

# ELEMENTS 2021



COLLEGE OF  
NATURAL SCIENCES  
COLORADO STATE UNIVERSITY

# WE ARE FUTURE FOCUSED

FROM THE MICROSCOPIC  
TO THE GALACTIC,  
THE DISCOVERIES WE MAKE TODAY  
PROPEL FUTURE INNOVATIONS.





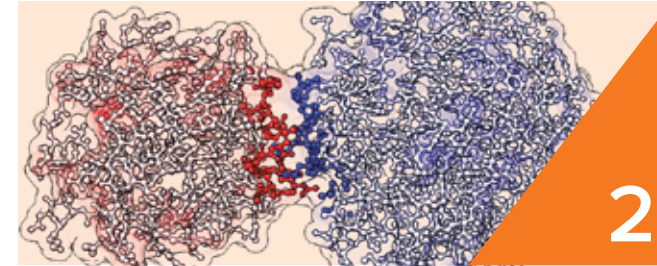
## A LETTER FROM THE DEAN

The North Star, the anchor of the northern sky, has been a symbol for direction and inspiration throughout history. It is a point upon which humanity can set its focus. In the College of Natural Sciences, we look to our North Star – our mission to lead transformative research, education, and community engagement; remove barriers to access; and foster a spirit of inquiry – and we set our focus on the future. We perform research to find answers to profound challenges, continually improve our courses and programs to ensure students graduate with the skills they need to enter an ever-changing world, and find new ways to promote scientific literacy throughout our community and globally. As I look to the future, I stay focused on our North Star, and I can only imagine how our College will continue to lead and transform the world. The disciplines that we study create the foundational knowledge needed to propel future innovations. I hope you enjoy this issue of *Elements* – you’ll find remarkable stories of accomplishments and boundless inspiration.

*Jan Neger*

Janice Neger, Dean  
College of Natural Sciences

# ELEMENTS 2021 TABLE OF CONTENTS



### IMPROVING HUMAN HEALTH /

Advancing Human Health.....	2
Getting to the Heart of the Matter With COVID-19 Patients.....	4
Where Is the Pollution? Identifying Trends in Daily Exposure.....	5
CBD’s Effect on Alcohol Use Disorders.....	5



### EXPANDING SCIENTIFIC LITERACY /

Educating CSU’s Students.....	6
Supporting Science and Math Teachers.....	8
YouTube Channel Promotes Scientific Literacy Internationally.....	9



### FOCUSING ON SUSTAINABILITY AND NEW ENERGY /

Scaling Up: Addressing the Climate Crisis.....	10
Is It Time To Create a Government Agency Focused on Climate? ..	12
Innovative Curriculum: Sustainability in Chemistry.....	13
Sustainable Catalysts Transform Chemical Creation.....	13



### PREPARING FUTURE LEADERS IN STEM /

Hands On: Learning Through Experience.....	14
A Powerhouse of Her Own.....	16
CSU Classes Launch Alumnus’s Career as a Leader in Tech.....	17
Critical Skills: Data Science Curriculum.....	17



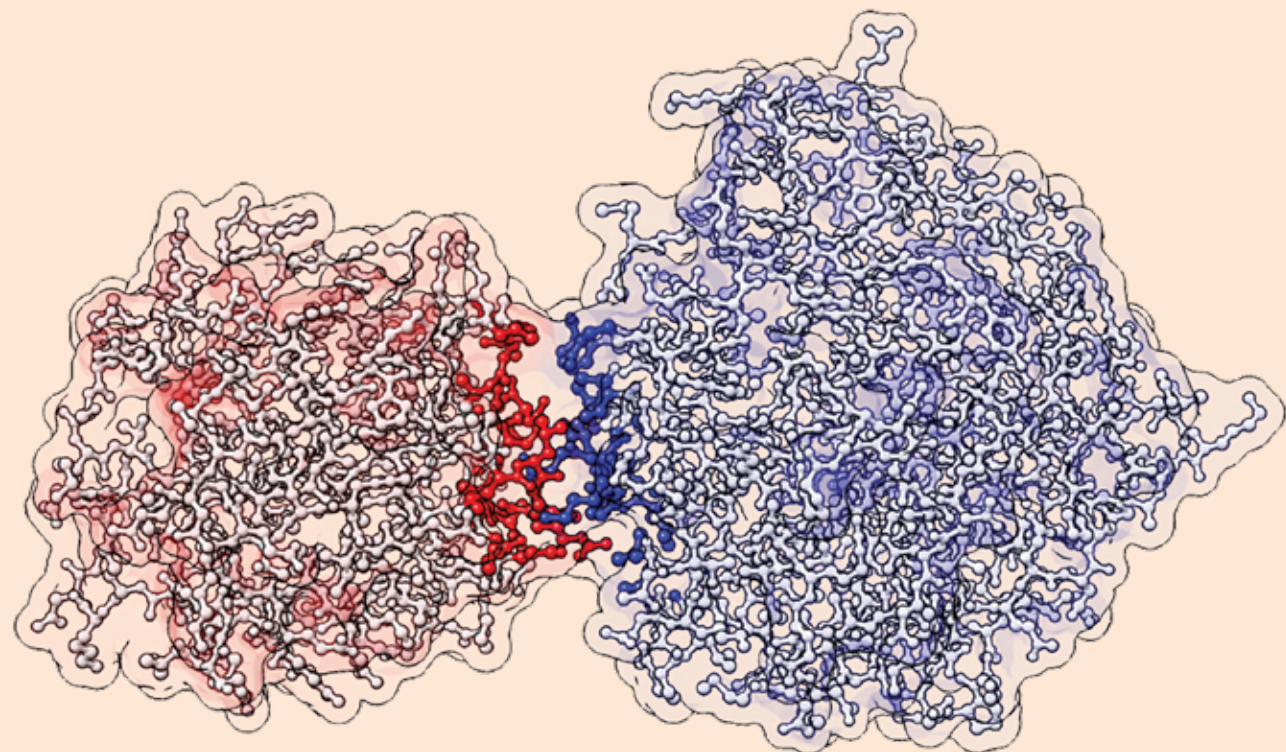
### ADVANCING TECHNOLOGY AND SECURITY /

On the Frontlines of Cybersecurity.....	18
Innovating the Future.....	20
Augmenting Reality.....	21
Computer and Data Sciences Meet Chemistry.....	21



### COLLEGE OF NATURAL SCIENCES /

Dean’s Leadership Council.....	22
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One of the protein complexes used to train a neural network for predicting protein interfaces (protein data bank ID 4M76).

## ADVANCING HUMAN HEALTH

BY LISA STREEB CASE

**R**esearchers in the College of Natural Sciences are on a constant quest to uncover new, fundamental knowledge about living systems. This curiosity leads them to ask big questions: How can we better use computation to understand protein interactions? Could dementia patients see cognitive improvement with personalized social interactions? Can we create better tools to visualize the underpinnings of cellular activity? The drive to answer such questions leads to discoveries with major implications for human health.

### MACHINE LEARNING TO BETTER UNDERSTAND OUR CELLS

A human cell is filled with millions of proteins, and how these proteins interact is critical to cellular health and functioning. Identifying and describing all such cellular activities is a big task. Enter machine learning and, more specifically, the area known as deep learning.

Deep learning architectures are inspired by the human brain. Computer scientists create deep learning programs and algorithms that, like the human brain, are able to learn by

taking in large amounts of data. “Deep learning has shown amazing accuracy to predict and identify objects in images,” said Asa Ben-Hur, professor of computer science and data science. “We asked ourselves if we could use these tools to better identify and describe proteins and their interactions.”

Ben-Hur and his students created a deep learning program and fed the program millions of data points from the Protein Data Bank, a database filled with the 3D structures of proteins. Using this machine learning program, Ben-Hur was able to train a computer to accurately predict the sites of protein-protein interactions.

This research has many potential applications, including creating targeted therapeutics that work inside cells to interrupt or encourage specific protein interactions. A paper published in 2017 about this research has been cited more than 300 times, showing the impact of Ben-Hur’s work.

### MUSIC AND NEUROPSYCHOLOGY – HOW SOCIAL PRESCRIBING IMPROVES DEMENTIA OUTCOMES

Dementia and dementia-related diseases are a widespread issue for aging populations. In the United States, a common treatment for dementia is pharmaceuticals. However, research from Deana Davalos and the Enriched Aging team has found that “social prescribing” – where patients are prescribed social activities – can be a powerful tool to improve cognitive function for people living with dementia.

“In 2015, we began research modeled after a group in Arizona who created the B Sharp program that provided music enrichment opportunities for people with dementia,” said Davalos. “They found that participants’ dementia symptoms seemed to improve. But they didn’t know why; no one was doing research on this yet.”

That was when Dr. Jeni Cross invited Davalos and other colleagues to get involved. Over the past several years, she has been part of a team facilitating the B Sharp program in Fort Collins in partnership with the Fort Collins Symphony.

*“Aging can be associated with cognitive decline and can be accelerated in people with conditions such as dementia. What I expected to find with this research was to see those declines become lessened,” said Davalos. “What we found instead was surprising. Not only was decline lessened, but we also actually saw people starting to improve cognitively.”*

This research has expanded to look at the role of caregivers and effects of the program on their lives.

