COLORADO STATE UNIVERSITY

RESEARCH

Fall 2020

ACTION IN A TIME OF CRISIS:

TRANSLATING DISCOVERIES AND SOLUTIONS INTO PRACTICE

CSU RESEARCHERS RAPIDLY DEVELOPING TREATMENTS, DRUGS, AND VACCINES

CONTENTS | Fall 2020

ON THE COVER

Kaitlyn Wagner is a Ph.D. candidate in Microbiology, Immunology, and Pathology at Colorado State University. Recently she has been working with Professor Mark Zabel to screen saliva for COVID-19, from students living on campus.

2 PRESIDENT JOYCE MCCONNELL GUEST PUBLISHER LETTER

3 LETTER FROM U.S. HOUSE REPRESENTATIVE JOE NEGUSE

4 CHASING PANDEMICS

6 A FRAMEWORK FOR RESILIENCE

10 LAND-GRANT UNIVERSITIES PREPARED TO MEET BIODEFENSE CHALLENGE

12 RE-CREATING LIVE-ANIMAL MARKETS IN THE LAB TO SEE HOW PATHOGENS JUMP SPECIES

14 CSU RESEARCHERS PART OF SEARCH FOR CORONAVIRUS VACCINE

16 AN INTERTWINED APPROACH: CSU INFECTIOUS DISEASE EXPERTS MAKE PROGRESS IN NATIONAL PANDEMIC RESPONSE

18 EHRHART NAMED DIRECTOR OF COLUMBINE HEALTH SYSTEMS CENTER FOR HEALTHY AGING

21 CSU ECONOMISTS HELPED SHAPE $2 TRILLION ECONOMIC STIMULUS BILL

22 ONE HEALTH SUMMER RESEARCH PROGRAM FOR VETERINARY STUDENTS

24 EARNING A PH.D. FROM THE KITCHEN TABLE

26 CSU'S MEDICAL RESEARCHERS RESPOND TO THE COVID-19 PANDEMIC

28 CSU RESEARCHERS RAPIDLY DEVELOPING TREATMENTS, DRUGS, AND VACCINES FOR COVID-19

30 VACCINE MANUFACTURING IN THE 21st CENTURY

32 WORKING WITH PHARMACEUTICAL COMPANIES TO SCREEN FOR ANTIVIRAL COVID-19 COMPOUNDS

34 WOODWARD, CSU TEAM JOIN FORCES ON RAPID-RESPONSE VENTILATOR PROJECT

36 RESEARCH TEAM INKS DEAL FOR COVID-19 VIRAL-DETECTION TEST

38 PUBLIC HEALTH RESEARCHERS ON THE FRONT LINES OF COVID-19

40 SAVING LIVES: TESTING HEALTH CARE WORKERS TO MINIMIZE TRANSMISSION OF COVID-19

42 ENGINEERING LAB TRANSFORMED INTO TESTING SITE FOR COVID-19 MEDICAL PROTECTIVE GEAR

44 RUSHIKA PERERA, SUE VANDEWOUDE, AND COVID-19 RESEARCH AWARDS FROM BOETTCHER FOUNDATION

46 CELL PHONE DATA HELPS TRACK MOBILITY PATTERNS

48 ENTER, STAGE LEFT: HOW THE PERFORMING ARTS CAN RETURN IN A HEALTHY MANNER DURING COVID-19 PANDEMIC

Send comments, news, or story tips to:
Office of the Vice President
for Research
Colorado State University
2001 Campus Delivery
Fort Collins, CO 80523-2001
Or email us at
vpr_office@mail.colostate.edu

COLORADO STATE UNIVERSITY RESEARCH

Publisher:
Alan Rudolph, Vice President for Research, Colorado State University

Guest Publisher:
Joyce McConnell, President, Colorado State University

Senior Editor and Writer:
Lauren Klamm, Director of Communications, Office of the Vice President for Research

Writers:
Alan Rudolph, Vice President for Research, Colorado State University
Jeanne McAdara, Principal, Biolexica Health Science Communications
Kerri Wright Platais, Special Adviser to the Chancellor for International Agriculture, CSU System
Richard Bowen, Professor, Department of Biomedical Sciences
Mike Hooker, Director of Media Relations, University Communications
Jeff Dodge, Writer and Senior Public Relations Specialist, University Communications
Christopher Staten, Marketing and Communications Coordinator, College of Agricultural Sciences
Tracy Webb, Veterinarian and Research Scientist
Ty Betts, Digital Media Specialist, Office of the Vice President for Research
Heather Pidcoke, Chief Medical Research Officer, Colorado State University
Mary Guiden, Science Writer and Senior Public Relations Specialist, University Communications
Coleman Cornelius, Executive Editor, University Communications
Allison Vitt, Communications Manager, Energy Institute
Anne Manning, Science Writer and Senior Public Relations Specialist
Tracy Nelson, Director of the Colorado School of Public Health, Colorado State University
Curtis Esquibel, Director of Communications and Community Engagement, Boettcher Foundation
Tony Phifer, Writer and Senior Public Relations Specialist, University Communications

Design and Production:
Lisa Schmitz, Designer, University Communications
Jakob Mueller, Design Intern, University Communications

Production Editor:
Adriana McClintock, Project Manager, University Communications

Copy Editor:
Betty Grace Mickey, Assistant Director of Communications, University Advancement

Your Source for Research News
To stay up to date on the latest Vice President for Research news, visit: **research.colostate.edu.**

President Joyce McConnell guest publisher letter

This is our time. As a land-grant University with a world-class research enterprise, Colorado State University has the strong foundation, clarity of purpose, and determination to address the global public health crisis posed by the COVID-19 pandemic. Even as we confronted the initial impacts of COVID-19 on our community and on University operations, more than 125 CSU researchers galvanized their research teams to address the specific challenges created by the pandemic.

Because CSU has decades of experience addressing community health needs via infectious disease research and response, our researchers were able to begin translating ideas into solutions, not just for Colorado, but also for our nation and our world.

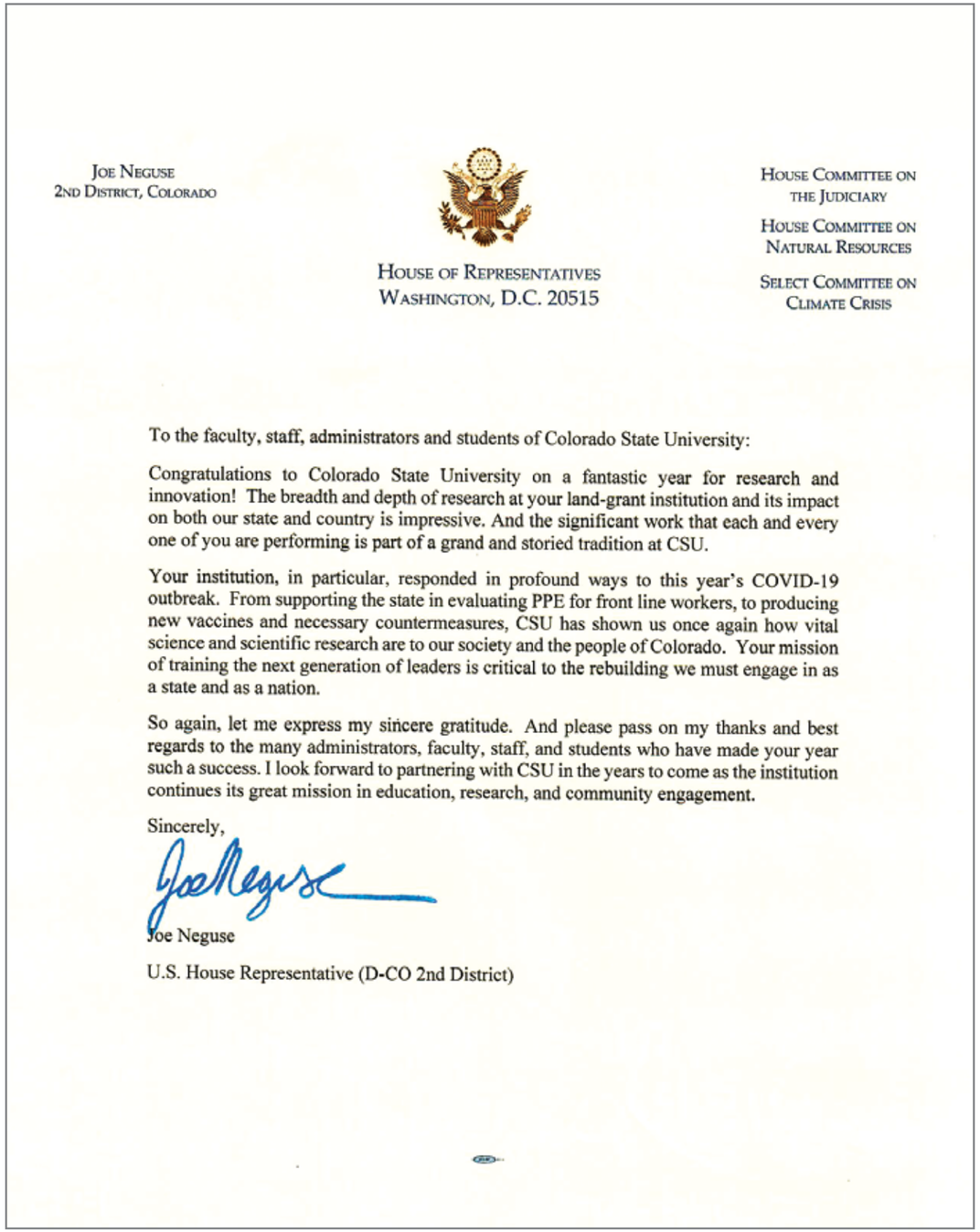
At CSU, teams are developing four COVID-19 vaccine candidates and creating innovative new methods and diagnostics to detect the virus. We partnered with Fort Collins-based Woodward Inc., to develop a low-cost, durable ventilator that could be quickly manufactured and deployed. And at the request of Gov. Jared Polis, CSU coordinated testing of new personal protective equipment to safeguard front-line workers.

Teams of our researchers are monitoring impacts of the pandemic on senior-care facilities, supply chains, mental health, and the efficacy and distribution of federal stimulus funds. Across the board, CSU is engaged with public and private entities and organizations, identifying and implementing new best practices that will help overcome a whole range of extraordinary pandemic-related challenges that are reshaping our world.

I am inspired and made hopeful every day by the expertise, the commitment, and the innovative spirit of CSU researchers across the University. They give me confidence that we will continue to create real-life solutions to whatever challenges come our way, and that our communities will emerge from these difficult times stronger than ever. Together, we will not just continue; we will thrive.

Sincerely,

Joyce McConnell
President



JOE NEGUSE
2ND DISTRICT, COLORADO

HOUSE OF REPRESENTATIVES
WASHINGTON, D.C. 20515

HOUSE COMMITTEE ON THE JUDICIARY
HOUSE COMMITTEE ON NATURAL RESOURCES
SELECT COMMITTEE ON CLIMATE CRISIS

To the faculty, staff, administrators and students of Colorado State University:

Congratulations to Colorado State University on a fantastic year for research and innovation! The breadth and depth of research at your land-grant institution and its impact on both our state and country is impressive. And the significant work that each and every one of you are performing is part of a grand and storied tradition at CSU.

Your institution, in particular, responded in profound ways to this year's COVID-19 outbreak. From supporting the state in evaluating PPE for front line workers, to producing new vaccines and necessary countermeasures, CSU has shown us once again how vital science and scientific research are to our society and the people of Colorado. Your mission of training the next generation of leaders is critical to the rebuilding we must engage in as a state and as a nation.

So again, let me express my sincere gratitude. And please pass on my thanks and best regards to the many administrators, faculty, staff, and students who have made your year such a success. I look forward to partnering with CSU in the years to come as the institution continues its great mission in education, research, and community engagement.

Sincerely,

Joe Neguse

U.S. House Representative (D-CO 2nd District)

CHASING PANDEMICS

by Alan Rudolph

Dr. Alan S. Rudolph has been active in translating interdisciplinary life sciences into applications for biotechnology development. He was introduced to infectious disease outbreaks research at Defense Advanced Research Projects Agency in the mid-90s, where he led biodefense programs in early detection of diseases for the Department of Defense. He founded Cellphire, a blood preservation company, which is in late-stage clinical trials for bleeding injuries, including those from hemorrhagic fevers such as Ebola. At the Defense Threat Reduction Agency, he led new outbreak programs including the antibody therapeutics that saved lives in the last U.S. Ebola outbreak. Before joining CSU, he led a U.S. animal biosecurity program in the Department of Homeland Security tasked to protect the U.S. agricultural and livestock sector. Since joining CSU, he has continued to lead the University in infectious disease research and translation for regional and global impacts.

It seems my entire career, I have been chasing pandemics. My first job after my doctoral work was at the Naval Research Laboratory in Washington, D.C., during the global pandemic outbreak of HIV, developing artificial blood to eliminate the risk of a broad set of transfusion-transmitted diseases. Starting at the Defense Advanced Research Projects Agency after the former Soviet Union offensive bioweapons program was discovered, I spent a good part of my government career leading teams chasing pandemics and new countermeasures against global infectious disease outbreaks. We looked for solutions from both emerging new threats and new adversaries who were weaponizing disease. I chased the development of medical countermeasures for pandemics in industry, innovating new countermeasures for the global outbreaks of mad cow and chronic wasting diseases and other global neurological diseases. I came to CSU and have invested internal institutional funds strategically in chasing preparedness for infectious disease outbreaks across our campus. And today, we are all chasing COVID-19 together.

In response to the growing threats from chronic and newly emerging infectious diseases, government agencies, corporate research and development, and foundations have continued sizable efforts to advance novel countermeasures to prevent and respond to the increasing number of threats from infectious disease outbreaks. The primary focus of these investments continues to develop a diverse portfolio of countermeasures from detection to protection in response to widespread outbreaks. While these investments have helped, the last decade has seen no shortage of infectious disease devastation, with outbreaks of influenza (human, avian, swine), Ebola, Zika, SARS-1, African swine fever, and now SARS-2, that have had devastating losses of life and economic infrastructures.

The last decade has seen no shortage of infectious disease devastation.

At Colorado State University, we have historically engaged in interdisciplinary programs to translate science in infectious disease research into useful applications in our community. Discoveries are generated from hundreds of faculty across campus with passion for their science and making a difference.

We have research and scholarly excellence programs that proactively link infectious disease research to community engagement and regional response. These activities enabled our agile response to chase the COVID-19 pandemic with more than 135 new proposals across industry, government, and nonprofit foundations addressing discoveries needed and potential solutions, from vaccines to ventilators, to the COVID-19 pandemic.

We empowered our expertise in the community with the earliest senior-care screening project and a testing lab for PPE in the nation, directly benefiting our medical front-line workers who protected and saved lives in our most precious Colorado communities. This annual edition of the research magazine highlights many of these outstanding ideas and actions in a time of crisis. Yet, we couldn't fit all the stories of the amazing people who helped make our response so impactful every day. There are many outstanding contributions from publications, patents, and community engagements that CSU scientists and scholars have undertaken during this crisis. We are in the chase.

One thematic focus of investments in chasing pandemics has been to realize a One Health approach that can more effectively respond to frequent outbreaks that consider the ecosystem interplay of animals, humans, climate, and the environment in disease. Most pandemic threats to humans still originate from animal or wildlife sources and are influenced by factors of movement of people, materials, and climate. Our One Health Institute is working to strengthen needed connections of understanding, application, and practice.

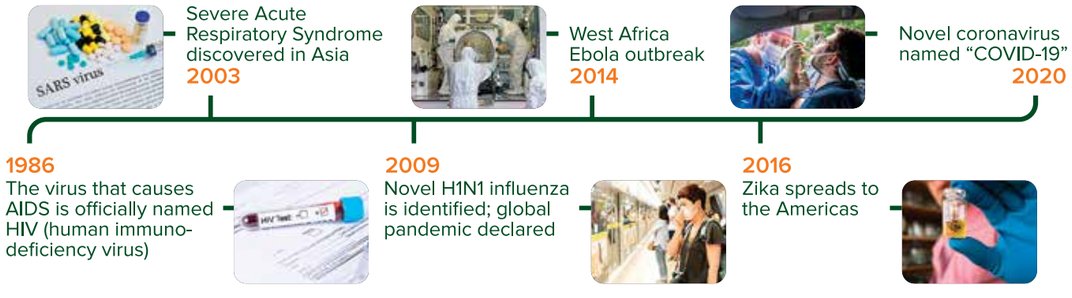
Faster surveillance tools and more agile manufacturing is needed that provide an earlier warning to detect and respond to an emerging disease in time to prevent significant losses. New facilities, such as the ones we are building at the CSU Foothills Campus, will focus research with vectors and hosts of disease such as mosquitoes, ticks, bats, rodents, and birds. With these new facilities, we will continue our contributions to understanding major outstanding questions about the interplay between pathogens such as SARS and hosts. Our expanding outbreak countermeasure biological manufacturing and technology accelerator facilities will also enhance our potential for chasing pandemics. New corporate strategic animal and human health partners in these facilities and the prominent work on COVID-19 at Foothills in One Health areas, including infectious disease and atmospheric and agricultural sciences, positions the Foothills Campus well for future growth opportunities that could be chasing pandemics well into our future.

A few more observations about chasing pandemics

Our current research and development approaches to medical countermeasures that we need to chase pandemics are unsustainable. Our world can no longer support a "one bug, one drug" approach in the approach to building a resilient needed infrastructure. We should amplify efforts to boost immunity to multiple pathogens or bugs in developing host-based methods and medical countermeasures that focus on a single drug or vaccine target. Examining the more facile off-label use of alternative drugs or vaccines that might show efficacy and developmental paths could offer a more agile response to finding solutions to a rapidly spreading disease.

Our legislative approach to chasing pandemics is also unsustainable. We have seen billions of dollars allocated in response to Ebola, swine flu, avian flu, Zika, and now the massive trillions in response to COVID-19. While these responses were unavoidable, a "one bug, one bill" approach is also not sustainable. The new chase will require strategies that invest in legislation to build resilience in our response to future threats. Legislation is needed to address and limit the jump of disease from wildlife and domestic animals to humans. It considers the environment and climate, and rural, agricultural, and urban influences on disease outbreaks. There are widespread public health consequences of this global pandemic and what it will mean for public health needs in chasing the next one.

