEARN CRYPTOGRAPHY FOR A DATA-DRIVEN FUTURE

"We may not realize it, but mathematics is in everybody's wallet," says mathematics Associate Professor Anton Betten. At its core, the security of our entire financial system – from automated stock trading to your most recent credit card dip – "is based on a combination of pure and applied mathematics, with some computer science and electrical engineering thrown in." And CSU students will soon have the opportunity to learn how all of those transactions can remain secure – now and in the future.

Two new mathematics courses, developed by Betten and mathematics Professor Jeff Achter and starting Spring 2020, will teach students the mathematical foundations of cryptography primitives and protocols as well as security requirements.

"Modern daily life is very much dependent on the smooth and safe workings of electronic systems, and security reaches into all aspects of it," Betten says.

But even the current standard of cryptography is not going to stand forever. "It is believed that in about a decade, quantum computers will render most of the currently deployed cryptography systems vulnerable," Achter says. So students will also "study secure communication in an environment where an adversary has access to a quantum computer," he says.

## PREDICTIVE EPIDEMIOLOGY

Microbiologists have pinpointed the mechanisms by which many viruses – from influenza to Ebola – spread. But what if we could better predict who will get sick – before they do?

Mathematics is on it. Professor Michael Kirby is developing models to identify within 24 hours who will come down with a virus and who won't. "The body is an amazing sensing system, and the signals cells use to communicate provide a wealth of information that captures the details of the host immune system response to infection," Kirby says. "Our challenge is to decipher their language."

# Showing Students the Path to Success

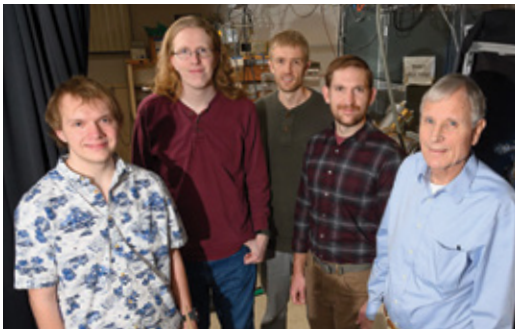
An undergraduate degree in physics can take you just about anywhere. But it is precisely that boundless opportunity that can confound an entering student. As part of the department's priority to energize undergraduates, it has brought faculty member Debra Dandaneau on board to advise students – as well as to develop new tools and analyze data for student success.

Dandaneau, who holds a Ph.D. in physics from the University of Colorado, Boulder, most recently helped the Kansas State University physics department to grow its number of undergraduates while increasing diversity and performance and decreasing the time to graduation. And she is already applying her experience in physics and in education (for which she holds a master's degree) here at CSU. "I have a broad perspective of what students can achieve – and the idea that a career path can be fluid," she says. This background informs her holistic approach to fostering success for all populations of students. "When you focus on all aspects of student support – advising, teaching, financial advising, career placement, student health – every student is served better," she says.

## PARSING PARTICLES

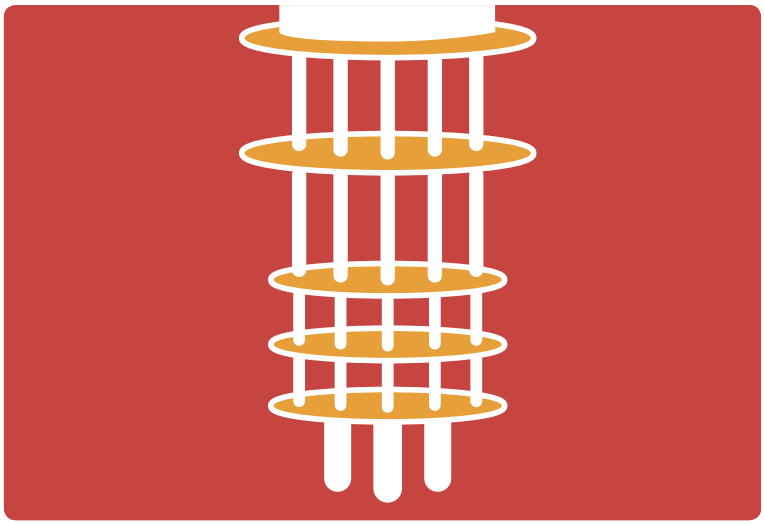
Neutrinos are among the most abundant particles but are still poorly understood. They are commonly found in radioactive beta decay. Until they're not. The idea that there could be a rare form of beta decay that occurs without neutrinos has remained theoretical. Known as neutrinoless double-beta decay, this process, if observed, would change our understanding of elemental particles – and would teach us more about the universe itself.

CSU physics Professor Bill Fairbank and his team are inching us one step closer to reaching this goal. They have created a way, for the first time, to image single atoms in a solid noble gas. The technique, known as barium tagging, was described in *Nature* earlier this year. The research is part of ongoing work for a larger detector for double beta decay that will supersede the EXO-200 detector based in New Mexico. The detection of a neutrinoless decay would suggest that neutrinos are their own antiparticles.