“Caregivers for people with dementia have a higher risk of getting dementia themselves,” said Davalos. “We have been thrilled with what we have seen so far for caregivers in this program. They have reduced stress and greater sense of belonging and connection with the person they are providing care to, and they have found an amazing support network by meeting each other.”

As this project progresses, Davalos and the Enriched Aging team plan to collect more data and have more participants, with the goal of being able to have individualized social programming care for participants.

“I could see us having a survey someday with five questions on it for caregivers to fill out,” said Davalos. “With those questions answered, we could provide a specific social interaction program that would be personalized for the person living with dementia, based on their interests and patterns of decline.”

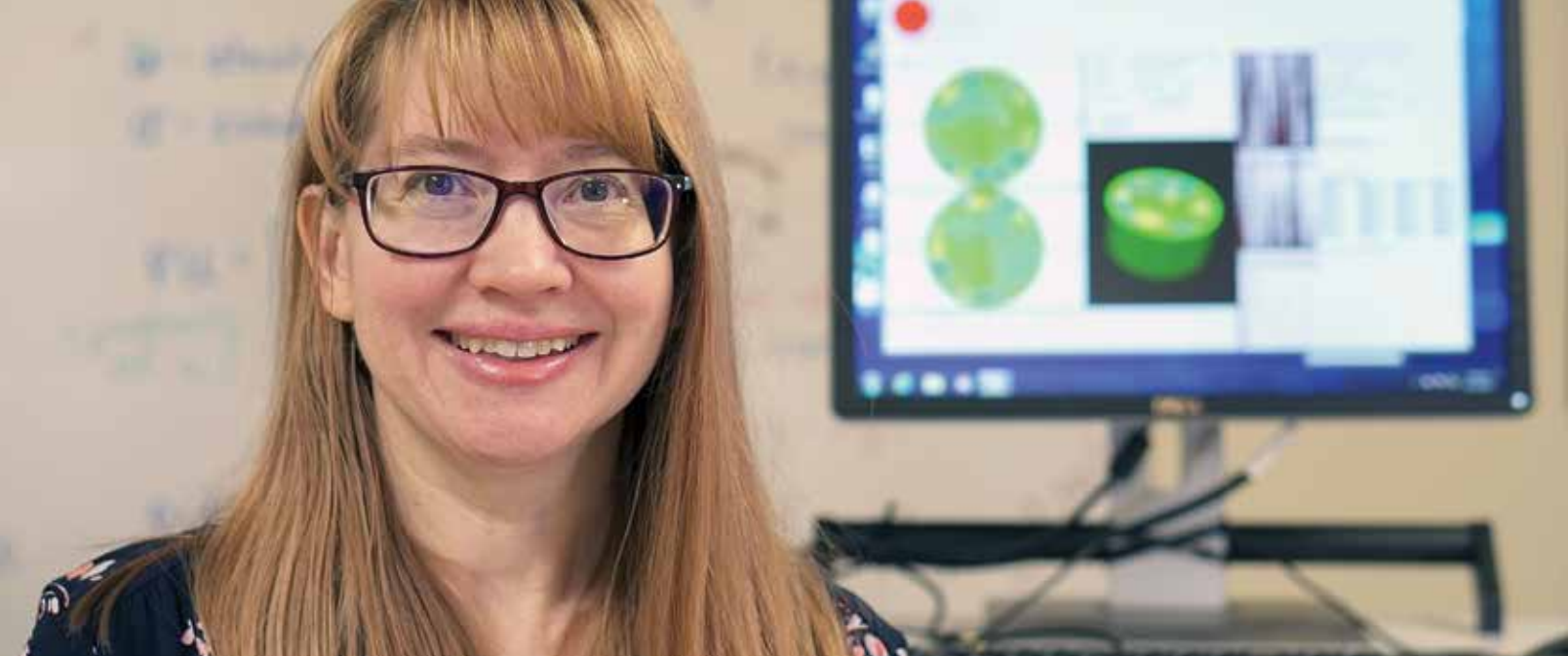
### RESEARCHING THE ORIGINS OF DISEASES IN LIVING CELLS

Biochemist and protein engineer Ning Zhao wants to understand the complexities of human cells – a pursuit that was made easier by her creation of “frankenbodies.” Frankenbodies, which Zhao developed as part of her postdoctoral research in CSU Monfort Professor Tim Stasevich’s lab, are intracellular antibody-based probes that allow for visualization of newly synthesized proteins while they’re still attached to mRNAs in living cells. In her recent research, Zhao is using these frankenbodies to investigate protein folding and misfolding live.

“Proteins must fold correctly to be able to perform their function,” said Zhao. “If they do not, this can cause bad health outcomes and degenerative diseases, including Alzheimer’s, Huntington’s disease, and cystic fibrosis.”

“My long-term goal is tracking proteins from birth to death and understanding how cells regulate gene expression and maintain intracellular protein balance. For my current research, I’m aiming at seeing the hard-to-see protein folding process co-translationally at single mRNA level in living cells,” said Zhao. Frankenbodies are a key tool in Zhao’s research because they allow researchers to visualize, among other things, single-molecule RNA translation.

In recognition of her research’s impact, Zhao has received the National Institutes of Health K99 Pathway to Independence Award for outstanding postdoctoral researchers. ●



## GETTING TO THE HEART OF THE MATTER WITH COVID-19 PATIENTS

BY ANNE MANNING

**C**COVID-19 is a respiratory illness that can lead to lung failure, requiring some patients to be sedated and placed on mechanical ventilation.

Helping extremely ill patients like this is the motivation behind a new study led by Jennifer Mueller, a professor in the Department of Mathematics and the School of Biomedical Engineering, and a Professor Laureate in the College of Natural Sciences. Mueller specializes in a noninvasive pulmonary imaging technology called electrical impedance tomography, and her goal is to help patients receive more targeted care and have better chances of recovery.

Teaming up with Dr. Ellen Burnham at the University of Colorado Anschutz Medical Campus, Mueller is supported by the National Institutes of Health on a COVID-19-focused study aimed at proving the clinical relevance of electrical impedance tomography, or EIT. Using an investigational EIT system produced by collaborators at GE Research, Mueller and colleagues are examining the lungs of COVID-19 patients undergoing mechanical ventilation to help doctors make decisions about individual patients' care.

As part of the study, Mueller is also partnering with Dr. Julie Dunn at the University of Colorado Medical Center of the Rockies. There, Dunn will lead imaging of patients suspected of having pulmonary embolism, or a blood clot in the lung, in order to validate EIT for computing ventilation perfusion ratios. These are measures of how well both air and blood are reaching the lungs.

The project is supplemental to ongoing NIH-funded work Mueller has led in collaboration with Dr. Emily DeBoer at

Colorado Children's Hospital, in which they've used EIT to image the lungs of patients with cystic fibrosis, spinal muscular atrophy, and bronchopulmonary dysplasia.

In the wake of the COVID-19 pandemic, Mueller received the supplemental NIH funding that allowed her to shift her EIT research to study COVID-19 patients suffering from acute respiratory distress syndrome. EIT, Mueller said, could provide doctors with simple, safe, targeted ventilation and intervention strategies for COVID-19 patients.

### BRINGING EIT TO THE CLINIC

EIT is not currently used in clinical settings in the United States. For more than two decades, Mueller has led pioneering studies aimed at proving out the technology and getting it ready for use in hospitals and doctors' offices. Mueller says the NIH-funded work could pave the way for the first commercial EIT system available in the U.S.

For imaging inside the body, doctors typically use gold-standard imaging such as computerized tomography or magnetic resonance imaging. Both require expensive machinery and are not suitable in all settings, particularly with children. EIT, on the other hand, is noninvasive and nonionizing and provides real-time data.

"Although the resolution of EIT cannot compete with that of CT and MRI," Mueller said, "the images still provide real-time regional maps of ventilation and perfusion in the lungs. This can't be obtained with any other imaging modality, and you can do it safely and continuously at the bedside, for as long as you want. Any age is fine, including kids and babies." ●

## WHERE IS THE POLLUTION? IDENTIFYING TRENDS IN DAILY EXPOSURE

BY ALLIE RUCKMAN



**I**f you think about the who, what, where, when, why, and how of scientific research, Lauren Hoskovec, a doctoral student in the Department of Statistics, studies the "how."

Her current question is: How can we determine an individual person's exposure to pollutants throughout the day?

Hoskovec's research utilizes data from the Fort

Collins Commuter Study and a self-developed method to answer this question.

For multiple days, 45 Fort Collins residents wore personal exposure monitoring devices that gathered pollutant exposure data every 10 seconds. The data helped in identifying different microenvironments – home, work,

transportation – and how pollutant exposure changed in each of these locations.

Hoskovec created a unique exposure assessment model to analyze this data that identifies shared states of exposure among multiple people that reflect changing activities within microenvironments. Even without exact information on where someone is, the model finds hidden activity patterns and is able to infer details about someone's life based on their pollutant exposure. If there is missing data, likely due to human error, the method is able to pretty accurately fill in the missing points.

The model has already started to indicate interesting trends. For example, around 7-9 a.m. and 5-9 p.m. Hoskovec found a spike in pollutant exposure for some people, a trend that could indicate exposure during cooking.