The COVID-19 pandemic has brought the pandemic chase to every person on the planet. Pursuing the next one will require new approaches across many sectors of our society to build new health agility and resilience. The CSU research enterprise will be prepared and is making tremendous impacts every day to help chase and defeat this one first.



A FRAMEWORK FOR RESILIENCE

CSU research leverages the strengths of its past and the ongoing passion of its land-grant culture to secure a prepared future

by Jeanne McAdara

Heading home after an evening hunting mice, a house cat pauses at the duck pond to drink. Earlier, in the growing dusk, the pond was visited by a family of rats from the nearby woodpile, a cottontail raising kits in the grassy field, and an assortment of wild birds who bathed and caught mosquitoes to feed to their nestlings. In the nearby barnyard, pigs wallow and a cow dozes. The cat sniffs the air, then carries its kill up to the house, where human families have gathered to watch a recital performed by the neighborhood kids. The sounds of singing and laughter, and the loud blast of an off-key trumpet fill the night.

The wild and domesticated animals in this barnyard – and the humans with whom they intermingle – represent a system reliant on shared environments; shared resources such as food, water, soil, and air; and shared threats from infectious diseases, microbial pathogens, environmental contamination, and climate perturbations. Studying how these human, animal, and environmental systems intersect with public health is known as the One Health approach and has long been an underlying driver of research programs at Colorado State University.

From studying zoonotic disease reservoirs to understanding how rapid shifts in urban food systems affect farming and ranching communities, the One Health approach is not just about addressing problems of today, but also about being prepared and resilient in the face of tomorrow's threats, like the SARS-CoV-2 pandemic currently sweeping the globe.

How we respond

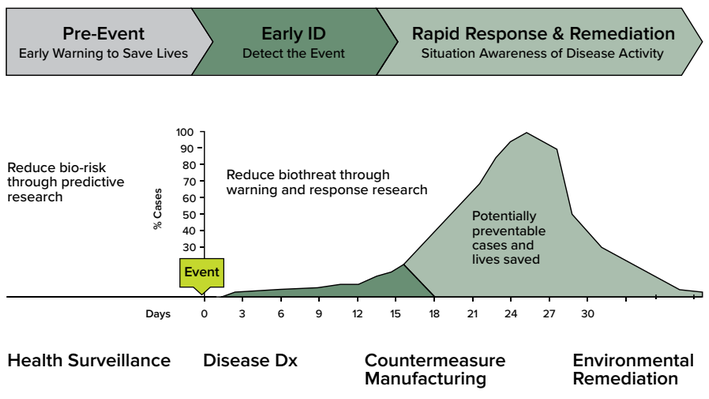
Based on his long career in disaster preparedness, CSU's Vice President for Research Alan Rudolph has sketched out what he calls a "framework for resilience," which describes the predictable patterns – preparation, rapid response, long-term remediation – the public follows to mitigate damage from emerging threats.

"There will always be new and unexpected outbreaks, disasters, and other crises to deal with," says Rudolph. "Whether they are of natural or intentional human origin, what we do before, during, and after these events determines the success with which we overcome them as well as our readiness for the next crisis."

It's impossible to anticipate the exact nature, timing, and consequences of every threat that emerges. But once an event such as the SARS-CoV-2 pandemic occurs, the mindset must shift from preparedness to rapid mitigation and then long-term remediation. Resilience can be thought of as one of the overall outcomes of this cycle; it's not just about how we've prepared for or dealt with any one threat; it's about how we apply that moment's lessons to prepare for the next.

The CSU research community's own response to SARS-CoV-2 provides fascinating examples of how preparedness translates to resilience, and how a large, public research institution set up to prepare for hypothetical futures pivots to meet a real-world, on-ground moment.

The Continuum of Response in Outbreak Response



Predictive research, rapid case detection, and response are key to saving lives and ending a disease outbreak.

How we coexist

Angela Bosco-Lauth is an assistant professor in the Department of Biomedical Sciences. For years, she has worked in the Animal Reproduction and Biotechnology Laboratory to develop animal models of infectious disease and study host susceptibility, interspecies disease transmission, and the biology of zoonotic disease reservoirs. The models are intended to provide tools for basic research and for testing new diagnostics, vaccines, and therapeutics. Some of her work has involved designing and evaluating artificial ecosystems – from barnyards to live-animal markets – within the Biosafety Level 3 containment laboratory and the TerraForma program headed by Richard Bowen.

With an interspecies mechanism of origin likely, SARS-CoV-2 presented a natural extension for Bosco-Lauth's work. She and her collaborators were well-prepared to take what they had learned studying influenza, West Nile, monkeypox, and other globally significant viruses, and apply it to models that will answer questions about SARS-CoV-2 from a One Health perspective.

"For SARS-CoV-2, first we're determining which animal species are susceptible, what the disease looks like in those models, and how the animals interact in the real world," says Bosco-Lauth. "We've learned, for example, that species such as mink and domesticated cats are susceptible to the virus; from there, we want to understand the parameters under which they interact with wildlife and humans and the physical and biological mechanisms that promote interspecies virus transmission."

The air we breathe

Understanding those mechanisms is critical to transitioning from rapid tactics to long-term, strategic responses to an ongoing infectious disease pandemic. For example, early measures to protect against all possible routes of human-to-human transmission have been refined to balance their effectiveness against social and economic costs, based on evidence supporting respiratory transmission. Now, devices and systems can be designed to mitigate transmission and restore the possibility of normal social and professional commerce.

Now, devices and systems can be designed to mitigate transmission and restore the possibility of normal social and professional commerce.

Some of the research supporting these efforts is coming out of CSU's Energy Institute, headed by Executive Director Bryan Willson, professor of mechanical engineering. In the rapid-response stages of the pandemic, when Colorado and other states were scrambling to source personal protective equipment for their health care workers, the institute was able to harness its expertise in measuring airborne particulates and aerosols to help evaluate the effectiveness of N95 masks coming from untried sources. Meanwhile, the institute partnered with an outside industrial manufacturer to design simple but robust respirators with parts sourced from the aerospace and automotive industries, in order to relieve the burden from the medical supply chain.

As the pandemic settles into longer-term response and remediation, the focus will shift to figuring out how to safely push against the constraints the virus has imposed on daily living. For example, in partnership with CSU's School of Music, Theatre, and Dance, an environmental exposure chamber previously used to measure particulates in cookstove smoke has been repurposed to test respiratory aerosols emitted by singers, musical instrumentalists, and lecturers, to help determine how such activities can be made safer while the world waits for vaccines and therapies. Ultimately, Willson says the work at the Institute helps turn basic knowledge about the viral life cycle into solutions for living.

"We're used to thinking about the biology and physiology of what the virus does inside the body," says Willson. "Our work helps to understand viral mechanisms from an engineering perspective – how the virus exits, how it travels and disperses, how it enters the next person, and what that all means in terms of probability of spreading disease. Scaled up, that information will be critical for partnering with architects and industrial designers to develop the resilient buildings of the future."

How food gets distributed

Food systems – how and where food is produced and distributed, and to whom – are another key component of the resilience framework. Rebecca Jablonski is an assistant professor and food systems Extension economist in the College of Agricultural Sciences and co-leads the CSU Food Systems Initiative. She asserts that the effects of COVID-19 on our food systems have underscored the need for more science and research in this area.

According to Jablonski, even though America has a highly efficient food system overall, that efficiency comes at the cost of flexibility in the face of sudden change. She points to examples such as milk and shredded cheese, which were packaged for use in schools and commercial buildings and therefore not as accessible to consumers for home use during the early lockdowns.

"It's not that the products didn't exist," she says. "It's that everything happened virtually overnight and the supply chain just couldn't pivot fast enough. We need research to tell us the kinds of changes that are possible and use those data to inform policy decisions that address the values-based tradeoffs between efficiency and resilience."

Other research in the Food Systems Initiative include analyzing COVID-19

(continued on next page)

A Framework for Resilience *(continued from Page 7)*

responses from local food-policy councils, school systems, hunger organizations, and producers to determine what actions and policies have been more successful than others in making sure that food-insecure people had access to food during the initial upheaval. How did efforts to increase the volume of food distributed alter end-user access, in both positive and negative ways? What long-term impacts will the pandemic exert on how people shop for food, and what will that mean for farmers, ranchers, and food businesses?

The data that connect us

"I've heard it said, 'there's enough data in all of this science for everyone.'" That's from Michael Kirby, a professor in the departments of mathematics and computer science, and the director of CSU's new Data Sciences Research Institute. He says that, although the seeds of the DSRI were planted in August of last year, the institute's value has really become clear as the University's faculty pivoted to meet the challenge of the pandemic. Across disciplines and across colleges, the research happening here is generating vast volumes of foundational data that, properly harnessed, can give CSU researchers predictive power that will contribute considerably to future resilience.

"We have built an epidemiological modeling team with folks from public health, computer science, mathematics, statistics, atmospheric science, and agricultural economics," says Kirby. "We're looking at refitting artificial intelligence algorithms to come up with stratified testing strategies; at parameter estimations that use wastewater data, test results, symptom checkers, and COVID-19 biomarkers to be able to model epidemiological scenarios and predict what will happen next; at novel algorithms that predict – based on longitudinal COVID-19 surveillance data being collected right now from skilled nursing facilities – the severity of outcomes and who is likely to become an asymptomatic shedder."

Kirby says that the DSRI's overarching goal is to break down silos between departments and colleges to facilitate new kinds of collaborations, and to get faculty teaming up and using their academic expertise to solve real-world problems.

We have built an epidemiological modeling team with folks from public health, computer science, mathematics, statistics, atmospheric science, and agricultural economics.

"We want to host all kinds of data as a repository for creators," says Kirby. "This has been a perfect opportunity to contribute something new and purposeful to CSU that will take down boundaries, create role models for young and upcoming researchers, and help us react effectively to future challenges."

The problems we solve with science

As the director of the Infectious Disease Research Center, Ray Goodrich has a broad perspective on the value of CSU's complex and interdisciplinary approach to research and its embrace of off-campus collaborators. The IDRC and its Biosafety Level 3 containment lab were established at CSU in 2000, as one of 14 facilities funded by the National Institutes of Health and the National Institute for Allergy and Infectious Diseases. The goal was to create a national infrastructure of laboratories, facilities, and people to enable research on disease-causing agents, originally to address the threat of bioterrorism.

Since then, says Goodrich, Mother Nature has sent her share of outbreaks and near misses, including West Nile, Ebola, Zika, and now SARS-CoV-2. The IDRC has the people and infrastructure to work with these kinds of agents and supports not only basic internal research at CSU, but also translational work with private-sector, government, and other academic organizations that may not have access to these resources on their own. Goodrich cites the example of SolaVAX, CSU's anti-SARS-CoV-2 vaccine development program that is a partnership between IDRC, the Bio-Pharmaceutical Manufacturing and Academic Resource Center, and the Biomedical Advanced Research and Development Authority. He says the program's strength is in the team's diversity of experience and perspectives.

"Academic institutions produce a lot of cutting-edge research that give us tremendous insights into new ways we can protect people from disease," says Goodrich. "But translating that research into processes that meet commercial and regulatory requirements is the skill of industry. Universities can't make that translation on their own, and industry alone can't do it either. We need elements of strength from both to deliver practical, safe, and affordable solutions to the world's problems."

How we ensure resilience

Sue VandeWoude, a professor of comparative medicine and associate dean for research in the College of Veterinary Medicine and Biomedical Sciences, was recently appointed as the director of CSU's One Health Institute. She reiterates the Institute's philosophy that solving large, systemic problems requires contributions across many disciplines, from people who are comfortable with complexity and context.

"Diseases like SARS-CoV-2 arise because humans and disease-carrying animals are coming into contact in ways that wouldn't happen under traditional contexts," says VandeWoude. "And once they jump to people, there are sociological, cultural, and behavioral factors that allow them to spread from one country across a continent and around the globe."

She says the unexpected domino effects of One Health problems point to new areas for research in many disciplines outside of biological sciences and engineering. "Did last year's global pork shortage from African swine fever lead people to seek out new protein sources, facilitating SARS-CoV-2's jump from animals to humans? Did the social constraints of the pandemic play any role in the intensity and effectiveness of recent civil unrest over social justice? Did food-shortage fears cause an uptick in backyard chicken husbandry and more salmonella infections? How has air pollution changed now that people are driving less?"

And, of course, the One Health Institute will use the answers to foster forward-looking approaches. Lessons learned and new questions answered become the foundation for responding to whatever is approaching next, whether they are threats we see on the horizon – an especially virulent influenza season, another agriculturally significant hemorrhagic fever, an antibiotic-resistant superbug, or extreme climate events – or something we haven't even dreamed of yet.

Considering the daunting complexity of these questions and how their answers fit into a resilient future, VandeWoude succinctly sums up the value of all of this investment in research at CSU and its focus on One Health.

"If we're prepared, we can be part of the solution."

Land-grant universities prepared to meet

BIODEFENSE CHALLENGE

by Kerri Wright Platais

The outbreak of African swine fever that started to spread to Southeast Asian countries in 2019 – and the response to this crisis – was an early indication that we have much to do to strengthen the U.S. response to diseases that threaten our agricultural base, nationally and globally.

We live in an increasingly interconnected world, which impacts everything from telecommunications and travel to the food we eat. We have access to purchasing, growing, or raising almost anything we want, anywhere.

But with quick and easy access to global goods comes the attachment of everything else that travels and moves with great speed around our planet, including a wide array of pathogens. Many of us think of "biodefense" as how we defend against a biological weapons attack, but for agriculture, the term has a more layered connotation: It means that we need to be ready and understand how quickly diseases spread and what this means for food security and the health of the planet.

In November 2019, Colorado State University had the privilege of hosting the Bipartisan Commission on Biodefense, an organization led by former high-ranking government officials that assesses and advises on how well our country is prepared for biological threats. The meeting focused on "Too Great a Thing to Leave Undone: Defense of Agriculture."

Faculty, staff, and students from across campus had the rare chance to see policy at work and to meet commission members, former U.S. Sen. Tom Daschle (D-South Dakota) and former Homeland Security Advisor Kenneth Wainstein, as well as the commission's team from Washington, D.C., led by Dr. Asha George. Participants also heard from distinguished panelists, including former Secretary of Agriculture Tom Vilsack and U.S. Rep. Joe Neguse (D-Colorado, 2nd District). Topics included response and recovery, surveillance and detection, and the unique role and responsibilities of land-grant universities.

At the forefront

Colorado State is particularly well-prepared to host discussions of such magnitude, as a land-grant campus that for decades has been at the forefront in battling infectious diseases worldwide and promoting advances in human and animal health. In 2018, CSU joined the commission on biodefense to testify to Congress on the role of land grants in research, development, and engagement on agricultural biodefense. In 2019, the Office of the Vice President for Research at CSU led the formation of a land-grant coalition with Texas A&M, Kansas State University, Iowa State University, University of Nebraska-Lincoln, and University of California at Davis. Known as the Coalition for Epi Response Engagement and Science, it's focused on increasing agility and resilience in agricultural biodefense. Prior to coming to Colorado, CSU Vice President for Research Alan Rudolph spent decades in the federal government helping to lead planning and response around potentially devastating outbreaks.

As we think ahead to CSU's role in helping feed the 10 billion people who will one day share the planet, our role as catalysts and educators around global food security will be of increasing importance. With the creation of the CSU Spur campus at the reimagined National Western Center in Denver, opening in 2022 on the site of the current National Western Stock Show, we will have an opportunity to build awareness around these issues at the intersection of food, water, and health (animal and human) in unprecedented ways in an unparalleled setting. It will include platforms for engagement that contribute to global food security.

After a long career in international agricultural development and food policy, I accepted a joint appointment with the CSU campus and CSU System to look at how we are and potentially can be engaged with international agriculture and the issues that surround it – which is how I became involved with helping to organize this meeting of the bipartisan commission. But while such meetings are important, it's more important that we, as a University system (including CSU Global and CSU Pueblo), are providing the platforms for faculty, students, and scholars to lead on these critical global issues.

Kerri Wright Platais is special adviser to the Colorado State University System Chancellor for International Agriculture at CSU's Spur Campus at the National Western Center.

"As we think ahead to CSU's role in helping feed the 10 billion people who will one day share the planet, our role as catalysts and educators around global food security will be of increasing importance."

– *Kerri Wright Platais, Special Adviser to the Chancellor for International Agriculture at CSU's Spur Campus at the National Western Center*

Since hosting the meeting of the Bipartisan Commission on Biodefense, CSU and the CSU System have been busy formulating research efforts needed to address the COVID-19 pandemic by building the affiliated partnerships and platforms that will make a difference in how we deal with future pandemics. In partnership with the Global Forum for Rural Advisory Services, the CSU System is helping to create and host the North American Agricultural Advisory Network and housing a small Secretariat at the new CSU Spur Campus in 2022. This effort is a partnership with the governments of Canada, Mexico, and the United States and is focused on the sharing of best practices and information for Extension and educational programs across the three countries. This network is focused on three thematic areas of work with biodefense and biosecurity (for both plants and animals) as one. Building on the Coalition for Epi Response Engagement and Sciences' existing work, the six land-grant universities that make up CERES are focused on training and education programs to accelerate our collective biosecurity responses. CERES is another example of CSU leadership, through the Office of the Vice President for Research.

Another important partner in the NAAAN effort is the group Together We Grow, also headquartered at the CSU Spur Campus. Together We Grow is a consortium of agricultural companies, non-government organizations, academics, and government focused on building a skilled, diverse, and inclusive workforce for the future of agriculture and agribusiness.

We know solutions are not found in silos; they are crafted through dialogue and participation – and across disciplines. And we know grand challenges facing our future with regard to food security, climate resilience, and food safety are real. Through the effort of crafting a shared vision and listening to each other as we seek solutions, CSU will continue to play a catalytic role in providing some of those answers through science, research, policy, and our shared resources to chart our course.