**Fairbank (far right) with his lab team**

## SPINNING UP A NEW APPROACH TO MICROELECTRONICS



Electron spin has long been a subject of fascination for fundamental physics as well as for applications in technology, such as information storage and quantum computing. And spin electronics or "spintronics" was the topic of the 2007 Nobel Prize in Physics. But the primary focus of electronics has been on the charge. Physics Professor Mingzhong Wu is interested in the spinning itself.

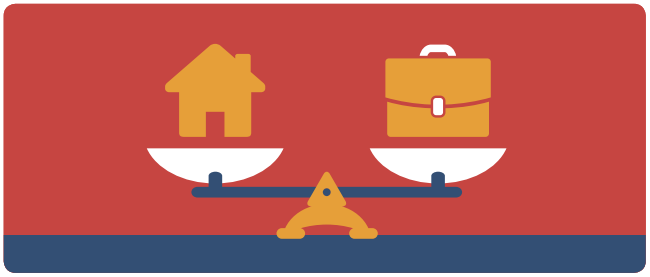
Wu, who is also the director of CSU's Designated Center for Advanced Magnetics has been working on establishing a new path toward using and powering this electron spin. He has pioneered using spin currents to switch magnetization direction of electrons in magnetic insulators and also using magnetic insulators to produce spin currents. His work, which has been published in *Nature Physics, Nature Communications*, and *Science Advances* also includes investigations into topological insulators, which have conductive surfaces but insulating interiors, that could function at room temperature, improving energy transfer in electronics.

# A Different Hill for Every Body

When you look at a hill in front of you, the incline might look vastly different to someone standing right next to you. According to research conducted by psychology Professor Jessica Witt, how we perceive the world is shaped in part by our ability to act in it. She has found that distances look shorter to those who are younger, have a lower body weight, and who do not have chronic pain. Similarly, she has found that softball players who are on a hitting streak actually perceive the ball as larger.

But her work has implications far beyond weekend hikes or the sports field. She also investigates other matters of how our physical states influence our perception of potential threats. In a striking study, she and her colleagues showed participants images of other individuals holding either guns or neutral objects. When participants were themselves holding guns in the study environment, they were substantially more likely to perceive others as holding a gun and, as they note, were more likely to "engage in threat-induced behavior" such as "raising a firearm to shoot." The findings have significance for law enforcement and public safety – as well as for our overall understanding of how we act in the world every day.

## CAN SCIENCE POINT TO TRUE WORK-LIFE BALANCE?



With email, texts, and cell phone calls, it is often now difficult to say where work time ends and personal time begins. And for many people, that boundary is almost entirely fluid.

"Technology gives many workers flexibility, but it comes at a cost of making it difficult to set and maintain boundaries," says psychology Associate Professor Gwenith Fisher. "We need breaks from work – some time to disengage and disconnect – for psychological recovery so we can feel rested and ready to get back to work."

At the CSU Occupational Health Psychology lab, Fisher and her colleagues investigate the work/nonwork interface. Their research has suggested ways individuals and organizations can foster a better balance amid heavy workloads. Their results include the importance of recognizing that resources – including time and energy – are finite, so finding other tactics, such as maintaining autonomy or control over how you do your work, obtaining support from supervisors and coworkers, and setting boundaries is key.

## SERVING THE COMMUNITY WITH PSYCHOLOGY

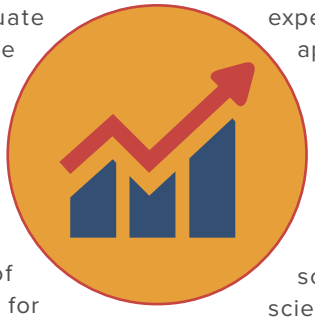
Acquiring mental health care can be a major stumbling block – especially for individuals in underserved populations. But the department's Psychological Services Center is working to fill this important role. "CSU's centralized location in Fort Collins is well-suited for a mental health clinic," says Deborah Essert (Ph.D., psychology, '17), director of the center.

The clinic, which has been in operation for 50 years, serves upward of nearly 100 individuals at any given time, offering assessment and therapy on a sliding-fee scale. "We provide services to children, adults, couples, and families from all across Northern Colorado," Essert says. "And we are now able to accept Medicaid, which opens even more doors for those who are in need of services but may struggle to access them."

The clinic provides real-world training for psychology doctoral students and those in the Master of Addiction Counseling program. "This benefits the clinic and the community because all of the PSC clinicians are bright, eager, invested providers," Essert notes. "They are scientist-practitioners, integrating research into the services they provide and seeking out training in the evidence-based practices that could yield the best outcomes for their clients."