"Long-term, I feel like this method has a lot of potential to be scaled up," said Hoskovec. She envisions this method one day being as convenient as an app, where you could track your pollutant exposure through your phone. Her model could aggregate data from across the user's city, identifying pollutant hot spots and increasing targeted interventions and better health outcomes. ●

## CBD'S EFFECT ON ALCOHOL USE DISORDERS

BY LISA STREEB CASE



**C**an CBD help people who are experiencing alcohol use disorders drink less? Or does it cause them to drink more? These are the questions that psychology Assistant Professor Hollis Karoly is asking with her current research project.

"It is common for people who regularly drink alcohol to also report using cannabis products,"

said Karoly. "Early research in rodents suggests that CBD might reduce alcohol consumption, but we don't know whether the same holds true for humans."

Karoly is interested in understanding the relationship between these two substances and if CBD can be used to reduce harmful effects of drinking for people living with an alcohol use disorder.

The study, which is currently underway, will use subjective feedback from participants and objective tracking of cognitive and motor performance, as well as monitoring of breath alcohol level, to further understand how a person's brain and body are reacting to the combination of CBD and alcohol.

Karoly's work will also expand into other cannabinoids, including THC, through a mobile testing lab that is currently being built.

"There is not enough research into cannabinoids," said Karoly. "We want to better understand how CBD and alcohol might impact each other so that people can make informed decisions." ●



## EDUCATING CSU'S STUDENTS

BY LISA STREEB CASE

**F**oundational science classes are critical to the education of CSU students. These classes teach the fundamentals of biology, chemistry, math, and more – subjects that are important to nearly every field of study. Beyond that, these classes teach students an important skill set that includes critical thinking, data analysis, problem-solving, communicating, and working in a lab. That is why 90% of all CSU undergraduates on the Fort Collins campus take at least one College of Natural Sciences class.

### LEARNING ABOUT LIFE

Understanding how life works is fundamental knowledge needed by CSU students. That is why the LIFE courses are taken by many first-year students.

“LIFE courses provide a strong foundation that sets up students to succeed in later science classes. We focus on fundamental biology concepts and vocabulary,” said Kim Hoke, professor of biology and director of the LIFE courses. “We also work on developing skills that are common to all sciences.”

In the LIFE core curriculum, students learn about living systems – from the molecular level to the ecosystem level. With such broad course material, these classes have applications for many majors at CSU.

“Basic biology knowledge can help students prepare for many other careers that focus on applications of biology,” said Hoke. “For example, engineers, statisticians, mathematicians, and computer scientists might focus their careers on developing tools to understand biology. Forestry, agricultural biology, biochemistry, health sciences, and environmental science all build on some of the basic biological principles we introduce in LIFE.”

These courses also help first-year students learn how to study and manage their time outside the classroom.

“We want to help students fine-tune their study habits so they can be successful in later courses. We also want students to deepen their understanding of the process of science, from asking good questions to designing experiments and interpreting outcomes,” said Hoke.

*One way that LIFE instructors are ensuring student success is by employing undergraduate learning assistants – students who have taken the course before and are coming back to assist current students with their learning.*

### LEARNING THROUGH APPLICATION

Calculus is a critical class for many majors at CSU because it teaches students how to quantify, model, and discuss how things change – an important tool for innovating in fields from engineering to medicine to economics. However, the skills learned in calculus go way beyond just calculations.

“Not only does calculus provide tools for solving problems in many fields,” said Hilary Freeman, senior instructor in math. “It also teaches how to think about problems creatively.”



Calculus problems require pulling tools from other math disciplines to find a solution. There is no ‘one-size-fits-all’ formula to follow, so students must get creative.”

This creative problem-solving is integrated into the calculus curriculum through interactive lessons and group work that encourage students to engage in their learning in many ways. Lessons are taught theoretically and with specific applications to expand the students’ knowledge. The grading system in the class focuses on learning, and a variety of assignments are given to allow students to demonstrate understanding according to their strengths. The Calculus Center is also available to students to provide additional learning and tutoring opportunities.

Freeman hopes that her students walk away from the class with increased confidence.

*“I hope students learn to be independent thinkers as well as collaborators,” said Freeman. “I hope they gain an appreciation for the language of mathematics and confidence in thinking mathematically.”*

### LEARNING IN THE LAB

The skills necessary to pursue a research project – asking questions, making educated guesses, thinking critically, and communicating results – are also important skills that students will need when entering the workplace. These skills are not gained through simply consuming knowledge found in a textbook or online. That is why chemistry laboratory classes are an important part of many students’ majors at CSU.

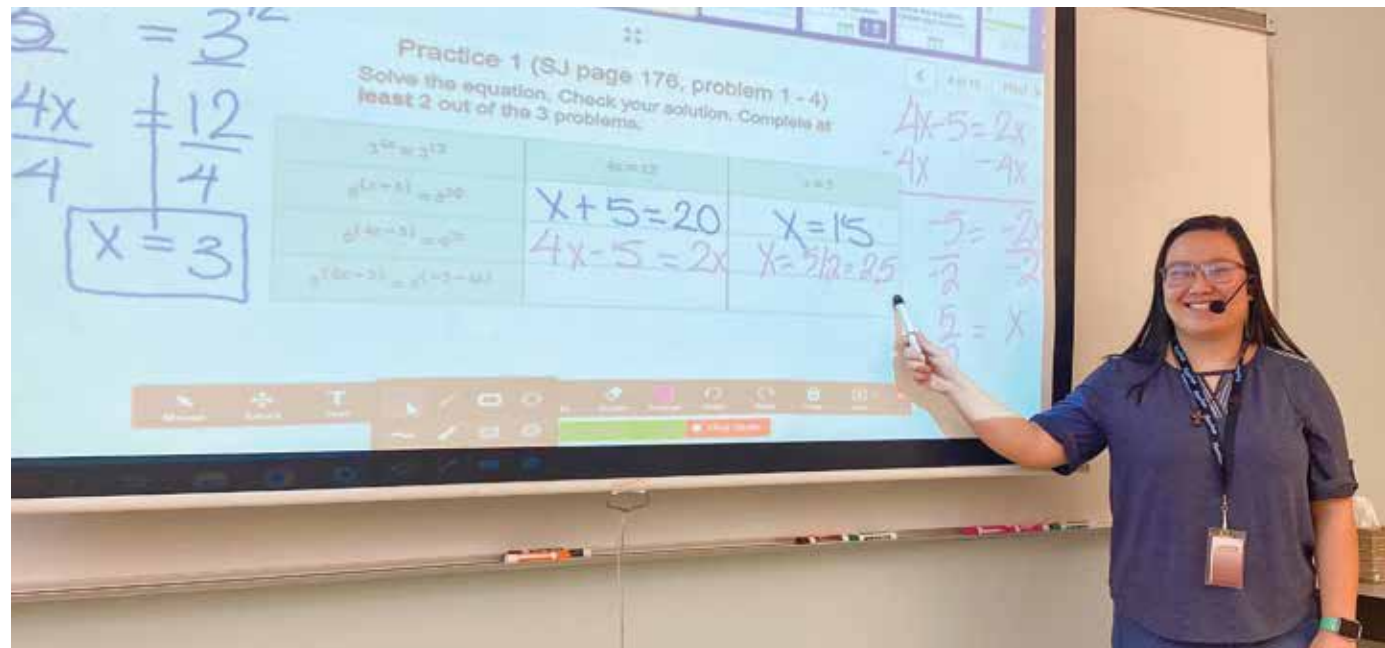
“We are focused on having students develop mindsets that begin to shift them from knowledge consumers to knowledge creators,” said Ben Reynolds, assistant teaching professor in chemistry. “Scientific discovery isn’t about looking up pre-existing answers; it is about creating knowledge through experimentation and empirical methods.”

Chemistry lab curriculum focuses on introducing scientific ways of thinking beyond just verifying information in a textbook.

“In our labs, we are most concerned about how we arrive at scientific knowledge and how those claims are supported,” said Reynolds.

The concepts learned in chemistry lab have applications in many fields of study.

“Every material encountered in daily life and in every field of study is made of chemicals,” said Reynolds. He notes that the application of chemistry knowledge is important to everything from creating vaccines to properly storing and displaying artifacts. ●



## SUPPORTING SCIENCE AND MATH TEACHERS

BY LISA STREEB CASE

Science and math teachers can be transformative figures in children’s lives. Having a teacher who has expert knowledge in the subject matter they are teaching and a passion for their work can increase a student’s curiosity and creativity in science, technology, engineering, and math. By encouraging scientific curiosity and literacy, teachers are giving kids important life tools, including the ability to think critically, problem-solve, and communicate complex information.

“When people have scientific literacy, they are more prepared to be engaged community members and make informed decisions to make their world a better place,” said Meena Balgopal, professor in the Department of Biology.

For the past 10 years, the College of Natural Sciences has been involved with the Robert Noyce Teacher Scholarship Program through the National Science Foundation. This program, combined with specific curriculum designed for STEM teachers, supports teachers through their education and in their first few years on the job.

“STEM teachers are expected to do a lot. They must increase both content knowledge and competencies of their students, while also increasing their students’ confidence and sense of belonging in STEM disciplines, all while managing a classroom and building a community for the students,” said Balgopal, who is a principal investigator on numerous Noyce grants.

Through the Noyce Scholarship program, teachers are paired with mentors and join a national community of

practice that they can reach out to as they begin their careers. The program also provides financial support and a way for teachers to submit data back to CSU so researchers can track teaching best practices.