Re-creating live-animal markets in the lab lets researchers see how pathogens like coronavirus jump species

by Alan Rudolph and Richard Bowen

Places where lots of animals come into contact can help pathogens move from species to species. *Photo: Baloncici/iStock via Getty Images Plus*

Nobody yet knows for sure the definitive origins of the newly recognized coronavirus now known as SARS-CoV-2 that's currently spreading across the globe as a human respiratory pathogen. Early reports indicate that the source of the virus was the Huanan seafood market in Wuhan, China, where an eclectic mix of animals including rodents, rabbits, bats, and other wild animals and seafood are all on display for consumption and in contact with human shoppers.

Over the past two decades, the world has seen the emergence of multiple pandemic threats, including bird flu (H5N1 avian influenza), SARS, Ebola, Middle East Respiratory Syndrome, chikungunya, Zika, and now the new coronavirus from Wuhan. The viruses that cause these diseases, and indeed roughly two-thirds of all recent emergent viruses, originated in animals before they jumped to humans.

Each of these events underscores that multiple parts of an ecosystem are at play during an outbreak. For instance, wild bats and rodents harbor numerous viruses that have the potential to infect humans and animals. When these wild animals are extracted from their natural habitat and come into close contact with people, very rare transmission events become much more likely.

These pathogen jumps are complex. They can occur via direct contact, consumption of bushmeat, or transmission by insect vectors that carry the germs among a variety of species. And a range of environmental conditions – such as temperature, humidity, sunlight, and even seasonal rain and soil conditions – can affect transmission.

Despite the complexity of the natural world, the research approach to understanding how potentially pandemic pathogens and their animal and human hosts interact has been relatively simple. Scientists typically focus on a single species at a time, studied under conditions of constant temperature, humidity, and airflow. This strategy has clearly helped researchers understand infectious disease processes.

But as biologists, we believe that more explicitly acknowledging the complexity of the natural world will provide a more robust understanding of emerging infectious diseases. We've set up what we call "artificial ecosystems" in the lab to mimic the complicated conditions out in the real world. They're helping us gather new insights into how viruses and other pathogens actually emerge to become global threats.

RECONSTRUCTING LIVE-ANIMAL MARKETS AND BARNYARDS

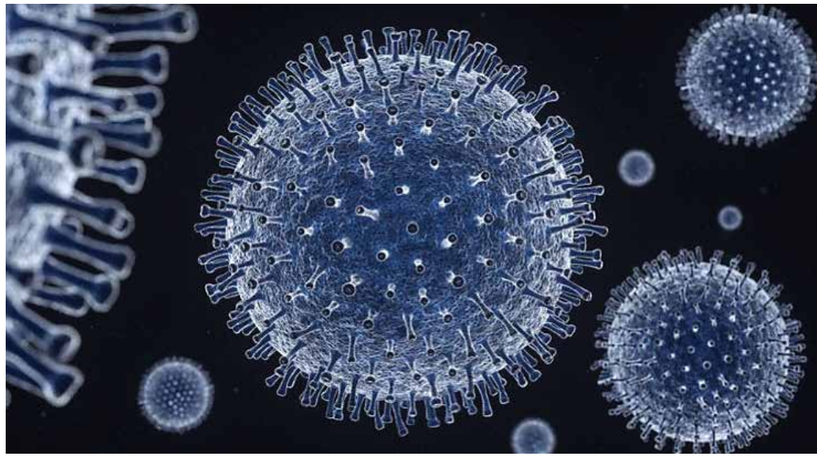
It's undoubtedly rare for pathogens to jump directly from animals in nature into people. But within markets like the one in Wuhan, there are abundant opportunities for the type of interactions that promote pathogen transmission among species.

To mimic these scenarios, we've established artificial ecosystems in our lab. That way, we can study the transmission and spread of pathogens, such as influenza viruses, among diverse groups of birds and mammals all housed together and interacting freely.

Because the pathogens we're studying are potentially deadly and contagious, we need to be very careful they can't escape from the lab. We establish our ecosystems under strict biocontainment conditions: All exhaust air is filtered and personnel use respirators, wear facility apparel, and shower before exiting.

For our studies with bird flu, we created artificial barnyards that housed ducks, chickens, pigeons, blackbirds, and rats. They freely interacted with one another, sharing access to common feed and water. As occurs in real barnyards, the rats were never seen outside of their enclosed nests during daylight hours, though video recordings showed them cavorting around the room, bathing in the water pool, and harassing the ducks in the dark. We then introduced a small number of infected ducks into the room and watched to see how infection spread.

In a different setup, we investigated transmission of another avian influenza virus among chickens, quail, pheasants, and rabbits caged as in a live-animal market. Additionally, sparrows and pigeons were loose in the room and able to interact with the caged animals. As anticipated, birds housed beneath those inoculated with virus were more likely be become infected, as waste runs downhill. Quail were the most susceptible to infection.



Artificial ecosystems complement other research approaches that identify viruses and their properties. *Photo: xia yuan/Moment via Getty Images*

Key discoveries have emerged from our artificial ecosystem approach. For example, we were able to show that avian influenza viruses pass among diverse birds and mammals interacting freely with one another in an artificial barnyard or artificial live-animal market. We found that there's massive accumulation of virus in shared water sources.

More recently, we've created even more sophisticated artificial ecosystems that allow us to modulate temperature and humidity. We can even impose rain and wind onto an ecosystem, allowing us to evaluate environmental conditions that facilitate virus transmission.

LESSONS FROM INSIDE THE ARTIFICIAL ECOSYSTEMS

Despite the known complexity of these sorts of interactions in the real world, it's more typical to study emerging pathogens by focusing on infection in a single species at a time. This is partly due to the regulatory processes by which diagnostics or vaccines are approved. They require definitive demonstration of safety and efficacy in individual animal models.

We hope this new approach could foster a more realistic understanding of how pathogens are transmitted among species, including jumping into human populations, and will facilitate development of new diagnostic tests, vaccines, or therapeutics.

Our ecosystem method fits in with what's called the One Health approach to public health. One Health is based on the concept that human health is inextricably tied to the health of animals and the environment. Understanding infection in natural hosts in mixed ecosystems that mimic real-world scenarios of transmission is crucial for developing disease control methods. ▮

EDITOR'S NOTE: Alan Rudolph, Vice President for Research at CSU, and Dick Bowen, Professor of Biomedical Sciences at CSU, wrote this piece for *The Conversation* in February 2020. Colorado State is a contributing institution to *The Conversation*, an independent collaboration between editors and academics that provides informed news analysis and commentary to the public.

CSU researchers part of national search for coronavirus vaccine

by Mike Hooker

As the world looks for ways to stop the spread of the new coronavirus, Colorado State University has activated a unique combination of national experts, facilities, and vaccine manufacturing capability to help in the fight.

"Once again, when it comes to this kind of research, CSU is the center of the universe," said U.S. Sen. Michael Bennet (D-Colorado), who toured CSU's Infectious Disease Research Center on March 4. "They've got the people and they've got the facilities, and they've got the history with dealing with viruses like this one."

The CSU center is one of the nation's secure Biosafety Level 3 facilities, where special construction, filters, and other safety equipment, along with rigorous training, allow experts to safely conduct research with microbes such as those that cause yellow fever, malaria, plague, SARS, MERS, and other contagious diseases. In mid-February – as the current coronavirus outbreak was beginning to spread to countries outside China – research teams at the IDRC received live samples of the new coronavirus that causes COVID-19, and within days they were working to create an inactivated version to use as they attempt to create an effective vaccine.

"You create a virus particle that has all of the characteristics of the native virus, but it can't replicate. It can't cause disease. And that's – we believe – a good candidate for a vaccine," said Richard Bowen, professor in CSU's Department of Biomedical Sciences and a pre-eminent researcher in infectious diseases. Bowen has been deeply involved in research of two other types of coronavirus that caused global outbreaks: SARS in 2003 and MERS in 2012.

RESEARCH EXPERTISE

In the SARS and MERS outbreaks, bats and camels were discovered to be key vectors in the spread of the viruses. At the time, the expertise of CSU's James L. Voss Veterinary Teaching Hospital and the Veterinary Diagnostic Laboratories gave CSU a head start in being able to offer important research expertise on bats and camels in the urgent worldwide effort to understand and slow those outbreaks.

In the spread of the current coronavirus, bats are again a probable transmission vector, and CSU's expertise puts this R1 public research University in a position to lead the way toward better understanding of the virus and a possible vaccine.

"We have the knowledge of how to do this and how to do it in a very effective way," said Ray Goodrich, executive director of the IDRC and a professor in the Department of Microbiology, Immunology, and Pathology at CSU. "There's a lot that we're building off of that gives us a leg up, and that's the thing that you need when you're dealing with an emerging disease. You need to get ahead of it, because (without that) you'll quickly fall behind."

In addition, Goodrich explained, CSU's unique capability to create and mass-produce vaccine through BioMARC, part of the IDRC, is another reason the University is well-positioned to help lead in the fight against diseases such as COVID-19. BioMARC is a nonprofit biopharmaceutical manufacturing operation that operates in compliance with Good Manufacturing Practice requirements used by the FDA and other regulatory agencies for the production of pharmaceuticals suitable for human use.

BioMARC's ability to scale production of vaccines and translate basic research findings into practical and compliant manufacturing procedures is an incredible resource in the fight against an emerging disease such as COVID-19, Goodrich said.

"The beauty of the processes that we are developing in CSU labs for making a vaccine for COVID-19 is that it's fast, it's rapid, and we also have the capability to assess its effectiveness and safety in initial preclinical testing," he added. "The fact that we can also use the facilities and skills of BioMARC personnel to scale up production of a vaccine candidate in a way that is compliant with GMP requirements is really a valuable asset to the state and the nation."

SHARING KNOWLEDGE

Several of the 125 infectious disease experts who are studying the COVID-19 virus at CSU described their work and answered questions at a community Coronavirus Outbreak Forum on campus Feb. 19. A video of the forum is on the Vice President for Research website. The researchers' overarching message was much the same as Sen. Bennet's as he toured the CSU facility.

"We have to take it very seriously, but we shouldn't panic," Bennet said, standing in a mock BSL-3 lab – used for training – where CSU researchers sharpen their skills before they enter parts of the facility where work with the actual viral agents is done.

"It's always exciting to be at CSU because these guys are on the cutting edge of so much scientific research, and it's really exciting to know it's right here in Colorado," he added. "They've made an investment in people, they've made the investment in facilities, they have the ability not just to invent this but to manufacture. That didn't come without a lot of vision and a lot of hard work and a lot of planning, and I'm really excited that it's right here in the state of Colorado."

At left: Ray Goodrich, executive director of the IDRC, discusses the vaccine-creating capabilities of CSU's Mirasol PRT system (background) with U.S. Sen. Michael Bennet, second from left. Also pictured: Alan Rudolph, CSU vice president for research, and Lindsay Hartson, lab manager.

Below, left: In a mock-up training space with U.S. Sen. Michael Bennet, Bob Ellis and Sara Cope demonstrate the safety features found in CSU's BSL-3 lab facilities.

Below, right: U.S. Sen. Michael Bennet; Ray Goodrich, executive director of CSU's Infectious Disease Research Center; and Alan Rudolph, CSU vice president for research, discuss CSU's approach to researching a vaccine for the novel coronavirus.

AN INTERTWINED APPROACH:

CSU infectious disease experts make progress in national pandemic response

by Lauren Klamm

Colorado State University has continued to activate its nationally recognized researchers, facilities, and capabilities to help slow the spread of coronavirus that causes COVID-19, and on Aug. 25, U.S. Sen. Cory Gardner (R-Colorado) toured the Veterinary Diagnostic Laboratories to learn about the University's work in testing, senior-care facility surveillance, and vaccine development.

Typically, the laboratory conducts tests and identifies a variety of animal diseases, but during the pandemic, it has also worked to help the local community process coronavirus tests on humans.

We need to continue to work together to solve these problems with this intertwined approach.

Testing approach

During his visit, Gardner learned about the Veterinary Diagnostic Lab's Biosafety Level 3 facility for testing highly infectious bacteria and viruses. This lab, usually used for animal testing, is now analyzing 400-600 human COVID-19 tests daily, doubling – and sometimes tripling – the lab's normal caseload. To date, the lab has tested more than 21,000 COVID-19 samples, sending results electronically to the Colorado Department of Public Health and Environment to assist with timely decision-making from state health officials.

"Sen. Gardner has been a great supporter of our laboratory and has helped advocate for us, including supporting federal funding for the National Animal Health Laboratory Network," said Dr. Kristy Pabilonia, director of clinical diagnostics for the CSU Veterinary Health System. "We appreciate his interest in our work, and we are proud to serve our state in this time of great need."

Gardner also learned about the work Pabilonia; Greg Ebel, a professor in the Department of Microbiology, Immunology, and Pathology; and Dr. Nicole Ehrhart, director of the Columbine Health Systems Center for Healthy Aging, are doing to test workers in senior-care facilities. Together, the team is working to improve Colorado's public health by identifying the coronavirus in senior-care providers to reduce the spread of the disease within those facilities.

"We now know that the problem we face in infectious disease outbreaks is interconnected between climate, animals, and humans," said Alan Rudolph, vice president for research at CSU, "and we need to continue to work together to solve these problems with this intertwined approach."

During his visit to the CSU Veterinary Diagnostic Laboratories, Sen. Cory Gardner heard from Dr. Marcela Henao-Tamayo about the SolaVAX vaccine initiative (left), as well as Dr. Kristy Pabilonia (above, top) and Greg Ebel (above, lower) about surveillance testing of workers at senior-care facilities. *Photos: William A. Cotton, CSU Photography*

Vaccine development

Ray Goodrich, executive director of the Infectious Disease Research Center at CSU, described the SolaVAX vaccines manufacturing process to Gardner. The SolaVAX platform has previously been shown to inactivate a different infection in the coronavirus family, MERS-CoV. This vaccine initiative has also recently secured an agreement with the Biomedical Advanced Research and Development Authority to further develop a novel virus inactivation process.

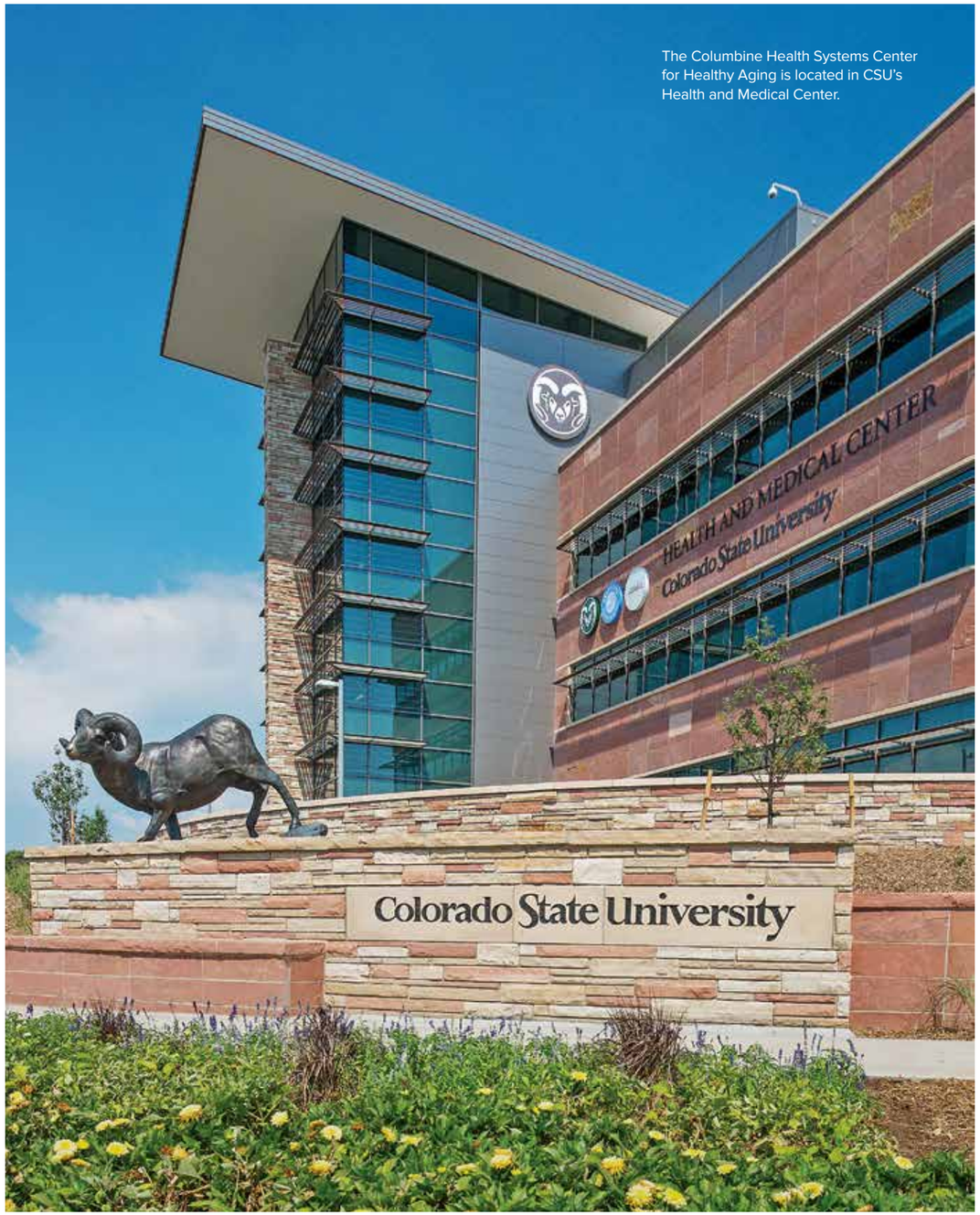
Colorado State's faculty have moved swiftly to provide the state, the nation, and the world a range of potential solutions and medical countermeasures, such as SolaVAX, to combat the coronavirus.

"Colorado State's faculty have moved swiftly to provide the state, the nation, and the world a range of potential solutions and medical countermeasures, such as SolaVAX, to combat the coronavirus," said Rudolph. "We want to thank Sen. Gardner and his staff, who have helped us acquire key capabilities we will be using for COVID-19 surveillance on campus and across the state."