# Bringing Statistics to Students – Wherever They Are

The Department of Statistics is the academic home of more than 50 graduate students. But it provides essential course work for many more graduate students across campus – and beyond. So the department is "making significant changes and additions to the traditional applied graduate statistics courses," says interim Department Chair Jay Breidt. "This includes offering a key applied statistics course year-round in a 'video-delivered' format that uses live instructors but reduces the number of times graduate students must travel to campus for lectures," he explains. The department is also adding more than a dozen different applied statistics courses on specialized topics, which "were chosen based on extensive discussions across campus," Breidt says. This year, the courses include data wrangling and visualization, experimental design, applied regression models, applied multivariate statistics, and more. The offerings will evolve to match developments in the statistical field as well as changing demands in science.



Statistics lives at the foundation of many fields of study, providing the tools for scientific inference in fields ranging from crop science to social policy. The department's new applied statistics offerings will educate CSU students across campus and beyond, who will then take their training into a variety of industries across the world.

## BETTERING HEALTH WITH BIOSTATISTICS

With the proliferation of digital medical records, genetic studies, and general health data, there is a growing need to develop much more sophisticated statistical models and methods to make sense of all of that powerful information.

We need better biostatistics.

So to improve study and instruction in this rapidly evolving field, the college is investing in new faculty, research, and courses.

For example, Assistant Professor Josh Keller is the first to join the department with a Ph.D. in biostatistics. Keller, together with Professors Wen Zhou and Ander Wilson (read more on Page 10), develops statistical methods and models in areas of genomics, bioinformatics, system biology, measurement error, and environmental health, notes interim Department Chair Jay Breidt. "This young, talented, and energetic group brings a collaborative focus to biostatistics at CSU."

Assistant Professor Ander Wilson addresses the workshop.

## WELCOMING TOP RESEARCHERS TO CAMPUS

This summer, the Joint Statistical Meeting drew thousands of statisticians from all over the globe to Denver. The CSU Department of Statistics was well represented at the meeting, with six faculty members, four students, and several alumni presenting, and recent Ph.D. Henry Scharf receiving the annual Savage Award for his dissertation on Bayesian analysis.

Before the meeting kicked off, CSU hosted the annual Institute for Mathematical Statistics' New Researchers Workshop at Canvas Stadium. This workshop was organized by statistics faculty members Bailey Fosdick and Ander Wilson and brought 60 promising new researchers in the field of statistics to campus for networking and career development. Notable faculty from Harvard University, NORC at the University of Chicago, Virginia Tech, University of Colorado, and CSU gave presentations and participated in panels offering advice to the new researchers. "The conference put a spotlight on CSU while also developing future leaders in statistics and data science," Wilson says.

COLLEGE COMMUNITY

## BRINGING CSU SCIENCE TO SCHOOLS,

# ONE KIT AT A TIME


**MOST SCHOOL STUDENTS DON'T GET TO EXPERIENCE** university-level research firsthand. But Andrew Warnock and his small staff of educators and students at the college's Education and Outreach Center are working hard to change that.

The center provides hands-on science experiences to thousands of students across the state and the country each year – in addition to providing education and support to teachers. "The goal is to show kids how scientific research is done and to inspire them," says Warnock, who is director of the center.

The center was launched 30 years ago as the Center for Science, Mathematics, and Technology Education. Renamed and reimagined as the Education and Outreach Center in 2010, it now operates under an innovative and impactful model. It leverages National Science Foundation research grants – along with private donations – to create lasting outreach programs.

As part of NSF grants, researchers must describe plans for the "broader impact" of their work through public engagement, a step that can often stymie even the most thoughtful of faculty. So Warnock and his staff partner with CSU faculty during the grant development process, learning about the research and outlining an educational component. This benefits the faculty member as well as the center because with the grant funding, the center can develop and build related science activity kits for their permanent lending library. This allows the scientific outreach to continue even after the research grant itself has ended.

These kits – and there are now nearly 20 research topics covered – are geared toward fourth- through 12th-graders. Each topic has a set of 15 identical kits (designed to be completed by pairs of students, accommodating class sizes of up to 30) that live in the lending library for teachers and schools to "check out" for free, whether they are going down the road or across the country. The topics of the CSU research-inspired kits range from ice core climate tracking (pictured above) to fish evolution to the mathematics of optimization.

In addition to sending engaging science out into the world, the EOC also hosts Colorado educators and classes for activities in their own on-campus classroom weekly program known as STEM Fridays. These visits provide hands-on education to aspiring science educators at CSU as well. "The students who help at STEM Fridays absolutely love it," says Courtney Butler, assistant director of the center who also serves as director of the Colorado Science and Engineering Fair. "They gain a lot of skills in working with different student populations and different ages."