“After receiving the Noyce Scholarship while at CSU, I was able to attend many different conferences and meet teachers from around the country,” said ThanhTu Nguyen, a Noyce Scholarship recipient who is now a math teacher at Mountain Range High School in Westminster, Colorado.

“Through these Noyce conferences, I have learned many skills and resources that support my teaching career. I have also met many scholars who I still keep in touch with, and I’m thankful to the Robert Noyce Foundation for it.”

Nguyen’s first year of teaching was during the beginning of the COVID-19 pandemic. This presented many challenges, including the need to teach in remote and hybrid environments.

“The pandemic brought many changes to the school year, and my most difficult challenges were adapting to the different learning models. At times, I was fully remote, and other times I taught hybrid where students were both in person and online,” said Nguyen.

Now that her classes have moved back to fully in person, Nguyen says that she is enjoying seeing the kids in class.

“My most memorable part of the year was watching students getting excited coming to math class and rolling their eyes at my math jokes,” said Nguyen. ●

## YOUTUBE CHANNEL PROMOTES SCIENTIFIC LITERACY INTERNATIONALLY

BY ALLIE RUCKMAN

When COVID-19 hit the U.S. last year, it became apparent that our virtual environment is becoming increasingly important. In order to keep pace with the increased need for virtual resources, scientific literacy efforts had to adapt. This is what Henry Adams, a professor in the Department of Mathematics, achieved with his YouTube channel titled the Applied Algebraic Topology Research Network.

The channel focuses on applied topology, the mathematic study of shapes and surfaces in higher dimensions.

“When the COVID-19 pandemic began, we realized that our online platform could help keep the applied topology community active, despite the postponement of in-person conferences,” Adams said. “We started an interview series, in which members of our community tell stories from their academic and professional paths, share professional development advice, and describe their visions for how applications of topology may continue to grow and evolve.”

Adams, along with Teresa Heiss, Hana Dal Poz Kouřimská, Sara Kališnik, and Elchanan Solomon, directs the channel, which contains more than 325 videos of talks, interviews, and tutorials. During the pandemic, the channel also hosted a talk series for early career researchers and ran a tutorial-a-thon that challenged community members to create a library of short tutorial videos.

The channel started in 2014, and pre-pandemic had around 540 subscribers and three hours watched per day.

“We now have over 2,550 subscribers and about 20 hours watched per day,” said Adams. “We are optimistic that freely available online opportunities will continue to expand in all areas of academia, now that we have learned how to reach a more geographically diverse audience.”

YouTube has proven to be an incredibly valuable tool in sharing high-level content as it is free, the content is easy to find, viewership tends to increase over time, and it can reach audiences internationally. Viewership has ranged from Germany and India to South Korea, Cameroon, and the United Kingdom.

“We are inspired by the fact that with tools like YouTube, we can help improve mathematical literacy not only in Colorado but also globally,” said Adams. “Mathematicians need to communicate how our tools are relevant for real-world problems, and I hope that our YouTube channel aids these efforts by including videos on a wide array of interdisciplinary applications. The most popular videos on our channel are the tutorials and interviews that are targeted at non-mathematicians. We take this as evidence that the global demand for content allowing one to increase their scientific literacy exceeds current supply – so there is much more work to be done!” ●





# SCALING UP: ADDRESSING THE CLIMATE CRISIS

BY ALLIE RUCKMAN

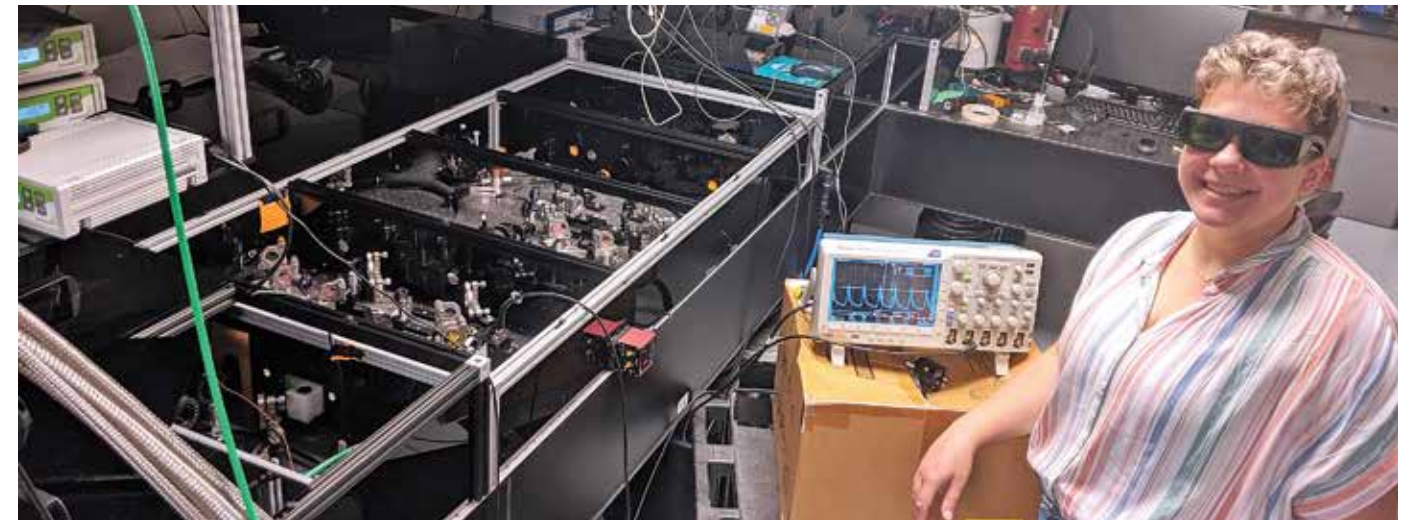
**D**iscoveries in foundational science often come when researchers investigate small things; small discoveries that when scaled up have massive impacts on people and the planet – a more efficient semiconductor material for solar panels, the breakdown of chemicals in batteries, the genetic adaptation of one species. Students across the College of Natural Sciences are using their expertise in the little things to pursue foundation-setting research that will have large-scale implications on sustainability issues.

Clara Tibbetts, Rebecca Cheek, and Pascal Jundt were named sustainability leadership fellows by the School of Global Environmental Sustainability because of their outstanding research.

### INCREASING BATTERY LIFE

Lithium-ion batteries are at the core of many devices, including cell phones. These batteries are also key to more efficient renewable technologies.

Lithium-ion batteries are powered by the movement of lithium inside the battery while it is charging. Batteries often



break down due to liquid materials inside decomposing and preventing the necessary movement of lithium, thus shortening the battery's lifetime.

Clara Tibbetts, a Ph.D. candidate in the Department of Chemistry, measures the breakdown of battery components with the hope of translating her findings into increased battery life, which is critical to the success of renewable energy sources.

Molecules in a liquid move on the order of femtosecond timescales. A femtosecond is to a second, as a second is to 32 million years. To capture these incredibly fast dynamics, Tibbetts uses 100 kHz 2D infrared spectroscopy to capture molecular motions in different environments.

Tibbetts plans to create a “chemical movie” of a running battery to watch the breakdown process inside, giving her a better picture of how each component plays a role in the overall battery operation.

“Hopefully, this investigation can help pave a path to better understand what battery modifications could further improve efficiencies and lifetimes,” she said. “Investment in better understanding battery technology is crucial to an effective transition to renewable energies.”

### PRESERVING GENETIC DIVERSITY

Genetic and biological diversity are essential to productive, efficient ecosystems, which in turn are essential to the wellness of humanity and the planet. As the climate changes, it is important that scientists understand diversity and niches on small scales, in order to scale up and preserve the many unique ecosystems present on Earth.

Evolutionarily, animals possess traits encoded by DNA that help them survive. Rebecca Cheek, a Ph.D. candidate in the Department of Biology, is researching how variation in DNA within a specific species corresponds to differences in traits that could help individuals within that species survive.

She is specifically looking at how differences in beak shape correlate to patterns in the DNA of Island Scrub-Jays. She hopes to understand the evolutionary mechanisms that drive and maintain adaptive traits in this specific species of bird.

In the short term, Cheek's research will inform the management of the Island Scrub-Jay. In the long term, she hopes her work will create a robust framework to further test for microgeographic adaptation in other species. Studying microgeographic adaptation, or adaptation within very small spatial scales, allows scientists to admire and preserve the full range of evolutionary histories and niches needed for wildlife populations to continue to survive in changing environments.

“Studying how genetic diversity is shaped across time and space is critical if we are to sustain biological diversity,” said Cheek.

### IMPROVING SOLAR POWER

Today, most solar cells are made of silicon, a semiconductor material that is ubiquitous in electronics. The second-most common type of cell is made from cadmium telluride.

Cadmium telluride is easier, faster, and cheaper to manufacture than silicon. It absorbs more light so the cells can be made much thinner. It also has the fastest energy payback time of all solar technologies, meaning that within a year, the cells are able to produce the same amount of energy that it took to create the cells.

However, silicon is still more efficient.

Because of cadmium telluride cells' advantages, Pascal Jundt, a graduate researcher in the Department of Physics, is researching methods to increase their efficiency.

“Simply put, we are trying to make cadmium telluride more efficient without sacrificing any of the advantages,” said Jundt.

Jundt shines lasers on solar cells to determine why a cell is more or less efficient. With this method, he can answer questions about the material quality and interfaces between the cell's materials and structure to identify good and bad characteristics of a cell, helping guide research.