Congressional support

Gardner expressed gratitude to the researchers at CSU who have pivoted away from their usual research areas to help find solutions to end the coronavirus pandemic.

"Research and science is key. The testing is key," said Gardner. "As we invest in the science, as we in invest in the research, the breakthroughs will come."



The Columbine Health Systems Center for Healthy Aging is located in CSU's Health and Medical Center.

Ehrhart named director of COLUMBINE HEALTH SYSTEMS CENTER FOR HEALTHY AGING

by Jeff Dodge

Nicole Ehrhart, one of Colorado State University's foremost experts in translational medicine, has been named director of the Columbine Health Systems Center for Healthy Aging.

Ehrhart, the first woman at CSU to receive a University Endowed Chair, is a veterinarian, board-certified surgical oncologist, and professor of surgical oncology in the College of Veterinary Medicine and Biomedical Sciences. She was awarded the Ross M. Wilkins, M.D. Limb Preservation Chair in Musculoskeletal Biology and Oncology in 2015.

Ehrhart was selected to lead the healthy aging center in CSU's Health and Medical Center after a national search. She says her vision for the center, which was launched in 2017 with a $5 million gift from Columbine Health Systems owners Bob and Kitty Wilson, involves creating a place where various disciplines come together to extend "healthspan," or the period during which one is free of diseases that limit quality of life.

Interdisciplinary hub

"The science of aging is a highly complex issue," said Ehrhart, who started August 2019. "To make a meaningful impact in improving healthspan, we need to bring multiple theories, skills, and data to bear on a common problem. We need to ask how the disciplinary research strengths that already exist here at CSU can be merged, expanded, and transcended. I believe that the greatest opportunity to impact healthy aging exists at the intersections between scientific disciplines. Columbine Health Systems and CSU have been visionary in partnering to create an interdisciplinary research center to address exactly that."

Nicole Ehrhart

Lise Youngblade, who led the center on an interim basis as head of the Department of Human Development and Family Studies, said Ehrhart is an ideal choice.

"Having spent the last several years helping to develop the Columbine Health Systems Center for Healthy Aging, I can say unequivocally that Nicole is the perfect person to direct the center," said Youngblade, now dean of CSU's College of Health and Human Sciences. "She brings a unique vision, passion, and wealth of experience that will be enormously beneficial to the campus in uniting researchers who study healthy aging from a variety of disciplines, utilizing human and animal models, and supporting the generation and translation of cutting-edge interdisciplinary research into important programs that promote healthy and successful aging."

Comparative medicine

Ehrhart's work in veterinary medicine has focused on comparative oncology. For example, she's explored how the treatment of naturally occurring osteosarcoma, or bone cancer, in dogs can inform and improve the treatment of that disease in humans, especially children.

"Leveraging the expertise that already exists here on campus, along with a world-class veterinary college that leads the

(continued on next page)

Ehrhart named director of Columbine Health Systems Center for Healthy Aging *(continued from Page 19)*

pack in comparative animal models, we have an opportunity to bridge the translational gap in a way we have never had before," Ehrhart said. "I'm excited to lead the Columbine Health Systems Center for Healthy Aging in uniting expertise and active research programs across campus to translate from discovery to novel therapeutics, programs, and policies that support successful aging in both animals and people."

She explained that while there are other centers around the country dedicated to the field of healthy aging, what makes CSU's distinctive is the University's highly ranked veterinary school, which provides opportunities for translational medicine, or transferring what we learn from animals to humans.

"We are uniquely positioned to make a difference in comparative medicine like no other center could because of our vet med college," Ehrhart said. "There are existing aging centers at many universities, so if we're going to be the new kid on the block, our center has to bring something unique. That's where I think the magic happens, in this interdisciplinary space, where aging pet dogs can provide answers that help people age successfully, and vice versa. The levels of intersection and similarity are remarkable, and are only just beginning to be explored."

Reverse effects of aging?

Ehrhart said she will continue to hold her endowed chair and direct the Laboratory of Comparative Musculoskeletal Oncology and Traumatology, since 25 percent of her new position will be devoted to research. She said she wants to continue her work on regenerative medicine, including the use of stem cells to regenerate tissue – perhaps reversing the effects of aging someday. "Ultimately, could we come up with a therapeutic solution for restoring the muscle mass we lose in aging?" she asked.

"Nicole's energy and enthusiasm for this work is infectious, and I am excited about the collaborations she will foster and build on campus, as well as with our community and University partners locally and at the state level," Youngblade said. "I have no doubt that under her leadership, this center will grow rapidly and quickly build a national reputation for innovation and excellence in aging research. I am enthusiastically looking forward to working with her as she takes our new center into the future."

Vice President for Research Alan Rudolph, whose office oversees the center, agreed.

"We are excited to work with Dr. Ehrhart as director of the Columbine Health Systems Center for Healthy Aging," he said. "Her experience and connectivity across campus will be an important asset for the further development of collaborations across CSU and with the community around us. We are poised to make great impacts under her leadership."

Next logical step

Ehrhart acknowledges that despite being excited about her new opportunity, she's enjoyed working with her students and clients.

"I'll miss working with the residents and surgical fellows, training young surgeons," she says. "I'll miss working with clients too. That's been extraordinarily rewarding. But that background and experience has brought me to this place. The environment I've been raised in as a researcher has prepared me to think this way, to translate those skills to a different area of science."

She credited Youngblade and the center's associate directors, Deana Davalos of psychology and Karyn Hamilton of health and exercise science, for getting the center running.

"They have been superheroes in standing the center up since its inception," Ehrhart said. "I will welcome and rely on their mentorship as we go forward, and my job will be to build on that framework they've already started."

CSU economists helped shape $2 trillion economic stimulus bill

by Christopher Staten

As the U.S. House of Representatives passed the coronavirus economic stimulus bill in late March 2020 – the largest relief bill in U.S. history – two Colorado State University faculty members had the satisfaction of knowing they did their part in protecting some of the most vulnerable people working in the nation's food supply chain.

Dawn Thilmany and Becca Jablonski, economists in the College of Agricultural Sciences' Department of Agricultural and Resource Economics, played an essential part in informing a policy paper released by the National Sustainable Agriculture Coalition that was circulating on Capitol Hill in the week leading up to the historic vote.

The paper, titled "Mitigating Immediate Harmful Impacts of COVID-19 on Farms and Ranches Selling Through Local and Regional Food Markets," drew from data DARE had collected for roughly a decade, focusing on agricultural producers that operate outside of commodity markets. The analysis estimated that the effects of COVID-19 could see a loss of up to $1.32 billion in local and regional agribusiness from March to May 2020 if certain recommendations weren't included in the bill.

"People will never be able to access local foods as easily as they can by going to the grocery store, but local producers are being entrepreneurial," noted Thilmany. "The ways [COVID-19] will impact local producers are very different than for larger farmers. We need to keep these smaller producers viable since they are going to be the most impacted. Luckily, we had done our homework enough that we could answer questions about what that impact would be."

OFTEN-OVERLOOKED AGRIBUSINESSES

With schools shut down and stay-at-home orders in place throughout large swaths of the country, smaller agribusinesses such as farmers markets, food stands, and local farm-to-school programs were predicted to take a sizable hit as bailout bills often overlook those types of producers.

"People don't necessarily think of these businesses as being negatively impacted by something like COVID-19, and sometimes the way these bills are rolled out, people who don't go through commodity markets aren't always understood to be impacted," said Jablonski. "So, this is the first time disaster or emergency relief has set aside a pot of money for these people to benefit from."

Based on DARE's research, the policy paper identified three types of agribusinesses that could be greatly impacted by the coronavirus pandemic: farmers markets, farm-to-school programs, and food hubs serving other institutions such as direct farm-to-restaurant sales. The resulting policy recommendations advised that the bill:

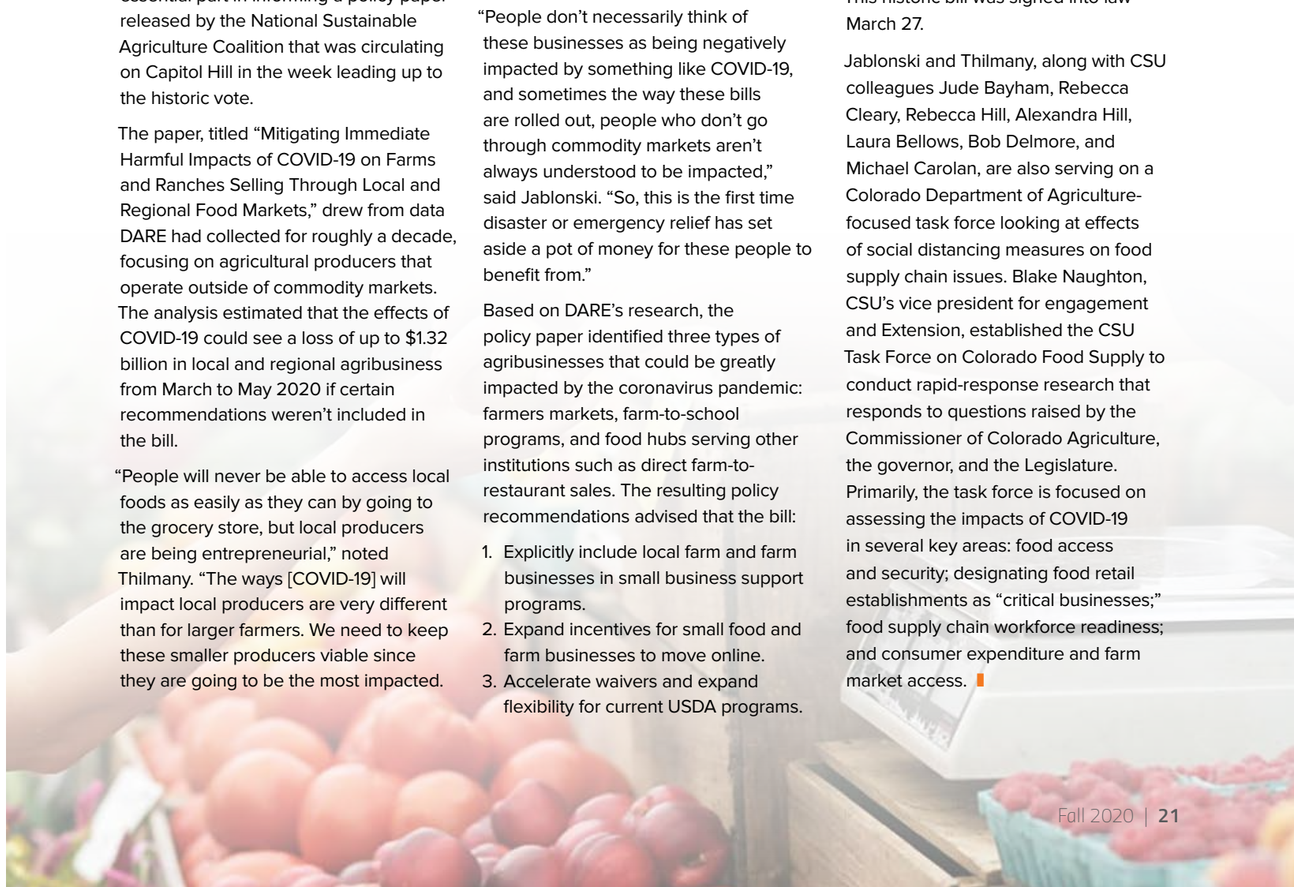
1. Explicitly include local farm and farm businesses in small business support programs.
2. Expand incentives for small food and farm businesses to move online.
3. Accelerate waivers and expand flexibility for current USDA programs.

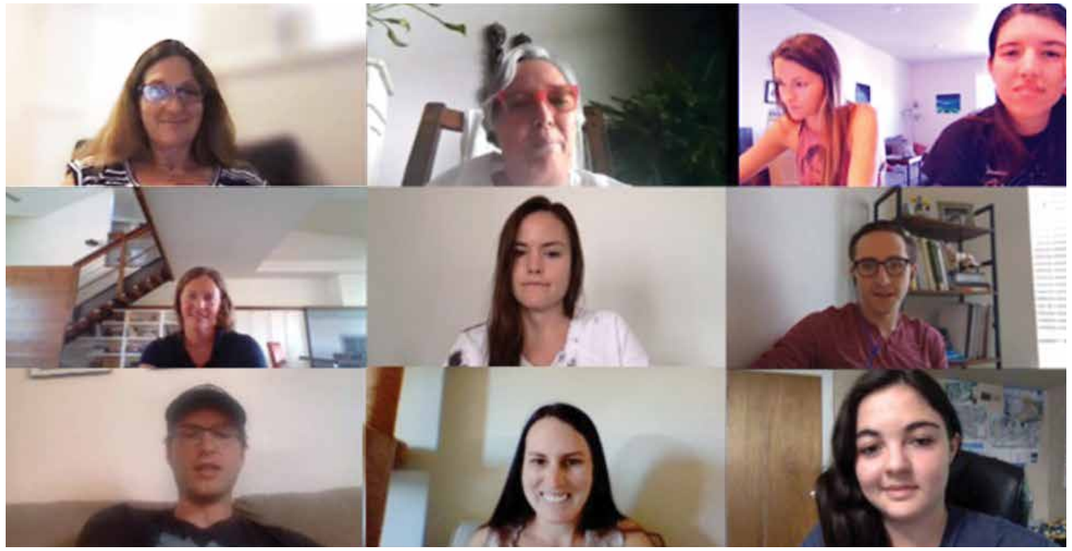
Sen. Debbie Stabenow (D-Michigan), a ranking member on the U.S. Senate's Committee on Agriculture, Nutrition, and Forestry, saw the study and her staff got in contact for further information and clarification.

"CSU is an engaged land-grant institution," said Thilmany. "We've established the right contacts in the right circles. We've done this great research to have good intuition and good data to turn around an answer."

This historic bill was signed into law March 27.

Jablonski and Thilmany, along with CSU colleagues Jude Bayham, Rebecca Cleary, Rebecca Hill, Alexandra Hill, Laura Bellows, Bob Delmore, and Michael Carolan, are also serving on a Colorado Department of Agriculture-focused task force looking at effects of social distancing measures on food supply chain issues. Blake Naughton, CSU's vice president for engagement and Extension, established the CSU Task Force on Colorado Food Supply to conduct rapid-response research that responds to questions raised by the Commissioner of Colorado Agriculture, the governor, and the Legislature. Primarily, the task force is focused on assessing the impacts of COVID-19 in several key areas: food access and security; designating food retail establishments as "critical businesses;" food supply chain workforce readiness; and consumer expenditure and farm market access.





CSU and partners create ONE HEALTH SUMMER RESEARCH PROGRAM FOR VETERINARY STUDENTS

by Tracy Webb

The term “One Health” embodies teamwork and collaboration to solve complex and interdependent problems affecting people, animals, and the environment.

Accordingly, despite the current world pandemic, motivated faculty and staff from Colorado State University and the University of Alaska at Fairbanks came together to develop a One Health summer program for veterinary medical students.

Teamwork to solve complex problems

With generous sponsorship from CSU’s One Health Institute, PetSmart Charities, and the Veterinary Summer Scholars Program, 12 veterinary students were selected to work on One Health projects in one of three impactful areas: climate change, inclusive health collaborative, and COVID-19.

The Climate Change Team evaluated the effects of climate change, air pollution, and water quality on animal populations as well as developed resources for veterinary medical professionals on climate change and sustainable medical practices. The team included professional veterinary medicine students Bonni Beaupied, Brian M. DeFilippo, Maria Koytcheva, Jon Maxwell, Josh Moore, and Leah Sauerwein.

The Inclusive Health Collaborative was an interdisciplinary program supporting health care for people experiencing homelessness with their pets. For their summer projects, the team looked into available resources locally and nationally, resource gaps locally, and exploring ways to connect people with these resources. The team included PVM students Sarah Deluty and Isabella Mazariegos.

The COVID-19 Team investigated how the SARS-CoV-2 pandemic has impacted veterinary medical education, access to veterinary care for companion animals, and the use of telemedicine in veterinary medicine. The team included PVM students Zack George, Kate McCaw, Sage Smith, and Rachel Wertheimer.

The eight-week summer program – designed by Colleen Duncan, associate professor in the microbiology, immunology, and pathology department, and Danielle Frey, director of International Student Experiences for D.V.M. students – involved virtual meetings with mentors as well as educational meetings to help ensure student support and success.

One Health Institute

The One Health Institute benefits the health of animals, peoples, and environments by collaborating across boundaries in a way that sees and integrates the whole system. CSU’s OHI was launched in 2015 and is housed within the Office of the Vice President for Research.

The One Health summer research program represents one of several new initiatives within the OHI, now under the direction of Dr. Sue VandeWoude.

In addition to the veterinary student summer researchers, three pre-professional students, Kara Billington, Lizzy Creighton, and Raegan Petch, have spent the summer virtually learning about the translational value of One Health. Each student has studied diseases that occur in people and are also diagnosed commonly in companion animals, such as epilepsy, diabetes, and cancer. They have interviewed CSU researchers to learn how each disease is being investigated and are drafting articles to highlight how this research impacts human and veterinary medicine. These articles will serve as key, tangible examples of how translational medicine benefits the lives of animals and humans, while showcasing the value of team science and collaboration.

The OHI has recently welcomed Dr. Claire Tucker as a postdoctoral fellow. Tucker will be working on new OHI initiatives and communication, including an article highlighting two ongoing “One Health Pandemics”: African swine fever and SARS-CoV-2. Additional information on existing and new OHI programs will be released soon with a rollout of a new portfolio on One Health Day in November 2020. ▮

At left: The One Health summer program for veterinary medical students meeting online.

Unprecedented times create opportunity for exploration

A few of the One Health Summer Program students shared their experiences in the program.

“Working with such a motivated and ambitious team, even remotely, has been a great experience in these uncertain and unprecedented times. With everyone using the same interface and being able to connect so quickly through Microsoft Teams, the ability to reach out, network, and bounce ideas off each other has not been inhibited by this remote setting, which has proven to be very conducive to collaboration. I look forward to continuing this project, working with faculty and my fellow veterinary students, and seeing what all of the dedicated research yields.”