Antoinette Smith (B.S., chemistry, natural sciences, '18) has benefited from the center's work as a student and now as a science teacher at Fossil Ridge High School in Fort Collins. She started working with the EOC in 2017, which also runs the SciTrek summer camp and the Triunfo Mentoring Program on campus. "I learned a lot about teaching in terms of how we can bring something that is real and is pertinent to these kids' lives – and how we can make it hands-on and inquiry-based and meaningful to them," says Smith.

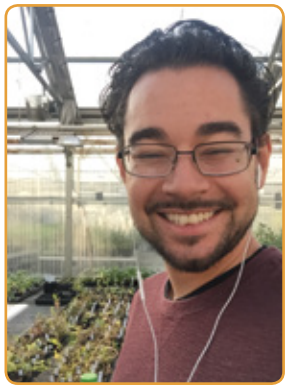
In the summer of 2018, Smith led the development of a new kit called High-Tech Rocks that was created in partnership with the Department of Chemistry lab of James Neilson. As a double major, Smith was in a unique position to help translate the cutting-edge, NSF-funded high-temperature solid-state chemistry of Neilson and his colleagues into an engaging, safe, hands-on activity for students.

"Those are things that students don't normally have access to," Smith says. "It's related to real research, and it's unique – and it's structured in a way I can bring it into the classroom and really get kids excited and engaged without derailing from what I need to cover." And beyond enriching students' experience in middle and high school, the program "shows kids what real research is happening and that if they went to CSU, it is something they could study", she says. "It really opens their eyes to different areas of science – and different educational possibilities." ●

ONE DEGREE

# MANY IMPACTS

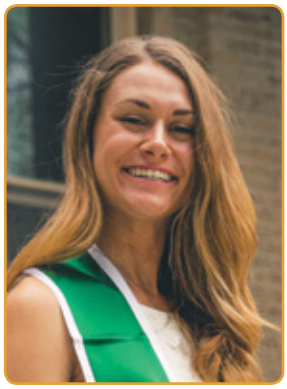
COLLEGE OF NATURAL SCIENCES STUDENTS SHARE THEIR JOURNEYS TO DEGREES – AND THE IMPACT THE COLLEGE HAS HAD ON THEIR LIVES.



## ANDREW CORDOVA

**Biochemistry and Molecular Biology – Class of '19**

"I grew up in Fort Collins and am the fourth generation of my family to live in a city with a land-grant institution, but I am the first to attend. I welcomed my son into the world right after high school. I attempted a semester at community college but was quickly overwhelmed with the added stress of a newborn. As my son started preschool, I had become frustrated with my life as a single father and bartender. I rode the bus to Front Range Community College for the first few semesters until I could afford a car. I was empowered not only to finish my associate degree, but to transfer to CSU and go all the way! It feels great to use my new skills. Getting involved in undergraduate research, applying my studies to agriculture, boosted my confidence as a scientist. For the first time in my life, a Ph.D. feels obtainable."



## CLAIRE GOLDSTEIN

**Computer Science – Class of '19**

"I had taken a computer science class in high school and found the class a fun way to build things. When I came to CSU, I lived in the College of Natural Sciences Learning Community on a hall with a bunch of computer science students, which was a great way to find study partners. I had the honor of being an undergraduate teaching assistant in the department. I loved witnessing the learning process in all of the students and getting challenged to find new ways to connect computer science concepts to everyday events. I am now at a data science startup in Old Town Fort Collins and learning about front-end development. The College of Natural Sciences gave me the skills for the real world – and the mentors to encourage me to do things out of my comfort zone."

## KAITLYN EWAN

**Psychology and Social Work – Class of '19**

"I had planned to go pre-med when I was 19, but I had a brain tumor. I had surgery to remove the tumor, and it went badly. I decided I wanted to help people in a different way after surgery. The College of Natural Sciences had a major impact on not only my education, but also my future career endeavors because it completely elevated my understanding of human behavior. I worked in a psychology research lab directed toward developing a new treatment model and therapeutic protocol for individuals dealing with diseases. I aim to integrate my psychology and social work degrees to create new treatment models, improve standards of care, empower individuals, and better understand human behavior throughout my entire career. The college fostered my interest and passion for psychology, human behavior, and helping others."

## LOUIS MORALES SHNAIDER

**Biological Sciences – Class of '19**

"I started as a college athlete at Metro State University in Denver. When I transferred to CSU, I relinquished my athletics scholarship and got accepted into the pre-med track. College classes were rigorous, and as a first-generation student, the only support I got from my parents was, 'keep studying.' Succeeding involved a lot of growth. Thanks to my experience in the College of Natural Sciences, though, I am now getting my master's in biomedical science and biotechnology at the University of Colorado Denver Anschutz Medical Campus and applying to medical schools. I want to be a role model for my community and for other minorities and first-generation students, letting them know there is a person of color who is in this rigorous field – and you can do this too."

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