“Cadmium telluride is rapidly catching up to silicon. If it can match the performance of silicon, we will have a truly amazing technology on our hands,” said Jundt. ●





## IS IT TIME TO CREATE A GOVERNMENT AGENCY FOCUSED ON CLIMATE?

BY ANNE MANNING

Few will deny that climate change is the crisis of our time and demands radical solutions. A group of Colorado State University faculty have a fittingly radical idea for how to fund and deploy such solutions.

Their idea – a new federal agency focused squarely on climate issues – was reflected in President Joe Biden’s budget proposal to Congress.

The faculty group, a CSU Energy Institute leadership corps from the College of Natural Sciences and other departments, dubbed their proposed new agency “ARPA-C,” or Advanced Research Projects Agency-Climate. Working off a similar model first implemented by the U.S. Department of Defense and later the U.S. Department of Energy, they envision a climate agency as a catalyst for innovation to solve climate-related problems. But critically, the mission of such an agency would place issues of culture and equity front and center alongside new science and technologies.

The researchers described their vision for ARPA-C in a commentary piece published by the American Geophysical Union journal *Earth’s Future*. The authors are Lynn Badia, assistant professor in the Department of English; Josie Plaut, associate director of CSU’s Institute for the Built Environment; Joseph von Fischer, professor in the Department of Biology; John Volckens, professor in the Department of Mechanical Engineering and the School of Biomedical Engineering; and Jeff Muhs, associate director for programs and initiatives at the CSU Energy Institute.

“The technologies that humans have innovated are deeply interwoven with culture,” von Fischer said. “If we try to fix climate change with a new widget, we ignore all the features of climate change that are not strictly about technology but are really about human behavior, culture, economics, and society.”

In early 2019, the group began meeting informally, and the idea for ARPA-C began to crystallize. They drew on the experience of Muhs who, as a legislative fellow for U.S. Sen. Lamar Alexander earlier in his career, had helped codify a set of recommendations to the National Academies of Sciences, Engineering, and Medicine that led to the creation of the Department of Energy’s ARPA-E in 2009.

In the spring of 2020, the faculty group went to Bill Ritter, former governor of Colorado and director of the Center for the New Energy Economy at CSU. He agreed to help them get the idea in front of the then-Biden campaign team.

Fast-forward to early 2021, with Biden in the White House. Members of White House Climate Director Gina McCarthy’s office requested the CSU team’s then-prepublished paper on ARPA-C. Soon after, McCarthy announced ARPA-C as part of Biden’s budget proposal that was delivered to Congress.

Whether or not the agency as proposed is funded in the final budget, the CSU group is now working to develop effective transdisciplinary strategies for climate research and education at CSU. ●

## INNOVATIVE CURRICULUM: SUSTAINABILITY IN CHEMISTRY

BY LISA STREEB CASE

Chemistry and sustainability have long been interconnected, as chemistry is both a cause of and solution to many environmental problems. End-use products such as modern medicine and new energy sources can greatly advance the quality of human life but can also generate large amounts of waste. Chemistry research is also at the forefront of creating new, more sustainable solutions to problems such as plastic waste.

The interconnected nature of chemistry and sustainability is why chemistry instructors Terry Gray and Harmony Tucker and Assistant Professor Kerry MacFarland have created chemistry curriculum that focuses on sustainability and the social, economic, and environmental impacts of chemistry. This new curriculum was awarded a Curriculum Innovation Grant from the School of Global Environmental Sustainability.

“We are teaching students about key structures and properties of pollutants and the associated problems with the use of such chemicals,” said Gray. “It is important to teach sustainability profiles as part of chemistry so that

students can understand the important role these chemicals are having in today’s world and how chemists can contribute to solving the environmental problems that we face.”

Each year, about 3,000 CSU students will take one of the chemistry courses where this new suite of learning tools is being deployed.

“Understanding how the processes observed in the small scale in our class can have potential global implications, helping students connect what may seem more theoretical to the real world,” says Tucker.

Topics of study for the students include greenhouse gases, fossil fuel use and carbon dioxide emissions, ammonia synthesis and use, acid rain, air and water pollution, and nuclear power.

“These are important topics to consider as a global citizen,” said Tucker. “In our classes, we extensively cover fundamental chemistry concepts and how they relate to the critical sustainability topics that are related to them.” ●

## SUSTAINABLE CATALYSTS TRANSFORM CHEMICAL CREATION

BY LISA STREEB CASE



in the Department of Chemistry is advancing the research behind chemical transformation catalysts and using a sustainable source of energy – light.

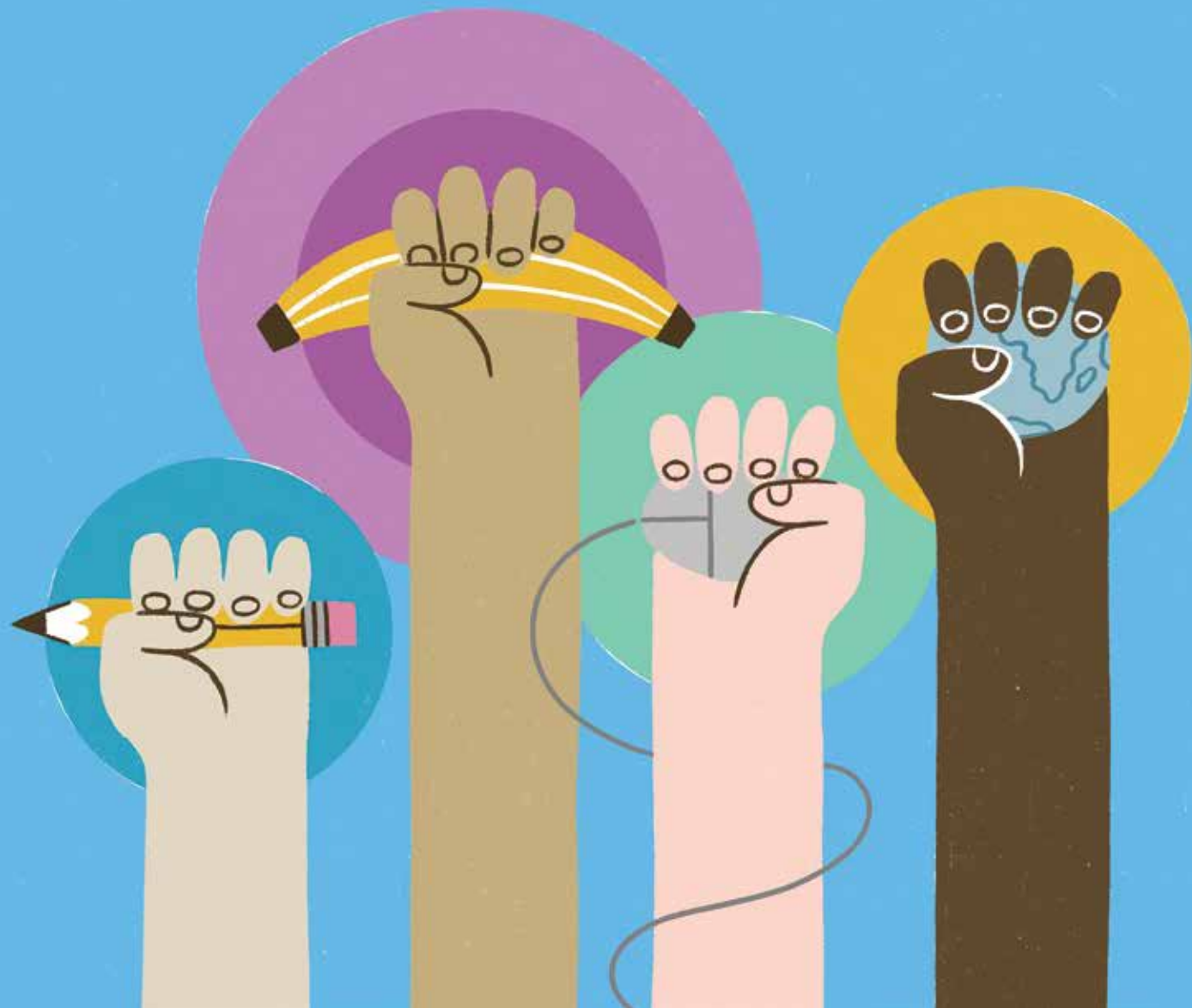
Chemical transformations are critical to the development of molecules and materials, the basic building blocks of everything from pharmaceuticals to plastics to energy sources. For a long time, the catalysts for chemical transformations required the use of precious metals and high heat – inputs that are not sustainable and require a lot of energy. To solve this challenge, Associate Professor Garret Miyake

“My research focuses on replacing existing high-energy catalysts with organic materials that can operate under mild conditions using the energy from light,” said Miyake. “We use light to power catalysts to open new chemical pathways to access and create new materials and molecules.”

Light is an infinitely sustainable way to create new materials and molecules. The implications of this research are far-ranging.

“Because we are using organic catalysts powered by light and not precious metals, we can create new polymers that have broad biomedical applications,” said Miyake. “We are also focusing on commodity chemicals, such as converting CO<sub>2</sub> to fuels such as methanol. This could take a dangerous greenhouse gas out of the air and convert it to a useful chemical.”