— Sage Smith, third-year PVM student

“The One Health Institute and partners have used these unprecedented times as an opportunity for exploration and problem-solving. They have brought together a dynamic and motivated group of students with whom I am grateful to be able to collaborate remotely.”

— Kate McCaw, third-year PVM student

Earning a Ph.D.
from the kitchen table

by Ty Betts

With a cheap, beat-up flute purchased from a pawn shop, Colby Evans used the extra time spent at home these past few months to learn how to restore an instrument he loves to play.

"If I can refurbish it right, I might be able to sell it. But I might mess it up with this being my first time," said Evans, a Ph.D. student in the Department of Chemistry at Colorado State University.

Evans' new skill set is just one of a number of additional skills and hobbies that the latest cohort of Office of Vice President for Research Graduate Student Fellows has acquired while studying from home during the COVID-19 pandemic.

Now, as research operations are in the process of returning to campus, the OVPR fellows reflect on the unexpected turn in their spring semester and what they learned during this time, research-related or otherwise.

Heading home

In March, when the CSU community had to transition to remote courses and operations, researchers had to postpone experiments and fieldwork or refocus efforts on coronavirus research. For Ph.D. students, this meant a pause to their projects.

For Paige Ostwald, a Department of Biology doctoral student, it meant saying goodbye to her zebrafish – a fish species with translucent embryos that has allowed her to study genetic heart defects.

"Any of my work – I just had to pretty much stop," Ostwald said. "Thankfully, we have people who take care of our fish for us, so they were well taken care of."

The pause in lab experiments offered Ostwald time to dig into the literature and start writing a review paper, a valuable skill set that's difficult to find time for normally. "I've just been reading, reading, reading – so I've learned a lot," Ostwald said.

Not only were research labs temporarily shut down, but field research as well. Alison Post, who is pursuing a Ph.D. in ecology, was mentoring a first-year doctoral student who had to forgo a field season of data collection at the Pawnee National Grasslands. Post, who studies how grasslands respond to climate change, is fortunate to have already collected the data she needed for her paper and is now in the writing process.

Post also was a teaching assistant and lab instructor for an undergraduate plant biology course and had to work quickly with her colleagues to take the hands-on lab course and adapt it to be taught entirely online.

"That was difficult," Post said. "We ended up making it work, but you can imagine putting a lab class online is really hard."

Daniel Corbin researches ways to manufacture plastic with solar energy and regularly makes use of lab space and equipment. Thankfully, Corbin was wrapping up the last of his experiments when the stay-at-home orders were issued. He has been able to take the time to submit and start revisions to his journal article along with writing a book chapter related to his research.


Alison Post

"It was also a good opportunity to dive into the literature and brush up on some background and fundamentals," Corbin said.

Time for self

Kaylee Clark took some time to get married on a mountaintop in Roosevelt National Forest.

Clark, a Ph.D. student researching ways to create low-cost biosensors for people with diabetes, was among the many couples who had to cancel their wedding plans. But it didn't stop her from hiking up a mountain in her custom-sewn wedding dress to one of her favorite places.

"At first I was upset, but it turned out really nice and cute as just the two of us," said Clark, who still plans to have a celebration when it's safer for people to gather again.

But while many hold off on trips and large gatherings, there are other ways to fill the time.

"As cliché as it is, I took up baking," said Alexandra Koegel, a Ph.D. student in the Department of Chemistry. Koegel is researching ways to make artificial white light – the rays that are emitted from phones and computer screens. Koegel's latest experiment was cinnamon rolls, which she jokingly said turned out ugly but still delicious.

Post's lab team also used baking to exercise their competitive side by re-creating the Netflix baking competition *Nailed It*. During a group video call, each participant had two hours to bake a three-layer cake with a scientific twist.


Alexandra Koegel

The aptly named, "Soil Horizons Cake" had to represent the underground layers of Earth as accurately as possible.

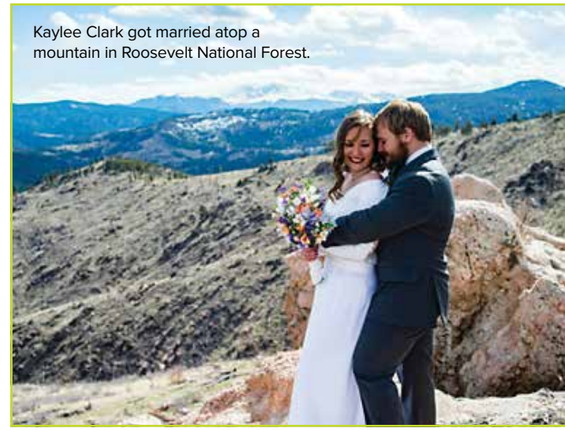
"We baked three layers that were all different colors and decorated it with 'roots' growing through the soil," Post said. But regardless of how they turned out, Post thought it was a great way to maintain a sense of community while the group was apart.

There and back again

As labs reopen on campus, there is a sense of excitement to get back to work and an eagerness among students.

Many labs are establishing shifts to minimize the number of people in a laboratory at once. Evans' lab has three shifts per day, each lasting about four hours, which has come with a learning curve.

"If you get a chance to come into lab and work, you must be efficient," Evans said.


Kaylee Clark got married atop a mountain in Roosevelt National Forest.

But there is an aspect to this workflow that Evans enjoys. He said when he's in the lab, his full attention is on completing experiments and collecting data during a limited time frame, but when he leaves, he allows himself to take a break from academia to enjoy a bike ride or grab a coffee.

During the stay-at-home period, Evans discovered the benefits of taking time to think more deeply about philosophy and his emotions, something he plans to maintain moving forward.

"Taking time each week to think about the way you feel and why you feel that way can be really beneficial," Evans said, emphasizing the importance emotional intelligence has to our mental well-being, especially during times like these.

Koegel has found this time spent at home to be a learning experience as well. Graduate school certainly has a hefty workload, and at times, Koegel has felt pressure to constantly be working, but at home, there are some things you just can't work on.

"In graduate school, it's easy to feel guilty when you're not working, and I think this experience will hopefully shift this mindset a little bit," Koegel said.

As for the research these Rams are involved with, returning to campus will enable them to continue their research and finish their degrees on a high note. The scientific community has shown its resiliency during this pandemic, and the ability for researchers to rise to the occasion has been inspiring.

For Corbin, this experience has shown that the scientific community is one that he is proud to be a part of as he furthers his education.

"It's been really cool being in science at this time and watching how communities are adapting. It's definitely pretty impressive," Corbin said. "Seeing how quickly the scientific community has changed directions and mobilized to combat COVID-19 has been really special to see and be a part of."

Vice President for Research Graduate Fellows Program

The VPR Graduate Fellows Program at Colorado State University was created by the vice president for research to support excellence in graduate research and to promote interdisciplinarity at the University by engaging the best and brightest students from graduate programs across the institution.

LEARN MORE AT RESEARCH.COLOSTATE.EDU/VPR-FELLOWS-PROGRAM.

CSU's medical researchers respond to the COVID-19 pandemic

by Heather Pidcoke

Heather Pidcoke, M.D., M.S.C.I., Ph.D., has experience with large, publicly funded biomedical research programs and is Colorado State University's first chief medical research officer. During the COVID-19 pandemic, she has helped multidisciplinary teams come together to address unmet medical needs. Additionally, Dr. Pidcoke has collaborated with the Larimer County Department of Health and Environment on CSU and Larimer County initiatives. Here, she shares some of her experiences working with CSU's talented researchers, administrative leadership, and external partners to navigate biomedical research's complex and changing environment in the age of COVID-19.

On March 13, 2020, leaders from CSU's Office of the Vice President for Research and the CSU Health Network scheduled a call with representatives from the Larimer County Department of Health and Environment and the Colorado Department of Public Health and Environment. Members of the call explored whether CSU's extensive biomedical capabilities, talents, and investigators could be leveraged to provide on-campus reverse transcriptase, real-time polymerase-chain-reaction clinical testing for Severe Acute Respiratory Syndrome Coronavirus 2 – the virus that causes COVID-19.

Facing a severe shortage of testing capabilities and mounting statewide cases, the county and state officials expressed interest, but this would be no small task. Human clinical testing for COVID-19 requires not only that the test itself be authorized by the U.S. Food and Drug Administration, but also that the clinical laboratories responsible for performing the test are certified by the Centers for Medicare and Medicaid Services under the Clinical Laboratory Improvement Amendment regulations.

CSU had proposed to use a laboratory-developed test, which according to the FDA, "is a type of *in vitro* diagnostic test designed, manufactured, and used within a single laboratory."[1] Under regular (pre-COVID-19 pandemic) circumstances, CLIA certification of a research laboratory to perform clinical testing with an FDA 510(k) cleared LDT would be a big lift.

Compliance with these regulatory requirements would take substantial effort, hundreds of millions of dollars, and significant infrastructure capital investments. In practice, the FDA has had a policy of enforcement discretion, rarely enforcing LDT regulatory requirements provided that LDTs were not used outside of a single laboratory. Although FDA reserves the right to offer formal regulatory oversight, in the past, the laboratories were left to self-regulate at their own risk.

Circumstances changed with the arrival of SARS-CoV-2 and a sudden need across the U.S. for expanded clinical testing, including at CSU. Despite a previous lack of enforcement, the FDA began issuing Emergency Use Authorizations to individual labs for LDTs related to SARS-CoV-2 testing, clearly indicating that it considers these tests to be subject to FDA oversight. Simultaneously, the FDA also gave broad discretionary authority to individual states and territories utilizing guidance regarding COVID-19 testing published on March 11, 2020.[2] The guidance stated, "a state or territory choosing to authorize laboratories within that state or territory to develop and perform a test for COVID-19 would do so under the authority of its state law, and under a process that it establishes."

What ensued was a jumble of approaches in which some labs around the country requested EUAs from FDA for their testing processes. Others received authorization to conduct COVID-19 testing from their state governments, and some even proceeded under the authority of their county health departments. CSU's unique approach, and in consort with its land-grant heritage, was to take advantage of existing EUAs covering the testing for SARS-CoV-2 at CSU's Veterinary Diagnostic Laboratories. However, that was not the end of the story, because the FDA is not the only agency regulating *in vitro* diagnostic tests. Suppose even a single test result is to be released to an individual (instead of publishing unidentified group results as part of a study). In that case, CMS oversight is required to ensure compliance with CLIA regulations. While the CMS website cites a four- to 12-week turnaround time for certification, this does not account for the time needed to prepare the application, which can take six months to a year. Preparation requires testing laboratories to demonstrate compliant processes and procedures, provide extensive training to the staff, and set up HIPAA-compliant data systems. However, CSU's Veterinary Diagnostic Laboratories already adheres to similar standards as those required by CLIA regulations due to its work with the Centers for Disease Control and Prevention. Thus, it was already in the position to apply for necessary permits for operation.

Additionally, reduced data system requirements to facilitate the pandemic response further expedited the application process. Remarkably, within three weeks of applying for access to gain critical capacity for our community, the CSU team received approval from the Colorado CLIA office to move forward with clinical testing.

The team that supported this effort included a diverse group of CSU researchers, administrative leaders, and lawyers who were joined by representatives from the Larimer County Department of Health and Environment and the Colorado Department of Public Health and Environment. Over those three weeks, this group convened weekly for online video chats. A Brady Bunch-like panel of participants discussed the logistical, regulatory, scientific, and legal aspects of the project and worked together to identify resources and share expertise.

This same multidisciplinary team approach has been expanded to a variety of other innovative efforts on campus. Groups are coming together to address the myriad, often urgent unmet medical needs related to the COVID-19 pandemic, overcoming considerable hurdles and navigating the complex regulatory landscape of biomedical research. Their success is evidenced by the diversity and the sheer number of projects that are underway on campus. This section of the magazine will highlight several multidisciplinary teams leveraging the University's unique research talent and advanced technological capabilities to develop solutions across a whole spectrum of challenges posed by this pandemic.

This same multidisciplinary team approach has been expanded to a variety of other innovative efforts on campus.

With more than 170 projects and 125 researchers and staff working on antivirals, vaccine development, and other technologies to combat SARS-CoV-2, the University is poised to significantly impact this effort at local, state, and federal levels. Some of the innovative projects highlighted in this section of the magazine include the SolaVAX vaccine development effort, led by Dr. Ray Goodrich, executive director of the Infectious Disease Research Center, which has garnered significant government funding. The vaccine candidate uses a novel process effective against Middle East Respiratory Syndrome Coronavirus, which is in the same coronavirus family as SARS-CoV-2. Another team, led by CSU professor, Dr. Rushika Perera, is testing drugs and chemicals to see if they might be effective against SARS-CoV-2. Dr. Bryan Willson, executive director of CSU's Energy Institute, and a team of engineers from CSU collaborated with the Fort Collins-based Woodward Inc. to submit an EUA to FDA for a novel emergency ventilator using parts more available in the supply chain.

The diversity of efforts at CSU brings a wealth of groundbreaking solutions to the challenges posed by the COVID-19 pandemic, but these efforts will also require careful navigation of the complex mix of regulatory, operational, and technical difficulties. The situation is further complicated by dynamic changes in FDA regulations and fast-paced guidance at a rate that has not been seen in many decades. While regulatory consultants, clinical research coordinators, and researchers struggle to understand an often-changing regulatory landscape and stay on the right side of compliance, FDA is signaling that at least some of its modifications in response to the pandemic may become permanent. FDA needs to ensure it can continue to be responsive as this pandemic unfolds and that it remains prepared for future public health emergencies, should they arise.

As CSU multidisciplinary teams increasingly place their knowledge, experience, and innovative solutions in service of the broader community's needs, they will require more support in regulatory assistance, clinical research, and an expanded compliance system. The ultimate success of these initiatives at CSU will be measured in lives saved and our broader Colorado community's improved health and safety. ▮

[1] https://www.fda.gov/medical-devices/vitro-diagnostics/laboratory-developed-tests

[2] https://www.fda.gov/emergency-preparedness-and-response/mcm-legal-regulatory-and-policy-framework/emergency-use-authorization

CSU researchers rapidly developing treatments, drugs, and vaccines for COVID-19

by Mike Hooker, Mary Guiden, and Coleman Cornelius

Decades of experience fighting deadly viruses has researchers at Colorado State University uniquely positioned to lead in the fight against COVID-19. Colorado's leaders in Congress are working to build on the nation's ability to fully use CSU and other Colorado research institutions to slow the pandemic and save lives.

At CSU, there are more than 125 investigators engaged in more than 170 projects in the worldwide battle against the virus. The University's efforts to rapidly provide treatment for and protection from the coronavirus include studying convalescent plasma, repurposing of already approved antivirals and other U.S. Food and Drug Administration-approved drugs, and creation of vaccine candidates.

"It's amazing how prepared we were for this with our assets – both physical and intellectual – and how fast we've moved in providing the state, the nation, and the world a range of potential solutions and medical countermeasures to the virus that are near-term and far-term," said Alan Rudolph, CSU's vice president for research.

The University's efforts to create a vaccine against this novel coronavirus were recognized by U.S. Rep. Joe Neguse (D-Colorado) in comments made on the House floor March 27. He urged Congress to provide support for Colorado's research universities in the battle to slow the pandemic: "Will we step up … for the scientists at CSU and at NIH and everywhere in between working to develop a vaccine to the COVID-19 pandemic?"

U.S. Sen. Michael Bennet (D-Colorado) also visited CSU's Research Innovation Center in early March to learn more about the University's vaccine development efforts and expertise.

PROJECTS UNDERWAY

Among the more than 170 active COVID-19 research projects at CSU, some of the research areas include the following.

Convalescent plasma

Plasma from those who have recovered from COVID-19 can be used to treat those who have yet to get the disease or are early in their disease progression. The plasma contains neutralizing antibodies that can boost a person's immune system to fight the virus. A team of investigators including Ray Goodrich, CSU's executive director of the Infectious Disease Research Center and Heather Pidcoke, CSU's chief medical research officer, are collaborating on a project to study the efficacy and potential methods to improve the safety of this repurposed plasma treatment as part of planning for potential clinical trials.

"The antibodies in convalescent plasma are specifically made to find the virus and take it out. We are studying pathogen reduction methods that may lower the chance of accidentally giving someone COVID-19 or another infection without meaning to," Pidcoke said. "Ultimately, we want to protect health care workers and other high-risk people from getting sick if they are exposed to the virus that causes COVID-19."

Improved screening of drug combinations to speed regulatory approval

The FDA has already approved a number of individual drugs to treat patients showing symptoms of COVID-19, but use of those drugs in new combinations requires additional approval. CSU researchers have established the use of vero cells to screen "cocktails" of approved drugs to accelerate the approval process.

CSU researchers have initiated projects with at least six industry partners to quickly move these combination drug products toward FDA approval.

"A lot of industries are limited with how they can work with the virus," said Rushika Perera, an associate professor of virology who is leading the project to repurpose approved drugs for COVID-19 treatment. "They need to partner with CSU to do this research. We have the expertise, labs, and physical space."

Vaccine development

Vaccines can offer long-term protection from COVID-19, and CSU has four vaccine candidates in development.

SolaVAX repurposes a commercial platform that is currently used to inactivate pathogens in blood transfusions. The strategy uses light and riboflavin to produce an inactivated virus that stimulates a person's immune system to fight the virus.

"We are building off of nearly 20 years of experience of using this process to improve the safety of blood transfusion products. That prior knowledge and current experience helps to translate this rapidly into a way to manufacture vaccine products," said Goodrich.

Another vaccine project underway would use a genetically modified form of the common probiotic *Lactobacillus acidophilus* to avert infection by the novel coronavirus. The concept of this work, led by Gregg Dean, head of CSU's Department of Microbiology, Immunology, and Pathology, starts with a microorganism that thrives in the mucous membrane – exactly where the new coronavirus attacks the body. The vaccine would interrupt attachment of the virus to host cells at two key junctures, sites that amount to "the Achilles heel of the virus," Dean said.

"We're fortunate to have such a depth and breadth of expertise in infectious disease here at CSU," he said. "Investigators are working on vaccines, on antiviral therapies, on diagnostic strategies, and on how we can inactivate the virus on surfaces. We're trying to tackle this problem from every angle we can."

A third vaccine candidate is being developed by Dr. Amy MacNeill, a veterinary pathologist whose team is developing a poxvirus-based vaccine candidate that will express a protein from SARS-CoV-2. The vaccine is designed to stimulate the immune system to produce antibodies that bind SARS-CoV-2, preventing entry of the virus into host cells. Blocking entry of the virus will protect vaccinated people from the effects of COVID-19.

Professor Mary Jackson is working on the fourth vaccine candidate at the University. She is using the platform for the Bacillus Calmette-Guerin or BCG vaccine, which prevents tuberculosis, with the hope that it will stimulate an even greater and more specific immune response against COVID-19.

To coordinate the full range of CSU's research expertise mobilized against COVID-19, Rudolph says the University will scale up secure production of the virus and key reagents for research and manufacturing at the BioMARC biomanufacturing plant. The Biosafety Level 3 cGMP facility is already making products for other infectious diseases under sponsorship from the federal government, industry, and major foundations. This facility was established by the National Institutes of Health in 2006 for infectious disease outbreak research and response and was the recipient of the 2019 Colorado Manufacturers Award.

"CSU has unique assets to quickly move these agile repurposed strategies into development," Rudolph said. "We have already established animal models and human clinical development plans for each of these treatment options. We are currently partnering around the globe on these solutions and will have updates for each strategy in the days and months to come as this current pandemic unfolds." ▮

Vaccine Manufacturing in the 21st Century

by Mary Guiden

Izabela Ragan, a postdoctoral fellow in biomedical sciences, works in a training lab at CSU.

Ray Goodrich

A team of infectious disease researchers at Colorado State University has entered into an agreement with the Biomedical Advanced Research and Development Authority to further develop a novel virus inactivation process, successfully used for MERS, which has the potential to inactivate the SARS-CoV-2 virus.

BARDA is part of the Office of the Assistant Secretary for Preparedness and Response at the U.S. Department of Health and Human Services.

CSU will receive $699,994 from BARDA to support preclinical research on the vaccine technology process – known as SolaVAX – which repurposes a commercial platform that is currently used to inactivate pathogens in blood transfusions. The strategy uses UV light and riboflavin to produce an inactivated virus which stimulates a person's immune system to fight the virus.

The University will contribute $448,143 to support this project, bringing the total contribution for this phase of the research to $1.15 million.

This project will demonstrate the effectiveness of the SolaVAX process to inactivate SARS-CoV-2, which causes COVID-19 and could potentially advance vaccine manufacturing capabilities on a global basis.

"We are building off of nearly 20 years of experience of using this process to improve the safety of blood transfusion products," said Ray Goodrich, executive director of the Infectious Disease Research Center at CSU. "That prior knowledge and current experience helps to translate this rapidly into a way to manufacture vaccine products," he added.

PLATFORM INACTIVATES ANOTHER CORONAVIRUS

During this global pandemic, the ability to produce large quantities of vaccines in a cost-effective manner is critical. The SolaVAX platform has already been shown to inactivate MERS-CoV – another virus in the coronavirus family – very efficiently and has also been evaluated for production of other vaccine products.

As the research progresses, the team will scale up production of the virus and key reagents for research and manufacturing at the University's BioMARC biomanufacturing plant. The Biosafety Level 3 cGMP facility is already making products for other infectious diseases under sponsorship from the federal government, industry and major foundations; cGMP stands for Current Good Manufacturing Practices, as designated by the U.S. Food and Drug Administration.

The Infectious Disease Research Center is home to one of 14 labs across the country that are part of the Regional and National Biocontainment Laboratory network under the National Institute of Allergy and Infectious Diseases.

Alan Rudolph, CSU's vice president for research, said this new award to support the development for SolaVAX highlights the University's prominence in infectious disease research and the response to the COVID-19 pandemic.

"Our researchers have moved swiftly to provide the state, the nation, and the world a range of potential solutions and medical countermeasures to the virus," he said.

Rudolph expressed gratitude for the support from the state's congressional delegation for the University's application to BARDA.

"We sincerely appreciate the encouragement and recognition of our efforts from Colorado's congressional delegation and, in particular Sens. Michael Bennet and Cory Gardner, and their staffs." ▮

Working with pharmaceutical companies to screen for antiviral COVID-19 compounds

by Mary Guiden

Colorado State University researchers are testing hundreds of existing drugs, compounds, and chemicals to see if they might provide options to fight the virus that causes COVID-19. Some of these substances are approved by regulatory agencies to treat conditions including malaria, HIV, and hepatitis C and may be repurposed and used in clinical trials to treat people who have contracted COVID-19.

Rushika Perera, associate professor in the Department of Microbiology, Immunology, and Pathology, said that many companies are limited in their ability to test the coronavirus, SARS-CoV-2, because they lack the appropriate biosafety level facility. So, they've turned to CSU for help.

"A lot of industries are limited with how they can work with the virus," said Perera, who studies mosquito-borne viruses such as dengue, chikungunya, yellow fever, and Zika. "They need to partner with CSU to do this research. We have the expertise, labs, and physical space."

The Centers for Disease Control and Prevention recommends that scientists using the virus in research conduct these experiments in a Biosafety Level 3 laboratory. CSU has been designated as a regional biocontainment laboratory, one of 14 at universities across the country, to support biodefense and emerging infectious diseases research.

Perera swiftly pivoted from conducting her own research to establish a laboratory in the BSL-3 facility in March. She tapped two recent CSU graduates, Elena Lian and Gabriela Ramirez, to join her team and to help conduct the antiviral testing.

Lian and Ramirez had never worked on this type of project before and have very quickly acquired the capability to test candidate compounds against this virus, Perera said.

"Their commitment to research and learning is exemplary, especially the hours they are willing to work," she added. Perera said the team is working long days, seven days a week.

Requests for testing

Since the start of the pandemic, CSU has been inundated with requests for testing from companies and organizations in the United States and internationally.

Brian Geiss, associate professor in the Department of Microbiology, Immunology, and Pathology, and David Paterson, assistant vice president for research, translation, and commercialization, are handling logistics for the project, fielding inquiries from companies and establishing contracts.

"We will be providing companies with a report that says whether these compounds are effective against SARS-CoV-2, or whether they are not," said Perera. Some of these compounds are clinically approved to treat other viruses, while others might be at more preliminary stages in the regulatory approval process.

Due to nondisclosure agreements with these companies, CSU cannot identify them.

Karen Dobos, professor in the Department of Microbiology, Immunology, and Pathology, said that Perera's team will test disinfectant wipes created by members of CSU's Mycobacteria Research Laboratories.

Dobos, who also directs CSU's Research Integrity and Compliance Review Office, said scientists used ethanol, glycerol, and hydrogen peroxide to create the wipes and hand sanitizer, which both appear to be effective against SARS-CoV-2.

"We began to make wipes and disinfectant based on information from the Environmental Protection Agency," she said. "I kept waiting to see if these ingredients would be tested against SARS-CoV-2. To date, ethanol has been tested and reported as effective against the virus, but not hydrogen peroxide as a spray disinfectant. Fortunately for us, Rushika and her team will be able to conduct disinfectant testing."

Making a difference quickly

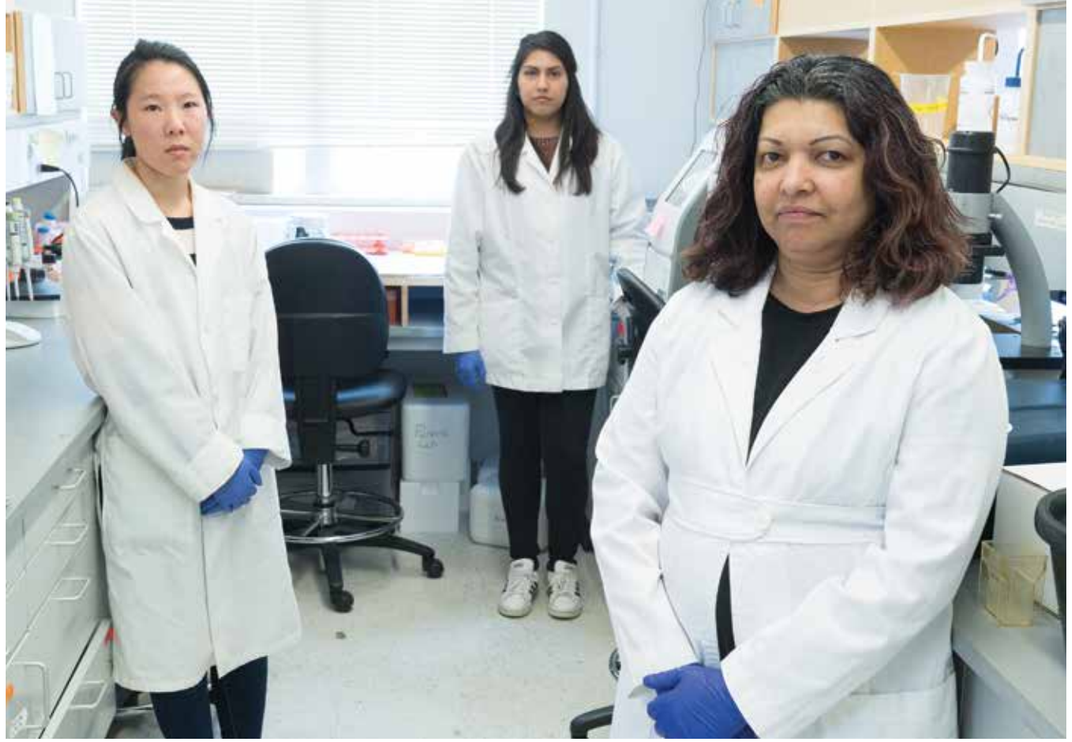
Perera said that while the last few months have been extremely stressful, she is also happy to lead this new research effort.

"I didn't realize it at first, but now I realize I have a unique opportunity to make a difference quickly," she said. "It feels amazing as a virologist; this is why I became a virologist – to be able to help others."

Mark Zabel, research associate dean and a professor in the CSU College of Veterinary Medicine and Biomedical Sciences, said Perera exemplifies the adaptability and drive of the University's infectious disease researchers to tackle big problems in a big hurry.

"Dr. Perera and other infectious disease researchers in our college are applying their collective knowledge, skills, innovation, and expertise to tackle some of the most important aspects of COVID-19," he said.

This research effort is supported with a startup award from the Office of the Vice President for Research and additional support from the Department of Microbiology, Immunology, and Pathology at CSU. The financial support has assisted Perera in obtaining basic equipment required for antiviral testing and a state-of-the-art Celigo imaging cytometer that will enable medium-throughput testing capacity.



Associate Professor Rushika Perera (right), leads a team that is testing drugs and chemicals to see if they might provide options to fight the virus that causes COVID-19. She is pictured with research assistants Elena Lian (left) and Gabriela Ramirez (middle), who also happen to be recent CSU graduates. *Photos: William A. Cotton/CSU Photography*

Perera said through this research effort, she and the team have the opportunity to make a difference, quickly.

Elena Lian and Gabriela Ramirez head into the BSL-3 lab facility at CSU. *Note: This photo was taken through several panes of glass.*

Perera is part of the Infectious Disease Research and Response Network, one of 21 Programs of Research and Scholarly Excellence at Colorado State University. The IDRRN brings together large research and service programs, and more than 60 faculty members from six departments to address local, national, and international needs for infectious disease control and prevention.

Award-winning investigator

Perera was recently chosen to receive the American Chemical Society's Infectious Diseases Young Investigator Award, which recognizes scientists who are making a significant contribution to explaining the underlying biochemistry and the use of biochemical approaches to develop interventions for infectious diseases. She is one of three researchers who will receive the distinction for 2020.

John Belisle, professor in the Department of Microbiology, Immunology, and Pathology, said the honor was "a significant and well-deserved award for one of our highly productive and talented faculty members." ▮

Woodward, CSU team

JOIN FORCES

on rapid-response ventilator project

by Allison Vitt

A natural gas fuel injector may not be a staple in the medical device industry, but for a team of engineers from Colorado State University and Fort Collins-based Woodward Inc., it proved to be a key component in the design of a low-cost, durable ventilator.

Back in early March, CSU and Woodward engaged in a joint effort to develop a ventilator that could be quickly manufactured and deployed if the state faced shortages. The project was a response to Colorado Gov. Jared Polis' Innovation Task Force charged with developing rapidly deployable solutions to address the impacts of COVID-19.

In statewide remarks May 1, Polis gave a shoutout to the Woodward-CSU team's efforts over the past several weeks.

"What a great example of Colorado innovation and ingenuity," Polis said.

The new ventilator project, now in clinical testing stages, recently received further external validation and support: a $100,000 prize from the U.S. Army.

The XTech COVID-19 Ventilator Challenge was launched on April 5 by the Army Acquisition Executive with the goal to solicit the innovation community's ideas for combating the COVID-19 pandemic. With a prize pool totaling $1 million, applicants were asked to deliver white papers and virtual pitches describing their ideas, and concepts were judged based on their alignment with mission requirements, technical viability, regulatory aspects, and speed to production and deployment.

LOOKING FOR ALTERNATIVES

Bryan Willson, executive director of CSU's Energy Institute, was tapped to join a ventilator subteam as part of the governor's task force back in March.

"We knew we had to look for alternatives to current supply chains, which were already being strained by the pandemic," Willson said.

Willson contacted Tom Gendron, president and CEO of Woodward – known for its expertise in the manufacture and design of control systems for the aerospace and industrial sectors – to propose an idea: Could their off-the-shelf fuel injectors be modified to regulate the flow of oxygen for a ventilator?

Could their off-the-shelf fuel injectors be modified to regulate the flow of oxygen for a ventilator?

Woodward engineers Chris Burenheide, Rohit Vaidya, and Dave Richards discuss the ventilator project.

"The Energy Institute has partnered with Woodward for years on different projects, and when I called Tom to suggest the idea of working together to build a ventilator, he was immediately on board," Willson said.

Woodward had never manufactured a medical device before, let alone a ventilator that would need to be designed and produced over the course of weeks, not months or years. What they did have were the people and the expertise to develop a ventilator solution with the same precision and rigorous design process that the company is known for, Willson said.

Gendron and Doug Salter, Woodward's vice president for corporate technology, recruited help from four of their business divisions to form a comprehensive team of engineers, programmers, designers, and systems experts. The team also enlisted help from Ann Batchelor, assistant director of CSU's Walter Scott, Jr. College of Engineering Department of Systems Engineering, and Dr. Heather Pidcoke, CSU's chief medical research officer and associate director of research for the C. Wayne McIlwraith Translational Medicine Institute at CSU.

"We wanted to move fast, but knew we had to make sure we stayed disciplined in our processes," said Salter. "We first decided that there were four things that we wanted: provide air to those in crisis; do no harm; ensure we're not contributing to the spread of the virus; and tackle this project with a disciplined sense of urgency."

The team worked around the clock, conducting extensive research on ventilator design and interviewing experts, including pulmonologists and respiratory therapists, to better understand ventilator functionality, use cases, and requirements.

Just four days later, the first prototype ventilator design was ready for testing.

The Aether 100 ventilator, developed through a collaboration between Woodward and CSU.

"We gathered a team at 8 a.m. at our technology lab in Windsor, Colorado," Salter said. "We laid out a bunch of components and pieces on the tables, and by 8 p.m. the team had a working ventilator in a box."

FINE-TUNING DESIGN

The ventilator – dubbed the Aether 100 – underwent several iterations aimed at fine-tuning the controls, design, oxygen delivery, and human-machine interface before the first two pilot units went into production in early May.

"We've put this project into one of our aerospace facilities, which means that we have very firm traceability of all the components that go into it, control over materials, and control of the process to make sure that it's assembled the same way every time," Salter said. "We intentionally put it into an aerospace division because we felt like the idea of having to breathe for a patient is like flying an airplane – it has to work correctly every time."

The pilot units were tested side by side with commercial ventilators at Saint Joseph Hospital in Denver, Salter said.

The team is also focused on ensuring the long-term durability of the product. The Army XTech Challenge required a solution that was rugged enough for a field hospital, while having a small footprint. Aether 100 accomplishes both without losing any of its core functionality, and it is also designed to be quickly and cost-effectively scaled to production if a critical need arises.

Salter said they plan to continue with additional clinical testing to ensure efficacy and safety. This work will be done in partnership with the Anschutz Medical Center, and partial support has been received to fund the clinical trials.

"This is a team [of individuals] who had never worked together before this," Salter said. "The CSU and Woodward interface has been spectacular, quite frankly. It never feels like we're two organizations trying to fit together; we're just one team trying to move this forward." ▮

Research team inks deal for COVID-19 viral-detection test

by Anne Manning

A small, inexpensive virus-detection technology invented by Colorado State University researchers will soon form the basis of a new product that could compete with standard diagnostic testing for COVID-19.

The new diagnostic device, which aims to be fast, portable, and more accurate than currently available COVID-19 tests, is one of several technologies spawned from a collaboration among CSU researchers Brian Geiss, Chuck Henry, and David Dandy. Combining their wide-ranging expertise in virology, chemistry, and chemical engineering, the team has licensed their viral RNA-testing platform to Quara Devices, a startup company specializing in diagnostic biosensors.

The licensing deal, mediated by CSU Ventures, was inked this summer and allows the company to move the invention into product engineering and design phases, while the CSU scientists continue testing the devices for efficacy and accuracy. The chief science officer of Quara is Ken Reardon, a professor in the CSU Department of Chemical and Biological Engineering.

Geiss, Henry, and Dandy have worked several years together developing low-cost biological diagnostic platforms for applications including viruses, bacteria, and antibodies. For the device they've licensed to Quara, their original goal was detecting organisms with antimicrobial resistance. As COVID-19 was becoming a pandemic, they found they could generalize their basic platform, which they began developing over a year ago, into a sensitive test for RNA viruses, including coronaviruses such as SARS-CoV-2.

CSU faculty Chuck Henry, Brian Geiss, and David Dandy.