Miyake’s research is advancing to the next phase through two companies he co-founded with his former students – New Iridium, which is focused on commercializing light-powered catalysts, and Cypris Materials, which is creating coatings that reflect infrared light away from buildings and reduce the need for air conditioning. ●



# HANDS ON: LEARNING THROUGH EXPERIENCE

BY ALLIE RUCKMAN

**A** lot of students ask how they can prepare for their future careers. The answer? Hands-on experiences! Luckily, students in the College of Natural Sciences participate in a diverse array of experiences that are not only fun but also uniquely prepare them for careers in their fields.

“Employers across all industries recognize the value of hands-on learning for students, as well as the organizations that will hire them,” said Amy Cailene, career education

manager for the College. “CSU’s First Destination Survey of graduates consistently demonstrates that those who complete at least one internship or research experience have higher rates of landing jobs related to their majors, are more likely to have a job upon graduation, and receive offers worth thousands more than other candidates.”

### GOING BANANAS FOR SUMMER RESEARCH

Completing a research project related to a relevant field of study is a perfect way for many students to get hands-on experiences.



This is why Ryann Gregory, a master’s student in the Professional Science Master’s in Zoo, Aquarium, and Animal Shelter Management, studied methods to increase foraging behavior with orangutans at Cheyenne Mountain Zoo for her capstone this past summer.

In the wild, orangutans spend most of their days foraging and on the move, so it’s important that zoos continue to give the orangutans in their care the most authentic experiences possible. This is where Gregory’s research comes in.

“Great apes are a very intelligent species and need a lot of mental stimulation on a daily basis,” said Gregory. “So, zoos are always trying to find new ways to get them to engage with their environment.”

Gregory first started by taking a baseline, a set of measurements to figure out how long the orangutans foraged for scattered snacks in their enclosed area without any additional stimuli.

For the treatment, she used an animal vending machine that delivered a handful of snacks in exchange for a plastic token. The goal was to measure if the animals increase their foraging behavior with the presence of the vending machine.

Gregory hopes to one day work at a zoo in animal care with primates and, eventually, wants to become a primate or behavior curator. Her summer capstone research was directly related to this goal – she’s on her way to making it a reality.

### SECURING CSU’S NETWORK

Internships are one of the best ways to get hands-on experiences both on and off campus.

Bond Alexander, a senior in the Department of Computer Science, has been working as an intern, and now a team lead, on cybersecurity projects with CSU’s Division of IT for 2.5 years.

As a team lead, Alexander has written code for real-work applications, proposed projects to Central IT leadership, managed a team of interns, and been involved in the hiring process of new interns.

“I have no doubt that this experience will serve me well as I enter the industry after college,” he said. “My internship gave me perspective to see that even if the road to working in my industry may be hard, once I got there, the work would be fulfilling and, honestly, fun! I love my internship and the work I do. Being able to work on projects that I feel have an impact on my own growth as well as bettering CSU has made me see why everything I have to learn is important.”

### PSYCHOLOGY ABROAD

*The foundational sciences are international fields of study; thus, it is feasible for many students to get hands-on experiences while studying abroad. This is what the new First Year Psychology Seminar in Costa Rica hopes to promote.*

“Studying psychology abroad offers a unique opportunity to observe human and nonhuman behavior within a different culture,” said Kelli Gupton, an academic success coordinator in the Department of Psychology and a program leader for the seminar.

This CSU faculty- and staff-led program explores the diverse field of psychology, builds a skill base of successful academic strategies, and investigates cross-cultural psychology.

Sara Anne Tompkins, an assistant professor in the Department of Psychology and the other program leader, noted that the program is meant to facilitate a unique way of connecting with other students as well as provide exposure to languages, cultures, and experiences that can’t be shared as poignantly in the classroom.

The program will begin in Fall 2022, and Gupton and Tompkins can’t wait to share this incredible hands-on opportunity with their first class of students. ●

# A POWERHOUSE OF HER OWN

BY ALLIE RUCKMAN



“While we still don’t completely know whether or not the delivery of the [erm-1] message is required for a healthy intestine, at the very least we can potentially use this as a marker for the presence of disease,” said Winkenbach, who studies the effect of ERM-1 mis-regulation and regulation in small-worm intestines.

*“The finding suggests that undiscovered machineries and pathways bring mRNAs to membranes, and this is a brand-new idea,” said Laurie Stargell, chair of the Department of Biochemistry and Molecular Biology. “Lindsay Winkenbach is truly a gifted and remarkable young scientist.”*

## SHAPING SCIENCE THROUGH ADVOCACY AND INVOLVEMENT

Aside from her impressive research, Winkenbach was also named a 2020-2021 Vice President for Research fellow, honoring her as one of the “best and brightest graduate students from graduate programs across the institution,” according to the VPR website.

She is on the Biochemistry and Molecular Biology First Year Welcoming Committee, as well as the department’s Inclusion, Diversity, Equity Action Committee. She is the engagement officer for Science in Action and co-president of the Graduate Student Council. The GSC is a group that advocates for graduate students’ needs. They’ve been managing travel grants and professional development and supply grants to help support students’ participation in professional conferences and have helped provide them with funds to buy necessary technology during the COVID-19 pandemic, such as software to analyze data or new computers and hard drives.

“We’ve also been able to collaborate with the Graduate School to increase our access to mental health benefits by adding graduate students to the Employee Access Program and are working with folks from student health to increase health insurance coverage and improve health insurance literacy,” she said.

It is clear that Winkenbach is a powerful force in the STEM community at CSU, one that will not only shape the people here, but could impact millions through her research and community involvement. ●

Institutions like CSU are powerhouses of learning and discovery, but universities would be nothing without the intelligent, creative minds of the students, faculty, and staff who fill their halls.

Lindsay Winkenbach, a graduate student in the Department of Biochemistry and Molecular Biology, is a powerhouse of her own, and in her time at CSU has shaped the STEM community through her research, involvement, and advocacy.

## REVEALING NEW IDEAS ABOUT CANCER METASTASIS

Winkenbach studies a messenger RNA called erm-1 in the Osborne Nishimura Lab. erm-1 carries instructions to make the ERM-1 protein, which helps to maintain correct cell shape in developing embryos. The ERM-1 protein, made from the erm-1 messenger RNA, works at the edge of the cell to help link it with its neighboring cells, ultimately working to form a functioning organ.

Recent evidence links the regulation or mis-regulation of the ERM-1 proteins to cancer metastasis and progression. Preventing ERM proteins from maintaining the cell shape is thought to permit cancer cell invasion into healthy tissue.

# CSU CLASSES LAUNCH ALUM’S CAREER AS A LEADER IN TECH

BY LISA STREEB CASE



“Everything that I learned at CSU was the foundation for my career,” said Jeff Wood, a computer science alumnus who spent 25 years working at Hewlett-Packard and is now the chief strategy officer for Lenovo Workstations. Wood credits his long and storied career to his foundational education at CSU and the passion that he found in user experience.

Wood began his CSU career as an electrical engineering major, but in his second year, he took a computer science class that changed everything.

“I remember thinking ‘this is amazing, I can see a real application to this,’” said Wood. Wood went on to many

classes that were cutting edge at the time, but he specifically remembers CS 410 – Introduction to 3D Graphics.

“It was a difficult class, having to learn about viewports, camera angles, and light sources,” said Wood. “But I remember being amazed that I could write code that would draw something on the screen. I could see a visual result of what I was trying to accomplish.”

This class led Wood to pursue his first position in application development for 2D and 3D graphics. Through that work, he found his passion in the end-user experience and long-term product strategy. Since then, his career has focused on developing workstations that optimize workflows to meet challenging deadlines for his customers. Workstations – computers with high computing power, multiple graphics cards, and large data storage – are used by many industries to process and compute data with speed and efficiency. From movie producers creating computer-generated images to automakers designing the next vehicles, to aerospace engineers building jets and rockets taking us to new heights.

For today’s students, Wood has one piece of advice, “find your passion, the thing that will keep you motivated and moving forward.” ●

# CRITICAL SKILLS: DATA SCIENCE CURRICULUM

BY LISA STREEB CASE

Data scientists need a diverse skill set, one that combines the disciplines of math, statistics, and computer science, to allow them to process and analyze massive amounts of data. They also must have knowledge of their specific field of study – understanding where and how the data is collected informs their conclusions and guides their decisions. In the College of Natural Sciences, our data science major is cognizant of the skills needed by graduates and is structured to provide students with a deep understanding of these critical skills.

“The skill set needed by data science students is not fulfilled by only one discipline,” said Simon Tavener, executive associate dean for academics. “That is why we have made this an interdisciplinary degree at CSU.”

Students in data science take courses in the computer science, math, and statistics departments as well as specialized data science courses. Within the major, there are five concentration areas, with students in the economics and

neuroscience concentrations taking advanced courses in these disciplines. Students are encouraged to work together with people in different concentrations.

*“We think a lot about what skills they need in the workplace. These skills include the ability to work in teams and communicate between different people with varying expertise, but sharing a common language,” said Tavener.*

When students graduate with a data science degree from CSU, they will enter a career with high earning and growth potential. This program, which started in 2018, saw its first two graduates in Spring 2021 and is continually growing with the incoming Fall 2021 class being the largest to date. ●



## ON THE FRONTLINES OF CYBERSECURITY

BY LISA STREEB CASE

Over the past three decades, Internet-connected devices have proliferated every aspect of human life. From managing our day to day with thermostats, baby monitors, and smart phones, to running our country through military intelligence, supply chains, and more, we've never been more connected.

With the ubiquity of these devices, cyberattacks are a growing and daily threat to enterprises large and small. Such attacks can have broad impacts such as data breaches, shutdowns of critical infrastructure, losses of billions of dollars, and personal identity and privacy theft.

Cybersecurity is a rapidly changing field that exists to prevent, detect, and defend against cyberattacks. CSU is home to the Colorado Cybersecurity Center, where computer science faculty are on the front lines of cybersecurity research and are training students for the cybersecurity workforce.

### DETECTING PHISHING SCAMS

Phishing scams are one of the most prolific and detrimental forms of cyberattacks, causing billions of dollars in financial loss, stolen identities, and privacy breaches.

Indrakshi Ray, professor in the Department of Computer Science and director of the Colorado Cybersecurity Center, is fighting back against phishing attackers in many ways.

"It is like a cat-and-mouse game," says Ray. "Phishing scams are constantly changing, so we have to change with them."

One of Ray's research projects focuses on detecting phishing before it happens by identifying websites that are prone to attack. In these scams, an attacker lures a user to a malicious website that mimics a legitimate website. Here, website attackers can persuade users to give them their personal information.

"What we are doing is creating unique fingerprints for websites that we can use to detect when a malicious website is trying to mimic a legitimate one," says Ray.

Other phishing research projects Ray is working on include machine learning algorithms that can be downloaded to users' devices to detect such attacks or to flag fake social media accounts.

### SECURITY BY DESIGN – FISSION BATTERIES

Others at CSU are working to make emerging battery technologies more secure by incorporating cybersecurity into their core design. Fission batteries, now being developed by the Department of Energy, are showing promise as portable nuclear energy sources that could support transition to the new energy economy. They would allow power to be moved to remote locations, far from energy grids and to communities in need.

Because these batteries are autonomous, however, they cause security and safety concerns. Working on this problem is professor and cybersecurity expert Indrajit Ray in the Department of Computer Science, in collaboration with nuclear engineers at The Ohio State University, New York University, and DOE's Idaho National Laboratory.

"We want these batteries to be as autonomous as possible, and as secure and safe as possible with people being able to monitor them from far away," said Ray. "To do this, we need to incorporate security features at the design level."

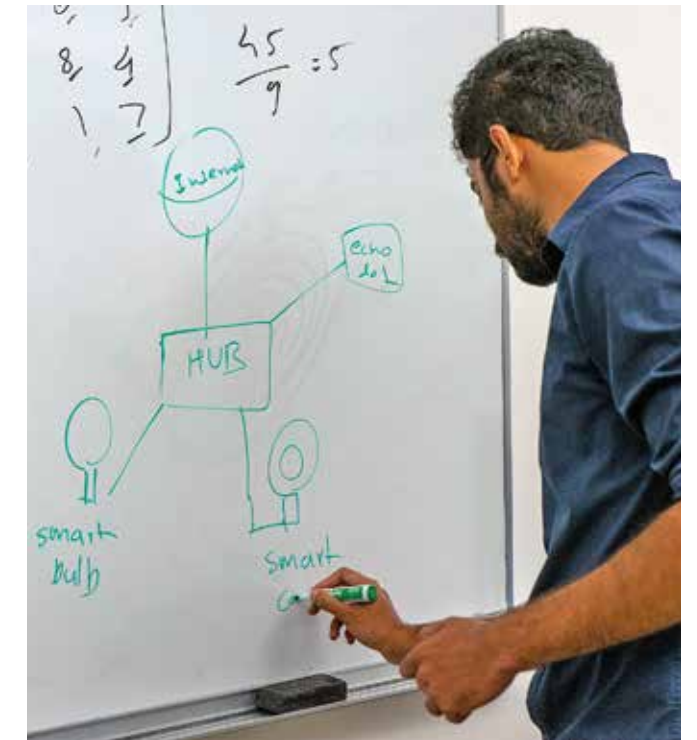
Once operable, these batteries can identify and deploy autonomous defenses in the event of a cyberattack.

"In the past, people have tried to add cybersecurity on to existing products or projects after an issue arises," says Ray. "With this project, we are thinking about potential future cyber issues and designing the batteries to combat those issues."

### PREPARING THE CYBERSECURITY WORKFORCE

Beyond the cutting-edge research taking place at CSU, students are also being trained as the next generation of professionals working to protect the data and cyber infrastructure of tomorrow.

All computer science students are required to know the fundamentals of cybersecurity – how to defend against



ransomware and data breaches and the basics of data privacy, said Joseph Gersch, assistant professor in the Department of Computer Science.

Gersch, who teaches cybersecurity courses, including Modern Cybersecurity and Blockchain Principles and Applications, ensures that his students are learning about emerging security threats and defenses.

"Topics include everything from cryptography to denial-of-service to firewalls to 'zero-trust,'" says Gersch. "We don't just teach the tools, we teach the methods that attackers use, so that when students graduate, they will have the knowledge to invent new technologies, processes, and methods in this rapidly changing field."

*In his courses, Gersch gives students hands-on experience in cyber defense by teaching them how to perform an attack.*

"We have labs in which they run experiments in an isolated environment where they can safely launch attacks and defenses," says Gersch. "They will do projects such as taking a vulnerable website and finding the different ways it can be hacked, then practicing defensive coding techniques so that the holes are filled in."

At least one cybersecurity course is required for every computer science student, with the goal that all students graduate with the foundational knowledge and skills they need for their careers. ●

# INNOVATING THE FUTURE

BY ALLIE RUCKMAN



Envision the future of technology where emerging advancements such as artificial intelligence are used in environmental research – to bolster accurate discoveries – and in classrooms – where sighted AI and human instruction intermingle to create personalized educational environments.

Faculty from the Department of Computer Science are building for this future as part of two of the five new AI research institutes being created as a result of a \$100 million National Science Foundation commitment to further AI research. Professor Chuck Anderson and his team are part of the newly formed Trustworthy AI in Weather, Climate, and Coastal Oceanography Institute being led by the University of Oklahoma. Professor Ross Beveridge and his team are part of the AI Institute for Student-AI Teaming being led by the University of Colorado.

## FORECASTING BIG WEATHER

*The Trustworthy AI in Weather, Climate, and Coastal Oceanography Institute is focusing on delivering fast, accurate, and trustworthy climate research.*

“Extreme weather events and climate change pose significant risks that are difficult to predict. This project aims to develop

new AI models for making such predictions faster and more reliable by discovering patterns across diverse kinds of information about the atmosphere, oceans, and other weather-related phenomena,” said Anderson. “In addition, our models will be able to explain their predictions in ways that experts can understand and trust.”

Hurricanes are best analyzed by observations taken from the microwave spectrum of light. Unfortunately, satellites that can provide this microwave imagery are few and far between, and other, more efficient satellites use only visible or infrared imagery.

This is where AI steps in – helping to piece together the relationships between what a storm looks like in microwave imagery and in visible or infrared light. This method is so fast that forecasters can work in real time.

## ‘SEEING’ THE FUTURE OF EDUCATION

*The AI Institute for Student-AI Teaming is developing AI partners that will facilitate collaborative learning in classrooms by interacting through speech, gesture, gaze, and facial expression.*

Beveridge is one of four co-principal investigators on the project and is focusing on enabling the in-classroom AI partner to see and make sense of what it is seeing.

“If you are doing a physics exercise in school with a set of items on a table, a blind agent isn’t going to be a very good partner in learning,” said Beveridge. “Sight is important.”

AI partners need sight to understand student interactions and engage in group conversation.

Beveridge and the computer vision group at CSU, working closely with partners at Brandeis University, are well positioned for this work. The team has created a multimodal embodied avatar system – known as the Diana System – that integrates computer vision and natural language processing so that it can listen, see, and interpret simultaneously.

“The NSF has a long history of creating revolutionary centers, but there aren’t that many of them, so they are a big deal,” he said. “It’s impressive that between Chuck Anderson and me we have managed to land CSU in two of these new groups.” ●

# AUGMENTING REALITY

BY ALLIE RUCKMAN

You may have heard of virtual reality, a technology that replaces your reality with a new one, but you might not have heard about augmented reality. Augmented reality uses glasses or headsets with optical see-through displays to augment, but not completely replace, what the user is seeing and experiencing.

While VR has great potential, it does tend to cause cyber sickness, a feeling similar to motion sickness. AR avoids this issue by leaving much of the user’s reality still visible through the glasses.

Francisco R. Ortega, assistant professor in the Department of Computer Science, runs the Natural User Interface Lab that has been exploring the world of AR and VR. This year, they have been moving toward immersive analytics, which allows for 3D visualizations in AR headsets. They’ve also been concentrating on integrating multiple inputs such as gestures

and speech into the AR technology, which will allow users to interact naturally with AR headsets using their hands, voice, and eyes.

For example, if someone was interacting with complex data in AR, they could, (1) see it in 3D space, and (2) interact with it via gestures, speech, and gaze-tracking. Ortega is also researching methods so that AR and VR can recognize micro-gestures, which are very small gestures that may produce less fatigue for the user over time.

Ortega’s end goal for this technology, at the moment, is to create adaptive user interfaces that can adapt and evolve based on the user they’re interacting with.