Reardon, who joined Quara last year after consulting on a bacterial-detection technology for the company, approached his CSU colleagues about possibly extending their viral-detection strategy into a product that Quara could commercialize. During these negotiations, the COVID-19 pandemic worsened, which further spurred the group toward a deal that would allow them to enter the COVID-19 diagnostics market. Their technology is envisioned as a point-of-need genetic analyzer for viruses and bacteria, including but not limited to SARS-CoV-2, the virus that causes COVID-19.

"This technology predated the pandemic, but because of its versatility as a platform and the significant need for high accuracy in detecting COVID-19 in patients, we see an urgency to get it out now," Reardon said. "We are trying to get this into the market within the year, which is a pretty aggressive acceleration."

HOW IT WORKS

Henry, a professor in the Department of Chemistry, explained that the licensed technology is a paper-based, "lateral-flow" device reminiscent of a home pregnancy test. It recognizes a target sequence in the virus's genetic material, then amplifies that signal to display a positive readout – like the line on a pregnancy test.

The test serves the same purpose as the genetic analysis technique called quantitative polymerase chain reaction, which is the gold standard for diagnosing COVID-19 from saliva samples. PCR requires large, expensive laboratory instrumentation and a "chain reaction" of copying the viral genome sequence of interest using temperature cycles. The CSU test works at one temperature, and it includes an extra chemical step that improves the test's selectivity and accuracy. Because it combines all these elements in one handheld device, it doesn't require laboratory analysis, keeping the cost down.

"I am very much a believer that if you don't get a technology like this into someone's hands who can make and produce it, it's just an academic exercise," said Henry, who has been involved in several CSU research-based startup companies. "It was a big deal for us to move this into a product that will help people."

Beyond the genetic analyzer they've licensed, the team is continuing to develop other diagnostic tests with the same goals of accuracy, portability, and cost-effectiveness. For example, they are hard at work on a serological test that detects proteins, whether antibodies or antigens, that would compete with the industry standard "ELISA" tests used today.

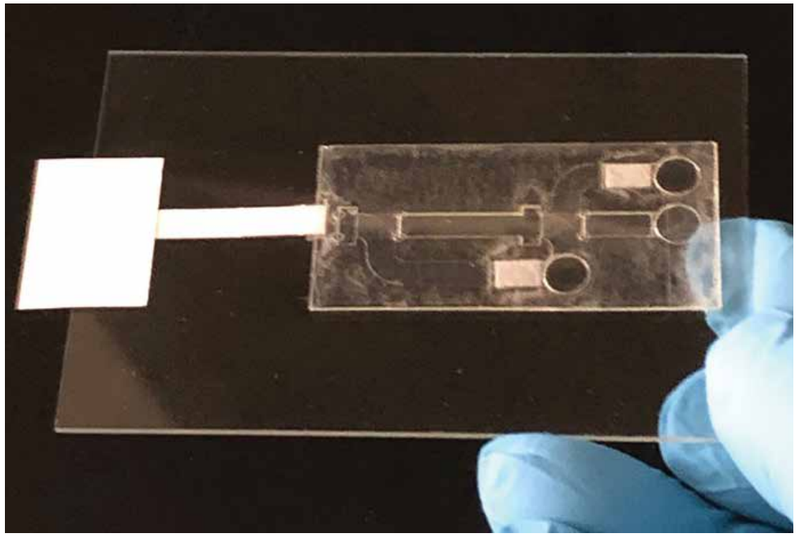
ACROSS DISCIPLINES

The research team first came together in 2015 under an Office of the Vice President for Research initiative called Catalyst for Innovative Partnerships that provided seed funding for cross-disciplinary work. CSU's vice president for research office has for several years made strategic investments in research relating to outbreak diagnostics, including for the team that invented the Quara device, as well as another team that develops molecular tags for in vivo imaging and editing.

Geiss is an associate professor in the Department of Microbiology, Immunology, and Pathology with biological expertise in how RNA viruses replicate. Henry, an analytical chemist, has broad experience in microfabrication of paper-based chemical tests, chromatography, and microfluidics. Dandy, a professor in the Department of Chemical and Biological Engineering, has expertise in transport mechanics, including the physics of how materials and fluids interact with sensor surfaces.

"All three of us work well together to cover all aspects of making biosensors and assay devices," Henry said.

Rod Reum, CEO of Quara Devices, said: "We are excited to work with the high-caliber cross-disciplinary CSU team, and for the great potential for this technology to be an accessible tool to quickly and accurately detect COVID-19 and other viruses." ▮



A prototype of the viral sensor CSU researchers have licensed to Quara Devices.

Perspectives from the School of Public Health

by Tracy Nelson

Tracy Nelson is the director of the Colorado School of Public Health at CSU. She has been involved with the Colorado School of Public Health since 2006. She has a background in biobehavioral health as well as cardiovascular epidemiology. Her research has focused on genetic and environmental risk factors and chronic disease outcomes; most recently, she has worked with communities to evaluate and improve interventions to decrease community-level chronic disease risk.

What's interesting about public health is when it's working efficiently you don't know it's there. We take for granted our clean water and air, that the food we eat, the parks our children play in, and our work environments are safe, and, importantly, that infectious diseases are controlled through vaccination programs, proper hygiene, and vector control. When a public health problem overwhelms the system like in the coronavirus pandemic, public health becomes front and center, and we realize the importance of this system built to protect ourselves and our communities.

The breadth of public health research on the CSU campus is vast and includes water, atmospheric sciences, climate, environmental epidemiology, occupational health, agriculture, food, nutrition, chronic disease, obesity, aging, cancer, and infectious diseases, to name a few. Given this wide array of public health work and our campus interest in interdisciplinary challenges that make an impact in our community, a public health research task force was convened in 2018 by the Office of the Vice President for Research to develop a strategic vision for CSU's collective efforts in public health research. The task force was charged with inventorying this work, as well as identifying strengths, opportunities, weakness, and threats so that recommendations could be made to address gaps and build on strengths.

The demand for those trained in public health will dramatically accelerate as a result of the COVID-19 pandemic.

This breadth of activity and the task force work on research priorities enhanced our ability to act in providing timely assistance to the county by CSU faculty and students at the outset of this pandemic. The Colorado School of Public Health and multiple CSU faculty have taken an important lead within the state to respond to the COVID-19 pandemic. There are more than 70 CSU faculty with appointments in the Colorado School of Public Health. These faculty represent 25 departments within seven of CSU's eight colleges.

One clear need in the response to the pandemic is assessment and analysis of the large amount of data that is generated. Dr. Jude Bayham, an assistant professor in the Department of Agricultural and Resource Economics and a public health faculty member, has been leading efforts at CSU in conducting analyses aimed at addressing the toll that long-term school closures may have on U.S. health care providers. This work is gaining international attention as school districts grapple with long-term school closures. Dr. Bayham also serves on Colorado Gov. Jared Polis' COVID-19 Public Health Task Force.

Other work at CSU that addresses this public health crisis includes the efforts by Dr. John Volckens, who runs the Center for Energy Development and Health and is a faculty member of CSU's school of public health. He leads a team that was tasked and supported by Gov. Polis to test medical protective gear, serving as the state's designated center for evaluating the safety and efficacy of such gear for hospital workers fighting the pandemic. Dr. Volckens is also co-leading an effort with Dr. Dan Goble, director of the School of Music, Theatre, and Dance, to determine how the performing arts can return safely. They are considering how far airborne particles and droplets are projected by those playing wind and brass instruments, as well as among singers, actors, and dancers. They hope to determine if steps can be taken to protect both performers and audience members from the risks of COVID-19.

Disease surveillance during the pandemic has been shown to be critically important for protecting communities from COVID-19. CSU faculty have been instrumental in executing high-impact health surveillance work in support of our most vulnerable aging population. Work being conducted by Dr. Greg Ebel, director of the Arthropod-borne and Infectious Disease Laboratory, and Dr. Nicole Ehrhart, director of the Columbine Health Systems Center for Healthy Aging, at the outset of the pandemic has shown the power of identifying and removing asymptomatic workers at senior and nursing care facilities who are carriers and could transmit the virus to this most vulnerable resident population. They have been so successful in identifying such individuals and helping to deter outbreaks among this population that they were recently authorized by Gov. Polis to continue this work on a much larger scale, considering more than 25 more facilities. We have extended these studies to more extensive testing of both the senior care facility participants and University employees.

The demand for those trained in public health will dramatically accelerate as a result of the COVID-19 pandemic. Colorado is fortunate to have the Colorado School of Public Health, a distinct institution that connects Colorado State University, the University of Colorado Anschutz Medical Campus, and the University of Northern Colorado. The ColoradoSPH will train the next generation of public health experts in epidemiology, statistical and health services research, health education, environmental health science, occupational health, health policy, health promotion, community health, and administration of public health programs. These are all key needs in a future of public health resilience to future infectious disease outbreaks.

As director of the Colorado School of Public Health at CSU, I could not be more proud of the work we are accomplishing, both as a school and a University to assist our local community and state during this public health crisis.

A student employee trained to facilitate COVID-19 tests waits to assist fellow students during Ram Welcome. *Photo: CSU Photography.*

Laboratory technician Sara Watson processes samples at Colorado State University's Veterinary Diagnostic Laboratories. *Photo: John Eisele/ CSU Photography*

Saving Lives:

Testing health care workers to minimize transmission of COVID-19

by Mary Guiden

A team of faculty at Colorado State University is leading an effort to help the most vulnerable people in our communities – residents in long-term care communities – during the coronavirus pandemic.

Earlier this year, Greg Ebel, professor in the Department of Microbiology, Immunology, and Pathology, tested samples from thousands of health care workers in Colorado to determine if workers without symptoms were silently carrying the virus.

At a press conference on April 29, Colorado Gov. Jared Polis announced a new partnership with the state and CSU to run almost 45,000 tests on nursing home workers. Polis described the project as a "big priority," with the aim to prevent additional COVID-19 outbreaks at those facilities. Since the project's inception, the team has been testing nursing facilities, which are prioritized by the state. The tests have identified dozens of individuals who tested positive for COVID-19, but had no symptoms.

Ebel is working on this project with Dr. Nicole Ehrhart, director of the Columbine Health Systems Center for Healthy Aging at CSU, and Dr. Kristy Pabilonia, director of clinical diagnostics for CSU's Veterinary Health System.

Ehrhart introduced the concept for the groundbreaking project during a conference call with Gov. Polis and state health care leaders, including Dr. Greg Gahm, a geriatrician and corporate medical director of Vivage, which owns a range of skilled nursing communities in Colorado and Missouri.

Following the call, he tracked down Ehrhart and asked, "How can we work together?"

The purpose of the project, Ehrhart explained, is to enact an early warning system in long-term care facilities that would allow them to temporarily remove asymptomatic but positive caregivers who contract SARS-CoV-2, the virus that causes COVID-19, from the workforce until they were no longer infectious. This would minimize the chance that these workers could unwittingly infect vulnerable residents.

"The scientific community is putting their heads down, working around the clock, and sharing data across cultural belief systems and across borders that are closed right now," Ehrhart said. "It's an incredible moment of humanity, and it's the greatest interdisciplinary scientific effort that's ever happened on Earth."

DISEASE SURVEILLANCE

The concept behind the research is a basic principle in disease surveillance, especially during a pandemic, said Ehrhart, a veterinarian and professor of surgical oncology at CSU.

"We don't know when people become infectious with SARS-CoV-2," she said. "It's possible that they could be infectious prior to the onset of symptoms. It's important that when there's an at-risk community, like seniors, that we think about how to minimize the potential for transmission."

Ehrhart said the team has been sequencing the virus genomes from these samples to learn more about how the virus is being spread. This will help researchers determine whether it's due to a common source within the facility or if it's being brought into the facility from the community.

Gahm said that there are numerous reasons why his organization wanted to know if asymptomatic workers test positive for COVID-19.

"It allows us to identify those people to say: 'you're positive, even though you've been wearing a mask and following other safety protocols,'" he said. "The Centers for Disease Control and Prevention and the health department is saying you need to go home at this time."

It's an incredible moment of humanity, and it's the greatest interdisciplinary scientific effort that's ever happened.

BRIDGING EXPERTISE

Once the diagnostic samples are collected at the nursing facilities, they are sent to the CSU Veterinary Diagnostic Laboratories. Dr. Bruce Smith and lab manager Tina Dihle at the CSU Health Network helped the diagnostic lab obtain the Clinical Laboratory Improvement Amendments certification to conduct SARS-CoV-2 testing on human samples.

The Veterinary Diagnostic Laboratories, a national leader in animal diagnostics, has begun analyzing up to 700 human COVID-19 tests daily, significantly increasing the lab's normal caseload, according to Pabilonia.

She said that the lab was already testing animal samples for a number of zoonotic pathogens, such as rabies virus and *Yersinia pestis*, the bacteria that causes plague. As part of the National Animal Health Laboratory Network, the lab runs molecular assays and Pabilonia said that the equipment typically used for animal testing is the same equipment that can be used for human testing.

To date, the lab has tested more than 30,000 samples and is staffed by 60 employees charged with entering data into a reporting system, testing the samples in a Biosafety Level 3 laboratory at CSU, and providing timely results. Test results are instantaneously shared with the Colorado Department of Public Health and Environment to assist with decision-making from state health officials.

"Real-time messaging is important to the overall public health response," said Pabilonia. "This way, public health officials can respond quickly to any positive results. Our team is working tirelessly to provide accurate and timely results to combat the global outbreak."

CSU Professor Greg Ebel, Dr. Nicole Ehrhart, director of the Columbine Health Systems Center for Healthy Aging at CSU, and Dr. Kristy Pabilonia, director of clinical diagnostics for the CSU Veterinary Health System, have teamed up on a new research project to minimize the chance that health care workers could unwittingly infect vulnerable residents in long-term care communities. *Photos: CSU Photography*

This research project was originally supported by startup funds through Ehrhart's work at the Columbine Health Systems Center for Healthy Aging at CSU and Ebel's lab. Additional support comes from the Office of the Vice President for Research at CSU, College of Health and Human Sciences, College of Natural Sciences, College of Veterinary Medicine and Biomedical Sciences, and Walter Scott, Jr. College of Engineering. The project is also funded by the state of Colorado.

Engineering lab transformed into testing site for COVID-19 medical protective gear

by Anne Manning

Researcher Christian L'Orange prepares a mask for testing. *Photos: Allison Vitt.*

Professor John Volckens' 2,000-square-foot lab on the campus of Colorado State University is normally a place for experiments on air quality, pollution sensors, and how breathable particles can trigger disease.

Over the last months, the lab has suspended most of its usual activities and transformed into the official testing site for respirators and surgical masks for distribution throughout the state of Colorado. These forms of personal protective equipment are critical for ensuring the safety of front-line medical workers who are battling COVID-19 every day.

On March 25, Gov. Jared Polis announced that CSU, and specifically the Center for Energy Development and Health which Volckens leads, is the state's designated center for evaluating the safety and efficacy of protective gear, mostly medical masks, that are made by different vendors and sources and are destined for Colorado hospital workers. CSU's role is to initiate and coordinate testing and provide recommendations to the state on distributing such equipment. Primarily, the CSU team is focused on N95 particulate respirators that offer certified protection from aerosols in the workplace.

The only federal lab that regularly performs this type of N95 testing is in Pennsylvania. The state of Colorado has now designated CSU as, essentially, an emergency substitute for standard federal testing, to be done in state for in-state needs.

SHORING UP SUPPLIES

The state estimates between 60,000 and 100,000 disposable masks and other protective items, per day, will be needed for Colorado health care workers in coming months. In an effort to stave off shortages, the state has kicked into high gear to stockpile supplies, and CSU is at the forefront of making sure the masks in particular will work to specifications.

"Our lab has the facilities and engineering expertise to perform those tests," said Volckens, a professor in mechanical engineering and environmental and occupational health. "We can essentially mimic the stringent requirements put forth in the federal protocol."

WHAT IS AN N95 RESPIRATOR?

To be designated an N95 respirator, a mask must pass a specific federal safety inspection that includes 95 percent or greater filtration efficiency for particles that would normally be inhaled. Meant to form an airtight seal over the wearer's face, these respirators must offer a high level of breathability so that they can be worn continually across a work shift. They are indicated for use when treating patients with diseases that could be transmitted by aerosolized particles, including COVID-19, which is believed to spread through both large airborne droplets and smaller, breathable particles.

Volckens and his team have toiled furiously since March to run mask tests, as shipments come in from various vendors. For any given type of mask, it can take several hours to complete a test.

N95 TEST STEPS

The N95 inspection involves a number of steps, said Christian L'Orange, a CSU professor of research practice who is performing most of the tests. First, the mask is conditioned at a set temperature and relative humidity, then sealed down to a fixture. The mask is then placed in an environmental aerosol chamber, where particles are drawn through it. Sophisticated equipment is used to count the number of particles upstream and downstream of the mask, as a measure of its efficiency. The researchers must also perform a breathability test, because the mask's safety is tied to how easily the wearer can breathe through it.

"It's not just about how well it filters," L'Orange said. "A mask with too much of a pressure drop actually puts too much burden on the person breathing through it, which can be downright dangerous."

The N95 tests simulate real working conditions with high dust loadings, which can include viral particles. The researchers are following National Institute for Occupational Safety and Health protocols for N95 masks, which are used in many trades and occupations – not just health care.

"It's a worst-case scenario test," Volckens said.

The testing looks at particle penetration only, not fluid spills or splatters, Volckens added. To test each lot of masks that comes in, the researchers will take a statistically valid sample and require that every mask in that sample pass quality standards, adhering identically to those published by NIOSH.

In the lab, L'Orange is leading overall procedure design, and lab manager John Mehaffy is prepping masks for testing. Postdoctoral researcher Jessica Tryner is performing data analysis so that results can be immediately processed and shared with the state. The team operates from different locations in order to limit personal contact and further protect their health.

"We don't know how long this need will go on, but we will continue to serve the state until they tell us we're in good shape and we can stop," Volckens said.

Christian L'Orange seals a mask to a frame with beeswax to prepare it for testing.

During testing, researchers monitor values of particle filtration efficiency for each mask.

Rushika Perera, Sue VandeWoude, and COVID-19 research awards from Boettcher Foundation

by Curtis Esquibel at Boettcher Foundation

Two research teams from Colorado State University have received grants from Boettcher Foundation to fight COVID-19 and potential future pandemics. The foundation revealed the names of six grantees awarded a total of just under $1 million in biomedical research funding on May 15.

More than 120 grant applications were submitted for the foundation's COVID Biomedical Research Innovation Fund. The awards average $165,000 per team.

The award recipients from CSU include:

- Associate Professor Rushika Perera, who is leading a team that is testing hundreds of existing drugs, compounds, and chemicals to see if they might provide options to fight the virus that causes COVID-19. Brian Geiss, associate professor in the Department of Microbiology, Immunology, and Pathology, and David Paterson, assistant vice president for research, translation, and commercialization, are handling logistics for the project, fielding inquiries from companies and establishing contracts.
- Dr. Sue VandeWoude, University Distinguished Professor, who is launching a pilot study to develop a COVID-19 surveillance testing approach that can be modified for different types of workers. The overall aim is to minimize the local risk of continued intermittent outbreaks among vulnerable populations while pursuing a return to normal workforce productivity and function. Dr. Nicole Ehrhart, director of the Columbine Health Systems Center for Healthy Aging at CSU, is a co-investigator on this project.

"As a group, the six projects are innovative in how they are researching multiple facets of COVID-19 and its impacts on Coloradans," said Boettcher Foundation President and CEO Katie Kramer in a news release. "We are proud to support these efforts at a time when biomedical research is a public health priority for response, treatment, and future pandemic prevention."

Rick Miranda, then-provost and executive vice president at CSU, said that Perera and VandeWoude exemplify how the University's scientists have stepped up in recent months to help find solutions to this global pandemic we're experiencing.

"I'm incredibly proud of the work that they're doing, along with other investigators at CSU and recent alumni on their teams," he said.

OTHER PROPOSALS FUNDED

Additional researchers in Colorado who submitted winning proposals include:

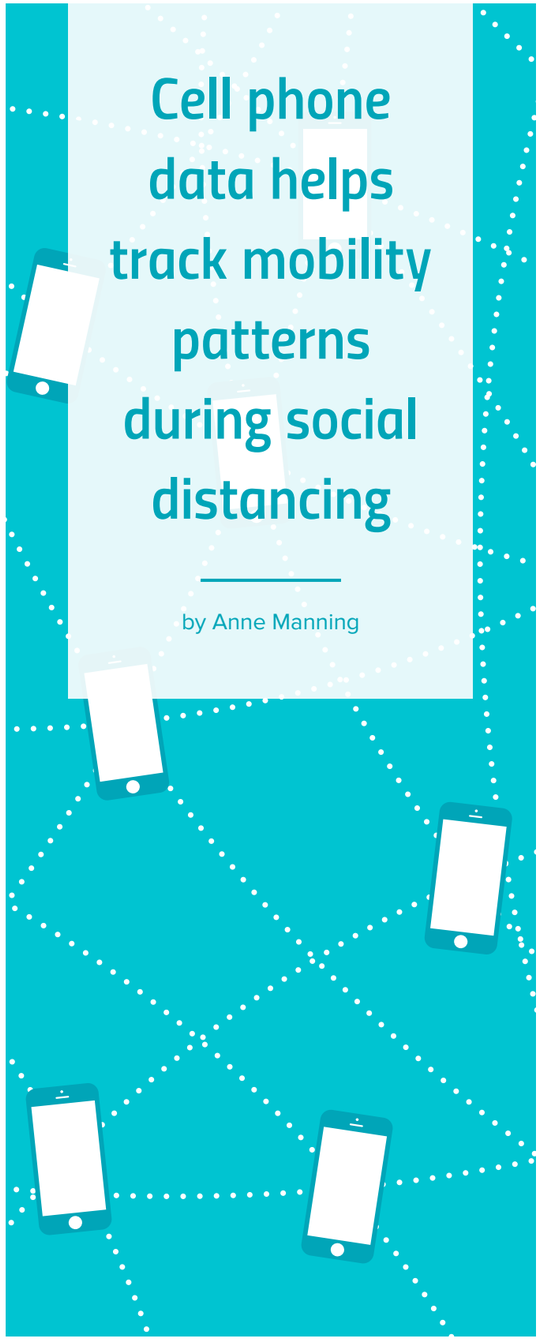
- Dr. James Crapo, National Jewish Health and BioMimetix
- Dr. Elena Hsieh, University of Colorado Anschutz Medical Campus and Children's Hospital Colorado
- Dr. Kara Mould, National Jewish Health
- Theodore Randolph, University of Colorado Boulder and VitriVax

Boettcher Foundation has supported biomedical research in Colorado since the 1940s. Since 2008, the investments have included more than $15 million in research grants through the foundation's Webb-Waring Biomedical Research Awards. The awards have supported 68 Boettcher Investigators to establish their bioscience and biomedical research – several at Colorado State – encouraging Colorado's top scientific minds to remain in state.

"Colorado has long been home to incredible innovation, so it's no surprise that we're seeing an effort like this to support research around our state that could help us address this pandemic," said Gov. Jared Polis.

Cell phone data helps track mobility patterns during social distancing

by Anne Manning



A recent modeling report released by Colorado public health scientists estimated just how much Coloradans have changed their behaviors since the start of the pandemic – and how those behaviors may now be shifting with the state's Safer at Home orders.

The report, led by CSU researcher Jude Bayham, focuses on "mobility patterns" – broad patterns of how Coloradans move from place to place – using the devices nearly everyone carries with them nearly all the time: cell phones.

Jude Bayham

The Colorado School of Public Health assembled the expert research group, which includes modeling scientists at ColoradoSPH and the University of Colorado School of Medicine at the CU Anschutz Medical Campus, as well as experts from the University of Colorado Boulder, University of Colorado Denver, and Colorado State University.

"On March 25, in the face of a global pandemic, Colorado Gov. Jared Polis ordered the state's residents to stay home as much as possible to mitigate COVID-19's spread," said Jonathan Samet, dean and professor for the ColoradoSPH and head of the modeling group. "Some restrictions were eased on April 26, and by and large, the majority of Coloradans have heeded the message."

Tracking reduced social contact

The "Colorado Model" team has been collaborating with the Colorado Department of Public Health and Environment since March to track the spread of COVID-19 throughout Colorado and assess how to control it. The team provides state officials with timely reports and projections that both inform policies, such as mandatory social distancing, and assess how the disease may continue to spread under different scenarios. In an epidemiological modeling report issued in April, the team estimated that state residents effectively reduced social contact by about 75 to 80 percent since being told to stay home.

The new mobility report supports that finding, using heavily aggregated, anonymized data from two companies to create estimates of Coloradans' mobility patterns, broken down by regions, municipalities, and counties.

"We are essentially devising metrics by which we can track trends in mobility over time, and ultimately, we are trying to link those trends back to disease transmission and social distancing parameters," said Bayham, an assistant professor in the CSU Department of Agricultural and Resource Economics who specializes in pandemic modeling and is a member of the CSU Task Force on Colorado Food Supply. "We are keeping a careful eye on case rates and hospitalization data in an effort to stay ahead of mobility patterns that may lead to greater transmission."

Data privacy and opt-in

The researchers note that the mobility data comes to them in an aggregated format, allowing them to see patterns without identifying individual users. The users from whom the data are obtained have opted-in by leaving their location services turned on; if such settings on phones are toggled off, those devices are not included in the data. The data are not being used for contact tracing, identifying who is infected, and where they are going.

"It would be very hard to try and figure out who individuals are, and that is not our intention," Bayham said. "We are trying to understand general patterns."

The report shows that people have clearly responded to the requests for distancing, spending more time at home and less time in public places throughout March and April. But behaviors varied across the state, with rural counties social distancing less than urban areas.

The researchers saw declining activity in Denver, Silverthorne, and Steamboat Springs throughout March. Overall activity in Durango, by contrast, did not seem to decline until well into March. The decline in activity was also relatively slower in Fort Collins.

The modeling team was able to show trends in time spent at home across 64 Colorado counties since Jan. 1, 2020, and time varied significantly across counties. The data now also show those behaviors shifting. While time spent at home had been increasing since the start of the pandemic in early March – likely encouraged by closures and stay-at-home orders – the trend appeared to change in mid-April.

A decline of time at home "does not necessarily imply that time is spent in locations of increased transmission risk," the researchers note in the report. The warmer weather likely prompted people to take walks in their neighborhoods or visit recreation sites, they say.

Demographic and socioeconomic differences

The team also showed demographic differences within mobility patterns. They did so by using statistical models to associate census block group data with anonymized cell phone data; they did not access demographic data from individual devices.

While people of all ages spent more time at home throughout March, younger populations spent less time there relative to older populations.

The researchers note that age patterns might simply be correlated with other factors that influence the ability to stay home. For example, people under 30 may be more likely to work in essential industries and not have the flexibility to stay home.

Areas with higher proportions of household incomes of less than $25,000 appeared to be away from home more, whereas households with incomes between $50,000 and $100,000 allocated relatively more time at home. These trends reflect the likelihood that higher-income households have more flexibility to work at home, and lower-income households are more likely to be employed in essential industries and are also experiencing higher rates of job loss.

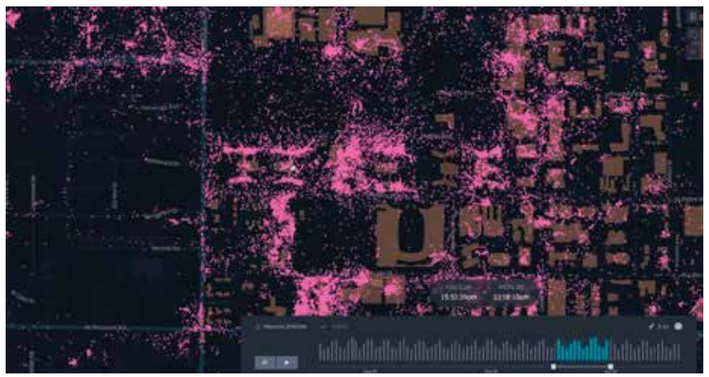
The report also includes observations of visitation rates to grocery stores, restaurants, public parks, museums, and other sites.

Ongoing updates

The team plans to regularly update the estimates in the report.

"We want to be certain not to overshoot and relax social distancing too much, so we'll continue to monitor these mobility patterns and include them in our epidemiological modeling efforts," said Jimi Adams, co-author of the report and associate professor of health and behavioral sciences at CU Denver.

"The mobility data provides us a potential window by which we might be able to monitor and anticipate social distancing patterns and their effects on the spread of the pandemic," added co-author Debashis Ghosh, professor and chair of biostatistics and informatics in the Colorado School of Public Health at CU Anschutz.



Pink dots represent mobile device geolocated signals (pings) provided by Xmode for a week in early September. The brown polygons are buildings on CSU's campus. The visualization was made in kepler.gl.

ENTER, STAGE LEFT:

CSU study looks at how the performing arts can return in a healthy manner during COVID-19 pandemic

by Tony Phifer

How far apart should the trumpet section be from the trombone section at my first band rehearsal during COVID-19?

How many singers can rehearse together or perform on my school's stage?

Can dancers resume their rehearsals and performances? Can actors rehearse and perform scenes with other actors? Should I cancel my group's performance schedule?

These are questions that are on the minds of thousands of band leaders, choir directors, acting coaches, dance instructors, performers, and countless others connected to the performing arts. And a unique team at Colorado State University is searching for those answers.

"Colorado State is a Tier 1 research institution, and we also have a highly regarded performing arts school. It makes sense that a scientific study be launched here because we have the people and facilities to do it well."

— Dan Goble

Led by John Volckens, a professor of mechanical engineering in the Walter Scott, Jr. College of Engineering, and Dan Goble, director of the School of Music, Theatre, and Dance, the team is launching a study – Reducing Bioaerosol Emissions and Exposures in the Performing Arts: A Scientific Roadmap for a Safer Return from COVID-19.

Researchers will aim to determine how far airborne particles and droplets are projected by those playing wind and brass instruments, singers, actors, and dancers, and whether steps can be taken to protect both performers and audience members from the risks of co-exposure to COVID-19.

Interdisciplinary approach

The team, which includes Rebecca Phillips, CSU's director of bands in the College of Liberal Arts; Charles Henry, chemistry professor in the College of Natural Sciences; and Dr. Heather Pidcoke, the University's chief medical research officer, began collecting and analyzing data in July. The multidisciplinary team also includes experts in environmental health, Kristen Fedak and Nick Good, from the College of Veterinary Medicine and Biomedical Sciences, and engineers Christian L'Orange, John Mehaffy, and Jacob Fontenot. They hope to be able to recommend best practices for those in the performing arts in a timely manner.

"What we know is this issue is being looked at by a lot of people around the world, but there appears to be very little actual scientific study going on," Goble said. "Colorado State is a Tier 1 research institution, and we also have a highly regarded performing arts school. It makes sense that a scientific study be launched here because we have the people and facilities to do it well."

Goble said he has been getting questions from school music teachers around the country. Those same questions have been keeping him up at night as he tries to navigate the uncharted waters created by the pandemic.

"Over the centuries, performers have always found a way to adapt, to keep their art forms viable, even in the worst of times," he said. "This is different. COVID-19 has not only shut down school programs, it has halted groups such as the Larimer Chorale and the Colorado Symphony. The Metropolitan Opera had to shut down until at least 2021, and Broadway has gone dark. Everyone is looking for a path forward.

"This really was one of those 'why not us?' moments," Goble continued. "This is something we can and should do."

Measuring aerosol emissions

The key scientific piece of the project is a human exposure facility, built by a team of mechanical engineering undergraduate students as part of their senior capstone project. This unique facility, at CSU's Powerhouse Energy Campus, can be used to measure human aerosol emissions and exposures in a clean, versatile environment. Only a handful of the chambers exist, and Volckens and his team use a custom-built computer control and data acquisition system to track human release of aerosols of varying size, concentration, and chemical composition.

"This is a great example of what a top research university can do, and a great example of colleagues from across campus working together to solve a challenging and serious problem."

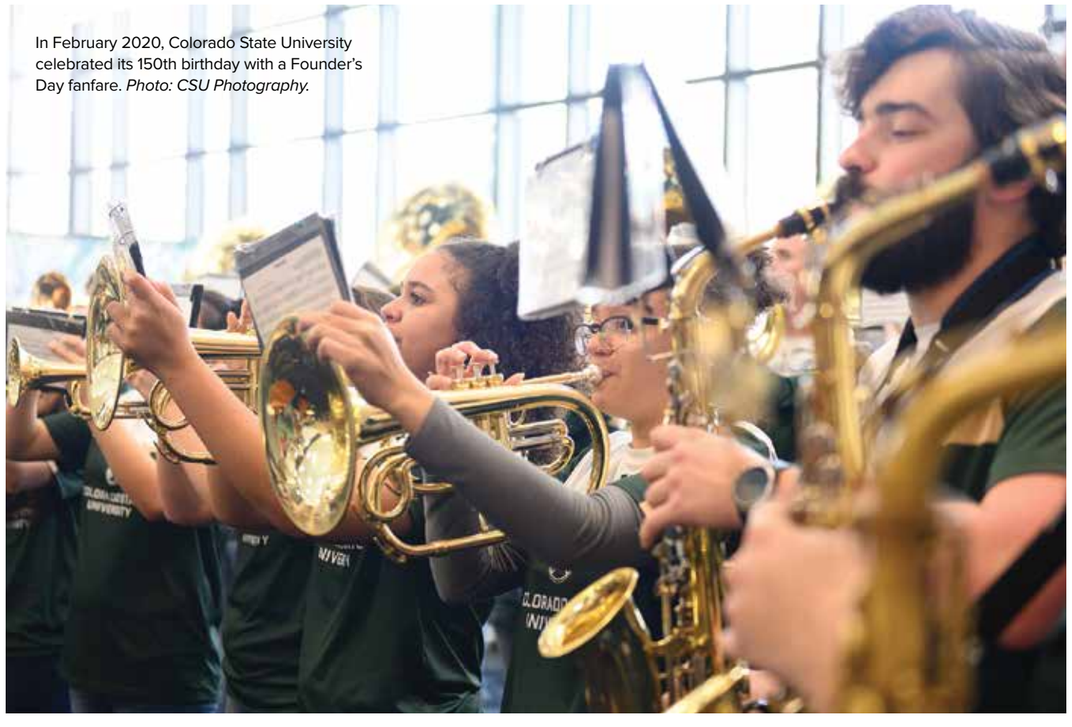
— John Volckens

Volckens hopes to recruit up to 100 volunteers to participate in the study. Each participant will do some singing, and he is seeking brass and woodwind multi-instrumentalists. Subjects will wear a variety of face coverings, including cloth and N95 masks, to determine best practices for singers, actors, and dancers. "This is a great example of what a top research university can do, and a great example of colleagues from across campus working together to solve a challenging and serious problem," Volckens said. "Our goal is to develop actionable information that allows people in the performing arts to get back to what they love to do."

Goble said similar studies have been launched at the University of Colorado and the University of Maryland.

"John (Volckens) is well connected with the researchers at CU, so our research will be collaborative," he said. "The bottom line is that the more people who are working on this, the better. The quicker we can come to some conclusions, the better. It will take some time to reach conclusions, and this is something we want to get right. There are a lot of people depending on us." ▮

To learn more about the study and how to lend your support, visit smtd.colostate.edu/reducing-bioaerosol-emissions-and-exposures-in-the-performing-arts.



In February 2020, Colorado State University celebrated its 150th birthday with a Founder's Day fanfare. *Photo: CSU Photography.*

VICE PRESIDENT
FOR RESEARCH
COLORADO STATE UNIVERSITY

203 Administration Building
2001 Campus Delivery
Fort Collins, Colorado 80523-2001

NONPROFIT
ORGANIZATION
U.S. POSTAGE
PAID
Fort Collins, Colorado 80523
Permit Number 19

Learn how to support our mission at **advancing.colostate.edu/RESEARCH**

VICE PRESIDENT
FOR RESEARCH
COLORADO STATE UNIVERSITY