“This will, one day, allow everyone to be using glasses that can augment your reality, to improve work, school, and many other areas of life,” Ortega said. ●

# COMPUTER AND DATA SCIENCES MEET CHEMISTRY

BY CONNOR MCHUGH



Lilianna Gallegos is a fourth-year graduate student focusing on computational organic chemistry and machine learning. Gallegos currently studies under Dr. Robert Paton and does research as a member of the Paton Research Group at Colorado State University.

Gallegos said that facing daily challenges of maximizing yields and

ratio of desired products in synthetic organic chemical reactions “has inspired my graduate research work to develop tools that increase efficiency in the laboratory.”

In her research, Gallegos applies quantum mechanical modeling to the components in a reaction in order to understand the most probable reaction process to form the products along with statistical modeling.

“Lilianna is at the forefront of a new generation of ‘data chemists,’ able to apply methods from statistics and machine learning to challenging chemical problems,” said Paton.

Gallegos has been awarded the Frontera Computational Science Fellowship for the upcoming academic year. The Frontera Computational Science Fellowship is extremely competitive with only four recipients in the 2021-22 year. Through the fellowship, Gallegos will receive a \$34,000 stipend and \$12,000 of tuition assistance, the opportunity to connect with and receive guidance from other researchers and industry professionals, and access to the Frontera Computing resources.

Along with all this, Gallegos said, “This fellowship also allows me to compute my research on the most powerful academic supercomputer in the world!” Gallegos hopes that her research improves the optimization process of challenging organic reactions.

Gallegos will continue doing her exciting research at CSU, but she hopes to visit Frontera at the Texas Advanced Computing Center in Austin, Texas, in the future. ●

# DEAN'S LEADERSHIP COUNCIL

The College of Natural Sciences Dean's Leadership Council provides support to the dean to advance the College's mission, ensuring it realizes its research, education, engagement, and fundraising goals. The council assists the dean in implementing both short- and long-range goals, developing community outreach and partnership opportunities, and garnering financial support for the College.



**Elaine Dorward-King (Ph.D., '84), Council Chair**

Elaine brings more than 25 years of leadership experience in creating and implementing sustainable development, safety, health, and environmental strategy and programs in the mining, chemical, and engineering consulting sectors. She is a non-executive director of Kenmare Resources plc, Great Lakes Dredge and Dock, Sibanye Stillwater, and NovaGold, and is on the board of environmental economics nonprofit Resources for the Future. In 2020, she retired from Newmont Mining Corporation as the executive vice president of sustainability and external relations. Prior to Newmont, she served as managing director of Richards Bay Minerals in South Africa, and global head of health, safety, and environment at Rio Tinto. She earned her Ph.D. in analytical chemistry from Colorado State University.



**Miranda Ballentine (B.S., '96)**

Miranda is the founding CEO of Renewable Energy Buyers Alliance, an alliance of large clean energy buyers, developers, and service providers. Previously, she was CEO of Constant Power Inc. and served as managing director of the Rocky Mountain Institute's Business Renewables Center, a members-based platform that accelerates corporate purchasing of renewable energy. RMI is the only think tank exclusively focused on advanced energy's role in national security, economic prosperity, and solving climate change: topics to which Miranda has devoted her career. From 2014-2017, she served President Obama as the 4th assistant secretary of the Air Force for Installations, Environment, & Energy. She received her B.S. in psychology from Colorado State University and an M.B.A. from George Washington University.



**Leslie Buttorff (B.S., '79)**

Leslie is the CEO of Panacea Life Sciences Inc., a cannabinoid product company that manufactures and develops medically relevant, THC-free CBD products for humans and pets. She is the founder and former president and CEO of Quintel-MC Incorporated, a business consulting firm, and continues to serve on the board. Previously, Leslie was the global practice leader for Arthur D. Little's utilities management consulting practice; was president of Electronic Data Systems' utilities, energy, and chemical divisions; and served as a vice president with Stone & Webster. She is also a board member of jobZology, a CSU spinoff company that provides a service for modeling best-fit careers through online tools and test assessments. She earned her B.S. in statistics from Colorado State University and her M.S. in industrial engineering and finance from Iowa State University.



**Peter I. Wold (B.S., '71)**

Peter grew up in Casper, Wyoming, and graduated with a B.S. in biological science from Colorado State University in 1971. He is currently president of Wold Oil Properties LLC, an exploration and production company. The company owns and operates wells producing oil and gas in the Rocky Mountain states. Peter is managing partner of Hole-in-the-Wall Ranch, a cattle-ranching operation located near Barnum, Wyoming. He presently serves as trustee of the Casper Family YMCA, Mountain States Legal Foundation, and the Buffalo Bill Center of the West. Peter was a member of the Wyoming State House of Representatives (1989-1992); and he served two terms (1984-1990) on the executive committee of the Petroleum Association of Wyoming, where he presently serves as a director. He also served as director of Pacificorp Inc., an electrical and telecommunications utility company (1993-1999); was director of the National Advisory Board to the College of Engineering at the University of Wyoming (1997-2000); was a member of the New York Board of Oppenheimer Funds Inc., a mutual fund company (2002-2015); served as commissioner and chairman of the Wyoming Enhanced Oil Recovery Institute (2003-2012); and was on the board of Arch Coal Company Inc. (2010-2017).



**Kazem Kazempour (M.S., '80; Ph.D., '87)**

Kazem is president and CEO of Amarex Clinical Research, a globally active clinical research organization. He co-founded Amarex in 1998, which became part of NSF International in 2019. He also serves as an adjunct professor of biostatistics and epidemiology at George Washington University's School of Medicine. Kazem began his career as a mathematical statistician working at the Genetics Institute. He has worked in various therapeutic areas in multiple capacities, including as a presenter to the Food and Drug Administration, as an FDA reviewer, and as a sponsor representative in diverse areas, including anti-infective drugs, AIDS, cardiovascular diseases, vaccines, and wound healing. Kazem's expertise has earned him multiple recognition awards from the FDA for his contributions to the drug approval process, particularly for his work on HIV and AIDS clinical trial designs and analyses. He received his M.S. and Ph.D. in statistics from Colorado State University.



**E. William Radany (B.S., '74)**

Bill is currently the CEO at LCY Bioscience and has more than 40 years of experience in the biotechnology industry. Prior to founding LCY Bioscience, he was the president and CEO of Verdezyne, a synthetic biology company, and president and CEO of High Throughput Genomics Inc., a provider of novel array-based gene expression assay technology for the life science industry. Previously, Bill was president of Biacore, a spinoff from Pharmacia, and founder and CEO of NeoGenex. Bill has held executive positions at Xencor, Caliper Technologies, and Stratagene, where he helped establish business relationships with major pharmaceutical and biotechnology companies. Bill has spoken at numerous conferences and has invented several patents over the past 40 years. He received his Bachelor of Science in cell biology from Colorado State University and a Ph.D. in biochemistry/physiology from the University of Wyoming.



**Bonnie Ross (B.A., '89)**

Bonnie is corporate vice president at Microsoft and head of 343 Industries. She is responsible for defining the vision of and leading the Halo franchise. In 2007, she founded 343 Industries, an entertainment studio committed to fostering the growth and expansion of the Halo franchise, as well as driving innovation across Microsoft platforms. She is passionate about bringing together art and technology to transform how people experience entertainment. Bonnie is also deeply involved in promoting efforts to drive diversity across the games industry and generating interest among women and children in the pursuit of science, technology, engineering, and math careers. She was named the 2019 inductee of the Academy of Interactive Arts & Sciences Hall of Fame and has been named one of Fortune's most powerful women in gaming. She earned her B.A. in technical communication at Colorado State University in 1989.



**Denise Rutherford (Ph.D., '89)**

Denise is senior vice president of 3M's Corporate Affairs organization. She previously served as vice president of R&D and Commercialization in 3M's Industrial Business Group. Before that, Denise was president, 3M Japan LTD, president, Greater China Area, and president of Latin America International Operations for 3M. Denise has held several other leadership positions at 3M, including vice president and general manager of 3M's Aerospace and Aircraft Maintenance division and managing director of 3M Belgium. Denise joined 3M in 1989 after completing her Ph.D. in chemistry at Colorado State University.



**Bruce Given (B.S., '76)**

Bruce retired in May 2020 as COO of Arrowhead Pharmaceuticals Inc., after a more than 30-year career in biotechnology and pharmaceutical research, development, and sales and marketing. Previously, he served as CEO of Leonardo Biosystems Inc., CEO and member of the board of directors of Encysive Pharmaceuticals, and chairman of the board of directors of ICON plc. He also held senior operational roles at Johnson & Johnson, Ortho-Clinical Diagnostics, and Janssen Pharmaceutica (US). Prior to entering the pharmaceutical industry, he was on the medical faculty at the University of Chicago. Bruce received his B.S. in physical sciences from Colorado State University and his M.D. with honors from the University of Chicago and was a Fellow at Harvard University.

We are the question-askers,  
the discoverers, the curious.

We seek what we do not yet know.

We are the supporters,  
teachers, mentors, advisers.

We care, we learn, we improve.

Our histories, perspectives,  
differences matter.

Because science is shaped by us.

**Science is shaped by the people who study it.**

*– Poem by Lisa Streeb Case*



COLLEGE OF  
NATURAL SCIENCES  
COLORADO STATE UNIVERSITY